IMPROVING FIXATION TECHNIQUES OF PROXIMAL HUMERUS FRACTURES BY MEANS OF FINITE ELEMENT ANALYSIS

By Dominic Mischler (AO Research Institute Davos, Switzerland) Jana Felicitas Schader (AO Research Institute Davos, Switzerland) Markus Windolf (AO Research Institute Davos, Switzerland)

Abstract Id: 7678
Event: EORS 2019
Topic: Biomechanics

Introduction

To date, the fixation of proximal humeral fractures with angular stable locking plates is still insufficient with mechanical failure rates of 18% to 35% [1, 2]. The PHILOS plate (DePuy Synthes, Switzerland) is one of the most used implants. However, this plate has not been demonstrated to be optimal; the closely symmetric plate design and the largely heterogeneous bone mineral density (BMD) distribution of the humeral head [3] suggest that the primary implant stability may be improved by optimizing the screw orientations. Finite element (FE) analysis allows testing of various implant configurations repeatedly to find the optimal design [4]. The aim of this study was to evaluate whether computational optimization of the orientation of the PHILOS plate locking screws using a validated FE methodology [5] can improve the predicted primary implant stability.

Goal

The FE models of nineteen low-density (humeral head BMD range: 73.5 – 139.5 mg/cm3) left proximal humeri of 10 male and 9 female elderly donors (mean ± SD age: 83 ± 8.8 years) were created from high-resolution peripheral computer tomography images (XtremeCT, Scanco Medical, Switzerland), using a previously developed and validated computational osteosynthesis framework [4, 5]. To simulate an unstable mal-reduced 3-part fracture (AO/OTA 11-B3.2), the samples were virtually osteotomized and fixed with the PHILOS plate, using six proximal screws (rows A, B and E) according to the surgical guide (Fig 1). Three physiological loading modes with forces taken from musculoskeletal models (AnyBody, AnyBody Technology A/S, Denmark) were applied. The FE analyses were performed with Abaqus/Standard (Simulia, USA). The average principal compressive strain was evaluated in cylindrical bone regions around the screw tips; since this parameter was shown to be correlated with the experimental number of cycles to screw cut-out failure (R2 = 0.90) [4]. In a parametric analysis, the orientation of each of the six proximal screws was varied by steps of 5° in a 5x5 grid, while keeping the screw head positions constant (Fig 2). Unfeasible configurations were discarded. 5280 simulations were performed by repeating the procedure for each sample and loading case. The best screw configuration was defined as the
one achieving the largest overall reduction in peri-screw bone strain in comparison with the PHILOS plate.

Method

Results

With the final optimized configuration, the angle of each screw could be improved, exhibiting significantly smaller average bone strain around the screw tips (range of reduction: 0.4% – 38.3%, mean ± SD: 18.49% ± 9.56%, p

Conclusions and recommendations


A novel 3-dimensional in vitro model for osteomyelitis associated staphylococcal abscess communities

By Marloes I. Hofstee (AO Research Institute Davos)Martijn Riool ()Keith Thompson ()

Abstract Id: 7675
Event: EORS 2019
Topic: Infection

Introduction

Staphylococcus aureus is the main cause of osteomyelitis and forms biofilm and staphylococcal abscess communities (SACs) in humans. While S. aureus has several toxins with specificity for human targets and working with human host cells would be preferred, for SACs no in vitro models, two-dimensional (2D) or three-dimensional (3D), have been described in literature to date. Advanced 3D in vitro cell culture models enable the incorporation of human cells and resemble in vivo tissue more closely than conventional 2D cell culture. Therefore, the aim of this study was to develop an in vitro model of SACs by using a 3D system. The model should allow for studies into antibiotic tolerance and S. aureus - human host cells interactions.

Goal
With a clinical isolate (S. aureus JAR) or a lab strain (S. aureus ATCC 49230-GFP), SACs were grown in a collagen gel (1.78 mg/ml, Gibco) supplemented with 200 µl human plasma at 37 °C. Transmission and scanning electron microscopy was used to obtain a detailed overview of SACs, whereas immunofluorescent stainings were done to determine whether the pseudocapsule around SACs consist of fibrin. Antibiotic tolerance of SACs was assessed with 100x the minimal inhibitory concentration (MIC) of gentamicin (Roth). Bacterial clearance of non-establised SACs and established SACs with or without pseudcapsule was determined by exposure to differentiated PLB neutrophil-like cells (differentiation with 1.25% DMSO and 5% FBS for 5 days; dPLB) or primary neutrophils isolated with lymphoprep from fresh heparin blood. Degradation of the pseudocapsule was done with 7.5 µl/ml plasmin (Sigma). Colony forming unit (CFU) counts were performed as quantification method. Statistical analysis was performed with the ANOVA multiple comparison test or, when data was not normally distributed, with a Mann-Whitney U test.

Method

Results

We have developed a 3D in vitro model of SACs which after overnight growth were on average 200 micrometers in diameter, consisted of 8 log10 CFUs and were surrounded by an inner and outer fibrin pseudocapsule. The in vitro grown SACs tolerated 100x the MIC of gentamicin for 24h and did not significantly differ from control SACs (p=0.1000). dPLB neutrophil-like cells or primary neutrophils did not clear established in vitro SACs (p=0.1102 and p=0.8767, respectively). When the fibrin pseudocapsule was degraded by the enzyme plasmin, dPLB neutrophil-like cells or primary neutrophils caused for a significant decrease in total CFU compared the SACs that did had a pseudocapsule (p=0.0333 and p=0.0272, respectively).

Conclusions and recommendations

The in vitro SACs model offers a tool for host-pathogen interaction and drug efficacy assessments and is a valuable starting point for future research.

Insulin Resistance and Diabetic Tendinopathy

By Sik-Loo Tan (Tissue Engineering Group (TEG), NOCERAL, Department of Orthopaedic Surgery, University of Malaya, 50603 Kuala Lumpur, MALAYSIA) Hui-Yee Tan (Tissue Engineering Group (TEG), NOCERAL, Department of Orthopaedic Surgery, University of Malaya, 50603 Kuala Lumpur, MALAYSIA) Kian-Hua Yeoh (Tissue Engineering Group (TEG), NOCERAL, Department of Orthopaedic Surgery, University of Malaya, 50603 Kuala Lumpur, MALAYSIA)
**Introduction**

Type 2 diabetes (T2D) is one of the most common diseases throughout the world, with around 350 million cases in 2014 (International Diabetes Federation 2014). This number is predicted to increase dramatically in the coming years, as a consequence of unhealthy life-styles, increasing obesity and extended life spans. Disability as a result of poor glucose control, cardiovascular disease, renal disease, blindness, neuropathy leading to amputations and Alzheimer’s disease will resulting in health system and economic challenges. Tendinopathies are part of this spectrum of disabilities and AGEs have been reported contribute at least partly to many chronic stress conditions in diabetes. Previous study has shown that metformin inhibits AGEs-induced apoptosis and inflammatory and fibrotic reaction in renal tubular cells (Ishibashi et al. 2012) and osteoblastic cells (Schurman et al. 2008), the effect of metformin in tendon cells remains to be elucidated. The aims of this study were to determine the effect of T2D on tenocytes in tendon tissues and the effect of insulin resistance on tenocytes anabolic and catabolic gene expressions.

**Goal**

The ethical approval was granted by the University Malaya Medical Centre (UMMC) Ethic committee (ethics approval reference number: 20157-1486 and 20164-2398) for normal and diabetic tendon tissues procurement. Diabetic Achilles tendons (AT) were collected from the patients who required a major lower limb amputation in UMMC and deceased donors of the Silent Mentor Programme (SMP), either with or without chronic T2D condition. Informed consent was obtained from each donor (or from their relatives for the SMP donors). The clinical samples collected were used for atomic force microscopy (AFM) imaging and gene expression. In the in vitro study, the primary human tenocytes (hTeno) derived from the remnant of human hamstring tendon, were induced with tumor necrosis factor-alpha (TNF-α) to develop IR condition. At 24 hours, the NBDG assay, total collagen assay, Annexin V apoptosis assay and gene expression analysis were performed. The hTeno without TNF-α or insulin supplement were used as the basal control group. Statistical analysis was performed to assess the statistical significance (p

**Method**

**Results**

AFM imaging showed an increase in the collagen fibril diameters and Young’s modulus in the T2D AT. The tenogenic marker genes (i.e. COL-I, SCX, and TNMD) mRNA expressions levels were significantly down-regulated in the T2D AT. In the in vitro IR experiments, the glucose uptake levels and total collagen expression levels were significantly reduced in the IR group compared to the basal control group. Annexin V apoptosis assay showed an increased in the early and late apoptotic cells in the IR hTeno group. The mRNA gene expressions levels of candidate tenogenic markers (eg. SCX and COL I) were significantly down-regulated in IR group. The apoptosis effector gene, BAK was not detectable by gene expression analysis in any of the samples (AT tendon tissue or in vitro IR hTeno cells), but the BCL2 was significantly up-regulated in both T2D AT and the IR hTeno group.

**Conclusions and recommendations**

In conclusion, IR affects the AT tendon ultrastructure and candidate tenogenic markers genes expression levels. In in vitro, IR down-regulates glucose uptake and total collagen expression
levels in the tenocytes (hTeno), and increase apoptotic cells in IR hTeno. These findings will underpin an understanding of the effects of IR related tendon degeneration in T2D and support development of focused therapeutic approaches.

The Role of circFOXP1-RNA in the Osteo-regenerative Properties of Mesenchymal Stem Cells

By Murtadhah M. K. Jalal (Orthopaedics and Trauma Surgery, The University of Edinburgh) A. Hamish SIMPSON (Orthopaedics and Trauma Surgery, The University of Edinburgh) Robert Wallace (Orthopaedics and Trauma Surgery, The University of Edinburgh)

Abstract Id: 7601
Event: EORS 2019
Topic: MSC's

Introduction

There is increasing interest in applying mesenchymal stem cells (MSCs) in orthopaedics due to their osteo-regenerative properties. These multipotent cells are available in different human tissues and are most commonly harvested from bone marrow. However, the underlying mode of action is not clear yet, particularly the mechanism by which xenogeneic MSCs induce fracture healing in atrophic non-union. A large number of studies investigated the molecular basis of MSCs differentiation, most recently the study by Cherubini et al who have reported that circFOXP1 is the gatekeeper responsible for keeping the undifferentiated identity of these cells (Cherubini et al., 2019). We compared, in vivo, the osteo-regenerative effect of silenced circFOXP1-RNA MSCs with that of ordinary MSCs.

Goal

All surgical procedures were approved by the UK Home Office and Local Research Ethics Committee. We used our clinically relevant model of atrophic non-union. Tibiae were osteotomised at the mid-shaft, periosteum and endosteum were stripped to a distance equal to one bone diameter proximal and distal to the fracture site. Fracture was then fixed by IM nail; a 1 mm non-critical gap was maintained using a spacer. Twelve adult male Wistar rats were randomly divided into two groups: in group 1, silenced circFOXP1-RNA hBM-MSCs were injected locally into the fracture (n=6). Ordinary hBM-MSCs were used as controls, (group 2, n=6). All silenced cells were imported from our collaborative group in Milan, Italy, Dr Lorenza Lazzari’s group (Cherubini et al., 2019). Fracture status was evaluated by serial x-rays and the diagnosis was made by two orthopaedic surgeons. A further assessment, at the end of experiment, was done by micro CT scan, biomechanical testing, and histology.

Method

Results
Clinical diagnosis showed that five out of six tibiae healed to union in the control group, whereas only two fractures out of six proceeded to union in group 1, one of them revealed sub-optimal healing. The number of union in the control group was higher, however no statistical difference was noticed, $P=0.242$ (Fisher’s exact test). This was confirmed by micro CT analysis and histological evaluation, callus formation and new bone bridging were noticed at the fracture gap in tibiae with union, whereas no bonny bridging was detected in the non-union tibiae with fibrous tissue filling the gap at fracture ends.

Conclusions and recommendations

It is postulated that these genetically modified xenogeneic cells lost their MSCs characteristics and immune-modulatory properties. Thus they were exposed to the host immune system and rapidly killed losing their ability to stimulate the healing process. In contrast, the ordinary MSCs persisted long enough to stimulate fracture healing.

Study of osteoarthritis (OA) development and prediction of potential intervention targets by an in silico approach

By Raphaëlle Lesage (Prometheus, Division of Skeletal Tissue Engineering, KU Leuven, Belgium) Liesbet Geris (Prometheus, Division of Skeletal Tissue Engineering, KU Leuven, Belgium. (2) Biomechanics Section, KU Leuven, Belgium. (3) GIGA In silico medicine, University of Liège, Belgium)

Abstract Id: 7596
Event: EORS 2019
Topic: Cartilage

Introduction

During OA the homeostasis of healthy articular chondrocytes is dysregulated, which leads to a phenotypical transition of the cells, further influenced by external stimuli. Chondrocytes sense those stimuli, integrate them at the intracellular level and respond by modifying their secretory and molecular state. This process is controlled by a complex interplay of intracellular factors. Each factor is influenced by a myriad of feedback mechanisms, making the prediction of what will happen in case of external perturbation challenging. Hampering the hypertrophic phenotype has emerged as a potential therapeutic strategy to help OA patients (Ripmeester et al. 2018; Tchetina, 2011). Therefore, we developed a computational model of the chondrocyte’s underlying regulatory network (RN) to identify key regulators as potential drug targets.

Goal

A mechanistic mathematical model of articular chondrocyte differentiation was implemented with a semi-quantitative formalism and temporal priority classes. It is composed of a protein RN and a gene RN(GRN) and developed by combining two strategies. First, we established a
mechanistic network based on accumulation of decades of biological knowledge. Second, we combined that mechanistic network with data-driven modelling by inferring an OA-GRN using an ensemble of inference algorithms. This required a large gene expression dataset, provided by distinct public microarrays merged through an in-house pipeline for cross-platform integration.

Method

Results

We successfully merged various micro-array experiments into one single dataset where the biological variance was predominant over the batch effect from the different technical platforms. The gain of information provided by this merge enabled us to reconstruct an OA-GRN which subsequently served to complete our mechanistic model. With this completed model, we studied the system’s multi-stability, equating the model’s stable states to chondrocyte phenotypes. The structure of the network could explain the occurrence of two biologically relevant phenotypes: a hypertrophic-like and a healthy-like phenotype, recognized based on their predicted expression profiles. Second, we tested several hypotheses that could trigger the onset of OA to validate the model with relevant biological phenomena. For instance, forced inflammation pushed the chondrocyte towards hypertrophy but this was partly rescued by higher levels of TGF-b. However, we could annihilate this rescue by concomitantly mimicking an increase in the ALK1/ALK5 balance. Finally, we performed a screening of in-silico (combinatorial) perturbations (inhibitions and/or over-activations) to identify key molecular factors involved in the stability of the chondrocyte state. More precisely, we looked for the most potent conditions for decreasing hypertrophy. Preliminary validation experiments have confirmed that PKA and AKT activities have an influence on the hypertrophic phenotype in primary chondrocytes. However, inhibition of AKT promoted hypertrophy, contrary to the in-silico predictions.

Conclusions and recommendations

A priori testing of conditions with an in-silico model may cut time and cost of experiments and opens new routes for OA combinatorial therapies.

In vitro gentamycin release from impregnated femoral head allograft

By Elyarbek (Tashmetov)Berik (Tuleubaev)Dina (Saginova)

Abstract Id: 7585
Event: EORS 2019
Topic: Infection

Introduction

Management of bone infection and resulting bony defects is one of the major issues in orthopaedic surgery. In order to combine the effects of bone repair and eradication of
infection, with both Gram-positive and Gram-negative pathogens, the behaviour of a compound of bone graft and antibiotics was investigated.

**Goal**

Samples of allogenic femoral head transplants (Marburg bone bank system) was processed and incubated with gentamycin. According to methods of bone impregnation they were divided into two groups: 1 group - entire femoral head allograft mixed for 1 hour with 1.2 g gentamycin + 300 ml NaCl (EA+G); 2 group – allograft was perforated before mixed for 1 hour with 1.2 g gentamycin + 300 ml NaCl (PA+G). Acquired bone grafts were manually fragmented into cortical bone and cancellous bone pieces (0.5- to 1.0 - cm). The compounds were placed in deionized water and the surrounding liquid was exchanged completely every 24 h. Concentrations of antibiotics in the fluid were measured over 14 days using high pressure liquid chromatography and a bioassay.

**Method**

**Results**

All tested combinations eluted mainly in the initial phase with a logarithmic decrease over the testing period. The concentration of antibiotics in the deionized water was well above the MIC for common pathogens throughout the investigation in all tested specimens. The highest initial concentrations were measured in the compound of PA+G. EA+G and PA+G have significantly different properties. The storage capability of cancellous bone was generally lower than that of cortical bone in both groups. Gentamycin concentrations were significantly lower in cortical bone in the initial phase; however, it eluted more steadily and over a longer period, so that from day 6 onwards, its concentration was greater than that in cancellous bone. After 14 days, the gentamycin concentration in PA+G (cortical bone, cancellous bone) was higher than that in EA+G.

**Conclusions and recommendations**

Further study is needed to confirm these findings in vivo and to determine appropriate antibiotic/allograft concentration.

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**Prospective Study of Patellar Tendon Changes with Ultrasonographic Investigation and the Effect on Clinical Outcomes After Knee Prosthesis**

By Öزال Özcan (Afyonkarahisar Health Sciences University) Murat Yeşil (Afyonkarahisar Health Sciences University) Hakan Boya (Başkent University Hospital)
Introduction

Shortening of patellar tendon after total knee arthroplasty (TKA) was previously reported by several studies. Its aetiology still remains controversial. Patellar tendon shortening, a direct cause of patella baja, has a dramatic negative impact in terms of clinical outcomes after TKA. Main objective of this study is to assess the feasibility of utilizing a different technique with ultrasound that is easy to use, cost-effective and able to eliminate the problem of differential magnification occurring in other techniques which count on standard x-rays and to establish the correlation between clinical outcomes and changes in patellar tendon length and thickness after TKA.

Goal

The study was designed as prospective cohort and, after a minimum of 4-year-follow up period, 47 knees of 24 patients who had undergone primary TKA without patellar resurfacing were included in the study. All patients were scored with Kujala and HSS scores and all patellar tendons were evaluated with USG regarding their length and thickness. We used conventional grey-scale ultrasound imaging (US) to determine any changes in patellar tendon morphology. All cases were evaluated by the same radiologist. The patellar tendon was examined with the knee in 30° flexion. The flexion angle helped to stretch the extensor mechanism and avoid anisotropy (concavity) of the patellar tendon. The transducer was placed along the long axis of the tendon. The patellar tendon was initially examined in the longitudinal plane in order to measure the total length. Then, total length was divided into three parts and sagittal thickness was calculated at the proximal, median, and distal thirds of the patellar tendon. Both the length and thickness of the tendon were measured before surgery and at the 4th year of follow-up.

Method

Results

Of the 47 knees that were included in our study, the mean pre-operative and postoperative length of the patellar tendon was 40.78±6.15 mm and 35.93±4.52 mm. Our results suggested significant shortening of the patellar tendon after primary TKA surgery (p<0.05). Intergroup analysis suggested that reduced sagittal thickness in the proximal third of the tendon was more strongly correlated with an increase in functional outcomes (p<0.05). Our results suggested no significant difference in clinical outcome scores between patients with increased or decreased length of the patellar tendon after TKA (p>0.05).

Conclusions and recommendations

We suggest that determining morphologic changes in sagittal thickness as well as length is important in explaining some of the ambiguous causes of anterior knee pain and impaired clinical outcomes after TKA. More accurate documentation of morphologic changes in the patellar tendon after TKA will certainly help to develop new techniques by surgeons or avoid some existing routines that may harm the tendon. USG is a feasible method for evaluating patellar tendon morphology after TKA but more future studies are needed.
Bone Cement with Screw Augmentation Technique in Primary Knee Arthroplasty: When or How to use?

By Özal Özcan (Afyonkarahisar Health Sciences University) Murat Yeşiil (Afyonkarahisar Health Sciences University) Uğur Yüzügül dü (Afyonkarahisar Health Sciences University)

Abstract Id: 7581
Event: EORS 2019
Topic: Arthroplasty

Introduction

The technique of bone cement with screw augmentation (BCSA) had stepped forward with its cost-effectiveness and practical use. In our clinical experience, we utilized bone cement and screw augmentation technique in management of moderate tibial defects during primary total knee arthroplasty (TKA). The main objective of this cross-sectional study is to assess intermediate term follow-up outcomes of bone cement and screw augmentation technique which we used in the management of moderate tibial bone defects with a depth of >5mm.

Goal

This cross-sectional study included patients who had undergone primary knee arthroplasty. Bone cement and screw augmentation technique was used in all cases. Tibio-femoral angle was measured on routine AP knee X-ray images and, in order to measure the filled tibial defect area below the tibial plate (CSA), PACS software was used by the same radiologist. The distance between the base of tibial plate and the deepest point of the defect area (DPDA) was measured using PACS software: one parallel line was drawn to the base of the tibial plate and, another perpendicular line was drawn to the deepest point of the tibial defect as to measure the distance.

Method

Results

There was no statistically significant difference between early postoperative and late radiographs regarding the tibiofemoral angle (p=0.115). Mean post-operative cement and augmented screw area (CSA) was 98.25±35.37 mm² and it was not correlated with early postoperative tibiofemoral angle (p=0.149), and not correlated with late tibiofemoral angle either (p=0.158). Mean distance between the base of tibial plate and the deepest point of the defect area (DPDA) was measured as 7.4 ± 2.6 (max 12.93- min 3.53) mm. DPDA was not correlated with age (p=0.896), BMI (p=0.728) and HSS scores (p=0.603). HSS for knee scores had negative correlation between early (p=0.231) and late (p=0.320) tibiofemoral angles however it was not statistically significant. Statistical analysis revealed that mean BMI of the patients was not correlated with HSS scores (p=0.082) or late postoperative tibiofemoral angle (p=0.591). Besides, any correlation was present neither between BMI and CSA (p=0.261) nor between BMI and changes in tibiofemoral angle (p=0.903).
Conclusions and recommendations

We think BCSA technique is effective and easy to use in the treatment of moderate bone defects of tibia during total knee arthroplasty surgery. In addition, BCSA technique can be safely used without being precautious about BMI. However, more randomized studies are needed.

Prospective Study of Patellar Tendon Changes with Ultrasonographic Investigation and the Effect on Clinical Outcomes After Knee Prosthesis

By Özal Özcan (Afyonkarahisar Health Sciences University) Murat Yeşil (Afyonkarahisar Health Sciences University) Hakan Boya (Başkent University Hospital)

Abstract Id: 7580
Event: EORS 2019
Topic: Arthroplasty

Introduction

Shortening of patellar tendon after total knee arthroplasty (TKA) was previously reported by several studies. Its aetiology still remains controversial. Patellar tendon shortening, a direct cause of patella baja, has a dramatic negative impact in terms of clinical outcomes after TKA. Main objective of this study is to assess the feasibility of utilizing a different technique with Ultrasound that is easy to use, cost-effective and able to eliminate the problem of differential magnification occurring in other techniques which count on standard x-rays and to establish the correlation between clinical outcomes and changes in patellar tendon length and thickness after TKA.

Goal

The study was designed as prospective cohort and, after a minimum of 4-year-follow up period, 47 knees of 24 patients who had undergone primary TKA without patellar resurfacing were included in the study. All patients were scored with Kujala and HSS scores and all patellar tendons were evaluated with USG regarding their length and thickness. We used conventional grey-scale ultrasound imaging (US) to determine any changes in patellar tendon morphology. All cases were evaluated by the same radiologist. The patellar tendon was examined with the knee in 30° flexion. The flexion angle helped to stretch the extensor mechanism and avoid anisotropy (concavity) of the patellar tendon. The transducer was placed along the long axis of the tendon. The patellar tendon was initially examined in the longitudinal plane in order to measure the total length. Then, total length was divided into three parts and sagittal thickness was calculated at the proximal, median, and distal thirds of the patellar tendon. Both the length and thickness of the tendon were measured before surgery and at the 4th year of follow-up.
Method

Results

Of the 47 knees that were included in our study, the mean pre-operative and postoperative length of the patellar tendon was 40.78±6.15 mm and 35.93±4.52 mm. Our results suggested significant shortening of the patellar tendon after primary TKA surgery (p<0.05). Intergroup analysis suggested that reduced sagittal thickness in the proximal third of the tendon was more strongly correlated with an increase in functional outcomes (p<0.05). Our results suggested no significant difference in clinical outcome scores between patients with increased or decreased length of the patellar tendon after TKA (p>0.05).

Conclusions and recommendations

We suggest that determining morphologic changes in sagittal thickness as well as length is important in explaining some of the ambiguous causes of anterior knee pain and impaired clinical outcomes after TKA. More accurate documentation of morphologic changes in the patellar tendon after TKA will certainly help to develop new techniques by surgeons or avoid some existing routines that may harm the tendon. USG is a feasible method for evaluating patellar tendon morphology after TKA but more future studies are needed.

Computational optimization and biodegradation of 3D-printed patient-specific acetabular implants

By Mojtaba Barzegari (Biomechanics Section, Department of Mechanical Engineering, KU Leuven, Leuven, Belgium) Fernando Perez Boerema (Biomechanics Section, Department of Mechanical Engineering, KU Leuven, Leuven, Belgium) Liesbet Geris (Biomechanics Section, Department of Mechanical Engineering, KU Leuven, Leuven, Belgium)

Abstract Id: 7576
Event: EORS 2019
Topic: Biomechanics

Introduction

3D-printed orthopedic implants have been gaining popularity in recent years due to the control this manufacturing technique gives the designer over the different design aspects of the implant. This technique allows us to manufacture implants with material properties similar to bone, giving the implant designer the opportunity to address one of the main complications experienced after total hip arthroplasty (THA), i.e. aseptic loosening of the implant. To restore proper function after implant loosening, the implant needs to be replaced. During these revision surgeries, some extra bone is removed along with the implant, further increasing the already present defects, and making it harder to achieve proper mechanical stability with the revision implant. A possible way to limit the increasing loss of bone is the use of biodegradable orthopedic implants that optimize long-term implant stability. These implants
need to both optimize the implant such that stress shielding is minimized, and tune the implant degradation rate such that newly formed bone is able to replace the degrading metal in order to maintain a proper bone-implant contact. The hope is that such (partly) degradable implants will lead to a reduction in the size of the bone defects over time, making possible future revisions less likely and less complex.

Goal

We focused on improving the long-term implant stability of patient-specific acetabular implants for large bone defects and the modeling of their biodegradable behavior. To improve long-term implant stability we implemented a topology optimization approach. A patient-specific finite element model of the hip joint with and without implant was derived from CT-scans to evaluate the performance of the designs during the optimization routine. To evaluate the biodegradation behavior, a quantitative mathematical model was developed to assess the degradation rates of the biodegradable part of the implant (see fig. 1). Currently, the biodegradation model has been implemented for magnesium (Mg) implants as a first proof of concept.

Method

Results

For a first test case, an optimized implant was found with stress shielding levels below 20% in most regions. The highest stress shielding levels were found at the bone implant interface. The biodegradation model has been validated using experimental data, which includes immersion tests of simple scaffolds created from Commercial Pure Mg. The mass loss of the scaffold is about 0.8 mg/cm² for the first day of immersion in simulated body fluid (SBF) solution. After the formation of a protective film on the surface of the simple scaffold, the degradation rate starts to slow down.

Conclusions and recommendations

Reducing implant-induced stress shielding, obtaining a better implant integration and reduction of bone defects, by allowing for bone to partially replace the implant over time, are crucial design factors for large bone defect implants. In this research, we have developed in-silico models to investigate these factors. Once validated and coupled, the models will serve as an important tool to find the appropriate biodegradable implant designs and biodegradable metal properties for THA applications, that improve current implant lifetime while ensuring proper mechanical functioning.

A Clinical Audit to Investigate the Clinical Utility of the Ottawa Ankle Rule Scoring System to Reduce Ionising Radiation Exposure to Patients with Acute Ankle Injuries
Introduction

The ankle radiograph is a commonly requested investigation as the ankle joint is commonly injured. Each radiograph exposes 0.01 mSv of radiation to the patient that is equivalent to 1.5 days of natural background radiation [1]. The aim of the clinical audit was to use the Ottawa Ankle Rule to attempt to reduce the number of ankle radiographs taken in patients with acute ankle injuries and hence reduce the dose of ionising radiation the patient receives.

Goal

A retrospective audit was undertaken. 123 ankle radiograph requests and radiographs taken between May and July 2018 were evaluated. Each ankle radiograph request including patient history and clinical examination was graded against the Ottawa Ankle Rule. The rule states that ≥1 point(s) indicates radiograph series; (1) malleolar and/or midfoot pain; (1) tenderness over the posterior 6cm or tip of the lateral or medial malleolus (ankle); (1) tenderness over the navicular or the base of the fifth metatarsal (foot); (1) unable to take four steps both immediately and in the emergency department [2]. Patients who score 0 do not need radiograph series. Each radiograph was reviewed if a fracture was present or not.

Method

Results

The clinical audit identified 14 true positives where the Ottawa Ankle Rule scored ≥1 and the patient had an ankle fracture, and 2 false negatives (sensitivity 88%). There were 81 false positives, and 23 true negatives (specificity 22%). Therefore, a total of 23/123 ankle radiographs were unnecessary which is equivalent to 34.5 days of background radiation. The negative predictive value of the Ottawa Ankle Rule in this audit was 92%.

Conclusions and recommendations

The low rate of Ottawa rule utilisation may unnecessarily cause patient harm that should be addressed. An educational intervention with physicians combined with integration of the Ottawa rule scoring in ankle radiograph requests is planned with re-audit in 6 months.

First clinical comparison of autologous conditioned serum secretome (ACS) vs platelet-rich plasma (PRP) as intra articular
injections for knee osteoarthritis. Biochemical markers propose regenerative mechanism as basis for clinical superiority of physiological ACS blood cell secretome vs PRP concentrated blood cell therapy. Open label comparative clinical study.

By K. Yu. Shirokova (Yaroslavl State Medical University, Yaroslavl, Russian Federation) M. V. Zhomova (Yaroslavl State Medical University, Yaroslavl, Russian Federation) A. S. Noskova (Yaroslavl State Medical University, Yaroslavl, Russian Federation)

Abstract Id: 7553
Event: EORS 2019
Topic: Pathology

Introduction

Dysfunction of intra-articular cells/tissues is one mechanism for painful decay of cartilage and periodic effusions in OA. Dysfunction shows in clinical scores and synovial fluid markers including cytokine dysbalance, excessive oxygen (ROS) and nitrogen radicals (RNS) and reduced viscosity. Conjugated dienes (ROS footprints) are formed by oxygen radical attack on e.g. unsaturated fatty acids. Nitric oxide (NO) rapidly reacts to NO2 and NO3, detectable as footprints. ACS is a cell free secretome therapy based on whole blood coagulated under physiological conditions. PRP is a cell-based therapy with higher-than-natural platelet numbers in anti-coagulated plasma. Both have shown positive results in intra-articular OA therapy.

Goal

123 patients with knee OA, Kellgren&Lawrence grade II-III with sub-clinical (scs) and moderate synovitis (ms) were treated with six each 5mL intra-articular injections of ACS or PRP [Table 1]. Clinical scores: visual analog pain scale (VAS) and WOMAC. Synovial fluid markers: viscosity, IL-1Ra, IL-1b, NO3 and conjugated dienes (CD). Patient number was not based on statistical considerations. Statistical processing on a PC Intel CORE i3. Software included Excel spreadsheets 10.00, statistical software packages Primer of Biostatistics (Version 4.03. Copyright 1998. McGraw Hill) and STATISTICA® (Data analysis software system, StatSoft Inc.) release 7.0. Means and standard deviations were calculated. Reliability of indicators was determined using Student's t-test. In the nonparametric distribution of indices, Wilcoxon. Mann-Whitney and χ2 tests were used. To assess reliability of repeated events, an analysis of variance (F) was carried out. Correlation analysis was carried out using Spearman rank correlation coefficient (r). Confidence level was assumed to be p

Method
Results

VAS and WOMACglobal were significantly better for ACS vs PRP at 3 months. VAS: scs: p=0.03, ms: p=0.000 [Figures 1 and 2]; WOMAC: scs: p=0.044, ms: p=0.000. PRP was clinically inferior to ACS in both scs and ms at 3 months follow up. Synovial fluid analysis was possible in patients with sufficient effusion (ms). IL-1Ra/IL-1b post ACS was significantly superior vs PRP at 1 month (IL-1Ra: p=0.016; IL-1b: p=0.008). SF viscosity for ACS was improved at 3 months by 72% vs 22% for PRP. CD for ACS improved at 3 months by 53%, not for PRP (p=0.000). NO3 for ACS decreased at 3 months by 45% vs 30% for PRP (p=0.011). PRP was biochemically inferior to ACS in both scs and ms at 3 months follow up.

Conclusions and recommendations

ACS treatment, both in subclinical and moderate synovitis cases of knee osteoarthritis K&L grade II-III, is significantly superior to PRP at 3 months follow up. Since both treatments are autologous blood derived methods and have a low risk profile ACS is the preferable option, based on clinical and biochemical analysis and the protocol used.

Enhancing lifetime of prosthetic joint implants by fluidic lubricants

By Ruben del Campo Muga (Technical University of Denmark) Seunghwan Lee (Technical University of Denmark)

Abstract Id: 7457
Event: EORS 2019
Topic: Biomaterials

Introduction

Wear of joint replacement implants, such as those used in total hip arthroplasty (THA) or total knee arthroplasty (TKA), has been known to initiate a cascade of adverse immune responses, often leading to osteolysis and failure of the implants. To date, efforts to solve this problem have mainly been directed towards development and/or application of new bearing materials with superior tribological properties. In this study, we propose a markedly different approach; instead of material development and/or modification, we aim to reduce the wear of bearings by administering fluidic lubricants to prosthetic joints. The first target to test the feasibility of this approach is ultra-high molecular weight polyethylene (UHMWPE), a most commonly used bearing material as acetabular cup lining.

Goal

Pin-on-disk tribometry was employed to assess the frictional properties of the sliding contacts between UHMWPE and CoCrMo tribopair in serum as model synovial fluid, with or without fluidic lubricants. Hip joint wear simulator (ISO 14242-1) was employed to assess the wear properties of UHMWPE. Fluidic lubricants were formulated by dissolving amphiphilic triblock copolymers, PEO-PPO-PEO (“Pluronics®”, specifically “F127”), in aqueous buffer
solution (HEPES, 1 mM with no extra salts). The concentration of the amphiphilic copolymers was varied from 0.1 % (1 mg/ml) to 20 % (200 mg/ml) in HEPES buffer solution. For comparison, various other polymers, including homopolymeric PEO, hyaluronic acid (HA), bovine submaxillary mucin (BSM), were also tested as lubricant additives. For in-vitro cytotoxicity tests, cell morphology and standard MTT tests have been performed by employing murine fibroblast (L929 fibroblasts) and murine osteoblast (MC3T3).

Method

Results

Frictional tests showed that the fluidic lubricants display an immediate reduction in the coefficient friction upon injection into serum in which the sliding contacts between CoCrMo pin and UHMWPE disk are taking place. A representative example, the case where 1 ml of F127 solution (20%) injected into 2 ml of serum is shown in Figure 1 (The final concentration of F127 is thus diluted to 1/3, i.e. 6.7%). Wear tests of UHMWPE cup after 1 million cycles in hip joint wear simulator (according to ISO 14242-1) showed that gravimetric wear of UHMWPE in serum with F127 was only ca. 20% that in serum alone. When other polymers, including homopolymeric PEO, BSM etc., were employed to formulate fluidic lubricants, no or less lubricating effect was observed. Lastly, MTT tests showed that in-vitro cell viability of fibroblast and osteoblast exposed to F127 was comparable to a control when they were exposed to HEPES and cell culture medium only.

Conclusions and recommendations

More advanced biocompatibility tests e.g. on animal and human subjects, are required for clinical application.

The Role of Type I Diabetes in Intervertebral Disc Degeneration

By Fabrizio Russo (University Campus Bio-Medico of Rome)Luca Ambrosio (University Campus Bio-Medico of Rome)Kevin Ngo (University of Pittsburgh Medical Centre)

Abstract Id: 7450
Event: EORS 2019
Topic: Spine

Introduction

Intervertebral disc degeneration (IDD) is a major cause of low back pain, which affects 80% of the adult population at least once in their life. The pathophysiological conditions underlying IDD are still poorly understood. Genetic makeup, aging, smoking, physical inactivity and mechanical overloading, especially due to obesity, are among the strongest risk factors involved. Moreover, IDD is often associated with chronic inflammation within disc tissues, which increases matrix breakdown, glycosaminoglycan (GAG) loss and cell death. This micro-inflammatory environment is typical of several metabolic disorders, including
diabetes mellitus (DM). As the etiopathogenesis of IDD in diabetic subjects remains scarcely understood, we hypothesised that this may be driven by a DM-induced inflammation leading to a combination of reduced GAG levels, decreased proteoglycan synthesis and increased matrix breakdown within the disc. The objective of the study was to investigate the pathogenesis of IDD in a murine model of type 1 DM (T1DM), namely non-obese diabetic (NOD) mouse.

**Goal**

Total disc glycosaminoglycan (GAG) content, proteoglycan synthesis, aggrecan fragmentation mediated by matrix metalloproteinases (MMPs) and a Disintegrin and Metalloproteinase with Thrombospondin motifs (ADAMTS), glucose transporter (mGLUT1) gene expression and apoptosis (TUNEL assay) were assessed in NOD mice and wild-type euglycemic control mice. Spinal structural and molecular changes were analysed by micro-computed tomography (mCT), histological staining (Safranin-O and fast green) and quantitative immunofluorescence (anti-ADAMTS-4 and -5 antibodies). Statistical analysis was conducted considering the average of 3–5 samples ± standard error for each measurement, with 95% confidence intervals calculated to determine statistical significance (p-value < 0.05).

**Method**

**Results**

IVDs of NOD mice showed increased disc apoptosis (p < 0.05) and higher aggrecan fragmentation mediated by ADAMTS (p < 0.05). However, ADAMTS-4 and -5 did not appear to be involved in this process. The total GAG content normalized to DNA and PG synthesis showed no statistically significant alterations, as well as Safranin O staining. Although not significantly, NOD mice showed reduced glucose uptake. In addition, the vertebral structure of NOD mice at mCT seemed not to be altered.

**Conclusions and recommendations**

These data demonstrate that DM may contribute to IDD by increasing aggrecan degradation and promoting cell apoptosis, which may represent early indicators of the involvement of DM in the pathogenesis of IDD.

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**Improving Fracture clinic services and becoming compliant with BOAST 7 Guidelines with the use of Virtual Fracture clinic**

By charlesnwallace@gmail.com (charlesnwallace@gmail.com)

Abstract Id: 7341
Introduction

The British Orthopedic Association recommends that patients referred to fracture clinic are reviewed within 72 hours. With the increase in referrals and limited clinic capacity it is becoming increasingly difficult to see every referral within a 72 hour time frame. Some patients are waiting 2 weeks or more before they can be seen in a fracture clinic. With the aim of improving care by seeking to meet BOAST 7 target, waiting times for fracture clinic appointments at the Homerton University Hospital were audited prospectively against this national guideline, before virtual fracture clinic was implemented and 6 weeks after the implementation of virtual fracture clinic at our hospital. Virtual fracture clinic is where an Orthopedic consultant reviews a patient’s x-rays and A&E documentation and decides if that patient needs to be seen in a face to face fracture clinic to discuss operative vs. non-operative management of their injury or if a treatment plan can be delivered without the patient having to come back to hospital.

Goal

The study was conducted as a prospective closed-loop audit in which the second cycle took place after the implementation of the new virtual fracture clinic service.

Method

Results

The first cycle showed a non-compliant waiting time with only 18% of patients being seen within 72 hours. Following the implementation of virtual fracture clinic, 84% of all patients were reviewed within 72 hours.

Conclusions and recommendations

Virtual fracture clinic delivered a significant reduction in waiting times. Virtual fracture clinic has only just been implemented at the Homerton University Hospital and hopefully at the next audit we will be 100% compliant with the BOA BOAST 7 Guideline. We would recommend that virtual fracture clinics being rolled out in Orthopedic departments in all hospitals which have Orthopedic services.

Primary repair of the ACL using the Suture Tape Augmentation technique: a case series with 2-year follow-up

By Katja Zazulia (Antwerp University Hospital) Malou Lyssens (Antwerp University Hospital) Mathijs Gijbels (Antwerp University Hospital)
Introduction

The Suture Tape Augmentation (STA) technique, also known as Internal Bracing, has been introduced for the repair of an acute anterior cruciate ligament (ACL) rupture. This technique provides an environment in which the native ACL can heal. ACL repair is a “hot topic”, but literature is not extensive. To date, no previous case series have been published comparing preoperative and postoperative data on the ACL STA technique. This paper presents the results of patients with an acute ACL rupture, treated with the STA repair technique.

Goal

This prospective study has been approved by the local ethical committee and informed consent of all patients is obtained. Thirty patients with an ACL mid or proximal bundle rupture of less than 12 weeks old, with good ACL tissue quality and contact between the stumps were included and followed up for two years. Recorded pre-injury and post-operative patient related outcome measures (PROMS) were: Tegner, Lysholm and International Knee Documentation Committee (IKDC) score. Reruptures, return to work and sports were recorded. Anterior-posterior (AP) knee laxity was measured using a Rolimeter.

Method

Results

The recorded PROMS (mean and SD) and AP knee laxity difference are summarized in Table 1. The clinical outcomes over time is modelled using a mixed model. The ACL rerupture rate is expressed as a proportion with 95% confidence interval. The mean return to work time (SD) is 8.8 (7.3) weeks, range 0-32 weeks, mean return to sports time is 29.1 weeks (18.9), range 12-80 weeks. Four patients (13.3% 95%CI [5.3, 29.7]%) had a rerupture while playing sports.

Conclusions and recommendations

For acute ACL ruptures which are not retracted and of good tissue quality, repair with the STA technique could be a treatment choice. The results are promising for the PROMS, return to sports and work, but the rerupture rate of 13.3% is high. Further research is needed for long term follow-up and if a stricter patient selection can be of influence on the rerupture rate.

The Cambridge Experience in Spontaneous bone regeneration after Traumatic Segmental bone defect: a case series and review of literature
Introduction

High-energy traumatic long bone defects are some of the most challenging to reconstruct. Although cases of spontaneous bone regeneration in these defects have been reported in the literature, we are aware of no guidelines or recommendations for when spontaneous bone regeneration should be considered a viable management option in treating extreme segmental traumatic bone loss. By comparing our experience as a major trauma centre for east of England with published case reports, we aim to identify how certain patient characteristics and surgical factors may help more quickly predict spontaneous bone regeneration as a definite treatment.

Goal

A retrospective analysis of polytrauma cases with long bone traumatic segmental defects over a 6-year period at Cambridge University Hospital – Addenbrookes major trauma centre was conducted.

Method

Results

A total of 26 cases with traumatic segmental defects were treated at our institution, with eight cases (30.8%) undergoing spontaneous regeneration. All patients were males and their average age was 39.5 years. Of the eight cases, six reported a degree of periosteal preservation status and four (66%) of which reported an intact periosteum. Four (50%) cases were associated with traumatic brain injury (TBI) and none were complicated by an underlying infection. The average time to observed spontaneous bone regeneration was 2.06 months. The time to regeneration was independent of the size of the defect.

Conclusions and recommendations

A combination of patient characteristics including age, periosteal preservation, associated TBI, and presence of infection play a significant role in the process of spontaneous bone regeneration.

CALCULATION OF FORCES IN UHMWPE CABLES USED FOR
CORRECTION OF ADULT SPINAL DEFORMITIES

By Alex K. Roth (Department of Orthopaedic Surgery, Maastricht University Medical Centre, The Netherlands) Paul C. Willem (Department of Orthopaedic Surgery, Maastricht University Medical Centre, The Netherlands) Lodewijk W. van Rhijn (Department of Orthopaedic Surgery, Maastricht University Medical Centre, The Netherlands)

Abstract Id: 6800
Event: EORS 2019
Topic: EORS 2019

Introduction

Currently, between 9-17% of patients undergoing surgery for adult spinal deformity experience severe instrumentation related problems such as screw pullout or proximal junctional failure necessitating revision surgery [1]. Cables may be used to reinforce pedicle screw fixation as an additive measure or may provide less rigid fixation at the construct end levels in order to prevent junctional level problems. The purpose of this study is to provide insight into the maximum expected load during flexion in UHMWPE cable in constructs intended for correction of adult spine deformity (degenerative scoliosis) in the PoSTuRe first-in-man clinical trial.

Goal

Following the concept of ‘topping-off’, a new construct is proposed with screw/cable fixation of rods at the lower levels and standalone UHMWPE cables at the upper level (T11) (Fig. 1). A parametric FE model of the instrumented thoracolumbar spine, which has been previously validated [2], was used to represent the construct. Pedicle screws are modeled by assigning a rigid tie constraint between the rod and the lamina of the corresponding spinal level. Cables are modeled using linear elastic line elements, fixing the rod to the lamina medially at the cranial laminar end and laterally at the caudal laminar end (Fig. 2). A Young’s modulus was assigned such that the stiffness of the line element was the same as that of the cable [3]. An 8 Nm flexion moment was applied to the cranial endplate.

Method

Results

The maximum value of the force in the wire (80 N) is found at the T11 (upper) level. At the other levels, forces in the cable are very small because most of the force is carried by the screw (T12) or because the wires are ‘force shielded’ by the contralateral and adjacent level pedicle screws (L2, L3) (Fig. 3).

Conclusions and recommendations

The model provides first estimates of the forces that can be expected in the UHMWPE cables in constructs for kyphosis correction during movement. It is expected that this approach can

**Novel biomarkers in Osteomyelitis**

By Nachappa Sivanesan Uthraraj (Senior Clinical Research Fellow in Knee Surgery, UCLH) Meghana Prakash Hiriyur Prakash (Medical Officer, Narayana Hridalaya, Bangalore)

Abstract Id: 6591  
Event: EORS 2019  
Topic: Infection

**Introduction**

Early diagnosis of Osteomyelitis is of vital importance so as to avoid devastating complications. Although serum inflammatory markers like C-reactive protein (CRP), Erythrocyte Sedimentation Rate (ESR), White Blood Cells (WBC) are used for the diagnosis of osteomyelitis, they lack sensitivity and are not specific as their levels can also be elevated in non pyogenic causes of inflammation. Data regarding the role of Procalcitonin (PCT) in osteomyelitis is scarce. Serum pct at 0.5 ng/ml it's going to be an accurate marker for pyogenic infections. The aim of this prospective study is to assess the performance of procalcitonin for the diagnosis of patients with osteomyelitis.

**Goal**

METHODS: A total study population of 200 patients between the age groups of 18 to 65 years with suspected osteomyelitis (acute, subacute and chronic) were prospectively included in our study for analysis. Initial diagnosis of osteomyelitis was based on clinical examination and was confirmed by imaging studies (X-ray, MRI), following which the patients were subjected for serum PCT estimation. The p value was estimated for statistical significance.

**Method**

**Results**

RESULTS: Outcome revealed that the PCT was elevated to statistically significant levels in the study population. The data was analysed when the patients were admitted for osteomyelitis and treated with IV antibiotics in the hospital.

**Conclusions and recommendations**

CONCLUSION: In this study, Serum procalcitonin, at a cut-off of 0.4 ng/ml, was found to be a useful, sensitive and a specific marker in the diagnosis of osteomyelitis.
Comparison Of In Vivo Wear Of Ceramic, Metal And Titanium Nitride Coated Total Hip Arthroplasty Heads

By Łukasz Łapaj (Department of General Orthopaedics, Musculoskeletal Oncology and Trauma Surgery, Poznan University of Medical Sciences) Paweł Chodór (Department of General Orthopaedics, Musculoskeletal Oncology and Trauma Surgery, Poznan University of Medical Sciences) Rafał Rubach (Metal Forming Institute, Poznan)

Abstract Id: 6590
Event: EORS 2019
Topic: Biomaterials

Introduction

Conventional Cobalt - Chromium heads (CoCrMo) used in total hip replacements (THRs) undergo in vivo scratching and degradation. This accelerates polyethylene wear leading to osteolysis and loosening. To minimize this heads made of hard ceramic materials such as alumina or hard coatings like titanium nitride (TiN) films have been introduced to clinical practice, however so far little is known about differences in their performance in vivo. This retrieval study compared in vivo wear of conventional CoCrMo, second generation ceramic (Biolox Forte), and TiN coated heads. We determined in vivo surface damage of the components using a semiquantitative scoring system, examined their roughness using contact profilometry and examined heads using scanning electron microscopy (SEM) to determine the wear mechanisms.

Goal

This study included 66 retrieved heads articulating with polyethylene. After revising 22 heads with titanium nitride coatings which were used in vivo for 3-72 months, we matched 22 heads made of CoCrMo and alumina (Biolox Forte) respectively. Heads were matched according to following criteria, presented in the order of their importance: (1) implantation time, (2) cause of revision (3) diameter (4) type of implant – cemented/uncemented, so that ultimately a group of ceramic heads were used in vivo for 2-75, and metal components used for 3-72 months were included. Additionally three unused heads of each type were included as controls. First heads were examined using optical microscopy, next surface damage was evaluated using the semiquantitative Hothi wear score (HWS). Briefly heads were divided into 8 sectors where presence of various features (such as scratching, embedded third bodies, loss of coating) was quantified. Surface roughness (Ra) was measured in each sector using contact profilometry. Statistical analysis of the results was performed using the Kruskall-Wallis test. Finally, the heads were examined using SEM (ceramic heads were first sputter coated with 10nm of gold) with Energy-Dispersive X-ray Spectroscopy (EDS) to verify the elemental composition of various surface features.

Method

Results
After microscopic examination we observed, that CoCrMo heads exhibited various degrees of scratching, while ceramic heads exhibited barely no visible wear. TiN coated heads were characterized by polishing of their surface, and macroscopic loss of coating in five cases. This was confirmed in semiquantitative analysis, since lowest wear scores were found for ceramic heads (mean HWS 10.7; Ra 0.03µm); these results were significantly lower (p

Conclusions and recommendations

This study suggests, that ceramic heads are an optimal choice for polyethylene bearing, TiN coated heads seem to be more susceptible to wear, yet better than conventional metal components.

Retrieval analysis of Zirconia Toughened Alumina components from failed ceramic-on-ceramic total hip replacements

By Łukasz Łapaj (Department of General Orthopaedics, Musculoskeletal Oncology and Trauma Surgery, Poznan University of Medical Sciences) Paweł Chodór (Department of General Orthopaedics, Musculoskeletal Oncology and Trauma Surgery, Poznan University of Medical Sciences) Rafał Rubach (Metal Forming Institute, Poznan)

Abstract Id: 6589
Event: EORS 2019
Topic: Biomaterials

Introduction

Ceramic bearings are used in arthroplasty due to their excellent tribological properties and a small number of inert wear particles, however little is known about wear characteristics of modern zirconia toughened components and reactions or periprosthetic tissues to wear debris. In this study we conducted a retrieval analysis of 14 failed fourth generation ceramic-on-ceramic bearings, and examined samples of periprosthetic tissues to determine presence of adverse reactions to ceramic debris.

Goal

This study included components from fourteen patients (23-48 years) revised at 11-28 months because of infection (2), radiolucency around femoral stem (2), pain related to conflict with iliopsoas tendon (2), recurrent dislocations (1 patient; 3 episodes) catastrophic liner failure (3); leg length discrepancy (2) and unexplained pain (2). In each case femoral head and the liner were obtained except for five patients (catastrophic failures, two liners damaged during removal). Three unused 28 mm heads were included as controls. Components were examined using scanning electron microscopy (SEM); roughness was measured using contact profilometer. Microscopic slides of periprosthetic tissues available for 12 patients were examined according to the Morawietz classification;
Method

Results

In all cases except one (catastrophic failure) there was very little wear visible on retrieved components. Surface roughness measured on weight-bearing and non-weight-bearing parts were low (Ra range 0.03-0.06 micrometers) and comparable to the unused head. In two cases stripe wear was found on retrieved heads; in these areas roughness was increased (mean Ra 0.28 micrometers); SEM studies demonstrated grains pull-out. In the implant subjected to multiple dislocations we found presence metal transfer on the head; while the liner was intact. SEM studies showed that very few ceramic grains were pulled from adjacent areas; however no damage was visible in the remainder of this specimen. In two cases we saw presence of metallic third bodies entrapped between the head and inlay. They formed a large number of curved marks on the head; little damage to adjacent ceramic material was seen. Head from the catastrophically failed hip showed severe damage with multiple indentations and material loss. In seven cases tissue samples were classified as indeterminate type; there were very few macropages seen in these cells, and collagen fibers were the predominant finding. In one case of infection a corresponding histological findings were seen, two membranes (catastrophic failure, radiolucencies.) were classified as wear particle induced type. In these cases a large number of metallic debris were found.

Conclusions and recommendations

Ceramic bearings seem to have excellent tribological properties, yet they may catastrophically fail due to improper implant handling. Care should be taken when assembling modular ceramic components

Design and validation of an open-hardware wearable motion sensors for evaluation proprioception based on measurement of joint positional error.

By Łukasz Łapaj (Department of General Orthopaedics, Musculoskeletal Oncology and Trauma Surgery, Poznan University of Medical Sciences)Marta Jokiel (Traumatology, Orthopaedics and Hand Surgery Department, Poznan University of Medical Sciences)Paweł Chodór (Department of General Orthopaedics, Musculoskeletal Oncology and Trauma Surgery, Poznan University of Medical Sciences)

Abstract Id: 6588
Event: EORS 2019
Topic: Sensors

Introduction
Objective evaluation of proprioception is an important outcome measure following multiple orthopaedic procedure, and can be performed by measuring joint positional error (JPE). In recent years development of microelectronics, wearable inertial measurement units (IMUs) which allow estimating JPE were introduced to biomechanical research. Unfortunately currently available systems are expensive and have limited capabilities. In this study we development an inexpensive system of wearable joint position sensors based on an open-hardware architecture, which can be easily build by anyone with basic soldering and computer skills.

**Goal**

The system was designed to be compatible with tools freely available for non-commercial use : Microsoft Visual C# was used to develop the computer software, the Arduino system was used for the microcontroller firmware. Three types of commercially available IMU sensors were used in the sensor : Bosch BNO055, TDK-Invensense MPU-9250, ST Microelectronics LSM9DS1. The first is a system on-chip which performs the sensor fusion, in case of the latter IMUS sensor fusion was performed using the Magdwick algorithm to yeald the yaw – pitch – roll (YPR) axes of each sensor. All sensors were first evaluated using a “wired” system and compared against a commercially available system (Progress Propriometer) in a series of JPE tests. Initially static tests involving fixed spatial reference points were performed in various locations. Then validation of the sensors based on JPE measurements of shoulder joints of 30 healthy volunteers was performed. Next a wireless version communicating with the PC using Wi-Fi was developed using the Espressif Systems ESP8266 microcontroller (YPR readings weresent using the UDP protocol at a rate of 100 Hz). The data was JPE measurements performed using the wireless devices were than performed and compared with data from “wired” prototypes.

**Method**

**Results**

Initial comparison of all three sensors used in this study demonstrated, that the BNO055 system with on-board fusion provided the most accurate, instantaneous YPR readings the static tests. The other sensors required meticulous magnetometer calibration, and the Yaw readings obtained using the Magdwick algorithm were imprecise (up to 15 degrees of yaw error), additionally readings were stable after up to 3 seconds. In the dynamic test involving healthy volunteers there was no statically significant difference between readings provided by all IMUs and the commercially available system; however in case of the BNO055 the results scatter was noticeably lower for some shoulder positions. There were no statistically significant differences between data obtained using the wireless and “wired” system for all IMUs; the wireless communication had no effect on precision of measurements, and only 0,02% of data packets were lost when using two sensors at a distance of less than 5 meters from the PC.

**Conclusions and recommendations**

This study demonstrated, that inexpensive wearable IMU based sensors can be developed by electronics hobbyists and used in JPE proprioception examination. IMU chips with on-board data fusion output more precise readings, are easier to interface, and can be successfully implemented in wireless devices.
The Use of Entanox and intranasal Diamorphine is a safe and effective analgesia for the manipulation of displaced paediatric limb fractures

By Mr Paul Erdman (Orthopaedic SPr Watford General Hospital) Mr Senthil Muthian (Orthopaedic SPr Watford General Hospital) Mr Arjun Puvanendran (Orthopaedic SHO Watford General Hospital)

Introduction

Children presenting to the Children's Emergency Department (CED) with an isolated deformed limbs should be managed with the patient’s best interest, with the aim to reduce their fracture in the least distressing and painful way possible. Prior to the introduction of the trust guidelines for the management of deformed limbs, patient's were managed on an individual basis, and it was not uncommon to be admitted to hospital for a planned manipulation under anaesthesia the next working day rather then at presentation to CED . An Isolated Deformed Limb Protocol (IDLP) had subsequently been designed and implemented in July 2018, to establish appropriate guidelines and management of a deformed paediatric limb in the (CED) at Watford General Hospital (WGH). The aim of the protocol was to change the mindset of the hospital staff to encourage the manipulation of deformed limbs in the CED. With the use of Entanox and intranasal morphine we wanted to demonstrate that manipulation in CED was safe and effective at relieving the child from ongoing pain, reducing the disturbance to the soft tissues to the affected limb, and can avoid an unnecessary general anaesthetic and admission to hospital.

Goal

We performed a retrospective review of all paediatric (aged below 16) orthopaedic referrals between 08/2018 and 03/2019. The inclusive criteria were a closed isolated deformed limb, amenable to manipulation, that was not a major trauma injuries or required plastic surgery, with all subsequent post-reduction X-rays evaluated by a blinded orthopaedic consultant. At the time of manipulation, parental and patient questionnaire feedback were taken on the experience of pain control, explanation of treatment, and whether the manipulation in CED was appropriate, and we also recorded the method of treatment and any side effects.

Method

Results

326 patients were referred within the specified time period. The inclusion criteria were met by 84 patients. On presentation 66 patients received a manipulation in CED (forearm (n=56):
lower limb (n=8): phalanx (n=2)). Of those manipulated, 10 patients were meant as pain relief before inevitable general anaesthetic and definitive treatment, and 10 patients required a second manipulation for definitive treatment. 17 of the remaining inclusive patients went direct to theatre and 1 was conservatively managed. Parental feedback responses were gained for 23 patients with pain control management (8.7/10), explanation of treatment (8.6/10) and overall experience (9.1/10). Parental evaluations (n=20) felt manipulation in CED was appropriate. At the time of submission we have begun collecting prospective data and we aim to have more detailed statistics at the time of presentation. To date there have been no recorded serious adverse side effects during manipulation. 2 children felt temporarily nauseous from the excess use of Entanox during manipulation

Conclusions and recommendations

The use of intranasal diamorphine with Entanox is very safe and effective method of analgesia without adverse side effects for the use of manipulating deformed limb fractures. We are aware the feedback form parents and patients is limited and at the time of submission we have re-started collecting prospective feedback to improve our results prior to the time of presentation.

A health economic analysis of the cost of managing open fractures in the elderly.

By Caitlin Pley (University of Cambridge) Katie Purohit (University of Cambridge) Matija Krkovic (Department of Trauma and Orthopedics, Cambridge University Hospital)

Introduction

Open lower limb fractures are resource-intensive fractures, accounting for a significant proportion of the workload and cost of orthopaedic trauma units. A recent study has evaluated that the median cost of direct inpatient treatment of open lower-limb fractures in the National Health Service (NHS) is steep, at £19189 per patient. Healthcare providers are expected to be aware of the costs of treatments, although there is very limited dissemination of this information, neither on a national or local level. Older adults (>65 years old) are at an increased risk of the types of high-energy injuries that can result in open lower limb fractures. Generally, there remains a significant lack of literature surrounding the cost of open fracture management, especially in specific patient groups that are disproportionately affected by these fractures. This study has calculated the direct inpatient care costs of older adults with open lower limb fractures.

Goal

Open lower limb fractures in adult patients over 65 years old treated at Addenbrooke's Hospital of Cambridge University Hospitals NHS Trust were identified over the period of
March 2014-March 2019. Isolated fractures of the femur, tibia and fibula over this time period were included. Direct inpatient care costs were calculated using information about the sustained fracture, operative time, implant(s) and theatre kit(s) used, the number of patient bed-days on the orthopaedic ward and critical care unit, and the number of hours of inpatient physiotherapy received. Direct inpatient care costs were compared with the income received by our centre for each of these cases, according to Healthcare Resource Group (HRG) cost codes. Our data was also compared with existing literature on Patient Level Costing (PLC) figures for open lower limb fractures.

Method

Results

We extracted data from 58 patients over the age of 65 years treated for open isolated lower limb fractures at Addenbrooke's Hospital, Cambridge University Hospitals NHS Trust, between March 2014 and March 2019. Data analysis is currently in the final stages and will be finalised promptly.

Conclusions and recommendations

The absence of published primary literature and clinical audits on this topic continues to hinder the inclusion of cost-effectiveness as an important factor in clinical decision-making. This study provides valuable insight into the true cost of open lower limb fractures in a key patient population. These results should be used to inform the construction of cost codes utilised to reimburse NHS hospitals for the treatment of elderly patients with these injuries.

Prediction of stair falls in older people using a biomechanical profiling approach: A 12-month longitudinal study

By Thijs Ackermans (Liverpool John Moores University) Natasha Francksen (Liverpool John Moores University) Raul Casana-Eslava (Liverpool John Moores University)

Abstract Id: 6585
Event: EORS 2019
Topic: Biomechanics

Introduction

Stair falls are a major health problem for older people and represent a high risk for major injury, such as hip fracture. However, at present there are no specific screening tools for stair fall prediction. Various general fall risk screening tests based on clinical and functional scores are available, but it remains unknown if such measurements can identify older individuals at risk for a stair fall specifically. We have recently developed a stair-specific biomechanical approach which profiles individual stepping strategies, but its validity for predicting stair fall risk has not been tested. The purpose of the present study was: 1) to investigate whether stair
fallers could be differentiated from non-fallers by mutual biomechanical risk factors or functional parameters; 2) to establish the biomechanical stepping profile at the greatest risk for a stair fall and identify the underlying functional parameters.

Goal

Eighty-seven older adults (>65 years) negotiated an instrumented seven-step staircase and performed a range of clinical and functional tasks. K-means clustering was used to profile the overall stair negotiation behaviour for stair ascent and descent with six biomechanical outcome measures indicative of fall risk as input. Cluster profiles were calculated to examine differences between behaviours. Falls and events of balance perturbation (combined referred to as “hazardous events”) were monitored during a 12-month follow-up. Logistic regression analysis was executed to determine the underlying clinical and functional capabilities of each cluster. Cox-regression analysis was executed to examine if the clinical and functional tests or biomechanical outcome measures could predict hazardous events. Kaplan-Meier survival curves and log-rank tests were obtained to identify the stepping strategy at greatest risk for a hazardous event.

Method

Results

The commonly used Fall Risk Assessment Tool classified 1 out of 17 stair fallers at risk for a fall. No significant Cox-regression model could be obtained for the clinical and functional tests. None of the single biomechanical risk factors significantly improved prediction of a hazardous event in either stair ascent and descent. Two particular stepping strategies identified by the biomechanical profiling approach in stair ascent were linked with prospective hazardous events.

Conclusions and recommendations

The stepping profiling method showed potential to predict stair fall risk in older adults against the limited predictability of functional and single parameter approaches currently used as screening tools. Future research should implement the stepping profiling method in more people in real life stair negotiation conditions, avoiding the constraints necessary to conduct biomechanical research in the lab.

Material properties and multiaxial mechanical loading to optimize chondrogenesis but limit proteoglycan loss in cell-enriched hydrogel constructs

By Seyed Ali Elahi (Biomechanics Section, Department of Mechanical Engineering, KU Leuven, Leuven, Belgium; Human Movement Biomechanics Research Group, Department of Movement Sciences, KU Leuven, Leuven, Belgium)Heleen Fehervary (Biomechanics Section, Department of Mechanical Engineering, KU Leuven, Leuven, Belgium)Nele Famaey
Abstract Id: 6584  
Event: EORS 2019  
Topic: Cartilage

Introduction

To unravel the relation between mechanical loading and biological response, cell-seeded hydrogel constructs can be used in bioreactors under multi-axial loading conditions that combines compressive with torsional loading. Typically, considerable biological variation is observed. This study explores the potential confounding role of mechanical factors in multi-directional loading experiments. Indeed, depending on the material properties of the constructs and characteristics of the mechanical loading, the mechanical environment within the constructs may vary. Consequently, the local biological response may vary from chondrogenesis in some parts to proteoglycan loss in others. This study uses the finite element method to investigate the effects of material properties of cell-seeded constructs and multiaxial loading characteristics on local mechanical environment (stresses and strains) and relate these to chondrogenesis (based on maximum compressive principal strain (MCPS) - Zahedmanesh et al., 2014) and proteoglycan loss (based on fluid velocity (FV) - Orozco et al., 2018).

Goal

The construct was modelled as a homogenized poro-hyperelastic (using a Neohookean model and Darcy’s law) cylinder of 8mm diameter and equal height using Abaqus. The bottom surface was fully constrained and dynamic unconfined compression and torsion loading were applied to the top surface. Free fluid flow was allowed through the lateral surface. We studied the sensitivity of the maximum values of the target parameters at 9 key locations to the material parameters and loading characteristics. Six input parameters were varied in preselected ranges: elastic modulus (E=[20,80]kPa), Poisson’s ratio (nu=[0.1,0.4]), permeability (k=[1,4]×10^-12m^4/Ns), compressive strain (Comp=[5,20]%), rotation (Rot=[5,20]^o) and loading frequency (Freq=[1,4]Hz). A full-factorial design of experiment method was used and a first-order polynomial surface including the interactions fitted the responses.

Method

Results

MCPS varies between 7.34% and 33.52% and is independent of the material properties (E, nu and k) and Freq but has a high dependency on Comp and a limited dependency on Rot. The maximum value occurs centrally in the construct, except for high values of Rot and low Comp where it occurs at the edges. FV vary between 0.0013mm/sec and 0.1807mm/sec and dominantly depends on E, k and Comp, while its dependency on Rot and Freq is limited. The maximum value usually occurs at the edges, although at high Freq it may move towards the center of the superficial and deep zones.

Conclusions and recommendations
This study can be used as a guideline for the optimized selection of mechanical parameters of hydrogel for cell-seeded constructs and loading conditions in multi-axial bioreactor studies. In future work, we will study the effect in intact and injured cartilage explants.

Calcium-functionalized 3D silk gelatin bioink promotes osteogenesis of mesenchymal stromal cells: perspectives for orthopedic surgery

By Cristina Manferdini (IRCCS Istituto Ortopedico Rizzoli; Laboratorio di Immunoreumatologia e Rigenerazione Tissutale)

Abstract Id: 6583
Event: EORS 2019
Topic: 3-D Printing

Introduction

Bone tissue engineering (BTE) is aimed at developing innovative biomaterials capable of promoting tissue repair. 3D bioprinting technology is a promising strategy to develop osteoinductive and osteoconductive “smart” biomaterials and it can offer new perspectives for developing defect site-specific and patient-specific bone constructs. Herein, we developed a calcium functionalized silk gelatin-based 3D (SF-G-CaCl2) scaffold and evaluated the potential of enhancing the osteogenic differentiation of encapsulated human mesenchymal stromal cells (hMSCs).

Goal

Silk gelatin-based 3D bioprinted constructs, composed of 5% bombyx mori silk fibroin (SF) and gelatin (G) were functionalized with 2.6 mM CaCl2 and encapsulated with hMSCs through the bioprinting platform (3D Discovery, RegenHU). SF-G was used as experimental control. SF-G-CaCl2 and SF-G constructs were cultured with D-MEM high glucose with and without osteogenic factors (OF). Cell viability assessment and osteogenic differentiation through histology, gene expression analyses by Real Time PCR (RUNX2, OPN, COL1A1, ALP, OCN and SOST) and proteins analyses by MALDI-TOF mass spectrometer (BMP-2, BMP-4, β catenin) were carried out. Days 1,14 and 21 were chosen to monitor osteogenic differentiation.

Method

Results

SF-G-CaCl2 resulted biocompatible ensuring high percentage of cell viability. Histological analysis with von Kossa staining showed significant increase of mineralization deposition in
the presence of calcium. Gene expression analyses displayed a high expression of RUNX2, OPN and COL1A1 in 3D bioprinted SF-G-CaCl2 (P

Conclusions and recommendations

The advantages of combining Ca2+, SF-G bioink and 3D bioprinting technology opens potential insights for improving in vitro osteogenic potential of hMSCs for future BTE approaches.

Nanostructured silver thin films for biomedical devices: evaluation of biofilm inhibition capability

By Gabriela Graziani (IRCSS Istituto Ortopedico Rizzoli, Bologna, Italy)M. Cappelletti (Department of Pharmacy and Biotechnology, University of Bologna, Bologna, Italy)D. Ghezzi (Department of Pharmacy and Biotechnology, University of Bologna, Bologna, Italy)

Abstract Id: 6580
Event: EORS 2019
Topic: Infection

Introduction

Infections are among the main complications connected to implantation of biomedical devices, having high incidence rate and severe outcome. Because their treatment is challenging, prevention must be preferred. For this reason, solutions capable of exerting suitable efficacy while not causing toxicity and/or development of resistant bacterial strains are needed. To address infection, inorganic antibacterial coatings, and in particular silver coatings, have been extensively studied and used in the clinical practice, but some drawbacks have been evidenced, such as scarce adhesion to the substrate, delamination, or scarce control over silver release.

Goal

Here, antibacterial nanostructured silver-based thin films are proposed, obtained by a novel plasma-assisted technique, Ionized Jet Deposition (IJD). Coatings are obtained by deposition of metallic silver targets. Films thickness is selected based on previous results aimed at measuring extent and duration of silver release and at evaluating toxicity to host cells (fibroblasts). Here, composition (grazing incidence XRD) and morphology (SEM) of the obtained coatings are characterized for deposition onto different substrates, both metallic and polymeric. For heat sensitive substrates, possible alterations caused by coatings deposition in terms of morphology (SEM) and composition (FT-IR) is assessed. Then, a proof-of-concept study of the capability of these films to inhibit microbial biofilm formation is performed by using two different supports i.e. the Calgary Biofilm Device and the microplates. To the best of the Authors’ knowledge, this is the first study describing the application of specific anti-biofilm analyses to nanostructured coatings. In particular, anti-biofilm activities are tested
against the following pathogenic strains: Escherichia (E.) coli NCTC12923, Staphylococcus (S.) aureus ATCC29213 and S. aureus 86. Among these, the strain 86 is not only pathogen but it also possess several antibiotic resistance genes, allowing the evaluation of the utilization of nanostructured coatings as an alternative anti-microbial systems to face the global threat of antibiotic resistance.

Method

Results

Results indicate that films deposited from silver targets are composed of nanosized aggregates of metallic silver, indicating a perfect transfer of composition from the deposition target to the coatings.

Conclusions and recommendations

Results obtained here indicate that the films have significant antibacterial and antibiofilm activity. In addition, they prove that the system can be successfully applied for evaluation of antibacterial efficacy of coatings for biomedical applications.

**Vestibular Symptoms are More Common in Higher Cobalt Ion Concentrations in MoM Arthroplasty**

By Jetse Jelsma (Department of Orthopedics, Zuyderland Medisch Centrum)Martijn Schotanus (Department of Orthopedics, Zuyderland Medisch Centrum)Henne Kleinveld (Department of Clinical Chemistry, Zuyderland Medisch Centrum)

Abstract Id: 6578
Event: EORS 2019
Topic: Other

Introduction

An increase in metal ion levels is seen after implantation of all MoM hip prosthesis due to release from the surface directly, more so during articulation and corrosion of the bearing surfaces. The bearing surfaces in MoM prosthesis consist of cobalt, chromium and molybdenum. Several case-reports of cobalt toxicity due to a MoM prosthesis have been published in the last decade. Cobalt intoxication may lead to a variety of symptoms: neuro-ocular toxicity (tinnitus, vertigo, deafness, blindness, convulsions, headaches and peripheral neuropathy), cardiotoxicity and thyroid toxicity. Nausea, anorexia and unexplained weight loss have been described. Systemic effects from metal ions even with well functioning implants or with ion concentrations lower than those associated with known adverse effects may exist and warrant investigation. The aim of this study is to investigate self-reported systemic complaints in association with cobalt ion concentrations in patients with any type of MoM hip prosthesis.
**Goal**

A cohort study was conducted. Patients with both unilateral and bilateral, resurfacing and large head metal on metal total hip arthroplasties were included for the current study. Blood metal ion concentrations (cobalt and chromium) were measured by inductively coupled plasma mass spectrometry (ICP-MS). Based on the known cobalt toxicity symptoms of case-reports and toxicology reports a new non-validated questionnaire was developed. Questions were subdivided in general questions/symptoms, vestibular symptoms, neurological symptoms, emotional health and cardio- and thyroid toxicity symptoms.

**Method**

**Results**

Independent samples T test, Fisher’s Exact Test and Pearson’s (R) correlation were used. Analysis was performed on two groups; a low cobalt ion concentration group and a high cobalt ion concentration group A total of 62 patients, 36 (58%) men and 26 (42%) women, were included with a mean age at surgery of 60.8 ± 9.3 years (41.6 – 78.1) and a mean follow up of 6.3 ± 1.4years (3.7 – 9.6). In these patients a total of 71 prosthesis were implanted: 53 unilateral and 9 bilateral. Of these, 44 were resurfacing and 27 large head metal on metal (LHMoM) total hip arthroplasties. Mean cobalt and chromium ion concentrations were 104 ± 141 nmol/L (9 – 833) and 95 ± 130nmol/L (6 – 592), respectively. Based on the different thresholds (120 – 170 or 220 nmol/L) the low cobalt ion concentration group consisted of 44 (71%), 51 (82%) or 55 (89%) subjects respectively. No differences were found in general characteristics, independently of the threshold. The composite score of vestibular symptoms (vision, hearing, tinnitus, dizziness) was significantly higher (p < .050) in all high cobalt ion concentrations groups, independent of the threshold value.

**Conclusions and recommendations**

This study aimed to detect a trend in self-reported systemic complaints in patients with metal-on-metal hip arthroplasty due to raised cobalt ion concentrations. Vestibular symptoms were more common in high cobalt ion concentration groups independent of the three threshold levels tested. The upperlimit of acceptable cobalt ion concentrations remains uncertain. With regards to proactively inquired, self-reported symptoms the threshold where effects may be present could be lower than values currently applied in clinical follow-up. It is unknown what exposure to elevated metal ion concentrations for a longer period of time does with aging subjects. Further research with a larger cohort and more standardized questionnaire is necessary to uncover previously undiscovered or under-reported effects warranting investigation.

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**‘Quality over Quantity’ - Habitual Physical Activity and the Association with Metal Ion Concentrations in Unilateral Hip Resurfacing**
Introduction

Hip resurfacing arthroplasty (HRA) became a popular procedure in the early 90s because of the improved wear characteristic, preserving nature of the procedure and the optimal stability and range of motion. Concerns raised since 2004 when metal ions were seen in blood and urine of patients with a MoM implant. Design of the prosthesis, acetabular component malpositioning, contact-patch-to-rim distance (CPR) and a reduced joint size all seem to play a role in elevated metal ion concentrations. Little is known about the influence of physical activity (PA) on metal ion concentrations. Implant wear is thought to be a function of use and thus of patient activity levels. Wear of polyethylene acetabular bearings was positively correlated with patients’ activity in previous studies. It is hypothesized that daily habitual physical activity of patients with an unilateral resurfacing prosthesis, measured by an activity monitor, is associated with habitual physical activity.

Goal

A prospective, explorative study was conducted. Only patients with a unilateral hip resurfacing prosthesis and a follow-up of 10 ± 1 years were included. Metal ion concentrations were determined using ICP-MS. Habitual physical activity of subjects was measured in daily living using an acceleration-based activity monitor. Outcome consisted of quantitative and qualitative activity parameters.

Method

Results

In total, 16 patients were included. 12 males (75%) and 4 females (25%) with a median age at surgery of 55.5 ± 9.7 years [43.0 – 67.9] and median follow-up of 9.9 ± 1.0 years [9.1 – 10.9]. The median cobalt and chromium ion concentrations were 25 ± 13 and 38 ± 28 nmol/L. A significant relationship, when adjusting for age at surgery, BMI, cup size and cup inclination, between sit-stand transfers (p = .034) and high intensity peaks (p = .001) with cobalt ion concentrations were found (linear regression analysis).

Conclusions and recommendations

This study showed that a high number of sit-stand transfers and a high number of high intensity peaks is significantly correlated with high metal ion concentrations, but results should be interpreted with care. For patients it seems save to engage in activities with low intensity peaks like walking or cycling without triggering critical wear or metal ions being able to achieve important general health benefits and quality of life, although the quality (high intensity peaks) of physical activity and behaviour of patients (sit-stand-transfers) seem to influence metal ion concentrations.
Does a single Haemcues test reduce the need for extensive pre-operative blood tests and their associated costs in elective arthroplasty?

By Joao Valverde ()Rakan Kabariti ()James Smith ()

Introduction

Pre-operative anaemia can present in up to 30% of elective arthroplasty patients. The presence of anaemia increases the risk of requiring blood transfusions post-operatively as well as acts as an independent risk factor for poor outcomes. Recent international consensus on this topic has recommended a specific care pathway for screening patients with pre-operative anaemia using a simple bedside Haemacue test in an attempt to reduce the need for blood transfusions and the need for extensive peri-operative bloods tests which can be time consuming and costly. This pathway was therefore incorporated in our trust.

Goal

This was a retrospective study done at a single tertiary arthroplasty centre. Our data collection included the Haemacue test results and formal haemoglobin levels if they were performed as well as compliance and costs of each of the tests for patients listed for an elective shoulder, hip and knee arthroplasty between September and December 2018. Medical records and demographics were also collected for these patients for subgroup analysis. Our exclusion criteria comprised patients listed for revision arthroplasty surgery.

Method

Results

87 patients were included in this study. Our compliance rate was 15%. The difference between a Haemacue test and a formal FBC result was only 17.6g/L suggesting that it has a high sensitivity and specificity. With regards to costs, we found that a Haemacue test costs £2, compared to £7.5 for a full blood count and Haematinics combined. This gave an overall cost saving of £5.5 per patient. Extrapolation of this date locally for 2017 at our hospital, where 1575 primary joint arthroplasties were done, a cost saving of £8,662.5 could have been achieved. Within the UK using data extrapolated form the National Joint Registry a total of £1,102,205.5 could have been saved.

Conclusions and recommendations
The use of a single, Haemcue test to screen for pre-operative anaemia in elective arthroplasty patients is more cost effective compared to a formal full count and haematinics tests. However, we found that compliance with the care pathway is variable due to system limitations. This may be addressed through implementing changes to our electronic system in which patients are booked for surgery. We also noted a significant cost reduction if this pathway were to be used Nation Wide. On the whole, we encourage other centres to consider the use of the Haemacue test and its incorporated care pathway pre-operatively in elective arthroplasty.

Surgical repair outcome for tendinopathy is affected in obese patients microscopically

By Matteo Spezia (University of Padua, Italy) Gabriele Schiaffini (Sapienza – University of Rome, Italy) Silvia Elli (University of Milan, Italy)

Abstract Id: 6575
Event: EORS 2019
Topic: Tendon

Introduction

Obese patients show a higher incidence of tendon-related pathologies. These patients present a low inflammatory systemic environment and a higher mechanical demand which can affect the tendons. In addition, inflammation might have a role in the progression of the disease as well as in the healing process.

Goal

A systematic review was performed by searching PubMed, Embase and Cochrane Library databases. Inclusion criteria were studies of any level of evidence published in peer-reviewed journals reporting clinical or preclinical results. Evaluated data were extracted and critically analysed. PRISMA guidelines were applied, and risk of bias was assessed, as was the methodological quality of the included studies. We excluded all the article with high risk of bias and/or low quality after the assessment. Due to the high heterogeneity present among the studies, a metanalysis could not be done. Thus, descriptive analysis was performed.

Method

Results

After applying the previously described criteria, were included thirty articles assessed as medium or high quality. We analysed the data of 50865 subjects, 6096 of which were obese (BMI ≥ 30 accordingly to the WHO criteria). The overall risk of re-tear after surgery is about the 10% more than normal BMI subjects. The rupture risk fluctuates in the studies without showing a significant trend.

Conclusions and recommendations
Obese subjects have a higher risk to develop tendinopathy and a worse outcome after surgery as confirmed in several human studies. The obese influence on tendon structure and mechanical properties may rely on the fat tissue endocrine proprieties and on hormonal imbalance. Clinicians should consider obesity as a predisposing factor for the development of tendinopathies and for a higher risk of complications in patients who underwent surgical repair of tendons.

The role of adipokines in tendinopathy: a systematic review

By Matteo Spezia (University of Padua, Italy)Marina Macchi (University of Milan, Italy)Silvia Elli (University of Milan, Italy)

Introduction

Adipose tissue release several bioactive peptide and hormones, the adipokines, that promotes a low inflammatory systemic state. Inflammation, affecting the tendon homeostasis, could play a role in the development of tendon disease as well as in the healing process. Obese patients show a dysregulated level of adipokines and considering the higher mechanical demand, this relate to the higher incidence of tendinopathies in these subjects.

Goal

A systematic review was performed by searching PubMed, Embase and Cochrane Library databases. Inclusion criteria were studies of any level of evidence published in peer-reviewed journals reporting clinical or preclinical results. Evaluated data were extracted and critically analysed. PRISMA guidelines were applied, and risk of bias was assessed, as was the methodological quality of the included studies. We excluded all the article with high risk of bias and/or low quality after the assessment.

Method

Results

After applying the previously described criteria, we included 12 articles assessed as medium or high quality. Leptin, others adipokines and in general changes in the hormones delicate equilibrium affect the tendon either qualitatively and/or quantitatively. The evidence still lacks consensus on their role which is probably involved in both anabolic and catabolic pathways.

Conclusions and recommendations
The role of adipokines in the structure and healing of tendons is still debated. Further studies are needed to clarify the relation between deregulated levels of adipokines and the development of tendinopathy. A better understanding of the molecular interactions could allow us to individuate future therapeutic targets.

Development of a muscle cell culture model from human muscle biopsy

By Antoine Florin (Bone and Cartilage Research Unit (ULiège)) Cécile Lambert (Bone and Cartilage Research Unit (ULiège)) Christelle Sanchez (Bone and Cartilage Research Unit (ULiège))

Abstract Id: 6570
Event: EORS 2019
Topic: Pathology

Introduction

Sarcopenia is an age-related muscle disease characterized by decreased muscle strength, muscle quantity / quality and physical function. The diagnosis of sarcopenia is based on clinical criteria by measurement of lean body mass. The study of the skeletal muscle cell secretome could allow the identification of biomarkers of sarcopenia, in order to diagnose and follow the evolution of the disease. In this purpose, we have developed a culture model of skeletal muscle cell obtained from human muscle biopsy.

Goal

Human muscle biopsies from vastus lateralis were obtained from cadavers (n=16). Two enzymatic digestion methods of the biopsy were compared: collagenase/dispase/CaCl2 vs. collagenase/trypsin. In order to purify the cell population into myoblasts, and to eliminate fibroblasts, we used magnetic beads sorting (MACS) of the cells directly after the enzymatic digestion. The beads, coated with an anti-CD56 antibody, were incubated for 15 minutes at room temperature, in order to prevent mortality. We developed an immunofluorescence protocol for a number of muscle-specific proteins, to characterize skeletal muscle cells. One set of proteins were markers of proliferation (Ki-67 and desmin) and another set were markers of myoblast differentiation (MyoD, Myf5, Myosin Heavy Chain (MYH)). To select the best proliferation medium, we have compared 5 media on cell doubling time, by counting the cells with trypan blue. Similarly, in order to select the best differentiation medium, we have challenged 2 media on the following criteria: the fusion index (FI, ratio between the number of nuclei present in the myotubes and the total number of nuclei), the surface of the myotubes (SM), and the mortality induced by the change of medium (M).

Method

Results
To digest biopsies with collagenase/dispase and CaCl2 gave a higher return than collagenase/trypsin. The anti-CD56 immunomagnetic beads sorting method (MACS) allowed to obtain high purity (>95% myogenic cells). The medium DMEM supplemented with 10% Fetal Bovine Serum (FBS), 2% UltroserG(UG), 1% glutamine, 1% penicillin/streptomycin (P/S) and 1% HEPES was selected out-off 5 proliferation media, because it had the best doubling time (31-hour). The medium DMEM supplemented with 0,5% UG, 1% glutamine, 1% P/S and 1% HEPES was selected among 2 differentiation media because it showed the best fusion index, the larger myotubes and the lower mortality (FI=74,07%; SM=27%; M=1,25%).

Conclusions and recommendations

To conclude, this model will be used to study the secretome of healthy patients vs. sarcopenic patients in order to identify potential biomarker of sarcopenia.

Loading of chondrocytes in a multi-axial bioreactor platform shows differential responses between chondrogenic precursor cells and osteoarthritic chondrocytes

By Anke Govaerts (KU Leuven)Valeria Graceffa (KU Leuven)Rik Lories (KU Leuven)

Abstract Id: 6568
Event: EORS 2019
Topic: Cartilage

Introduction

Mechanical loading regulates the metabolism of chondrocytes in cartilage1. Nowadays, studies exploring the in vitro response of cartilage towards loading often rely on bioreactor experiments applying only compressive loading. This is likely not sufficiently representative for the complex multi-directional loading profile in vivo (i.e. where typical compressive and shear loading are both present)2. The impact of multi-axial loading is specifically relevant in the context of the onset of osteoarthritis (OA) due to joint destabilization. Here, alterations in the 3D loading profile, and in particular increased shear forces, are suggested to initiate catabolic molecular responses leading to cartilage degeneration3. However, in vitro/ex vivo data confirming this hypothesis are currently lacking. Therefore, we aim to investigate how increased shear loading affects the metabolism and ECM deposition of a healthy chondrogenic cell line and if this response is different in osteoarthritic primary chondrocytes.

Goal

A murine chondrogenic precursor cell line (ATDC5) and primary human osteoarthritic articular chondrocytes (hOACs) were encapsulated in 2.2% alginate disks and cultured in DMEM medium for three days. Hydrogels seeded with the different cell groups were loaded
in the TA ElectroForce® BioDynamic Bioreactor and subjected to following loading conditions: (a) 10% compression at 1Hz for 1h, (b) 10% compression and 10° shear loading at 1Hz for 1h. Unloaded constructs were used as control. After loading, hydrogel constructs were stabilized in culture medium for 2 hours, to facilitate adequate gene expression responses, before being dissolved and snap frozen. RNA was isolated and gene expression levels specific for anabolic pathways, characterized by extracellular matrix (ECM) genes (Col2a1, Aggrecan and Perlecan), catabolic processes (MMP-3 and MMP-13) and chondrogenic transcription factor (Sox9) were evaluated using RT-qPCR.

Method

Results

The TA ElectroForce® BioDynamic Bioreactor was successfully set-up to mimic cartilage loading. In ATDC5 cells, compression elicits an increase in all measured ECM genes (Col2a1, Aggrecan and Perlecan) compared to unloaded controls, suggesting an anabolic response. This upregulation is decreased when adding additional shear strain. In contrast to ATDC5 cells, the anabolic response of proteoglycans Aggrecan and Perlecan to compressive loading was lower in osteoarthritic chondrocytes, and Col2a1 expression appeared decreased. Adding shear strain reversed this effect on Col2a1 expression. Multi-directional loading increased transcription factor Sox9 expression compared to compression in both ATDC5 and OA chondrocytes. In OA chondrocytes, both loading regimens increased MMP-3 and MMP-13 expression.

Conclusions and recommendations

Shear loading reduces the anabolic effect of compressive loading in both cell types. OA cells presented more catabolic response to mechanical loading compared to precursors, given the increase in catabolic enzymes MMP-3 and MMP-13. In future work, healthy human primary cells will be used as an additional group. Furthermore, varying magnitudes of compression and shear loading will be imposed to define multi-directional loading protocols that better correspond to the in vivo physiological and pathological loading.

A retrospective audit of post operative rehabilitation management of quadriceps tendon repair

By Arjun Puvanendran (NHS)

Abstract Id: 6567
Event: EORS 2019
Topic: Other

Introduction
Quadriceps tendon rupture repair has few established protocols for recommended regime of rehabilitation. This audit aimed to evaluate the post-operative rehabilitation management plans of patients who had undergone a repair of a ruptured quadriceps tendon in a UK district general hospital according to six pre-defined criteria.

**Goal**

A retrospective audit was performed of patient operative notes generated by utilising pathway coding term ‘quadriceps tendon repair’ in the Trust's theatre patient data system between January 2014- January 2019. The following six parameters were reviewed in the management plans for quadriceps tendon rupture: a recorded plan for range of motion (ROM), initialised time of full weight bearing (FWB) use of hinge knee brace (HKB), duration and requirement of thromboprophylaxis, time and requirement of physiotherapy (PT) input and outpatient (OPD) follow-up schedule. Exclusion criteria included: tibial spine avulsion injuries, paediatric extensor mechanism injuries and patella fractures.

**Method**

**Results**

A total of 34 operative case notes were reviewed for patients who had undergone a repair of quadriceps tendon rupture. All notes (n=34) included a plan for ROM. However, only 21 (62%) indicated the initialised time of FWB, 29 (85%) mentioned use of HKB, 13 (38%) detailed duration and requirement of thromboprophylaxis, 19 (56%) specified time and requirement of PT input and 5 (14%) included OPD follow-up schedule. Whilst a ROM plan had been fully documented in each operative note, the described plan of allowances and restrictions in ROM demonstrated different recommendations amongst surgeons.

**Conclusions and recommendations**

Recommendation to generate a uniform post-operative plan for quadriceps tendon rupture patients, to ensure a well structured and systematic regime of rehabilitation.

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**Feasibility and preliminary efficacy study of an online pain management programme for children undergoing major orthopaedic surgery: iCanCope Post-Op Surgery.**

By Mary-Rose Mulry (Centre for Pain Research, School of Psychology, National University of Ireland, Galway, Ireland) Paul O'Reilly (Centre for Pain Research, School of Psychology, National University of Ireland, Galway, Ireland) Bláithín O'Grady (Centre for Pain Research, School of Psychology, National University of Ireland, Galway, Ireland)
Introduction

One in four children experience chronic post-surgical pain (i.e. pain that lasts longer than 3 months). Children and adolescents report that chronic pain makes them feel insecure, affects school attendance and affects their relationships with friends and family. It is important that children and adolescents learn ways to cope with acute (or short-term) pain so that it does not become chronic in nature. Smartphone applications have the potential to give children and adolescents practical tools to deal with their pain. An application called iCanCope PostOp has been developed to help kids deal with pain after surgery.

Goal

Using a mixed methodological approach the study is comprised of three phases. The three phases are as follows: Phase 1 aims to adapt a comprehensive, theory and evidence-based app called iCanCope PostOp to support adolescents recovering from a major orthopaedic surgery. Focus groups will be held with health care professionals, focus groups/individual interviews will be held with adolescents and their parents/guardians. Phase 2 aims to test the usability, accessibility and acceptability of the newly adapted app using an iterative process of testing and refinement to ensure the app meets the needs of adolescent scoliosis patients. Invision software will be used to display the app prototype to parents and adolescents. Individual interviews will be conducted with a sample of 2-3 adolescents and 1-2 parents/guardians recruited per cycle (2-3 cycles; total N=6 to 9 adolescents, total N=3-6 parents/guardians). Phase 3 aims to determine whether the iCanCope PostOp app reduces the impact of acute and chronic pain for adolescents following surgery for scoliosis through a pilot RCT. 90 participants who are undergoing major orthopaedic surgery will be randomly allocated to 3 groups; treatment as usual, educational articles only or iCanCope PostOp smartphone app.

Method

Results

We hypothesis that iCanCope PostOp will be effective in reducing post-operative: pain disability and distress in adolescents and will reduce the risk of having chronic post-surgical pain 3 and 12 months post-surgery.

Conclusions and recommendations

It is hypothesised that the proposed iCanCope PostOp app will be effective in aiding the management of pain following major orthopaedic surgery.

Development of Shape-memory Balloon for Bone Tumor Treatment
By Sosuke Ouchi (National Institute for Material Science, Tokyo University of Science)Eri Niiyama (National Institute for Material Science, University of Tsukuba)Koichiro Uto (National Institute for Material Science)

Abstract Id: 6559
Event: EORS 2019
Topic: Biomaterials

Introduction

Treatment of pain in malignant bone tumor case is a key strategy for improving quality of life in patients. Minimally invasive bone cement injection procedures such as percutaneous vertebroplasty (PVP) and balloon kyphoplasty (BKP) have been widely reported as a recovery technique after bone tumor surgery. These two developed techniques remarked as highly effective pain relief treatment for metastatic vertebral tumors. However, cement leakage problem arises after bone cement injection is carried out into the cavity following the balloon removal. Leakage of cement into the spinal canal have been reported to induce serious complications such as pulmonary embolism, cerebral infarction, cardiogenic shock, and spinal cord injury. Currently, BKP balloon technique has only been used to create the cavity regardless leakage problem. In this study, we have developed a shape-memory balloon which can prevent the leakage of bone cement (Fig.1). In addition, the balloon is capable of carrying large loads of chemotherapeutic drug, doxorubicin hydrochloride (DOX), as well as magnetic nanoparticles (MNPs). Magnetic nanoparticles were included in the balloon to generate sufficient heat for hyperthermia treatment by applying alternating magnetic field (AMF). The generated heat can also be used to trigger DOX release from the balloon due to its thermo-responsive property.

Goal

Shape-memory polymer was prepared by crosslinking poly(ε-caprolactone) (PCL). The balloon shape was formed by blow molding the PCL (Fig. 2). Subsequently, bone cement injection test was performed using pig femur and evaluated by computed tomography (CT) image. Furthermore, we evaluated the heat generation and drug release behavior of the balloon when AMF was applied (166 kHz, 192 A).

Method

Results

No leakage was observed after bone cement injection test was performed by using this shape-memory balloon. CT image also suggested that the injection test with balloon prevented the leakage of the bone cement from the corpse pig femur compared to direct injection of bone cement into the cavity. Infrared thermal imaging showed that the 31.6 wt%-MNPs loaded balloon generated heat up to 47.8 °C after 360 s AMF application. In term of drug release, the PCL film releases DOX slowly for at least 4 weeks when tested in vitro. In addition, during the DOX release test at 45 °C, assuming combined use of thermotherapy, the amount of DOX released per day was 3.3 times higher than the release test conducted at 37 °C. This was higher than the IC50 value (2.8 μg/mL, 24 hours) of human osteosarcoma cells when combined with thermal treatment.
Conclusions and recommendations

Based on these results, the proposed modified BKP system may provide a promising novel design of safe and efficient bone cement injection and local drug delivery system for improved bone tumor treatment.

Morphometric characteristics of the trochleodysplastic knee: a landmark-based 3D analysis

By Jonas Grammens (M.D.) (University of Antwerp, Antwerp, Belgium) Wouter Peeters (M.D.) (Antwerp Orthopaedic Center, AZ Monica Hospitals, Antwerp, Belgium) Annemieke Van Haver (P.T., Ph.D.) (MoRe Institute, Antwerp, Belgium)

Abstract Id: 6555
Event: EORS 2019
Topic: Imaging

Introduction

Trochlear dysplasia is a specific morphotype of the knee, characterized by but not limited to a specific anatomy of the trochlea. The notch, posterior femur and tibial plateau also seem to be involved. In our study we conducted a semi-automated landmark-based 3D analysis on the distal femur (1), tibial plateau and patella (article submitted).

Goal

The knee morphology of a study population (n=20), diagnosed with trochlear dysplasia and a history of recurrent patellar dislocation was compared to a gender- and age-matched control group (n=20). The arthro-CT scan based 3D-models were isotropically scaled and landmark-based reference planes were created for quantification of the morphometry. Statistical analysis was performed to detect shape differences between the femur, tibia and patella as individual bone models (Mann-Whitney U test) and to detect differences in size agreement between femur and tibia (Pearson’s correlation test).

Method

Results

The size of the femur did not differ significantly between the two groups, but the maximum size difference (scaling factor) over all cases was 35%. Significant differences were observed in the throchlear dysplasia (TD) versus control group for all conventional parameters (Figure 1). Morphometrical measurements showed also significant differences in the three directions (anteroposterior (AP), mediolateral (ML), proximodistal (PD)) for the distal femur (Figure 2), tibia (Figure 3) and patella (Figure 4). Correlation tests between the width of the distal femur and the tibial plateau revealed that TD knees show less agreement between femur and tibia.
Conclusions and recommendations

The morphology of the trochleodysplastic knee differs significantly from the normal knee by means of an increased ratio of AP/ML width for both femur and tibia, a smaller femoral notch and a lack of correspondence in mediolateral width between the femur and tibia. More specifically, the medial femoral condyle shows no correlation with the medial tibial plateau.

Bibliography

A sterilizable mechanical inclinometer to measure acetabular cup inclination: A proof of concept study.

By Bernard van Duren (University of Leeds) Jonathan Lamb (University of Leeds) Mohammed Al-Ashqar (Bradford Royal Infirmary)

Abstract Id: 6554
Event: EORS 2019
Topic: Arthroplasty

Introduction

The angle of acetabular inclination is an important measurement in total hip replacement (THR) procedures. Determining the acetabular component orientation intra-operatively remains a challenge. An increasing number of innovators have described techniques and devices to achieve this. This paper describes the design of a mechanical inclinometer to measure intra-operative acetabular cup inclination. Subsequently the accuracy of this mechanical device is tested to determine its accuracy.

Goal

Inclinometer design: The aim was to design an inclinometer to measure inclination without requiring modification to existing instrumentation. The device was designed to meet the following criteria: 1. Measure inclination with acceptable accuracy (within +/- 5°) 2. Easy to
use intra-operatively (handling & visualisation) 3. Adaptable/useable with majority of instrumentation kits without modification 4. Sterilizable by all methods (Radiation, Heat, Steam) 5. Robust/reusable The prototype device was drafted using computer aided design (CAD) software. Subsequently a prototype was constructed using a 3D printer to establish the final format. The final device was CNC machined from SAE 304 stainless steel. The design uses an eccentrically weighted flywheel mounted on two W16002-2RS ball bearings pressed into symmetrical housing components. The weighted wheel is engraved with calibrated markings relative to the centre of mass of the wheel. Functioning of the device is dependent on gravity maintaining the weighted wheel in a fixed orientation while the housing can adapt to the calibration allowing for the corresponding measurement to be determined. Accuracy: The accuracy of the prototype device was compared against a digital device. A digital protractor was used to create an angle. The mechanical inclinometer (user blinded to digital reading) was used to determine the angle and then compared to the digital reading.

Inclinometer vs. Freehand: The accuracy of the device compared to the standard freehand technique was assessed using a sawbone pelvis fixed in a lateral decubitus position. 18 surgeons (6 expert, 6 intermediate, 6 novice) were asked to place an uncemented acetabular cup in a saw bone pelvis to a target of 40 degrees. First freehand then using the inclinometer. The inclination was determined using a custom built inertial measurement unit with the user blinded to the result.

Method

Results

Comparison between the mechanical and digital devices showed that the mechanical device had an average error of -0.2, a standard deviation of 1.5, and range -3.3 to 2.6. The average root mean square error was 1.1 with a standard deviation of 0.9. Comparison of the inclinometer to the freehand technique showed that with the freehand component placement 50% of the surgeons were outside the acceptable range of 35-45 degrees. The use of the inclinometer resulted all participants to achieve placement within the acceptable range. It was noted that expert surgeons were more accurate at achieving the target inclination when compared to less experienced surgeons.

Conclusions and recommendations

This work demonstrates that the design and initial testing of a mechanical inclinometer is suitable for use in determining the acetabular cup inclination in THR. Experimental testing showed that the device is accurate to within acceptable limits and reliably improved the accuracy of uncemented cup implantation in all surgeons to improve their accuracy reliably.

From failure to success: the in vivo translation of a novel bone adhesive test model

By Philip Procter (1) Division of Applied Materials Science, Department of Engineering Sciences, Uppsala University, Box 523, 75120 Uppsala, Sweden, (2) GPBio Ltd, Shannon,
Introduction

An ex vivo biomechanical test model for evaluating a novel bone adhesive has been developed (REF1). However, at day 1 in the in vivo pilot, high blood flow forced the study to halt until the solution presented here was developed.

Goal

The profuse bleeding after bone core removal affected the bond strength and was reflected in the lower mean peak value 1.53N. After considering several options, we were successful in sealing the source of blood flow by pressing adhesive into place after bone core removal. After the initial adhesive had cured additional adhesive was used to secure the bone core in place. The animals were sacrificed after 24 h and a tensile test was undertaken on the bone core to failure (figures 1.1 & 1.2).

Method

Results

The ex vivo study (REF1) produced mean peak tensile loads of 7.63N SD 2.39N (n=8, 4 rats 8 femurs). Whilst the mean peak tensile loads in the day 1 in vivo pilot were significantly lower 1.53N SD1.57 (n=8, 6 rats 8 femurs - 4 used for other test). The subsequent layered adhesive bone cores showed a mean peak tensile force of 6.79N SD =3.13 (n=8, 4 rats 8 femurs). 7/8 failed at the bone to glue interface (see figures 2 & 3).

Conclusions and recommendations

The development of a double adhesive method of fixing a bone core in the distal femur enabled mean peak tensile forces to be achieved at 24 hours that were comparable with the ex-vivo results previously demonstrated. Biomaterials researchers that intend to use gel or paste like preparations in distal femur defects in the rat should be aware of the risks of biomaterial displacement by local blood flow. References: (1) A biomechanical test model for evaluating osseous and osteochondral tissue adhesives, Procter P. et al., BMC Biomedical Engineering 2019 1:11. (2) Bone defect animal models for testing efficacy of bone substitute biomaterials. Li Y. et al., J Orthop Translat. 2015 16;3(3). (3) Roach H.I, et al.,Temporal analysis of rat growth plates: cessation of growth with age despite presence of a physis. J Histochem Cytochem. 2013 51:373-83.

Radiostereometric analysis (RSA) of the un cemented Trident Tritanium and the
Trident hydroxyapatite (HA) coated acetabular component shows equal implant stability after 2 years of clinical follow-up: a randomized controlled trial

By Timothy Vranken (MUMC+), Liesbeth Jutten (MUMC+), Bart Kaptein (LUMC)

Abstract Id: 6549
Event: EORS 2019
Topic: Arthroplasty

Introduction

Long-term implant survival of total hip arthroplasty (THA) depends on several requirements, with early implant stability being one of the most important ones. Assessment of early implant stability during the first two years of follow-up by measuring micromotion of the implant with radiostereometric analysis (RSA) is a well described and validated technique. Extensive research is performed to enhance early implant fixation, with a shift the past years towards uncemented acetabular components. Besides the well-known hydroxyapatite (HA) acetabular components which provide bone ongrowth to enhance implant fixation, new uncemented acetabular component designs showing ingrowth of bone have been developed. These cups initiate ingrowth of bone into the implant by their open metallic structure with peripheral pores, to obtain a mechanical interlock with the surrounding bone, thereby stabilizing the prosthesis in an early stage after implantation. This study compared migration of two types of acetabular components in a prospective randomized clinical trial using RSA. It is hypothesised that the Tritanium acetabular component will have an enhanced fixation compared with the Trident HA coated acetabular component, leading to improved implant stability.

Goal

Between 2011-2014, 36 patients were recruited at the Maastricht University Medical Center (MUMC+) and randomly assigned to either the ongrowth acetabular component (Trident HA coated) or the ingrowth acetabular component (Trident Tritanium). All patients received an X-3 insert (CE509982) and the uncemented Symax HA femoral prosthesis (CE 545074). All components are manufactured by Stryker (Mahwah, NJ, USA). The study was set up to compare micromotions of the implants by using RSA images that were made at 4 weeks, 3-6-12 months post-operatively with the baseline RSA acquisitions after weight-bearing. Using a model-based software package (Medis Leiden, the Netherlands) migration patterns were calculated by independent observers.

Method

Results
The translation values, with standard deviation in between brackets, of the Trident HA coated group at 2 years follow-up on the X-, Y-, and Z-axis were -0.08 (0.76), 0.24 (0.26), and 0.18 (0.45) micrometers. The Trident Tritanium group showed similar migration results on the three axes, 0.26 (0.63), 0.56 (0.63), 0.19 (0.79) micrometers respectively, with no statistical difference between these results (P-value; 0.3071, 0.7283, 0.5060). The rotation values of the Trident HA coated group at 2 years follow-up on the X-, Y-, and Z-axis were 0.15 (0.62), -0.10 (0.55), 0.06 (1.37) degrees. The Trident Tritanium group showed similar migration results on the three axes, -0.28 (0.61), 0.42 (0.63), 0.34 (0.64) degrees respectively, with no statistical difference between these results (P-value; 0.1426, 0.0950, 0.5281).

Conclusions and recommendations

The Trident Tritanium acetabular component shows good implant stability after two years of RSA follow-up and seems therefore a promising implant with a new porous coating design to be used in orthopaedic surgery.

Knock-down of RIPK1 in chondrocytes attenuates the pathogenesis of osteoarthritis

By Zheng-gang Wang (Department of Orthopedics, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology)Shuang Liang (Department of Orthopedics, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology)An-min Chen (Department of Orthopedics, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology)

Abstract Id: 6528
Event: EORS 2019
Topic: Pathology

Introduction

Osteoarthritis(OA) is a common degenerative joint disease worldwide. RIPK1 is an essential downstream component of many pattern recognition and death receptors. It has emerged as a promising therapeutic target for the treatment of a wide range of human neurodegenerative, autoimmune, and inflammatory diseases. However, the role of RIPK1 in OA remains unclear.

Goal

The destabilized medial meniscus (DMM) surgical model of OA was produced on the right knee according to a previously published protocol. Forty mice were average divided into four groups. Intra-articular injection was performed with 10 μL Ad-shRIPK1 or Ad-negative adenoviruses (1×109 plaque forming units) once a week for 8 weeks before sacrifice. The right knee joint was analyzed with hematoxylin and eosin(H&E) staining, Safranin-O/Fast Green(Saf-O) staining, TUNEL staining and immunohistochemistry. Mouse primary chondrocytes were collected from the knee cartilage of new-born mice. The expression of MMPs was measured by western blot after 5ng/ml IL-1β treatment with adenovirus for 2 days. The role of RIPK1 playing in TRIF and MYD88-dependent IL-β-induced inflammation...
was investigated by western blot. Meanwhile, we used western blot and immunofluorescence to explore the interaction between RIPK1 and TRAF2. Finally, we investigated the effect of RIPK1 in apoptosis and the potential signal transduction pathways in inflammation. Statistics is in attachments.

Method

Results

Saf-O and H&E staining suggested that OA mouse samples were reliable(Fig.1a-d). Then we found the phosphorylation level of RIPK1 was significantly up-regulated in DMM mouse(Fig.1e-f) and in chondrocytes induced by IL-β for 10 min(Fig.3f-g). With the treatment of Ad-shRIPK1, the degree of cartilage degeneration and the synovitis was significantly reduced, which was quantized with OARSI scores(Fig.2a-f). Meanwhile, the expression levels of MMPs were markedly decreased in DMM+sh-RIPK1 group, compared with DMM group(Fig.2c-d). In vitro experiment, western blot and ELISA showed the knock-down of RIPK1 inhibits IL-1β-induced catabolism and inflammatory cytokines(Fig.3). As shown in Fig.4c-d, the knock-down of RIPK1 decreased the synthesis of MMPs induced by Pam3CSK4 and poly(I:C). Consistently, the knock-down of MYD88 or TRIF present the same trend in MMPs expression induced by IL-1β(Fig.4a-b). And the phosphorylation levels of RIPK1 were down-regulated compared with control group(Fig.4e-f). These results suggested RIPK1 potentiate TRIF and MYD88-dependent IL-β-induced inflammation. Western blot and immunofluorescence revealed the up-regulation of TRAF2 promoted by IL-1β was obviously increased by the overexpression of RIPK1 or decreased by the knock-down of RIPK1 respectively(Fig.5a-c). The phosphorylation levels of RIPK1 were significantly reduced with the overexpression of TRAF2(Fig.5d-e). Therefor the relationship between TRAF2 and RIPK1 may be a negative feedback. Western bolt and immunohistochemistry suggested RIPK1 kinase-dependent osteoarthritis didn’t proceed MLKL-dependent necroptosis(Fig.6a-d). Oppositely, western blot and TUNEL staining suggested it proceeded dependently of apoptosis(Fig.6e-k). We also found JNK and NF-κB were involved in the RIPK1-mediated inflammation(Fig.7).

Conclusions and recommendations

Our study may provide a new insight into the mechanism of OA and lay a foundation for the future development of new drugs.

placement of poller screws during intramedullary nailing

By Maria Tennyson (University of Cambridge)Ali Abdulkarim (Cambridge University Hospital)Matija Krkovic (Cambridge University Hospital)
Introduction

Various technical tips have been described on the placement of poller screws during intramedullary nailing however studies reporting outcomes are limited. Overall, there is no consistent conclusion about whether intramedullary nailing alone, or intramedullary nails augmented with poller screws is more advantageous. In a systematic review, we asked: (1) What is the proportion of non unions with poller screw usage? (2) What is the proportion of malalignment, infection and secondary surgical procedures with poller screws usage?

Goal

We conducted a systematic review of multiple databases including Pubmed, EMBASE, and the Cochrane Library. Seventy-four records were identified, twelve met our inclusion criteria.

Method

Results

Twelve studies with a total of 348 participants and 353 fractures were included. Mean follow up time was 21.4 months and mean age of included patients was 40.1 year. Seven studies had heterogenous population of nonunions and/ or malunions in addition to acute fractures. Three studies included only acute fractures and two studies examined non unions only. Four of the twelve studies reported non unions with an overall outcome proportion of 4%. Six studies reported coronal malalignment with an overall outcome proportion of 6%. The secondary surgical procedures rate ranged from 2 - 40% with an overall outcome proportion of 8% and included grafting, revisions and any reported cases of removal of metal work.

Conclusions and recommendations

When compared with existing literature our review suggests intramedullary nailing with poller screws has lower rates of non unions and coronal malalignment than those reported in the literature for intramedullary nailing alone. Prospective randomized control trial is necessary to fully determine outcome benefits.

INTERVERTEBRAL DISC DEGENERATION FROM A BIOMECHANICAL POINT OF VIEW: WHAT DO WE NEED TO FIX?

By Pieter-Paul A. Vergroesen (Spaarne Gasthuis, Hoofddorp, The Netherlands)Christine M.E. Rustenburg (Amsterdam UMC, Amsterdam, The Netherlands)Theodoor H. Smit (Amsterdam UMC, Amsterdam, The Netherlands)

Abstract Id: 6455
Introduction

Since its early beginnings in the 1960s biomechanical research in the spine has matured into a multifaceted research field including a multitude of different disciplines. Although a body of research provided us with deeper insights into ‘healthy’ and ‘degenerative’ spine biomechanics, this has not yet led to adequate therapies. This work reviews current concepts on healthy and degenerative intervertebral disc biomechanics and provides a perspective on future directions for biomechanical research in the spine.

Goal

We searched Pubmed, Embase and Google Scholar for intervertebral disc, biomechanics, degeneration, regeneration and therapies. Inclusion criteria were works covering investigations into normal — ‘healthy’ — or ‘degenerative’ biomechanics and therapeutic interventions relating or resulting in biomechanical stimuli. Exclusion criteria were cellular therapies, and injectables that did not affect biomechanical properties of the intervertebral disc.

Method

Results

From the combined works, we synthesized a glossary and a contemporary overview of current possible avenues of research. It was necessary to determine a glossary first as numerous often used terms lack a concise definition, which hampers understanding, especially across disciplines. Using the works included, we conclude that although a quick-fix is elusive, certain promising avenues of research are open. Especially promising are biomechanical stimulation within boundary’s, restoration of a discs’ fixed charge density, and restoration of the discs’ permeability to water.

Conclusions and recommendations

When considering the degeneration of the spine as a vicious circle including biomechanics, cells and extracellular matrix, we must also intervene in the domains of cells and matrix to durably reverse degeneration.

Introduction

Femoral neck fractures account for half of all hip fractures and are recognized as a major public health problem associated with a high socioeconomic burden. Whilst internal fixation is preferred over arthroplasty for physiologically younger patients, no consensus exists about the optimal fixation device yet. The recently introduced implant Femoral Neck System (FNS) (DePuy Synthes, Zuchwil, Switzerland) was developed for dynamic fixation of femoral neck fractures and provides angular stability in combination with a minimally invasive surgical technique. The placement of its dynamic bolt is facilitated by target center-center placement. Alternatively, the Hansson Pin System (HPS) (Swemac, Linköping, Sweden) with two parallel pins exploits the advantages of internal buttressing. However, the obligate peripheral placement of the pins, adjacent to either the inferior or posterior cortex, renders the instrumentation more challenging. From a previous study it is known that FNS performs biomechanically superior to Three Cannulated Screws in unstable Pauwels III fractures involving inferior and posterior comminution. Considering the pinning principle of HPS, higher stability may be anticipated for FNS over the former. However, the application of HPS is preferred in more stable Pauwels II fractures with existing calcar support, for which no comparison to FNS has been undertaken yet. The aim of this study was to evaluate the biomechanical performance of FNS versus HPS in a Pauwels II femoral neck fracture model with simulated posterior comminution.

Goal

Forty-degree Pauwels II femoral neck fractures AO 31-B2.1 with 15° posterior wedge were simulated in fourteen paired fresh-frozen human cadaveric femora, followed by instrumentation with either FNS or HPS in pair-matched fashion. Implant positioning was quantified by measuring the shortest distances between implant and inferior cortex (DI) as well as posterior cortex (DP) on anteroposterior and axial X-rays, respectively. Biomechanical testing was performed in 20° adduction and 10° flexion of the specimens in a novel setup with simulated iliopsoas muscle tension. Progressively increasing cyclic loading was applied until construct failure. Interfragmentary femoral head-to-shaft movements, namely varus deformation, dorsal tilting and rotation around the neck axis were measured by means of motion tracking and compared between the two implants. In addition, varus deformation and dorsal tilting were correlated with DI and DP.

Method

Results

Cycles to 5/10° varus deformation were significantly higher for FNS (22490±5729/23007±5496) versus HPS (16351±4469/17289±4686), P≤0.043. Cycles to 5/10° femoral head dorsal tilting (FNS: 10968±3052/12765±3425; HPS: 12244±5895/13357±6104)
and cycles to 5/10° rotation around the femoral neck axis (FNS: 15727±7737/24453±5073; HPS: 15682±10414/20185±11065) were comparable between the implants, \( P \geq 0.314 \). For HPS, the outcomes for varus deformation and dorsal tilting correlated significantly with DI and DP, respectively (\( P \leq 0.025 \)), whereas these correlations were not significant for FNS (\( P \geq 0.148 \)).

Conclusions and recommendations

From a biomechanical perspective, by providing superior resistance against varus deformation and performing in a less sensitive way to variations in implant placement, the angular stable Femoral Neck System can be considered as a valid alternative to the Hansson Pin System for the treatment of Pauwels II femoral neck fractures.

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**NOF cancellation audit**

By Jennifer Oluku (Queen Elizabeth Hospital, woolwich) Natalie Hope (Queen Elizabeth Hospital, woolwich) Karmen El-Raheb (Queen Elizabeth Hospital, woolwich)

**Abstract Id:** 6450  
**Event:** EORS 2019  
**Topic:** Other

**Introduction**

Hip fractures are a common injury in elderly patients. The UK has a National Hip Fracture Database to collect data on all patients presenting to hospital with a hip fracture. Literature evidence suggests that early surgery for hip fracture patients improves morbidity and mortality. UK national guidelines (BOA, NICE) recommend that surgery is performed within 36 hours of presentation and/or diagnosis for inpatients. Best Practice Tariffs ensure that hospitals are paid a set value if they meet this target of surgery within 36 hours. This study aims to look at reasons for delay to surgery for patients presenting to our busy level 2 trauma unit.

**Goal**

This is a retrospective review of prospectively collected data for patients referred to the orthopaedic team at our hospital with a diagnosis of a neck of femur fracture between 1st April and 31st December 2018. Patients under the age of 65 year of age were excluded from our study. Only patients who were operated on after 36 hours were included. The database for reasons of surgical delay was reviewed and electronic patient records were used to collect further data on length of stay and 30 day mortality.

**Method**

**Results**

A total of 249 patients were diagnosed with a hip fracture during the study period. 2 patients were too unwell for an operation and died within 24 hours of diagnosis/admission. 46 patients
were included in the study. The primary reasons for surgical delay were patients not being fit for surgery (14/46) and the use of anti-coagulation (14/46). Other reasons included a lack of surgical capacity (7/46) and delayed diagnosis due to further imaging (CT). Mean delay to surgery was 51.8 hours (range 34.5 – 157.2 hours; median 42.9 hours), mean length of stay 20.4 days (range 5.3 – 55.7 days, median 15.6 days). 30 day mortality was 4/46 (8.6%) for patients who were delayed.

Conclusions and recommendations

Many of the issues we found in this study are unusual however these problems are commonly faced in many level 2 trauma units that serve an ever growing ageing population. Changing practice to provide improved out-of-hours medical care to facilitate medical optimisation and using current literature evidence that shows that the use of DOACs/NOACs does not adversely affect outcomes when patients are operated on within 24 hours of the last dose may help improve times to surgery.

Day case versus inpatient elective total shoulder arthroplasty: A retrospective cohort study

By Aditya Borakati (North Middlesex Hospital, London) Asad Ali (North Middlesex Hospital, London) Chetana Nagaraj (North Middlesex Hospital, London)

Abstract Id: 6446
Event: EORS 2019
Topic: Arthroplasty

Introduction

Total shoulder arthroplasty is typically performed under general anaesthetic with an inpatient admission to ensure adequate analgesia prior to discharge. Increasingly, this is being performed with continuous nerve block infusions for postoperative analgesia to enable same day discharge. The benefits of this are manifold and include significant cost savings, improved efficiency and reduced complication rates. Despite numerous studies exploring this technique in the USA, there is no available literature on this in the UK or other European settings. We therefore conducted a retrospective cohort study comparing inpatient and day case total shoulder arthroplasty at our UK centre.

Goal

All patients undergoing elective total shoulder arthroplasty for non-traumatic indications between January 2017 and July 2018 at North Middlesex University Hospital were included. Patients were grouped into planned day cases and those who had overnight stays. Day case patients were sent home on the day of operation with continuous intrascalenal local anaesthetic infusion, with removal on day 3 in the community. Data was collected on age, gender, type of operation and indication for the procedure as covariates. Multivariate linear and logistic (for
discharge rates) regression analysis was conducted to adjust for the covariates. Primary outcome measures were the mean increase in active flexion and abduction and the proportion discharged from clinic at 3 months. Secondary outcomes were adverse events and re-admissions within 3 months postoperatively.

Method

Results

59 eligible patients were identified in the study period (18 day case and 41 inpatients). Adjusted mean differences in abduction and flexion between day case and inpatient groups were 9.69 degrees (95% CI -20.0 to 39.4, p=0.516) and 14.1 degrees (-17.8 to 45.9, p=0.380) respectively. Adjusted odds ratio of discharge in the inpatient group was 3.96 (1.2-13.8, p=0.026). No patients in either group had any adverse events or re-admissions at 3 months.

Conclusions and recommendations

Total shoulder arthroplasty is safe and effective when performed as a day case procedure. Centres in the UK and Europe may benefit from conducting the surgery routinely in this way, with significant potential for cost savings, improved efficiency and reduction in bed occupancy. Ideally, an appropriately powered randomised controlled trial with cost effectiveness analysis comparing inpatient and day case total shoulder arthroplasty is needed to definitively compare the two approaches.

Uncemented Hemiarthroplasties: a relic from the past or the way of the future?

By Vivek Balachandar (Sheffield Teaching Hospitals NHS Trust) Simon Woods (Leeds Teaching Hospitals NHS Trust) Christopher Lewis (Leeds Teaching Hospitals NHS Trust)

Abstract Id: 6445
Event: EORS 2019
Topic: Arthroplasty

Introduction

National Institution of Clinical Excellence guidelines recommend proven cemented femoral stems when treating intracapsular hip fractures with hemiarthroplasty. In practice the stem of choice in most institutions is the Exeter Trauma Stem (ETS), and this allows trainee surgeons to deliver an operation they are familiar with. The guidelines are, however, based on outdated studies in which most uncemented stems examined are no longer routinely used in current UK Orthopaedic practice and would not achieve the more recently required ODEP rating. There is sparse evidence comparing the outcomes of commonly used modern prostheses for intracapsular hip fractures. This retrospective study compares the outcomes for displaced intracapsular hip fractures with a cemented (ETS), cemented (Furlong), and hydroxyapatite coated (HAC Furlong) prostheses. These are three of the most commonly used implants in hip arthroplasty in the UK.
Goal

Data was collected from one district general hospital. Patients undergoing hemiarthroplasty over a 3-year period were identified and placed into one of three groups based on the prosthesis received: cemented Exeter, cemented Furlong, or HAC Furlong. The primary outcome was mortality, and the secondary outcome was length of stay.

Method

Results

After exclusions, 334 hip fracture patients were included. All patients received one of three prostheses - Cemented Exeter (n=238), Cemented Furlong (n=56), HAC Furlong (n=40). Patient groups were matched for age, sex, and pre-operative AMTs (p≤0.01). Statistical tests were completed for both patient groups to identify statistical significance; the Fisher Exact test for the primary outcome, and unpaired t-test for the secondary outcome. Post-operative mortality was significantly higher with large effect following cemented Furlong (48%) compared to HAC Furlong (15%) up to three years (p≤0.01). Post-operative mortality was also higher with cemented ETS (32%) compared to HAC Furlong (15%) but this was not statistically significant. No significant difference in length of stay was identified between the three prostheses.

Conclusions and recommendations

We would recommend re-evaluation of NICE guidance considering the significant changes to clinical practice and advance in prosthesis design since it was published.

Role of Particulated Juvenile Cartilage Allograft Transplantation in Osteochondral Lesions of the Talus: A Systematic Review

By Khalifah Aldawsari (College of Medicine, King Saud University, Riyadh, Saudi Arabia) Hamza M. Alrabai (Department of Orthopedics, King Saud University, Riyadh, Saudi Arabia) Albaraa Sayed (Department of Orthopedic, King Saud University, Riyadh, Saudi Arabia)

Abstract Id: 6440
Event: EORS 2019
Topic: Cartilage

Introduction

Osteochondral lesion of the talus (OCLT) is defined as a defect on the articular surface of the talus with/without subchondral bone involvement. Treatment of OCLT is considered as a challenge due to the lack of blood supply and inadequate ability of intrinsic healing. Because of this, surgical intervention is often required. Several surgical techniques are described in
literature to treat OCLT. Particulated Juvenile Cartilage Allograft Transplantation (PJCAT) is a new emerging technique that has the potential of restoring the native cartilage rather than fibrocartilage. PJCAT has shown promising clinical and radiological outcomes. However, available data on PJCAT in treating OCLT is confined to a small number of studies with heterogeneous population. The aim of this study is to systematically review the literature on clinical and radiological outcomes of PJCAT in treating OCLT.

Goal

A systematic search of Medline database was performed using Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. Number of patients and demographic data included age, gender and body mass index (BMI) were extracted. The level of evidence of each included study was identified. When feasible, mechanism of injury, lesion size and average follow up were recorded. The American Orthopedic Foot and Ankle Society Score (AOFAS), and Foot and Ankle Outcome Score (FAOS) were obtained to assess the functional outcomes. Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) score was selected to evaluate the radiological outcomes.

Method

Results

A total of 10 studies were eligible for this review involving 132 patients. Postoperative AOFAS scores were available for 44 patients who underwent PJCAT with an average of 86.14 at 25.5 months follow up. FAOS scores have been reported in 3 studies for 81 patients. The average preoperative score was 47.35 which has been improved to 62.88 at follow up of 23.6 months. MOCART was evaluated in 42 feet after the mean follow up of 18.2 months. The repair tissue was characterized by variable features; however, certain peculiarities were observed with higher frequency including infill hypertrophy, incomplete border zone integration, deep surface disruption, structure inhomogeneity, patches of hyperintense signals, damage of subchondral lamina and subchondral bone, adhesions and absence of effusion.

Conclusions and recommendations

PJCAT seems to be a promising modality of treatment for OLT in terms of functional outcomes. Fair attempts of defect filling can be confirmed with MRI. Nevertheless, heterogeneous picture of regenerate cartilaginous tissue and lack of repair in subchondral bone and subchondral lamina are not in favor with claims of full restoration of lost normal hyaline articular cartilage.

Scapular reconstructions using statistical shape modeling: Design and Validation

By Alexander Meynen (KU Leuven, Institute for Orthopaedic Research and Training, Leuven, Belgium) Filip Verhaegen (KU Leuven, Institute for Orthopaedic Research and Training, Leuven, Belgium; Division of Orthopaedics, University Hospitals Leuven, Belgium) Philippe Debeer (KU Leuven, Institute for Orthopaedic Research and Training, Leuven, Belgium; Division of Orthopaedics, University Hospitals Leuven, Belgium)
Introduction

During shoulder arthroplasty the native functionality of the diseased shoulder joint is restored, this functionality is strongly dependent upon the native anatomy of the pre-diseased shoulder joint. Therefore, surgeons often use the healthy contralateral scapula to plan the surgery, however in bilateral diseases such as osteoarthritis this is not always feasible. Virtual reconstructions are then used to reconstruct the pre-diseased anatomy and plan surgery or subject-specific implants. In this project, we develop and validate a statistical shape modeling method to reconstruct the pre-diseased anatomy of eroded scapulae with the aim to investigate the existence of predisposing anatomy for certain shoulder conditions.

Goal

The training dataset for the statistical shape model consisted of 110 CT images from patients without observable scapulae pathologies as judged by an experienced shoulder surgeon. 3D scapulae models were constructed from the segmented images. An open-source non-rigid B-spline-based registration algorithm was used to obtain point-to-point correspondences between the models [1]. The statistical shape model was then constructed from the dataset using principle component analysis. The cross-validation was performed similarly to the procedure described by Plessers et al. (2018) [2]. Virtual defects were created on each of the training set models, which closely resemble the morphology of glenoid defects according to the Wallace classification method [3]. The statistical shape model was reconstructed using the leave-one-out method, so the corresponding training set model is no longer incorporated in the shape model. Scapula reconstruction was performed using a Monte Carlo Markov chain algorithm, random walk proposals included both shape and pose parameters, the closest fitting proposal was selected for the virtual reconstruction. Automatic 3D measurements were performed on both the training and reconstructed 3D models, including glenoid version, critical shoulder angle, glenoid offset and glenoid center position.

Method

Results

The root-mean-square error between the measurements of the training data and reconstructed models was calculated for the different severities of glenoid defects, as shown in Table 1. For the least severe defect, the mean error on the inclination, version and critical shoulder angle (°) was 2.22 (± 1.60 SD), 2.59 (± 1.86 SD) and 1.92 (± 1.44 SD) respectively. The reconstructed models predicted the native glenoid offset and centre position (mm) an accuracy of 0.87 (± 0.96 SD) and 0.88 (± 0.57 SD) respectively. The overall reconstruction error was 0.71 mm for the reconstructed part. For larger defects each error measurement increased significantly.

Conclusions and recommendations

A virtual reconstruction methodology was developed which can predict glenoid parameters with high accuracy. This tool will be used in the planning of shoulder surgeries and

**Inter-leg and gender differences in gait in typically developing children**

By R. de Bot (Department of Orthopaedics, Maastricht University Medical Center, the Netherlands.) V. Groen (Department of Orthopaedics, Maastricht University Medical Center, the Netherlands.) R. Senden (Department of Movement Sciences, Maastricht University Medical Center, Maastricht, the Netherlands)

Abstract Id: 6435  
Event: EORS 2019  
Topic: Biomechanics

**Introduction**

Gait plays an important role in allowing individuals to function within their environment. Gait analysis is frequently used to explore gait alternations, which develop during the normal process of aging, and gait deviations that occur in several disorders and abnormalities. Gait data for the right and left legs and for males and females are often combined and analyzed together. This study investigates in children whether combining data at the spatiotemporal and kinematic level is a valid method of analysis.

**Goal**

In order to obtain spatiotemporal and kinematic gait data, eleven male and nine female children (of ages ranging from 8–17 years) walked on the Computer Assisted Rehabilitation Environment (CAREN) system. They walked at comfortable (self-chosen), fast (1.3 times comfortable), and slow (0.7 times comfortable) gait velocities. Spatiotemporal, kinematic, and range of motion (ROM) data were calculated and evaluated. Joint (i.e., hip, knee, and ankle) flexion/extension, hip rotation, and foot progression were examined.

**Method**

**Results**

No significant differences were observed in spatiotemporal parameters between the right and left legs and between genders. Kinematic graphs illustrate a symmetrical inter-leg curvature. In males, no significant ROM differences were observed between the right and left legs. In females, ROM of foot progression at a comfortable velocity was significantly smaller in the left leg (P=0.02). Furthermore, kinematic data illustrates similar joint motions between genders. However, in nearly all joints a greater ROM was observed in females. Significantly different joint motions were observed in hip flexion/extension at comfortable (P
Conclusions and recommendations

Collagen fibril diameter distribution of bovine Anterior Cruciate Ligament changes from bimodal to unimodal upon injury with subsequent decrease in mean diameter

By Zhuldyz Beisbayeva (Nazarbayev University) Ainur Zhanbassynova (Nazarbayev University) Guzlada Kulzhanova (Nazarbayev University)

Abstract Id: 6406
Event: EORS 2019
Topic: Tendon

Introduction

More than 250,000 people are suffering from Anterior Cruciate Ligament (ACL) related injuries each year in the US, with a cost of $17-25K/patient. There is an unmet clinical demand for improving grafts/scaffolds to provide biological integration in addition to mechanical support. Currently, no data is available for the utilization of fibrous scaffolds with bimodal distribution for ACL regeneration. The novelty in this study is that it proposes for the first time to investigate the collagen fibril diameter distribution in healthy and injured bovine ACL tissue, and utilization of such structure for scaffold design. Objectives are 1) developing a bovine ACL tear model and measuring the collagen fibril diameter distribution of both healthy and injured ACL tissues, and 2) fabricating scaffolds to mimic the structural properties of healthy and injured ACL tissue.

Goal

Bovine ACL tissues (1-3 years old) were harvested and characterized for their fibril diameter distribution using Transmission Electron Microscopy (TEM) and biomechanical properties under tension (Fig 1). The electrospun polycaprolactone (PCL) scaffolds were characterized using SEM and mechanical testing.

Method

Results

Healthy and injured ACL fibril diameter, and that of PCL scaffolds representing healthy and injured ACL are compared using unpaired student t-test. Differences with p

Conclusions and recommendations
The proposed fibrous scaffold design represents a significant departure from the conventional unimodal approach, and is expected to have significant contribution to ACL regeneration. These discoveries will serve as the foundation for the development of biomimetic tissue engineering substrates aimed at promoting biological graft fixation.

Additively manufactured biodegradable porous zinc implants for Orthopaedic applications

By Prathyusha Pavanram (Anatomy and Cell Biology, University Hospital RWTH Aachen, Germany) Yageng Li (Department of Biomechanical Engineering, Delft University of Technology, The Netherlands) J. Zhou (Department of Biomechanical Engineering, Delft University of Technology, The Netherlands)

Abstract Id: 6405
Event: EORS 2019
Topic: Biomaterials

Introduction

As compared to magnesium (Mg) and iron (Fe), solid zinc (Zn)-based absorbable implants show better degradation rates. An ideal bone substitute should provide sufficient mechanical support, but pure Zn itself is not strong enough for load-bearing medical applications. Modern processing techniques, like additive manufacturing (AM), can improve mechanical strength of Zn. To better mimic the in vivo situation in the human body, we evaluated the degradation behavior of porous Zn implants in vitro under dynamic conditions. Our study applied selective laser melting (SLM) to build topographically ordered absorbable Zn implants with superior mechanical properties.

Goal

Specimens were fabricated from pure Zn powder using SLM and diamond unit cell topological design. In vitro degradation was performed under both static and dynamic conditions in a custom-built set-up under cell culture conditions (37 °C, 20% O2 and 5% CO2) for up to 28 days. Mechanical properties of the porous structures were determined according to ISO 13314: 2011 at different immersion time points. Modified ISO 10993 standards were used to evaluate biocompatibility through direct cell seeding and indirect extract-based cytotoxicity tests (MTS assay, Promega) against identically designed porous titanium (Ti-6Al-4V) specimens as reference material. Twenty-four hours after cell seeding, its efficacy was evaluated by Live-Dead staining (Abcam) and further analyzed using dual channel fluorescent optical imaging (FOI) and subsequent flow cytometric quantification.

Method

Results
Porous Zn implants were successfully produced by means of SLM with a yield strength and Young’s modulus in the range of 3.9-9.6 MPa and 265-570 MPa, respectively. Dynamic flow significantly increased the degradation rate of AM porous Zn after 28 days. Results from Zn extracts were similar to Ti-6Al-4V with >95% of cellular activity at all tested time points, confirming level 0 cytotoxicity (i.e.

**Conclusions and recommendations**

This study clearly shows the great potential of AM porous Zn as a bone substituting material. Moreover, we demonstrate that complex topological design permits control of mechanical properties and degradation behavior.

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**EphA2 ligand-functionalized microparticles for targeted delivery of chemotherapeutic drugs against osteosarcoma**

By Zheng-gang Wang (Department of Orthopedics, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology) Shuang Liang (Department of Orthopedics, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology) An-min Chen (Department of Orthopedics, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology)

**Abstract Id:** 6400  
**Event:** EORS 2019  
**Topic:** Biomaterials

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**Introduction**

Osteosarcoma is the most common primary bone cancer affecting children and adolescents. Chemotherapy is administered as part of the treatment, but faced with drug resistance. Therefore, novel treatment strategies should improve treatment efficacy and reduce toxicity. Microparticles (MPs) have emerged as a promising drug carrier with low immunogenicity, high biocompatibility and delivery efficiency. However, without a cell source selection and membrane modification, MPs are lacking a natural targeting ability. So, a modification is necessary. The Ephrin Alpha 2 receptor (EphA2) is a surface molecule which is highly up-regulated on osteosarcoma cell lines and primary osteosarcoma cells, while down-regulated on healthy bone cells. YSA (YSAYPDSVPMMMS) is a 12-amino acid peptide which is a ligand for EphA2. Thus, it represents a novel potential therapeutic target for Osteosarcoma.

**Goal**

Human osteosarcoma cell lines 143B and MG63 were incubated with methotrexate (MTX) after ultraviolet irradiation. Then the cell supernatant was collected and density gradient centrifugated to isolate MPs loading MTX (MP/MTX). We coated surface-carboxyl Fe3O4 nanoparticles (CN) with YSA-peptide by coupling reaction (YSA-CN). Based on the
excessive YSA-peptide on the surface of YSA-CN, YSA-CN and MP/MTX formed a complex known as YSA-CN-MP/MTX. The complex was physicochemically characterized and tested in antitumor activity (Fig.1).

Method

Results

The transmission electron microscope (TEM) image and western blot analysis showed MPs were successfully extracted (Fig.2a-b). The number of MPs was counted by a flow cytometry-based method, excluding background noise or nonspecific events (Fig.2c,S1). Doxorubicin was clearly shown to be encapsulated by MPs under the fluorescence microscopy (Fig.2d). Moreover, high-performance liquid chromatography analysis showed that the different concentrations of MTX in MPs were owing to drug doses (Fig.2e,S2). FT-IR spectra and dynamic light scattering (DLS) showed YSA-peptide was successfully coated on CN (Fig.3a-b,S3a). Meanwhile, DLS and the TEM image showed YSA-CN-MP was successfully formed. And extremely excessive YSA-peptide could disrupt the stability of complex and form sediment (Fig.3c-d,S3b). EphA2-positive 143B and MG63 cells were blocked with YSA-peptide following treatment with YSA-CN-MP, and the fluorescence intensity of PKH67 was apparently decreased compared with that without blocking. In the targeting study, fluorescence was decreased in EphA2-negative THP-1 cells compared with that in EphA2-positive cells without blocking at the same concentration of YSA-CN-MP. These results indicate that YSA-CN-MP targeted EphA2-positive cells (Fig.4a). The flow cytometry results indicated a high uptake of YSA-CN-MP than MP (Fig.4b). Besides, the uptake behavior was concentration-dependent and time-dependent (Fig.4c-d,S4). The cell viability of YSA-CN-MP/MTX is shown in Figure 5a-b, no obvious reduction in cell viability was observed after 24h incubation with YSA-CN-MP, suggesting that the blank carrier exhibited little cytotoxicity. YSA-CN-MP/MTX group showed higher cytotoxicity as compared with other groups. The effects of YSA-CN-MP/MTX on apoptosis and necrosis were investigated (Fig.5c-d). The results suggested that YSA-CN-MP could increase the effects of MTX. And we also found YSA-CN-MP/MTX group showed better effect in inhibiting migration (Fig.6). Statistical analysis is in attachment.

Conclusions and recommendations

Microparticles functionalized by targeting ligands through coating with high-density antibodies may prove to be a novel delivery system for targeted drugs against human cancers.

Mortality and re-revision following single-stage and two-stage revision surgery for the management of infected primary knee replacement: a study from the National
Introduction

Knee replacement is a safe and effective treatment for severe knee conditions. Periprosthetic joint infection (PJI) is an uncommon but catastrophic complication of total knee replacement for both patients and surgeons. The two-stage revision strategy has traditionally been considered the gold standard and remains the most commonly used surgical option for PJI treatment. There has been an increasing interest in the use of the single-stage revision strategy, as it may be associated with better patient outcomes and has advantages such as shorter overall time in hospital, quicker recovery and significant cost-benefits. There is currently no evidence to conclusively support the clinical superiority of one revision strategy over the other for the management of knee PJI.

Goal

This is a prospective cohort study using data for England and Wales from the National Joint Registry (NJR) for England, Wales, Northern Ireland, and the Isle of Man between April 1, 2003, and Dec 31, 2014. All-cause re-revision, re-revision specifically for PJI and mortality rates were compared between patients revised for knee PJI with a single- or two-stage procedure. Debridement and implant retention procedures were excluded. Cox shared frailty model (to account for within-hospital correlation) were used to compute the overall hazard ratio (HR) of re-revision/mortality. Poisson regression models with restricted cubic splines were used to calculate time-varying hazard ratios (HR). We also compared the surgical burden between patients initially managed for their PJI with a single-stage approach with those initially managed with a two-stage approach, by comparing the total number of revision and further re-revision procedures recorded in the NJR using zero-truncated Poisson.

Method

Results

489 primary knee replacements were revised with a single-stage procedure and 2,880 with a two-stage procedure. All-cause re-revision and re-revision for PJI rates were comparable between the groups. Patients initially managed with single-stage revision received fewer revision procedures than after two-stage revision (1·2 vs. 2·2, p

Conclusions and recommendations
This study has not demonstrated superiority of the so called “gold-standard” two-stage approach over the single-stage approach for knee PJI. When considered alongside the results of recent methodologically sound evidence synthesis, the single-stage revision strategy is a reasonable option to reduce the distress experienced by patients having to undergo multiple PJI surgeries and the burden of knee PJI on health system.

**Mortality and re-revision following single-stage and two-stage revision surgery for the management of infected primary hip replacement: a study from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man**

By Erik Lenguerrand (University of Bristol)Michael Whitehouse (University of Bristol)Andrew Beswick (University of Bristol)

Abstract Id: 6308  
Event: EORS 2019  
Topic: Infection

**Introduction**

Hip replacement is a safe and effective treatment for severe hip conditions. Despite this, devastating complications such as periprosthetic joint infection (PJI) can occur. Several treatment options exist for PJI management with the majority of patients who undergo revision being treated with a single-stage or two-stage revision. Of the two options, the two-stage revision strategy is more commonly used and has been presumed to be more effective in clearing infection than single-stage revision. There has been an emerging interest in the use of the single-stage revision strategy, as it may be associated with better patient outcomes and has advantages such as shorter overall hospital stay, quicker recovery and significant cost-benefits. It is unclear which of the common treatment strategies (single- or two-stage revision) leads to the best outcomes.

**Goal**

This is a prospective cohort study using data for England and Wales from the National Joint Registry (NJR) for England, Wales, Northern Ireland, and the Isle of Man between April 1, 2003, and Dec 31, 2014. All-cause re-revision, re-revision specifically for PJI and mortality rates were compared between patients revised for hip PJI with a single- or two-stage procedure. Debridement and implant retention procedures were excluded. Cox shared frailty model (to account for within-hospital correlation) were used to compute the overall hazard ratio (HR) of re-revision/mortality. Poisson regression models with restricted cubic splines
were used to calculate time-varying hazard ratios (HR). We also compared the surgical burden between patients initially managed for their PJI with a single-stage approach with those initially managed with a two-stage approach, by comparing the total number of revision and further re-revision procedures recorded in the NJR using zero-truncated Poisson.

**Method**

**Results**

535 primary hip replacements were revised with a single-stage procedure and 1,605 with a two-stage procedure. All-cause re-revision was higher following single-stage revision especially in the first three months (HR at 3 months=1·98 [1·14, 3·43]). The risks were comparable thereafter. Re-revision for PJI was also higher in the first 3 postoperative months for single-stage revision and waned with time (HR at 3 months=1·81[1·22, 2·68], HR at 6 months=1·25 [0·71, 2·21], HR at 12 months=0·94 [0·54, 1·63]). Patients initially managed with single-stage revision received on average fewer revision operations than after two-stage revision (1·3 vs. 2·2, p

**Conclusions and recommendations**

The risk of unplanned re-revision was lower following two-stage revision, but patients treated with single-stage revision undergo fewer revision operations to manage their PJI. With a two-stage strategy, the treatment burden due to the greater numbers of surgeries and complications associated with the interim period and prolonged periods of immobility is considerable. There is also a trade-off between the possibility of successful re-revision surgery after failed infection clearance in a single-stage operation and long-term antibiotic treatments between stages before reimplantation in a two-stage strategy with associated distressing side effects and concerns over antibiotic resistance. Thus, surgeons and patients need to consider the complex balance of risks and benefits of treatment strategies for the treatment of hip PJI. The lower revision burden overall associated with single-stage revision and the equivalent mortality rates to two-stage revision are reassuring. Further work is required to determine whether tailored and acute monitoring of patients revised for PJI with a single-stage for the first three post-operative months could reduce the increased risk of re-revision. Meanwhile, patients should be appropriately counselled regarding the outcomes and treatment burden of treatments for hip PJI.

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**Prosthetic Joint Infection Following Primary Total Knee Replacement and type of fixation method: Meta-Analysis of Observational Cohort and Randomised Intervention Studies**

By Setor Kunutsor (University of Bristol)Vikki Wylde (University of Bristol)Michael Whitehouse (University of Bristol)
Abstract Id: 6305  
Event: EORS 2019  
Topic: Infection

Introduction

In primary total knee replacement (TKR), the femoral and tibial component can be secured to the bone with or without bone cement. The TKR construct fixation is referred to as cemented if the femoral and tibial implants are both fixed with cement; in uncemented fixation, the femoral and tibial implants use press-fit into the bone for initial stability and then bone ingrowth into coatings on the structure of the implant to achieve fixation; in hybrid fixation, there is a mixture of fixations, with one of the implants being cemented and one being uncemented. Although TKR is often a successful intervention, some patients experience complications such as prosthetic joint infection (PJI). PJI is a rare but dreaded complication of TKR. The literature on whether fixation methods affect PJI rates differentially following TKR remains is conflicting. We aimed to evaluate the body of evidence on the association of fixation methods with the risk of PJI following primary TKR, using a systematic review and meta-analysis of both observational and randomised trial (RCT) evidence. We compare the nature and magnitude of potential associations of different fixation methods with risk of PJI and assess if the associations varied by study and individual level characteristics.

Goal

This review was conducted according to PRISMA and MOOSE guidelines. Its pre-defined protocol has been registered in the PROSPERO (CRD42018114592). RCTs and observational cohort studies comparing fixation methods and reporting PJI incidence following primary TKR were identified in MEDLINE, Embase, Web of Science, and Cochrane Library up until November 2018. Summary measures were relative risks (RR) with 95% confidence intervals (CIs). Heterogeneity across studies was assessed using the Cochrane χ² statistic and the I² statistic. Heterogeneity sources and interactions on the associations by pre-defined study-level characteristics were assessed using stratified analyses and univariable meta-regression. Publication bias was assessed by visually inspecting a funnel plot and applying Egger’s regression symmetry test bias. The effect of publication bias was adjusted for by the use of the Duval and Tweedie’s nonparametric trim-and-fill method.

Method

Results

We identified 32 eligible articles (24 observational studies and 8 RCTs) involving 1,161,292 TKRs. In pooled analysis of observational studies, uncemented fixation was associated with a decreased overall PJI risk when compared with cemented fixation (RR: 0.76; 0.64–0.89). Comparing antibiotic-loaded cemented fixation with plain cement, there was no significant difference in overall PJI risk at (0.95; 0.69–1.31), but PJI risk was higher in the first 6-month postoperative period to 1.65 (1.12–2.43). Limited data from RCTs showed no differences in PJI risk among the fixation types.

Conclusions and recommendations
It appears cemented fixation may be associated with an increased risk of PJI when compared to uncemented fixation. However, the current evidence suggests a higher overall rate of revision for uncemented TKR compared to cemented TKR. There is a possibility that antibiotic-loaded cement fixation has no effect on the prevention of PJI after primary TKR. Even though the evidence base is limited, antibiotic-loaded cement is commonly used for primary TKR throughout Europe, whereas in the United States it is mostly used for treating revision for infection in TKR. Much of the evidence is based on observational data, which are limited by biases and results should be interpreted with caution. RCTs with long-term follow-ups are required to confirm or refute these findings.

**Hip Replacement and type of fixation method: Meta-Analysis of Observational Cohort and Randomised Intervention Studies**

By Setor Kunutsor (University of Bristol) Andrew Beswick (University of Bristol) Michael Whitehouse (University of Bristol)

Abstract Id: 6304  
Event: EORS 2019  
Topic: Infection

**Introduction**

Findings on whether the fixation methods affect the risk of prosthetic joint infection (PJI) following total hip replacement (THR) have been inconsistent. Some studies have reported that uncemented fixation was associated with increased risk of revision for PJI compared to cemented fixation, others have reported the opposite. Hybrid fixation has also been reported to be associated with increased risk of revision compared to other fixation methods. We aimed to evaluate the body of evidence on the association of fixation methods with the risk of PJI following primary THR using a systematic review and meta-analysis of both observational and interventional evidence. We compared the nature and magnitude of potential associations of different fixation methods with risk of PJI and aim to identify any gaps in the existing evidence.

**Goal**

This review was conducted according to PRISMA and MOOSE guidelines and its pre-defined protocol is registered in PROSPERO (CRD42018106503). We systematically searched MEDLINE, Embase, Web of Science, and Cochrane databases from the date of inception of each database to 24 April 2019 for studies comparing at least two of the main fixation types—cemented, uncemented, hybrid, and reverse hybrid—and reported the incidence of PJI following primary THR. Summary measures were relative risks (RR) with 95% confidence intervals (CIs). We reported estimates for the overall duration of follow-up (long-term follow-
up) and that for the early postoperative period (first six months of follow-up) for studies that provided relevant data. Random-effect models were used to pool RRs to minimize the effect of heterogeneity (identified with Cochrane $\chi^2$ and the I2 statistics). We assessed for effect modification by predefined study-level characteristics, specific PJI outcome, degree of adjustment, and study quality using stratified analysis and random effect meta-regression. Funnel plots and Egger’s regression symmetry tests were used to assess publication bias.

Method

Results

We identified 11 distinct observational cohort studies comprising 2,260,428 THRs and 4 RCTs comprising 945 THRs. In pooled analyses of observational studies, all cemented fixations (plain and antibiotic cement combined), plain cemented fixations, hybrid fixations, and reverse hybrid fixations were each associated with an increased overall PJI risk when compared with uncemented fixations: 1.10 (95% CI: 1.04–1.17), 1.50 (95% CI: 1.27–1.77), 1.49 (95% CI: 1.36–1.64), and 1.49 (95% CI: 1.14–1.95) respectively. However, in the first six months, uncemented fixations were associated with increased PJI risk when compared to all cemented fixations. Compared to antibiotic-loaded cemented fixations, plain cemented fixations were associated with an increased PJI risk (1.52; 95% CI: 1.36–1.70). One RCT showed an increased PJI risk comparing plain cemented fixations with antibiotic-loaded cemented fixations.

Conclusions and recommendations

Evidences published to date have major limitations and we encourage colleagues with access to large, unselected sample representative of national clinical practices with data on PJI and implant fixation methods to conduct further research in this area.

SmartBone a composite Xeno-hybrid bone graft: clinical experiences in orthopaedic applications

By Riccardo Ferracini (Università di Genova Italy) Piana Raimondo (Department of Traumatology and Rehabilitation CTO Torino Italy) Perale Giuseppe (Mezzovico Vira Switzerland)

Introduction

Alternatively to autografts, several bone grafts are available for the clinical use with their own peculiar biological and mechanical properties which reflect into clinical performances. A new bone graft was obtained combining mineral structures from natural bovine bones with
bioresorbable polymers and collagen fragments exposing the aminoacidic RGD sequence, from gelatin. The aim of our study is to retrospectively evaluate clinical, biological and structural properties of this bone graft, commercially traded as SmartBone®, and its reliability in a wide range of orthopedic applications, ranging from trauma to oncology.

Goal

In traumatology cases, 67 adult patients (age range 21-78ys, mean 48), have been arranged in 3 major groups: “tibial plateau fractures” (34 patients), “distal radio fractures” (20 patients) and “other cases” (13 patients), reflecting the statistical incidence of such traumas; while 23 adult patients (age range 18-85ys, mean 43) have been treated for oncologic pathologies: low grade chondrosarcoma (4), giant cell tumor (GCT, 2), enchondroma (4), benign fibrous histiocytoma (2), unicameral bone cysts (4), aneurismal bone cyst (2), fibrous dysplasia (3), non-ossifying fibroma (1), myxofibrosarcoma with bone involvement (1). Safety and number of adverse events have been evaluated throughout the whole set of enrolled patients, while radiological outcomes (via RX, CT or MRI), graft integration and overall clinical benefits have been evaluated according to different involved districts, assessing pain, range of movements, recovery time and bone regeneration. Local complications such as infection, local recurrence, wound dehiscence, fracture, or early reabsorption have been evaluated. Follow-up time windows spans from 1 to 2.5 years.

Method

Results

In traumatologic cases, xenohybrid graft performance was comparable with the gold standard autologous graft, either cortical, cancellous or mixed, from either historical cases from our institution or from literature data. After 1 year, mean VAS score was recorded; in proximal tibia fracture Tegner Lysholm Scoring Scale and mean IKDC 2000 were assessed; for the distal radius fracture the DASH questionnaire was used. Radiographs were collected up to 1 year. Follow up did not show further depressions of articular surface after post surgical evaluation or defects of consolidation and demonstrated a good grade of grafts integration. No fracture or infection occurred. The same was true for oncologic cases where we report one case of patellar GCT recurrence after 1 year and two wound dehiscences occurred (one required a local flap).

Conclusions and recommendations

This xenograft has demonstrated to be a safe biomaterial, with satisfactory mechanical and biological performances in the mid-term period. It also showed a high grade of osteointegration and anatomically selective remodelling. In particular in oncology cases the investigated graft has mechanical structural function that can (in selected cases) allow early weight bearing and avoid a preventive bone fixation (necessary only in 4 patients in this series). Complication rate was low, a rapid integration was observed with no inflammatory reaction in the surrounding tissues.

The short-term functional and radiologic outcomes in adult patients who underwent
total hip arthroplasty using the modified trochanteric slide approach

By Pamela Louise G. Gervasio (Philippine General Hospital) Nicole Teresa C. Lukban (Philippine General Hospital) Gregorio Marcelo S. Azores (Philippine General Hospital)

Abstract Id: 6264
Event: EORS 2019
Topic: Arthroplasty

Introduction

Various trochanteric osteotomies have been developed for use as surgical approaches to the hip. They aid in extending the exposure, facilitate proper placement of components and allow ease of removal of previous implants. This study aims to determine the short-term functional and radiologic outcomes of patients who underwent arthroplasty with the modified trochanteric slide approach in the Philippine General Hospital.

Goal

This study retrospectively gathered additional patient data on the modified trochanteric slide approach during a 7-year period (January 2012 to December 2018) to analyze the short-term functional and radiologic outcomes.

Method

Results

A total of 23 patients with 25 hips were included, 9:16 male to female ratio, with an average age of 52.16 years. The union rate was 60% at 6 weeks and 84% at 12 weeks post-operatively. The fibrous union rate was 32% at 6 weeks and 4% at 12 weeks post-operatively. Overall, there was a 4% non-union rate at 12 weeks. (P

Conclusions and recommendations

In the surgical management of difficult primary total hip arthroplasty requiring additional surgical exposure and in revision surgery, the use of the modified trochanteric osteotomy may be useful, with acceptable clinical and radiologic outcomes within the short-term post-operative period. Recommendations for future study include a wider pool of subjects, to include patients in other institutions for a larger and wider population. Another is to start a prospective study for better data gathering, where variables could be completed and tested for each participant.

Gait deviations in relapse clubfoot patients compared to healthy controls
Introduction

Gait analysis is a frequently applied tool to assess functional outcome after clubfoot treatment. Compared to healthy controls, treated clubfoot patients show small but distinct differences in their gait pattern(1, 2). Despite excellent initial results of the Ponseti treatment a relapse of the clubfoot at a later age is a known problem within the clubfoot population (3, 4). A relapse is defined as the re-occurrence of one or more components of the initial clubfoot that requires additional treatment. Gait analysis has not yet been used to specifically identify gait impairments in Ponseti treated clubfoot patients suffering from a relapse. In order to grasp the full complexity and three-dimensionality of the clubfoot applying a multi-segment foot model in addition to a standard lower extremity model during the 3D gait analysis is essential.

Research question: This study aims to identify kinematic and kinetic differences in gait between children with relapse clubfeet who are planned for a surgical intervention and age-matched healthy controls.

Goal

Unilateral or bilateral relapse clubfeet were recruited by an orthopaedic surgeon specialized in the treatment of clubfeet. Testing of these children and healthy controls took place between March 2018 and April 2019. Gait analysis was performed using a wireless active 3D-system (Charnwood Dynamics Ltd., Codamotion CX 1, sampling rate: 100Hz) and one force plate (Advanced Mechanical Technology, Inc., OR 6-7, sampling frequency: 400 Hz). A plug-in-gait model was combined with the Oxford Foot Model (OFM) resulting in 25 infrared markers and four pointer landmarks to determine kinematics of the forefoot, hindfoot, shank, thigh and the pelvis(5). Ankle, knee and hip kinetics were calculated using the plug-in-gait model. Participants were instructed to walk in a straight line (8m) at comfortable speed. Sagittal and transversal plane kinematics and kinetics were analysed and compared between groups using two-tailed T-test according to statistical parametric mapping (SPM). A p-value ≤ 0.10 was considered significant.

Method

Results

Currently, five relapse patients (age: 6.0±1.6y, height: 1.17±0.12m, walking speed: 0.89±0.21 m/s) and ten healthy controls participated (age: 5.6±1.6y, height: 1.19±0.13m, walking speed: 1.05±0.12m/s). Several gait analyses are planned in the upcoming months. Preliminary results show significant decreased tibia/hindfoot dorsiflexion during midstance and swing phase and increased hindfoot/forefoot adduction during the second part of the stance phase and first part of the swing in relapse patients (Figure 1). Furthermore, relapse patients show significant decreased ankle moment and power during preswing (Figure 2).
Conclusions and recommendations


Elastic and viscoelastic characterization of Iliotibial Band and Gracilis Tendon Grafts for Anterolateral Ligament Reconstruction


Abstract Id: 6238
Event: EORS 2019
Topic: Biomechanics

Introduction

The anterolateral ligament (ALL) has been recently recognized as a distinct stabilizer for internal rotation in the ACL-deficient knee and it has been hypothesized that ALL reconstruction may play an important role in improving anterolateral instability following ACL reconstruction [1]. Both the gracilis tendon (GT) and a portion of the iliotibial band (ITB) have been suggested as graft materials for ALL reconstruction, however, there is an ongoing debate concerning whether GT or ITB are appropriate grafting materials [2,3]. Furthermore, there is limited knowledge in how the mechanical properties of these potential grafts compare to the native ALL. Consequently, the aim of this study was to characterize the elastic (Young’s modulus and failure load) and viscoelastic (dynamic and static creep) mechanical properties of the ALL and compare these results with the characteristics of the grafting materials (GT and ITB), in order to provide guidance to clinicians with respect to graft material choice.

Goal
Fourteen fresh-frozen cadaveric knees (85.2±12.2 yr) were obtained. The ALL, ITB, and the distal (GTD) and proximal gracilis tendons (GTP) (bisected at mid portion) were harvested from each donor and tested with a dynamic materials testing frame. Prior to testing, the cross-sectional area of each tissue was measured using a casting method and the force required to achieve a min-max stress (1.2-12 MPa) for the testing protocol was calculated (preconditioning (20 cycles, 3-6 MPa), sinusoidal cycle (200 cycles, 1.2-12 MPa), dwell at constant load (100 s, 12 MPa), and load to failure (3%/s)). Kruskall-Wallis tests were used to compare all tissue groups (p

Method

Results

Elastic properties: The Young’s modulus of both ALL (181.3±63.9 MPa) and ITB (357.6±94.4 MPa) are significantly lower than GTD (835.4±146.5 MPa) and GTP (725.6±227.1 MPa). In contrast, the failure load of ALL (124.5±40.9 N) was comparable with GTD (452.7±119.3 N) and GTP (433±133.7 N), however, significantly lower than ITB (909.6±194.7 N), (Fig.1.a-b). Viscoelastic properties: Dynamic creep of the ALL (0.5±0.3 mm) and ITB (0.7±0.2 mm) were similar (p>0.05) whereas the GTD (0.26±0.06 mm) and GTP (0.28±0.1 mm) were significantly lower. Static creep progression of the ALL (1.09±0.4 %) was highest across all tissues, while GTD (0.24±0.05 %) and GTP (0.25±0.0.04 %) were lowest and comparable with ITB (0.3±0.07 %) creep progression(Fig.1.c-d).

Conclusions and recommendations

Our results showed no clear advantage of using either ITB,GTD or GTP for ALL reconstruction. Further studies should be performed in order to evaluate which parameters play a vital role to determine the optimum grafting choice.

An in vitro study of the influence of bone density in bone cement interface behavior

By João Paula (TEMA, Department of Mechanical Engineering, University of Aveiro, Portugal)António Ramos (TEMA, Department of Mechanical Engineering, University of Aveiro, Portugal)

Abstract Id: 6165
Event: EORS 2019
Topic: Biomaterials

Introduction

Acrylic bone cement (PMMA) has several applications in orthopaedic surgery manly in prosthesis fixation in different joint articulations. The number of surgeries in different orthopaedic register was increased [1], but the cement fixation decrease instead of press-fit fixation, for patients with less than 60 years old [2]. However, the hybrid fixation increase manly in hip prosthesis. The success rate in some arthroplasties is high but present some
problems associated to the cement fixation [3]. The cement fixation behaviour depends of several factors, including depth of interdigitating [4] and penetrate into bone, cement thickness and viscosity. The hypotheses of the present work is, the bone quality in the interface cement-bone is important to improve the fixation of stem prosthesis.

Goal

The present experimental study centred in the influence of bone density/quality in the stem fixation properties. To analyse the importance of bone quality, a simplified arthroplasty concept was designed using composite bone as cortical. The stem as a conical shape 12-14mm of diameter and cancellous and cortical bone was similar to the femur geometry. Tree densities of cancellous bone structure was (0.12, 0.16, 0.20) g/cm3 of open cell polyurethane foam [5], The cement bone was Palacos R for cementation and stems are in CrCo. The diameter of cortical bone was 40mm with 5mm of thickness and 40mm of length. Was tested 3 samples of each density of bone. The canal for femoral stem were machined to maintain the same geometry in all experiments. The cementation procedure was realized manually as the introduction of cement in bone canal. After cementation, the cemented stem were submitted to a pull out test in a Shymatsu machine. The cortical bone is fixed and the stem tensioned with a 25mm/s of velocity

Method

Results

The results of experiments shows the importance of bone density in the maximum load observed in pull out test. The results of experiments are presented in FIG 1, where is possible compare the maximum load between 2600N and 1450N, depending of bone density. Better quality of bone improve the fixation of arthroplasty for the same cementation conditions and bone geometry. Other very important aspect is related with bone interconnection in cement. This aspect is important for the maximum force observed. For the same density of bone, was observed a good and a bad cementation in same conditions. In that case, for the bad cementation condition the load observed reduces in 50%.

Conclusions and recommendations


Assessment of Graft Maturity After Cruciate Ligament Reconstruction. A systematic review.

By Bart van Groningen (Máxima Medical Centre)
Introduction

After anterior cruciate ligament reconstruction (ACLR) the graft tissue changes from tendinous to ligamentous-appearing in the new intra-articular environment, a process also called remodelling. Knee stability and patient-oriented outcome measures (PROMs) have traditionally been used to evaluate the success of ACLR and timing of return to sports. However, these outcome measures may lack the sensitivity to determine graft maturity. Other methods applied to determine graft maturity include histologic analysis on biopsy graft specimens and MRI signal to noise quotient (SNQ) of the graft. In order to evaluate the applicability of these methods to determine graft maturity after ACLR this systematic review will focus on the following questions: 1) what are the newest insights on graft remodelling in the field of human biopsy studies? 2) how does MRI SNQ of the graft after ACLR evolve over time; and 3) can MRI parameters predict clinical and functional outcome measures in patients after ACLR?

Goal

A systematic search was performed by an experienced librarian in Embase, Medline ovid, Cochrane Central, Web-of-Science, Scopus, Cinahl EBSCOhost, Sportdiscus, selecting studies published until May 15th 2019. Accepted methods of graft maturity assessment were biopsy studies, MRI studies reporting serial SNQ values, whether or not combined with clinical parameters in adult patients after ACLR using autologous grafts.

Method

Results

Twenty-four studies were included. Histologically the process of remodelling consists out of 3 phases: an early healing phase, a remodelling phase, and a maturation phase. Biopsy studies showed remodelling activity beyond 1 year after ACLR, mainly based on the histologic appearance of active fibroblasts. MRI studies found an initial increase of the graft SNQ, followed by a gradual decrease over time. However, study and MRI technique heterogeneity complicate comparison between studies. In humans the relationship between MRI parameters and histological or biomechanical properties has not yet been investigated. Graft SNQ and clinical parameters are poorly correlated.

Conclusions and recommendations

Histologic analysis remains the golden standard to assess graft maturity after ACLR, but is not clinically feasible due to its invasive character. The current literature lacks clear criteria to use MRI SNQ for the verification of graft maturity, and therefore cannot be used to guide in patient return to sports after ACLR.
Glucocorticoid induced mitophagy regulates osteocytic osteolysis

By Jun (Centre for Orthopaedic Translational Research, the University of Western Australia)

Abstract Id: 6069
Event: EORS 2019
Topic: Bone

Introduction

The finding in GC treated mice that the lacunae size enlarged while the elastic modulus around lacunae were reduced makes “osteocytic osteolysis” an appealing candidate account for GC induced bone loss. Nevertheless, there is no evidence as yet of the functional role of osteocyte in bone matrix remodelling under the effects of GC, and biological details are still limited to support this hypothesis. Besides, autophagy has been proved to be induced by glucocorticoid in osteocytes, however, the subsequent outcomes have not been fully illustrated. Whether there is an association between autophagy and osteocytic osteolysis is worthy to be explored.

Goal

Given the cellular complexity of osteocytes deeply located within mineralized bone matrix and prisoned inside cave like lacunae, the potential degradation of osteocytic bone matrix was investigated on a novel established ex vivo culture primary calvaria system. The osteocyte like cell line, MLO-Y4 cell is used to figure out the genetic and protein changes with using real-time PCR and western blotting. In addition, confocal imaging was also employed to show the influences of glucocorticoid on osteocytes.

Method

Results

Here, by employing the ex vivo primary calvaria system, we showed that glucocorticoid was able to cause potential degradation of osteocytic bone matrix. Following GC treatment, primary osteocytes were found to be able to fragment type I collagen from lacunae wall by producing cathepsin K (CTSK) under the acidification of V-ATPase. Subsequently, using the osteocyte like cell line, MLO-Y4 cells, we observed the over-expression of mitophagy specific gene, PTEN-induced kinase 1 (PINK1). Notably, we go on to prove that mitophagy, as an activating factor, promotes the production of osteocytes derived CTSK, whereby leading to the GC induced extracellular collagen degradation.

Conclusions and recommendations

Taken together, our study provides new evidence that osteocytes is also responsible for GC induced bone loss. Specifically, GC induces the osteocytic CTSK to degradation extracellular type I collagen, and mitophagy as a possible regulator, plays a crucial role in the activation of CTSK. Therefore, osteocyte should be taken into account when designing osteoporosis
Knee adduction moments are not increased in obese knee osteoarthritis patients during stair negotiation

By Loek Verlaan (Maastricht University Medical Center) Ramon Boekesteijn (Maastricht University Medical Center) Pieter Oomen (Maastricht University Medical Center)

Abstract Id: 5998
Event: EORS 2019
Topic: Biomechanics

Introduction

Osteoarthritis is one of the major causes of immobility. Most commonly, osteoarthritis manifests at the knee joint (1). Prevalence of knee osteoarthritis (KNOA) increases with age. Another important risk factor for KNOA is obesity. Research has shown that obese subjects have almost four times the risk of developing KNOA, which may be explained by both an increased knee loading (2, 3). In medial compartment KNOA, the knee adduction moment (KAM) during gait is considered a marker for disease severity (4). KAM is dependent of the magnitude of the ground reaction force and its moment arm relative to the knee joint centre (5). In addition, obesity has been reported to augment KAM during gait (6). However, after removal of the direct contributions of body weight, KAM parameters may be different due to obesity-related gait adaptations to limit knee loading (6, 7). While KAM has been thoroughly investigated during gait, little is known about KAM during stair negotiation (8), during which knee loads are higher compared to gait (9). The aim of the current study is therefore to compare normalized KAM during the stance phase of stair negotiation between lean KNOA patients, obese KNOA patients, and healthy controls.

Goal

This case control study included 20 lean controls, 14 lean KNOA patients, and 16 obese KNOA patients (Table 1). All subjects ascended and descended a two-step staircase at a self-selected, comfortable speed (Figure 1). Radiographic imaging and MRI were used to evaluate knee cartilage and KNOA status. Motion analysis was performed with a three-dimensional motion capture system. Kinetic data were obtained by one force platform. The parameters of study included: stance phase duration, toe-out angle, KAM peaks and KAM impulse.

Method

Results

During stair ascent obese KNOA patients showed a longer stance phase than healthy controls (P 0.050). Despite high between-subject variability (Figure 2), KAM impulse was found 45%
higher in the obese KNOA group during stair descent, when compared to healthy controls (P =0.012).

Conclusions and recommendations

The absence of a significant effect of groups on the normalized KAM during stair negotiation may be explained by a lower ambulatory speed in the obese KNOA group, that effectively lowers GRFz. Decreasing ambulatory speed may be an effective strategy to lower KAM during stair negotiation.

Comparative surgical risk between type of trampoline (size and place) and type of patients (age and sex) in trampoline related injury: a systematic review and meta-analysis

By Janisa Maljadi ()

Abstract Id: 5986
Event: EORS 2019
Topic: Other

Introduction

The popularity of trampoline has been increasing significantly, but in line with that, the injuries caused by trampoline use are also goes up. Despite of those risks of injuries, many people are still favor trampoline. However, currently there is no consensus as to which type of trampoline (full versus mini or park versus home) and participant (age and sex) is prone to have risk of surgery after trampoline related injury.

Goal

This systematic review and meta-analysis aims to assess and compare surgery related after trampoline injury between place of trampoline (park versus home), size of trampoline (full versus mini), age of participant (children versus adult) and sex of participant (male versus female majority). These clinical outcomes consist of the surgery related after trampoline injury. This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Method

Results
Relevant studies that reported surgery related after trampoline injury of either group were identified from Medline and Scopus from inception to May 14, 2019. 16 studies were included for the analysis of surgery related after trampoline injury; all 16 studies were retrospective cohorts studies. 6 studies and 2 studies were included for analysis of full (most participant used full size) and mini size trampoline related injuries. 4 studies were park trampoline (most participant used park) and 4 studies were home trampoline. 13 studies were majority in children and 3 studies were adult. 7 studies were male majority and 6 studies were female majority. Overall, there were 5622 trampoline related injuries patients (739 in the full size group and 402 in the mini size group, 3534 in park group and 746 in home group, 4916 in children group and 706 in adult group, 978 were female majority and 4009 were male majority). A total of 4491 and 1121 patients were treated with conservative method and surgical method. The total surgery rate per patient was 31% (95%CI: 16%, 46%) in all patients. The surgery rate were 0.3 (95%CI: 0.03, 0.58) and 0.06 (95%CI: 0.04, 0.09) in the full and mini size trampoline group. There were 0.36 (95%CI: 0.06, 0.67) and 0.11 (95%CI: 0.0, 0.22) in the park and home trampoline group. The surgery rate were 0.33 (95%CI: 0.14, 0.53), 0.24 (95%CI: 0.07, 0.11), 0.49 (95%CI: 0.47, 0.51) and 0.38 (95%CI: 0.22, 0.53) in children, adult, female majority and male majority respectively. Indirect meta-analysis shows that full size trampoline provided a higher risk of surgery of 6.0 (95%CI: 3.7, 9.7) when compared to mini size trampoline. Park trampoline had a higher risk of having surgery of 2.17 (95%CI: 1.70, 2.78) when compared to home trampoline. In terms of age and sex of participant, there had significant higher of 1.65 (95%CI: 1.35, 2.01) and 1.54 (95%CI: 1.36, 1.74) in children compared to adult and female majority compared to male majority.

Conclusions and recommendations

Prospective randomized controlled studies are needed to confirm these findings as the current literature is still insufficient.

Ankle fracture management – Are we complying to BOAST guidelines?

By Karam Ahmad (UHNM)

Abstract Id: 5969
Event: EORS 2019
Topic: Bone

Introduction

Ankle fractures are common. They often result from low energy trauma from torsion injuries. Treatment focusses on 1) restoration and maintenance of stability and 2) Alignment of the joint, as closely to normal anatomy as possible. Enhancing these two ensures that functional recovery is optimal and the risk of developing post traumatic arthritis is reduced. The Royal Stoke University Hospital, part of the University Hospital of the North Midlands (UHNM) is a major trauma centre. We assess compliance to the British Orthopaedic Association
Standards for Trauma and Orthopaedics (BOAST) guidelines for our ankle fracture patients using BOAST 12.

Goal

Patients who suffered from ankle fractures in the month of July 2018 were identified on the PACs system. Paediatric fractures, open fractures and fractures which underwent operative intervention were excluded. Age, gender, stability and weber classification were recorded. The remaining patient’s clinic letters were reviewed, immobilisation, weight bearing status and venous thromboprophylaxis (VTE) documentation were recorded.

Method

Results

72 patients suffered from ankle fractures in the month of July 2018. Following exclusion criteria application this number reduced to 44. Average age of our patients was 56.8 (19-97). 28 were female and 16 males. 31 fractures were identified as stable, 13 unstable. In terms of Weber classification, we had A-17, B-27 and C-0. In terms of immobilisation, 22 patients were offered a cast, 18 boot, 0 AFO and in 4 patients there was no documentation of immobilisation. All patients had documented advice on weight bearing status. 11 Patients had no documentation on VTE status in their clinic letters.

Conclusions and recommendations

We propose the development of a pre-emptive ankle fracture clinic letter which will ensure that the above issues are resolved to ensure 100% compliance to the BOAST 12 guidelines.

Compromised Cell Function and Extracellular Collagen Degeneration in Stress deprived Tendon

By Peilin (University of Western Australia)

Abstract Id: 5968
Event: EORS 2019
Topic: Tendon

Introduction

Tendon was a mechanosensitive tissue where mechanical stress was conducted. Appropriate mechanical stress was great of importance for tendon homeostasis and healing after injury. However, both excessive and insufficient mechanical stress can distressfully lead to either acute tendon rupture or chronic tendinopathy. For many previous and current studies, the mechanism and process underpin tendon rupture and tendinopathy have been intensively investigated. Nonetheless, tendon pathological changes under insufficient mechanical stress
was less explored. Tendon experienced insufficient mechanical loading was very common in bed riding patient or individuals suffering from neurological impairment, which are more immobile than healthy people. Tendon atrophy and degeneration were devastating event for those patient during their rehabilitation, so the intrinsic mechanism underlying pathological changes is needed to be revealed in order to finding a point either for prophylaxis or treatment strategy.

**Goal**

36 mice was used in our study. Hind limb was paralysed by injection of botox to quadriceps to establish mechanical stress deprived tendon model. PBS injection was used as control. 2 weeks after injection, mice were sacrificed and petella tendon were investigated histologically by H&E staining. Polarized microscopic examination was performed to detect collagen alignment. Tendon derived stem cells were isolated and cell colony formation, cell proliferation by MTS assay and potential of tri-lineage differentiation were examined. (Osteogensis: Calcium nodule formation by Alizarin red staining and mRNA expression of ALP, BMP2 and RUNX2 by qPCR; Chondrogenesis: Safarinin-O staining of pellet culture and mRNA expressions of SOX9 and Aggrecan by qPCR; Adipogenesis: Oil-red staining for TDSC cultured in adipogenesis medium.) Collagen hybridising peptides were used to detect collagen degeneration in samples with frozen section. qPCR for mRNA expressions of Tenomodulin, Mohawk, MMP-13 and TNF-Alpha. Western Bot for Tenomodulin, TNF-Alpha, MMP-13 and MMP-9 (Beta-actin as loading control)

**Method**

**Results**

Hitological and polarised microscopic analysis: Degenerative extracellular matrix and disorientated collagen fibres in botox injected group. MTS assay for TDSCs: Cell proliferation was compromised in botox injection group. Tri-lineage differentiations: Osteogensis, chondrogenesis and adipogenesis were diminished in botox group. Collagen hybridising peptides incubation: showed more collagen degeneration in botox group

Tenogenesis, inflammatory cytokine and MMP-13: qPCR and western blot showed decreased Tenomudulin which is tenogenic marker and qPCR showed decreased Mohawk expression which is another tenogenesis marker in botox group. TNF-Alpha and MMP-13 were increased in both mRNA expression and proteins productions in botox group. However, MMP-9 was not involved.

**Conclusions and recommendations**

In this study, we utilize botox to paralysed quadriceps resulting in mechanical loading deprivation on patella tendon and compared normal and mechanical deprived tendon in histological and cellular level. Tendon atrophy and collagen fibres disorientation were noticed in botox group. TDSCs from botox group exhibited decreased proliferation and colony formation capacity. Besides, trilineage differentiation (osteogenesis, chondrogenesis and adipogenesis) and tenogenesis of TDSCs from botox group are diminished which meant the compromised potential of TDSCs. As for extracellular matrix, collagen degeneration detected by CMP was increased and also, TNF-Alpha and MMP-13 were upregulated where inflammation might be indicated. And we speculated that collagen degeneration was possibly due to increased MMP-13. However, there is still limitations and further studies are needed. These including clarify the tendon pathological process in more specific time points to
provide more details for purpose of therapy development. Moreover, intrinsic relation between inflammation and MMPs remains unclear in tendinopathy, and our studies are needed to be carried in the future with more investigations regarding inflammation and MMPs.

The effect of IL-1beta in osteochondral tissues using a novel patellar explant for osteoarthritis

By Isabel Amado (Royal college of Surgeons in Ireland) Neashan Mathavan (Royal college of Surgeons in Ireland) Brenton Cavanagh (Royal college of Surgeons in Ireland)

Abstract Id: 5960
Event: EORS 2019
Topic: Bone

Introduction

Osteoarthritis (OA) is a disease that affects both bone and cartilage (1). Typically, this disease leads to cartilage degradation and subchondral bone sclerosis but the link between the two is unknown. Also, while OA was traditionally thought of as ‘non-inflammatory’ condition, it now seems that a low level ‘smouldering’ inflammation may be involved in the link between these responses. This is particularly relevant in the case of Post-Traumatic OA (PTOA), where an initial phase of synovial inflammation occurs after injury. The inflammatory mediator interleukin 1 beta (IL-1B) is central to this response and contributes to cartilage degradation (2). However, whether there is a secondary effect of this mediator on subchondral bone, via bone-cartilage crosstalk, is not known. To address this question, we developed a novel patellar explant model, to study bone cartilage crosstalk which may be more suitable than commonly used femoral head explants. The specific aim of this study was to validate this novel patellar explant model by using IL-1B to stimulate the inflammatory response after joint injury and the subsequent development of OA.

Goal

Female Sprague Dawley rats (n=48) were used to obtain patellar explants, under an institutional ethical approval license. Patellae were maintained in high glucose medium sterile culture condition, with or without IL-1B (10ng/ml), for 7 days with contralateral patellae serving as controls. One group (n= 12) of patellae were assessed for active metabolism of explant, using two different cell viability assays: Live and Dead (L/D) and Alamar blue assay (AB). A second group (n=12) was used for tissue specific biochemical assays for both bone (Alkaline Phosphatase) and cartilage (sulfated proteoglycan and glycosaminoglycan (sGaG)). Finally, a third group (n=28) of explants were used for histologically analysis. Samples were decalcified, embedded in paraffin and sectioned to 7µm thickness, and then stained using H&E; and Safranin O with fast green. Additionally, toluidine blue and alkaline phosphatase staining were also performed.
Method

Results

Our results demonstrate that our system maintains explant viability for 7 days, but that IL-1B reduces cell viability in patellar cartilage, as measured by both LD/AB after 0, 2, 4 and 7 days in culture. In contrast, sGaG content in cartilage were increased by treatment. Additionally, ALP, a marker of osteoblastic activity, was increased in IL-1B treated group 4 and 7 days, but was also increased in control groups. Histological analyses showed that IL-1B reduced proteoglycan staining, demonstrating the powerful effect of this factor in injury response over time (Figure 1).

Conclusions and recommendations

Thus, we can imply that IL-1B affects both bone and cartilage tissues independently in this system. Furthermore, we demonstrated that this patellar explant system can be useful to model bone-cartilage crosstalk in OA.

Evaluating the Impact of a Virtual Fracture Clinic in a District General Hospital

By Ross Campbell

Abstract Id: 5954
Event: EORS 2019
Topic: Other

Introduction

Musculoskeletal injuries account for 30% of presentations to A+E and their ongoing management represents a significant resource burden. In a traditional fracture clinic model, all referred patients are seen for urgent follow-up. Virtual Fracture Clinics (VFC) seek to improve service efficiency by identifying which patients can be discharged directly from orthopaedic follow-up and which require urgent or routine clinic appointments. Previous studies suggest non-inferiority of clinical outcomes following appropriately selected direct discharge. A VFC was introduced at Raigmore Hospital, Scotland, in 2016 with the aim of reducing unnecessary clinic appointments. Referred patients are reviewed remotely by an orthopaedic surgeon and either discharged with telephone advice or seen for in-person follow-up. In 2017, a specialist orthopaedic physiotherapist was added as an alternative option for follow-up. Aims were - 1. Evaluate the use of the VFC service since its introduction. 2. Review the impact of orthopaedic physiotherapy referral pathway.

Goal

Referral outcome from each VFC review was recorded. The proportion of patients discharged directly from VFC before and after the introduction of the physiotherapy service was compared.
Method

Results

Between 07/2016 – 12/2016 944 patients were referred to the VFC. 24.5% of these were directly discharged with the remainder seen in-person by an orthopaedic surgeon. After the introduction of the physiotherapy service, between 07/2017-12/2017, 1015 patients were referred and 20.1% directly discharged, with 23% of patients seen in the physiotherapy clinic.

Conclusions and recommendations

Virtual Fracture Clinics are an effective way to reduce resource burden without impacting the management of stable musculoskeletal injuries.

Hypermobility among patients with greater trochanteric pain syndrome

By Lisa Cecilie Urup Reimer (Department of Orthopaedics, Aarhus University Hospital) Julie Sandell Jacobsen (Department of Physiotherapy, Faculty of Health Sciences, VIA University College, Aarhus) Inger Mechlenburg (Department of Clinical Medicine, Aarhus University)

Abstract Id: 5910
Event: EORS 2019
Topic: Tendon

Introduction

Greater trochanteric pain syndrome (GTPS) is a common and disabling hip condition. Hypermobility has been suggested as a possible cause of GTPS. The purpose of this study was to report the prevalence of hypermobility and to investigate its impact on hip-related function and awareness in patients with GTPS.

Goal

This cross-sectional study was based on a cohort of patients diagnosed with GTPS in the 2013-2015 period. Hypermobility was investigated with the Beighton Score and defined by a cut-off score ≥ 5. Data on patients’ current hip function and awareness were collected with the questionnaires the Copenhagen Hip and Groin Outcome Score and the Forgotten Joint Score.

Method

Results

A total of 612 patients with GTPS were identified based on the diagnosis system; out of those, 390 patients were assessed for eligibility, and 145 (37%) were included. The prevalence of hypermobility within this cohort was estimated to be 11% (95% confidence interval (CI): 3-
26%) for males and 25% (95% CI: 17-34%) for females. No significant association was found between hypermobility and self-reported hip function and awareness.

**Conclusions and recommendations**

We recommend that future studies of GTPS will include hypermobility and investigate the consequences of hypermobility among patients with GTPS.

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**Longitudinal analysis of effects of modified beta tricalcium scaffold on bone regeneration using a critical size fracture: healing model in mice**

By Mersedeh Tohidnezhad (Anatomy and Cell Biology, RWTH Aachen University, Germany) Yusuke Kubo (Anatomy and Cell Biology, RWTH Aachen University, Germany) Philipp Lichte (Department of Trauma Surgery RWTH Aachen, Germany)

**Introduction**

The large bone defects with high risk of delayed bone union and pseudoarthrosis remain significant clinical challenge. Aim of the present study was the investigation of the critical size fracture healing process in transgenic mice using a novel β-TCP scaffold.

**Goal**

The luciferase transgenic mice strains (BALB/C-Tg(NF-κB-RE-luc)-Xen) and FVB/N-Tg(Vegfr2-luc)-Xen were used. Critical size fracture on femur was performed and stabilized using external fixation (RISystem). The fracture was bridged with a synthetic scaffold with and without Strontium. In consequence, the expression levels of NF-κB and VEGFR2 could be monitored in a longitudinal fashion using the Xenogen imaging system for two months. Animals were euthanized, serial section of femur were prepared, and the fracture sites were histologically examined.

**Method**

**Results**

Sr reduced inflammation in the early phase of healing (15th days), but it was increased in the late healing stage. The level of VEGFR2 activity increases in the Sr doped β-TCP group at the 15th day, the luciferase activity starts to decrease in this group and show significantly less activity compared to other groups in the second half. In the group without scaffold a
connective tissue formation were observed. In both, β-TCP and β-TCP+Sr, the connection of newly formed tissue within integrated canals in scaffold was visible. Tissue formation in β-TCP+Sr group was significantly higher than in the β-TCP group, whereas the percentage of osseous tissue in relation to the newly formed tissue was in β-TCP scaffold much more than in β-TCP+Sr groups.

Conclusions and recommendations

This study presents the first data regarding VEGFR2 and NF-κB and angiogenesis activity profiles during fracture healing. The collected longitudinal data reduces the number of experimental animals in the study. Addition of strontium in scaffolds influenced the inflammation in different stage of the healing. This effect might influence the healing process and may prove to be advantageous for osteoporosis fracture healing.

Biology versus clinical outcome: a human Achilles tendon study

By Franka Klatte-Schulz (Julius Wolff Institute, BIH-Center for Regenerative Therapies, Charité-Universitätsmedizin Berlin) Susann Minkwitz (Julius Wolff Institute, BIH-Center for Regenerative Therapies, Charité-Universitätsmedizin Berlin) Aysha Schmock (Julius Wolff Institute, BIH-Center for Regenerative Therapies, Charité-Universitätsmedizin Berlin)

Abstract Id: 5880
Event: EORS 2019
Topic: Tendon

Introduction

Tendon healing is a complex process that often results in compromised healing of the tendon tissue. It has recently been shown that temporal changes in the expression profile and the histological tissue quality of the tendons occur during the early healing process after acute Achilles tendon rupture. Whether these changes are accompanied by an altered healing process, is not yet known and was the aim of the present study.

Goal

Tendon biopsies were obtained from 24 patients with acute Achilles tendon rupture at the time of surgery (2-9 days after rupture) and examined histologically as well as on RNA level. Histologically, the tendon architecture, the amount of aligned collagen, glycosaminoglycan and fat as well as the cellularity, vascularity and immune cell infiltration were determined. On RNA level the expression of markers for the modeling/remodeling (MMPs and TIMPs), collagens (1, 3, 5), tendon markers (scleraxis, tenomodulin), pro- and antiinflammatory markers (IL1β, IL6, IL10, IL33, TNFa, TGFβ1, COX2) and immune cell markers (CD3, CD68, CD80, CD206) were analyzed by Real-Time PCR. To determine the clinical outcome, the patients were followed up 12 months after the operation and the following scores were recorded: Subjective score, Tegner score, Visual Analog Scale (VAS) pain, VAS function,
Correlation analysis shows that early post-rupture surgery is associated with better clinical outcome (ATRS Score: p=0.022). Histologically, a good functional healing outcome shows a positive correlation to the amount of aligned collagen (Heel Rise Test: p = 0.009) and glycosaminoglycans in the tendon (Heel Rise Test: p = 0.026, Matles difference: p = 0.029), as well as a negative correlation to the fat content (Thermann score: p = 0.018, subjective score: p = 0.027, VAS function: p = 0.031). On RNA level, a good healing outcome correlates with increased expression of MMP13, collagen 1, 3, 5 (Heel Rise Test: p = 0.019, p = 0.048, p = 0.030), and TIMP2 (Tegner Score: p = 0.040), TGFβ1 (Thermann Score: p = 0.032) and CD80 (ATRS: p = 0.025, Thermann score: , p = 0.032). Whereas a limited healing outcome is associated with an increased expression of MMP2 (Heel Rise Test: p = 0.033), MMP3 (Matles Test: p=0.001, Heal Rise test p = 0.017), and IL33 (Tegner Score: p = 0.047).

Conclusions and recommendations

The results of the study show a clear relationship between the tendon biology at the time of the surgery and the clinical and functional healing outcome 12 months after the operation. Especially matrix formation and remodeling play a crucial role, while the examined immunological factors seem to influence the tendon healing to a lesser extent. The modulation of matrix formation could potentially lead to improved treatment options in the future.

Robotic total knee arthroplasty may facilitate early recovery when compared to navigated and conventional jig based techniques.

By Thomas Clive Edwards (Imperial College Healthcare NHS Trust)Nina Dela Cruz (Imperial College Healthcare NHS Trust)Ben Sephton (Imperial College Healthcare NHS Trust)

Abstract Id: 5799
Event: EORS 2019
Topic: Arthroplasty

Introduction

Robotic arthroplasty surgery is growing in popularity. Despite good evidence for improved accuracy in implant positioning, there is less evidence to suggest still this improved accuracy translates into superior clinical outcomes. This retrospective study looks to compare three

Goal

90 primary total knee arthroplasty patients were included in this study divided into 3 matched groups. 30 were performed using the Navio Robotic System (Smith & Nephew), 30 were performed using Brainlab Navigation and 30 were performed using conventional jigs. The same implants were used in all patients (Genesis II Smith & Nephew) and the operations were performed by 2 experienced knee surgeons at the same center between 2016 and 2019. Patients were followed up to 6 months. We reported range of motion, blood loss, time to hospital discharge, opiate requirement, and Oxford Knee Scores at 6 months. Data was analysed and statistics were calculated in Stata/IC 14.2.

Method

Results

Mean Age was 70.2. 62 female patients and 28 male patients were included. Most patients were ASA II (68), 4 were ASA I, 16 ASA III and 2 ASA IV. Mean BMI was 31.1. There were no significant differences between groups in ASA or BMI (p>0.05). Age was noted to be significantly different between the robotic group and the navigated group (p=0.02) with the robotic group being older (mean age 73.3 compared with 67.1), otherwise between groups no differences were found. Day 1 ROM was significantly better in the Robotic group (mean 67.9) compared with the jigs (mean 48.6) p= 0.007. Navigated group day 1 ROM was 54.8. The robotic group had significantly less estimated blood loss with mean fall in hemoglobin of 16 compared to the Jigs 29.4 and the navigated 21.7 (p=0.000). No patients in the robotic group required a blood transfusion, 7 needed blood transfusions in the jig group and 2 of the navigated group were transfused. The robotic group were discharged from hospital faster with an average stay of 102 hrs compared to the jigs 145hrs and the Navigated 119hrs however this was not significant p=0.07. No significant differences were found in opiate requirement or 6-month OKS between the 3 groups.

Conclusions and recommendations

Robotic knee surgery may facilitate early recovery in total knee arthroplasty. More work is needed to investigate this further

Externalized Locked Plating Of Unstable Proximal Tibia Fractures Can Provide Sufficient Stability Under Partial Weightbearing – A Finite Element Study

By Biser Makelov (University Multiprofile Hospital for Active Treatment 'Prof Stoyan Kirkovitch’, Stara Zagora, Bulgaria)Juan Diego Silva (AO Research Institute Davos, Davos,
Introduction

Osteosynthesis of high-energy metaphyseal proximal tibia fractures is still challenging, especially in patients with severe soft tissue injuries and/or short stature. Although the use of external fixators is the traditional treatment of choice for open comminuted fractures, patients' acceptance is low due to the high profile and therefore the physical burden of the devices. Recently, clinical case reports have shown that supercutaneous locked plating used as definite external fixation could be an efficient alternative. Therefore, the aim of this study was to evaluate the effect of implant configuration on stability and interfragmentary motions of unstable proximal tibia fractures fixed by means of externalized locked plating.

Goal

Based on a right tibia CT scan of a 48 years-old male donor, a finite element model of an unstable proximal tibia fracture was developed to compare the stability of one internal and two different externalized plate fixations. A 2-cm osteotomy gap, located 5 cm distally to the articular surface and replicating an AO/OTA 41-C2.2 fracture, was virtually fixed with a medial stainless steel LISS-DF plate. Three implant configurations (IC) with different plate elevations were modelled and virtually tested biomechanically: IC-1 with 2-mm elevation (internal locked plate fixation), IC-2 with 22-mm elevation (externalized locked plate fixation with thin soft tissue simulation) and IC-3 with 32-mm elevation (externalized locked plate fixation with thick soft tissue simulation). Axial loads of 25 kg (partial weightbearing) and 80 kg (full weightbearing) were applied to the proximal tibia end and distributed at a ratio of 80%/20% on the medial/lateral condyles. A hinge joint was simulated at the distal end of the tibia. Parameters of interest were construct stiffness, as well as interfragmentary motion and longitudinal strain at the most lateral aspect of the fracture.

Method

Results

Construct stiffness was 655 N/mm (IC-1), 197 N/mm (IC-2) and 128 N/mm (IC-3). Interfragmentary motions under partial weightbearing were 0.31 mm (IC-1), 1.09 mm (IC-2) and 1.74 mm (IC-3), whereas under full weightbearing they were 0.97 mm (IC-1), 3.50 mm (IC-2) and 5.56 mm (IC-3). The corresponding longitudinal strains at the fracture site under partial weightbearing were 1.55% (IC-1), 5.45% (IC-2) and 8.70% (IC-3).

Conclusions and recommendations

From virtual biomechanics point of view, externalized locked plating of unstable proximal tibia fractures with simulated thin and thick soft tissue environment seems to ensure favorable conditions for callus formation with longitudinal strains at the fracture site not exceeding
10%, thus providing appropriate relative stability for secondary bone healing under partial weightbearing during the early postoperative phase.

**Slipped Upper Femoral Epiphysis: Are We Missing the Point?**

By Muhammad Nouman Baig (Galway University Hospital)

**Introduction**

Slipped upper femoral epiphysis (SUFE) is characterized by the slippage of the proximal femoral metaphysis anteriorly and superiorly relative to the epiphysis. SUFE is also known as a slipped capital femoral epiphysis. The average age of its manifestation is 13.4 years in boys and 12.2 years in girls [1]. It has a higher incidence in boys, especially in obese children. We describe a case of a 12-year-old boy who presented with the late presentation of an unstable SUFE.

**Goal**

A 12-year-old boy was referred to our hospital from a peripheral hospital with a diagnosis of SUFE of the left hip. He initially presented to the peripheral hospital with left knee pain and limping two weeks prior. He went to the local hospital where the accident and emergency department personnel obtained knee X-rays showing no abnormality. He was given analgesia, advised bed rest, and was treated as having a soft tissue injury. The knee pain and limping did not resolve. The child presented to the local hospital again after four days with the same concern, and they obtained new knee X-rays. They also performed a clinical examination of the knee and found no abnormality. The analgesia was changed, and they advised further bed rest. The child’s symptoms persisted. He presented again with the knee pain, and the orthopaedic team was asked to review him. The orthopaedic team ordered bilateral knee X-rays and a pelvic X-ray along with a computed tomography scan of his pelvis. The scans confirmed the left hip slipped epiphysis.

**Method**

**Results**

He underwent the open epiphyseal reduction and fixation using the modified Dunne procedure (Figures 4, 5). He was monitored via follow-up in the clinics after he was discharged. Approximately three months after the procedure, he developed signs of avascular necrosis.

**Conclusions and recommendations**
Whenever a limping adolescent child presents, the initial presenting concerns such as knee pain can be deceiving. Therefore, physicians should be vigilant and rule out all the provisional diagnoses. It is important to diagnose SUFE before it becomes unstable as there is a high chance the condition will proceed to avascular necrosis.

**Breaking Bad: A Comparative Descriptive Analysis of Periprosthetic Fractures Around Cemented and Uncemented Femoral Stems**

By Muhammad Baig (Galway University Hospitals)

Abstract Id: 5786  
Event: EORS 2019  
Topic: Arthroplasty

**Introduction**

Periprosthetic fractures are most commonly classified according to the Vancouver classification system and more recently the Unified Classification System. The aim of this study is to provide a descriptive analysis of fracture patterns in femoral periprosthetic fractures (PPFs) by femoral stem fixation.

**Goal**

A retrospective observational study of all femoral PPFs over a 10-year period at our institution was conducted. Presenting radiographs were examined to assess the fracture pattern.

**Method**

**Results**

Over the 10-year period, 138 femoral PPFs that underwent operative treatment were examined. Mean age of patients was 78 years with 45.7% male and median American Society of Anaesthesiologists grade 3. The femoral stem fixation was cemented in 83 patients and uncemented in 55 patients. Uncemented femoral stems most commonly caused a simple oblique fracture pattern (69.1%) with a more comminuted pattern seen in cemented fixation (59%).

**Conclusions and recommendations**

Fracture patterns differ according to femoral stem fixation. A simple “sickle-like” oblique fracture pattern was more commonly seen in uncemented stems while cemented tapered stems resulted in a comminuted “axe splitting” pattern.
Injectable, resorbable, porous bone substitute with controlled release of antimicrobial agents: a novel tool for the treatment of osteomyelitis

By Lucy Vojtova (CEITEC - Brno University of Technology, Purkynova 656/123, 612 00 Brno, Czech Republic) Lenka Michlovska (CEITEC - Brno University of Technology, Purkynova 656/123, 612 00 Brno, Czech Republic) Veronika Grezlova (CEITEC - Brno University of Technology, Purkynova 656/123, 612 00 Brno, Czech Republic)

Abstract Id: 5785
Event: EORS 2019
Topic: Biomaterials

Introduction

Infections are among the most important complications related to the treatment of bone traumas. Bone infections (osteomyelitis) are generally treated with systemic and local antibiotic therapy, while the last is commonly provided by non-degradable poly(methyl methacrylate) spacers loaded with antibiotics. However, reports show that only 3 - 5% of antibiotic is released from polymeric cement in vivo [1]. In this work, biodegradable, self-setting, thixotropic polymer/ceramic bone substitute loaded with antibacterial agents based on non-metallic biogenic selenium nanoparticles (SeNPs) was studied to avoid the use of antibiotics in the treatment of osteomyelitis.

Goal

The bone substitute consists of alpha-tricalcium phosphate and water solution of thermosensitive, copolymer based on poly(lactic acid), poly(glycolic acid) and poly(ethylene glycol) (PLGA—PEG—PLGA) [2]. The rheological properties during setting were studied in steady mode using controlled-stress rheometer. The microstructure after setting was investigated by scanning electron microscope, the compression test and accelerated degradation study at pH = 2.2 were performed on cement cylinders after 10 days of setting. The cytocompatibility was evaluated using human mesenchymal stem cells (hMSC) by dsDNA and MTS assays and the osteointegration was preliminarily tested in vivo on Wistar rats by filling iatrogenic bone defect in femoral bone. The new bone substitute was doped with 20-170 ppm of SeNPs with the size of about 100 nm and antibacterial properties on Staphylococcus aureus (SA) strain and its methicillin-resistant form (MRSA) were evaluated by disk diffusion method.

Method

Results

PLGA—PEG—PLGA copolymer addition provides a thixotropic rheological behavior of the bone substitute, providing good injection and cohesion at injected site. The compressive
strength of the set cement was 12 MPa. The accelerated degradation study demonstrated more than 25% of mass loss in 8 h and the release of calcium ions over the exposure time. Moreover, the degradation of the cement generates pores with morphology similar to the reabsorption pits produced by osteoclasts. The use of the copolymer did not exhibit cytotoxicity in contact with hMSC and showed good biocompatibility and osteoinduction in rat animal model. Computed micro-tomography proved total substitute resorption and healed defect after 4 weeks from implantation. Addition of SeNPs releasing from 96% within first 8h at 37 °C made the bone substitute very effective against gram-positive SA and MRSA being mainly presented in osteomyelitis. The results were evaluated statistically using the One Way Analysis of Variance method and the Student-Newman-Keuls test (SigmaStat 12.0, Systat). Statistical significance was considered when p ≤ 0.05.

Conclusions and recommendations


A novel technique of minimally invasive dynamic hip screw.

By Gunasekaran Kumar (Royal Liverpool University Hospital) Ekansh Debuka (Royal Liverpool University Hospital)

Abstract Id: 5736
Event: EORS 2019
Topic: Other

Introduction

Increasing incidence of osteoporosis, obesity and an aging population have led to an increase in low energy hip fractures in the elderly. Perceived lower blood loss and lower surgical time, media coverage of minimal invasive surgery and patient expectations unsurprisingly have led to a trend towards intramedullary devices for fixation of extracapsular hip fractures. This is contrary to the cochrane review of random controlled trials of intramedullary vs extramedullary implants which continues recommends the use of a sliding hip screw (SHS) over other devices. Furthermore, despite published literature of minimally invasive surgery (MIS) of SHS citing benefits such as reduced soft tissue trauma, smaller scar, faster recovery,
reduced blood loss, reduced analgesia needs; the uptake of these approaches has been poor. We describe a novel technique one which remains minimally invasive, that not only has a simple learning curve but easily reproducible results.

Goal

All patients who underwent MIS SHS fixation of extracapsular fractures were included in this study. Technique is shown in Figure 1. We collated data on all intertrochanteric hip fractures that were treated by a single surgeon series during period Jan 2014 to July 2015. Data was collected from electronic patient records and radiographs from Picture Archiving and Communication System (PACS). Surgical time, fluoroscopy time, blood loss, surgical incision length, post-operative transfusion, Tip Apex Distance (TAD) were analysed.

Method

Results

There were 10 patients in this study. All fractures were Orthopaedic Trauma Association (OTA) type A1 or A2. Median surgical time was 36 minutes (25-54). Mean fluoroscopy time was similar to standard incision sliding hip screw fixation. Blood loss estimation was

Conclusions and recommendations

MIS SHS can be undertaken safely and expeditiously for extracapsular hip fractures.

Multimodal blood management for reducing perioperative blood loss in total knee arthroplasty

By FU DONGLIN (FUYANG PEOPLE'S HOSPITAL) LI YIFAN (FUYANG PEOPLE'S HOSPITAL) LI LI (FUYANG PEOPLE'S HOSPITAL)

Abstract Id: 5734
Event: EORS 2019
Topic: Arthroplasty

Introduction

To investigate the effectiveness of multimodal blood management in reducing perioperative blood loss and postoperative transfusion rate in total knee arthroplasty (TKA).

Goal

121 patients with TKA were analyzed for perioperative blood loss and transfusion. 72 patients underwent multimodal blood management as group A, and 49 patients did not apply multimodal blood management as group B. Multi-mode blood management program includes:
optimization of preoperative hemoglobin concentration, minimization of surgical trauma, application of intra- and extra-articular therapy during operation, setting of tourniquet pressure, intraoperative intra-articular injection of tranexamic acid combined with drainage tube clamped for 3h and so on. The intraoperative blood loss, postoperative drainage and blood routine correlation values between pre- and post-operation were recorded in the two groups. The severe complications such as postoperative deep vein thrombosis were checked.

Method

Results

The drainage volume, total and hidden blood loss of group A were significantly lower than those of group B. The hemoglobin concentration and hematocrit on day 1 and 3 after operation were significantly higher than those in group B. The difference between the two groups was statistically significant. (P < 0.05). No deep vein thrombosis and related complications were found in either group.

Conclusions and recommendations

The multi-mode blood management program is effective in reducing blood loss and lowering blood transfusion rate. The program is safe and effective.

Robotic vs navigated unicompartmental knee arthroplasty: How recreating native posterior tibial slope anatomy may improve early recovery.

By Thomas Edwards (Imperial College Healthcare NHS Trust) Nina Dela Cruz (Imperial College Healthcare NHS Trust) Ben Sephton (Imperial College Healthcare NHS Trust)

Abstract Id: 5733
Event: EORS 2019
Topic: Arthroplasty

Introduction

Robotic arthroplasty surgery is growing in popularity. The evidence behind improved accuracy is abundant however controversy still exists as to whether this improved accuracy translates into superior clinical outcomes. This retrospective study looks to compare early recovery between robotic unicompartmental knee arthroplasties (UKA’s) where the posterior tibial slope was recreated anatomically to navigated UKA’s where a standard 3-5 degree slope was used.

Goal
78 UKA patients were included. A group of 41 UKA's performed using the Navio Robot (Smith & Nephew) were matched for age, ASA score & BMI to a control group of 37 UKA's performed using navigation BrainLab software. All operations were performed by a single surgeon using the same implants (Smith and Nephew Accuris) at a single center between 2016 and 2018. We reported post operative range of motion, time to hospital discharge, blood loss, opiate requirement during inpatient stay and Oxford Knee Score at 6 months. Posterior tibial slopes were measured using a validated technique on pre & post-operative lateral radiographs by two independent assessors blinded as to whether they were measuring robotic or navigated UKA's. The difference between the native posterior tibial slope and PTS recreated by the UKA was calculated. All statistics were computed using Stata/IC 14.2 package, differences were considered significant when p

Method

Results

44 females and 34 males were included with a mean age of 66.2 and a mean BMI of 30.2. 70 medial UKA's and 8 lateral UKA's were included. 38 were left knees and 40 were right. 13 were ASA I, 51 were ASA II and 14 were ASA III. There were no significant differences in age, ASA grade or BMI between the two groups. The difference in posterior tibial slope (PTS) was significantly lower in the robotic group compared to the navigated group (mean=2.6 degrees and 6.2 degrees respectively, p=0.000) indicating the robotic group better recreated the native anatomy. Linear regression showed the difference in PTS was negatively correlated with day 1 ROM and this was also significant (Coef -2.44 R-squared= 0.135, p=0.0075). Mean range of motion recorded on day 1 was significantly lower in the navigated group (44.6 deg) compared to 61.2deg in the robotic group (p=0.001), this remained significant at day 3 (50 and 75 degrees p=0.013). Mean time to hospital discharge was significantly lower in the robotic group at 64.7 hours compared to 98.1 hours in the navigated group (p= 0.018). There was no significant difference reported in blood loss and Oxford knee scores at 6 months between the two groups (38.2 navigated & 38.3 robotic p=0.938)

Conclusions and recommendations

Robotic UKA with matching of the native posterior tibial slope can facilitate early recovery compared to navigated alone. Whilst these early gains do not currently translate into better PROM's scores at 6 months the authors still feel there are important benefits particularly when considering early hospital discharge or performing UKA's in an outpatient setting. Further work will be necessary with longer follow up to assess for longevity and the long term impact of this surgical technique.

What is the Cost of Chemical Venous Thromboembolism Prophylaxis in Primary Total Hip and Knee Arthroplasty Patients Following the Implementation of the Latest
Chemical venous thromboembolism (VTE) prophylaxis constitutes an important area in everyday orthopaedic practice. Recent studies have shown aspirin, as a chemical VTE prophylaxis agent following arthroplasty, was equivalent to newer oral anticoagulants in terms of efficacy and overall risk profile. The new United Kingdom (UK) guidelines from the National Institute For Health and Care Excellence (NICE) now recommend aspirin monotherapy as an appropriate regimen for chemical VTE prophylaxis in patients undergoing primary total knee arthroplasty, and they recommend aspirin after an initial course of low molecular weight heparin (LMWH) following primary total hip arthroplasty. Given aspirin is a much cheaper drug than the newer oral anticoagulants, this may provide substantial cost-savings to the orthopaedic community. We compared the cost difference of chemical VTE prophylaxis in primary total hip and knee arthroplasty patients at our hospital pre- and post-implementation of the new NICE guidelines to assess any potential financial savings.

**Goal**

This single-centre study was performed at a tertiary arthroplasty centre. In 2017 a total of 1,455 primary arthroplasties were performed (780 hips and 675 knees). The pre-implementation regimen was the respective chemical VTE prophylaxis agent(s) prescribed routinely by all consultants performing lower limb arthroplasty. The post-implementation regimen was adopted following a departmental agreement to follow the 2018 NICE guidelines for VTE prophylaxis; for hips NICE recommend 10 days of LMWH followed by a further 28 days of 150mg aspirin, and for knees 14 days of 150mg aspirin. Costs for each drug and regimen were determined using our pharmacy hospital database, with costs calculated on a per patient basis. The differences in cost pre- and post-implementation of the NICE guidelines were then calculated. The cost difference (per patient) was then multiplied by the number of primary arthroplasties performed in 2017, which established the expected cost difference during a typical one-year period.

**Method**

**Results**

The mean cost per patient pre-implementation was £21.03 (€24.18: range £0.21-£64.08) compared with £8.43 (€9.69: range £0.21-£18.02) post-implementation. This gave an overall mean cost saving of £12.60 (€14.49) per patient. Post-implementation there was a
mean saving of £15.50 (€17.83) for hips and £10.11 (€11.63) for knees. In 2017, if the new NICE guidance had been used the hospital would have saved a total of £18,915 (€21,752). As previous work has suggested 5% of our patients are on anti-coagulation prior to undergoing arthroplasty and thus would continue with this postoperatively, this equates to an estimate total annual saving of £17,969 (€20,664) when implementing the new NICE guidance at our centre.

Conclusions and recommendations

We have identified potential cost savings by implementing the new NICE guidelines and using aspirin as chemical VTE prophylaxis in all patients undergoing arthroplasty who are not already on anticoagulation. These savings were greater in patients undergoing hip arthroplasty compared with knee arthroplasty. We encourage other institutions to consider using aspirin as routine VTE prophylaxis following arthroplasty given the potential for substantial cost savings by adopting this approach.

Post-Operative Urinary Retention Following Lower Limb Arthroplasty: Incidence And Analysis Of The Associated Factors

By Rakan Kabariti ()

Abstract Id: 5731
Event: EORS 2019
Topic: Arthroplasty

Introduction

Acute post-operative urinary retention (POUR) is a recognised complication following lower limb arthroplasty. Its occurrence may have patient and ultimately medico-legal implications. Identifying high-risk patients and the associated risk factors pre-operatively, is vital to tackle this issue and reduce its occurrence, which ultimately, may enhance the overall success of our operations. Our aim was to assess the incidence of POUR following elective lower limb arthroplasty and analyse the related factors that could potentially predict the likelihood of developing POUR in our patient cohort.

Goal

A prospective audit of 158 patients was conducted in our department. POUR was defined as inability to pass urine voluntarily within the first 24 hours following elective lower limb arthroplasty leading to the insertion of a urinary catheter. Surgical-related factors including intra-operative fluid use, type of spinal anaesthetic, duration of surgery, time from surgery till insertion of a urinary catheter as well as patient-related factors including medication, urological history and Body Mass index (BMI) was collected and analysed.
Method

Results

21 (13.3%) patients developed post-operative urinary retention, 11 (52%) and 10 (48%) following knee and hip replacements respectively. Of which, 19 (90.5%) were male and 2 (9.5%) were female with an average age of 66 yrs. 13 (62%) had a previous urological history and 10 (48%) were on retention associated medication. Bupivacaine as a spinal anaesthetic was associated with an increased risk of developing post-operative urinary retention. The average time till catheter insertion was 14 hrs. Only 2 (10%) had an unsuccessful TWOC on discharge.

Conclusions and recommendations

Bupivacaine as a spinal anaesthetic and a previous urological history can be considered as risk factors for the development of POUR. Pre-operative urinary catheterisation should be considered in this high-risk group of patients.

An Audit of Distal Radius Fracture Management at a Level 2 Trauma Centre

By Miss Natalie Hope (Queen Elizabeth Hospital, Woolwich) Dr Tooba Arif (Queen Elizabeth Hospital, Woolwich) Dr Attila Stagl (Queen Elizabeth Hospital, Woolwich)

Abstract Id: 5729
Event: EORS 2019
Topic: Other

Introduction

Distal radius fractures (DRF) are very common injuries. National recommendations (British Orthopaedic Association, NICE) exist in the UK to guide the management of these injuries. These guidelines provide recommendations about several aspects of care including which type of injuries to treat non-operatively and surgically, timing of surgery and routine follow-up. In particular, current recommendations include considering immobilising patients for 4 weeks in plaster for those managed conservatively, and operating on fractures within 72 hours for intra-articular injuries and 7 days for extra-articular fractures. With increased demands for services and an ageing population, prompt surgery for those presenting with distal radius fractures is not always possible. A key factor is the need for prompt surgery for hip fracture patients. This study is an audit of the current standard of care at a busy level 2 trauma unit against national guidelines for the management of DRFs.

Goal

This is a retrospective audit of patients presenting to our emergency department from June to September 2018. Patients over 18 years of age with a diagnosis of a closed distal radius fracture and follow-up in our department were included in the study. Those with open
fractures were excluded. Data was retrieved from clinical coding, electronic patient records, and IMPAX Client (Picture archiving and communication system). The following data was collected on patients treated conservatively and those managed surgically: - Time to surgery for surgical management - Period of immobilisation for both conservative and operative groups.

Method

Results

45 patients (13 male, 32 female) with 49 distal radius fractures (2 patients had bilateral injuries) were included. Patients had mean age 63 years (range 19 – 92 years) 30 wrists were treated non-operatively and 19 wrists treated surgically (8 K-wires, 10 ORIF, 1 MUA). Mean time to surgery in the operative group was 8 days (range 1 - 21 days, median 7 days). Mean time to surgery for intra-articular fractures was 7 days (range 1 - 21) and 12 days for extra-articular fractures (range 4 - 20). Mean immobilisation period in those treated in plaster is 6 weeks (range 4 - 13 weeks, median 5.6 weeks).

Conclusions and recommendations

At busy level 2 trauma units with limited theatre capacity and a high volume of hip fracture admissions, time to surgery for less urgent injuries such as wrist fractures is often delayed. National guidelines are useful in helping to guide management however their standards are often difficult to achieve in the context of increasing populations in urban areas and an ageing population.

Single Dose of Tranexamic Acid Effectively Reduced Blood Loss and Transfusions in Elderly Patients Undergoing Surgery for Hip Fracture

By Vasileios Nikolaou (2nd Department of Orthopaedics, National and Kapodistrian University of Athens, Greece) Themistoklis Floros (2nd Department of Orthopaedics, National and Kapodistrian University of Athens, Greece) Ioannis Sourlas (2nd Department of Orthopaedics, National and Kapodistrian University of Athens, Greece)

Abstract Id: 5728
Event: EORS 2019
Topic: Arthroplasty

Introduction

To investigate the hypothesis that a single dose of tranexamic acid (TXA) will reduce blood loss and transfusion rates in elderly patients, undergoing surgery for intertrochanteric (IT) or femoral neck fractures.
Goal

In this single-center randomized trial, consecutive elderly patients undergoing hip fracture surgery for a stable or unstable intertrochanteric fracture with the insertion of a short intramedullary nail (IMN) as well as patients treated surgically with cemented hemiarthroplasty for acute femoral neck (subcapital) hip fracture were screened for inclusion. Patients were randomly allocated to a study group by sealed envelope. One dose of 15 mg kg⁻¹ of i.v. tranexamic acid diluted in 100 ml N/S or one dose of i.v. placebo 100 ml N/S were administered 5 mins before the skin cut. Hemoglobin (Hb) concentration was measured at the time of admission and prior to surgery. Post-operatively it was measured on a daily basis until the fourth post-operative day, giving a total of four Hb measurements (days 1 to 4). The transfusion trigger point was determined in accordance with the French guidelines for erythrocyte blood transfusion. The transfusion trigger was 10 g dl⁻¹ for patients at risk. In all other cases, transfusion trigger was 9 g dl⁻¹. Information regarding the number of transfusions was assessed directly by the hospital blood bank database. Blood loss was calculated by the hemoglobin dilution method. Nadler’s formula for blood volume was used to calculate patient blood volume. For calculation of the total blood loss (TBL) expressed to total Hb loss and total Volume loss, the number of transfusions (55 grams of hemoglobin per transfusion), the hemoglobin concentration on preoperatively (Hgbi) and the hemoglobin concentration on the last available measure of hemoglobin concentration (Hgbe) were used. (Hemoglobin balance method). The primary efficacy outcome was the number of transfusions of allogeneic RBC from surgery up to day 4. The secondary outcomes were the total blood loss from surgery to day 4 as it was calculated by the “hemoglobin balance method”.

Method

Results

After randomization, 35 patients with femoral neck fracture and 30 patients with IT fracture received TXA prior to surgery. Respectively, 30 patients with femoral neck fracture and 55 with IT fracture didn't receive TXA. The groups did not differ significantly in their basic demographics (age, gender, BMI, injury mechanism, ASA score, and co-morbidities). Results showed that patients undergoing hemiarthroplasty after receiving TXA, were transfused with less allogeneic RBC and had less total blood loss than patients that didn't receive TXA. However, the difference was not statistically significant. On contrary, patients treated with IM nailing in the TXA group received a significantly lower number of RBC units than the control group (1.28 ± 1.049 vs 2.075 ± 1.685), (P = 0.0396), had a significantly lower loss of hemoglobin 98.59± 55.24 g vs 161.6± 141.7), (P = 0.0195) and a significantly lower total blood volume loss (951.3 ± 598.9 ml vs 1513 ± 1247 ml), (P = 0.023).

Conclusions and recommendations

This randomized trial confirmed the efficacy of TXA administration in reducing blood loss and transfusion rate in the fragile subgroup of elderly patients, undergoing hip fracture surgery. A single dose of TXA may be a safer option, taking into account the physiological status and co-morbidities of these patients.
AN AUTOMATED COMPUTATIONAL PLATFORM TO ASSESS SAFETY AND COMPATIBILITY OF ORTHOPEDIC DEVICES

By Vincenzo Carbone (InSilicoTrials Technologies) Elena Lucano (InSilicoTrials Technologies) Alberto Palazzin (InSilicoTrials Technologies)

Abstract Id: 5727
Event: EORS 2019
Topic: Other

Introduction

Regulatory bodies impose stringent pre-market controls to certify that medical devices are manufactured with all the necessary safety precautions. Internationally recognized ISO and ASTM standard tests provide the measure of safety needed for the regulatory submission. However, they are expensive, time-consuming and challenging for orthopedic implants because of many possible sizes, components and configurations. It is here proposed an integrated computational platform for automating the set-up and solution of in silico safety testing for orthopedic devices, in line with recognized standards and regulatory guidelines, for worst case assessment within a family of implant sizes to provide efficiencies in the amount of physical testing to be conducted.

Goal

An automated and streamlined modeling and simulation workflow for the assessment of safety and compatibility of orthopedic devices was designed, where all the technical components were seamlessly integrated in the InSilicoTrials.com computational platform implemented on the Microsoft Azure cloud infrastructure (Figure 1). The first tool, developed in ANSYS Mechanical v.19.4, replicates the requirements and considerations of the ASTM F2996-13 Standard Practice for Finite Element Analysis (FEA) of Non-Modular Metallic Orthopaedic Hip Femoral Stems, for the estimation of the static implant stresses and strains when loaded following the ISO 7206-4 (2010). The second tool, developed in ANSYS Mechanical v.19.4, replicates the requirements and considerations of the ASTM F3161-16 Standard Test Method for FEA of Metallic Orthopaedic Total Knee Femoral Components under Closing Conditions, for the prediction of the static implant stresses and strains. The third tool, previously developed in collaboration with the U.S. F.D.A. Center for Devices and Radiological Health and ANSYS, Inc. using ANSYS HFSS v.19.3 and ANSYS Mechanical v.19.3, replicates the directives of the ASTM F2182–11a Standard Test Method for Measurement of Radio Frequency (RF) Induced Heating On or Near Passive Implants During Magnetic Resonance Imaging (MRI), for the prediction of RF energy absorption and thermal heating for 1.5 T and 3 T MRI systems.

Method
Results

Two M&S workflows have been implemented for the assessment of structural safety and MRI compatibility of hip implants (Figure 2) and knee implants (Figure 3), allowing the user to define the geometry and material parameters of the implant, automatically submit simulations to the cloud platform and obtain results that are automatically summarized in a report following the U.S. F.D.A. guidelines on Reporting of Computational Modeling Studies in Medical Device Submissions.

Conclusions and recommendations

The proposed platform promotes the broader adoption of modeling and simulation solutions and digital evidence in preclinical trials for the safety and effectiveness assessment of orthopedic devices, helping manufacturers to accelerate time and reduce costs during the device development, the device submission process and pre-market regulatory evaluation.

Biomechanical analysis of retrograde intramedular reamed nails in distal femoral fractures : study of the optimal nail length

By SERGIO GABARRE (VIB-KULEUVEN)JORGE ALBAREDA (Department of Surgery, University of Zaragoza. Zaragoza, Spain)LUIS GRACIA (Department of Mechanical Engineering, University of Zaragoza. Zaragoza, Spain)

Abstract Id: 5726
Event: EORS 2019
Topic: Biomechanics

Introduction

Femoral fractures affect to three different groups of people: younger patients that suffer high-energy trauma, old patients with fragile bones and people with periprothetic fractures around a prior total knee arthroplasty. Intramedular nailing is mainly indicated for supracondylar fractures of type A or C, according to AO fracture classification. The principal objective of this study is to analyse using Finite Element simulation, the influence of retrograde nail length, considering different interlocking screw configurations and different fracture gap sizes, the biomechanical behaviour of supracondylar type A fractures.

Goal

A 3D finite element model of the femur was generated from a 55 year old male donor, followed by a stability analysis for the fixation with a retrograde nail considering three different fracture gap sizes: 0.5 mm, 3 mm y 20 mm (Fig.1). Furthermore for each fracture size, three nail lengths were studied (320 mm, 280 mm y 240 mm), considering two transversal screws at the distal part and different configurations above the fracture site.
The study was focused on the early stage after surgery, considering accidental supports prior to bone consolidation.

Method

Results

The obtained results show a worse biomechanical behaviour as the length of the nail decreases, yielding to less stability regarding the global movement of the superior part of the femur towards the inferior (Fig.2), bigger mobility at the fracture site (Fig.3), as higher stresses at the cortical bone (Fig. 4), which could lead to secondary fractures.

Conclusions and recommendations

Retrograde nails can provide enough stability to the analysed fractures, provided that the correct length is used. Furthermore, alternative interlocking screw configurations to the usual ones were tested, proving a better global behaviour, leading to recommendations for nail design and improve its clinical applications.

Microcomputed tomographic, biomechanical and histological analyses of lumbar interbody fusion with iliac crest bone graft in pig model

By Nekuda ()Krticka ()Brinek ()

Abstract Id: 5725
Event: EORS 2019
Topic: Spine

Introduction

The use of lumbar fusion procedures in the USA and Europe has rapidly increased over the last decade and a large number of these procedures involve the use of bone grafts. Despite of technical progress of spinal surgery and operative materials the risk of vertebral fusion failure occurs in 5 – 35 % of cases. Autografting has been considered the gold standard for bone graft procedures.

Goal

12 male pigs 4 months old weighting around 40 Kg were included in our study. All pigs underwent lateral lumbar interbody fusion (L2/3) with implantation of iliac crest bonegraft. Group was divided into two subgroups from these 6 spines were harvested 8 weeks (subgroup A1) and 6 spines 16 weeks (subgroup A2) after surgery. After sacrifice, the lumbar spines were taking out and micro-CT, biomechanical testing and histomorphological analysis were
performed to evaluate a quality of intervertebral fusion. As controls (group N), 6 cadaveric intact lumbar spines underwent biomechanical, microCT and histological testing.

Method

Results

All animals recovered from general anesthesia without unusual events. The operations lasted between 50-90 minutes (mean 70). All of the pigs from could stand up and were mobile within 20 hours (range 7-20) and they were limping on the first postoperative day. Total body weight of the pigs increased from 37 kg (range 36-40) at the start to 85 (range 80-89) at sacrifice. Biomechanics evaluation shows that extension flexural stiffness values are statistically significantly different between A2 (16 weeks post-implant) and A1 (8 weeks post-implant). Group A2 achieves higher values than Group A1 and also these both groups achieves higher values than control Group N, which is attributed to the adhesion of the implant to the surrounding vertebras. Biomechanical evaluation supports findings on microCT and histological specimens, where both adjacent vertebras in group A2, where there is no or incomplete fusion.

Conclusions and recommendations

Use of bone graft is the gold standard in fusion of vertebras, but the findings on microCT and histological specimens show that, even after 16 weeks, there is no or incomplete vertebral bone fusion that is often made up of only fibrous tissue. Also in connection with increased morbidity by harvesting bone graft, it is necessary to look for new biomaterials that would produce better results in vertebral body fusion.

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**Five-year clinical outcomes of 263 cementless Oxford unicompartmental knee replacements at a non-inventor centre.**

By Harshadkumar Rajgor (Worcester Royal Hospital)Rajpal Nandra (Worcester Royal Hospital)Nadim aslam (Worcester Royal Hospital)

Abstract Id: 5724
Event: EORS 2019
Topic: Arthroplasty

Introduction

The cementless oxford knee replacement (OUKR) has been demonstrated to be safe and effective in the treatment of anteromedial compartment knee arthritis. The invention of the cementless OUKR was due to problems with cementing of OUKR. Pandit et all has demonstrated partial tibial lucencies occur in 43% of cemented OUKR tibial components and 7% percent in uncemented OUKR tibial components at one year. Mobile bearing devices have shown to have a reduction in wear related failure however a higher dislocation rate. Our aim
was to examine the clinical outcomes in 263 consecutive arthroplasties (228 patients) five years post-operatively in a non-inventor centre. The aims of this large multicentre study was to perform a survival analysis for all cause mortality of the cementless OUKR at a non-inventor centre. Thereafter we also wanted to compare clinical outcome based on oxford knee scores, intraoperative complications and revision rates. 5 year revision rates for the cementless OUKR according to NJR data is reported at 6.1%. This higher revision rate may be attributed to misinterpretation of post procedural films. The implant used in all patients was the Biomet cementless OUKR. The cementless OUKR has been shown to have multiple benefits compared to a cemented UKR. The partial porous spray and hydroxiapetite coating provides a mechanical interlock. The twin peg femoral component adds additional rotational stability.

**Goal**

This study was a retrospective review of longitudinal medical records data taken from 228 patients over a six-year period. These patients during the study period underwent 263 cementless OUKR. All of the procedures were undertaken by a single surgeon at two surgical centres (Worcester Royal (National Health Service centre) and Spire (Private medical centre). Patients were included in the review if they had defined anteromedial that was suitable for cementless OUKR guideline based on radiographic findings. Data was collated based on patient demographics (age and gender), ASA criteria, oxford knee scores, intraoperative fracture rates, revision rates and five year survivorship. Data was gathered from clinic follow up, mail correspondence, telephone consultations. Survivorship data was collated from the mortality register. Intraoperative lateral compartment articular cartilage loss and ACL integrity was assessed in all cases. Postoperatively all surviving patients were followed for up by the primary surgical team. No control for co-morbidity, gender or age occurred when performing survival analysis for all cause mortality

**Method**

**Results**

The mean age was 65 years, 56% were male and predominantly ASA 1 (n=23, 34.6%) or ASA 2 (n=118, 65%). There were no intra-operative complications, particularly tibia fractures. Average oxford knee score was 41.3 at a mean 6 years from surgery. Five patients had their prosthesis revised. Five-year cumulative survival was 98.1% (95% CI 96.3 to 99.9, SE 0.009). Indications for failure were bearing dislocation (n=4) and lateral side wear (n=1). Five-year all cause cumulative survival rate was 94.4% (95% CI 91.5 to 97.34, SE 0.015).

**Conclusions and recommendations**

The Oxford cementless unicompartmental knee replacement is safe and effective to use for medial compartment arthritis. The revision rate was 1.8% which is lower than cemented UKR with no intraoperative fractures. 4 revisions took place.
Can an Activity-based Score Measure Health-gain in High Performing Patients After Hip Resurfacings Arthroplasty

By Roberta Quarshie (MSK lab, Imperial College London) Sarbraj Marway (MSK lab, Imperial College London) Kartik Logishetty (MSK lab, Imperial College London)

Abstract Id: 5723
Event: EORS 2019
Topic: EORS 2019

Introduction

Patients undergoing hip resurfacing arthroplasty (HRA) is typically reserved for highly active patients. Patient Reported Outcome Measures (PROMs) such as the Oxford Hip Score (OHS) are reported to have ceiling effects, which may limit physicians’ ability to measure health gain in these patients. The Metabolic Equivalent of Task (MET) index is a validated compendium assigning energy expenditure to a wide range of activities; for example, a slow walk expends 2.9 kcal/kg/hour, golf expends 4.0 kcal/kg/hour, while moderate lacrosse typically expends 8.1 kcal/kg/hour. We hypothesized that for patients with high OHS (47-48) after HRA, the MET index could better discriminate between high-performing individuals.

Goal

We evaluated 97 consecutive HRA patients performed by a single surgeon. They prospectively completed an online Oxford Hip Score. They also listed three activities which they had performed independently in the preceding 2 weeks with a Likert-scale slider denoting intensity of effort. 23 patients of 97 had OHS of 47-48 at 6-months; their activity with the highest MET index was selected for analysis.

Method

Results

The 23 patients' OHS improved from 29.3 ± 7.04 preoperatively to 47.6 ± 0.50 after 6-months, while their MET indices improved from 8.53 ± 3.7 to 13.1 ± 3.3 kcal/kg/hr. The activities performed by these high-performance individuals ranged from the lowest: pilates (8.05 kcal/kg/hour) to highest: running at 22km/hr (23 kcal/kg/hour).

Conclusions and recommendations

24% of patients undergoing HRA in this cohort had OHS of 47 and 48 at 6-months after surgery. Unlike the OHS, the MET index described variation in physical activity in these high-performance individuals, and did so on an objective measurable scale.
Cross- and non-crosslinked hyaluronic acid-based hydrogel differentially promote axonal outgrowth from tissue cultures of spinal cord slices and dorsal root ganglion

By Andrej Bajic (Uppsala University)

Abstract Id: 5722
Event: EORS 2019
Topic: Biomaterials

Introduction

Background: Numerous biomaterials have been studied for their ability to promote axonal outgrowth. It was shown in previous studies that spinal cord slice cultures (SCSCs) maintained on a hyaluronic acid (HA)-based hydrogel were superior in terms of neuronal survival compared to SCSCs maintained on a collagen gel. However, how these HA-based biomaterials could influence axonal outgrowth was not investigated. It was our aim to investigate axonal outgrowth from different tissue models on various soft biomaterials. We hypothesized that the biomaterials based on HA – but not collagen, differentially promote axonal sprouting depending on the type of tissue culture.

Goal

Methods: Tissue cultures were obtained from postnatal mouse spinal cord and dorsal root ganglion. SCSCs and dorsal root ganglion cultures (DRGCs) were maintained on three different biomaterials i.e. collagen gel, non-crosslinked HA-based hydrogel called Healon 5® and crosslinked HA-based hydrogel. Tissue cultures were maintained in the presence of culture medium (CM) or neurotrophine medium (NM; culture medium containing BDNF, GDNF, CNTF – ciliary neurotrophic factor and NT3 – third neurotrophic factor), resulting thus in six groups for both SCSCs and DRGCs (Collagen CM, Collagen NM, Healon 5 CM, Healon 5 NM, Crosslinked CM, Crosslinked NM. After four days in vitro, axonal outgrowth was investigated by light microscopy and automated image analysis using a novel approach called "Neurite Segmentation Manual Body". To ensure that the investigated structures were actually axons, a number of cultures were immunohistochemically stained for neurofilament.

Method

Results

Results: Axonal outgrowth was observed in all the groups in both tissue culture models. In SCSCs the highest amount of axonal density was observed in the crosslinked CM group and it was significantly higher compared to the rest of the groups (19,2x10³ pixels ± 7,6x10³). In DRGCs the most intense outgrowth was observed in the Healon 5 NM that was significantly higher compared to the rest of the groups (185,9x10³ pixels ± 6x10³). In SCSCs the axons tended to grow longer when maintained on crosslinked HA-based hydrogel or Healon 5
compared to collagen. Axons from SCSCs maintained on crosslinked HA-hydrogel grew significantly longer than axons maintained on Healon 5® regardless the presence of neurotrophic factors. In DRGCs however no significant differences were observed regarding the length of the axons.

Conclusions and recommendations

Conclusion: Axonal outgrowth that was best promoted on HA-based hydrogel can partially be explained by the fact that the extracellular matrix in the neural structures mostly consists of hyaluronic acid rather than collagen. Axons from SCSCs grow much better on crosslinked hydrogel regardless the presence of neurotrophic factors. In contrast, axonal outgrowth from DRGCs was notably promoted in Healon 5® in the presence of neurotrophic factors suggesting that different type of axons respond differentially to mechanical signals coming from different type of biomaterials. DRGCs are mostly consisted of pseudomonopolar neurons that should give rise to sensory axons. On the other hand, SCSCs should give rise to a considerable amount of motor axons. When developing a nerve graft, we need to consider that the type of biomaterial and/or neurotrophic factors selectively affect axonal outgrowth from different types of neurons.

The modified Hedgehog technique to reattach chondral fragments in the young adult knee – follow-up with PROMs and 7.0T MRI at 3 months and 1 year after surgery

By Marloes Peters (Department of Orthopedic Surgery, Maastricht University Medical Center) Ralph Jeuken (Department of Orthopedic Surgery, Maastricht University Medical Center) Esther Steijvers (Scannexus, Maastricht)

Abstract Id: 5721
Event: EORS 2019
Topic: Imaging

Introduction

The modified “Hedgehog” technique was previously used to reattach pure chondral shear-off fragments in the pediatric knee. In the modified Hedgehog technique, the calcified side of chondral fragments is multiply incised and trimmed obliquely for an interlocking fit in the defect site. Fibrin glue with or without sutures is subsequently applied to fix the fragment to the defect. This preliminary report further elucidates the potential of the technique by evaluation of its application in young adults using patient reported outcome measures (PROMs) and high-field Magnetic Resonance Imaging (MRI) as outcome measures.

Goal
Three patients with a femoral cartilage defect (2 medial, 1 lateral), and a concomitant pure chondral corpus liberum were operatively treated by the modified Hedgehog technique. Age at surgery ranged from 20.6–21.2 years, defect size ranged from 3.8–6.0 cm². Patients were evaluated at three months and one year after surgery by PROMs and 7.0T MRI. PROMs included the Internation Knee Documentation (IKDC), Knee Injury and Osteoarthritis Outcome Score (KOOS) and Visual Analog Scale (VAS) questionnaires. 7.0T MRI (Magnetom, Siemens Healthcare, Erlangen, Germany) using a 28-channel proton knee coil (QED, Electrodynamics LLC, Cleveland, OH) included a proton density weighted turbo spin-echo sequence with fat suppression to assess morphological tissue structure and gagCEST imaging to measure the biochemical tissue composition in terms of glycosaminoglycans (GAG).

Method

Results

Twelve months after surgery all patients reported no pain and showed full range of motion. While PROMs at three months showed large variability between patients, one year after surgery the scores were consistently improved. Over time, morphological MRI visualized improvements in integration of the cartilage fragment with the surrounding cartilage (figure 1A), which was supported by biochemical MRI showing increased GAG values at the defect edges (figure 1B). Statistics were not applied to the results because of the small sample size.

Conclusions and recommendations

The modified Hedgehog technique in young adults with an acute onset caused by a pure chondral corpus liberum can be considered promising. The improved PROM results over time were supported by 7.0T MRI that visualized improvements in tissue structure and biochemical composition. Inclusion of more patients in future studies would allow statistical analysis and more conclusive results. The etiology of loosening and time between onset of symptoms and surgery for successful graft integration may differ between pediatric and young adult patients and is subject for future studies.

Pre operative planning strategy for the fixation of ‘complex’ ankle fractures at a major trauma centre: A 5 year study

By Harshadkumar Raigor (UNIVERSITY HOSPITALS BIRMINGHAM) Joanna Richards (UNIVERSITY HOSPITALS BIRMINGHAM) Paul Fenton (UNIVERSITY HOSPITALS BIRMINGHAM)
Introduction

Management of complex posterior malleolar fractures requires a detailed appreciation of ligamentous and bony anatomy for optimal fracture fixation and restoration of articular congruency. Pre operative planning is vitally important to determine the surgical strategy for complex ankle fractures. We evaluated pre operative planning strategy pre and post implementation of BOAST 12 guidelines (2016) focusing on pre operative CT scans prior to definitive fixation at a major trauma centre.

Goal

A multi-surgeon retrospective review of prospectively collected data from 2013 to 2018 was performed at a major trauma centre. Patients who had sustained a posterior malleolar fracture and definitive fixation were identified. Information was collated from PICS, PACS, the trauma database and operative notes.

Method

Results

134 patients were identified over a 5 year period who had sustained a posterior malleolar fracture and had definitive fixation. (Pre BOAST guidelines = 61, Post BOAST guidelines = 73). Prior to the implementation of BOAST guidelines ¼ with posterior malleolar fractures did not have a pre operative CT scan (15/61). Post implementation of BOAST 12 90% (66/73) patients with fixation of posterior malleolus fractures had a pre operative CT scan. Posterior malleolus surgery most commonly took place in patients between 18-30 years.

Conclusions and recommendations

Changes in national guidelines have heavily influenced pre operative planning strategy for ankle fractures at University Hospitals Birmingham. A detailed appreciation of fracture pattern pre operatively helps guide surgical strategy.

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Early outcomes of total knee replacement using a novel technique for proximal tibial alignment

By Christopher Gee (Golden Jubilee National Hospital) Brandon Bee (Glasgow Medical School) Fahd Mahmood (Golden Jubilee National Hospital)

Abstract Id: 5719
Event: EORS 2019
Topic: Arthroplasty

Introduction
Conventional instrumentation for total knee replacement (TKR) assumes that the anatomical and mechanical axes of the tibia are aligned. Work at our institution using long leg alignment films has demonstrated that >40% of tibiae in our population were bowed a mean 3.5°. Conventional TKR techniques in bowed tibiae may result in proximal tibial malalignment with the tibial keel lying adjacent to cortical bone, risking increased stresses to this region. To minimise this risk, we present early results of a novel surgical technique, which aims for accurate proximal tibial alignment but accepts greater deviation from the mechanical axis. We present early results of this technique in a single surgeon series performed at a high-volume arthroplasty centre.

**Goal**

Patients with tibial bowing were identified from preoperative long leg x-rays. Computer navigation and gap balancing were used, with the tibial cut adjusted depending on the bow; such that a 3° valgus cut would be used for a 3° medial bow. Patients were followed up at 6 weeks and 1 year and data on range of movement, patient reported outcomes, patient satisfaction and complications were collected prospectively.

**Method**

**Results**

68 knees in 65 patients were identified. The mean tibial bow was 2.45° (-1.28-4.76°), 67 of 68 knees had a medial bow. In keeping with the described technique, 88.2% of patients had coronal implant alignment within 3° of the proximal tibia, but only 70.6% were aligned within 3° of the mechanical axis. Data was available for all patients at 6 weeks and 29 patients had completed 1 year follow-up. No patients were lost to follow-up. At 6 weeks, mean range of movement was 1.7 – 98.1°, this improved to 1.4 – 101.4° at 1 year. Pre-operative, 6 weeks and 1 year Oxford knee scores were 16.2, 29.3 and 9.6 respectively. 92.5% of patients were satisfied or highly satisfied at 6 weeks and 82.7% at 1 year. No patients required revision. One patient underwent manipulation due to stiffness and two suffered superficial wound infections.

**Conclusions and recommendations**

Consideration should be given to extra-articular deformities of the tibia when deciding the target alignment for Total Knee Arthroplasty. Recruitment of a larger cohort and extended follow up will establish whether this technique is associated with improved implant survival.

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**Early Clinical and Patient-Reported Results of a Bi-cruicate Retaining Total Knee Implant: Six-month Results of a Prospective Multicenter Study of 149 primary TKAs**

By James MacDonald, MD (Anne Arundel Medical Center)William Huang, MD (Providence Regional Medical Center Everett)Ran Schwarzkopf, MD (NYU Hospital for Joint Diseases)
Introduction

Bi-cruciate sparing knee implants are a relatively new type of knee implant and are marketed as active knee systems that promise improved patient outcomes. They utilize a different tibial component that spares both the anterior and posterior cruciate ligaments, ligament retention potentially allowing for dynamics that better resemble the natural knee joint, improved kinematics and muscle function, with better patient outcomes. However, given the more complex design and more challenging installation, there is concern for under-performance and early revision due to more complex device design and a technically demanding surgical procedure.

Goal

In a multicenter prospective study, a total of 141 patients (149 TKAs, 8 bilaterals) were enrolled to-date into an ongoing study at nine investigational sites in the U.S. and Europe. 86 subjects have 6-month outcome data. The average age was 63.7 years (range, 33-79), 76 (53.9%) were females and 129 (91.5%) were Caucasian. Patella was resurfaced in all TKAs. Pre and post-operative KOOS scores were recorded PROM’s.

Method

Results

At 6 months, mean KOOS Pain score improved from 48.74 (SD 13.6) pre-operative to 74.71 (SD 16.5)(p< 0.0001). There was one device was revised for postoperative periprosthetic tibia fracture.

Conclusions and recommendations

Long term follow up to 10 years is ongoing to determine mid-term outcomes

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Hydroxyapatite: A Platform for Recruiting Systemically Administered Drugs

By Deepak Bushan Raina (Lund University) Yang Liu (Lund University) Hanna Isaksson (Lund University)
Targeted delivery of drugs is a major challenge in diseases such as infections and tumors. The aim of this study was to demonstrate that hydroxyapatite (HA) particles can act as a recruiting moiety for various bioactive molecules and as a proof-of-concept demonstrate that the affinity of drugs to hydroxyapatite can exert a biological effect.

Goal

A bisphosphonate, zoledronic acid (ZA), was used as a model drug. Experiment 1 (ZA seeks HA): Calcium sulphate (CaS)/hydroxyapatite (HA) biomaterial pellets (ø=5 mm, h=2 mm) were implanted in the abdominal muscle pouch of rats. After 2-weeks of implantation, a subcutaneous injection of 14C-ZA (0.1 mg/kg) was given. 24 h later, the animals were sacrificed and the uptake of ZA determined in the pellets using scintillation counting. Experiment 2 (Systemically administered ZA seeks HA and exerts a biological effect): A fenestrated implant was filled with the CaS/HA biomaterial and inserted in the proximal tibia of rats. 2-weeks post-op, a subcutaneous injection of ZA (0.1 mg/kg) was given. Animals were sacrificed at 6-weeks post-op. Empty implant was used as a control. Peri-implant bone formation was evaluated using different techniques such as micro-CT, mechanical testing and histology. Welch’s t-test was used for mechanical testing and Mann-Whitney U test for micro-CT data analysis.

Method

Results

Experiment 1: Uptake of radioactive ZA in the CaS/HA biomaterial was confirmed. Almost no ZA was present in the surrounding muscle (Fig. 1). These results show high specific binding between systemically administered ZA and synthetic particulate HA. Experiment 2: Significantly higher peri-implant bone was measured using micro-CT in the group wherein the implant contained the CaS/HA biomaterial and ZA was administered systemically (Fig. 2) (p

Conclusions and recommendations

This study presents a method for biomodulating HA in situ by different bioactive molecules. The approach of implanting a biomaterial capable of recruiting systemically given drugs and thereby activate the material is novel and may present a possibility to to treat bone infections or tumors.

Fabrication of chemobrionic tubular calcium phosphate scaffolds

By Erik Hughes (University of Birmingham) Miruna Chipara (University of Birmingham) Liam Grover (University of Birmingham)
Introduction

Despite considerable advances in regenerative medicine, producing novel regenerative scaffolds remains challenging. For example, autologous bone remains widely considered as the “gold standard” over synthetic alternatives for replacing hard tissue. New approaches are therefore required to realise next-generation healthcare technologies. Chemobrionics describes understanding, controlling and exploiting the chemical and physical phenomena behind self-organisation reactions that result in the formation of abiotic micro- and nano-material architectures. A range of mineralised hierarchical microstructures can be derived from chemobrionic systems that have great potential as regenerative tissue scaffolds.

Goal

In this research, methodologies have been developed that enable biologically analogous calcium phosphate mineral to be generated from a gel/solution interface. Calcium loaded gels were prepared by adding agarose to calcium nitrate tetrahydrate solution and heating to 90 degrees Celsius. Gels were cast and allowed to cool to room temperature. Formation of chemobrionic structures was then initiated by layering sodium phosphate solutions upon gel surfaces.

Method

Results

Calcium phosphate tubules grow several centimetres in length within minutes and are approximately 100-200 µm in diameter (Figure 1A and 1B). The mineral consists of low crystallinity hydroxyapatite and resembles native bone microstructures, such as Haversian canals, which serve as conduits for blood vessels in mineralised tissues. Both the microstructure and composition of the tubules can be adjusted by physiochemical and thermal treatments. Tubular structures were shown to support cellular attachment and stimulate pre-osteoblast gene expression associated with osteogenic differentiation and mineralisation in vitro.

Conclusions and recommendations

As an up and coming synergistic field, chemobrionics will open exciting new avenues of exploration for biomaterials research and engineering. Adopting this approach may further enable the generation of regenerative materials with advanced capabilities of function and cellular interaction.

Osseointegration of BCP-coated versus non-coated Non-Degradable Polyurethane Focal Knee Resurfacing Implants: A Caprine Proof-of-Concept Study
Introduction
Focal knee resurfacing implants (FKRI’s) are typically intended to treat focal cartilage defects in middle-aged patients. All currently available FKRI’s are (partly) composed of metal, which potentially leads to degeneration of the opposing articulating cartilage and hampers follow-up using magnetic resonance imaging (MRI). The purpose of this study was to investigate the in vivo osseointegration process of a novel non-degradable thermoplastic polycarbonate-urethane (TPU) osteochondral implant.

Goal
Bi-layered implants measuring 6 mm in diameter, with a double-curvature to match the approximate curvature of the goat medial femoral condyle were fabricated. TPU implants were composed of an articulating Bionate® II 80A top layer, and a Bionate® 75D bottom layer (DSM Biomedical, Geleen, the Netherlands) which is intended to osseointegrate. A biphasic calcium phosphate coating formulation, optimized during a prior in vitro study, was applied to half of the TPU implants, while the other half was left uncoated. Bi-layered metal implants (articulating cobalt-chromium top layer and titanium bottom layer) were used as positive control implants. Eight implants per group were implanted bilaterally in the medial femoral condyle of the stifle joints in 12 Dutch milk goats. 18F-sodium fluoride (18F-NaF) positron emission tomography-computed tomography (PET-CT) scanning was performed at 3 and 12 weeks postoperatively, and the corrected maximum standard uptake values (cSUVmax) was calculated to assess the peri-implant bone metabolism. After sacrifice 12 weeks postoperatively, bone histomorphometric analysis was performed to assess the bone-to-implant contact area (BIC). Student's T-test was used in case of normal distribution and the Mann-Whitney-U-test was used in case of abnormal distribution for comparison of BIC and cSUVmax.

Method
Results
The BIC value of 10.27 ± 4.50% (mean ± SD) for the BCP-coated TPU implants was significantly (P=0.03) higher than the 4.50 ± 2.61% for the uncoated TPU implants. The uncoated TPU implants scored significantly (P=0.04) lower than the BIC of 12.81 ± 7.55% for the metal implants, whereas there was no significant difference between BCP-coated TPU implants and the metal implants (P=0.68). There was a strong correlation between the cSUVmax values and the BIC values at 12 weeks (Pearson’s R=0.74, P=0.001). The cSUVmax values significantly decreased between 3 and 12 weeks for the metal implants (p=0.04). BCP-coated TPU implants followed a similar trend but did not reach statistical significance (p=0.07). cSUVmax in the uncoated TPU implants did not show a significant difference between the time-points (p=0.31).
Conclusions and recommendations

Osseointegration of BCP-coated TPU implants did not significantly differ from metal implants. 18F-NaF PET-CT is a feasible modality to assess osseointegration patterns and showed a similar trend between the BCP-coated and metal implants. Hence, an implant fully composed of TPU may avoid the typical metal-related drawbacks of currently available FKRI’s. Long-term follow-up studies are advocated to address the effects of the implant to the opposing cartilage, and are therefore warranted.

Cyclic stretching of ACL-derived fibroblasts in two-dimensional and three-dimensional biomaterial-free and biomaterial cultures leads to synchronized cell orientation and activation

By Clemens Gögele (Institute of Anatomy, Paracelsus Medical University, Nuremberg and Salzburg, Nuremberg, Germany) Bernd Hoffmann (Institute für Complex Systems, Forschungszentrum Jülich, Germany) Christina Linnartz (Institute für Complex Systems, Forschungszentrum Jülich, Germany)

Abstract Id: 5711  
Event: EORS 2019  
Topic: Biomaterials

Introduction

Due to the fact that the mechanical strain of ligaments can change, ligament fibroblasts must be mechanosensitive and possess sufficient adaptability to novel mechanomilieus to ensure the permanent load capacity of the tissue. When mechanoreceptors are activated, the fibroblasts react with a specific signal transmission (mechanotransduction), which ultimately leads to an adaption of their cytoskeletal organization and modification in protein synthesis. However, the cellular response of fibroblasts of the anterior cruciate ligament (ACL) to cyclic mechanical stretching is still unclear. Hence, this study aims to provide a deeper understanding of the reaction profile of mechanically loaded ACL derived ligamentocytes in two-dimensional (2D) and three-dimensional (3D) biomaterial-free and biomaterial cultures with respect to cell survival, size, orientation, migration, and distribution.

Goal

For the 2D approach consisting of monolayers with 6000 lapine (L) ACL cells per cm2 and for the 3D cultures using preformed LACL cell spheroids (2.5-4/cm2) with 25,000 cells per spheroid, silicone chambers were coated with geltrix® and statically colonized with the LACL cells for 24 h before cyclically stretched for 48 h (14 % uniaxial stretch). A second approach using 3D scaffold cultures was performed which were seeded dynamically for 24 h
with LACL cells before cyclically stretched in a novel custom-made mechanostimulator. The scaffolds [consisting of polylactic acid (PLA) and polycaprolactone (PCL)] were functionalized with 10 % gas fluorination, flushing with oxygen and a collagen foam. Scaffolds (30 x 4 x 1 mm) were precolonized dynamically with an LACL cell suspension (1 x 10^6 cells/mL) for 24 h and then stretched for 72 h (4 % uniaxial stretch). Survival of adherent cells was analyzed by a vitality assay and cells were counted. The orientation of the cytoskeleton was shown by immunocytochemical staining (F-actin and DAPI) and evaluated (ImageJ). Cell proliferation, based on the DNA content was measured with the CyQuant Assay.

Method

Results

The results showed that the cell viability in stretched samples (2D, 3D and scaffold) was above 90 % compared to unstretched control conditions. We could show, that stretching on the silicone chambers resulted in an increase in cell counts, cell length and a significantly higher colonized area than in unstretched controls. An increased number of LACL cells migrating out of the 3D spheroids could be observed under stretching conditions. In response to intermittent stretching, cells oriented (in a 70° angle) against the stretch direction under 2D and 3D conditions in the silicone chambers, whereas a more compact cell arrangement was found in the 3D scaffolds on the threads than in unstretched cultures.

Conclusions and recommendations

In summary, stretching induced a rapid (48 h) cell and cytoskeletal alignment in 2D as well as in 3D cultures. The natural ACL is characterized by a strongly uniaxial cell and extracellular matrix organization which could be achieved in tissue engineered constructs by a suitable cyclic stretching protocol.

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**A CLOUD-BASED PLATFORM TO DRIVE TECHNOLOGY TRANSFER OF MODELING AND SIMULATIONS TOOLS ACROSS ORTHOPEDICS RESEARCH AND DEVELOPMENT**

By Vincenzo Carbone (InSilicoTrials Technologies), Alessia Baretta (InSilicoTrials Technologies), Elena Lucano (InSilicoTrials Technologies)

Abstract Id: 5710
Event: EORS 2019
Topic: Other

**Introduction**
For decades, universities and research centers have been applying modeling and simulation (M&S) to problems involving health and medicine, coining the expression in silico clinical trials. However, its use is still limited to a restricted pool of specialists. It is here proposed an easy-to-use cloud-based platform that aims to create a collaborative marketplace for M&S in orthopedics, where developers and model creators are able to capitalize on their work while protecting their intellectual property (IP), and researcher, surgeons and medical device companies can use M&S to accelerate time and to reduce costs of their research and development (R&D) processes.

**Goal**

Digital libraries on InSilicoTrials.com are built on collaborations among first-rate research center, model developers, software and cloud providers (partners). Their access is provided to life science and healthcare companies, clinical centers and research institutes (users), offering them with several solutions for the different steps of the orthopedics and medical devices R&D process. (Figure 1). The platform is built using the Microsoft Azure cloud services, conforming to global standards of security and privacy for healthcare, ensuring that clinical data is properly managed, protected, and kept private. The environment protects the IP of partners against the downloading, copying and changing of their M&S solutions; while providing a safe environment for users to seamlessly upload their own data, set up and run simulations, analyze results and produce reports in conformity with regulatory requirements (Figure 2).

**Method**

**Results**

The first medical devices application hosted on InSilicoTrials.com is InSilicoMRI (Figure 3), a digital library of automatic tools concerning the magnetic resonance imaging (MRI) systems (software, hardware and images). The tool NuMRis, implemented in collaboration with the U.S. F.D.A. Center for Devices and Radiological Health, and ANSYS, Inc., addresses the assessment of MRI imaging radio-frequency (RF) safety for medical implants such as orthopedic devices (e.g., rods and screws), pain management devices (e.g., leads), and cardiovascular devices (e.g., stents). NuMRis promotes the broader adoption of digital evidence in preclinical trials for RF safety analysis, supporting the device submission process and pre-market regulatory evaluation.

**Conclusions and recommendations**

InSilicoTrials.com aims at defining a new collaborative framework in healthcare, engaging research centers to safely commercialize their IP, i.e. model templates, simulation tools and virtual patients, by helping clinicians and healthcare companies to significantly expedite the pre-clinical and clinical development phases, and to move across the regulatory approval and HTA processes.
Guided Motion Total Knee Arthroplasty System: Five-Year Outcomes of the Prospective Multicenter US Study

By Adam I. Harris, MD (San Antonio Orthopaedic Specialists) Tianyi David Luo, MD (Wake Forest Baptist Medical Center,) Jason E. Lang, MD (Blue Ridge Bone and Joint)

Abstract Id: 5709
Event: EORS 2019
Topic: Arthroplasty

Introduction

We previously reported the 2-year outcomes of a multicenter study of a second-generation guided motion total knee system (Journey II Bi-Cruciate Stabilized Knee System, Smith & Nephew, Inc., Memphis, TN, USA). This analysis reports the clinical and patient-reported postoperative outcomes at 5 years.

Goal

Between December 2011 and October 2013, 186 patients with a total of 209 primary total knee arthroplasties (TKAs) were prospectively enrolled at 12 US sites.

Method

Results

The average age was 61.1 (range 39-85 years); 52.7% were female; the majority were Caucasian (90.9%). Patellae were resurfaced in all patients. Patients were followed-up at 6 months and at 1, 2, and 5 years postoperatively. The 5-year follow-up rate was 82%. Device revisions were monitored continuously. Objective Knee Score (OKS) and Patient Satisfaction Score (PS) improved between the 6-month and 1-year follow-ups and remained unchanged at the 2- and 5-year follow-ups. At 5 years, the OKS was 96 and the PS was 35. The Functional Capacity Score improved until the 2-year follow-up and remained unchanged at 5 years at 82. Ten (4.8%) knees were treated with closed manipulations for stiffness. There were 7 revisions: 2 involved femoral or tibial component replacement and 5 involved tibial insert or patellar component replacement only. Three TKAs were revised in the first 2 years, an additional 3 in years 2-5, and 1 in years 5-6. The K-M cumulative revision risk was 3.0% (95% C.I. 1.3% to 6.5%) at 5 years postoperatively, compared to the AOANJRR registry reported rate of 4.1% for the cemented posterior stabilized class.

Conclusions and recommendations

Guided motion total knee implants have favorable clinical and functional outcomes and low revision rates.
Guided Motion Total Knee Arthroplasty (TKA) in Patients with BMI of 40 kg/m2 or More: Results from the International Multicenter Study of 2,059 Primary TKAs with up to 6 Years Follow-up

By Adam Harris, MD (San Antonio Orthopaedic Specialists) Christopher O'Grady, MD (Andrews Research & Education Foundation) Paul R. Sensiba, MD (University Orthopedics Center)

Abstract Id: 5708
Event: EORS 2019
Topic: Other

Introduction
Outcomes for guided motion primary total knee arthroplasty (TKA) in obese patients are unknown.

Goal
1,684 consecutive patients underwent 2,059 primary TKAs with a second-generation guided motion implant between 2011–2017 at three European and seven US sites.

Method

Results
Of 2,003 (97.3%) TKAs in 1,644 patients with BMI data: average age 64.5 years; 58.4% females; average BMI 32.5 kg/m2; 13.4% had BMI ≥ 40 kg/m2. Subjects with BMI ≥ 40 kg/m2 had longest length of hospital stay (LOS) at European sites; LOS similar at US sites. Subjects with BMI ≥ 40 kg/m2 (P=0.0349) had longest surgery duration. BMI ≥ 40 kg/m2 had more re-hospitalizations or post-TKA reoperations than BMI < 40 kg/m2 (12.7% and 9.2% at five-year post-TKA, P

Conclusions and recommendations
Surgery duration and long-term complication rates are higher in patients with BMI ≥ 40 kg/m2, but device revision risk is not elevated.

Guided Motion Total Knee Arthroplasty (TKA) System in Younger Patients Has a
Lower Revision Rate than Registry Controls: Results from the International Multicenter Study with up to 6 Years Follow-up

By Adam I. Harris, MD (San Antonio Orthopaedic Specialists) Christopher O’Grady, MD (Andrews Research & Education Foundation) Paul R. Sensiba, MD (University Orthopaedics Center)

Abstract Id: 5707
Event: EORS 2019
Topic: Other

Introduction

Patients ≤ 55 years have a high primary TKA revision rate compared to patients >55 years. Guided motion knee devices are commonly used in younger patients yet outcomes remain unknown.

Goal

In this sub-group analysis of a large multicenter study, 254 TKAs with a second-generation guided motion knee implant were performed between 2011–2017 in 202 patients ≤ 55 years at seven US and three European sites. Revision rates were compared with Australian Joint Registry (AOANJRR) 2017 data.

Method

Results

Average age 49.7 (range 18–54); 56.4% females; average BMI 34 kg/m2; 67.1% obese; patellae resurfaced in 98.4%. Average follow-up 4.2 years; longest follow-up six years; 27.5% followed-up for ≥ five years. Of eight revisions: total revision (one), tibial plate replacements (three), tibial insert exchanges (four). One tibial plate revision re-revised to total revision. Revision indications were mechanical loosening (n=2), infection (n=3), peri-prosthetic fracture (n=1), and instability (n=2). The Kaplan-Meier revision estimate was 3.4% (95% C.I. 1.7% to 6.7%) at five years compared to AOANJRR rate of 6.9%. There was no differential risk by sex.

Conclusions and recommendations

The revision rate of the second-generation guided motion knee system is lower in younger patients compared to registry controls.
The relationship between tibial cartilage thickness and bone mineral density varies with bone depth and osteoarthritis severity

By H. Babel (Swiss BioMotion Lab, Department of Musculoskeletal Medicine, Lausanne University Hospital and University of Lausanne, Lausanne, Switzerland)P. Omoumi (Department of Imaging, Lausanne University Hospital and University of Lausanne, Lausanne, Switzerland)B.M. Jolles (Swiss BioMotion Lab, Department of Musculoskeletal Medicine, Lausanne University Hospital and University of Lausanne, Lausanne, Switzerland)

Abstract Id: 5706
Event: EORS 2019
Topic: Other

Introduction

While knee osteoarthritis (OA) is now recognized as a complex disease affecting the whole joint, not just the cartilages, there remains a paucity of data regarding the interactions between knee components. One relationship of particular interest is between the spatial variations in cartilage thickness (CTh) and subchondral bone mineral density (BMD). Indeed, bone and cartilage are two mechanosensitive tissues that interact as a functional unit and there is evidence of a biomechanical coupling between both tissues. Particularly, a recent in vivo study has shown a positive relationship in non-OA knees with thicker cartilage where bone is denser, and an alteration of this relationship in OA knees. These observations support the concept of an osteochondral unit and warrant additional research to assess the influence of bone depth. Therefore, this study aimed to characterize the relationship between spatial variations in CTh and BMD measured at various depths below the bone surface.

Goal

CT-arthrography of 20 non-OA tibias and 20 severe medial-compartment OA tibias (Kellgren-Lawrence grade ≥ 3) were segmented to build 3D mesh models of the bones and cartilages. Each individual tibia model was registered to a reference tibia, allowing to calculate BMD maps at 1, 3, 5 and 10mm below the bone-cartilage interface in the medial compartment. Pearson correlations between CTh maps and the four BMD maps were then calculated for each knee. Lastly, differences in correlation coefficients between successive bone layers were assessed using Wilcoxon signed-rank tests.

Results

In both OA and non-OA tibias, the correlation coefficients were higher with the BMD measured in the 1mm layer, and followed a pattern of statistically significant decrease with bone layers of increasing depth (p < 0.021). In non-OA tibias, the median relationship was positive with a strong effect size in the 1, 3 and 5mm layers, while in OA tibias the median relationship was positive only in the 1mm layer and with a medium effect size. In the OA
tibias, the median relationship was negative with a weak effect size in the 3 and 5mm layers, and it was negative with a medium effect size in the 10mm layer.

Conclusions and recommendations

In conclusion, the results of the present study support the value of considering bone and cartilage as a unit, and more generally support OA pathophysiology models based on relationships among knee properties.

Clinical and Functional Outcomes of JOURNEY™ II Cruciate-Retaining Total Knee System: Interim Results of an Ongoing, Prospective, Multicenter Study

By Pramod Achan, MD (Royal London Hospital & Barts Health Orthopaedic Centre) James MacDonald, MD (Anne Arundel Medical Center) Tad Gerlinger, MD (Midwest Ortho at Rush)

Abstract Id: 5705
Event: EORS 2019
Topic: Other

Introduction

The JOURNEY™ II Cruciate-Retaining Total Knee System (JIICR) (Smith & Nephew, Memphis, TN, USA) is part of the JOURNEY family of knee implants utilized for treatment of end-stage degenerative joint arthritis. Cruciate-retaining total knee replacements have seen tremendous historic success; however, clinical results with this type of knee system have not been fully evaluated at this time. The purpose of this investigation was to evaluate the early clinical success and efficacy of this recently introduced JOURNEY™ II CR Total Knee System to establish a track record of adequate patient safety.

Goal

A total of 174 patients (174 knees) were prospectively enrolled into this ongoing study at nine investigational sites in the U.S. and Europe. Minimum one-year follow-up results have been completed for all patients.

Method

Results

The average age was 62.9 years (range, 38-78) and 63.2% were females. All patients received patella resurfacing. Nine patients withdrew and 138/165 (84%) completed one-year follow-up. At one year, the EQ-5D utility score improved from 0.63 pre-operative to 0.89 (P <
In addition, the Objective Knee Score increased from 46.5 pre-operative to 92.7 (P < .0001); the Satisfaction Score increased from 12.9 to 34.8 (P < .0001); and the Functional Capacity Score increased from 40.1 to 79.5 (P < .0001). All improvements were significant at three months. There were two revisions. One revision occurred after 322 days and was due to instability. The second revision was due to immediate post-operative dislocation while the patient was still in the hospital.

Conclusions and recommendations

The risk of revision is low.

Using Statistical Shape and Intensity Models with Dynamic Stereo X-Ray

By Allison Clouthier (University of Ottawa, Canada)Maarten Beek (HAS-Motion Inc., Kingston, Canada)Alan De Asha (C-Motion Inc., Germantown MD USA)

Abstract Id: 5703
Event: EORS 2019
Topic: Biomechanics

Introduction

Joints must function properly in a range of postures and complex loading conditions. Dynamic Stereo X-ray (DSX) is the only motion capture technology capable of sub-millimeter spatial accuracy and sufficiently high sample rates to capture dynamic movements for clinical measures such as tissue stresses, joint loading or impingement (Anderst et al., 2009). DSX enables an estimation of the position and orientation of bones and implants by registering paired X-ray image sequences with digitally reconstructed radiographs (DRRs) generated from a segmented computerized tomography (CT) scan of each object to be tracked (Bey et al., 2006). CT scans, however, are often unavailable for research purposes. As a surrogate approach to a CT scan we are exploring the possibility of using a Statistical Shape and Intensity Model (SSIM) for generating DRRs (Reyneke et al, 2019).

Goal

Our implementation of SSIM was based initially on a Statistical Shape Model (SSM) for the knee (Clouthier et al, 2019). Correspondence among tetrahedral-sets was established using the Coherent Point Drift algorithm (Myronenko & Song, 2010). The meshes were aligned so that variations from rotational and translational effects were eliminated using a generalized Procrustes analysis (Lorusso at al,1995). This SSM parameterization generated a representative bone surface by scaling a modest set of principal components to measurable features of the bone. DRRs, however, require both surface and internal structures of the bone (particularly the inner cortical surface). For this study tetrahedral meshes of the distal end of the femur and proximal end of the tibia were generated from 35 knees that were segmented manually from CT data (Mimics, Materialise, Leuven, Belgium). A model of shape variation based on a tetrahedral mesh of each bone was generated using principal component analysis
(PCA), selecting the eigenvalues that accounted for 98% of variance in the shape data from the training set. The locations of the voxels in the tetrahedral meshes were used to create a “shape-free patch” from each CT that had the same shape as the reference mesh. PCA was applied to voxel intensities in the set of shape-free patches to create a statistical texture model (Cootes et al, 2001). The shape and texture models were then combined into a 3D SSIM, which parameterized both surface and internal structures (Reyneke et al, 2019).

Method

Results

From a previously collected set of data on running, we have computed DRRs for the femur and tibia using the original CT and SSIM (Figure 1). At the time of submission we have only just started evaluating comparison metrics for the effectiveness at estimating the 3D pose of the bones from DSX using DRRs from CT versus SSIM.

Conclusions and recommendations

SSIMs appear to be a suitable surrogate for segment CT scans for generating DRRs. The sensitivity of the DSX pose estimation of SSIMs is currently being investigated.

__Radiofrequency Coblation Technology: A safe and viable option for osteochondritis dissecans lesions__

By Wesley R. Stroud (University of Alabama at Birmingham) Eric Wilkerson (University of Alabama at Birmingham) Anna Turco (Smith & Nephew)

Abstract Id: 5702
Event: EORS 2019
Topic: Cartilage

Introduction

Osteochondritis dissecans (OCD) lesions disrupt the osteochondral unit along articular surfaces, with significant potential for joint deterioration if not managed appropriately. Although many OCD lesions will heal conservatively, others require operative intervention for stabilization and cartilage restoration. This paper discusses management options for OCD lesions, highlighting a case using radiofrequency Coblation as an adjunct for cartilage debridement and stabilization.

Goal

A thorough literature review of the current evidence pertaining to radiofrequency Coblation was conducted. In addition, we present the results of a case involving a 15-year-old male
athlete who underwent arthroscopic knee surgery for a symptomatic OCD lesion using this technology for the chondroplasty portion of the procedure.

Method

Results

At the patient’s 6-week follow-up, crutches and brace were discontinued but therapy persisted. At approximately 3 months postoperatively, repeat imaging demonstrated excellent interval healing and he was released to slowly engage impact activities. He returned approximately 8 months postoperatively with a contralateral ACL tear, but reported the operative knee with the OCD was doing extremely well.

Conclusions and recommendations

Our case report and review of the current literature show that radiofrequency coblation appears to be a viable adjunct management strategy for OCD lesions in children.

Discoid Meniscus – A Case for Coblation

By Eric Wilkerson (University of Alabama at Birmingham) Wesley R. Stroud (University of Alabama at Birmingham) Anna Turco (Smith & Nephew)

Introduction

Management of meniscal injuries in children incorporates various strategies. Although meniscal tears are often associated with concomitant ligamentous or chondral injury in adolescents and adults, skeletally immature youth are more prone to isolated meniscal injuries, particularly in the setting of congenital variants. This case aims to demonstrate the safety and efficacy of radiofrequency coblation in the management of meniscal injury, highlighting a case of a discoid lateral meniscal saucerization and repair in a pediatric patient.

Goal

A thorough review of the current evidence pertaining to radiofrequency Coblation was conducted. In addition, we present a case involving a six-year-old female who underwent arthroscopic lateral meniscal saucerization using mechanical debridement with forceps followed by precise radiofrequency coblation for symptomatic congenital discoid lateral meniscal tears. Post-operatively she was initially touch down weight bearing and progressed with therapy to full range of motion by three months. At that time, the family opted for an identical surgery on the contralateral side. A similar procedure and post-operative recovery were noted.

Method
Results

At approximately eight months post-operatively from the initial side and four from the contralateral limb, she was no longer having pain, had regained full range of motion bilaterally, no longer had clunking, and had a visibly improved gait.

Conclusions and recommendations

Coblation is a simple and effective technique for treating congenital discoid lateral menisci.

The Effect of Duration of Vitamin D3 Application on the Osteogenic Differentiation of Human Adipose Stem Cells

By C. Kelder (Departments of Oral Implantology and Prosthetic Dentistry, and Oral Cell Biology, Academic Centre for Dentistry (ACTA), University of Amsterdam and Vrije Universiteit Amsterdam, Gustav Mahlerlaan 3004, 1081 LA Amsterdam, The Netherlands) J.M.A Hogervorst (Department Oral Cell Biology, Academic Centre for Dentistry (ACTA), University of Amsterdam and Vrije Universiteit Amsterdam, Gustav Mahlerlaan 3004, 1081 LA Amsterdam, The Netherlands) C.J. Kleverlaan (Department of Material Sciences, Academic Centre for Dentistry (ACTA), University of Amsterdam and Vrije Universiteit Amsterdam, Gustav Mahlerlaan 3004, 1081 LA Amsterdam, The Netherlands)

Abstract Id: 5699
Event: EORS 2019
Topic: MSC's

Introduction

Critical size bone defects pose a serious clinical problem, as the intrinsic healing capacity of bone fails due to the size of the defect. Bone healing might be aided by addition of 1,25(OH)2 vitamin D3 (vitD3) to bone tissue engineering scaffolds. VitD3 can promote osteogenic differentiation of human stem cells such as adipose stem cells (hASCs), which is a clinically relevant source of mesenchymal stem cells. However, it is unknown which release kinetics of vitD3, i.e. short or sustained release from scaffolds, leads to the most optimal osteogenic differentiation of hASCs. We hypothesized that sustained release of vitD3 leads to more osteogenic differentiation of hASCs than shorter applications.

Goal

hASCs (1x10^5, passage 3-4) were seeded on 20 ± 1 mg of calcium phosphate particles (day 0), cultured for 20 days, and treated with a total amount of 124 ng vitD3. This treatment was provided either during 30 min before seeding (pre-incubation, short stimulation : [200 nM]),
after seeding, over the first 2 days (burst-release high: \([100 \text{ nM}]\)), or over the total culture period of 20 days (sustained-release: \([10 \text{ nM}]\)). In the extra condition: burst-release low, the hASCs were treated for 2 days after seeding with 6.2 ng vitD3 (\([10 \text{ nM}]\)) per day.

Method

Results

Live/dead staining followed by fluorescent microscopy showed that hASCs attached to the calcium phosphate particles and were mostly viable (±75 %) at day 2. VitD3 applied for any duration did not affect the proliferation of hASCs at day 7 and day 20, measured with an alamar blue assay. At day 7, sustained-release increased the release of active alkaline phosphatase on average by 3.5 fold, compared to all the other conditions. At day 20, this was increased 4.3-fold. At both day 7 and day 20 total protein levels were similar in all conditions.

Conclusions and recommendations

Our results suggest that sustained release of VitD3 from bone tissue engineered scaffolds may be beneficial for the osteogenic differentiation of human stem cells for the treatment of critical bone size defects.

Label-Free Proteomic Analysis of Osteochondrotic Chondrocytes

By Elisabetta Chiaradia (Department of Veterinary Medicine, University of Perugia, 06126 Perugia, Italy) Marco Pepe (Department of Veterinary Medicine, University of Perugia, 06126 Perugia, Italy) Ronny Mohren (The Maastricht Multimodal Molecular Imaging Institute (M4I), Division of Imaging Mass Spectrometry, Maastricht University, The Netherlands)

Abstract Id: 5698
Event: EORS 2019
Topic: Pathology

Introduction

Osteochondrosis (OC) is a common joint disease that affects developing cartilage and subchondral bone in human and in multiple animal species including horses. It is an idiopathic localized joint disorder characterized by focal chondronecrosis and retention of growing cartilage that can lead to the formation of fissures, subchondral bone cysts or intra-articular fragments. OC is considered a complex multifactorial disease with chondrocyte biogenesis impairment mainly due to biochemical and genetic factors (1). Likewise, the molecular events involved in the OC are not fully understood. Moreover, the OC pathogenesis seems to be shared across species. In particular, equine OC and human juvenile OC share some symptoms, predilection sites and clinical presentation (2). In this study, by using the label-free mass spectrometry approach, proteome of chondrocytes isolated from equine OC fragments has been analyzed in order to clarify some aspects of cell metabolism impairment occurring in OC.
Goal

Equine chondrocytes isolated from 7 healthy articular cartilages (CTRL) and from 7 osteochondritic fragments (OC) (both were obtained from metacarpo/metatarsophalangeal) were analyzed. Proteins were extracted using urea and ammonium bicarbonate buffer, reduced, alkylated and digested with Trypsin/Lys-C Mix. Peptides were analysed using Q Exactive™ UHMR Hybrid Quadrupole-Orbitrap™ Mass Spectrometer (Thermo Scientific). All mass spectra of label-free samples analyzed was set up to search against all equine and human Swiss Prot database entries. One-way ANOVA was used to calculate the p-value based on the normalized abundance. P value at least 0.05 between experimental groups was used to compare proteins significantly modulated in OC chondrocytes.

Method

Results

Statistical analysis evidenced 41 proteins up-regulated in OC while 18 were down-regulated with respect to the CTRL. Functional analysis showed that up-regulated proteins in OC were related to extracellular matrix degradation, lysosome, apoptotic execution phase, unfolded protein response, hyaluronan and keratan sulfate degradation, oxidative stress response and negative regulation of BMP signaling pathway. The down-regulated proteins were associated with endochondral ossification, vitamin D in inflammatory disease, Wnt signaling pathway and ECM proteoglycans.

Conclusions and recommendations

These findings may contribute to clarify the events determining the onset and progression of both equine and human OC. Validation assays to confirm these findings are in progress as well as Imaging MS analysis of OC and healthy cartilage to analyze lipid and metabolomic changes occurring in OC cartilage. (1) K Olstad , et al. An Update on the Pathogenesis of Osteochondrosis. Vet Pathol. 2015 Sep;52(5):785-802; (2) A M McCoy et al. Articular Osteochondrosis: A Comparison of Naturally-Occurring Human and Animal Disease. Osteoarthritis Cartilage. 2013 Nov; 21(11): 1638-47.

Bioactive nanostructured thin films for 3D-printed biomedical devices

By Gabriela Graziani (IRCSS Istituto Ortopedico Rizzoli, NanoBiotechnology Laboratory (NaBi), Bologna, Italy)Silvia Farè (Department of Chemistry, Materials and Chemical Engineering "Giulio Natta", Politecnico di Milano, Milano Italy)Monica De Carolis (IRCSS Istituto Ortopedico Rizzoli, NanoBiotechnology Laboratory (NaBi), Bologna, Italy)

Abstract Id: 5696
Event: EORS 2019
Topic: Biomechanics

Introduction
Calcium phosphates-based coatings have been widely studied to favour a firm bonding between orthopaedic implants and the host bone. To this aim, thin films (thickness below 1 micron) having high adhesion to the substrate and a nanostructured surface texture are desired, capable of boosting platelet, proteins and cells adhesion. In addition, a tunable composition is required to resemble as closely as possible the composition of mineralized tissues and/or to intentionally substitute ions having possible therapeutic functions. The Authors have demonstrated that nanostructured thin films having high surface roughness and a composition perfectly resembling that of the deposition target can be achieved by Ionized Jet Deposition (IJD). In particular, by depositing bone-apatite like thin films by ablation of deproteinized bovine bone, highly adhesive nanostructured coatings were obtained, capable of promoting host cells attachment, proliferation and differentiation. Here, biomimetic films are deposited by Ionized Jet Deposition (IJD), by the use of biogenic and synthetic apatite targets. Because IJD deposition can be carried out without heating the substrate, application on heat sensitive polymeric substrate, i.e. 3D printed porous scaffolds, is investigated.

**Goal**

Biogenic apatite coatings are obtained by deposition of deproteinized bone (bovine, ovine, equine and porcine) and compared to coatings of stoichiometry hydroxyapatite. Coatings composition (FT-IR-ATR, FT-IR microscopy, XRD, EDS) and morphology (SEM, AFM) are tested, for deposition onto metallic and 3D-printed polymeric substrates (polyurethane). For metallic substrates, different post treatment annealing procedures are compared (350-425°C), to optimize crystallinity. Then, uniformity of substrate coverage and possible damage caused to the polymeric substrate are studied by SEM, DSC and FT-IR microscopy.

**Method**

**Results**

Biogenic coatings are composed of carbonated hydroxyapatite (XRD, FT-IR). Trace ions sodium and magnesium are transferred from the deposition target to the coating. All coatings are nanostructured, as they are composed by nano-sized globular aggregates, whose morphology and average dimensions depend on the characteristics of the target. As-deposited coatings are amorphous, but crystallinity can be easily tuned by post treatment annealing. In particular, a crystallinity similar to that of bone can be achieved for heating at 400°C and above, also depending on heating duration. When deposited on 3D printed polyurethane scaffolds, coatings effectively coat the entire scaffolds, without causing alterations in their composition. Because of sub-micrometric thickness, coatings do not alter fiber shape and porosity of the 3D printed scaffolds.

**Conclusions and recommendations**

Biomimetic bone apatite coatings were obtained, that can be deposited onto a variety of metallic and polymeric biomedical devices, thus finding several perspective applications in the biomedical field.
The loss of collagen type IX causes premature ossification of the murine femoral head

By Juliane Heilig (Cologne Center for Musculoskeletal Biomechanics (CCMB), Medical Faculty, University of Cologne, Germany)Helen Dietmar (Cologne Center for Musculoskeletal Biomechanics (CCMB), Medical Faculty, University of Cologne, Germany)Frank Zaucke (Dr. Rolf M. Schwiete Research Unit for Osteoarthritis, Orthopaedic University Hospital Friedrichsheim, Frankfurt/Main, Germany)

Abstract Id: 5695
Event: EORS 2019
Topic: Cartilage

Introduction

The ossification of the murine femoral head occurs in a unique pattern compared to long bone epiphyses. Instead of a fast formation of a secondary ossification center the cartilage matrix gets calcified and persists for several weeks, until vessels invade the cartilage and the ossification of the femoral head starts. We analyzed mice deficient for collagen type IX to better understand the role of this minor collagen in femoral head development. By doing so, we aimed at getting insight into potential mechanisms involved in the development of premature osteoarthritis in collagen IX deficient mice and humans with polymorphisms in collagen IX coding genes.

Goal

Female Col9a1-/- mice with an age of 2 - 16 weeks were compared to wildtype (WT) mice. The ossification state of the femoral head was determined by microCT analysis as well as by histological stainings. Immunohistochemical stainings as well as immunoblot analysis of tissue extracts were performed to analyze the expression of ossification and angiogenesis related proteins.

Method

Results

Female Col9a1-/- mice at the age of 16 weeks showed a significantly accelerated ossification compared to corresponding WT animals. At the age of 12 weeks neither WT nor Col9a1-/- femoral heads were yet ossified, but the Col9a1-/- samples displayed significantly more and smaller chondrocytes. While the number of vessels adjacent to the growth plate was unchanged, first vessels could be found within the Col9a1-/- calcified cartilage but not in the WT cartilage. TRAP staining showed an increased number of mature osteoclasts adjacent to the growth plate in Col9a1-/- mice and, in addition, first osteoclasts could be found within the calcified cartilage of Col9a1-/- femoral heads. Protein levels of two main antiangiogenic factors expressed by chondrocytes, thrombospondin-1 (TSP-1) as well as matrilin-1 (Matn-1), were found to be reduced in the Col9a1-/- femoral head calcified cartilage.
Conclusions and recommendations

Collagen type IX deficiency causes premature ossification of the murine femoral head.

Ligamentocyte cell sheets for anterior cruciate ligament tissue engineering

By Gundula Schulze-Tanzil (Department of Anatomy, Paracelsus Medical University, Salzburg and Nuremberg, Prof. Ernst Nathan Straße 1, 90419 Nuremberg, Germany)Clemens Gögele (Department of Anatomy, Paracelsus Medical University, Salzburg and Nuremberg, Prof. Ernst Nathan Straße 1, 90419 Nuremberg, Germany; Department of Biosciences, Paris Lodron University Salzburg, Austria)Daniel Stöbener (Institute for Chemistry and Biochemistry, Freie Universität Berlin, Takustrasse 3, 14195 Berlin, Germany)

Abstract Id: 5694
Event: EORS 2019
Topic: Tendon

Introduction

Cell sheets are manufactured from a high-density cell layer stabilized by its own freshly produced extracellular matrix (ECM). Cell sheets could be used as versatile scaffolds for tissue repair. Unfortunately, cell sheet production often remains time-consuming requiring weeks of culturing. Tendon and ligament cell sheets are so far barely available. Regarding musculoskeletal tissues exposed to high repetitive biomechanical forces, the stability of cell sheets is insufficient. It could help to combine them with a biomechanical competent scaffold e.g. produced by an embroidering technique (Hahner et al., 2015). Hence, we wanted to (1) develop a very rapid strategy to produce ACL ligamentocyte sheets within 24 h by using a thermoresponsive polymer surface, (2) to use the sheets for scaffold seeding and (3) to reflect the ligament-fibrocartilaginous transition zone of an ACL enthesis by combining cell sheet of ligamentocytes with chondrocytes or chondrogenic precursor cells as a strategy for directed seeding of two cell types on topologically different scaffold areas.

Goal

Different cell numbers of lapine anterior cruciate ligamentocytes (L-ACLs), lapine articular chondrocytes L-ACs and human mesenchymal stromal cells (H-MSCs) were used for cell sheet formation. Experiments were performed with novel, self-assembled poly(glycidyl ether) (PGE) brushes (Stöber et al., 2018) based on random glycidyl methyl ether and ethyl glycidyl ether copolymers (Heinen et al., 2017) on polystyrene 12-well cell culture plates, which allow rapid cell sheet formation within 24 h. Uncoated 12-well plates served as controls. Between 0.13-0.526 x 106 cells/cm2 were seeded into the wells followed by culture at 37 °C and 5 % CO2 for 24 h. Temperature-triggered detachment was performed by incubation with PBS at 20 °C for 10 min followed by treatment with fresh 37 °C warmed PBS for 5 min at 37 °C. Harvested cell sheets were transferred on polyglycolic acid (PGA) or embroidered poly-lactic acid / poly-co-caprolactone (PLA/P[LA-CL]) scaffolds, functionalized with collagen foam and fluorine gas treatment. Cell distribution, growth, vitality and synthesis of ECM.
components were monitored up to 7 days in scaffold culture using live dead assay, histology, immunohistochemistry and confocal laser scanning microscopy.

Method

Results

Cell numbers required for stable sheet preparation (3.9 cm²) depended strongly on the cell type (L-ACLs: ≥0.395 x 10⁶/cm², L-AC: ≥0.342 x 10⁶/cm², H-MSCs: =0.131 x 10⁶/cm²) and was highest for L-ACLs. The majority of cells survived sheet assembly, detachment, transfer onto the scaffolds and culturing. Cells grew out from the sheets, migrating into the scaffolds and spread through the scaffolds. L-ACLs and L-ACs produced ECM and maintained their specific-phenotypes (type II collagen and sulfated glycosaminoglycans in L-AC sheets, decorin and tenascin C in L-ACL sheets). The presence and distribution of two cell types in scaffold cocultures (L-ACLs and H-MSCs) could be proven by anti-human vimentin immunolabeling.

Conclusions and recommendations

The thermosensitive PGE brush surface is appropriate for rapid cell sheet formation (24 h) with the tested musculoskeletal cell types, providing a versatile strategy for directed and stable scaffold colonization. Cell sheets of two different cell types could be cocultured on the same scaffold to establish a zonal construct.

Influence of low-frequency alternating electrical fields on the bone remodelling capacity of human osteoblast

By Franziska Sahm (Biomechanics and Implant Technology Research Laboratory | Department of Orthopaedics | Rostock University Medical Centre | Germany) Vivica Freiin Grote (Biomechanics and Implant Technology Research Laboratory | Department of Orthopaedics | Rostock University Medical Centre | Germany) Rainer Detsch (Institute of Biomaterials | Department of Materials Science and Engineering | University of Erlangen-Nuremberg | Germany)

Abstract Id: 5692
Event: EORS 2019
Topic: Bone

Introduction

Several Electrical fields are known to be present in bone tissue as originally described by Fukada and Yasuda in the year 1957. Intrinsic voltages can derive from bone deformation and reversely lead to mechanical modifications, called the piezoelectric effect. This effect is used in the clinic for the treatment of bone defects by applying electric and magnetic stimulation directly to the bone supplied with an implant such as the electroinductive screw system.
Through this system a sinusoidal alternating voltage with a maximum of 700 mV can be applied which leads to an electric field of 5-70 V/m in the surrounding bone. This approach is established for bone healing therapies. Despite the established clinical application of electrical stimulation in bone the fundamental processes acting during this stimulation are still little known. A better understanding of the influence of electric fields on cells involved in bone formation is important to improve therapy and clinical success.

**Goal**

To study the impact of electrical fields on bone cells in vitro, Ti6Al4V electrodes were designed according to the pattern of the ASNIS III screw for a 6 well system. Osteoblasts were seeded on collagen coated coverslip and placed centred on the bottom of each well. During four weeks the cells were stimulated 3x45 min/d and metabolic and alkaline phosphatase (ALP) activity as well as gene expression of cells were analysed. Furthermore, supernatants were collected and proteins typical for bone remodelling were examined.

**Method**

**Results**

The electrical stimulation did not exert a significant influence on the metabolic activity and the ALP production in cells over time using these settings. Gene expression of BSP and ALP was upregulated after the first 3 days whereas OPG was increased in the second half after 14 days after electrical stimulation. Moreover, the concentration of the released proteins OPG, IL-6, DKK-1 and OPN increased when cells were cultivated under electrical stimulation. However, no changes could be seen for essential markers, like RANKL, Leptin, BMP-2, IL-1β and TNF-α.

**Conclusions and recommendations**

Therefore, further studies will be done with osteoblasts and osteoclasts to study bone remodelling processes under the influence of electrical fields more in detail. This study was supported by the German Research Foundation (DFG) JO 1483/1-1.

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**Rewriting ankle anterior approach:**
**Crossing of Extensor Hallucis Longus (EHL) and neurovascular bundle**

By Chin Yik Tan (Tan Tock Seng Hospital) Muhd Farhan Mohd Fadil (Tan Tock Seng Hospital)

**Introduction**
Anterior approach to the ankle is commonly used for operations such as debridement of infected cases, surgical fixation and total ankle arthroplasty. It is important to avoid injury to neurovascular bundle during this approach. Neurovascular bundle (Deep peroneal nerve and Anterior tibial artery) crosses underneath Extensor Hallucis Longus (EHL) laterally in dorsum of ankle to lie in the plane between (EHL) and Extensor Digitorum Longus (EDL). However, the distance of this crossing to the ankle joint is not well documented in the current literature.

**Goal**

The aim of our study is to investigate the exact distance of EHL/neurovascular bundle crossing to ankle joint. This is a cadaveric study involving 18 embalmed specimens from 9 bodies. Dorsum of ankle was dissected to expose EHL, neurovascular bundle and anterior ankle joint. Distance of EHL/neurovascular bundle crossing from ankle joint was measured.

**Method**

**Results**

The mean age of the bodies was 64.8 years old (range 38 to 86). The mean distance of EHL/Neurovascular bundle crossing to ankle joint was 3.95 cm (proximal to ankle joint).

**Conclusions and recommendations**

This finding is important for surgeons performing anterior approach to the ankle to avoid injury to neurovascular bundle.

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**Virtual Fracture Clinic : Have the implementation of new guidelines and teaching improved the service? A closed looped audit.**

By Alexander Vaughan (Kent & Canterbury NHS Trust) Natalie Holmes (Kent & Canterbury NHS Trust) Andrew Smith (Kent & Canterbury NHS Trust)

Abstract Id: 5690  
Event: EORS 2019  
Topic: Other

**Introduction**

Virtual Fracture Clinic (VFC) is a consultant-led orthopaedic trauma outpatient triage and management service. The use of VFC has recently become commonplace in the United Kingdom. It allows multiple referral sources to the orthopaedic team, with clinical information and imaging reviewed by a consultant in VFC who formulates an appropriate management plan with the patient contacted; either to attend clinic for consultation or
discharged with advice over the phone. The VFC is more efficient than a traditionally delivered outpatient fracture clinic service. We have utilized VFC for 1 year at our hospital, East Kent University Hospital Foundation Trust (EKHUFT), and undertook a closed loop audit to evaluate the service and highlight potential areas of improvement. The Objective of the study was to identify whether the implementation of new re-designed VFC referral guidelines together with teaching set across one of the hospitals in EKHUFT improved the effectiveness and standards of VFC referrals.

Goal

An initial audit was performed of all referrals made to VFC over a 2 week period in December 2018. Changes to the VFC referral pathway were implemented, and teaching sessions performed by the orthopaedic team to all referring units, including minor injury units (MIU) and the emergency department (ED). After implementation, re-audit of VFC referrals was performed in February 2019 over a similar 2 weeks period. Patient demographics, diagnosis and outcomes were collected from the online patient record with images reviewed using PACS software.

Method

Results

Following intervention, referral rates dropped by 27.7% (136 vs 188 patients) over the 2 week periods. Patient demographics, injury type and severity remained the same between the 2 groups. 51.5% (70/136) did not meet VFC pathway criteria after the intervention and were considered ‘inappropriate’, compared to 70% in the original group. 15.4% (21/136) referrals could have been managed in the emergency department using the new guidelines and leaflet discharge. 5.1% (7/136) of the referrals should have been referred to orthopaedic on-call acutely and 22% (30/136) of the referrals had a soft tissue injury or no injury identified. This did not change between the 2 groups despite intervention.

Conclusions and recommendations

Referring MIU and ED units require continued support and teaching over a prolonged time period to hopefully see further improvements. Immediate ‘hot-reporting’ of radiographs may further benefit the service, but staffing and funding issues particularly out of hours, means this is remains an aspiration.

Why Asians have different squat: A cadaveric study

By Chin Yik Tan (Tan Tock Seng Hospital) Muhd Farhan Mohd Fadil

Abstract Id: 5689
Event: EORS 2019
Topic: Biomechanics
Introduction

Asian squat is a squatting position with the whole feet including hindfoot portion touching the ground whereas western population tend to squat with hindfoot lifted off the ground. We hypothesize that Achilles tendon is proportionately longer in Asian population compared to western population, contributing to Asian squat.

Goal

The aim of our study is to investigate the proportionate length of Achilles tendon to tibia length in an Asian population. This is a cadaveric study involving 18 embalmed specimens from 9 bodies in an Asian population. Dissection was carried out to expose calcaneal insertion of Achilles tendon, musculotendinous junction of medial gastrocnemius, ankle joint and medial tibia plateau. Achilles tendon length (AT) was measured from calcaneal insertion to musculotendinous junction of medial gastrocnemius and tibia length (TL) was measured from ankle joint to medial tibia plateau.

Method

Results

There were 5 male and 4 female bodies. The mean AT was 19.25 cm, mean TL was 32.78 cm and mean AT/TL ratio was 59 %.

Conclusions and recommendations

This finding not only tells us an interesting fact about difference in anatomy between Asian and western population, but also serves as guide for surgeons in estimating tendon length in Achilles tendon reconstruction.

Wnt signaling and fibronectin fragments impair chondrocyte response to mechanical compression

By Valeria Graceffa (Tissue Homeostasis and Disease, Skeletal Biology & Engineering Research Center (SBE),KU Leuven)Anke Govaerts (Tissue Homeostasis and Disease, Skeletal Biology & Engineering Research Center (SBE),KU Leuven)Rik Lories (Tissue Homeostasis and Disease, Skeletal Biology & Engineering Research Center (SBE), KU Leuven)
In a healthy joint, mechanical loading increases matrix synthesis and maintains cell phenotype, while reducing catabolic activities. It activates several pathways, most of them yet largely unknown, with integrins, TGF-β, canonical (Erk 1/2) and stress-activated (JNK) MAPK playing a key role[1]. Degenerative joint diseases are characterized by Wnt upregulation and by the presence of proteolytic fibronectin fragments (FB-fs)[2]. Despite they are known to impair some of the aforementioned pathways[2], little is known on their modulatory effect on cartilage mechanoresponsiveness. Understanding their effect is crucial to discover new therapeutic targets and improve cartilage regeneration approaches. This study aims at investigating the effect of mechanical loading in healthy and in vitro diseased cartilage models. To assess this, human cartilage explants and primary chondrocytes have been incubated with the pro-hypertrophic Wnt agonist CHIR99021 or with the pro-catabolic FB-fs 30 kDa, before being subjected to mechanical compression.

Goal

Human primary chondrocytes from OA patients have been grown in alginate hydrogels for one week, prior to be incubated for 4 days with 3 μM CHIR99021 or 1 μM FB-fs. Human cartilage explants isolated from OA patients have incubated 4 days with 3 μM CHIR99021 or 1 μM FB-fs. Both groups have then been mechanically stimulated (unconfined compression, 10% displacement, 1.5 hours, 1 Hz), using a BioDynamic® 5270 from TA Instruments. Expression of collagen type I, II and X, aggrecan, ALK-1, ALK-5, αV, α5 and β1 integrins, TGF-β1 have been assessed by Real Time-PCR and normalized with the expression of S29. Percentage of phosphorylated Smad2, Smad1 and JNK were determined through western blot. TGF-β1 content was quantified by sandwich ELISA; MMP-13 and GAG by western blot and DMMB assay, respectively. At least three biological replicates were used. ANOVA test was used for parametric analysis; Kruskal-Wallis and Mann-Whitney post hoc test for non-parametric.

Method

Results

Preliminary data show that compression increased collagen II expression in control, but not in CHIR99021 and FB-fs pre-treated group (Fig. 1A-B). This was associated with downregulation of β1-integrin expression, which is the main collagen receptor and further regulates collagen II expression[3] (Fig. 1A), suggesting inhibition of Erk1/2 pathway. A trend of increase expression of collagen type X after mechanical loading was observed in CHIR and FB-fs group (Fig. 1B). ALK-1 and ALK-5 showed a trend toward stronger upregulation in CHIR99021 group after compression (Fig. 1B), suggesting the activation of both Smad1/5/8 and Smad 2/3 pathways. To further investigate pathways leading to these different mechano-responses, the phosphorylation levels of Smad1 and Smad2, Erk1/2 and JNK proteins are currently being studied. Preliminary results show that Smad2, Smad1 and JNK protein levels increased in all groups after mechanical loading (Fig. 2C), independently of an increase in TGF-β1 expression or content (Fig. 2A-B). Compression further increased phosphorylation of Smad2, but not of Smad1, in all groups. Higher phosphorylation rate of JNK was observed in FB-fs group both before and after mechanical loading (Fig. 2C).

Conclusions and recommendations
Further investigation on pathways differentially activated by FB-fs and CHIR is needed to identify new potential therapeutic targets and improve current cartilage regeneration approaches.

Sequential and sustained release of doxorubicin and paclitaxel from a calcium sulfate/hydroxyapatite carrier

By Yang Liu (Lund University Hospital) Deepak Bushan Raina (Lund University Hospital) Lars Lidgren (Lund University Hospital)

Abstract Id: 5685
Event: EORS 2019
Topic: Biomaterials

Introduction
Doxorubicin and paclitaxel are commonly used as chemotherapy in malignant bone tumors. By systemic administration, high local concentrations cannot be reached without serious side effects. However, using a carrier, placed close to or within the tumor, super high local concentrations can be reached, and by using drugs locally, systemic effects avoided. In this study, we determine the release kinetics of doxorubicin and paclitaxel from a commercially available biphasic calcium sulphate/hydroxyapatite carrier.

Goal

The biphasic material was mixed with the drugs in solution and casted as a circular cone. The pellets were immersed in 1 mL PBS and the supernatants collected and replenished with 1 mL fresh PBS. For doxorubicin (10μg of doxorubicin in 100μl of ceramic paste), the supernatants were collected on day 1, 3, 7, 14, 21 and 28. For paclitaxel, (2μg AF-488 paclitaxel in 100μl of ceramic paste), the supernatants were collected on day 1, 3, 7, 10, 14 and 21. The fluorescence was detected using a spectro-fluorimeter (Doxorubicin, Excitation: 485 nm, Emission: 580 nm and Paclitaxel, Excitation: 485 nm Emission: 535 nm).

Method

Results
At pH 7, the biphasic material released 28% of the doxorubicin during the first week and additionally only

Conclusions and recommendations
An injectable calcium sulphate/hydroxyapatite carrier may constitute an attractive platform for local delivery of anti-tumor drugs. Additional long term in vivo studies are at present ongoing.
THE SNORNA U3 INFLUENCES THE CELLULAR PHENOTYPE OF CHONDROCYTES AND PLAYS A ROLE IN THEIR TRANSLATIONAL CAPACITY

By E.G.J. Ripmeester (Maastricht University) M.M.J. Caron (Maastricht University) M.M.F. Steinbusch (Maastricht University)

Abstract Id: 5684
Event: EORS 2019
Topic: Cartilage

Introduction

During osteoarthritis (OA) progression the articular chondrocyte undergoes a phenotypic change and adopts a catabolic and hypertrophy-like state. This hypertrophic phenotype consists of reduced chondrogenic gene expression, while hypertrophic, cartilage degrading and inflammatory modulators are upregulated. Small nucleolar RNAs (snoRNAs) are small non-coding guide RNAs, some of which are implicated in the endoribonucleolytic cleavage of the pre-ribosomal RNA (pre-rRNA) and potentially influence the cellular anabolic state via control over ribosome and thus protein biogenesis. One of the most abundant snoRNAs is U3 snoRNA. We hypothesize that snoRNAs play a role in the OA chondrocyte’s reduced anabolic state and shift towards a catabolic hypertrophic phenotype via altered processing of pre-rRNA.

Goal

OA cartilage for microarray analysis was collected following total knee arthroplasty surgery (n=6) and non-OA cartilage was collected following anterior cruciate ligament repair (n=6) (with ethical permission). Total RNA was extracted and hybridised onto Affymetrix miRNA 4.0 arrays. The probe set for Homo sapiens was used to determine differentially expressed snoRNAs, with additional validation using RT-qPCR. Ribosomal RNA gene expression, and phenotypic chondrocyte markers were measured using RT-qPCR. Translational capacity was assessed using SUNSET assays. U3 knockdown and overexpression in non-OA chondrocytes was undertaken following transfection of antisense oligonucleotides (ASO) or a pre-U3 expression plasmid, respectively. Protein levels of the chondrocyte phenotypic markers were determined via immunoblotting. Transcriptional regulation of U3 gene expression was determined via a human U3 promoter-luciferase reporter assay.

Method

Results
Microarray and RT-qPCR analyses demonstrated reduced expression of U3 snoRNA in OA articular cartilage, compared to non-OA cartilage. OA Human Articular Chondrocyte (HAC) cultures demonstrated a decrease in U3 snoRNA and 18S, 5S, 28S and 5.8S rRNA gene expression, compared to non-OA HACs. SUnSET assays revealed an overall reduction in ribosomal translational capacity in OA chondrocytes. Altering U3 snoRNA expression levels following ASO-mediated knockdown or the exposure of non-OA HACs to OA synovial fluid, revealed a reduction in expression of 5.8S, 18S, 28S and 5S rRNAs, accompanied with a reduction in overall translational capacity. In contrast, overexpression of U3 snoRNA in non-OA HACs revealed increased 5.8S, 18S, 28S and 5S rRNA expression levels and translational capacity. Following knockdown or increase of U3 snoRNA levels, the articular chondrocyte’s phenotype altered towards a more catabolic or anabolic phenotype, respectively. Finally, several catabolic and anabolic extracellular stimuli were able to alter U3 snoRNA promoter activity.

Conclusions and recommendations

Our data suggest that cellular U3 snoRNA levels are controlled via extracellular ligands at the U3 gene transcriptional level. Future research aims to restore declined U3 snoRNA levels in OA chondrocytes to favourably alter the diseased catabolic chondrocyte in OA articular cartilage.

Proteomics Characterization of hMSC chondrogenic and osteogenic differentiation in 3D printed scaffolds

By Clarissa Tomasina (Maastricht University, the Netherlands) Ronny Mohren (Maastricht University, the Netherlands) Khadija Mulder (Maastricht University, the Netherlands)

Abstract Id: 5683
Event: EORS 2019
Topic: 3-D Printing

Introduction

The extracellular matrix (ECM) is the non-cellular structural support that provides cells with a network of biochemical and biomechanical factors for cellular processes. The ECM regulates cell function, differentiation and homeostasis. Here, we present a proteomics characterization of three commonly used additive manufactured polymers: polylactic acid (PLA), polyactive (PA) and polycaprolactone (PCL) [1].

Goal

We cultured human mesenchymal stromal cells (hMSCs) and make them undergo chondrogenic and osteogenic differentiation on 3D printed PCL, PA and PLA scaffolds. hMSCs were cultured in basal, chondrogenic and osteogenic media (200000 cells/scaffold) and analyzed after 35 days of culture. Differentiation was proved through biochemical assays,
immunofluorescence and histology. The protein content was explored using label free liquid chromatography–mass spectrometry (LC-MS), which revealed upregulated proteins and their related pathways.

Method

Results

A higher difference was found among different media compared to the scaffold type through principal component analysis (PCA). Interestingly, in all three materials, chondrogenesis was characterized by a lower but more diverse amount of proteins. PCL induced ECM production in both differentiation media, but it led to more apoptosis and GAG degradation in the chondrogenic medium compared to the osteogenic one. During chondrogenesis in PA and PLA, cell differentiation resulted in the activation of stress response cascades, collagen formation and ECM remodeling. On the other hand, in osteogenesis, PCL enhanced insulin-like growth factor pathway and fibrin clot related pathways.

Conclusions and recommendations


Identification of BMP-7-mimicking peptides that reverse the katabolic-chondrocyte phenotype in OA chondrocytes

By E.G.J. Ripmeester (Maastricht University) M.M.J. Caron (Maastricht University) J. Steijns (Maastricht University)

Abstract Id: 5682
Event: EORS 2019
Topic: Cartilage

Introduction

Osteoarthritis (OA) is the most common degenerative joint disease worldwide. During OA progression the articular chondrocyte undergoes pathological phenotypic changes, facilitating articular cartilage destruction in OA. However, biological therapies that slow down or reverse this pathological chondrocyte phenotypic shift are still to be developed. Bone morphogenetic protein 7 (BMP-7, OP-1) has been shown to have OA disease-modifying properties. BMP-7 suppresses the chondrocyte hypertrophic and katabolic phenotype and may be effective to target the chondrocyte phenotype in OA. To improve the potential for clinical use of the OA disease-modifying BMP-7 activity, we sought for BMP-7-mimicking peptides that are compatible with the harsh OA joint-environment and can potentially be formulated with an intra-articular drug delivery system. We hypothesized that human BMP-7 harbors peptide
sequences able to mimic the disease-modifying properties of the full-length human BMP-7 protein on the OA chondrocyte phenotype.

Goal

To identify BMP-7-mimicking peptides, a BMP-7 peptide library was custom-made and consisted of a library of 20-mer peptides with 18 amino-acids overlap between each sequential peptide, covering the whole BMP-7 amino acid sequence. Human OA articular chondrocytes (HACs) were isolated from OA cartilage from total knee arthroplasty (n=18 donors). HACs were exposed to hBMP-7 (1 nM) or BMP-7 library peptides at different concentrations (1, 10, 100 or 1000 nM) for 24 hours. Expression of signature chondrogenic-, hypertrophic-, cartilage degrading- and inflammatory mediator genes was determined by RT-qPCR. GAG content and ALP activity were determined using colorimetric assays and PGE2 levels in culture supernatant were measured by EIA (Enzyme Immune Assay). BRE- and CAGA12-luciferase reporter assays were used to chart overall BMP and TGFβ signaling activity, respectively.

Method

Results

The hBMP-7 peptide library was screened for the presence of full-length human BMP-7-mimicking bioactivity on a pool of human OA HACs. Gene expression analysis, as well as analysis of GAG content, ALP activity and PGE2 levels revealed two distinct regions in the BMP-7 protein from which the peptides showed BMP-7-mimicking bioactivity. This was based on their pro-chondrogenic (COL2A1, ACAN, SOX9, BAPX1.NKX.3.2 and GAG upregulated) and OA-phenotype suppressing (COL10A1, ALPL, RUNX2, ADAMTS5, IL-6, MMP13, COX-2 and PGE2 downregulated) actions on human OA HACs. One peptide of each region was further analysed for its OA chondrocyte disease-modifying properties in the presence of OA synovial fluid. Gene expression analyses showed that also in the presence of OA synovial fluid these peptides retained their bioactivity, albeit at lower efficacy. After a single 24 hours exposure, their OA chondrocyte phenotype-modulating actions could be detected up to 8 days in culture. Finally, the peptides induced BRE-luciferase reporter activity in SW1353 cells, while CAGA12-luciferase activity was reduced following peptide exposure.

Conclusions and recommendations

In ongoing research the mechanism-of-action of these BMP-7-mimicking peptides is being investigated further. Ongoing biochemical fine-tuning of the peptides, and in vivo evaluation, will potentially result in a peptide-based chondrocyte-targeting experimental OA treatment with the potency to favourably alter the diseased chondrocyte phenotype in OA articular cartilage.

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COMPARATIVE ASSESSMENT OF GAIT IN TOTAL KNEE ARTHROPLSTY PATIENTS BETWEEN MULTI-RADIUS
AND GRADUALLY REDUCING RADIUS FEMORAL COMPONENT DESIGNS DURING SIT-TO-STAND AND STAIR DESCENT MOVEMENT

By SANG JIN LEE (Inje University / Haeundae Paik Hospital)

Introduction

Previous studies demonstrated that an abrupt change in conformity occurs during flexion of knee joint after total knee arthroplasty (TKA) using the multi-radius (MR) femoral design implant. An abrupt change in conformity was shown to lead to instability such as paradoxical anterior sliding and anteroposterior movement. For this reason, a gradually reducing radius (GR) femoral design was introduced. Recent studies showed that the gradually reducing radius design helped to attenuate paradoxical anterior sliding and provide better contact area without point loading or edge loading. The purpose of this study was to compare lower-limb biomechanics of TKA patients with MR versus GR knee design during Sit-to-stand (STS) and stair decent (SD).

Goal

Thirty-two knees were examined at one year after TKA. The groups consisted of subjects who had undergone total knee arthroplasty with a representative MR designed implant (n=15, B Braun-Aesculap Vega® Knee System) and a representative GR designed implant (n=17, Depuy Attune® Knee System). The kinematic and kinetic parameters of hip and knee joints were evaluated during STS movement and stair descent. Patient-reported outcomes including Knee Society Score (KSS) and Knee Injury and Osteoarthritis Outcome Score (KOOS) were also evaluated.

Method

Results

During STS movement, peak hip adduction moment of GR implant group was smaller than MR implant group (p=0.014) and peak knee flexion moment of GR implant group was greater than MR implant group (p=0.011). In the sagittal plane during SD, the knee was more flexed in the GR group than the MR group (p=0.009) and the flexion/extension ROM of the knee joint was significantly greater in the GR group than the MR group (p=0.004). In the coronal plane during SD, the maximal varus angle and the varus/valgus ROM of the knee joint were significantly smaller in the GR group than the MR group (p

Conclusions and recommendations
GR group showed more improved knee function and stability during STS movement and SD after TKA when compared with MR group.

PULLOUT TESTING OF SPINAL INSTRUMENTATION IN AN IN VIVO MIMICKING EXPERIMENTAL SETUP

By Remco Doodkorte (Department of Orthopaedic Surgery, Research School CAPHRI, Maastricht University Medical Center, Maastricht, the Netherlands)

Abstract Id: 5674
Event: EORS 2019
Topic: Biomechanics

Introduction

Complications after spinal fusion surgery are common, with implant loosening occurring in up to 50% of osteoporotic patients. [1]. Pedicle screw fixation strength reduces as a result of decreased trabecular bone density, whereas sublaminar wiring is less affected by these changes. [2]. Therefore, pedicle screw augmentation with radiopaque sublaminar wires (made with Dyneema Purity® Radiopaque fibers, DSM Biomedical, Geleen, the Netherlands) may improve fixation strength [3]. Furthermore, sublaminar tape could result in a gradual motion transition to distribute stress over multiple levels and thereby reduce implant loosening. The objective of this study is to test this hypothesis in a novel experimental setup in which a cantilever bending moment is applied to individual human vertebrae.

Goal

Thirty-eight human cadaver vertebrae were stratified into four different groups: ultra-high molecular weight polyethylene sublaminar tape (ST), pedicle screw (PS), metal sublaminar wire (SW) and pedicle screw reinforced with sublaminar tape (PS+ST). The vertebrae were individually embedded in resin, and a cantilever bending moment was applied bilaterally through the spinal rods using a universal materials testing machine. This cantilever bending setup closely resembles the loading of fixators at transitional levels of spinal instrumentation (Figure 1).

Method

Results

The pull-out strength of the ST (3563 ± 476N) was not significantly different compared to PS, SW or PS+ST. The PS+ST group had a significantly higher pull-out strength (4522 ± 826N) compared to PS (2678 ± 292N) as well as SW (2931 ± 250N) (Figure 2).

Conclusions and recommendations

Postmarketing survey of the CD-horizon Solera instrumentation in posterior spinal correction and fusion for Adolescent Idiopathic Scoliosis.

By L.D.E.D.M. Smals (Maastricht University, Laboratory of Experimental Orthopedics) M.H.H.M. Hulsbosch (VieCuri Medisch Centrum) J.J. Arts (Maastricht University Medical Centre, Orthopedics department)

Abstract Id: 5673
Event: EORS 2019
Topic: Spine

Introduction

The new MDR (Medical Devices Regulations) state that Post-Market Clinical Follow-Up should be integrated into the MDR as from 2020 to provide vital clinical evidence. The CD Horizon Solera 4.75 mm instrumentation (CD-Solera) was worldwide introduced in 2009. It is specifically intended for pediatric and adolescent patients, because of its low profile.

Goal

Study design: retrospective cohort study Objective: to evaluate the safety and efficacy of the CD-solera 4.75 instrumentation in surgical treatment of adolescent idiopathic scoliosis (AIS).

Method

Results

About 77% of the patients had a structural thoracic curve (Lenke 1-2), and 23% had a structural (thoraco)lumbar curve (Lenke type 3-6). Preoperatively, the average primary curve Cobb angle was 58.7°. A correction of 55.1% and 51.8% was achieved respectively immediately post-operative, and at last follow up. Sagittal alignment was preoperative 22.2 ± 15.4° kyphosis (T5-T12), 16.4 ± 12.5° thoracolumbar junction (T10-L2) and 17.8 ± 12.1° lordosis (T12-S1). At last follow-up this was respectively 17.8 ± 12.1°, 7.5 ± 6.0° and 54.7 ± 13.6°. The average SRS-22r-questionnaire score was good (4.0, in which 0.0 is the minimum and 5.0 is the maximum score). In total 6 revision surgeries were executed. One complication (rod breakage) was related to the material. Other revision surgeries were executed because of
invalidating pain, skin irritation, mental health problems, ventral screw protrusion and deep infection. No neurological problems were encountered.

Conclusions and recommendations

The CD-Solera can be regarded as a safe and effective instrumentation in surgical treatment of AIS.

Enzymatically crosslinked natural polymers for cartilage repair

By Bram Zoetebier (Department of Developmental BioEngineering, MIRA Institute for Biomedical Technology and Technical Medicine, University of Twente, The Netherlands) Kavitha Sivasubramaniyan (Dept Orthopedics, Erasmus MC University Medical Center, Rotterdam, The Netherlands) Martina Puricelli (LifeTec Group, The Netherlands)

Abstract Id: 5663
Event: EORS 2019
Topic: Cartilage

Introduction

Osteoarthritis is the most common chronic condition of the joints. It is characterized by the degeneration of articular cartilage, formation of osteophytes and alterations in the synovium. This process has a severe impact on the quality of life of the patients and the currently available treatments are unsatisfactory and often merely focused on pain relief. In our group we are working on the development of in situ crosslinkable hydrogel platforms that could be used for resurfacing the damaged articular cartilage using a minimally invasive arthroscopic procedure. Stable fixation of the gel at the joint surface, facilitating the ingrowth of local stem and progenitor cell populations and supporting intrinsic repair mechanisms are considered minimal design parameters. To achieve this we are exploring the use of enzymatically crosslinkable natural polymer-tyramine conjugates.

Goal

Dextran-tyramine conjugates were prepared by activation of dextran-OH and subsequent reaction with tyramine. Hyaluronic acid-tyramine and protein-tyramine conjugates were prepared using DMTMM coupling. In situ crosslinking is achieved by mixing the polymer conjugates with the enzyme HRP and minute, non-toxic amounts of H2O2 as oxidizing agent. Support of cartilage formation was studied after mixing of the polymer conjugates with mesenchymal stem cells, chondrocytes or combinations of both prior to crosslinking. Cell ingrowth was studied by implanting the hydrogels in an ex-vivo cartilage defect while mechanically loading the explant in a bioreactor and cell migration in the hydrogels was evaluated by tracking the sprouting of fluorescently labeled cell-spheroids.

Method
Results

We prepared dextran-tyramine conjugates with a degree of substitution of 10 tyramine residues per 100 monosaccharide units. The conjugated hyaluronic acid-tyramine had a degree of substitution of 10% of the carboxylic acid groups, while for the proteins the substitution was dependent on the protein type.

Conclusions and recommendations

Enzymatically crosslinked hydrogels, based on dextran and hyaluronic acid, with the addition of co-crosslinkable proteins show excellent properties for application in the regeneration of damaged cartilage.

Prosthetic knee component size and patient reported functional outcomes after total knee arthroplasty: a one year follow-up study

By Kendrick To (Division of Trauma and Orthopaedics, Department of Surgery, University of Cambridge, UK) Wasim Khan (Division of Trauma and Orthopaedics, Department of Surgery, University of Cambridge, UK) Prabhvir Marway (School of Clinical Medicine, University of Cambridge, UK.)

Abstract Id: 5660
Event: EORS 2019
Topic: Arthroplasty

Introduction

Companies manufacturing total knee arthroplasty (TKA) prostheses produce a variety of tibial and femoral components of different dimensions denoted by numbers or letters. Surgeons frequently implant components that are compatible but not of the same size on the femur and tibia. Recent studies suggest that equally sized femoral and tibial components produce better outcomes compared to size-mismatched components. In our study, we aim to explore the relationship between component size and outcome measured by oxford knee score at six weeks and one year following TKA.

Goal

A cohort of twenty-four patients who underwent TKA and had well-functioning prosthesis were studied. Thirteen (54%) had equally sized TKA components implanted, seventy-four patients (42%) had components that were mismatched by one size, and one (4%) had components that were mismatched by more than one size. The Oxford Knee Score (OKS) obtained preoperatively, at six weeks and one year postoperatively were retrieved from an electronic database. All data were analysed using R software.
Method

Results

A significant improvement in pre-operative and one year postoperative OKS was observed. Patients who received one-size mismatched tibial and femoral components demonstrated a less pronounced improvement in OKS as compared with patients who received equally sized components.

Conclusions and recommendations

When possible, it may be best to utilise equally sized prothetic tibial and femoral components when performing total knee arthroplasty. Manufacturers may be able to produce better patient outcomes by including prostheses that are between sizes as part of their production line.

The Radiological Assessment of Knee Protheses at follow up after Total Knee Arthroplasty; Do we need to change our practice?

By Kendrick To (Division of Trauma and Orthopaedics, Department of Surgery, University of Cambridge, UK) Wasim Khan (Division of Trauma and Orthopaedics, Department of Surgery, University of Cambridge, UK)

Abstract Id: 5659
Event: EORS 2019
Topic: Arthroplasty

Introduction

The current standard of practice following knee arthroplasty is to demonstrate the appropriate alignment of knee replacements using knee radiographs. Recent studies have suggested that standard knee radiographs provide adequate accuracy for tibial prosthesis alignment assessment as compared with long knee view radiographs which are more technically demanding and carry greater radiation exposure. In this study, we aim to address whether alignment measured on standard knee radiographs are reliable and reproducible over time.

Goal

We examined a cohort of 80 patients 37 male (46%), 43 female (54%), mean age = 68 years) who underwent total knee arthroplasty (TKA). Standard knee anteroposterior radiographs performed within 2 days following surgery were compared to standard knee anteroposterior radiographs taken 1 year following the surgery in patients with wellfunctioning prosthesis. Tibial prosthesis alignment angles between the longitude of the tibial shaft and the tibial
baseplate were calculated using Centricity Enterprise Web V3.0 software. The data was examined using R software.

Method

Results

In well-functioning primary knee arthroplasties, tibial prosthesis alignment angles measured in the 1 year follow-up standard view knee radiographs were found to deviate from measurements obtained with the same radiographic specifications in the immediate post-operative period. A significant mean percentage difference was found between the two radiographs.

Conclusions and recommendations

Long knee view radiographs may be required in order to accurately assess tibial prosthesis alignment following total knee arthroplasty.

Microcomputed tomographic, biomechanical and histological analyses of lumbar interbody fusion in pig model: Comparison of iliac crest bone graft and newly developed hybrid biodegradable nanocomposit porous implant.

By Milan Krticka (University Hospital and Masaryk University Brno) Vladimir Nekuda (University Hospital and Masaryk University Brno) Martin Trunec (CEITEC VUT Brno)

Abstract Id: 5653
Event: EORS 2019
Topic: Spine

Introduction

The use of lumbar fusion procedures in the USA and Europe has rapidly increased over the last decade and a large number of these procedures involve the use of bone grafts. Despite of technical progress of spinal surgery and operative materials the risk of vertebral fusion failure occurs in 5 – 35 % of cases. Main goal of this experimental study was to compare newly developed hybrid biodegradable nanocomposit porous implant (HBNPI) against bone graft from iliac crest as a new and better alternative for lumbar interbody fusion.

Goal
24 male pigs 4 months old weighting around 40 Kg were included in our study. These pigs were divided into two study groups depending on fusion method. Group A – 12 pigs underwent lateral lumbar interbody fusion (L2/3) with implantation of iliac crest bonegraft. Group B - 12 pigs underwent lateral lumbar interbody fusion (L2/3) with newly developed HBNPI. Each group were divided into two subgroups from these 6 spines were harvested 8 weeks (subgroup A1, B1) and 6 spines 16 weeks (group A2, B2) after surgery. After sacrifice, the lumbar spines were taking out and micro-CT, biomechanical testing and histomorphological analysis in all groups were performed to evaluate a quality of intervertebral fusion. As controls (group N), 6 cadaveric intact lumbar spines underwent biomechanical, microCT and histological testing.

Method

Results

All 24 animals recovered from general anesthesia without unusual events. The operations lasted between 50-90 minutes (mean 70) in Group A and between 35-72 minutes (mean 43) in Group B. All of the pigs from group A could stand up and were mobile within 20 hours (range 7-20). When bone graft harvesting was not necessary (group B) this time was shortened, ranging from 1 – 1,5 hour. All pigs from Group A were limping on the first postoperative day. No limping animal was observed in group B. Total body weight of the pigs increased from 37 kg (range 36-40) at the start to 85 (range 80-89) at sacrifice. Biomechanics evaluation shows that extension flexural stiffness values are statistically significantly different between A2 (16 weeks post-implant) and A1 (8 weeks post-implant). Group A2 achieves higher values than Group A1, which is attributed to the adhesion of the implant to the surrounding vertebrae. Similarly, this also applies to groups B2 and B1. The flexural stiffness at group B2 extension is statistically significantly higher than the A2 group and also than the native N group. Biomechanical evaluation supports findings on microCT and histological specimens, where both adjacent vertebrae are completely fused in groups B2, unlike in group A2, where there is no or incomplete fusion.

Conclusions and recommendations

Newly developed HBNPI represents new possibility how to do intervertebral fusion, and simultaneous become chance how to improve and accelerate bone healing process against standard procedures.

Injury specific 3D printed fixation plates for pelvic fracture management

By Rachel W Li (Australian National University)Paul N Smith (The Canberra Hospital, Australia)
Introduction

The geometric mismatch between a patient’s complex pelvic anatomy and the generic nature of standard implants would cause wear particles and osteolysis. To achieve a best possible fit to patient, the implants often need to be contoured and bent intraoperatively. The 3D printed fixation plates from 3D models based on the patient’s 2D CT images will provide an accurate and time efficient means of managing patient and injury specific pelvic fractures.

Goal

3D models were created from patient's CT image directory of pelvis using Drishti software. This created 3D model enabled us to superimpose right and left hemi-pelvis in order to validate the degree of symmetry between sides. A suite of 3D printing software were used to design and print optimal patient specific fixation plates. We then used the re-stitched fracture model, and further validated with application to the mirrored non-fractured hemi-pelvis.

Method

Results

3D models were created from patient's CT image directory of pelvis using Drishti software. This created 3D model enabled us to superimpose right and left hemi-pelvis in order to validate the degree of symmetry between sides. A suite of 3D printing software were used to design and print optimal patient specific fixation plates. We then used the re-stitched fracture model, and further validated with application to the mirrored non-fractured hemi-pelvis.

Conclusions and recommendations

The 3D modelling and printing techniques provide an innovative approach increasing the accuracy in fabricating surgical implants, improving reconstructive surgery and reducing the risk of a second intervention.

Treshold expression of nerve growth factor in cartilaginous tissues in human spine osteoarthritis

By Matthias Seidel (Medical Centre Biel)Nathalie Busso (University Hospital Lausanne)Thomas Hügle (University Hospital Lausanne)

Abstract Id: 5651
Event: EORS 2019
Topic: Spine

Introduction
Recent clinical studies on targeting nerve growth factor (NGF) in chronic low back pain and knee osteoarthritis have demonstrated efficient pain reduction in a short-term treatment regimen. However, the increased risk for the development of rapid progressive osteoarthritis at the required high drug dose remains a serious concern and prompts thorough analysis of the tissue distribution and role of NGF in degenerative musculoskeletal disorders. Here, we sought to investigate tissue distribution of NGF, its high affinity receptor TrkA and CD68-positive macrophages in human facet joint osteoarthritis of the lumbar spine.

Goal
Facet joint specimens (n=10) were harvested by facetectomy from patients undergoing elective lumbar intervertebral spine fusion. Facet joint osteoarthritis and presence of synovitis was graded using preoperative magnetic resonance imaging. Tissue distribution of NGF, TrkA and CD68 was determined using immunohistochemistry. Tissue degradation was graded on safranin-O-stained tissue sections. Association between imaging parameters and tissue distribution was determined using Pearson correlation analysis.

Method

Results
Synovitis was present in 6 cases and facet joints displayed moderate to severe radiological osteoarthritis (median Weishaupt grade; 2 [1.5-3]). NGF was expressed in 8 of 10 specimens. NGF was expressed in connective tissue, articular and fibrocartilage, but not bone tissue. Cartilaginous NGF expression was predominantly found in the extracellular matrix of superficial cartilage tissue with complete loss of proteoglycans, chondrocyte death and structural damage (fissures). Loss of cartilage proteoglycan staining alone did not display NGF immunoreactivity. NGF expression was not correlated with radiological osteoarthritis severity or presence of synovitis. NGF high affinity receptor TrkA was exclusively expressed in bone marrow tissues. Differential grades of bone marrow infiltration by CD68-positive macrophages were observed, yet these were not associated with NGF expression.

Conclusions and recommendations
Targeting NGF in chronic low back pain and/or facet joint osteoarthritis might affect pathomechanisms in cartilaginous tissues and NGF signaling in the bone marrow compartment.

Licochalcone A-induced apoptosis through activating p38 MAPK mediated mitochondria-apoptotic pathways in human osteosarcoma cells

By Renn-Chia Lin (Institute of Medicine, Chung Shan Medical University, Taichung, Taiwan) Yi-Hsien Hsieh (Institute of Biochemistry, Microbiology and Immunology, Chung...
Abstract Id: 5649
Event: EORS 2019
Topic: MSC’s

Introduction

Osteosarcoma is the most common malignant bone tumor. Complete radical en bloc resection is generally the typical treatment. However, the high metastatic ability of osteosarcoma and the five-year survival rate for patients with metastasis has essentially remained high at approximately 20%. New, effective, less-toxic, cost-effective natural compounds could be useful as novel anti-cancer therapeutics. Licochalcone A (LicA) has wide spectrum of pharmacological activities and is a flavonoid isolated from the famous Chinese medicinal herb Glycyrrhiza uralensis Fisch. In the present study, we investigated the anti-cancer effects and potential mechanisms of LicA in human osteosarcoma cell lines.

Goal

Cell viability was measured by the MTT [3-(4,5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide] assay with various concentrations of LicA (0, 20, 40, 60, 80, and 100 μM) on human osteosarcoma U2OS, HOS, 143B and MG-63 cell lines. The various concentration of LicA (0, 20, 40, and 60 μM) were chosen for the subsequent studies. The cell cycle was determined by flow cytometry after propidium iodide (PI) stain. Flow cytometric analysis was performed on cells co-stained with annexin V and PI to detect apoptosis in U2OS and HOS cells. The levels of apoptosis-related protein, including caspases and Bax/Bcl-2 family, were examined by Western blot analysis. Western blot analysis was performed to determine whether LicA could induce the activation of MAPK (mitogen-activated protein kinases) cascades including JNK, ERK and p38 MAPK in human osteosarcoma cell lines. All experiments were repeated at least three times. Statistical analysis was performed with one-way analysis of variance (ANOVA) followed by student’s t-test. The values of P < 0.05 were considered statistically significant.

Method

Results

LicA decreased cell viability and induced apoptosis in a dose-dependent manner in human osteosarcoma cells. LicA inhibited osteosarcoma cells growth by induced cell cycle arrest at sub G1 in U2OS and HOS cells and induced apoptosis. In addition, LicA induced caspase-3, caspase-9 activation and poly-ADP-ribose polymerase (PARP) cleavage, which displayed features of apoptotic signals. LicA-induced apoptosis was blocked by a caspase inhibitor, Z-VAD. LicA-induced apoptosis accompanies mitochondrial dysfunction in U2OS and HOS cells by the imbalance of Bax/Bcl-2 leading to the activated process of caspase-9. TUDCA can protect U2OS cells from LicA-induced apoptosis. Phosphorylated p38 MAPK was specifically activated in LicA-induced apoptotic pathway. BIRB 796 (p38 MAPK inhibitor) and p38 MAPK siRNA can prevent U2OS cells from LicA-induced apoptosis.

Conclusions and recommendations
These data provide few evidences that LicA has the potential to be used in the treatment of human osteosarcoma.

Biocompatibility and absorption behavior in vitro of direct printed porous iron implants

By Prathyusha Pavanram (Anatomy and Cell Biology, University Hospital RWTH Aachen, Germany) Yageng Li (Department of Biomechanical Engineering, Delft University of Technology, The Netherlands) Karel Lietaert (3D Systems – LayerWise NV, Grauwmeer 14, Leuven 3001, Belgium and KU Leuven Department of Materials Engineering, Kasteelpark Arenberg 44, Leuven 3001, Belgium)

Abstract Id: 5647
Event: EORS 2019
Topic: Biomaterials

Introduction

Direct metal printed (DMP) porous iron implants possess promising mechanical and corrosion properties for various clinical applications[1]. Nevertheless, there is a requirement for better co-relation between in vitro and in vivo corrosion and biocompatibility behaviour of such biomaterials[2]. Our present study evaluates absorption of porous iron implants under both static and dynamic conditions. Furthermore, this study characterizes their cytocompatibility using fibroblastic, osteogenic, endothelial and macrophagic cell types.

Goal

In vitro degradation was performed statically and dynamically in a custom-built set-up placed under cell culture conditions (37ºC, 5% CO2 and 20% O2) for 28 days. The morphology and composition of the degradation products were analyzed by scanning electron microscopy (SEM, JSM-IT100, JEOL). Iron implants before and after immersion were imaged by μCT (Quantum FX, Perkin Elmer, USA). Biocompatibility was also evaluated under static and dynamic in vitro culture conditions using L929, MG-63, HUVEC and RAW 264.7 cell lines. According to ISO 10993, cytocompatibility was evaluated directly using live/dead staining (Live and Dead Cell Assay kit, Abcam) in dual channel fluorescent optical imaging (FOI) and additionally quantified by flow cytometry. Furthermore, cytotoxicity was indirectly quantified using ISO conform extracts in proliferation assays, (Promega, CellTiter 96® AQueous One Solution Cell Proliferation Assay G3580).

Method

Results

Strut size of DMP porous iron implants was 420 ± 4 μm, with a porosity of 64% ± 0.2% as measured by μCT. After 28 days of physiological degradation in vitro, dynamically tested
samples were covered with brownish degradation products. They revealed a 5.7-fold higher weight loss than statically tested samples, without significant changes in medium pH. Mechanical properties (E = 1600–1800 MPa) of these additively manufactured implants were still within the range of the values reported for trabecular bone, even after 28 days of biodegradation. Less than 25% cytotoxicity at 85% of the investigated time points was measured with L929 cells, while MG-63 and HUVEC cells showed 75% and 60% viability, respectively, after 24 h, with a decreasing trend with longer incubations. Cytotoxicity was analyzed by two-way ANOVA and post-hoc Tukey's multiple comparisons test. Under dynamic culture conditions, live-dead staining and flow cytometric quantification showed a 2.8-fold and 5.7-fold increase in L929 and MG-63 cell survival rates, respectively, as compared to static conditions.

Conclusions and recommendations

Therefore, rationally designed and properly coated iron-based implants hold potential as a new generation of absorbable Orthopaedic implants.

The effects of knee meniscectomy on the development of osteoarthritis in the patellofemoral joint 40 years following meniscectomy

By Ioannis Pengas (Royal Cornwall Hospitals, UK) William Nash (Guys and St Thomas' Hospital, London, UK) Angelos Assiotis (Guys and St Thomas' Hospital, London, UK)

Introduction

Most knee osteoarthritis and meniscectomy studies focus on osteoarthritis in the tibiofemoral joint and ignore the patellofemoral joint. This study aims to assess the long term effects of total meniscectomy on the patellofemoral joint. To our knowledge, this is the only study of osteoarthritis in the patellofemoral joint following meniscectomy that extends to a 40 year follow up period.

Goal

Twenty-two patients with osteoarthritis were evaluated at a mean of 40 years post-meniscectomy using standardised weight-bearing radiographs of the operated and non-operated knees. Patellofemoral joint osteoarthritis was diagnosed by the presence of osteophytes and joint space narrowing to less than 5mm. Kellgren and Lawrence scores were calculated from the radiographs. Patellofemoral joint osteoarthritis and tibiofemoral joint
osteoarthritis were correlated with International Knee Documentation Committee scores and range of movement measurements.

Method

Results

A significant difference was observed between the operated and non-operated knees in terms of patellofemoral joint osteophyte formation. There was a significant difference in tibiofemoral joint Kellgren and Lawrence scores, International Knee Documentation Committee scores and range of movement measurements between knees with lateral facet patellofemoral joint space of 5mm.

Conclusions and recommendations

An osteoporotic osteoarthritis phenotype is prevalent in prematurely ageing mitochondrial DNA mutator mice

By Jeroen Geurts (University Hospital Lausanne) Sonia Nasi (University Hospital Lausanne) Ulrich Walker (University Hospital of Basel)

Abstract Id: 5642
Event: EORS 2019
Topic: Bone

Introduction

Mitochondrial dysfunction has been demonstrated in aging and osteoarthritic tissues. We investigated knee joints of prematurely aging mitochondrial DNA mutator mice (PolgD275A) to evaluate a relationship between mitochondrial dysfunction and osteoarthritis.

Goal

Cartilage damage was evaluated using OARSI histopathology grading and osteoclast numbers were quantified by tartrate-resistant acid phosphatase staining in wild type, heterozygous and homozygous PolgD275A mice. Subchondral cortical plate and epiphyseal trabecular bone structures were determined by micro-computed tomography. Apoptosis in cartilage and subchondral bone tissues was studied using an indirect TUNEL method.

Method

Results
Homozygous mutants displayed osteopenia of the epiphyseal trabecular bone and subchondral cortical plate in comparison to wild type and heterozygous mutants. Subchondral osteopenia was associated with a strong increase of osteoclast numbers (0.88±0.30/mm bone perimeter) compared to heterozygous (0.25±0.03/mm) and wild type mice (0.12±0.04/mm). Wild type mice as well as hetero- and homozygous mutants displayed low-grade cartilage degeneration (OARSI grade ≤ 1) due to loss of cartilage proteoglycans. In contrast, chondrocyte hypertrophy was more abundant in the homozygous mice. There were no differences in chondrocyte apoptosis rates between groups.

Conclusions and recommendations

Prematurely ageing mtDNA mutator mice with or without further mechanic or metabolic stimuli might serve as a valuable model for further experimental studies on aging-induced osteoporotic OA phenotype.

Displacement of sequential syndesmotic ankle injuries assessed by a 3D Weightbearing CT – A Cadaveric Analysis

By Anthony Cossement (BMSc)Nicola Krähenbühl (MD, Orthopedic Surgeon)Arne Burssens (MD, Orthopedic Surgeon)

Abstract Id: 5640
Event: EORS 2019
Topic: Biomechanics

Introduction

Introduction/Purpose: Diagnosis of syndesmotic ankle injuries in absence of frank tibiofibular diastasis remains challenging. This can be attributed to current imaging modalities, which are either limited by superposition or try to quantify a 3D displacement using 2D techniques [1]. Goal: Our aim is two-fold: (1) to determine displacement of sequential syndesmotic ankle injuries under various amounts of load using a 3D weightbearing CT (WBCT) and (2) to assess the relation with previous 2D imaging techniques.

Goal

Seven paired male cadaver specimens were included (tibia plateau to toe-tip) and mounted into a custom-built frame. WBCT scans were obtained to generate 3D models after different patterns of axial load (0kg, 85kg) combined with external torque (0N, 10T). These were repeated each time after an intact condition of the syndesmotic ligaments, sequential trans sectioning of the anterior inferior tibiofibular ligament (AITFL), deltoid ligament (DL), and interosseous membrane (IOM). Computer Aided Design (CAD) operations were used to establish reference anatomical landmarks relative to the intact position of the fibula, which allowed to quantify displacement [2]. A Cartesian coordinate system was defined based on the
tibia. Statistical analysis was performed using a linear mixed model analysis. A subsequent correlation analysis was performed between the 2D and 3D measurements.

Method

Results

Torque caused significant displacement in all directions (P<0.05). The highest displacement consisted of external rotation (mean=7.2 degrees; 95%CI -9.5,-4.8; Fig 1a-b) and posterior translation (mean=4.8mm; 95%CI -5.9,-3.7) after IOL sectioning combined with torque. Weightbearing increased lateral translation significantly (mean=-0.8mm; P

Conclusions and recommendations

The clinical relevance of these findings could improve diagnosis by incorporating rotatory platforms during imaging and treatment strategies by providing appropriate stabilization against rotation.

Evaluation of proprioception in subjects before and after total knee arthroplasty

By Barone Giuseppe (Department of Biomedical and Neuromotor Sciences, University of Bologna, Italy) Zati Alessandro (Functional Recovery and Rehabilitation – IRCCS – Istituto Ortopedico Rizzoli, Bologna, BO, Italy) Ferraresi Riccardo (Functional Recovery and Rehabilitation – IRCCS – Istituto Ortopedico Rizzoli, Bologna, BO, Italy)

Abstract Id: 5632
Event: EORS 2019
Topic: Arthroplasty

Introduction

Proprioception is one of the most significant factors in balance, joint stability, coordination and injury prevention. It includes a wide set of neural input that bring information from peripheral mechanoreceptors, located within joints, muscles and tendons, to central nervous system. Generally, proprioception is defined as the ability to sense position of a joint in the space. Total knee arthroplasty (TKA) is the gold standard procedure to treatments of severe gonarthrosis, which aims to alleviate the pain, restore the locomotor function and increase patient satisfaction. Even if osteoarthritis has already altered proprioception abilities, the TKA procedure can furtherly affect proprioceptors. Some studies demonstrated that TKA slightly improved the kinaesthesia and balance. Other researchers, differently, did not observe any improvement.

Goal
The aim of this study is to evaluate proprioception and postural control in subject with TKA, before and after the surgery, using Delos Postural Proprioceptive System (DPPS; Delos, Turin, Italy).

Method

A cohort of 11 subjects (6 women and 5 men) were involved in the study. Subjects were aged 67.1±4.9, had primary knee osteoarthritis, and were scheduled for TKA. DPPS was used to assess proprioception and postural control before and after the surgery. The two tests considered to evaluate postural and proprioceptive control were stabilometric test and static Riva test. The parameters taken into account for these tests were the Stability Index (SI; percentage score where 100% is a theoretical task performed with maximum stability), Autonomy (AU; percentage score based on hands support during tasks) and Postural Instability (PI; score in degree based on movement of trunk).

Results

All subject were assessed a month before the surgery and 4 month after surgery. The SI measured during the single stance test improved from 58.8%±23.1 to 73.2%±17.2 with opened eyes and decreased from 37.3%±10.9 to 33.0%±10.6 with closed eyes in the operated limb. PI measured during the double stance test increased of 0.10° with opened eyes and decreased of 0.10° with closed eyes. AU improved from 71.4% to 86.9% with open eyes and slightly decreased with closed eyes (from 47.2% to 44.6%).

Conclusions and recommendations

In TKA, mechanoreceptors of the knee are sacrificed, this should result in a drop of the proprioceptive information with respect to healthy knee, and consequently there is a decreased of balance and increased of risk of falls. The proprioceptive system is more stimulate during instability situation, for example in poorly lighting places or in restricted movement condition.

Can a medially stabilized TKA design approach a natural knee kinematics?

By Laura Bragonzoni (Department for Quality of Life, University of Bologna, Italy)Umberto Cardinale (Department of Biomedical and Neuromotor Sciences, University of Bologna, Italy)Marco Bontempi (II Orthopaedic and Traumatologic Clinic, IRCCS, Istituto Ortopedico Rizzoli, Bologna, Italy)

Abstract Id: 5629
Event: EORS 2019
Topic: Biomechanics

Introduction
Physiological kinematics is very difficult to restore after total knee arthroplasty (TKA). A new model of medial stabilized (MS) TKA prosthesis has a high spherical congruence of the internal compartment, which guarantees anteroposterior stability (AP) associated with a flat surface of the insert in the lateral compartment, that allows a greater AP translation of the external condyle during knee flexion. The aim of our study is to evaluate, by dynamic radiostereometric analysis (RSA), the in vivo kinematics of the knee after the implantation of a MS prosthesis during sit to stand and lunge movements. To describe the in vivo kinematics of the knee after MS Fixed Bearing TKA (GMK Sphere(TM) Medacta International AG, Castel San Pietro, Switzerland) using Model Based dynamic RSA.

Goal

A cohort of 18 patients (72.1 ± 7.4 years old) was evaluated by dynamic RSA 9 months after TKA. The kinematic evaluation was carried out using the dynamic RSA tool (BI-STAND DRX 2), developed at our Institute, during the execution of sit to stand and lunge movements. The kinematic data were processed using the Grood and Suntay decomposition and the Low Point method. The patients performed two motor tasks: a sit-to-stand and a lunge. Data were related to the flexion angle versus internal-external, varus-valgus rotations and antero-posterior translations of the femur with respect to the tibia.

Method

Results

During the sit to stand, the kinematic analysis showed the presence of a medial pivot, with a significantly greater (p=0.0216) anterior translation of the lateral condyle (3.9 ± 0.8 mm) than the medial one (1.6 ± 0.8 mm) associated with a femoral internal rotation (4.5 ± 0.9 deg). During the lunge, in the flexion phase, the lateral condyle showed a larger posterior translation than the medial one (6.2 ± 0.8 mm vs 5.3 ± 0.8 mm) associated with a femoral external rotation (3.1 ± 0.9 deg). In the extension phase, there is a larger anterior translation of the lateral condyle than the medial one (5.8 ± 0.8 mm vs 4.6 ± 0.8 mm) associated with femoral internal rotation (6.2 ± 0.9 deg). Analyzing individual kinematics we also found a negative correlation between clinical scores and VV laxity during sit to stand (R= -0.61) and that the higher femoral extra-rotation, the poorer clinical scores (R= 0.65).

Conclusions and recommendations

The finding of outliers in the VV and IE rotations analysis highlights the importance of a correct soft tissue balancing in order to allow the prosthetic design to manifest its innovative features.

Histone Demethylase UTX Protects Against Glucocorticoid-Induced Osteogenesis Loss and Osteoporosis

By Yu-Shan Chen ()Wei-Shiung Lian ()Feng-Sheng Wang ()
Abstract Id: 5627
Event: EORS 2019
Topic: Bone

Introduction

Chronic glucocorticoid use causes osteogenesis loss, accelerating the progression of osteoporosis. Histone methylation is shown to epigenetically increase repressive transcription, altering lineage programming of mesenchymal stem cells (MSC). This study is undertaken to characterize the action of histone demethylase UTX to osteogenic lineage specification of bone-marrow MSC and bone integrity upon glucocorticoid treatment.

Goal

Bone-marrow MSC were incubated in osteogenic medium containing supraphysiological dexamethasone. Osteogenic gene expression and mineralized nodule formation were probed using RT-PCR and von Kossa staining. The enrichment of trimethylated lysine 27 at histone 3 (H3K27me3) in Dkk1 promoter was quantified using chromatin immunoprecipitation-PCR. Bone mass and trabecular morphometry in methylprednisolone-treated skeletons were quantified using microCT analysis.

Method

Results

Supraphysiological dexamethasone decreased osteogenic genes Runx2 and osteocalcin expression and mineralized matrix production along with reduced UTX expression in MSC. Forced UTX expression attenuated the glucocorticoid-mediated loss of osteogenic differentiation, whereas UTX knockdown provoked osteogenesis loss and cytoplasmic oil overproduction. UTX demethylated H3K27 and reduced the glucocorticoid-mediated the H3K27 enrichment in Dkk1 promoter, reversing β-catenin signal, but downregulating Dkk1 production by MSC. In vivo, treatment with UTX inhibitor GSK-J4 significantly suppressed bone mineral density, trabecular volume, and thickness along with porous trabecular, fatty marrow and disturbed β-catenin/Dkk1 histopathology comparable with glucocorticoid-induced osteoporosis condition.

Conclusions and recommendations

This study offers a productive insight into how UTX protects MSC from methylated histone-mediated osteogenesis repression in the development of glucocorticoid-induced osteoporosis.

Engineered extracellular matrix enhances the bone regeneration potential of aged human bone marrow stromal cells

Abstract Id: 5625
Event: EORS 2019
Topic: Bone

Introduction

Regeneration of bone defects in elderly patients is limited due to the decreased function of bone forming cells and compromised tissue physiology. Previous studies suggested that the regenerative activity of stem cells from aged tissues can be enhanced by exposure to young systemic [1] and tissue microenvironments [2]. The aim of our project was to investigate whether extracellular matrix (ECM) engineered from human induced pluripotent stem cells (hiPSCs) can enhance the bone regeneration potential of aged human bone marrow stromal cells (hBMSCs).

Goal

ECM was engineered from hiPSC-derived mesenchymal-like progenitors (hiPSC-MPs), as well as young (70 years) hBMSCs. ECM structure and composition were characterized before and after decellularization using immunofluorescence and biochemical assays. Three hBMSCs of different ages were cultured on engineered ECMs. Growth and differentiation responses were compared to tissue culture plastic controls.

Method

Results

Decellularized ECMs contained collagens type I and IV, fibronectin, laminin and < 5% residual DNA. Cultivation of young and aged hBMSCs on the hiPSC-ECM in osteogenic medium significantly increased hMSC growth and markers of osteogenesis, including collagen deposition, alkaline phosphatase activity, bone sialoprotein expression and matrix mineralization compared to plastic controls. In aged BMSCs, matrix mineralization was only detected in ECM cultures in osteogenic medium. Comparison of ECMs engineered from hiPSC-MPs and hBMSCs of different ages suggested similar structure, composition and potential to enhance osteogenic responses in aged BMSCs.

Conclusions and recommendations

Compositional analysis of urine immersed nephrostomy catheters

By M. Fernández-Grajera (1 University of Extremadura, Department of Applied Physics, Badajoz, Spain. 2 University Institute of Biosanitary Research of Extremadura (iNube), Badajoz, Spain. 3 Networking Research Center on Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), Badajoz, Spain.) M. Hierro-Oliva (3 Networking Research Center on Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), Badajoz, Spain. 1 University of Extremadura, Department of Applied Physics, Badajoz, Spain. 2 University Institute of Biosanitary Research of Extremadura (iNube), Badajoz, Spain.) L. Fernández-de Alarcón (4 Department of Radiodiagnosis, University Hospital Infanta Cristina, Badajoz, Spain.)

Abstract Id: 5622
Event: EORS 2019
Topic: Biomaterials

Introduction

Percutaneous nephrostomy catheters (NC) are devices to treat obstructive uropathy.1 NCs are usually manufactured with silicone, polyurethane or mixtures of them.2 Also, Barium is typically used as radiomarker, being incorporated in bulk material or a mark line. Observation of used NC shows that catheters frequently appear degraded after contact with urine. In this research we are analyzing compositional modifications of NC after immersion in artificial urine, using the X-ray photoelectron spectroscopy (XPS) technique.

Goal

Nephrostomy catheters used were Multipurpose Drainage Catheters, from Cook Medical Company (IN, U.S.A.). They were immersed in synthetic urine3 at pH 5.5, 7.2 and 9.3, at 40° C for two months. The surface chemical composition was evaluated by XPS, with a K-Alpha (ThermoScientific). Analysis of the synthetic urine after immersion was done by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) with an Agilent 7900 ICP-MS system (Agilent Technologies).

Method

Results

XPS spectra of non-used NC shows carbon, hydrogen, silica and Barium. In the catheters removed appears, in addition to the elements of the catheter composition, nitrogen and also other elements present in food, drugs and urine composition of the patients. Differences were found in the amounts of superficial barium between used, unused and immersed catheters in artificial urine. The amount increases in the first and last case, and is nil. But the XPS spectrum shows amounts of Barium in the bulk of the unused catheter.

Conclusions and recommendations
After two months in synthetic urine, the elementary composition of the surface and bulk of the catheters have the presence of elements own of the synthetic urine. Also, radiomarker barium migrates in a significant amount from the NC to the surrounding fluid.

The adhesive behaviour of Staphylococcus aureus under diabetic model environment.

By M. Fernández-Grajera (1 University of Extremadura, Department of Applied Physics, Badajoz, Spain. 2 University Institute of Biosanitary Research of Extremadura (iNube), Badajoz, Spain.) A.M. Gallardo-Moreno (1 University of Extremadura, Department of Applied Physics, Badajoz, Spain. 2 University Institute of Biosanitary Research of Extremadura (iNube), Badajoz, Spain.) M.A. Pacha-Olivenza (4 University of Extremadura, Department of Biomedical Sciences, Badajoz, Spain. 3 Networking Research Center on Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), Badajoz, Spain.)

Abstract Id: 5620
Event: EORS 2019
Topic: Infection

Introduction

In prosthetic infections Staphylococcus aureus is one of the most harmful. The attachment and growth of this bacteria on titanium surfaces are associated with complications like prosthesis’s loss or osteomyelitis. [1] Diabetes mellitus is a chronic disorder that leads to hyperglycemia and ketoacidosis. According to WHO, was the seventh leading cause of death in 2016. [2] Hyperglycemia is a factor of risk and comorbidity. It compromises healing, osseointegration or vascularization and could promote infection incidences. [3,4] Biofilms formation starts with the approach and attachment of planktonic bacteria to the implant surface and the surface physical properties of both, substratum and bacterium control this moment. These properties include hydrophobicity and zeta potential. Changes in these properties due to anomalous glucose concentration and/or ketone-bodies could negatively influence the prosthesis's success and could help in the understanding on how diabetes influences biofilm formation on prosthesis devices. [5] Then, from this perspective it could be proposed some implant surface modification that inhibit the closer contact between bacteria and the host biomaterial. This work explores the effect of hyperglycemia and ketoacidosis on the surface physical properties (hydrophobicity and zeta potential) of S. aureus and on its adhesion behavior to one of the titanium alloy commonly used in osseous substitution, Ti6Al4V.

Goal

Bacteria were growth in glucose-free TSB medium supplemented with different concentrations of glucose, ketone-bodies and a combination of both. The effect was studied
by supplementing, in different experimental, the growth medium and/or the adhesion buffer. Hydrophobicity was quantified trough the MATH test. The electrical surface charge was analyzed in terms of zeta potential. Bacterial adhesion experiments were performed in phosphate buffer supplemented with each concentration for 60 min. The density of bacteria on the Ti6Al4V was carried out with an epifluorescence microscope.

Method

Results

Under hyperglycemia and ketoacidosis bacterial adhesion increased, except for high ketone-bodies concentration (p>0.05). Figure 1 shows the variation of the adhesion in the treatments. The bacterial adhesion increased except for a combination of both with pathological concentrations, with only the growth is supplemented. Figure 2 shows the rise in hydrophobicity in the bacterial wall with different supplements. Also, glucose increases the negative charge on the surface, against ketone-bodies. The same effect is observed when combining glucose with ketone-bodies, indicating the predominant effect of ketones.

Conclusions and recommendations

Glucose and ketone-bodies alter the surface physical properties and adhesive behavior of S. aureus to Ti6Al4V. Hydrophobicity and surface charge are more altered in presence of high concentration of ketone-bodies than in high concentrations of glucose. Revealing how complex is the system created by hyperglycemia and ketoacidosis, depending not only on the concentration of these compounds, but also on the moment they are present.

A rapid and accurate method for the quantification of neurite outgrowth from cell and tissue cultures: Two image analytic approaches using adaptive thresholds or machine learning

By Alexander Ossinger (Uppsala university)

Abstract Id: 5619
Event: EORS 2019
Topic: Imaging

Introduction

Assessment of axonal outgrowth and dendritic development are essential readouts when studying peripheral nerve regeneration in tissue cultures of spinal cord and dorsal root ganglia, as well as dissociated neuron cultures. Available analysis software are either based on the assessment of fixed immunolabeled tissue samples or image analysis of unstained cultures
using global thresholding. That makes it impossible to follow the dynamic development of neurite outgrowth on the one hand, and difficult to analyse images with varying background intensity on the other hand. The aim of this study was to develop automated algorithms that efficiently analyse phase-contrast images, such as those obtained during time-lapse microscopy.

Goal

We developed algorithms to quantify neurite outgrowth from unstained, living spinal cord slice cultures (SCSCs) and dorsal root ganglion cultures (DRGCs) based on an adaptive thresholding approach we named “NeuriteSegmentation”. For evaluation of dendritic development in dissociated neuron cultures we chose a machine learning approach using ilastik and CellProfiler. Neurite density and length was measured in pixels in SCSCs and DRGCs, output variables in dissociated neuron cultures were total cell count and ramification index. A total number of 10 SCSCs, 10 DRGCs and 8 wells with neuron cultures were analysed using the novel algorithms. The results were validated by using already established methods i.e. the plugin NeuriteJ based on global thresholding and manual count of cells.

Method

Results

NeuriteSegmentation successfully recognized axons in phase-contrast images of SCSCs and DRGCs (Figure 1). In dissociated neuron cultures the total number of cells and their dendritic outgrowth were successfully assessed using machine learning (Figure 2). Assessment of SCSCs showed a significant correlation compared to NeuriteJ (r²=0.5; p=0.025) as well as to manual measurements (r²=0.6; p=0.005). Analysis of DRGCs showed a significant correlation to NeuriteJ both regarding axonal density (r²=0.6, p=0.006) and maximal axonal length (r²=0.7, p=0.004). No linear correlation could be found in assessment of dissociated neuron cultures with machine learning compared to manual counts, however, analysis using Bland-Altman method did not show a statistically significant bias regarding total cell count (p=0.84) and ramification index (p=0.72). NeuriteSegmentation had a performing time of 40 seconds per SCSC or DRGC. Analysis with NeuriteJ was performed in 15 minutes for one SCSC and in 4 minutes for one DRGC. Image analysis of dissociated neuron cultures took about 30 seconds per image using machine learning and up to one hour with manual assessment.

Conclusions and recommendations

These tools may prove valuable in the quantitative analysis of axonal and dendritic outgrowth.

MECHANOREGULATIVE COMPARISON OF CONVENTIONAL AND 3D-PRINTED SILICONE

By Alexandra Zühlke (Aalto University Foundation)Michael Gasik (Aalto University Foundation)Nihal Engin Vrana (Protip Medical SAS)
Introduction

There is a growing trend to use 3D printing as the manufacturing method for prostheses, since it enables the personalization of the device. Medical grade silicone is often used in medical devices and can be manufactured using 3D printing. It is known that the microstructure and topology of porous layers are different from similar conventional materials made by moulding. In this way, the mechanical properties are also varied. Here we are analysing the effect of additive manufacturing on different silicone specimens during representative loading scenarios.

Goal

The mechanical tests were conducted using a dynamic mechanical analysis (DMA). In general DMA is used to characterize properties of a material as a function of time, temperature, frequency or a combination of these three parameters.

Method

Results

We show that under three-point free bending and compression the production method has a significant effect on the properties (i.e. modulus) of medical grade silicone.

Conclusions and recommendations

As 3D printing is generalizing as the production method for personalized implant, its effect on the materials mechanical properties should be studied. According to our DMA measurements it has a great significance on the mechanical properties of medical grade silicone samples measured in this study. This change in mechanical behaviour should be taken into consideration while moving from traditional production methods to additive manufacturing.

IDENTIFICATION OF PROMOTER REPORTERS TO MONITOR JOINT HOMEOSTASIS IN OSTEOARTHRITIS

By M. Neefjes (Experimental Rheumatology, Department of Rheumatology, Radboud University Medical Centre) B.A.C. Housmans (Laboratory for Experimental Orthopedics, Department of Orthopedic Surgery, Maastricht University) G.G.H. van den Akker (Laboratory for Experimental Orthopedics, Department of Orthopedic Surgery, Maastricht University)
Introduction

Intrinsic repair of articular cartilage was considered unattainable, but recent developments have demonstrated that it can be achieved in certain patients (Kuchuk et al, Ann Rheum Dis, 2015). However, it remains to be elucidated why this is a patient-specific process. There is a growing body of literature on the influence of tissue microenvironment on repair capacity of stem cells (Jayasuriya CT et al, Ann N Y Acad Sci, 2016). Here, we hypothesize that a major determinant for successful repair is the intra-articular microenvironment; being permissive or non-permissive for repair. In order to predict the outcome of cartilage repair therapy, it is crucial to establish a method to discriminate between permissive and non-permissive articular joint microenvironments. Therefore, our goal is to develop a rapid bioassay that will be able to discriminate between permissive and non-permissive joint conditions to support cartilage repair.

Goal

The human IL6 promoter (hIL6) (-600 till +78) and the human IL8 promoter (hIL8) (-572 till +100 bp) sequences were cloned in the pNL1.2 vector (Promega). H11 chondrocytes were cultured and stimulated with OA synovium-conditioned medium (OAs-cm) from six individual donors. Messenger RNA levels of IL6, IL8 were determined by RT-qPCR and normalized to GAPDH and RPS27A. In parallel, promoter reporter constructs were introduced by transient transfection in H11 chondrocytes and SW1353 cells. Transfected cells were stimulated for 8 hours with either OAs-cm or OA synovial fluid from end-stage OA patients undergoing joint replacement surgery (pool of 24 donors). Ethics for use of patient material are in place.

Method

Results

Stimulation with OAs-cm from different patients resulted in up-regulation of IL6 and IL8 gene expression in H11 chondrocytes. Interestingly, large heterogeneity was observed in the response of both IL6 and IL8 gene expression between the OAs-cm from distinct patients (Fig. 1A). Both genes revealed similar response patterns: OAs-cm donors 2, 3 and 6 showed a slight increase in gene expression of 16-32 fold differences, whereas OAs-cm donors 1, 4, and 5 demonstrated a ±33,000 fold change induction (IL6) and a ±2000 fold induction (IL8). In addition, stimulation of promoter reporter activity in H11 chondrocytes with the same OAs-cm showed comparable responses (Fig 1B). Finally, OA synovial fluid showed activation of IL6 and IL8 promoter reporters in SW1353 cells (Fig 1C).

Conclusions and recommendations

Further research will aim at investigating additional suitable promoter sequence candidates for bioassay development. Additionally, synovial fluid inter-patient responses for IL6, IL8, and other candidates will be evaluated for repair predictability using clinical outcomes.
OA synovial fluid induces proliferation and dedifferentiation of non-OA human articular chondrocytes

By B.A.C. Housmans (Laboratory for Experimental Orthopedics, Department of Orthopedic Surgery, Maastricht University) G.G.H. van den Akker (Laboratory for Experimental Orthopedics, Department of Orthopedic Surgery, Maastricht University) D.A.M. Surtel (Laboratory for Experimental Orthopedics, Department of Orthopedic Surgery, Maastricht University)

Abstract Id: 5616
Event: EORS 2019
Topic: Cartilage

Introduction

One of the main characteristics of osteoarthritis is cartilage degradation. Synovial fluid is in direct contact with articular cartilage and other joint tissues, functioning as a source of nutrients and morphogens. Synovial fluid plays a crucial role in regulating cartilage homeostasis and repair (Vasara AI, et al, 2009) and alterations in the synovial fluid composition have been associated with adverse effects on cartilage integrity and function (Barreto G, et al, 2018). The present study aimed to investigate the phenotypic changes of non-OA chondrocytes when cultured for an extended period of time with synovial fluid derived from end-stage OA patients.

Goal

A pool of Human Articular Chondrocytes (HACs) from four non-OA donors was cultured for two days in the presence of 10% (v/v) OA synovial fluid (OA-SF) (pool of 24 donors, mean age = 60) or 10% (v/v) synovial fluid (pool of 8 donors, mean age = 57) derived postmortem from macroscopically unaffected knees. Cells were formalin fixed and stained with DAPI/Hoechst33342 for DNA quantification. HACs were cultured for thirteen days in the presence of 10% (v/v) OA-SF or 10% (v/v) fetal bovine serum. Media were refreshed every day. Every second day cells were fixated and harvested for DNA quantification and RNA isolation. Expression of chondrocyte marker genes was determined by RT-qPCR. Gene expression was normalized to PPIA. Full ethics for use of HACs and SF are in place.

Method

Results

Proliferation was significantly increased by OA-SF compared to non-OA synovial fluid after two days stimulation (Fig. 1A). In addition, chondrocyte proliferation was monitored for thirteen days and was strongly induced by OA-SF (Fig. 1B). In the first days both serum and OA-SF induced proliferation, followed by a proliferation halt in the presence of serum, while OA-SF supported continuous induction of chondrocyte proliferation until day 13. Gene expression of cartilage extracellular matrix-related COL2A1 (Fig. 1C) and COMP, was
specifically downregulated by OA-SF. PRG4 expression was decreased over time for both OA-SF as well as serum. Unexpectedly, ACAN expression was maintained in both conditions. Similar to COL2A1 and COMP expression dynamics, expression of the key regulator of chondrocyte homeostasis, SOX9, was strongly downregulated by OA-SF. Expression of dedifferentiation-associated genes COL1A1 (Fig. 1D) and COL3A1 remained stable over time. Genes related to chondrocyte hypertrophy were either stable or downregulated by OA-SF over time compared to t=0. Furthermore, gene expression of inflammatory markers demonstrated variable responses over time after OA-SF exposure.

Conclusions and recommendations

The current study demonstrates that SF from end-stage knee OA patients induces a profound change in the chondrocyte phenotype, favoring dedifferentiation over a chondrogenic or hypertrophic phenotype. Further work will establish whether the OA-SF-induced changes in vitro can be reproduced in an ex vivo model.

Evaluation of viability and functionality of an ex vivo bone defect model for applications in bone tissue engineering and regenerative medicine

By R. Hassan (Dept. of Experimental Trauma Surgery, Dept. of Trauma and Orthopedic Surgery, University Medical Center Schleswig-Holstein, Campus Kiel) T. Klüter (Dept. of Experimental Trauma Surgery, Dept. of Trauma and Orthopedic Surgery, University Medical Center Schleswig-Holstein, Campus Kiel) A. Rasch (Dept. of Experimental Trauma Surgery, Dept. of Trauma and Orthopedic Surgery, University Medical Center Schleswig-Holstein, Campus Kiel)

Abstract Id: 5615
Event: EORS 2019
Topic: Bone

Introduction

Critical bone defects still remain a challenging issue for the treating surgeon. Currently, the grafting of autologous cancellous bone derived from the iliac crest remains the gold standard. The shortcomings of the biologically-derived bone grafts and the increasing demand for bone repair materials constitute the main driving forces for the continuous search of synthetic bone graft substitutes. Up to now these approaches are usually tested in vitro or in vivo for their regenerative performance. The aim of this study was to establish a novel ex-vivo bone defect model based on vital bone tissue slices to investigate the potential of bone substitute materials or bioactive compounds in order to support bone regeneration and vascularization.

Goal
Femoral heads derived from patients undergoing total hip replacement surgery were cut into cylinders of 20 mm diameter and a bone defect of 6 mm was drilled centrally. These bone defect models were cultured for 28 days. Medium was changed every third day and determined for lactate dehydrogenase (LDH) and alkaline phosphatase (ALP). On day 28 cells in the bone slices were lysed in 1% Triton X-100 and tested for LDH. After staining with Calcein-AM, Hoechst and propidium iodide fluorescence microscopy and confocal microscopy (CLSM) images were taken after 7 and 28 days of culture. In addition the DNA amount in bone tissue biopsies was quantified at different time point to monitor cell survival in the slices. Finally, collagen-1 gel was injected into the bone defect and was investigated 14 days later using CLSM, DNA quantification at different time points and qPCR for the presence of SPP1, RUNX2, COLA1, BGLAP and ALPL in relation to isolated mesenchymal stem cells (MSC) after osteogenic differentiation.

Method

Results

LDH levels in the supernatants of the bone slices increased during the first 7 days and decreased significantly afterwards. After day 28 bone cells were lysed with Triton-X to assure viability of remaining cells in the bone tissue. The LDH levels raised significantly, after this lysing step thus demonstrating persisting viability. ALP assay showed high concentrations in the first 7 days, followed by a significant decrease up to day 28. Fluorescence and CLSM images of bone defect models demonstrated increasing number of vital cells over culture time. This was also confirmed by DNA quantification and the DNA increase in bone slice biopsies samples. CLSM of collagen plugs in the defects documented a high number of vital and elongated cells which migrated into the center of the gel. DNA quantification of harvested collagen at different time points (7 and 14 days) gel show increase over time indicating a progressive invasion of cells into the defect. qPCR analysis of invaded cells indicated a typical osteogenic gene expression profile SPP1, RUNX2, COLA1, BGLAP and ALPL in comparison to mesenchymal stem cells.

Conclusions and recommendations

Consequently, the bone defect model showed viability and self-regeneration potential enabling to evaluate different treatment strategies in bone replacement such as using hydrogels for instance.

Quantifying bone remodeling around the uncemented acetabular component using a modified scoring system of DeLee and Charnley.

By Sander C van Eijck (Maastricht University) Deborah Husmann (Maastricht University) Jacobus J Arts (Maastricht University)
Abstract Id: 5613  
Event: EORS 2019  
Topic: Imaging

Introduction

Implant stability is an important factor for adequate bone remodeling and is crucial in the long-term clinical survival of total hip arthroplasty (THA). Open metal structure uncemented acetabular components are frequently used in THA. There is scarce literature regarding the local bone remodeling processes in association with clinical performance. Describing bone remodeling processes in detail and comparing designs is difficult due to the lack of a quantitative scoring system for plain radiographs. Therefore an osseointegration scoring system based on the adapted DeLee and Charnley zones for plain radiographs is introduced.

Goal

In a retrospective, single centre cohort study patients whom underwent primary THA with a Pinnacle Gription 100 acetabular component were included. X-ray images were made at 3 and 12 months post-operatively and reviewed by two reviewers. We divided the original 3 DeLee and Charnley zones (1-2-3) into 2 producing 6 zones (1A to 3B) (Figure 1). Each of the 6 zones was divided into 4 equally sized segments. Full bone implant contact in one segment resulted in 25 points for that segment. The observation of radiolucency was considered absence of bone implant contact resulting in 0 points for that segment. Full bone implant contact in all four segments resulted in the maximum score of 100 points per zone. The total of each zone was added together, resulting in a total score with a maximum of 600 points when there was full bone implant contact in all zones. The total score was divided by 6 to calculate outcome score in percentages. A percentage of 100% means optimal bone implant contact and 0% represents no visible bone contact around the acetabular rim. The paired T-test was used to determine a significant increase between different time-points. In order to determine inter- and intra-observer reliability the weighted Kappa coefficient was used.

Method

Results

Between 2016 and 2017, 119 Patients (145 acetabular components) had a primary Total Hip Replacement (THR). Total radiological outcome scores increased significant (p

Conclusions and recommendations

Plain radiographs are important for a reliable introduction of a new implant. This method makes the assessment more reliable and allows better comparisons between designs.

The role of magnetic actuation in IL-1B conditioned tendon cells cultured onto magnetic responsive biomaterials
Introduction

Inflammation plays a key role in tendon tissue healing. Persistently increased inflammatory cytokine levels have been associated to tendon degeneration and/or scar tissue formation upon injury and therefore may provide a target for assisting new therapeutic strategies. However, the molecular and cellular mechanisms involved are poorly understood requiring further insights. In previous studies, we showed that magnetic actuation modulates the behaviour of tendon cells exposed to IL-1β, a pro-inflammatory cytokine, and that magnetically actuated membranes could hold immunomodulatory properties in a rat ectopic model [1].

Goal

In this work, we envision to explore the synergistic action of magnetic actuation and magnetic responsive starch and polycaprolactone membranes incorporating magnetic nanoparticles (magSPCL) in hTDCs conditioned to an IL-1β treatment.

Method

Since IL-1β supplementation stimulates pro-inflammatory signals on tendon cells, which can be modulated by exposure to a magnetic with 5Hz, 4mT, 50%DC, as defined in our previous work, we hypothesized that the response to IL-1β could influence tendon cells via NFκB pathway and that magSPCL membranes could modulate the cytokine production, providing insights on the mechanisms of tendon pathogenesis as well as on potential solutions for improved therapies.
Results

Results demonstrate that magSPCL membranes have a modulatory effect on the inflammatory profile of IL-1B conditioned hTDCs through the IL1R1/NFkB pathway. The analysis of gene expression by RT-PCR showed that both IL1R1 and NFkB decrease in tendon cells cultured in magSPCL membranes under magnetic actuation. Moreover, immunodetection assays showed an increment in signal intensity of NFkB in the nucleus of cells stimulated with IL-1B, likely suggesting the activation of NFkB, in comparison to a cytoplasmic location of this protein in cells after exposure to PEMF.

Conclusions and recommendations

Overall, magnetic responsive membranes demonstrated potential in guiding the inflammatory profile of hTDCs with influence over the NFkB pathway, which highlights a potential beneficial role of magnetic actuation and the applicability of magnetic actuated therapies for tendon healing approaches in an inflammatory context. ACKNOWLEDGEMENTS: FCT (PD/BD/ 128089/2016), Doctoral Program TERM (PD/59/ 2013), NORTE-01-0145-FEDER-000021, H2020 under the TEAMING Grant agreement No. 739572-The Discoveries CTR, MagTendon No. 772817, Achilles No. 810850. Thank to Hospital da Prelada (Porto, Portugal) for providing tendon samples. References [1] Santos, L. et al, Nanomedicine, 2016, p. 1107-1122

Design of 3D printed scaffolds mimicking the natural features of healthy bone

By Giorgia Montalbano (POLITECNICO DI TORINO) Giulia Molino (POLITECNICO DI TORINO) Federica Banche Niclot (POLITECNICO DI TORINO)

Abstract Id: 5608
Event: EORS 2019
Topic: Biomaterials

Introduction

Bone tissue engineering is a promising strategy to treat the huge number of bone fractures caused by progressive population ageing and diseases such as osteoporosis. The design of bioactive and biomimetic materials able to direct and modulate cell behaviour can support the regeneration of healthy bone tissue. In this frame, type I collagen and hydroxyapatite (HA) have been often combined to produce biomimetic scaffolds. In addition, mesoporous bioactive glasses (MBGs) are known for their ability to promote the deposition of HA nanocrystals and their potential to incorporate and release therapeutic ions. Furthermore, the use of 3D printing technologies enables the effective design of scaffold reproducing the natural bone architecture.

Goal
This study aims at designing biomimetic and bioactive 3D printed scaffolds able to mimic the natural features of healthy bone tissue in terms of chemical composition, topography and biochemical cues. Optimised collagenous hybrid systems will be processed by means of extrusion 3D printing technologies with the aim to obtain high resolution bone-like structures. Protocols of human co-cultures of osteoblasts and osteoclasts will be developed and used to test the 3D scaffolds.

Method

Type I collagen has been combined with rod-like nano-HA and strontium containing MBGs (micro- and nano-sized particles) in order to obtain hybrid systems resembling the composition of native bone tissue. A comprehensive rheological study has been performed in order to investigate the potential use of the hybrid systems as biomaterial inks. Mesh-like structures have been obtained by means of extrusion-based technologies exploiting the freeform reversible embedding of suspended hydrogels (FRESH) approach. Different crosslinking methods have been tested to improve the mechanical properties of the final constructs. Both crosslinked and non-crosslinked biomaterials have been cultured in presence of human osteoblasts and osteoclasts to prove the biocompatibility of the hybrid matrix as well as its influence on cell behaviour.

Results

Homogeneous hybrid systems have been successfully developed and characterised, proving their suitability as biomaterial inks for 3D printing technologies. Mesh-like structures have been extruded in a thermo-reversible gelatin, exploiting the sol-gel transition of the systems under physiological conditions. Covalent bonds between collagen molecules have been promoted through genipin treatment, leading to a significant increase in the strength and stability of the matrix. The collagen methacrylation and the further crosslinking via UV light are under investigation as alternative promising method to reinforce the 3D structure during the printing process. Biological tests showed the potential of the developed systems especially for genipin treated samples, with a significant adhesion of primary cells.

Conclusions and recommendations

The collagenous hybrid systems proved their suitability for the design of bioactive 3D printed structures for bone tissue engineering. The multiple stimuli provided by the scaffold composition and structure will be investigated on both direct and indirect co-culture of human osteoblasts and osteoclasts, according to the developed protocols. This project has received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement No 681798-BOOST).
CANAL: PRE-AND POSTOPERATIVE ANALYSIS

By Sophie Leroy (Department of Neurosurgery, BG Klinikum Bergmannstrost Halle, Germany) Neha Agarwal (Department of Neurosurgery, BG Klinikum Bergmannstrost Halle, Germany) Zorica Buser (Department of Orthopaedic Surgery, Keck School of Medicine, University of Southern California, CA 90033, USA)

Abstract Id: 5607
Event: EORS 2019
Topic: Spine

Introduction

Low back pain is a chronic and common condition with few inexpensive and effective therapies. One of the pathophysiological mechanism behind the chronic back pain is intervertebral disc degeneration and subsequent compression of nerve roots and blood vessels in the spinal canal, caused by the narrowing of intraspinal space. The total back pain costs are estimated at 50 billion Euros approximately, 2.2% of the German GDP. Taking a look at these numbers makes the importance of an efficient pain reduction therapy evident. The conservative management of chronic low back pain primarily consists of physiotherapy, pain medication, non-steroidal anti-inflammatory drugs or mild narcotic analgesics. Microsurgical operation techniques have been developed to alleviate the patient’s back and leg pain. The aim of the study was to evaluate the preoperative, and postoperative 7-day and 6-month outcomes after dorsal-microsurgical decompression of the lumbar spinal canal.

Goal

A case series of 24 patients suffering from spinal canal stenosis who had undergone a decompression surgery between May 2017 and June 2018 at the BG Klinikum Bergmannstrost Halle in Germany were identified from the AOSpine DegenPRO multicenter prospective observational registry.

Method

The outcome of the surgery was evaluated using five standard patient-reported outcome (PRO) questionnaires preoperatively, and at 7 days and 6 months postoperatively: VAS-BP (Back pain), VAS-LP (Leg pain), ODI, EQ-5D-3L, and SF-36v2. Score changes at the different time points were evaluated using the Wilcoxon signed rank test with a significance level of 0.05.

Results

Preoperative and follow-up data for 21 patients was analyzed at 7-day and at 6-month follow-up, except SF-36 questionnaire for which data was collected only for 18 patients. 3 patients were lost during follow-up: 1 patient died after 6 months postoperative and 2 patients did not complete the follow-up. The outcome scores after a mean time of 5.6 (±1.5) days compared with preoperative scores significantly improved for VAS-BP -3.34 (±1.7), VAS-LP -4.57
(±2.6), ODI -8.05 (±15.1), EQ-5D -1.67 (±1.4), VAS-EQ-5D +8.43 (±14.1) and SF-36 +10.16 (±10.7). After a mean time of 7.5 (±3) months, the overall scores compared to baseline improved as well for VAS-BP -3.05 (±2.2), VAS-LP -4.48 (±2.6), ODI -19.76 (±16.2), EQ-5D -2.34 (±1.7), VAS-EQ-5D +7.77 (±18.1) and SF-36 +18.72 (±17.2). No intraoperative adverse events occurred. Postoperative adverse events were reported in four patients: 1 presented with a local hematoma, 1 with known reflux esophagitis vomited, 1 with recurrent disc herniation at the same level and 1 with a deep wound infection of grade 4.

Conclusions and recommendations

Pain, pain-related disabilities, quality of life and subjective health assessment are improved at seven days after microsurgical decompression of the lumbar spinal canal. After six months solely the pain-related disabilities further reduced.

Treatment of Osteochondral Defects of the Knee using bilayered scaffold-free constructs in rats

By Luis Freitas Mendes (KULeuven and Prometheus) Kathleen Bosmans (KULeuven and Prometheus) Marina Maréchal (KULeuven and Prometheus)

Abstract Id: 5604
Event: EORS 2019
Topic: Cartilage

Introduction

Joint surface restoration of deep osteochondral defects represents a significant unmet clinical need. Moreover, untreated lesions lead to a high rate of osteoarthritis1. The current strategies to repair deep osteochondral defects such as osteochondral grafting or “sandwich” strategies combining bone autografts with ACI/MACI fail to generate long-lasting osteochondral interfaces. Herein, we investigated the capacity of juvenile Osteochondral Grafts (OCGs) to repair osteochondral defects in skeletally mature animals. With this regenerative model in view, we set up a new biological, bilayered, and scaffold-free Tissue Engineered (TE) construct for the repair of the osteochondral unit of the knee.

Goal

Skeletally immature (5 weeks old) and mature (11 weeks old) Lewis rats were used. Cylindrical OCGs were excised from the intercondylar groove of the knee of skeletally immature rats and transplanted into osteochondral defects created in skeletally mature rats. To create bilayered TE constructs, micromasses of human periosteum-derived progenitor cells (hPDCs) and human articular chondrocytes (hACs) were produced in vitro using chemically defined medium formulations. These constructs were subsequently implanted orthotopically in vivo in nude rats. At 4 and 16 weeks after surgery, the knees were collected and processed
for subsequent 3D imaging analysis and histological evaluation. Micro-computed tomography (μCT), H&E and Safranin O staining were used to evaluate the degree of tissue repair.

Method

N/A

Results

Our results showed that the osteochondral unit of the knee in 5 weeks old rats exhibit an immature phenotype, displaying active subchondral bone formation through endochondral ossification, the absence of tidemark, and articular chondrocytes oriented parallel to the articular surface. When transplanted into skeletally mature animals, the immature OCGs resumed their maturation process, i.e., formed new subchondral bone, partially established the tidemark, and maintained their Safranin O-positive hyaline cartilage at 16 weeks after transplantation. The bilayered TE constructs (hPDCs + hACs) could partially recapitulate the cascade of events as seen with the immature OCGs, i.e., the regeneration of the subchondral bone and the formation of the typical joint surface architecture, ranging from non-mineralized hyaline cartilage in the superficial layers to a progressively mineralized matrix at the interface with a new subchondral bone plate.

Conclusions and recommendations

Cell-based TE constructs displaying a hierarchically organized structure comprising of different tissue forming units seem an attractive new strategy to treat osteochondral defects of the knee.

Local non-viral gene delivery to immunomodulate and enhance fracture healing

By M.A. Gomez-Sierra, W.A. Lackington, M. Alini, K. Thompson (AO Research Institute Davos, Switzerland)

Introduction

Although 80% of fractures typically heal without any problems, there is a small proportion (}
microenvironment, thereby promoting a more favorable healing environment to enhance fracture repair. Our approach involves the local delivery of nanoparticles complexing the non-viral vector polyethyleneimine (PEI) with therapeutic plasmid DNA (pDNA) encoding for IL-1Ra.

**Method**

pDNA encoding green fluorescent protein and Gaussia luciferase were used as reporter genes to determine the transfection efficiency of both rat and human MSCs using flow cytometry and to assess the transgene expression profile using a luciferase expression assay. The effect of transfection with PEI on the viability of MSCs was assessed using the metabolic assay Cell Titer Blue and dsDNA quantification. Levels of IL-1Ra produced by cells following transfection with nanoparticles encoding IL-1Ra was assessed using enzyme-linked immunosorbent assays (ELISA). HEK-Blue IL-1β reporter cells, which secrete alkaline phosphatase in response to IL-1β stimulation, were used to confirm that the IL-1Ra produced by transfected cells is functionally active, i.e. the successful antagonism of IL-1β bioactivity. Ultimately, our aim is to incorporate our optimized non-viral IL-1Ra gene delivery nanoparticles into collagen-nanohydroxyapatite scaffolds and confirm that transfection of MSCs in a complex 3D microenvironment can produce bioactive IL-1Ra.

**Results**

We've determined that using PEI-based nanoparticles we can achieve a transfection efficiency of 14.8 ± 1.8% in rat MSCs. Transgene expression was found to be transient, with a peak in expression at 7 days post-transfection and a gradual decrease over time, which was maintained for up to 4 weeks. Using an optimized concentration of PEI, the impact of the nanoparticles on MSC viability was limited, with no significant difference in cellular metabolic activity compared to non-transfected cells at 10 days post-transfection. We have additionally demonstrated the capacity to successfully transflect both rat and human MSCs with pDNA encoding for IL-1Ra, resulting in enhanced levels of IL-1Ra, which is functionally active.

**Conclusions and recommendations**

Non-viral gene therapy is a promising strategy for local delivery of immunomodulatory genes to prevent non-union and enhance bone fracture healing.

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**Improvement of the mesenchymal stem cell injection process into a non-union by a specially designed injection device**

By Lina Nießen (Clinic for orthopaedic and trauma surgery, University Medical Centre Schleswig-Holstein, Lübeck, Germany)Till Elsner (University of Lübeck)Klaus Waizner (Clinic for orthopaedic and trauma surgery, University Medical Centre Schleswig-Holstein, Lübeck, Germany)
Abstract Id: 5598
Event: EORS 2019
Topic: MSC's

Introduction

Every year 30.4 million people suffer from a fracture of long bone and in 5% - 20% of these cases a non-union occurs. In contrast to the treatment of hypertrophic non-unions, by stabilisation of the fracture ends, the treatment of atrophic non-unions is more complex, as the bone healing has to be initiated. The classical procedure is the use of autologous bone grafting. Usually, the necessary bone tissue is harvested from the anterior or posterior iliac crest. This additional intervention is associated with pain and other risks for the patient. Therefore, a less invasive treatment is desirable. One field of research is the use of mesenchymal stem cells (MSC) to initiate the bone healing. MSC are promising for cell-based therapy strategies due to their ability to self-renew and their high differentiation potential in different tissues like osteogenic, adipogenic and chondrogenic tissues.

Goal

Currently, there are clinical trials using stem cells to stimulate the bone healing in a non-union. In these trials trephines are used to inject the stem cell product. Originally, trephines were developed for biopsies taken from the bone and have therefore some disadvantages for the injection process. For these reasons a new injection device and a test setup to investigate the vitality after injection were developed.

Method

The focus during the development process was improvement of the handling of the device, because the used trephines are usually too long and inconvenient for the procedure, rendering exact positioning difficult and the exact injection into the fracture gap is not guaranteed. Therefore, an ergonomic handle was designed to facilitate the correct positioning in the non-union and a depth limiter was designed above the cannula to allow the surgeon to adjust the penetration depth of the cannula into the bone. Another part of major importance of the device is the cannula. Until now it is unclear if the injection process of stem cells through the cannula influences the vitality of the cells depending on the volume flow.

Results

The novel injection device overcomes the disadvantages of the current injection process by an ergonomically designed handle, which allows precise control of the device. The extended length of the device enables the surgeon to place and evaluate the needle without exposure to the main radiation field. The developed test setup ensures a constant volume flow into a tubular capillary, which has a flow resistance comparable to a non-union, thus leading to comparable forces acting on cell membranes in a test sample. Initial trials of the setup showed its capability to provide precise volume flows, enabling cell viability evaluation of the MSC after injection.

Conclusions and recommendations
An improved device for injection of MSCs into non-unions, as well as an test setup for cell viability evaluation after the injection process have been developed. Initial trials indicate the test setup is capable of producing constant volume flows enabling further research of cell viability evaluation. The useability of the injection device is subject to future experimental runs including a variety of different medical surgeons.

Evaluation of bone allograft processing methods: Impact on decellularization efficacy, biocompatibility and mesenchymal stem cell functionality

By A. Rasch (Dept. of Experimental Trauma Surgery, Dept. of Trauma and Orthopedic Surgery, University Medical Center Schleswig-Holstein, Campus Kiel) T. Klüter (Dept. of Experimental Trauma Surgery, Dept. of Trauma and Orthopedic Surgery, University Medical Center Schleswig-Holstein, Campus Kiel) H. Naujokat (Dept. of Experimental Trauma Surgery, Dept. of Trauma and Orthopedic Surgery, University Medical Center Schleswig-Holstein, Campus Kiel, Dept. of Oral and Maxillofacial Surgery, University Medical Center Schleswig-Holstein, Campus Kiel)

Abstract Id: 5597
Event: EORS 2019
Topic: Bone

Introduction

While autologous bone grafting still prevails as the gold standard, allografts and xenografts present viable alternatives with promising results. Physiochemical properties of a graft strongly depend on the processing method such as the decellularization protocol. In addition, the physiochemical characteristics are critical factors for a successful integration of the graft after the implantation and might influence mesenchymal stem cell (MSC) function in therapeutical approaches combining grafts and autologous MSCs. Several decellularization methods have been proposed, however it still remains unclear which method results in favorable physiochemical properties or might be preferred in stem cell applications.

Goal

In the first part of this study we compare two decellularization approaches based on either chemical treatment with Triton X-100 and sodium dodecyl sulfate, creating chemically processed allografts (CPAs), or treatment using sonication, creating sonication-based processed allografts (SPAs). Decellularized grafts were evaluated by histology, SEM, DNA quantification and EDX spectroscopy.

Method
In addition, the impact of these allografts on MSC functionality was compared including two commercially available grafts, Tutoplast® (TPAs) and Bio-Oss® (BPXs) as references. Extraction medium was generated from the differently processed grafts and tested in terms of biocompatibility using MSCs and MTS (3-(4,5-dimethylthiazol-2-yl)-5-(3-carboxymethoxyphenyl)-2-(4-sulfophenyl)-2H-tetrazolium) assessment. Finally, grafts were reseeded with MSCs and examined by confocal microscopy and SEM. Additionally, DNA levels, alkaline phosphatase activity and Alizarin Red S was quantified after 1, 7 and 14 days of cultivation.

Results

Histological examination and SEM examination showed SPAs to be void of tissue in marrow cavities while CPAs retained tissue. DNA quantification showed high values for CPAs, suggesting incomplete decellularization, while amounts for SPAs were significantly lower compared to CPAs and un-decellularized controls. EDX analysis showed no significant difference in Ca/P ratios, however BPXs showed the highest calcium values and TPAs the highest nitrogen values compared to all other grafts. Biocompatibility testing based on extraction medium indicated a high cell viability for TPAs extracts while all other grafts showed a reduced biocompatibility in relation to untreated controls. After reseeding with MSC, cells on SPAs and TPAs showed elongated morphology and prominent cell growth in SEM and CLSM. At the same time MSC-seeded TPAs showed the highest significant increase of DNA in a two-week time frame. BPXs on the other hand showed the highest tentative yet non-significant increase ALP activity normalized to the DNA content and the highest increase in normalized Alizarin Red S levels, suggesting osteogenic activity of cells on these grafts. Whereas TPAs indicated a comparable osteogenic activity for non-normalized data.

Conclusions and recommendations

Commercial Tutoplast® allografts showed overall the best effects on MSC functionality as indicated by extraction biocompatibility testing as well as by comparing proliferation and osteogenic differentiation.

Single injection of recombinant human bone morphogenetic protein-2-loaded artificial collagen-like peptide accelerates consolidation and bone union at the docking site in a mouse segmental bone transport model

By Ryo Tazawa (Department of Orthopaedic Surgery, Kitasato University School of Medicine)
Introduction

Segmental bone transport (SBT) using an external fixator is currently a standard treatment for large-diameter bone defects at the donor site with low morbidity. However, long-term application of the device is needed for bone healing. In addition, patients who received SBT treatment sometimes fail to show bone repair and union at the docking site, and require secondary surgery. The objective of this study was to investigate whether a single injection of recombinant human bone morphogenetic protein 2 (rhBMP-2)-loaded artificial collagen-like peptide gel (rhBMP-2/ACG) accelerates consolidation and bone union at the docking site in a mouse SBT model.

Goal

Six-month-old C57BL/6J mice were reconstructed by SBT with external fixator that has transport unit, and a 2.0-mm bone defect was created in the right femur. Mice were divided randomly into four treatment groups with eight mice in each group, Group CONT (immobile control), Group 0.2mm/d, Group 1.0mm/d, and Group BMP-2. Mice in Group 0.2mm/d and 1.0mm/d, bone segment was moved 0.2 mm per day for 10 days and 1.0 mm per day for 2 days, respectively. Mice in Group BMP-2 received an injection of 2.0 μg of rhBMP-2 dissolved in ACG into the bone defect site immediately after the defect-creating surgery and the bone segment was moved 1.0 mm/day for 2 days.

Method

All animals were sacrificed at eight weeks after surgery. Consolidation at bone defect site and bone union at docking site were evaluated radiologically and histologically.

Results

At the bone defect site, seven of eight mice in Group 0.2mm/d and two of eight mice in Group 1.0mm/d showed bone union. In contrast, all mice in Group CONT showed nonunion at the bone defect site. At the docking site, four of eight mice in Group 0.2 mm/d and three of eight mice in Group 1.0 mm/d showed non-union. Meanwhile, all mice in Group BMP-2 showed bone union at the bone defect and docking sites. Bone volume and bone mineral content were significantly higher in Group 0.2mm/d and Group BMP-2 than in Group CONT. HE staining of tissue from Group 0.2mm/d and Group BMP-2 showed large amounts of longitudinal trabecular bone and regenerative new bone at eight weeks after surgery at the bone defect site. Meanwhile, in Group CONT and Group 1.0mm/d, maturation of regenerative bone at the bone defect site was poor. Differences between groups were analyzed using one-way ANOVA and a subsequent Bonferroni's post-hoc comparisons test. P < 0.05 was considered significant.

Conclusions and recommendations

rhBMP-2/ACG combined with SBT may be effective for enhancing bone healing in large bone defects without the need for secondary procedures.
Lipid Profiles in Hoffa’s Fat Pad of Osteoarthritic vs Osteochondral Defect Patients

By Mirella J.J. Haartmans (Department of Orthopedic Surgery, Maastricht UMC+, Maastricht, the Netherlands & Maastricht MultiModal Molecular Imaging (M4I) institute, Division of Imaging Mass Spectrometry, Maastricht University, Maastricht, the Netherlands)Berta Cillero-Pastor (Maastricht MultiModal Molecular Imaging (M4I) institute, Division of Imaging Mass Spectrometry, Maastricht University, Maastricht, the Netherlands)Kaj S. Emanuel (Department of Orthopedic Surgery, Maastricht UMC+, Maastricht, the Netherlands)

Abstract Id: 5583
Event: EORS 2019
Topic: Imaging

Introduction

Early detection of knee osteoarthritis (OA) is critical for possible preventive treatment, such as weight loss, physical activity and sports advice and restoring biomechanics, to postpone total knee arthroplasty (TKA). Specific biomarkers for prognosis and early diagnosis of OA are lacking. Therefore, in this study, we analyzed the lipid profiles of different tissue types within Hoffa’s fat pad (HFP) of OA and cartilage defect (CD) patients, using matrix-assisted laser desorption ionization (MALDI) mass spectrometry imaging (MSI). The HFP has already been shown to play an important role in the inflammatory process in OA by prostaglandin release. Additionally, MALDI-MSI allows us to investigate on tissue lipid distribution at molecular level, which makes it a promising technique for the detection of disease specific biomarkers for OA development.

Goal

Samples of HFP were obtained from patients undergoing surgical treatment for OA (n=3) (TKA) or CD (n=3) (cartilage repair). In all cases, tissue was obtained without patient harm.

Method

HFP samples were washed in phosphate buffered saline (PBS) and snap-frozen directly after surgical dissection to remove redundant blood contamination and to prevent as much tissue degradation as possible. Tissue sections were cut at 15 μm thickness in a cryostat (Leica Microsystems, Wetzlar) and deposited on indium tin oxide glass slides. Norharmane (Sigma-Aldrich) matrix was sublimed onto the tissue using the HTX Sublimator (HTX Technologies, Chapel Hill). μMALDI-MSI was performed using Synapt G2Si (Waters) at 50 μm resolution in positive ion mode. MS/MS fragmentation was performed for lipid identification. Data were processed with in-house Tricks for MATLAB and analyzed using principle component analysis (PCA) and discriminant analysis (DA). LipidMaps was used for lipid assignments.
Results

OA and CD HFP specific lipid profiles were revealed by MALDI-MSI followed by PCA and DA. With these analysis we were able to distinguish different tissue types within HFP of different patient groups (figure 1A and B). Further discriminant analysis showed HFP intra-tissue heterogeneity with characteristic lipid profiles specific for connective and adipose tissues (figure 1C), but also for synovial tissue and blood vessels, revealing the high molecular complexity of this tissue. As expected, lipid signals were lower at the site of the connective tissue, compared to the adipose tissue. In particular, tri-acyl glycerol, di-acyl glycerol, sphingomyelin and phosphocholine species were differently abundant in the adipose tissue of HFP of OA compared to CD (figure 1D).

Conclusions and recommendations

MALDI-MSI technology for HFP lipid identification might be of great use for OA biomarker discovery.

Pixel Value Score Prior to Frame Removal in Tibial Lengthening

By Ari Demirel (Aalborg University Hospital)Markus Winther Frost (Aalborg University Hospital)Søren Kold (Aalborg University Hospital)

Abstract Id: 5582
Event: EORS 2019
Topic: Imaging

Introduction

The regenerative potential of bone is enormous, and it is possible to lengthen limbs by bone distraction. However, there remains a major risk of fracture after lengthening the bone. Previous studies have described how the pixel value ratio may be used for determining the time for frame removal.

Goal

The aim of this study was to investigate the intrarater and the interrater reliability of pixel value scores from radiographs in tibial lengthening prior to frame removal. Moreover, the study aimed to determine the overall number of X-rays obtained during circular frame treatment.

Method

Retrospective study. Patients treated with tibial lengthening by a circular frame at Aalborg University Hospital from January 1st 2000 to December 31st 2017 and a minimum of 12 months after frame removal were included. The bone was divided in proximal-, regenerate- and distal bone zone. These 3 zones were in AP x-ray divided in an anterior and posterior
zone and in sagittal X-ray medial and lateral zone producing 6 zones in which the pixel value was measured. Pixel value ratio was calculated as: \( \frac{1}{2}(\text{Proximal pixel value} + \text{distal pixel value})/\text{regenerate pixel value} \). Interrater correlations were calculated from measurements obtained by an orthopaedic registrar and an orthopaedic specialist. Intrarater correlation was calculated from repeated measurements obtained by an orthopaedic specialist.

**Results**

Mean duration of circular frame treatment was: 6 (+- 3) months. Median number of x-ray controls during frame treatment were: 9 (+-4). Out of 90 tibial lengthenings it was only possible to measure pixel value in all six areas of interest on 20 lengthenings prior to frame removal. Major reasons for inability to obtain measurements were metal hardware crossing the areas of bone interest on x-rays. The mean (95% confidence intervals) pixel ratios values were: 1) lateral: 0.96 (0.93-1.00); 2) medial: 0.95 (0.92-0.99); 3) anterior: 0.94 (0.90-0.97); 4) posterior: 0.96 (0.93-0.99). The mean (95% confidence intervals) inter rater ICC estimates were: 1) lateral: 0.8 (0.5-0.9); 2) medial: 0.8 (0.4-0.9); 3) anterior: 0.4 (-0.5-0.8); 4) posterior: 0.6 (0.1-0.9). The mean (95% confidence intervals) intra rater ICC estimates were: 1) lateral: 1.0 (0.9-1.0); 2) medial: 1.0 (1.0-1.0); 3) anterior: 0.9 (0.9-1.0); 4) posterior: 1.0 (1.0-1.0). Out of the 20 lengthenings examined one fracture occurred in the bone regenerate after frame removal.

**Conclusions and recommendations**

Prospective studies are warranted to determine whether the pixel value ratio can be used as an indicator for frame removal.

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**Equivalence between digital and paper-based Western Ontario Rotator Cuff index (WORC): a two-way crossover equivalence trial.**

By R.N. Wessel (St. Antonius Hospital)W.M. de Raadt (St. Antonius Hospital)F. Hollman (St. Antonius Hospital)

Abstract Id: 5573
Event: EORS 2019
Topic: Other

**Introduction**

Patient-reported outcome measures are ubiquitous in today's health care and clinical trials. The desire to shift from paper-based to digital administration is becoming more evident. It is not recommended to change the mode of administration without careful consideration, as an outcome tool should only be used in the validated format. It is necessary to first demonstrate that measurement properties remain comparable to the original format.
Goal

Objective: Collecting digital data offers many advantages over paper-and-pencil administration for both the patient and the administrator. It was hypothesized that no difference would exist between the digital and paper-based collected results and that these versions could therefore be considered interchangeable. Aims: To determine whether the digital version of the Western Ontario Rotator Cuff Index (WORC) produces results comparable with the paper-based version of the WORC.

Method

This study concerned a prospective, single center, cross-sectional, equivalence trial with a two-way crossover design. All patients older than 18 years of age with shoulder problems such as osteoarthritis, Sub Acromial Pain Syndrome, rotator cuff or biceps tendon problems or frozen shoulder, were eligible for this study. All patients gave informed consent and completed both paper and digital versions of the WORC. The two assessments were separated by a minimum of 30 minutes. Paired samples t-test was performed to determine the paired differences between the modes of administration. Intraclass correlation coefficients, Bland Altman plots and the limits of agreement were created to analyse the agreement between the paper-based and digital version of the WORC.

Results

A total of 93 patients were included. No significant differences were found between the two modes of administration. The mean paired differences ranged between 0.1 and 2.0 points on a 0-100 scale. The intraclass correlation coefficients ranged between 0.82 and 0.92 which is considered to be good to excellent. The scatter plot and Bland Altman plot of the WORC total scores showed no systematic errors between the modes of administration.

Conclusions and recommendations

The digital version of the WORC produces results comparable with the paper-based version and could therefore be considered interchangeable.

Different answering scales used within the Constant-Murley Score are not interchangeable.

By Freek Hollman (St. Antonius Hospital) W.M. de Raadt (St. Antonius Hospital) N. Wolterbeek (St. Antonius Hospital)

Abstract Id: 5572
Event: EORS 2019
Topic: Other
Multiple versions of the Constant-Murley score (CMS) exist with varying answering scales. The question arises whether the different versions of the CMS can be used interchangeably and if results of studies using different versions are comparable. The purpose of this study was to assess the interchangeability of various existing answering scales within the subjective part of the CMS.

Goal

Objectives: It was hypothesized that the different answering scales of pain, daily work and recreational activity of the CMS were interchangeable and would not influence the total score significantly. In addition, it was expected the inter- and intra-observer measurement of the different answering scales were reliable and comparable. Aims: The primary objective was to determine the interchangeability of different versions of the CMS for shoulder pathology. Secondly, to determine the inter- and intra-observer reliability of the different answering scales.

Method

This study concerned a prospective, cross-sectional trial. Patients older than 18 years of age with shoulder problems were eligible for this study. Six versions of the CMS were prepared with different orders of the answering scales for the measures of pain, occupational ability and recreational activity (verbal and paper based visual analogue scale (VAS), smiley face, numeric rating scale (NRS)). The internal consistency (Cronbach’s alpha) of the various CMS were assessed. Spearman correlation coefficients were calculated to examine the convergent validity. In addition, the intra-observer and inter-observer agreement was assessed (intraclass and interclass correlation coefficients (ICC)).

Results

A total of 93 patients were included. The total scores of the paper based VAS, smiley face score and NRS were 46.9 ± 19.4, 45.2 ± 18.5 and 45.0 ± 18.7 (Cronbach’s α range 0.76-0.79) respectively. Correlations of the total CMS scores of the different versions varied from 0.98 to 0.99. CMS-category versus CMS-smiley face score and CMS-category versus CMS-NRS pain were significantly different, P=0.02 and P=0.01, respectively. The total CMS score did not change significantly. Acceptable inter- and intra-observer reliability was found (ICC: 0.89-0.97, 0.98-0.99; P

Conclusions and recommendations

The different answering options for the CMS subscales pain, occupational ability and recreational activity were not interchangeable. However, with excellent inter- and intra-observer reliability, the total scores were interchangeable.

HETERO SPECIFIC BIVALENT HEAVY CHAIN ONLY ANTIBODIES FOR
TARGETING BMP7 TO OSTEOCHONDRAL LESIONS

By Michelle Koerselman (University of Twente) Xiaobin Huang (University of Twente) Emilie D. Rodrigues (University of Twente)

Abstract Id: 5571
Event: EORS 2019
Topic: Pathology

Introduction

Osteochondral lesions predispose to development of early onset post-traumatic osteoarthritis (PTOA). They pose a challenge to the orthopedic surgeon due to lack of successful interventions that can adequately restore the surface to normal. Growth factor BMP7 is well known for its role in cartilage and bone repair. Therefore, intra-articular injection of BMP7 may be a therapeutic option. However, intra-articular injected BMPs are rapidly cleared and do not preferentially target to the lesion.

Goal

A targeting strategy that directs BMP7 to the lesion can potentially solve this challenge. We hypothesize that engineered bivalent antibodies consisting of genetically fused variable domains of heavy chain only antibodies (VHHs) of which binds to both hydroxyapatite and BMP7 can potentially solve this issue. The aim of this study is to provide proof of concept that such bivalent antibodies can be used for targeting BMP7 to an osteochondral lesion after intra-articular injection.

Method

A highly specific VHH clone against BMP7 (G7) was derived after immunization of Llamas with hBMP7, phage library construction and panning rounds. A VHH clone binding specific to hydroxyapatite (MA10) was derived by using a non-immunized phage library and panning rounds. These VHHs were genetically fused to generate a bivalent VHH (G7-MA10). ELISA and Surface Plasmon Resonance (SPR) were used to assess binding affinity. To confirm biological activity, C2C12 cells were used for osteogenic differentiation and a BMP7 directed increase in alkaline phosphatase (ALP) activity was tested in the presence or absence VHHs. To demonstrate targeting to bone, hydroxyapatite binding VHHs were labeled with a near-infrared label and tail-vein injected in mice followed by non-invasive imaging. Co-injection with BMP7 was used to demonstrate targeting of BMP7 to bone. Specificity of targeting was demonstrated using immunohistochemistry.

Results

Characterization showed that all VHHs have a high affinity and dual binding of G7-MA10 was confirmed. We demonstrate that in the presence of hBMP7 both G7 and G7-MA10 were able to potentiate the induction of ALP. In the mice study (n=2) with non-invasive near-infrared imaging we saw efficient targeting and specific long-term accumulation of the VHHs
in bone in marked contrast to the controls. The presence of the VHHs in bone were confirmed using immunohistochemistry 3 weeks after injection. In the mice study (n=3, randomized) with G7-MA10 injection we saw that, co-injection of BMP7 with G7-MA10 in marked comparison to injection of BMP7 only resulted in accumulation of BMP7 in bone as confirmed using immunohistochemistry. Interestingly, injection of BMP7 24 hours prior to euthanizing showed specific accumulation in conditions with G7-MA10, demonstrating biological activity after 3 weeks.

Conclusions and recommendations

We derived a heterospecific bivalent VHH with dual binding specificity for hydroxyapatite in bone and BMP7. These antibodies accumulate in bone after systemic injection and can target BMP7 to bone. They remain biologically active in bone for at least 3 weeks in mice. We are now testing whether intra-articular injection of these bivalent VHHs specifically target BMP7 to osteochondral lesions. This proof of concept could be a stepping-stone towards developing strategies that target growth factors to the diseased joint.

The 47S pre-rRNA processing cascade of articular chondrocytes is impaired in an in vitro model of osteoarthritis

By A. Chabronova (Laboratory for Experimental Orthopedics, Department of Orthopedic Surgery, MUMC+)G.G.H. van den Akker (Laboratory for Experimental Orthopedics, Department of Orthopedic Surgery, MUMC+)M.M.J. Caron (Laboratory for Experimental Orthopedics, Department of Orthopedic Surgery, MUMC+)

Introduction

Osteoarthritis (OA) is the most common joint disorder and a leading cause of pain and disability among adults. Articular chondrocytes are highly specialized cells with the primary task of producing and maintaining the extracellular matrix (ECM). Ribosomes, large protein-RNA complexes, are necessary to ensure continuous translation of ECM-related mRNAs. In eukaryotes, three out of four ribosomal RNA (rRNA) arise from a single 47S pre-rRNA transcript. Maturation of these rRNAs (18S, 5.8S, and 28S) takes place by a cascade of ribonucleolytic cleavages of the primary 47S transcript.

Goal

Here we hypothesize that protein translational capacity of the articular chondrocytes in OA is impaired due to alterations in the 47S pre-rRNA processing cascade, thus contributing to OA development.
Method

Primary human knee OA articular chondrocytes from four donors (p2, pool, ethics in place) were cultured in DMEM/F12, 10% FCS, 1% P/S and 1% NEAA. Cells were seeded and exposed to knee OA synovial fluid (SF; pool from five donors) for 1-14 days. Expression levels of 47S pre-rRNA processing intermediates, as well as chondrogenic marker genes (COL2A1, ACAN), were measured by RT-qPCR.

Results

To test our hypothesis, we set-up an in vitro model using human primary articular chondrocytes exposed to osteoarthritic SF for 14 days. The expression of chondrogenic marker genes, COL2A1 and ACAN, was evaluated and both were significantly decreased after treatment with osteoarthritic SF. Primers covering selected cleavage sites (01 and 4a) of the 47S transcript were designed in order to evaluate alterations in 47S pre-rRNA processing. In concordance with our hypothesis, we observed a continuous drop in levels of 01, and a progressive increase in 4a intermediate ratios (Fig.1) upon OA SF treatment.

Conclusions and recommendations

In osteoarthritis, the chondrocytes’ environment changes dramatically, resulting in gradual loss of their anabolic phenotype. In line with this, we found a progressive decrease in expression of chondrogenic marker genes in our in vitro OA model. Using our model system we report for the first time changes in 47S pre-rRNA processing dynamics in the context of OA. The observed drop in 01/18S and increase in 4a/5.8S ratio indicates an impairment of the 47S processing cascade and accumulation of unprocessed, immature 5.8S, thus potentially affecting chondrocytes’ ribosome number. Our results suggest that ribosomes are not just passive nanomachines for protein synthesis, but might play a role in OA development and progression. Future experiments will be focused on validation of these findings by northern blotting and on detailed mapping of 47S processing cascade using RNA sequencing.

A highly sensitive multiplex biomarker assay for the early diagnosis of osteoarthritis

By Jan Hendriks (University of Twente)

Introduction

Osteoarthritis (OA) is a debilitating disease that is diagnosed at a late stage when effective treatment options are limited. Early diagnosis could help reduce or reverse progression resulting in large benefits for the patient. Currently, diagnosis by X-Rays occurs when there is
already irreversible damage to the joint. In contrast, biomarkers in the synovial joint fluid could provide a comprehensive early diagnosis of disease progression even before early symptoms are present. However, the complexity and heterogeneity of the disease requires the highly sensitive measurement of multiple classes of relevant OA biomarkers in a broad dynamic range in small volumes of complex fluids. Assays fulfilling these requirements do not yet exist.

**Goal**

Previously, we have demonstrated a multiplex biomarker assay that can measure up to 48 biomarkers with sub pg/ml sensitivity, a broad dynamic range of 7 logarithms and good recovery even in pure synovial fluid. Here, we demonstrate a biomarker panel relevant to diagnose OA at early stage. Pivotal in this panel is the biomarker C3F that could distinguish healthy vs OA from K&L score 0-1 using mass spec. However, ELISAs were not sensitive enough to measure this biomarker in the same samples. This technology in combination with the biomarker panel consisting of C3F together with several inflammatory factors, provides a comprehensive early snapshot of the disease state and can lead to the desired early diagnosis for OA.

**Method**

A biomarker assay based on SPRi with a nanoparticle enhancement cascade was developed. Briefly, specific capture antibodies were spotted on a gold sensor (Ssens), with a maximum of 96 individual spots, and were loaded into the SPRi machine (IBIS MX96). In this assay, samples with biomarkers were led to the sensor and the interactions with the antibodies were measured in real-time, enabling extensive quality control. Subsequently, the signal was enhanced by adding biotinylated detection antibodies, followed by neutravidin and a biotinylated gold nanoparticle resulting in an increase in sensitivity of more than 10000 times.

**Results**

We developed our enhanced SPRi assay for the peptide C3F and reached a limit of detection of 20 fg/ml, well below the physiological level (1 ng/ml). We subsequently added inflammatory markers implicated in early OA development, such as IL-1β, IL-6, TNF-α, and IFN-γ. These markers were measured with high sensitivity (low pg/ml) and broad dynamic range (>5 logs) in multiplex. Spiking experiments in serum and synovial fluid subsequently showed excellent recoveries, even without dilutions. Furthermore intra and inter-assay CVs were

**Conclusions and recommendations**

We have developed a reliable highly sensitive, multiplex assay for the measurement of biomarkers implicated in OA. Currently, we are validating this assay in a small patient cohort. This will result in a validated assay that has a large potential for the early clinical diagnosis of osteoarthritis.

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**Tyrosine kinase inhibitor ALW-41-27 reduces inflammatory markers and**
hypertrophy of human osteoarthritic chondrocytes

By Mauricio N. Ferrao Blanco (Erasmus MC, University Medical Center, Rotterdam, Netherlands)Yvonne M. Bastiaansen-Jenniskens (Erasmus MC, University Medical Center, Rotterdam, Netherlands)Mark G. Chambers (Eli Lilly and Company, USA)

Abstract Id: 5567
Event: EORS 2019
Topic: Cartilage

Introduction

Osteoarthritis (OA) is a chronic joint disease that is characterized by loss of articular cartilage, osteophyte formation and synovial inflammation which lead to pain and physical disability. The exact pathogenesis of OA remains unclear and therapeutic options are limited. Accumulating data suggest that the activation of inflammatory signalling pathways promote chondrocyte hypertrophy leading to the modification and degradation of cartilage extracellular matrix. Therefore, a therapeutic agent that inhibits inflammation and hypertrophy of articular chondrocytes would be a promising disease-modifying OA drug.

Goal

The aim of this study is to identify a novel therapeutic target for OA, associated with chondrocyte hypertrophy and inflammation.

Method

To identify targets, we combined previously published microarray data sets: A microarray from different zones of the growth plate of 14-days old C57BL/6 mouse tibiae, a microarray of articular cartilage of an OA mouse model where the destabilization of the medial meniscus was performed in C57BL/6, and a list of genes associated with inflammatory signalling pathways in mice obtained from UniProt. Finally, a human microarray dataset obtained from OA and healthy articular cartilage was used. Combination of datasets revealed candidate targets. To validate the target, human chondrocytes were isolated from donors who underwent total knee arthroplasty. Passage three chondrocytes were encapsulated in alginate beads and re-differentiated for one week in medium containing 10 ng/mL Transforming Growth Factor (TGF)β. Receptor tyrosine kinase inhibitor, ALW-41-27, with a high selectivity for ephrin receptor A2 (EPHA2) was added during 24 hours at 1 and 10 µM. Cytotoxicity was evaluated by measuring LDH in the culture medium and performing a Live/Dead staining. Nitric oxide (NO) production was quantified in the medium through the Griess reaction. mRNA expression of collagen type 2α1 (COL2A1), collagen type 10α1 (COL10A1), matrix metalloproteinase 1 (MMP1), matrix metalloproteinase 13 (MMP13), and interleukin 6 (IL6) was determined by qPCR.

Results
Cross-checking the three murine datasets, we found nine genes associated with hypertrophy, inflammation, and OA. Out of this list, ephrin receptor A2 (Epha2), a tyrosine kinase receptor, was upregulated in the hypertrophic zone and its expression was higher in OA versus sham mouse articular cartilage and human OA cartilage. EPHA2 activity was inhibited in human chondrocytes in vitro, using the tyrosine kinase inhibitor ALW-41-27. Based on the cytotoxicity assays, the compound did not affect the viability of the cells. Interestingly, we observed a dose-dependent reduction in chondrocyte hypertrophy, based on the expression of the hypertrophic marker COL10A1. To determine the role of EPHA2 in the inflammatory response of chondrocytes, TNF-α was used as an inflammatory stimulus. ALW-41-27 led to a significant decrease in MMP1 and MMP13, genes encoding catabolic enzymes, and IL6, encoding an inflammatory cytokine, as well as the production of the inflammatory mediator NO in the medium.

Conclusions and recommendations

These results identify EPHA2 as a novel target for OA, associated with chondrocyte hypertrophy and inflammation. ALW-41-27 attenuates the hypertrophic differentiation of human chondrocytes and reduces inflammatory markers. This receptor tyrosine kinase inhibitor may constitute a new approach for the treatment of OA.

Injectable gels for cartilage repair: a long-term follow-up study in an equine chondral defect model.

By S.K. Both (University of Twente, Department of Developmental BioEngineering) R.A. Vindas Bolanos (University of Costa Rica) S.M. Cokelaere (Utrecht University, Department of Equine Sciences)

Abstract Id: 5566
Event: EORS 2019
Topic: Cartilage

Introduction

Focal cartilage defects pose a still unresolved, increasing health care problem: If left untreated these defects predispose to the development of early onset osteoarthritis. We have developed an injectable in situ gelating hydrogel that can be applied in an arthroscopic procedure to fill up cartilage defects by simple injection. These hydrogels consist of hyaluronic acid – tyramine and dextran – tyramine conjugates that cross link in an enzymatic, peroxidase-based reaction initiated by non-toxic concentrations of H2O2. During the cross linking reaction the hydrogels co-valently attach to the cartilage resulting in strong bonding and fixation of the hydrogel in the defect.

Goal
To create an injectable hydrogel that can be used to plaster eroded cartilage surfaces and / or to fill up focal cartilage defects in a minimally invasive arthroscopic procedure. The hydrogel should protect the damaged cartilage surface against further cartilage erosion and possess an optimized environment for cartilage regeneration.

Method

We have developed an injectable hydrogel by introducing hydroxyphenyl groups in the backbone of naturally occurring polymers such as dextran, which resembles and normally reside in the extracellular cartilage matrix. This renders an injectable hydrogel which gels in an enzymatic peroxidase mediated reaction initiated by non-toxic concentrations of H2O2. In vivo studies in focal cartilage defect with a duration of 2 weeks and 7 months were performed in an equine joint model. In the 2 week pilot study the defects were only treated with the hydrogel. In the 7 month study defects were created and treated with hydrogel or with the golden standard microfracturing.

Results

The two week study proved that our hydrogel can be easily applied in a minimal invasive, arthroscopically guided procedure. It also revealed that cartilage-like cells migrated into the hydrogel and displayed a chondrocyte-like growth pattern. In the 7 months study the differences in cartilage repair between the hydrogel and the nano-fracture treatment were assessed with the ICRS-II scoring system (blinded n-3). The hydrogel treated joint showed significantly better scores for every ICRS-II criterion except matrix staining. Defects treated with nano-fracture contained mainly fibrous tissue and fibrocartilaginous repair tissue.

Conclusions and recommendations

The clinical and histological outcome of these studies suggest that this hydrogel could provide a clinical effective treatment for the repair of focal cartilage defects.

Is Double Plating Of Displaced Midshaft Clavicle Fractures Advantageous Over Single Plate Fixation?

By Parvan Yanev (AO Research Institute Davos, Davos, Switzerland; University Multiprofile Hospital "N. I. Pirogov", Sofia, Bulgaria) Yavor Pukalski (AO Research Institute Davos, Davos, Switzerland; University Multiprofile Hospital "N. I. Pirogov", Sofia, Bulgaria) Ivan Zderic (AO Research Institute Davos, Davos, Switzerland)

Abstract Id: 5561
Event: EORS 2019
Topic: Biomechanics

Introduction
Displaced midshaft fractures are the most common surgically treated clavicle fractures. However, they are associated with high complication rates after plating due to fixation failure in terms of plate breakage, screw breakage or screw loosening.

**Goal**

The aim of this study was to compare the biomechanical competence of three different plating techniques for fixation of displaced midshaft fractures.

**Method**

Displaced midshaft fractures type 2B according to the Robinson classification were simulated by standardized osteotomy gap in 18 artificial clavicles (Sawbones, Limhamn, Sweden). The specimens were assigned to three groups (n=6) for plating with either superiorly placed Dynamic Compression Plate (Group 1), locked Superior Anterior Clavicle Locking Compression Plate (Group 2), or two non-locked Reconstruction Plates placed superiorly and anteriorly (Group 3). Each specimen was mounted horizontally for mechanical testing under craniocaudal cantilever bending, superimposed with torsion around the shaft axis. The acromial clavicle end was cyclically loaded at 3Hz by means of vertically applied eccentric force between 20N tension and 50N compression along the machine axis over 720000 cycles or until failure occurred. The latter was defined by plate or screw breakage.

**Results**

Initial construct stiffness (N/mm) was 12.53±2.09 in Group 1, 4.19±0.46 in Group 2, and 22.30±4.07 in Group 3. Cycles to failure were 348541±212941 in Group 1, 19536±3586 in Group 2, and 712778±17691 in Group 3. Both these outcomes were significantly higher in Group 3 compared to Group 1 and 2 (p

**Conclusions and recommendations**

Double plating of unstable midshaft clavicle fractures with reconstruction plates seems to provide the highest stability under dynamic loading, when compared to single compression or locked plating, whereas the latter is associated with considerably inferior performance.

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**A patient-specific micro-tissue platform to compare biological properties in vitro to patient outcome for anterior cruciate ligament reconstruction**

By Marc van Vijven (Department of Biomedical Engineering & Institute for Complex Molecular Systems, Eindhoven University of Technology) Joyce Kimenai (Department of Biomedical Engineering, Eindhoven University of Technology) Bart van Groningen (Orthopaedic Center Máxima, Máxima Medical Center, Eindhoven/Veldhoven)
Introduction

The anterior cruciate ligament (ACL) does not heal upon rupture. Therefore, reconstructive surgery is often a prerequisite to restore knee stability for return to previous activity levels. The hamstring autograft is the most widely used graft for ACL reconstruction. Despite overall good results, ACL re-rupture occurs in up to 10% of the patient population, increasing to 30% of the cases for patients aged under 20 years. Animal and human biopsy studies showed that the graft’s mechanical strength decreases due to tissue remodeling in the first months to years after surgery. Resident fibroblasts in the graft secrete matrix metalloproteinases (MMPs), which break down the collagen I extracellular matrix. After necrosis of these fibroblasts, myofibroblasts repopulate the graft, and deposit collagen with an increased ratio type III over type I, which is weaker and less organized. Eventually, the cellular and matrix properties converge towards those of the native ACL, but full restoration of the biological and mechanical properties of the ACL is not achieved, increasing graft re-rupture risk. It is unknown to what extent inter-patient differences in tissue remodeling capacity contribute to increased risk of ACL graft re-rupture.

Goal

To measure various patient-specific tissue remodeling-related properties of human hamstring tendon-derived cells in an in vitro micro-tissue platform, in order to identify potential biological predictors for graft re-rupture when compared to patient outcome.

Method

Human hamstring tendon-derived cells were obtained from remnant autograft tissue after ACL reconstructions. These cells were expanded and seeded in collagen I gels on a micro-tissue platform to assess inter-patient biological differences in cellular functional tissue remodeling capacity. Functional remodeling was induced by removing the outermost microposts, and as a measure for remodeling, micro-tissue compaction over time was assessed using transmitted light microscopy. As biological factors, protein expressions of tendon marker tenomodulin and myofibroblast marker α-smooth muscle actin (αSMA) were measured using Western blot. Expression and activity of remodeling marker MMP2 were determined using gelatin zymography.

Results

Cells obtained from 12 patients (aged 12-51 years) were investigated. Patient-specific variations in speed and magnitude of micro-tissue compaction were observed. Up to 50-fold differences in the expression of αSMA were found between patients, although αSMA levels did not correlate with faster or stronger compaction. Surprisingly, tenomodulin was only detected in samples obtained from two patients. Total MMP2 expression varied between patients, however no large differences in active fractions were found. Correlation between patient age and any of the remodeling-related factors was not detected.

Conclusions and recommendations
Remodeling-related biological differences between patient tendon-derived cells could be assessed with the presented micro-tissue platform, and did not correlate with age, demonstrating the need to compare this biological variation in vitro—especially cells with extreme properties—to clinical outcome. Sample size is currently increased, and patient outcome will be determined by means of clinical knee stability, adverse outcomes and patient reported outcome measures at 3 and 12 months after surgery. Combined with results obtained from the in vitro platform, this could lead to a predictive tool to identify patients at risk for graft re-rupture and present opportunities for patient-specific rehabilitation programs.

Impact Of Titanium Elastic Nail Pre-Contouring On The Fixation Of Paediatric Diaphyseal Forearm Fractures

By Yavor Pukalski (AO Research Institute Davos, Switzerland; University Multiprofile Hospital for Active Treatment and Emergency Medicine 'N I Pirogov', Bulgaria) Parvan Yanev (AO Research Institute Davos, Switzerland; University Multiprofile Hospital for Active Treatment and Emergency Medicine 'N I Pirogov', Bulgaria) Mihail Rashkov (University Multiprofile Hospital for Active Treatment and Emergency Medicine 'N I Pirogov', Bulgaria)

Abstract Id: 5559
Event: EORS 2019
Topic: Implant registry data

Introduction

Paediatric diaphyseal forearm fractures occur at a rate of 560 per 100000 in the age of 5 to 14 years and have a clear male prevalence. Growing incidence of this pathology, as well as an increasing number of cases treated with elastic stable intramedullary nailing have been reported. The key point in this fixation is the nail pre-contouring to achieve three-point fixation with equal opposing elastic forces.

Goal

The aim of this study was to evaluate the influence of titanium elastic nail (TEN) pre-contouring on the postoperative radiographic outcome in AO PCCF 22-D/4.1 fractures of the forearm.

Method

Twelve paired human cadaveric forearms with simulated AO PCCF 22-D/4.1 fracture were assigned to 3 groups for TEN fixation with the use of either two straight nails (Group 1), one curved radial and one straight ulnar nail (Group 2), and two curved nails (Group 3). Same specimens were used in Group 1 and 2 by exchange of the radial nail only. Radial length and angulation (RA), as well as maximal radial bow (MRB), its location (LMRB) and rate in
percentage of the radial length (%MRB) were measured on anteroposterior X-rays in intact and instrumented state of each specimen in supination.

Results

Overall, the three groups differed significantly with regard to MRB, %MRB and RA (P

Conclusions and recommendations

Use of TENs of identical size and curvature ensures superior reduction of AO PCCF 22-D/4.1 fractures. In contrast, fixation with one curved radial and one straight ulnar implant leads to overcorrection of the radial bow, whereas utilization of two straight TENs leads to inferior outcomes, including straightening of the MRB and anticipated loss of range of motion in the clinical scenario.

Influence Of Different Lisfranc Ligament Injuries On CT Findings

By Preslav Penev (AO Research Institute Davos, Davos, Switzerland; Medical University Varna, Varna, Bulgaria) Feras Qawasmi (AO Research Institute Davos, Davos, Switzerland) Rami Mosheiff (Hadassah Medical Center, Jerusalem, Israel)

Abstract Id: 5557
Event: EORS 2019
Topic: Imaging

Introduction

Being commonly missed in the clinical practice, Lisfranc injuries can lead to arthritis and long-term complications. There are controversial opinions about the contribution of the main stabilizers of the joint – the dorsal, interosseous and plantar Lisfranc ligaments. Moreover, the role of the ligament that connects the medial cuneiform (MC) and the third metatarsal (MT3) is not well investigated. Despite the broad use of CT scans, there is no established correlation between the CT findings and the severity of this injury.

Goal

Therefore, the aim of this study was to investigate the influence of different Lisfranc ligament injuries on CT findings under two specified loads.

Method

Sixteen fresh-frozen human cadaveric lower limbs were embedded in PMMA at mid-shaft of the tibia and placed in a weight-bearing radiolucent frame for CT scanning. All intact specimens were initially scanned under 7.5 kg and 70 kg loads in neutral foot position. A dorsal approach was then used for sequential ligaments cutting: first – the dorsal and the (Lisfranc) interosseous ligaments; second – the plantar ligament between the MC and MT3;
third – the plantar Lisfranc ligament between the MC and the MT2. All feet were rescanned after each cutting step under the two loads. Based on the CT scans, the distances between MT1 and MT2, as well as between MC and MT2 were measured. In addition, the alignment and the dorsal displacement of MT2 were assessed.

**Results**

The average distances between MT1 and MT2 in the intact feet under 7.5 kg and 70 kg loads were 0.77 mm and 0.82 mm, whereas between MC and MT2 they were 0.61 mm and 0.80 mm, without any signs of misalignment or dorsal displacement of MT2. A slight increase in the distances MT1-MT2 (0.89 mm; 0.97 mm) and MC-MT2 (0.97 mm; 1.13 mm) was observed after the first disruption of the dorsal and the interosseous ligaments under 7.5 kg and 70 kg loads. A further increase in MT1-MT2 and MC-MT2 distances was registered after the second disruption of the ligament between MC and MT3. The largest distances MT1-MT2 (1.5 mm; 1.95 mm) and MC-MT2 (1.74 mm; 2.35 mm) were measured after the final plantar Lisfranc ligament cut under the two loads. In contrast to the previous two cuts, misalignment and dorsal displacement of 1.25 mm were seen at this final disrupted stage.

**Conclusions and recommendations**

The minimal pathological increase in the distances MT1-MT2 and MC-MT2 is an important indicator for ligamentous Lisfranc injury. Dorsal displacement and misalignment of the second metatarsal in the CT scans identify severe ligamentous Lisfranc injury. The plantar Lisfranc ligament between the medial cuneiform and the second metatarsal seems to be the strongest stabilizer of the Lisfranc joint. Partial lesion of the Lisfranc ligaments requires high clinical suspicion as it can be easily missed.

**Evidence-Based Generic Asian Pelvic Bone Models For Research, Development And Teaching Using CT-Based 3D Statistical Modeling**

By Marc-Daniel Ahrend (AO Research Institute Davos, Davos, Switzerland; Department of Traumatology and Reconstructive Surgery, BG Trauma Center Tübingen, Eberhard Karls University Tübingen, Tübingen, Germany)Hansrudi Noser (AO Research Institute Davos, Davos, Switzerland)Rukmanikanthan Shanmugam (University of Malaya Medical Centre, Kuala Lumpur, Malaysia)

Abstract Id: 5556
Event: EORS 2019
Topic: Bone

**Introduction**
Artificial bone models (ABMs) are commonly used in traumatology and orthopedics for training, education, research and development purposes. Currently available ABMs approximate the morphology of Europeans. However, they may not sufficiently depict the anatomy of the Asian population.

Goal

Therefore, the aim of this study was to develop the first evidence-based generic Asian pelvic bone model and compare it to an existing pelvic model. It was hypothesized that gender-related differences within the Asian population are smaller than differences between the novel Asian pelvic model and the existing one, which would justify the need for ethnicity-specific bone models for research, development and teaching purposes.

Method

A hundred clinical CT scans of intact adult pelves (54.8±16.4 years, 161.3±8.3 cm) were acquired. They represented evenly distributed female and male patients of Malay (n=33), Chinese (n=34) and Indian (n=33) descent. The CTs were segmented and defined landmarks were placed. By this means, 100 individual three-dimensional models were calculated using thin plate spline transformation. The latter generated homologous triangular meshes within all surfaces of the pelvic models with identical numberings and locations of surface points. Following, three statistical mean pelvic models (male, female, unisex) were generated. Anatomical variations were analyzed using principal component analysis (PCA). To quantify length variations, the distances between the anterior superior iliac spines (ASIS), the anterior inferior iliac spines (AIIS), the promontory and symphysis (conjugate vera) as well as the ischial spines (diameter transversa) were measured for the three mean models and the existing ABM. A sample size estimation using leave-one-out tests was performed to justify the number of used CT scans.

Results

PCA demonstrated large variability regarding pelvic surface and size. Principal component one (PC 1) contributed to 24% of the total anatomical variation and predominantly displayed a size variation pattern. PC 2 (17.7% of variation) mainly exhibited anatomical variations originating from differences in shape. Additionally, a large anatomical variability with regard to the innominate bones and their anteroposterior, craniocaudal and lateral diameter, was observed. Female and male models were similar in ASIS (225±20 mm; 227±13 mm) and AIIS (185±11 mm; 187±10 mm), whereas differed in conjugate vera (116±10 mm; 105±10 mm) and diameter transversa (105±7 mm; 88±8 mm). Comparing the Asian unisex model to the existing ABM, the external pelvic measurements ASIS (22.6 cm; 27.5 cm) and AIIS (186 mm; 209 mm) differed notably. Conjugate vera (111 mm; 105 mm) and diameter transversa (97 mm; 95 mm) were similar in both models. The leave-one-out-tests revealed a convergent line curve pattern with decreasing distances between anatomical homologous surface points of the mean pelvic models. Low variability of mean distances (3.78±1.7 mm) was found beyond a sample number of 30 CTs.

Conclusions and recommendations

Our analysis revealed notable anatomical variations regarding size dominating over shape and gender-specific variability. Dimensions of the generated mean models were comparatively
smaller compared to the existing ABM. This highlights the necessity for generation of Asian ABMs by evidence-based modeling techniques.

**Influence of ligament restrain variation on the wear behaviour evaluated on a high conformity posterior stabilized rotating platform knee design**

By Jens Schwiesau (Aesculap AG, Research & Development, Tuttlingen, Germany.) Bernd Fritz (Aesculap AG, Research & Development, Tuttlingen, Germany.) Matthias Woiczinski (Ludwig Maximilians University Munich Department of Orthopedic Surgery, Physical Medicine and Rehabilitation Campus Grosshadern, Munich, Germany)

Abstract Id: 5553  
Event: EORS 2019  
Topic: Bone

**Introduction**


**Goal**

This study evaluates the outcome of a wear simulation with two ligament-restraining conditions on a posterior stabilised rotating platform knee design.

**Method**

Material: The subject was a clinically introduced knee design (e.motion® PS PRO, Aesculap AG, Germany). An average size was selected for the tibia (T4L) and femur (F4L). The gliding surface with the lowest available height was used (F4L-10). The femur and tibia are made of a cast CoCr29Mo6-alloy. The gliding components are made of conventional ultra-high-molecular-weight-polyethylene (GUR 1020), sterilized by beta radiation under nitrogen. Three specimens for each loading case were tested. The selected design enables the evaluation
of two design aspects. The post transfers the anterior posterior load directly during engagement and the rotating platform can show the internal external torque transfer without design restrictions. Methods: A customized 4-station servo-hydraulic knee wear simulator (EndoLab GmbH Thansau, Germany) was used to apply two gait pattern. The following active kinematic components are realized for both gait pattern. Axial load with a triple peak in the stance phase up to 2600 N and a swing phase load of 166 N. Flexion up to 16° in the stance phase and up to 58° in the swing phase. Internal external (IE) torque in the stance phase between -1 Nm and +6 Nm. Anterior posterior (AP) load between -265 N and 110 N. The selection of the applied ligament restrain is based on two different standards. In ISO14243 1:2002 a linear restraining behaviour of the ligaments is simulated (linear group). In contrast ISO 14243 1:2009 simulates the ligaments with zero restraining around the neutral position (gap biphaseal group). Figure 1 shows the different restraining pattern. 5 million load cycles were applied. The wear was detected gravimetrically.

Results

Results: A wear rate of 1.76 (standard deviation 1.40) was determined for the linear group and 9.12 (standard deviation 0.30) for the biphaseal group. The individual results of the specimens are shown in figure 2.

Conclusions and recommendations

A factor of five was detected between the gravimetric wear results of the two tested groups. Compared to two previous studies with a comparable test set up this test result shows also a significant influence of the restraining system on the outcome of the wear test [6, 7]. Observations for the same knee design with a ZrN-multilayer coating were for the simulation of a linear restrain with a wear rate of 0.33 mg/million cycles 5.33 times smaller compared to the uncoated design. [6] Grupp, T.M., et al. Biotribology of a mobile bearing posterior stabilised knee design—Effect of motion restraint on wear, tibio-femoral kinematics and particles. Journal of Biomechanics (2014) [7] Grupp, T.M., et al. Effect of anterior–posterior and internal–external motion restraint during knee wear simulation on a posterior stabilised knee design. Journal of Biomechanics (2012)

Evaluation of Inter- and Intra-operator Reliability of Manual Segmentation of Femoral Metastatic Lesions

By Ali Ataei (Orthopaedic Research Lab, Radboud university medical center) Florieke Eggermont (Orthopaedic Research Lab, Radboud university medical center) Milan Baars (Orthopaedic Research Lab, Radboud university medical center)

Abstract Id: 5549
Event: EORS 2019
Topic: Bone

Introduction
Patients with advanced cancer can develop bone metastases in the femur which are often painful and increase the risk of pathological fracture. Accurate segmentation of bone metastases is, amongst others, important to improve patient-specific computer models which calculate fracture risk, and for radiotherapy planning to determine exact radiation fields. Deep learning algorithms have shown to be promising to improve segmentation accuracy for metastatic lesions [1], but require reliable segmentations as training input.

Goal

The aim of this study was to investigate the inter- and intra-operator reliability of manual segmentation of femoral metastatic lesions and to define a set of lesions which can serve as a training dataset for deep learning algorithms.

Method

CT-scans of 60 advanced cancer patients with a femur affected with bone metastases (20 osteolytic, 20 osteoblastic and 20 mixed) were used in this study. Two operators were trained by an experienced radiologist and then segmented the metastatic lesions in all femurs twice with a four-week time interval. 3D and 2D Dice coefficients (DCs) were calculated to quantify the inter- and intra-operator reliability of the segmentations. We defined a DC>0.7 as good reliability, in line with a statistical image segmentation study [2].

Results

Mean first and second inter-operator 3D-DCs were 0.54 (±0.28) and 0.50 (±0.32), respectively. Mean intra-operator I and II 3D-DCs were 0.56 (±0.28) and 0.71 (±0.23), respectively. Larger lesions (>60 cm3) scored higher DCs in comparison with smaller lesions (p

Conclusions and recommendations

This study reveals that manual segmentation of metastatic lesions is challenging and that the current manual segmentation approach resulted in dissatisfying outcomes, particularly for lesions with small volumes. However, segmentation of larger lesions resulted in a good inter- and intra-operator reliability. In addition, we were able to select 521 slices with good segmentation reliability that can be used to create a training dataset for deep learning algorithms. By using deep learning algorithms, we aim for more accurate automated lesion segmentations which might be used in computer modelling and radiotherapy planning.

Automated electromechanical system designed to investigate the effect of local mechanical conditions on fracture healing progression

By Jan Barcik (AO Research Institute Davos, Davos, Switzerland; Bulgarian Academy of Sciences, Institute of Metal Science 'Acad. A. Balevski', Sofia, Bulgaria)Manuela Ernst (AO
Introduction

In the course of uneventful secondary bone healing, a fracture gap is progressively overgrown by callus which subsequently calcifies and remolds into new bone. It is widely accepted that callus formation is promoted by mechanical stimulation of the tissue in the fracture gap. However, the optimal levels of the interfragmentary motion's amplitude, frequency and timing remain unknown. Although this subject was extensively investigated in the past, the mechanical conditions at the fracture site were not fully controlled because the influence of functional weightbearing was neglected while applying external mechanical stimulation.

Goal

The aim of this study was to develop an active fixation system capable of installing a well-controlled mechanical environment in the fracture gap with continuous monitoring of the bone healing progression.

Method

The experimental model was adapted from Tufekci et al. 2018 and required creation of a critical size defect and an osteotomy in a sheep tibia. They were separated by a mobile bone fragment. The distal and proximal parts of the tibia were fixed with an external fixator, whereas the mobile fragment was connected to the proximal part with an active fixator equipped with a linear actuator to move it axially for mechanical stimulation of the tissue in the fracture gap. This configuration installed well-controlled mechanical conditions in the osteotomy, dependent only on the motion of the active fixator and shielded from the influence of the sheep’s functional weightbearing. A load sensor was integrated to measure the force acting in the fracture gap during mechanical stimulation (Figure 1). The motion of the bone fragment was controlled by means of a custom-made controller allowing to program stimulation protocols of various profiles, amplitudes and frequencies of loading events. Prior to in vivo validation of the system, a series of dynamic bench tests was conducted to determine the loading regimes it is able to realize. Following in vitro testing, the system was tested in two Swiss White Alpine Sheep. It was configured to simulate immediate weightbearing for one of the animals and delayed weightbearing for the other. The applied loading protocol consisted of 1000 loading events evenly distributed over 12 hours resulting in a single loading event every 44 seconds.

Results

Bench testing confirmed the ability of the system to operate effectively with frequencies up to 1Hz over a range of stimulation amplitudes from 0.1 to 1.5 mm. Continuous measurements of in vivo callus stiffness revealed progressive fracture consolidation in the course of each experiment. A delayed onset of fracture healing was observed in the sheep with simulated delayed weightbearing.
Conclusions and recommendations

An electromechanical system capable of installing well-controlled mechanical conditions in the fracture gap was developed and tested in vivo. The conducted preclinical experiments demonstrated its robustness and reliability. The system can be applied for further preclinical research and comprehensive in-depth investigation of fracture healing.

Continuous monitoring of fracture healing to analyze short-term response of bone repair tissue to mechanical stimulation

By Jan Barcik (AO Research Institute Davos, Davos, Switzerland; Bulgarian Academy of Sciences, Institute of Metal Science 'Acad. A. Balevski', Sofia, Bulgaria)Manuela Ernst (AO Research Institute Davos, Davos, Switzerland)Marc Balligand (University of Liège, Liège, Belgium)

Abstract Id: 5522
Event: EORS 2019
Topic: Bone

Introduction

The course of secondary fracture healing typically consists of four major phases including inflammation, soft and hard callus formation, and bone remodeling. Callus formation is promoted by mechanical stimulation, yet little is known about the healing tissue response to strain stimuli over shorter timeframes on hourly and daily basis.

Goal

The aim of this study was to explore the hourly, daily and weekly variations in bone healing progression and to analyze the short-term response of the repair tissue to well-controlled mechanical stimulation.

Method

A system for continuous monitoring of fracture healing was designed for implantation in sheep tibia. The experimental model was adapted from Tufekci et al. 2018 and consisted of 3 mm transverse osteotomy and 30 mm bone defect resulting in an intermediate mobile bone fragment in the tibial shaft. Whereas the distal and proximal parts of the tibia were fixed with external fixator, the mobile fragment was connected to the proximal part via a second, active fixator. A linear actuator embedded in the active fixator moved the mobile fragment axially, thus stimulating mechanically the tissue in the osteotomy gap via well-controlled displacement being independent from the sheep’s functional weightbearing. A load sensor was integrated in the active fixation to measure the force acting in the osteotomy gap. During each stimulation cycle the displacement and force magnitudes were recorded to determine in vivo fracture stiffness. Following approval of the local ethics committee, experiments were
conducted on five skeletally mature sheep. Starting from the first day after surgery, the daily stimulation protocols consisted of 1000 loading events equally distributed over 12 hours from 9:00 to 21:00 resulting in a single loading event every 44 seconds. No stimulation was performed overnight.

**Results**

One animal had to be excluded due to inconsistencies in the load sensor data. In vivo stiffness data demonstrated measurable daily incremental changes in fracture healing. Onset of tissue stiffening was detected after 10±1 days considering all included sheep. For three sheep the increase in stiffness during the non-stimulated phase (overnight) was significantly higher than the increase during the stimulated phase (p

**Conclusions and recommendations**

The continuous measurements enabled resolving the tissue response to strain stimuli over hours and days. Although it is commonly accepted that bone needs mechanical stimulation for callus formation, this study demonstrated the importance of non-stimulated resting periods. The presented data contributes to understanding of the influence of patient activity on daily variations in tissue stiffness and can serve to optimize rehabilitation protocols post fractures.

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**High incidence of previously neglected meniscus lesions influencing knee biomechanics in association with ACL injuries.**

By Caroline Mouton (Department of Orthopaedic Surgery, Centre Hospitalier de Luxembourg – Clinique d’Eich, Luxembourg) Amanda Magosch (Department of Orthopaedic Surgery, Centre Hospitalier de Luxembourg – Clinique d’Eich, Luxembourg) Christian Nührenbörger (Department of Sports Medicine, Centre Hospitalier de Luxembourg – Clinique d’Eich, Luxembourg)

Abstract Id: 5520
Event: EORS 2019
Topic: Other

**Introduction**

Recent findings have identified the importance of previously undiagnosed or neglected meniscus lesions in association with anterior cruciate ligament (ACL) injuries (e.g. medial meniscus ramp lesions and posterior root tears of the lateral meniscus). There is increasing biomechanical evidence that they bear the potential to alter both anteroposterior and rotational laxity patterns in ACL injured knees. Few data exist with respect to the presence of these specific tear entities in large series of ACL injured patients.
Goal

The purpose of the study was to analyze the meniscus tear pattern in a series of ACL injured knees with a special focus on ramp lesions of the medial meniscus and posterior root lesions of the lateral meniscus. The hypothesis was that a significant number of ACL injured patients would display these types of lesions.

Method

Data from 358 patients undergoing an ACL reconstruction (227 males /131 females, age: 28±10) were extracted from a center-based registry. The type of ACL tear (partial versus complete) as well as the presence of associated meniscus lesions were documented. Meniscus lesions were classified into the following categories: medial ramp lesions, lateral root lesions, medial ramp and lateral root lesion, other medial meniscus injuries, other lateral meniscus injuries, other bimeniscal injuries. Chi-square tests were used to determine whether the percentage of meniscal lesions differed between types of ACL tear, gender and age (below 21, 21-35, above 35). Significance was set at p

Results

Isolated ACL tears were present in 107 (30%) of the operated knees (31 partial; 327 complete). Complete ACL lesions were more likely to present an associated meniscus injury (321 out of 327, 71%) than partial tears (13 out of 31, 42%; p

Conclusions and recommendations

The incidence of meniscus injuries which are associated with ACL tears is very high (70%). Previously undiagnosed or neglected meniscus injuries like medial ramp or lateral root tears could be identified in 35% of patients. As such, the hypothesis was confirmed that an important amount of ACL injured knees display this specific intraarticular soft tissue damage. A systematic evaluation of these lesions under arthroscopy should thus be performed and specific repair needs to be evaluated.

Mesoporous bioactive glasses as smart platform to stimulate bone regeneration

By Carlotta Pontremoli (Department of Applied Science and Technology, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy)Julia C. Berkmann (Julius Wolff Institute, Charité Universitätsmedizin Berlin, Augustenburger Platz 1, 13353, Berlin, Germany)Aaron X. Herrera Martin (Julius Wolff Institute, Charité Universitätsmedizin Berlin, Augustenburger Platz 1, 13353, Berlin, Germany)

Abstract Id: 5518
Event: EORS 2019
Topic: Biomaterials

Introduction
Recently, mesoporous bioactive glasses (MBGs) have been widely studied as bone regeneration systems, due to their excellent bioactivity and the ability to store and release therapeutic species with specific biological functions. The incorporation of these nanomaterials into a thermosensitive hydrogel, in which a solution undergoes a sol to gel transition under physiological conditions, represents a promising approach to design a multifunctional device able to deliver selected molecules to the pathological sites. In fact, this system can fit perfectly the shape of the defect cavity prior to the complete gelation and act as a carrier for prolonged release of therapeutic agents in situ. This challenging concept is the underlying idea of the MOZART project (H2020-NMP6-2015) whose general objective is to develop a library of MBGs containing different therapeutic ions and drugs, to be used as a new, smart platform technology for highly targeted therapies to enhance bone healing.

Goal

The aim of this work is to investigate the bone regeneration potential of MBGs containing strontium ions (as pro-osteogenic agent) and a thermosensitive poly(etherurethane) (PEU) based on Poloxamer 407 as a carrier system. In order to further increase the pro-osteogenic response, MBGs were also loaded with N-acetylcysteine (NAC).

Method

MBGs containing 2% mol of strontium were prepared by an aerosol-assisted spray-drying method and NAC was loaded post-synthesis through an incipient wetness method. The PEU hydrogel (SHP407) was synthesized via a two-step procedure in nitrogen atmosphere. Particles were characterized (FE-SEM, N2 adsorption-desorption analysis, TGA, DSC, FT-IR and XRD) and then were incorporated into the hydrogel. The hybrid systems’ rheological properties and stability in aqueous environment at 37°C, as well as its ability to co-release Sr2+ ions and NAC, were investigated. After preliminary biological in vitro tests, a proof of concept rodent study was performed to assess the performances of the resulting formulation as “bone healing device”. X-ray at 2- and 4-weeks post-surgery and µCT-analysis were performed to evaluate the healing outcome in a rat osteotomy model of biologically impaired healing. Subsequently, bones were processed for histological evaluation.

Results

Spherical-shaped MBG particles were characterized by different size ranging between 0.5 and 5 µm. The very high surface area and the accessible mesopores (in the range of 8-11 nm) allowed high NAC incorporation, around 11 mg/100 mg of MBG (based on TGA analysis). The incorporation of the particles into the SHP407 did not alter the stability and the rheological properties of the hydrogel. The release kinetics of ions and drug from the hybrid system showed a sustained release up to 7 days. Within a biologically delayed bone healing model, the local application into the fracture gap of the MBGs embedded in SHP407 was found to be beneficial for the bone healing process as confirmed via µCT and histology.

Conclusions and recommendations

Preliminary in vivo results demonstrated the incorporation of MBGs into a thermo-sensitive hydrogel is a very promising strategy to design a multifunctional injectable formulation for the in situ and sustained delivery of pro-osteogenic species able to enhance bone regeneration. This project has received funding from the European Union’s Horizon 2020 research and innovation programme (No 685872).
Inhibition of Bromodomain-Containing Protein 4 Counteracts Glucocorticoid-Induced Bone Loss and Fatty Marrow

By

Abstract Id: 5515
Event: EORS 2019
Topic: Bone

Introduction

Glucocorticoid excess is shown to deteriorate bone tissue integrity, increasing the risk of osteoporosis. Marrow adipogenesis at cost of osteogenesis is a prominent feature of this osteoporosis condition. Epigenetic pathway histone deacetylase (HDAC)-mediated histone acetylation regulates osteogenic activity and bone mass.

Goal

This study is aimed to figure out what the role of acetylated histone reader bromodomain-containing protein 4 (BRD4) did play in glucocorticoid-induced osteoporosis.

Method

Bone-marrow mesenchymal stem cells were incubated in osteogenic medium with or without 1 μM dexamethasone. Mineralized matrix and adipocyte formation were probed using von Kossa and Nile Red O staining, respectively. Osteogenic and adipogenic marker expression were quantified using RT-PCR. The binding of acetylated histone to promoter of transcription factors were detected using chromatin immunoprecipitation-PCR. Bone mineral density and microstructure in osteoporotic bone were quantified with μCT system.

Results

Glucocorticoid repressed osteogenic transcription factor Runx2 expression and mineralized matrix formation along with a low level of acetylated lysine 9 at histone 3 (H3K9ac), whereas BRD4 signaling and adipocytic formation were increased in cell cultures. BRD4 knockdown reversed the H3K9ac enrichment in Runx2 promoter and osteogenesis, but downregulated adipogenic differentiation. Silencing BRD4 attenuated H3K9ac occupancy in forkhead box P1 (Foxp1) relevant to lipid metabolism upon glucocorticoid stress. Foxp1 interference downregulated adipogenic activities of glucocorticoid-treated cells. In vivo, treatment with BRD4 inhibitor JQ-1 compromised the glucocorticoid-induced bone mineral density loss, spare trabecular structure, and fatty marrow, as well as improved biomechanical properties of bone tissue.

Conclusions and recommendations
Taken together, BRD4-mediated Foxp1 pathways drive mesenchymal stem cells shifting toward adipocytic cells rather than osteogenic cells to aggravates excessive marrow adipogenesis in the process of glucocorticoid-induced osteoporosis. Pharmacological inhibition of BRD4 signaling protects bone tissue from bone loss and fatty marrow in glucocorticoid-treated mice. This study conveys a new molecular insight into epigenetic regulation of osteogenesis and adipogenesis in osteoporotic skeleton and highlight the remedial effect of BRD4 inhibitor on glucocorticoid-induced bone loss.

Clinical and Radiological Outcomes after Open Reduction and Internal Fixation of Lisfranc Injuries – Single Centre Experience

By Sandeep Kohli (Princess Royal University Hospital) Sunil Bajaj (Queen Elizabeth Hospital, Greenwich, London)

Abstract Id: 5513
Event: EORS 2019
Topic: EORS 2019

Introduction

Lisfranc are rare injuries. Up to 24% of these injuries are missed or frequently diagnosed late. Untreated, delayed treatment or inadequately treated injuries result in poor functional outcome for the patient in proportion to the severity of the initial injury. The gold standard treatment for these injuries is ORIF though a number of studies have shown good results with Primary Arthrodesis.

Goal

The aim of our study is to evaluate the clinical and radiological results of joint sparing internal fixation of Lisfranc injuries. Primary outcome measures were AOFAS and FFI functional scores. Secondary outcome measures were rate of re-operation, complication rates and Radiological evidence of Osteoarthritis. We assessed the Functional and Radiological outcomes after ORIF of Lisfranc Injuries treated with Joint sparing surgery for the 2-3 Tarso Metatarsal Joint (TMT) using Dorsal Bridging Plates and Screws for the first TMT Joint.

Method

A total of 27 consecutive patients who underwent ORIF for Lisfranc Injuries between June 2013 and October 2018 were included in our study. The average age was 43.3 years. We used the Myerson Classification for Lisfranc injuries. All patients were treated by ORIF. The second TMT Joint was reduced first and then the medial TMT and lateral TMT Joints were reduced. Dorsal Bridging Plating (DBP) was the preferred mode of stabilization for the second and third TMT Joints. First TMT joint was stabilized with 3.5 mm screws. All patients
were recalled for clinical and radiological assessment and also completed Foot Function Index (FFI) and AOFAS mid foot score.

Results

We assessed 22 patients with an average followup of 2.4 years (6 to 65 months). 16 out of 22 patients had no pain and were wearing normal unadapted shoes and no insoles. 4 had mild intermittent pain and 2 had moderate pain. No patient had incapacitating pain. 4 patients were bothered by dorsal prominence from the metalwork. 19 patients were walking unaided, 2 used an elbow crutch and one used a walking stick. 16 patients had a normal gait pattern whilst 3 had antalgic gait and 3 used walking aids. The average AOFAS midfoot score of our patients (n=22) was 78.11, with median of 81.5 and the range from 63 to 100. The average Foot Function Index was 19.5 and the median of 17.3 and the range from 0.6 to 34. Radiographs revealed that 3 patients had evidence of degenerative changes though only one was symptomatic clinically.

Conclusions and recommendations

We conclude that these injuries have a high propensity to be missed in ED, as 8 of our patients presented late to us. Weight bearing radiographs or CT or MRI Scans can be used for accurate diagnosis. Overall good functional outcomes can be expected in majority of these patients with 68% of our mapatients able to return back to their pre-injury level of functional and mobility. However a small proportion of these patients will develop secondary midfoot OA with some residual symptoms.

Orthopaedics forward to precision medicine: Electronic tools using lifestyle parameters may lower the personal risk of early reoperations in total knee arthroplasty

By Jiri Gallo (Department of Orthopaedics, University Hospital Olomouc, Czech Republic) Milos Kudelka (Faculty of Electrical Engineering and Computer Science, Department of Computer Science, VSB-Technical University of Ostrava, Ostrava, Czech Republic) Martin Radvansky (Faculty of Electrical Engineering and Computer Science, Department of Computer Science, VSB-Technical University of Ostrava, Ostrava, Czech Republic)

Abstract Id: 5512
Event: EORS 2019
Topic: Arthroplasty

Introduction

Precision medicine tailoring the patient pathway based on the risk, prognosis, and treatment response may bring benefits to the patients. To identify risk factors contributing to the early
failure of treatment (development of events of interest) and when possible to change the
prognosis via modifying these factors may improve the outcome and/or lower the risk of
complications. There is an emerging goal to identify such parameters in total knee
arthroplasty (TKA) thus lower the risk of revision surgery.

Goal

The goal of this study was to identify factors explaining the risk for early revision of TKA
using an artificial intelligence method appropriate for this task.

Method

We applied a patient similarity network (PSN) for the identification of risk factors associated
with early reoperations (n=109, 5.8%) in patients with TKA (n=1885). Next, an algorithm
based on formal concept analysis was developed to support the patient decision on how to
change modifying personal characteristics with respect to the estimated probability of
reoperations.

Results

The early reoperations were less frequent in women (4.4%, median time to reoperation 4.5
mo) than in men (8.2%, 10 mo), reaching the highest incidence in younger men (10.9%,

Is tourniquet usage still needed in light of
ever evolving blood management strategies?

By Benjamin Sephton, Nina De La Cruz, Sanjitha Kantharuban, Julian Gaskin, Satyajit
Naique

Abstract Id: 5507
Event: EORS 2019
Topic: Arthroplasty

Introduction

Blood management protocols attempt to reduce blood loss by strategies including autologous
blood donation, red cell salvage, normovolaemic haemodilution and haemostatic agents such
as tranexamic acid (TXA). TXA usage in particular has become increasingly commonplace
with numerous studies demonstrating a significant reduction in peri-operative blood loss and
proportion of patients requiring transfusion, without increasing the risk of venous
thromboembolism. Tourniquet usage has now become ubiquitous in TKA operations with
reported benefits of improved visualization, shorter operative time and decreased intra-
operative bleeding. However, its use is not without considerable complications including
wounding dehiscence, increased venous thromboembolism, superficial wound infection and
skin blistering. It is therefore imperative that we review tourniquet usage in light of ever
evolving blood management strategies.
Goal

The aim of this study was to evaluate the effect of stopping tourniquet usage in primary TKRs, performed by an experienced surgeon, in light of new blood reduction measures, such as a TXA.

Method

A retrospective analysis identified a total of 31 patients who underwent primary TKR without the use of a tourniquet from January 2018 to March 2019. This was compared to an earlier group of patients from the same surgeon undergoing TKR with the use of a tourniquet; dating from July 2016 to November 2017. All surgeries were performed within the same hospital (CXH). Peri-operative factors and outcome measures were collected for analysis.

Results

There was no significant difference in post-operative haemoglobin drop (Tourniquet, 23.1 g/L; No Tourniquet, 24.4 g/L: p=0.604) and fall in haematocrit (Tourniquet, 0.082; No Tourniquet, 0.087: p=0.604). Allogenic blood transfusion rates were the same in both groups at 12.9% (2 patients) and blood loss was not found to be significantly different (Tourniquet, 1067ml; No tourniquet, 1058mls). No significant difference was found in operative time (Tourniquet, 103 minutes; No Tourniquet, 111.7 minutes: p=0.152) or length of stay (Tourniquet, 5.5 days; No Tourniquet, 5.2 days: p=0.516). Tranexamic acid usage was not found to be significant (p=1.000). ROM of motion and analgesia requirement was significantly better in the no tourniquet group on one post-operative day out of five analysed (p=0.025, p=0.011). No post-operative thromboembolic events were reported in either group. There was no significant difference in readmission rates (p=0.492) or complications (p=0.238).

Conclusions and recommendations

The increase in minor complications and potential increased VTE risk with tourniquet usage must be balanced against an improved visual field and reduced blood loss in TKR patients. Our study found no difference in post-operative blood loss and transfusion rates between tourniquet and no tourniquet groups. With ever evolving and improving blood loss management strategies, including the use of TXA, the application of tourniquet may not be needed. Further prospective RCTs are needed to assess the impact of tourniquet usage in light of this.

Predictors of Transfusion for Adults Undergoing Elective Posterior Thoraco-lumbar Spinal Fusion

By Khalid AlSaleh (Orthopedic Department, King Khalid University Hospital, Riyadh, Saudi Arabia)Khalifah Aldawsari (College of Medicine, King Saud University, Riyadh, Saudi Arabia)Omar Alsultan (Orthopedic Department, King Khalid University Hospital, Riyadh, Saudi Arabia aedic)
Abstract Id: 5479  
Event: EORS 2019  
Topic: Spine

Introduction

Posterior spinal surgery is associated with a significant amount of blood loss. The factors predisposing the patient to excessive bleeding—and therefore transfusion—are not well established nor is the effect of transfusion on the outcomes following spinal surgery.

Goal

We had two goals in this study. First, we were to investigate any suspected risk factors of transfusion in posterior thoraco-lumbar fusion patients. Second, we wanted to observe the negative impact—if one existed—of transfusion on the outcomes of surgery.

Method

All adults undergoing posterior thoraco-lumbar spine fusion in our institution from May 2015 to May 2018 were included. Data collected included demographic data as well as BMI, preoperative hemoglobin, American Society of Anesthesiologists classification (ASA), delta Hemoglobin, estimated blood loss, incidence of transfusion, number of units transfused, number of levels fused, length of stay and re-admission within 30 days. The data was analyzed to correlate these variables with the frequency of transfusion and then to assess the association of adverse outcomes with transfusion.

Results

125 patients were included in the study. Only 6 patients (4.8%) required re-admission within the first 30 days after discharge. Length of stay averaged 8.4 days (3-74). 18 patients (14.4%) required transfusion peri-operatively. When multiple variables were analyzed for any correlation, the number of levels fused, age and BMI had statistically significant correlation with the need for transfusion (P

Conclusions and recommendations

Patients undergoing posterior thoraco-lumbar fusion are more likely to require blood transfusion if they were older, over-weight & obese or had a multi-level fusion. Receiving blood transfusion is associated with increased complication rates.

Top 100 Cited Articles on Lumbar Spondylolisthesis: Bibliographic analysis

By Khalifah Aldawsari (College of Medicine, King Saud University, Riyadh, Saudi Arabia)Mohammad T. Alotaibi (College of Medicine, King Saud University, Riyadh, Saudi Arabia)Khalid AlSaleh (Orthopedic Department, King Khalid University Hospital, Riyadh, Saudi Arabia)
Abstract Id: 5478  
Event: EORS 2019  
Topic: Spine

Introduction
Spondylolisthesis is common recognized spine pathology. A lot of studies targeted spondylolisthesis in the recent years, few of which have made a major influential impact on the clinical practice. To the extent our knowledge this is the first study to highlight and analyze the top 100 cited articles on spondylolisthesis through a systematic search strategy used previously in published studies in different medical specialty.

Goal
The aim of this study is to identify the most cited studies on spondylolisthesis and report their impact in spine field.

Method
Thomson Reuters Web of Science-Science Citation Index Expanded was searched using title-specific search “spondylolisthesis”. All studies published in English language between 1900 and 2018 were included with no restrictions. The top 100 cited articles were identified using “Times cited” arranging articles from high to low according to citation count. Further analysis was made to obtain the following items: Article title, author’s name and specialty, country of origin, institution, journal of publication, year of publication, citations number, study design.

Results
The citation count of the top 100 articles ranged from 69 to 584. All published between 1950 - 2016. Among 20 journals, Spine had the highest number of articles 47, with citation number of 5964 out of 13644. Second ranked was Journal of Bone And Joint Surgery with 16 articles and a total citation of 3187. In respect to the primary author’s specialty, Orthopedic surgeons contributed to the majority of top 100 list with 82 articles, Neurosurgery was the second specialty with 10 articles. United states had produced more than half of the list by 59 articles. England was the second country with 7 articles. Surgical management of lumbar spondylolisthesis was the most common discussed topic.

Conclusions and recommendations
This article identifies the top 100 influential papers on spondylolisthesis and recognizes an important aspect of knowledge evolution served by leading researchers as they guide today’s clinical decision making in spondylolisthesis.

Accuracy and quality of educational videos for elbow physical examination: what should our students watch?
By Elisa Zwerus (Amsterdam UMC, AMC)

Introduction

Driven by increasing emphasis on problem-based and self-directed learning, medical students and doctors in orthopedic specialty training rely increasingly on the internet as learning resource. As students’ or residents’ performance on physical examination may be less supervised in comparison to other clinical skills (for example surgical competence), online videos may provide a valuable source for education of physical examination skills. Cognitive psychological research has shown that videos can help viewers to understand techniques and manage the sequential steps of physical examination and approach to patients. YouTube is the largest open-access video platform available and provides access to thousands of educational videos on orthopedics-related topics. VuMedi, G9MD, and Orthobullets are examples of online platforms requiring user-registration with video content that is more directly focused on orthopedic topics.

Goal

The objective of this study was to investigate the accuracy and quality of instructional videos on the physical examination of the elbow and identify factors influencing the educational usefulness.

Method

A YouTube, VuMedi, Orthobullets, and G9MD search was performed on October 7, 2018 for videos on the physical examination of the elbow. We included both basic examination and disease specific tests. The included videos were rated for accuracy and quality by two independent authors using a modified version of a validated scoring system. Inter-rater reliability was analyzed using mean difference and intra-class correlation coefficient.

Results

Twenty-three out of 126 videos were indicated as useful for educational purposes. Accuracy, quality and total scores were statistically significant higher for videos from specialized platforms compared to YouTube: 16.5 (95% CI 16 to 17) vs. 12.816 (95% CI 12.3 to 13.3) respectively. Video accuracy and quality were highly variable and did not correlate. The number of days online, views, and likes showed no or weak correlation with accuracy and quality. For the total score, our assessment tool showed excellent inter-rater reliability of 0.93 (95% CI 0.09-0.95) and a mean difference of 0.024 point between the two observers (p=0.871).

Conclusions and recommendations

There is considerable variation in accuracy and quality of online available videos on the physical examination of the elbow. We indicated 23 educationally useful videos and provided
an assessment method. This assessment method can be useful for both viewers to assess reliability of a video and educators interested in creating videos.

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**Activity level after lateral ankle ligament reconstruction, using gracilis autograft**

By Morten Kjær (Jeannette Østergaard Penny (Department of Orthopedic surgery, Køge Hospital) Peter Basse ()

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**Abstract Id: 5453**
**Event: EORS 2019**
**Topic: Tendon**

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**Introduction**

Limited information is published regarding the activity level after gracilis autograft reconstruction, and usually a knee-injury based score is used rather than a specific ankle PROM.

**Goal**

The purpose of this study was to investigate the activity level and functional results after lateral ankle gracilis autograft reconstruction in patients with severe lateral ankle instability. The hypothesis was that patients would regain their pre-injury Tegner activity level or one level below and secondary to compare a specific ankle activity score, instability and function score. Finally donor site and graft complications, clinical stability and range of motion were measured.

**Method**

All 69 patients (50 women, 19 men) recorded at the hospital with severe instability who underwent reconstruction of the anterior talofibular and the calcaneofibular ligament with a gracilis autograft and were minimum 6 months post operative, were invited to participate in the study. Outcomes measures included the Tegner Activity level (1-10), Ankle Activity Score (0-10) recorded as pre-injury and at follow up. The Karlsson Pettersson Ankle Function Score (0-100) and Visual Analog Score (VAS)(0-10) recorded pre-operatively and at follow up. All pre-injury and pre-operative data were recalled retrospectively from memory. Identification of functional ankle instability (IDFAI)(0-37) was recorded at follow up. The clinical tests, Anterior drawer test (0-4), Talar tilt test (0-4) and Range of motion (ROM)(degrees) were compared to the unaffected side at follow up. A difference of 1 in the activity scores was chosen as a clinical relevant difference. Data was tested for normal distribution and for statistical significant difference with a students t-test. study design: Cross sectional clinical study with a retrospective questionnaire.

**Results**
A total of 33 patients (27 women, 6 men), with a mean age on 45 years (range 19-68), were included in this study. Mean follow up was 3.7 years. Mean pre-operative Tegner score was 5.8 vs 5.6 at follow up (p

Conclusions and recommendations

On average, the patients returned to their pre-injury activity level, with similar specific ankle activity scores to the Tegner. The majority had good functional results and few residual symptoms of functional instability. The response rate was low with few men responding; hence a prospective study is called for to establish the true effect of the surgical technique.

The catabolic-to-anabolic shift in the osteoarthritic cartilage after knee joint distraction in dogs occurs after the distraction period.

By M. Teunissen (Clinical Sciences of Companion Animals, Faculty of Veterinary Medicine, Utrecht University, Utrecht, The Netherlands) J. Popov-Celeketic (Rheumatology & Clinical Immunology, University Medical Center (UMC) Utrecht, Utrecht University, Utrecht, The Netherlands) K. Coeleveld (Rheumatology & Clinical Immunology, University Medical Center (UMC) Utrecht, Utrecht University, Utrecht, The Netherlands)

Abstract Id: 5447
Event: EORS 2019
Topic: Cartilage

Introduction

Knee joint distraction (KJD) is a joint-preserving treatment strategy for severe osteoarthritis (OA) that provides long-term clinical and structural improvement [1]. Data from both human trials and animal models indicate clear cartilage regeneration from 6 months and onwards post-KJD [1, 2]. However, recent work showed that during distraction, the balance between catabolic and anabolic indicators is directed towards catabolism, as indicated by collagen type 2 markers [3], proteoglycan (PG) turnover and a catabolic transcription profile [unpublished data].

Goal

The focus of this study was to investigate the cartilage directly and 10 weeks after joint distraction in order to elucidate the shift from a catabolic to an anabolic cartilage state.

Method

Knee OA was induced bilaterally in 8 dogs according to the groove model [2]. After 10 weeks of OA induction, all 8 animals received right knee joint distraction, employing the left knee as
an OA control. After 8 weeks of distraction, 4 dogs were euthanized and after 10 weeks of follow-up the 4 other dogs. Macroscopic cartilage degeneration and synovial tissue inflammation was assessed using the OARSI canine scoring system [3]. PG content was determined spectrometrically using Alcian Blue dye solution and the synthesis of newly formed PGs was determined using 35SO42- as a tracer, as was described before [2].

Results

of the right tibial plateau was higher compared to the left OA control (OARSI score: 1.7±0.2 vs 0.6±0.3; p < 0.001). 10 weeks post-KJD this difference persisted (OARSI score: 1.4±0.6 vs 0.6±0.3; p = 0.05). Directly after KJD, there was no difference in synovial inflammation between KJD and OA control (OARSI score: 1.4±0.5). At 10 weeks synovial inflammation increased significantly in the distracted knee (OARSI score: 2.1±0.3 vs 1.4±0.5; p < 0.05). Biochemical analysis of the tibia cartilage directly after KJD revealed a lower PG content (20.1±10.3 mg/g vs 23.7±11.7 mg/g). At 10 weeks post-KJD this difference in PG content was less (24.8±6.8 mg/g vs 25.4±7.8 mg/g). The PG synthesis rate directly after KJD appeared significantly lower vs. OA (1.4±0.6 nmol/h.g vs 5.9±4.4 nmol/h.g; p < 0.001)). However, 10 weeks post-KJD this difference was not detected (3.7±1.2 nmol/h.g vs 2.9±0.8 nmol/h.g), and the synthesis rate in the distracted knee was increased compared to directly after distraction (p < 0.01).

Conclusions and recommendations

Further in-depth investigation of the material is ongoing; these first results suggest that the shift from a catabolic to an anabolic state occurs within the first weeks after joint distraction, mostly reflected in the biochemical changes. As such, the post-distraction period seems to be essential in identifying key-players that support intrinsic cartilage repair.


The effect of Point of Care (POC) INR testing on delay to theatre in patients on warfarin with neck of femur fractures

By Kendrick To (University of Cambridge) Jonathan Bartlett (John Lawrence ()

Abstract Id: 5436
Event: EORS 2019
Topic: EORS 2019

Introduction

Various studies have demonstrated that the necessity for reversal of Warfarin through the use of Vitamin K (Vit K) in neck of femur fracture patients introduces increased duration of stay
and poorer outcomes as measured by operative complications and mortality rate. One reason for this delay may be the time latency between admission and the clinician’s decision to investigate the INR.

Goal

In this study we aim to explore the different causes of latency which contribute to a delay to theatre and ascertain whether point of care testing may negate this.

Method

We carried out an audit of a cohort of neck of femur fracture patients between 2012 and 2015. Between September 2011 and September 2013, paper notes of 25 patients who were on warfarin at the time of sustaining a Neck of femur fracture (NOF) was obtained within Addenbrooke’s hospital archives. An additional 80 patient’s records from the year 2015 were retrieved from EPIC digital records. Time intervals were recorded as follows (from time of A&E assessment by Medical doctor); Interval to orthopaedic specialist assessment, Interval to first INR order, Interval to first INR result seen by specialist, Interval to first Vit K prescribed, Interval to first Vit K given, Interval to Second INR ordered, Interval to second INR seen by specialist, Interval to operation time (as determined by time of team briefing). Analysis of the time intervals as a proportion of total time elapsed between A&E assessment and Time to theatre was performed. Point of care (POC) testing of INR on admission to A&E was introduced and a symmetrical time period was analysed for the same intervals.

Results

The latency generated by time taken for a NOF to be assessed by an orthopaedic specialist occupied 8.60% of the total time, the interval between ordering and recording an INR value accounted for 7.96% of time to theatre, the interval between an INR being recorded and subsequently seen by a clinician accounted for 13.4% of time to theatre, the time between orthopaedic specialist assessment and prescription of Vit K took up 7.83% of the total time and the percentage time between Vit K prescription and administration was 12.3%. The time between the first dose of Vit K prescription and arriving at theatre accounted for 76.1% of latency and the time between viewing a second INR and time to theatre occupied 33% of the total time. Following introduction of POC INR testing, there was a statistically significant decrease in time taken for warfarin reversal and consequently a reduction between time of admission to time to theatres.

Conclusions and recommendations

NOF patients who are on warfarin at time of injury introduces complexity to surgical management and planning for theatre. In our audit we demonstrate that causes of delay are distributed throughout the pathway of care and there are several stages. POC INR testing represents an effective method of reducing this latency and improves patient outcome.

Long-term functional outcome after a low-energy hip fracture in elderly patients.
Introduction

The incidence of hip fractures is increasing. Elderly patients with a hip fracture frequently present with comorbidities, which are associated with higher mortality rates. Clinical studies regarding long-term functional outcome and mortality in hip fractures are rare.

Goal

The aim of this study was to analyse the functional outcome and the mortality rate after a follow-up of 5 years in elderly patients with a hip fracture.

Method

This combined retrospective and cross-sectional study included patients aged 65 years or older with a low energy hip fracture who underwent surgery in the Maastricht University Medical Center+, the Netherlands. Data such as demographics and mortality rates were retrospectively collected and functional outcome (i.e. mobility, pain, housing conditions and quality of life) was assessed by a questionnaire.

Results

Two hundred and sixteen patients were included in this study (mean age 82.2, SD ± 7.5). No significant differences were found in pain before hip fracture and after 1-year and 5-year follow-ups. Long-term functional outcome deteriorated after a hip fracture, with a significant increase in the use of walking aids (p

Conclusions and recommendations

Long-term functional outcome in elderly patients with hip fractures significantly deteriorated, with an increased dependency for mobility and housing conditions and a decreased physical quality of life. In addition, hip fractures are associated with high mortality rates at the 5-year follow-up.

The relationship between the degree of displacement of the atlas to axis and the clinical data in atlanto-axial subluxation
Abstract Id: 5432  
Event: EORS 2019  
Topic: Spine

Introduction

In the patients showing atlanto-axial subluxation, some author noted that anterior subluxation of greater than 10 to 12 mm implies the destruction of the entire ligamentous complex. However, to the best of our knowledge, the relationship between the degree of displacement before surgery and the clinical data has not yet been described elsewhere.

Goal

The purpose of this study was to clarify the relationship between the displacement of the atlas to axis and the clinical data obtained in patients with AAS.

Method

Fifty patients with AAS that were treated by surgery are herein reviewed. The average patient age at surgery was 59.7 years (range 29-78 years). The average follow-up period was 59.8 months (24-120). Those consisted of 37 females and 13 males. Based on the findings of preoperative lateral cervical radiographs in the neutral position, the patients were classified into two groups as follows: a 10+ group with an atlanto-dental interval (ADI) of \(\geq 10\) mm, and a 10- group with an ADI < 10 mm.

Results

Preoperative lateral cervical radiographs demonstrated 15 cases to belong to the 10+ group, while 35 cases belonged to the 10- group. In the preoperative MR imaging, an intramedullary high signal intensity was observed in seven cases that belonged to the 10+ group and in four cases belonging to the 10- group. Regarding the neurological severity, the 10+ group included significantly more cases showing severe neurological deficits before surgery; however, there was no significant difference between the two groups regarding the presence of severe deficits even after surgery. The laboratory studies indicated no significant differences in either the CRP levels or ESR between the two groups before surgery.

Conclusions and recommendations

The severe displacement group included significantly more cases showing an intramedullary high signal intensity in the preoperative MR images. Our results also suggest that a severe displacement before surgery affected the presence of neurological deficits before surgery; however, it did not affect the neurological recovery from such severe neurological deficits.
A cadaveric study of the cervical nerve roots and spinal segments

By Ito Shunsuke (Department of Orthopaedic Surgery, Isesaki Municipal Hospital) Kobayashi Ryoichi (Department of Orthopaedic Surgery, Isesaki Municipal Hospital) Iizuka Haku (Department of Orthopaedic Surgery, Isesaki Municipal Hospital)

Abstract Id: 5431
Event: EORS 2019
Topic: Spine

Introduction

Many anatomical studies on the cervical nerve root have been conducted, however, most authors evaluated the length and angle of the nerve root or rootlet. Although some authors assessed the diameter of the nerve root using ultrasonography and magnetic resonance imaging (MRI), to our knowledge, there are no previous reports describing the relationship between the width of the cervical nerve root and each spinal segment using cadavers.

Goal

The purpose of this study was to anatomically measure the width of the cervical nerve root and spinal cord segment in addition to clarifying the anatomical characteristics of the cervical nerve root.

Method

We assessed 132 cervical nerve roots obtained from 11 cadavers. A total of 11 cervical spines from C3 to C8 were directly evaluated using digital calipers. The patients from whom the cadaveric specimens were obtained ranged from 79 to 90 years of age at the time of death. Four measurements were taken: the width at the entry of the spinal nerve in the vertebral foramen (WE), the maximum width of the spinal nerve (MW) and the length of the spinal segment on the ventral (LV) and dorsal rootlets (LD).

Results

The mean values of the WE from C3 to C8 were 5.5 mm, 5.6 mm, 6.0 mm, 5.8 mm, 4.8 mm and 4.3 mm, respectively. The value of C8 was significantly smaller than that of C3, C4, C5 and C6. The mean values of the MW from C3 to C8 were 5.6 mm, 6.0 mm, 6.4 mm, 6.7 mm, 6.3 mm and 6.0 mm, respectively. The mean values of the LV from C3 to C8 were 12.1 mm, 12.5 mm, 12.6 mm, 12.7 mm, 11.8 mm and 10.6 mm, respectively. The value of C8 was significantly narrower than that of C4, C5 and C6. The mean values of the LD from C3 to C8 were 12.1 mm, 13.3 mm, 13.6 mm, 12.2 mm, 11.0 mm and 10.6 mm, respectively. The value of C8 was significantly narrower than that of C4 and C5.

Conclusions and recommendations
We anatomically measured the width of cervical nerve roots and spinal segments. The spinal segment of C8 was significantly narrower than some of the roots located in the middle of the cervical spine, and this characteristic continued to the entry of the root in the vertebral foramen, although the difference disappeared at the maximum width point of the root.

Weight-bearing low field MRI after total knee arthroplasty in patient with and without complaints.

By F.F. Schröder (OCON, centre for orthopaedic surgery, Hengelo, The Netherlands. University of Twente, Faculty of Engineering Technology; Biomechanical Engineering, The Netherlands.)C.E. Post (Orthopaedic Research Laboratory, Radboud University Medical Center, The Netherlands)F.F.J. Simonis (University of Twente, Faculty of science and technology; Magnetic Detection and Imaging, The Netherlands)

Abstract Id: 5418
Event: EORS 2019
Topic: Imaging

Introduction

Instability, loosening, and patellofemoral pain belong to the main causes for revision of total knee arthroplasty (TKA). Currently, the diagnostic pathway requires various diagnostic techniques such as x-rays, CT or SPECT-CT to reveal the original cause for the failed knee prosthesis, but increase radiation exposure and fail to show soft-tissue structures around TKA. There is a growing demand for a diagnostic tool that is able to simultaneously visualize soft tissue structures, bone, and TKA without radiation exposure. MRI is capable of visualising all the structures in the knee although it is still disturbed by susceptibility artefacts caused by the metal implant. Low-field MRI (0.25T) results in less metal artefacts and offers the ability to visualize the knee in weight-bearing condition.

Goal

Therefore, the aim of this study is to investigate the possibilities of low field MRI to image, the patellofemoral joint and the prosthesis to evaluate the knee joint in patients with and without complaints after TKA.

Method

Ten patients, eight satisfied and two unsatisfied with their primary TKA, (NexGen posterior stabilized, BiometZimmer) were included. The patients were scanned in sagittal, coronal, and transversal direction on a low field MRI scanner (G-scan Brio, 0.25T, Esaote SpA, Italy) in weight-bearing and non-weight-bearing conditions with T1, T2 and PD-weighted metal artefact reducing sequences (TE/TR 12-72/1160-7060, slice thickness 4.0mm, FOV 260x260x120m3, matrix size 224x216). Scans were analysed by two observers for: • Patellofemoral joint: Caton-Descamps index and Tibial Tuberosity-Trochlear Groove (TT-
TG) distance. • Prosthesis malalignment: femoral component rotation using the posterior condylar angle (PCA) and tibial rotation using the Berger angle. Differences in parameters between weight-bearing and non-weight-bearing were calculated with the Wilcoxon rank test. To assess the reliability the inter and intra observer reliability was calculated with a two-way random effects model intra class correlation coefficient (ICC). The two unsatisfied patients underwent revision arthroplasty and intra-operative findings were compared with MRI findings.

Results

In the satisfied group, a significant difference was found between TT-TG distance in non-weight-bearing and weight-bearing condition (p=0.018), with a good interrater reliability ICC=0.89 (figure 1). Furthermore, differences between weight-bearing and non-weight-bearing were found for the CD ratio, however, not significant (p=0.093), with a good interrater reliability ICC=0.89 (figure 1). The Berger angle could be measured with an excellent interrater reliability (ICC=0.94). The PCA was hard to assess with a poor interrater reliability (ICC=0.48). For one unsatisfied patient a deviation was found for tibial component rotation, according to the perioperative findings as, ‘malposition of the tibial component’. For the other unsatisfied patient revision surgery was performed due to aseptic loosening in which the MRI showed a notable amount of synovitis.

Conclusions and recommendations

It is possible to image the patellofemoral joint and knee prosthesis with low field MRI. Patellofemoral measurements and tibial component rotation measurements can reliably be performed. For the two patients with complaints MRI findings were consistent with intra-operative findings. Further research should focus on a larger group of patients with complaints after TKA to verify the diagnostic capacity of low field MRI for peri-prosthetic knee problems.

Orthopaedic aspects of SAMS syndrome

By D.E. Schrander (MUMC+), H. Staal (MUMC+), C.T.R.M. Stumpel (MUMC+)

Abstract Id: 5417
Event: EORS 2019
Topic: Other

Introduction

The combination of Short stature, Auditory canal atresia, Mandibular hypoplasia, and Skeletal abnormalities (SAMS, OMIM 602471) has been reported as a very rare, autosomal-recessive developmental disorder with unique skeletal anomalies. It is caused by mutations in the GSC gene. There are a number of striking orthopedic diagnoses within the SAMS syndrome.

Goal
This study will elaborate on the orthopedic aspects of the SAMS syndrome. A differential diagnosis and subsequent treatment recommendation is provided where possible.

Method

Up to now only four patients with SAMS syndrome have been reported worldwide. All known cases are elaborated on, orthopedic symptoms are enumerated.

Results

There are a number of striking orthopedic diagnoses within the SAMS syndrome. In particular the scapulohumeral synostosis and the bilateral congenital ventral dislocation of the hips. The differential diagnosis of the other orthopedic aspects of SAMS syndrome is broad. Early diagnosis of each symptom allows for early recognition and subsequent follow-up. Treatment in most cases is conservative, although functional impairment can determine otherwise.

Conclusions and recommendations

Whenever a bilateral congenital ventral dislocation of the hips and or a scapulohumeral synostosis is found or clinically suspected, SAMS syndrome should be considered as primary diagnosis until proven otherwise.

Validation of the OrthoPilot TKA 4.3 Kobe version® software in the measurement of continuous passive kinematics in three dimensions of the prosthetic knee

By Florent Baldairon ()Scott Arthur Banks ()Lindsey Palm ()

Abstract Id: 5402
Event: EORS 2019
Topic: Biomechanics

Introduction

The study of kinematics of the prosthetic knee is fundamental to understand pain after total knee arthroplasty (TKA), without cause. The navigation has been developed to get accurate placement of TKA through 3D modeling of bone and the measurement of their movements. But the measurement of knee kinematics has not been validated. The hypothesis of this study was that measurement of the knee axis, fémoral rotation, fémoral translation in relation to the tibia, and medial and lateral gap during continuous passive knee flexion, by the OrthoPilot system ® TKA 4.3 Kobe version, differed from measurement obtained by fluoroscopy.

Goal
To validate the OrthoPilot TKA 4.3 Kobe version® software in the measurement of continuous passive kinematics in three dimensions of the prosthetic knee.

Method

Ten cadavers knees preserved by chemical method were used. e.Motion® FP prothesis (BBraun-Aesculap) was implanted using Kobe version of the OrthoPilot TKA Version 4.3 navigation system. Kinematic measurement with the navigation system was then performed simultaneously with the recording of fluoroscopies during a continuous passive flexion movement of the prosthetic knee, twice. Kinematic measurements were extracted from the fluoroscopic recordings by post-processing using the JointTrack Auto® software. The main criteria were the knee axis, femoral rotation, femoral translation in relation to the tibia, and medial and lateral gap. The data analysis was performed by a Kappa correlation test. The concordance of the measures was evaluated using the intra-class correlation coefficient (ICC) and its 95% confidence interval.

Results

For the 20 kinematics studied, the ICC of HKA angle was 0.839 [0.820; 0.856], femoral translation 0.560 [0.517; 0.600], femoral rotation 0.652 [0.616; 0.686], medial gap 0.905 [0.894; 0.916] and lateral gap 0.767 [0.740; 0.791].

Conclusions and recommendations

Measurements of knee kinematics with Orthopilot and fluoroscopy were consistent for medial and lateral gap, HKA, but not for femoral translation and femoral rotation. These differences can be explained by a methodological bias, which concerned femoral reference used by the two systems. However, the OrthoPilot system can not be validated as a accurate instrument for measuring prosthetic knee kinematics.

Generation of A 3d Gradient Inducing a Precise Control Over Phenotype And Pre-Vasculature For Osteochondral Tissue Modelling

By Raphaël F. Canadas (3B's Research Group, I3Bs – Research Institute on Biomaterials, Biodegradables and Biomimetics, University of Minho, Headquarters of the European Institute of Excellence on Tissue Engineering and Regenerative Medicine, AvePark, Parque de Ciência e Tecnologia, Zona Industrial da Gandra, 4805-017 Barco, Guimarães, Portugal; ICVS/3B’s–PT Government Associate Laboratory, Braga/Guimarães, Portugal; Bio-Acoustic MEMS in Medicine (BAMM) Laboratory, Canary Center at Stanford for Cancer Early Detection, Department of Radiology, Stanford School of Medicine, Palo Alto, California 94304, USA)Tanchen Ren (Bio-Acoustic MEMS in Medicine (BAMM) Laboratory, Canary Center at Stanford for Cancer Early Detection, Department of Radiology, Stanford School of Medicine, Palo Alto, California 94304, USA)Alexandra P. Marques (3B's Research Group,
Abstract Id: 5396  
Event: EORS 2019  
Topic: Biomaterials

Introduction

Gradients of 3-D hierarchical tissues are common in nature and present specific architectures, as this is the case of the anisotropic subchondral bone interfaced with articular cartilage [1]. While diverse fabrication techniques based on 3D printing, microfabrication, and microfluidics have been used to recreate tailored biomimetic tissues and their respective microenvironment [2,3], an alternative solution is still needed for improved biomimetic gradient tissues under dynamic conditions with control over pre-vasculature formation.

Goal

Here, we engineered a gradient osteochondral human-based tissue with precise control over both cell/tissue phenotype and pre-vasculature formation, which opens-up possibilities for the study of complex tissues interfaces, with broader applications in drug testing and regenerative medicine.

Method

The fabrication of three-dimensional gradient of microparticles was performed combining methacrylated gelatin (GelMA) and gellan gum (GG) with hydroxyapatite microparticles (HAp). The mixing of the interface was controlled by the temperature of two polymeric layers, being the second added at 10 ºC higher than the first one. This subsequent addition of polymeric solutions at different temperatures promoted convection, which drove the microparticles through the interface of the two gels forming the gradient. After ionic and photo-crosslinking, the freezing step was programmed using an external cover of styrofoam forcing the ice crystals to grow linearly, generating an anisotropic gradient scaffold. A dual-chamber microreactor device was designed (figure 1A) to culture fat pad adipose-derived stem cells and microvascular endothelial cells under two biochemical microenvironments.

Results

Using control over temperature and crosslinking, hydrogel-like structures were built in 3-D isotropic and anisotropic HAp gradients. Then, an in vitro osteochondral tissue model was obtained using a dual-chamber platform (figure 1Bi). Results showed a significant difference of SOX9 (p < 0.05) and RUNX2 (p < 0.05) from the top to the bottom regions of the 3-D gradient structures under dynamic conditions (figure 1Bii). Finally, a pre-vasculature was controlled over 7 days, stimulating the subchondral bone-like region 35% more (p < 0.05) when compared to the cartilage-like region (figure 1C).
Conclusions and recommendations

In this work, microparticle and biochemical gradients were fabricated into iso- and anisotropic architectures. The obtained outcomes enable the precise control of 3-D gradients in different architectures, such as anisotropic or isotropic structures, with broad applications in interfaced tissue engineering, regenerative medicine and drug testing.

The role of Intrarticular Administration of Fetuin-A in Post-Traumatic Knee Osteoarthritis. An experimental study in a rat model

By Eleni Pappa (KAT General Hospital of Athens, Greece) Savvas Papadopoulos (Pathology Department, Hygeia General Hospital of Athens, Greece) Despina Perrea (Laboratory of Experimental Surgery and Research “N.S. Christeas”, Athens Medical School, Greece)

Abstract Id: 5392
Event: EORS 2019
Topic: Cartilage

Introduction

Osteoarthritis is a slowly progressive disease which includes the intervention of several cytokines and macrophage metalleinoproteinases reaction, leading to the degradation of the local cartilage but also having an impact on the serum acute phase proteins (APPs). Subsequently, biomarkers seem to be essential to estimate its progression and the need for any surgical intervention such as total arthroplasty, but also can be used as therapeutic agents. Recently, among APPs, fetuin A drew attention regarding its possible antiinflammatory role in animal models but also as a therapeutic agent in the inflammatory joint disease in clinical trials.

Goal

The purpose of this study is to investigate the possible attenuating role of the intra-articular administration of Fetuin-A in post-traumatic induced secondary osteoarthritis in rats, and also its effect on the systematic levels of IL-2, 4, 7, BMP2, 4, 7, CRP and Fetuin –A.

Method

30 male Sprague Dawley rats were separated in two groups where post-traumatic osteoarthritis was induced surgically by Anterior Cruciate Ligament Transection and the transection of the Medial Collateral Ligament of the right knee. In the Control Group, only surgical intervention took place. In Fetuin Group, along with the induction of osteoarthritis, a single dose of bovine fetuin was administrated intra-articularly intra-operatively in 5 and 8 weeks of the experimental protocol. Both groups were examined for 8 weeks. The levels of...
interleukins, bone morphogenetic proteins, Fetuin-A and C-Reactive Protein were evaluated by ELISA of peripheral blood in three time periods: preoperatively, 5 and 8 weeks postoperatively. Osteoarthritic lesions of the knee were classified according to the Osteoarthritis Research Society International Grading System, by histologic examination and the Modified Mankin Score.

Results

IL-2 levels were significantly decreased in the Fetuin Group. No statistical difference was signed on the levels of IL-7, BMP-2,4,7 and Fetuin-A between the two groups. CRP levels were significantly increased in the Fetuin Group in 5 weeks of the experiment. Fetuin Group signed better scores according to the OARSI classification system and Modified Mankin Score, without any statistical significance.

Conclusions and recommendations

Intra-articular administration of Fetuin-A restrictively affected the progression of post-traumatic arthritis in rats, as only the levels of IL-2 were decreased as well as limited osteoarthritic lesions were observed on the Fetuin Group.

The use of Virtual reality simulation of percutaneous pedicle screw fixation; is there a training effect?

By Mr Alexander Charalambous (The Royal London Hospital) Mr Neil Segaren (The Royal London Hospital) Mr Kalpesh Vaghela (The Royal London Hospital)

Abstract Id: 5389
Event: EORS 2019
Topic: Spine

Introduction

Virtual reality (VR) offers a risk free environment for surgical trainees to practice procedures. Recent changes to training and increased pressure to fill rota gaps in UK hospitals have put even more strain on surgical training. Exposure to specialised procedures such as pedicle screw fixation is often limited to placements within a particular subspecialty and training opportunities are therefore even more limited.

Goal

Our aim was to assess whether the use of a VR simulator of percutaneous guidewire placement would demonstrate a training effect.

Method
We recruited twenty-four participants, consisting of medical students, postgraduate doctors and specialty doctors in Orthopaedics and Neurosurgery. They were equally divided into three groups based on previous surgical experience; novice, intermediate or expert. The performance metrics measured were; total score, total time, fluoroscopy use, zone of wire placement, wall violation and final wire depth. Each participant performed the procedure in a set order through both left and right pedicles of lumbar vertebrae, resulting in four sets of data per person. The data was then analysed, using a multi-level linear regression model.

Results

Initial analysis showed very little variation in total score, zone of wire placement, wall violation and final wire depth. Analysis of learning effect therefore concentrated on time and fluoroscopy exposure and was performed separately for each group. There was a statistically significant reduction in time taken and fluoroscopy exposure over the four attempts for both novices and intermediates. The novice group showed a marked reduction in time taken with a median time of 390 seconds on the first attempt and 147 in the final attempt (P

Conclusions and recommendations

VR simulation should be considered a valuable method of augmenting surgical training in Orthopaedics and Neurosurgery. The improvement shown in the novice and intermediate groups suggests a significant learning effect with practice. As this was only evident in the less experienced groups, it suggests VR training would be most useful for trainees. As expected, the experienced group showed the best results overall. This therefore resulted in little scope for improvement. Exposure to procedures such as percutaneous pedicle screw fixation is limited and can result in serious complications. VR simulation would be especially useful for trainees moving into this subspecialty field for the first time, where a procedure can be attempted without risk to patients.

Construct validation of a Virtual reality simulator for percutaneous lumbar pedicle screw guidewire insertion

By Mr Alexander Charalambous (The Royal London Hospital)Mr Neil Segaren (The Royal London Hospital)Mr Anil Haldar (The Royal London Hospital)

Introduction

Surgical training is an ever-increasing challenge. Over recent years there have been several well-documented factors that have reduced operating exposure both in the UK and the rest of Europe. As we look to other methods of training to compensate for this, Virtual reality (VR) is increasing in popularity. Much of the previous research with VR in Orthopaedics has
centred on arthroscopy and fracture fixation. Through our research, we aim to show that the benefit of VR simulation is not limited to these procedures alone but also applies to more specialist procedures. We assessed the construct validity of a VR simulator for the percutaneous insertion of a pedicle screw guidewire in the lumber spine.

**Goal**

Our aim was to show that the benefit of VR simulation also applies to more specialist surgical procedures. We assessed the construct validity of a VR simulator for the percutaneous insertion of a pedicle screw guidewire in the lumber spine.

**Method**

Twenty-four participants were recruited into this study. They consisted of medical students, postgraduate doctors and specialty doctors. They were equally divided into three groups based on previous surgical experience; novice, intermediate or expert. The simulator provided six performance metrics that were recorded for each participant. These included total score, time, fluoroscopy use, zone of wire placement, wall violation and final wire depth. Each participant performed the procedure in a set order through both left and right pedicles of lumbar vertebrae, resulting in four sets of data per person. The data was then analysed for statistical significance.

**Results**

The results for time revealed a statistically significant difference between the three groups (p

**Conclusions and recommendations**

As pedicle screw fixation is a specialised procedure, experts would most likely have had the most frequent exposure to this procedure as well as the highest exposure historically. This study therefore supports the construct validity of the VR simulator for percutaneous pedicle screw guidewire fixation. VR simulation can now be considered a valuable method of augmenting surgical training for more specialised procedures where exposure is already limited. This would be especially useful for trainees moving into a subspecialty field for the first time, where a procedure can be attempted with no risks to patients. The simulator can also be considered as a valid assessment tool of technical skill of a surgeon in this field.

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**Anterior cruciate ligament reconstruction and return to sport: survey among orthopedic surgeons in the Netherlands**

By BB Koc (Orthopedic Surgery, Zuyderland Medical Centre)MGM Schotanus (Orthopedic Surgery, Zuyderland Medical Centre)EJP Jansen (Orthopedic Surgery, Zuyderland Medical Centre)

Abstract Id: 5385
Introduction

Despite the large-scale use of anterior cruciate ligament (ACL) reconstructions, controversy remains regarding the optimal surgical technique, selecting the optimal graft and defining conditions to return to sport.

Goal

The purpose of this study was to evaluate the preferences and opinions of orthopedic surgeons on ACL reconstruction and return to sport in the Netherlands.

Method

A web-based survey among the Dutch Association of Arthroscopy was conducted. Clinical agreement of the members was defined as a minimum of 80% in matching responses.

Results

A total of 125 members (24.0%) were included in the analysis. No clinical agreement on indications for ACL reconstruction was achieved. A total of 87.2% (n=109) used hamstring autografts for ACL reconstruction. The anteromedial technique was favored by 50.4% (n=63), whereas 11.2% (n=14) of the members favored the transtibial technique. Return to sport after 9 months of ACL reconstruction was allowed by 75.2% (n=94) of the members. A total of 85.6% (n=107) stated postoperative period as an important criterium for return to sport. No clinical agreement was achieved on the importance of clinical examination, patient reported outcome measurements and functional tests for return to sport.

Conclusions and recommendations

The majority of the members of the Dutch Association of Arthroscopy used hamstring autografts for primary ACL reconstruction. Thereby, the postoperative period has been stated as an important criterium for return to sport. The present study however highlights the need for further studies regarding indications for ACL reconstruction, surgical technique and criteria for return to sport.

Evaluation of the Etiologies of Implant Fracture in Patients With Fractures of the Implants of Lower Limbs’ Long Bones

By BABAK OTOUKESH (universitatsklinikum bonn) PEYMAN KAGHAZIAN (universitatsklinikum bonn)

Abstract Id: 5376
Introduction

Orthopedics implants are important tools for treatment of bone fractures. Despite available recommendations for designing and making the implants, there are multiple cases of fracture of these implants in the body. Hence, in this study the frequency of failure of implants in long bones of lower extremities was evaluated.

Goal

Hence, in this study the frequency of failure of implants in long bones of lower extremities was evaluated.

Method

In this cross-sectional study, two types of fractured implants in the body were analyzed and underwent metalogical, mechanical, and modeling and stress-bending analysis.

Results

The results revealed that the main cause of fractures was decreased mechanical resistance due to inappropriate chemical composition (especially decreased percentages of Nickel and Molybdenum).

Conclusions and recommendations

It may be concluded that following the standard chemical composition and use of optimal making method are the most important works for prevention of failure of implants.

Evaluation of inflammatory response in patients undergoing surgical treatment for early and delayed femoral fractures

By BABAK OTOUKESH (IRAN UNIVERSITY OF MEDICAL SCIENCES)

Introduction

It has been shown that long bone fractures are correlated with the inflammatory response. In the initial injury, surgical reduction and fixation of fractures induce the immunoinflammatory...
response. This study aimed to evaluate serum variation of inflammatory markers in patients undergoing surgical treatment for early and delayed femoral fractures

Goal

This study aimed to evaluate serum variation of inflammatory markers in patients undergoing surgical treatment for early and delayed femoral fractures

Method

This study aimed to evaluate serum variation of inflammatory markers in patients undergoing surgical treatment for early and delayed femoral fractures. The patients were randomly divided into two groups using the method of block randomization including early surgery (within 24 h) and delayed surgery (after 48 h). Serum levels of inflammatory markers in both groups including interleukin (IL)-1, 5, 6, tumor necrosis factor α (TNF-α) and interferon γ (IFN-γ) were determined using specific kits. From each patient 10 ml blood was collected for cytokine assay in their serum.

Results

Our findings suggest that serum levels of IL-8 were markedly decreased from 12 h until 48 h postoperatively (p < 0.05). Moreover, the results indicated that serum levels of TNF-α were significantly increased in the early hours, but after 48 h a decreasing trend was detected (p < 0.05). Furthermore, serum levels of IL-10, IFN-γ, and IL-6 were significantly increased from 12 h until 48 h postoperatively (p < 0.05)

Conclusions and recommendations

The inflammatory status of the patient may be a useful adjunct in clinical decisions. With an improved understanding of the molecular basis of the inflammatory response, and by identifying relevant clinical markers of inflammation, surgeons can better manage the timing of surgical stabilization

The first results of the infinity ankle replacement: a short-term clinical and radiographic assessment

By Peije Stam ()Martijn Poeze (MD, PhD)Adhiambo Witlox (MD, PhD)

Abstract Id: 5366
Event: EORS 2019
Topic: Arthroplasty

Introduction
Total ankle replacement (TAR) is increasingly used in the treatment of end-stage ankle arthropathy, but much debate exists about the clinical result. The goals of present study are: 1) to provide the first short-term clinical outcome of 12 TAR’s and 2) to assess the association between functional outcome and PROMS.

Goal

Success rate Ankle replacement

Method

We reviewed a prospective included cohort of 12 TAR’s in 12 patients with a mean age of 66.6 years (range 58.5-74.7) and a mean follow-up of 5.8 months (range 3-12). The TAR’s where performed by a single surgeon in a single centre (MUMC) between 2018 and 2019, using the infinity ankle replacement. A standard surgical protocol and standardized post-op rehabilitation was used. Patients were followed-up pre-op and at 1 day, 6 weeks, 3-6-12 months post-op. The PROMS, AOFAS/ EQ-5D/ FAOS/ MOX-FQ, were measured and range of motion (ROM) were assessed and all complications, re-operations and the presence of pain (VAS) were recorded. Radiographic assessment consisted of the estimation of prosthesis alignment, migration, translation and radiolucent lines using the Rippstein protocol (1). The clinical outcome was compared with a systematic review of TAR outcome.

Results

No complications occurred. The functional outcome improved after surgery and still improved till 12 months (23.3 ± 6.5 to 37.0 ± 4.5 degrees). Radiologically 3% of the TAR’s were positioned in varus (2.3 ± 4.8 degrees) and none in valgus. Finally, pain decreased significantly from 6 to 0.8 The EQ-5D improved from 0.8 to 0.9 while MOX-FQ improved from 030 to 88

Conclusions and recommendations

The first short term results of the infinity ankle replacement show promising results concerning no complications occurred and better functional and clinical outcome.

Topological and compositional gradients to generate 3D textured living microfibers resembling tendon-to-bone interface

By Isabel Calejo (3B’s Research Group, i3Bs - Research Institute on Biomaterials, Biodegradables and Biomimetics, University of Minho, Headquarters of the European Institute of Excellence on Tissue Engineering and Regenerative Medicine, Guimarães, Portugal)Raquel Costa-Almeida (3B’s Research Group, i3Bs - Research Institute on Biomaterials, Biodegradables and Biomimetics, University of Minho, Headquarters of the European Institute of Excellence on Tissue Engineering and Regenerative Medicine, Guimarães, Portugal)Rui L. Reis (3B’s Research Group, i3Bs - Research Institute on
Biomaterials, Biodegradables and Biomimetics, University of Minho, Headquarters of the European Institute of Excellence on Tissue Engineering and Regenerative Medicine, Guimarães, Portugal; ICVS/3B’s—PT Government Associate Laboratory, Braga/Guimarães, Portugal; The Discoveries Centre for Regenerative and Precision Medicine, Headquarters at University of Minho, Guimarães, Portugal)

Abstract Id: 5362  
Event: EORS 2019  
Topic: Biomaterials

Introduction

Tendon-to-bone multi-tissue transition exhibits a hierarchical and continuous gradient of matrix composition and alignment, allowing for efficient transmission of mechanical loading between tendon and bone. Upon injury, main problems associated with tendon-to-bone regeneration include disorganized matrix deposition, together with a gradual loss of mineral content resulting in poor mechanical properties, limiting tissue integration and the formation of a graded interface.

Goal

To overcome these challenges, we propose the assembly of two types of continuous microfibers with distinct topological and compositional features tailored to guide cell alignment and matrix deposition while matching the mechanical requirements of the native tissue.

Method

Wet-spinning was used to produce textured composite microfibers using different flow rates and two polymer blends to replicate the anisotropic architecture of tendon (PCL/Gelatin, 22/9%, w/v) and the isotropic organization together with mineral composition of bone (PCL/Gelatin/Hydroxyapatite, 22/9% w/v and 7.7% w/w HAp). Morphology, chemical and mechanical properties of obtained microfibers were evaluated. Biological performance was studied using human adipose-derived stem cells (hASCs). Cytoskeleton alignment, nuclei elongation, and matrix mineralization were evaluated. Additionally, textile techniques were used to create a 3D fibrous scaffold. Morphological features were analyzed by micro-CT.

Results

PCL/Gelatin fibers produced at 1 mL/h extrusion rate exhibited the highest anisotropic alignment, in opposition to PCL/Gelatin/HAp fibers produced under the same condition (Figure 1-A). Micro-CT analysis of PCL/Gelatin/HAp fibers demonstrated variations within pore diameter and particles size between the different flow rates. Herein, PCL/Gelatin fibers induced a higher cytoskeleton alignment and nuclei elongation (p < 0.0001) in seeded hASCs (Figure 1-A). In contrast, significantly higher mineralization was found in PCL/Gelatin/HAp fibers (day 7, p < 0.04; day 14, p < 0.0001) as observed by alizarin red staining and quantification, suggesting the induction of an osteogenic-like phenotype. As proof of concept, textile techniques were used to assemble the two types of fibers and create a 3D scaffold presenting a continuous gradient in HAp content, as well as topological cues (Figure 1-B, i). After 14 days of culture with hASCs, a gradient of collagen deposition and matrix
mineralization was found (Figure 1-B, ii-iii; * p < 0.014, **** p < 0.0001). Higher deposition of collagen type II was observed in the tendon and interface parts of the fibrous scaffold and collagen type X in the interface.

Conclusions and recommendations

Overall, the wet-spinning method was efficiently used to engineer continuous textured composite microfibers with distinct topological and compositional features. PCL/Gelatin fibers supported cell alignment mimicking tendon cell organization, while PCL/Gelatin/HAp fibers induced mineral deposition and possibly a phenotypic change without the need of additional medium supplementation. Straightforward textile techniques allowed assembling of fibers and fabrication of 3D scaffolds envisioning tendon-to-bone applications.

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Excellent survival of two different anatomically adapted hydroxyapatite coated cementless THAs. A follow-up of more than 11 years.

By IJM Heijnens (Resident orthopedic surgery Zuyderland Medical Centre)MGM Schotanus (Research manager orthopedic surgery Zuyderland Medical Centre)EM van Haaren (Orthopedic surgeon Zuyderland Medical Centre)

Abstract Id: 5347
Event: EORS 2019
Topic: Arthroplasty

Introduction

There are many different types of cementless anatomically adapted Total Hip Arthroplasties (THAs) on the market. The Anatomic Benoist Gerard (ABG) I and II are such types of cementless THAs and are investigated in several studies however never compared with each other. In this retrospective single-centre study we evaluated the overall survival with revision for any reason and aseptic loosening as endpoint at more than 11 years follow-up of the two different types of anatomically adapted hydroxyapatite coated cementless THAs. We hypothesis that the ABG-II THA had a higher survival rate compared with the ABG-I THA.

Goal

The overall long-term survival with revision for any reasons as endpoint of two anatomically adapted cementless THAs.
Method

Between 2000 and 2004, 244 cementless THAs were performed in 230 patients in a primary care hospital. The initial diagnosis for THA was primary osteoarthritis in 97.1%. At a mean of 11.3 years follow-up (range 9.8 – 12.8 years) clinical examination, plain radiography and Patient Reported Outcome Measures (PROMs) were obtained and analysed. The PROMs consisted of the Oxford Hip Score (OHS) and the Western Ontario and McMaster University Index (WOMAC). Patients unable to attend the follow-up appointment were contacted by telephone to make inquiries on possible revision surgery of their THA and PROMs were obtained.

Results

At a mean of 11.3 years follow-up 32 patients (13.1%) had died of unrelated causes. Of the remaining cohort all 198 patients (212 THAs) have been reached for evaluation. In 62 patients (66 THAs) had a partial follow-up and 136 patients (146 THAs) had a full follow up. There were no patients considered as lost to follow-up. At a mean of 11.3 years 11 patients (11 THAs) had a revision of either the femoral stem or acetabular component resulting in an overall survival of 95.5%. There was no statistically significant difference (p=0.564) in survival between the ABG I and II THAs. Radiographic there were no changes between the ABG I and II at more than 11 years of follow up. In PROMs (OHS and WOMAC) the ABG II performed statistically significant better with exception of the WOMAC pain score.

Conclusions and recommendations

We concluded that both anatomically adapted hydroxyapatite coated cementless THAs show excellent survival at more than 11 years follow-up. The ABG II performed statistically significant better on PROMs.


By LJM Heijnens (Resident orthopedic surgery) MGM Schotanus (Research manager orthopedic surgery) AD Verburg (Orthopedic surgeon)

Abstract Id: 5346
Event: EORS 2019
Topic: Arthroplasty

Introduction
Insert liner wear of the acetabular component is one of the predictive values for survival of Total Hip Arthroplasties (THAs) therefor the wear of the acetabular component needs to be as low as possible. Ultra-high molecular weight polyethylene (UHMWPE) and cross-linked UHMWPE are currently the most used insert liners in THA. UHMWPE, however, is vulnerable to long-term wear and release of polyethylene (PE) particles. Carbon-Fiber-Reinforced Poly-Ether-Ether-Ketone (CFR-PEEK) used as insert liner in THAs is thought to lead to low wear rates there laboratory ex-vivo studies show excellent wear resistance of CFR-PEEK. However in-vivo survival rates and wear rates have not been clarified. This prospective single-centre study was designed to evaluate the follow-up of CFR-PEEK insert liner used as bearing in cementless THAs and thereby the first study with follow up of CFR-PEEK used as bearing in THAs.

Goal

The goal of this study was to identify if CFR-PEEK used as insert bearing in THAs lead to lower wear rates and if CFR-PEEK used as insert bearing in THAs show higher survival rates compared with conventional PE used as insert bearing.

Method

Twenty-nine healthy patients with an indication for cementless THA were selected for a CFR-PEEK insert liner and followed over time. All patients received a Antomic Benoist Girard (ABG) II cementless THA with a CFR-PEEK insert liner used as bearing. At different follow-up moments patients were routinely examined and were analysed using the Oxford Hip Score (OHS), the modified Merle d’Aubigne-Postel (MAP) score, and radiologically. At the follow up moments the plain radiographs where assessed for loosening, cyst formations and wear of the CFR-PEEK liners. We used General Linear Mixed Model (GLMM) analysis for repeated measurements over time.

Results

At a mean of 14.3 years follow-up four revisions of the acetabular component were performed, resulting in a survival rate of 86.5% (CI 95% 72.4–96.6). During revision surgery the acetabular components were loose with a blackish mild reactive joint fluid. Also black colouring of the capsule was found in all cases, and in two cases a quite extensive pseudotumour formation was seen (Figure 1). The retrieved acetabular components were analyzed, and the synovial fluid and acetabular interface showed increased reactive fibrosis with a mild aspecific inflammatory reaction, mainly macrophage activity with some hemosiderine pigmentation. No giant-cell activity was observed. Also, signs of metallosis were seen with blackish CFR-PEEK particles (Figure 2). A statistically significant difference in OHS and MAP scores between pre- and postoperative follow-up moments was observed. The acetabular components of the remaining patients showed no radiological abnormalities at 14.3 years follow-up. The overall CFR-PEEK wear was low, with a mean of 0.81mm (0.2–1.4) wear at 14.3 years follow-up.

Conclusions and recommendations

In this series we found an aseptic loosening with unclear reasons in four well-positioned acetabular components, hence we do not recommend routine use of CFR-PEEK insert liners as bearing in cementless THAs. All the remaining THAs and acetabular components with CFR-PEEK insert liners were in situ without abnormalities at 14.3 years follow-up.
Expression of the ribosomal RNA pseudo-uridylase Dyskerin is decreased by inflammatory mediators in articular chondrocytes.

By Guus van den Akker (Maastricht University Center+) Alzbeta Chabronova (Maastricht University Center+) Donatus Surtel (Maastricht University Center+)

Abstract Id: 5330
Event: EORS 2019
Topic: Cartilage

Introduction

Post-transcriptional modification of RNA is an emerging field in epigenetics. Previously, we found that inflammatory mediators alter ribosomal (r)RNA expression in chondrocytes. rRNAs are heavily post-transcriptionally modified and this is crucial for ribosome function. Dyskerin (DKC1) is a multifunctional protein that pseudouridylates specific rRNA nucleotides. These modifications are required for ribosome biogenesis and faithful protein translation. We hypothesized that Dyskerin is required for maintenance of the chondrocyte phenotype.

Goal

To evaluate Dyskerin expression levels in normal and OA cartilage and after stimulation with OA-mimicking agents and to determine the function of Dyskerin in chondrocytes.

Method

SW1353 chondrosarcoma and primary Human Articular Chondrocytes (HACs, p2-4) from osteoarthritic or non-osteoarthritic donors were exposed to IL1β or osteoarthritic (OA) -synovial fluid for 1-14 days. siRNAs targeting Dyskerin or a negative control (Eurogentec) were transfected (Trans-IT X2, Mirus Bio) and protein/RNA samples were harvested. Protein and gene expression of Dyskerin, rRNAs and chondrocyte phenotypic markers were evaluated by western blot and qPCR. Bicistronic luciferase reporters containing the CrPv IGR or HCV IRES were used to evaluate cap- and Internal Ribosomal Entry Site (IRES)- mediated translation.

Results

SW1353 and HACs were exposed to IL1β or OA-synovial fluid for 1 or 14 days. mRNA expression of DKC1 was evaluated and found to be reduced by 20% and 75%, respectively (Figure 1A). IL1β treatment of SW1353 cells led to a concomitant decrease of pre-5.8S rRNA levels. In non-OA HACs, OA synovial fluid treatment (n=10) also decreased pre-5.8S rRNA
expression, as well as mature 5.8S and 18S rRNA. To evaluate the function of DKC1 in chondrocytes, siRNA mediated knock-down was performed in SW1353 and OA-HACs. DKC1 knock-down was successful and reduced DKC1 protein expression by 80% (Figure 1B). Total cellular RNA levels were reduced, while protein content was not strongly affected in DKC1 knock-down cells (Figure 1C). This is in line with the known requirement of DKC1 for pre-rRNA processing, as more than 80% of total cellular RNA is rRNA. Subsequently, a panel of chondrocyte phenotype markers was evaluated and specifically ALPL gene expression was consistently decreased by 50-80% following DKC1-knock-down (Figure 1D). Previously, reduction of DKC1 levels was shown to differentially affect the ribosome’s mode of translation. Hence, we evaluated ribosome translation modus using bicistronic luciferase reporters. Consistent with literature we found a reduction of 50-80% in CrPv IGR and HCV IRES mediated translation, with a 20% reduction in cap-mediated translation as a consequence of DKC1 knock-down in SW1353 cells (Figure 1E).

Conclusions and recommendations

DKC1 gene expression in SW1353 and human articular chondrocytes is reduced by IL1β or OA-synovial fluid. Pre-5.8S rRNA levels were consistently reduced, while varying effects were observed at the mature rRNA level. At the chondrocyte phenotype level a strong reduction of ALPL expression was observed. Viral IRES mediated translation was reduced in DKC1 knock-down cells. Future experiments will focus on the consequences of decreased DKC1 expression on the chondrocyte phenotype. Relevant eukaryotic IRES structures will be subcloned into bicistronic reporters constructs to evaluate the role of IRES-mediated translation for the chondrocyte phenotype.

Injectable cryopreserved allogenic bone-forming cells derived from bone marrow MSC (ALLOB) display potent osteogenic and bone repair properties

By Sylvain Normand (Bone Therapeutics) Delphine De Troy (Bone Therapeutics) Coline Muller (Bone Therapeutics)

Introduction

Delayed fracture repair still represents an unmet medical need with a major disability for patients and a huge socio-economic burden. Allogenic cell-based therapies could represent a good alternative to the heavy autologous and allogeneic bone-grafting procedures that are currently used. While undifferentiated human mesenchymal stromal cells (MSC) are still at the forefront of many investigations, they display several limitations including limited
production yields and weak in vivo adherence, engraftment and differentiation. To attempt to fulfill this unmet medical need, we developed ALLOB (patented allogeneic cell therapy platform) constituted of human bone-forming cells derived from bone marrow (BM)-MSC. Here, we optimized the manufacturing process of ALLOB, significantly increasing the production yield, substantially reducing production costs, and delivering the product as a ready-to-use cryopreserved formulation.

Goal

This study aimed to characterize ALLOB in vitro and to evidence its bone formation and bone repair capacities in relevant animal models.

Method

Human BM cells from healthy volunteer donors were expanded in vitro into undifferentiated MSC (BM-MSC) or differentiated into bone-forming cells (ALLOB) according to Bone Therapeutics’ proprietary manufacturing process. ALLOB cells were characterized and compared to BM-MSC in vitro for the expression of chondro-osteogenic markers by RT-qPCR. ALLOB bone formation potential was assessed in vivo, 28 days after a single administration over the calvaria of 12-week old female NMRI-Nude mice, using X-ray and histological approaches. Bone healing capacity was tested in a segmental femoral sub-critical size defect (sub-CSD) model (2 mm) in female NMRI-Nude mice using X-Ray analyses over time (up to 10 weeks).

Results

In vitro, ALLOB cells expressed significantly higher levels of chondro-osteogenic markers such as BMP2, SOX9, MMP13 and ALP than undifferentiated BM-MSC, indicating their engagement into the chondro-osteogenic lineage. In vivo, a single dose of ALLOB significantly enhanced bone neoformation, 28 days post-administration over the calvaria of NMRI-Nude mice compared to the excipient (p

Conclusions and recommendations

These results demonstrate that ALLOB, an injectable and cryopreserved (ready-to-use) cell-based product, is able to greatly enhance the two ossification mechanisms involved in the physiological bone repair process. In conjunction with being injectable and having a high production yield, ALLOB proves to be a highly promising cell therapy candidate for the treatment of impaired fracture healing such as DU and NU, currently in preparation for a Phase III/late stage clinical trial application.

Preliminary study on the use of 3D printed models in the pre-operative planning of revision ACL reconstruction
Introduction

Revision anterior cruciate ligament (ACL) reconstruction is a technically demanding procedure, reporting poorer outcomes compared to the primary procedure. Identification of the cause of primary failure and a thorough pre-operative evaluation is required to plan the most appropriate surgical approach. 3D printing technology has become increasingly commonplace in the surgical setting. In particular, patient-specific anatomical models can be used to aid pre-operative planning of complicated procedures.

Goal

We have conducted a qualitative study to gauge the interest amongst orthopaedic knee surgeons in using a 3D-printed model to plan revision ACL reconstructions.

Method

A tibia and femur model was printed from one patient who is a candidate for the procedure. The binder jetting printing technique was performed, using Visijet PXL Core powder. 12 orthopaedic knee surgeons assessed the usefulness of the 3D-printed model compared to conventional CT images on a likert scale. 6 key steps of preoperative planning were assessed, including the size and location of the tunnel defects, the need for notchplasty, and whether a staged revision was required.

Results

We found that surgeons preferred the 3D-printed model to conventional CT images only, and 83% of them would use such a model for both pre-operative simulation, and as an intra-operative reference. However, there were some variation in the perceived usefulness of the model in several areas assessed. This may reflect differences in individual’s approach towards planning of the procedure.

Conclusions and recommendations

Our findings suggest that 3D-printed models could be a versatile pre-operative and intra-operative tool for complicated arthroscopic knee surgery. While 3D printing technology is becoming increasingly accessible and affordable, in-depth cost-effectiveness studies need to be conducted before it can be integrated into clinical. Further study would be needed to determine the clinical utility and economic cost-effectiveness of the 3D-printed model in revision ACL reconstruction.
Familial influences in Blount disease

By Niels Jansen (Maastricht University)

Abstract Id: 5314
Event: EORS 2019
Topic: Bone

Introduction

Blount disease is a rare paediatric orthopaedic condition, characterized by a growth arrest of the posteromedial part of the proximal tibia. This results in genu varum, internal rotation and procurvatum. Blount disease seems more common in the African and Afro-American population, for reasons that remain unclear. A few cases of familial occurrence of Blount disease are described in the literature and a genetic predisposition is suggested, however not extensively studied.

Goal

The objective of this study is to find familial influences and a genetic predisposition for Blount disease to create a better understanding of the aetiology of Blount disease.

Method

After checking patient files and conventional roentgenologic imaging, 139 patients with Blount’s disease were included of which 102 patients were interviewed. During the interviews, patient characteristics and a family history were collected. Blood samples were taken from 5 patients and 3 complete families (patient and both parents) and a Whole Exome Sequencing was performed.

Results

Although patients came from all over the country, 90% of the patients belonged to the Akan tribe. A positive family history was found in 63 families (61.8%). Approximately two-third had a positive family history in a first-degree family member. In most cases (64.2%) of positive family history, the bowed legs resolved itself, only 8.8% had severe bowing ‘just like the patient’ and in 27.0% some bowing of the legs remained. The first results of the standard WES did not show a clear genetic predisposition.

Conclusions and recommendations

This study describes the largest group of Blount patients in the literature. Because of the high numbers of positive family history and the centralization of our patients in the Akan region, a genetic predisposition is suggested. Further genetic research is essential for better understanding of Blount disease.
Orthopaedic trainees’ perceptions of the educational value of daily trauma meetings

By zakir Haider (university college hospital)

Introduction
The daily orthopaedic trauma meeting is considered to serve a dual purpose; a way of discussing management of trauma patients and as a forum for teaching with an assumed educational benefit.

Goal
The primary aim of this study was to explore orthopaedic trainees' perspectives on the educational value of trauma meetings and identify factors that influence educational benefit.

Method
An online survey was created after discussion with the British Orthopaedic Association (BOA) educational adviser and pilot testing. Orthopaedic registrar trainees with a national training number within England were emailed the survey, which was completed via the BOA website. Results were analysed using thematic analysis and online survey software.

Results
113 responses were recorded from ST3 to post-CCT trainees nationally within England. 73% of trainees found the trauma meeting to be educationally “valuable” or “very valuable”. 60% of trainees reported that the meeting “rarely” or only “sometimes” helped identify deficiencies in knowledge requiring improvement and only 30% felt they were asked questions to aid their learning. Positive perceived educational themes included the broad variety of cases being discussed, consultant discussion on patient management and trainees being questioned or engaged in discussions by consultants in a constructive manner. Negative themes involved time pressures, an aggressive and critical atmosphere and disorganised meetings. Trainee suggestions for improvement included a more supportive atmosphere conducive to learning, questioning with feedback and incorporation of educational activities such as structured daily teaching cases and daily review of post-operative radiographs.

Conclusions and recommendations
This is the first nationwide study providing a detailed insight into factors that influence the educational value of the trauma meeting. This study reveals positive and negative factors that affect trainee learning and suggests improvements directly sourced from trainees. Recommendations from this study can be applied to orthopaedic departments nationally,
serving as a guide for positive change to maximise educational benefit for trainees during trauma meetings.

Retrograde Femoral Nailing Through an Open Physis Does Not Impair Growth in Pigs

By Ahmed Abood (Aalborg University Hospital) Ole Rahbek (Aarhus University Hospital) Bjarne Møller-Madsen (Aarhus University Hospital)

Abstract Id: 5292
Event: EORS 2019
Topic: Bone

Introduction

The use of retrograde femoral intramedullary nails in children for deformity correction is controversial. It is unknown if the injury to the central part of the growth plate results in premature bony union, leading to limb deformities or discrepancies.

Goal

The aim of this study was to assess physeal healing and bone growth after insertion of a retrograde femoral nail thorough the centre of the physis in a skeletally immature experimental porcine model.

Method

Eleven immature pigs were included in the study. One leg was randomised for operation with a retrograde femoral nail (diameter 10.7 mm), whilst the non-operated contralateral remained as control. All nails were inserted centrally in coronal and sagittal plane under fluoroscopic guidance, and the nails spanned the physis. The nails were removed at 8 weeks. Both femora in all animals underwent MRI at baseline (pre-operatively), 8 weeks (after nail removal) and 16 weeks (before euthanasia). Femoral bone length was measured at 5 sites (anterior, posterior, central, lateral and medial) using 3d T1-weighted MRI. Growth was calculated after 8 weeks (growth with nail) and 16 weeks (growth without nail). Physeal cross-sectional area and percentage violated by the nail was determined on MRI. Operated side was compared to non-operated. Corresponding 95% confidence intervals were calculated.

Results

No differences in axial growth were observed between operated and non-operated sides. Mean growth difference was 0.61 mm [-0.78;2.01] whilst the nail was inserted into the bone and 0.72 mm [-1.04;1.65] after nail removal. No signs of angular bone deformities were found when comparing operated side to non-operated side. No premature bony healing at the physis
occurred. Histology confirmed fibrous healing. Mean physeal violation was 5.72% [5.51; 5.93] by the femoral nail.

Conclusions and recommendations

The insertion of a retrograde femoral nail through the centre of an open physis might be a safe procedure with no subsequent growth arrest. However, experiments assessing the long term physeal healing and growth are needed.

Stability of Internal Fixation for Distal Clavicular Fractures

By Kohei Kawai (Department of Orthopaedic Surgery, Kitasato University School of Medicine) Terumasa Matsuura (Department of Orthopaedic Surgery, Kitasato University School of Medicine) Hiroaki Minehara (Department of Orthopaedic Surgery, Kitasato University School of Medicine)

Abstract Id: 5193
Event: EORS 2019
Topic: Biomechanics

Introduction

After a distal clavicle fracture, the proximal fragment is pulled superiorly and posteriorly by the trapezius muscle, and the distal fragment is pulled inferiorly by the weight of the upper extremity. The bone fragments are likely to be displaced, and conservation therapy often results in a nonunion. Various surgical procedures are used to treat distal clavicle fractures. However, rigid internal fixation for reduction and securely hold is difficult because the distal fragment is small and the fracture site is near the acromioclavicular joint. Our patients have achieved favorable outcomes after surgical treatment with the Scorpion® (Ai-medic Co., Ltd.,) plate, which improves the fixation of a distal clavicle fracture by inserting 1 screw into the distal fragment and supporting the fracture site with 2 hooks.

Goal

In order to determine the stability of fixation achieved with Scorpion plate, we experimentally compared it with other characteristically different means of internal fixation.

Method

The following methods of internal fixation were selected: tension band wiring fixation; fixation with a LCP clavicle hook plate; and fixation with a Scorpion plate. All 3 means of internal fixation were applied to a plastic model of the clavicle according to the standard surgical procedure. After internal fixation, the parts of the model that correspond to bones were cut with a T-saw in order to make distal clavicle fracture models. Each clavicle fracture model was rigidly held using custom test bench for mechanical testing. The acromioclavicular joints of the models were loaded in testing machine in an upright manner. The maximum load
was set at 50 N, which exceeded the force of gravity, and the load velocity was set at 24 mm/min. The amount of displacement and bending stiffness at the fracture sites were determined and compared for each means of internal fixation. The clavicle was fixed vertically with the load transducer. The lateral end of the clavicle was clamped rigidly with the robotic arm actuator. Torsional tests were conducted at 1 degree/sec between 0 and 10 degree, while continuously sampling rotation and torque. The torsional stiffness was calculated by dividing a torque by the rotation.

Results

The amounts of displacement in bending at the fracture sites were approximately equal between the LCP clavicle hook plate fixation group and the Scorpion plate fixation group. No significant difference was found between the 2 groups. The amount of displacement in the tension band wiring fixation group was significantly larger than that in the other 2 groups. No significant difference in bending stiffness and torsional stiffness were found between the LCP clavicle hook plate fixation group and the Scorpion plate fixation group. Bending stiffness and torsional stiffness in the tension band wiring fixation group were significantly lower than that in the other 2 groups.

Conclusions and recommendations

Stability of fixation with Scorpion plate and LCP clavicle hook plate was similar, and it was stronger than fixation by tension band wiring.

Corrosion, notching and fracturing of the neck in total hip arthroplasty - two multiple revision cases and a critical review of the literature

By P.G. van Doesburg (Alrijne Ziekenhuis, Department of Orthopaedic Surgery, Leiderdorp, Netherlands)E.J. van Langelaan (Delft University of Technology, Biomechanical Engineering Department Biomaterials & Tissue Biomechanics Section, Delft, Netherlands)I. Apachitei (Delft University of Technology, Biomechanical Engineering Department Biomaterials & Tissue Biomechanics Section, Delft, Netherlands)

Introduction

A hip stem fracture, due to metallurgic problems, was a specific complication well known in the past. Better quality stainless steel reduced this problem. In the nineteen-seventies, the concept of head-neck modularity was introduced to provide more intraoperative surgical options. However, modularity also led to new problems at the trunnion (head-neck junction),
such as wear and corrosion at the head-neck interface (trunnionosis), fractures of the neck and head dissociations (gross trunnion failure). The problem of corrosion was not recognized, neither seen as a major problem, during a long time. However, new studies show that up to 3% of all total hip revisions are performed because of trunnionosis. The exact pathology of trunnionosis is unknown. Micromotions between the head and the taper causes disruption of the oxide film, leading to a bio-tribocorrosion phenomenon called mechanically assisted crevice corrosion (MACC). Loss of material by MACC and cyclic loading could lead to a neck fatigue fracture.

Goal

The purpose of our study was to present two unique cases of neck fractures from our orthopedic clinic and to identify potential risk factors for the development of neck fractures, as well as providing future treatment recommendations in hip arthroplasty to prevent damage of the neck and neck fractures.

Method

A detailed clinical report of two late neck fractures (20y and 24y post-primary THA), in one type of hip stem (cementless Mallory Head), is presented. Both patients had multiple hip revisions prior to the fracture. Scanning electron microscopy (SEM) and Energy Dispersive X-ray Spectroscopy (EDS) analysis was done together with a systematic review of the available literature on neck fractures in THA.

Results

SEM analysis of the neck side demonstrated a typical fatigue fracture, with the fatigue fracture originated at the neck surface. SEM analysis of the head side showed a small notch at the surface of the neck that seemed to be the starting point of the fatigue crack. The elemental analysis of the femoral stem performed by EDS indicted that the alloy has a chemical composition close to Ti6Al4V. The systematic review included 30 eligible studies, with a total of 79 neck fractures. The included patients had a mean age of 65 years (range 31y - 91y), a mean weight of 98kg (range 70kg – 140kg) and a mean BMI of 30kg/m2 (range 24kg/m2– 47kg/m2). Most patients were relatively young. Neck fractures occurred on average 7 years (range 4m – 24y) after hip stem placement. Mechanically assisted crevice corrosion and the use of long skirted femoral heads were frequently reported in head-neck region fractures, whereas most of the neck-shoulder region fractures were associated with specific implant design features. Thereby, we identified male gender, high body weight, obesity, previous revision surgery and design flaws as risk factors.

Conclusions and recommendations

In conclusion, several potential and preventable risk factors for neck fractures were identified, leading to specific recommendations for future primary and revision hip arthroplasty.

Does an interspinous process device affect the stress at pars interarticularis after
decompressive surgery in lumbar spinal stenosis?

By Haoju Lo (Dali Branch, Jen-Ai Hospital, Department of Orthopedic Surgery, Taichung, Taiwan)

Abstract Id: 5166
Event: EORS 2019
Topic: Biomechanics

Introduction

Minimally invasive (MI) lumbar decompression is a common procedure for spinal stenosis disease. These dorsal decompression procedures can benefit so many patients by reducing pain and recovering the function. Resections of the posterior bony structure of lamina and partial or total disc in decompression procedure are often performed, but they are also associated with potential postoperative spinal instability on posterior neural arch. Recently, many interspinous devices (IPD) have been combined with MI decompression for surgery of degenerative lumbar disc disease as a concept of dynamic stabilisation. The IPD is designed to restrict segmental motion and theoretically did some potential beneficial effect and avoided the development of adjacent level complications.

Goal

A current study has been done to evaluate the biomechanical influence of MI decompression plus the DIAM at the pars interarticularis area.

Method

The MI decompression procedures are simulated to including the laminotomy over mainly part of L3 and less part of L4 combined with discectomy over L3/L4 level. Finite element models were developed for the intact spine (INT), the DIAM was implanted at L3/4 (DIAM), the unilateral MI decompression procedures with DIAM (DIAM+uni), and the bilateral MI decompression procedures with DIAM (DIAM+bil). The models were subjected to axial loads and pure moments and evaluated by a hybrid method on range of motion (ROM)s, disc stresses, pars interarticularis stresses, and facet joint contact forces.

Results

The investigation revealed that decreased ROM, intradiscal stress, and facet joint force at the implant level, but considerably increased stress at the pars interarticularis were found during flexion and torsion at the L4, as well as during extension, lateral bending, and torsion at the L3, when the DIAM was implanted compared with the defect model.

Conclusions and recommendations

The MI decompressions are broadly being performed for lumbar spinal stenosis. The surgeon always concerns the risk of stress fracture for the remaining posterior neural arch. The IDP
did alter the biomechanical behaviour in various indications. The effects of IDP combined with MI decompression is still unclear, and no previous studies were known or done to study the changes of the posterior neural arch with MI decompression procedures plus IDP. The results demonstrate the DIAM apply a distraction force and unload the facet force in posterior element after MI procedure, but this implantation may lead to much greater stress concentrated in pars area, especially in the upper level of implanted segment. The increased stresses at the pars interarticularis could still be a risk factor for a stress fracture. The surgeon should consider the possibilities for pars fracture in active patients group after these procedures with IDP.

THE IMPACT OF PATIENT CHARACTERISTICS ON LENGTH OF HOSPITAL STAY FOLLOWING JOINT ARTHROPLASTY IN A DEVELOPING COUNTRY SETTING

By Akintunde George (University of Bath)Paul Ofori-Atta (St Joseph's Orthopaedic Hospital, Koforidua, Ghana,West Africa)

Abstract Id: 5147
Event: EORS 2019
Topic: Arthroplasty

Introduction

Patient characteristics can be considered a challenge for physicians and surgeons at the perioperative setting for arthroplasty surgery. In the established literature, evidence indicates that obesity, co-morbidity status can increase perioperative complications. However, data on how these impacts on the length of patients undergoing total knee and hip arthroplasty in a developing country setting remain rare.

Goal

The aim of this study to evaluate the impact of patients characteristics on in-patient hospital stay following joint arthroplasty in an arthroplasty unit in a developing country. This retrospective study seeks to shed light on the experience of joint arthroplasty in a sub-Saharan African setting.

Method

The patients who had undergone hip and knee arthroplasty surgery between 2013 and 2018 at an arthroplasty unit in Ghana West Africa had their data prospectively collected. Data on gender, age, BMI, procedure, length of stay, American Society of Anaesthesiologist (ASA) grading were collated and analysed. Patients who had delayed discharge due to social and
financial constraints or had incomplete data were excluded. Length of stay was determined when a patient was discharged after achieving satisfactory mobility post-operatively following physiotherapy assessment.

Results

There were 32 males and 59 females enrolled in this study. Patients were classified based on ASA and Obesity classification (See Tables 2 and 3). It was noted that length of stay for females was more than that for males but this was not statistically significant \( p = 0.41 \) (p value significant < 0.05). The mean length of stay based on ASA classification was as follows - ASA3 > ASA2 > ASA1 but the difference was not statistically significant \( p = 0.3 \). Furthermore, there was no statistically significant difference in mean length of stay based on patient’s obesity classification. There was an improvement in the length of stay from the mean of 5.2 days in 2014 to 4.7 days in 2018 however there was no significant difference over the years. There was also no correlation between age of patients and length of stay, \( r (91) = 0.07 \), (p value significant at

Conclusions and recommendations

We can conclude that notable patient characteristics such as age, ASA grading and obesity does not affect significantly on the length of hospital stay though there has been an improvement in the length of stay of arthroplasty patients over the years from 2013 to 2018. This could be an index on the performance and delivery of this arthroplasty service. However, it would be worth knowing how this affects functional outcome in these patients peculiarly in a developing country setting.

Trabecular Bone Score of Postmenopausal Women

By Şerife Şeyma Torgutalp (Department of Sports Medicine, Hacettepe University, Ankara, Turkey) Naila Babayeva (Department of Sports Medicine, Hacettepe University, Ankara, Turkey) Ömer Serkan Kara (Department of Sports Medicine, Hacettepe University, Ankara, Turkey)

Abstract Id: 5126
Event: EORS 2019
Topic: Imaging

Introduction

Osteoporosis is a common disorder characterized by low bone mass and reduced bone quality that affects the bone strength negatively and leads to increased risk of fracture. Bone mineral density (BMD) has been the standard instrument for the diagnosis of osteoporosis and the determination of fracture risk. Despite the approximation of the bone mass, BMD does not provide information about the bone structure. Trabecular bone score (TBS), which provides an indirect evaluation of skeletal microarchitecture, is calculated from dual X-ray
absorptiometry and a simple and noninvasive method that may contribute to the prediction of osteoporotic fractures in addition to the measure of bone density.

Goal

The goal of this study was to determine the mean TBS values in healthy postmenopausal women and the overall association between TBS and demographic features, bone mineral density of the lumbar spine and femoral neck and bone mineral density to body mass index ratio (BMD/BMI) of the lumbar spine.

Method

Fifty-three postmenopausal healthy women participated. The bone mineral density of the lumbar spine and femoral neck were measured dual X-ray absorptiometry. Anteroposterior lumbar spine acquisitions were used to calculate TBS for L1–L4. Age, height, weight, BMI and the ratio of BMD to BMI, which was considered to be a simple tool for assessing fracture risk in especially obese individuals, were calculated. The relationship between TBS and other variables was examined using Spearman’s rank correlation coefficients.

Results

Mean BMD of the lumbar spine and the femoral neck were 0.945 ± 0.133 and 0.785 ± 0.112 g/cm2, respectively (Table 1). Mean TBS was 1.354 ± 0.107. There were a significant positive moderate correlation between TBS and total lumbar BMD/BMI ratio (r=0.595, p

Conclusions and recommendations

TBS values of postmenopausal women were negatively correlated with age and BMI and positively with bone mineral density and BMD/BMI ratio. The ratio between lumbar BMD and BMI presented a stronger correlation with TBS than that of BMD with TBS. Because of the better correlation, the BMD/BMI ratio may be used as a simple tool for the assessment of the risk of fractures. Further investigation may be needed to evaluate the factors influencing exercise intervention on TBS on this population of patients.

Biphasic Plating – In vivo study on a novel fixation concept to enhance mechanobiological fracture healing

By L. Hofmann-Fliri (AO Research Institute Davos, Switzerland)D. Epari (Queensland University of Technology, Brisbane, Australia)R. Schwyn (AO Research Institute Davos, Switzerland)

Abstract Id: 5124
Event: EORS 2019
Topic: Bone
Introduction

Fracture fixation has advanced significantly with the introduction of locked plating and minimally invasive surgical techniques. However, healing complications occur in up to 10% of cases, of which a significant portion may be attributed to unfavorable mechanical conditions at the fracture. Moreover, state-of-the-art plates are prone to failure from excessive loading or fatigue. A novel biphasic plating concept has been developed to create reliable mechanical conditions for timely bone healing and simultaneously improve implant strength.

Goal

The goal of this study was to test the feasibility and investigate the robustness of fracture healing with a biphasic plate in a large animal experiment.

Method

Twenty-four sheep underwent a 2mm mid-diaphyseal tibia osteotomy stabilized with either the novel biphasic plate or a control locking plate. Different fracture patterns in terms of defect location and orientation were investigated. Animals were free to fully bear weight during the post-operative period. After 12 weeks, the healing fractures were evaluated for callus formation using micro-computer tomography and strength and stiffness using biomechanical testing.

Results

No plate deformation or failures were observed under full weight bearing with the biphasic plate. Osteotomies stabilized with the biphasic plate demonstrated robust callus formation (Figure 1). Torsion tests after plate removal revealed no statistical difference in peak torsion to failure and stiffness for the different fracture patterns stabilized with the biphasic plate. However, the biphasic plate group specimens were 45% stronger (p=0.002) and 48% stiffer (p=0.007) than the controls.

Conclusions and recommendations

The results of this large animal study demonstrate the clinical potential of this novel stabilization concept.

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REACTIVE MESENCHYMAL STROMAL CELLS IN THE ACID TUMOR MICROENVIRONMENT ENHANCE LUNG METASTASIS IN OSTEOSARCOMA

By Sofia Avnet (IRCCS Istituto Ortopedico Rizzoli) Silvia Lemma (IRCCS Istituto Ortopedico Rizzoli) Margherita Cortini (IRCCS Istituto Ortopedico Rizzoli)
Abstract Id: 5111
Event: EORS 2019
Topic: Other

Introduction

Osteosarcoma (OS) is an aggressive bone malignancy with a high metastatic rate despite severe treatments regimen. Previous attempts to fight OS have focused on cancer cells, without proper consideration to the complexity of tumor microenvironment (TME). We recently demonstrated in vitro that tumor cells create an acidic milieu that promotes the activation of NF-kB inflammatory pathway in the tumor-associated mesenchymal stromal cells (MSC), which foster the release of cytokines that, in turn, support OS proliferation, invasiveness, and metastasis. Therefore, the cancer stroma has been recently regarded as target for biological intervention.

Goal

In this study we wanted to demonstrated the role of MSC reacting to the tumor-associated acid microenvironment in OS progression. The MSC-OS identified paracrine pathways might serve for the future for the identification of innovative therapies.

Method

We developed an orthotopic xenograft mouse model of OS obtained by injection into the tibiae of a cell suspension of bioluminescent 143B OS cells, with or without MSC, in Balb/c nude mice, and the subsequent injection of MSC or vehicle in the tail vein once/week. This model spontaneously develops lung metastasis. We then measure intratumoral pH by using MRI-CEST live imaging and immunostaining, and we evaluated the number of lung nodules by both luciferase-based imaging and immunostaining.

Results

We found that the co-injection of MSC and 143B cells significantly increased primary tumor growth and that xenograft obtained by the intratibial co-injection of MSC and 143B cells has a median intratumoral acid pH value similar to those of tumors derived from the subcutaneous injection of 143B cells alone (Fig.1), and to the intratumoral ph of human sarcoma, as reported by the literature. Moreover, we confirmed the expression of LAMP2, an indirect marker of acidosis, into tissue sections of xenograft, suggesting that intratumoral acidosis could promotes the activation of inflammatory pathways in MSC also in vivo. The local inflammation might in turn enhances the systemic tumor aggressiveness. As a demonstration, MSC promoted the occurrence of spontaneous lung metastases, increasing both number and area of nodules at 12-15 days since tumor inoculation in respect to the xenografts injected only with tumor cells. Of note, the co-injection of MSC and 143B cells induced lung colonization in 100% of mice, whereas only 33% of mice injected with 143B cells alone developed lung nodules.

Conclusions and recommendations

Our results demonstrated in vivo that MSC recruited by OS cells into sites of rapid tumor growth boost OS proliferation and dissemination to secondary site by promoting the
activation of inflammatory pathways possibly in response to the tumor-derived acid accumulation. These results emphasize the pivotal role of the stroma in OS progression, and pave the way to innovative approaches targeting tumor-stroma interactions and MSC homing toward the tumor.

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**Posterior Shoulder Instability: Is the Risk higher than anterior in specific sports?**

By Ashley Simpson (Princess Alexandra Hospital, Harlow, UK) Stefan Sundelin (Karolinska Institut, Stockholm, Sweden) Bjorn Engstrom (Karolinska Institut, Stockholm, Sweden)

Abstract Id: 4964
Event: EORS 2019
Topic: Pathology

**Introduction**

Posterior shoulder instability may present with subtle clinical signs and provide a diagnostic challenge. It is much rarer than anterior shoulder instability though its incidence may be significantly under appreciated. Certain sports may place the athlete at increased risk of posterior instability and participation in such sports may be a diagnostic clue in the patient presenting with vague shoulder pain.

**Goal**

This study aims to assess whether specific sports, in which the arm is repetitively used in an adducted, flexed and internally rotated position (risk position), increases the risk of posterior shoulder instability compared to anterior.

**Method**

All athletes who underwent primary arthroscopic shoulder stabilization during 2009-11 were included. A retrospective analysis of patients’ case notes, imaging and pre-operative scores, including type of sport, was performed. Sports utilising the arm in the risk position were labeled Type I Sports (weight lifting, boxing, handball, cross-country skiing, acrobatics and gymnastics).

**Results**

196 consecutive patients were included. 163 patients underwent arthroscopic stabilization for anterior instability (Mean age: 30.5 years), and 33 patients underwent posterior stabilization (Mean age: 27.5 years) (p=0.146). 74.5% were male. 33.3% with posterior instability participated in Type I Sports compared to 12.3% with anterior instability (p=0.002). 81% undergoing anterior stabilization sustained significant shoulder trauma with only 31% undergoing posterior stabilization experiencing shoulder trauma (p

**Conclusions and recommendations**
Posterior shoulder instability is less common than anterior, but specific sports increase the risk of its development. These patients often present without significant trauma, but with symptoms of pain and a feeling of instability, suggestive of overuse injuries. A high index of suspicion for posterior instability is required, particularly in athletes from Type I Sports, in order to achieve an early diagnosis in this difficult clinical problem.

Symmetry of the Normal Ankle Syndesmosis Analyzed by a 3D Weightbearing and non-Weightbearing CT

By Tanguy Segers (BMSc) Daute De Brucker (BMSc) Wouter Huysse (MD, Musculoskeletal Radiology)

Abstract Id: 4958
Event: EORS 2019
Topic: Imaging

Introduction

Syndesmotic ankle injuries are present in one-fourth of all ankle trauma and may lead to chronic syndesmotic instability as well as posttraumatic ankle osteoarthiritis. The main challenge remains distinguishing syndesmotic ankle injuries from other types of ankle trauma. Currently, diagnosis is based on plain radiographs by comparing 2D measurements of the injured to the non-injured side (1). However, comparison of these bilateral measurements remains difficult since it is unclear to what extent the 3D configuration of the normal ankle syndesmosis is symmetrical.

Goal

We aimed to assess the 3D symmetry of the normal ankle syndesmosis between the right and left side in a non-weightbearing and weightbearing CT.

Method

In this retrospective comparative cohort study, patients with a bilateral non-weightbearing CT (NWBCT; N=28; Mean age=44, SD=17.4) and weight-bearing CT (WBCT; N=33; Mean age=48 years; SD=16.3) were analyzed. Consecutive patients were included between January 2016 and December 2018 when having a bilateral NWBCT or WBCT of the foot and ankle. Exclusion criteria consisted of hindfoot pathology and age less than 18 years or more than 75 years. CT images were segmented to obtain 3D models of the ankle bones (Fig. 1a). Computer Aided Design (CAD) operations were used to mirror and fit the left ankle on top of the right ankle (Fig. 1b). A Cartesian coordinate system was defined based on the tibia. The best fitted axis (FSAx) most inferior point of the apex of the lateral malleolus (AML), anterior tubercle (ATF) and posterior tubercle (PTF) were computed on the left and right fibula. Coordinates of these anatomical landmarks were used to quantify symmetry in all six degrees
of freedom (2). Statistical analysis was performed using the Mann-Whitney used test to allow comparison between measurements from a NWBCT and WBCT.

Results

Reference values were determined for each 3D measurement in a NWBCT and WBCT based on their 2SD (Table 1). The highest difference in translation could be detected in the anterior-posterior direction (Mean APNWBCT= -0.01mm; 2SD=3.43/Mean APWBCT=0.1mm; 2SD=2.3) and the highest difference in rotation was detected in external direction (Mean APNWBCT=0.3°; 2SD=6.7/Mean APWBCT=-0.2°; 2SD=5.2). None of these differences were statistically significant in the normal ankle syndesmosis when obtained from a NWBCT compared to a WBCT (P>0.05).

Conclusions and recommendations


Innovative Antimicrobial Surfaces for Orthopaedic Applications

By Martin Fabritius (B.Braun Aesculap AG)Amin Al-Munajjed (Bio-Gate AG)Markus Zehe (QualityLabs BT GmbH)

Abstract Id: 4956
Event: EORS 2019
Topic: Infection

Introduction

Implants have changed the medicine that we know today, improving the lives of many patients. Yet there are still substantial problems with bacterial infections and biofilm formation on artificial surfaces in the body. A periprosthetic joint infection (PJI) has a tremendous impact on both the patients quality of life and the healthcare system. In general, the risk of infection for primary prostheses is relatively low (0.5 to 2%). Beyond that, register data indicates that the infection rate after implant revision is significantly higher (~ 15%). This is more and more relevant due to the demographic development and the increase in revision rates.
Goal

Our goal was to provide an antimicrobial system that works on various implant materials. We evaluated a silver based antimicrobial coating (HyProtectTM) that can be applied to both metal and polymer surfaces.

Method

In vitro tests, in vivo Osteomyelitis model, in vivo osseointegration

Results

To prove the antimicrobial activity of HyProtectTM we used an in vitro test model that is able to mimic the in vivo situation and gives a good indication about the antimicrobial activity under realistic conditions. Furthermore, we successfully established an osteomyelitis model to verify the antimicrobial activity in vivo. We also demonstrated the unimpaired osseointegration of coated implant material in an animal study which is essential for the cementless fixation of implant components

Conclusions and recommendations

In our opinion, the HyProtectTM coating is a promising candidate in the fight against PJI.

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**Development of anisotropic collagen substrates with controlled rigidity for tendon tissue engineering**

By Ignacio Sallent (1 Regenerative, Modular & Developmental Engineering Laboratory (REMODEL), National University of Ireland Galway (NUI Galway), Galway, Ireland. 2 Science Foundation Ireland (SFI), Centre for Research in Medical Devices (CÚRAM), National University of Ireland Galway (NUI Galway), Galway, Ireland.) Dimitrios Zeugolis (1 Regenerative, Modular & Developmental Engineering Laboratory (REMODEL), National University of Ireland Galway (NUI Galway), Galway, Ireland. 2 Science Foundation Ireland (SFI), Centre for Research in Medical Devices (CÚRAM), National University of Ireland Galway (NUI Galway), Galway, Ireland.)

Abstract Id: 4955
Event: EORS 2019
Topic: Tendon

Introduction

Adherent cells are known to respond to physical characteristics of their surrounding microenvironment, adapting their cytoskeleton and initiating signaling cascades specific to the type of cue encountered. Scaffolds mimicking native biophysical cues have proven to differentiate stem cells towards tissue-specific lineages and to maintain the phenotype of
somatic cells for longer periods of time in culture. Biomaterial-based tendon implants are designed to withstand high physiological loads but often lack the appropriate biochemical, biophysical and biological structure to drive tendon regeneration by populating cells.

Goal

The objective of this study is to use tendon main component, collagen type I, to create scaffolds that reproduce tendon natural anisotropy and rigidity, in an effort to engineer functional tendon tissue with native organization and strength, able to maintain tenocyte phenotype and to differentiate stem cells towards the tenogenic lineage.

Method

Porcine collagen type I in solution was treated with one of the following cross-linkers: glutaraldehyde, genipin or 4-arm polyethylene glycol (4SP). The resulting mixture was poured on micro-grooved (2x2x2 μm) or planar PDMS moulds and air-dried to obtain 5 mg/ml collagen films. Surface topography and elastic modulus were analyzed using SEM/AFM and rheometry, respectively. Human tendon cells were cultured on the micro-grooved/planar scaffolds for up to 10 days. Cell morphology, collagen III and tenascin C expression were analyzed by immunocytochemistry.

Results

Among the different cross-linkers used, only the treatment with 4SP resulted in scaffolds with a recognizable micro-grooved surface topography. Precise control over the micro-grooved topography (fig 1B) and the rigidity (fig 1A) of the scaffolds was achieved by cross-linking the collagen with varying concentrations of 4SP(0, 0.5, 1 and 1.5mM) at low pH and temperature. The elastic modulus of the scaffolds cross-linked with 4SP (0.5mM) matched the values previously reported to induce tenogenic differentiation in stem cells (50-90 kPa). Approximately eighty percent of the human tendon cells cultured on the micro-grooved collagen films aligned in the direction of the anisotropy for 10 days in culture (fig 1C), mimicking the alignment of tenocytes in the native tissue. Cell nuclei morphology, known to play a central role in the process of mechanotransduction, was significantly more elongated for the tenocytes cultured on the micro-grooved scaffolds after 4 days in culture for all the 4SP concentrations. Synthesis, deposition and alignment of collagen III and tenascin C, two important tenogenic markers, were up regulated selectively on the micro-grooved (fig 2A) and rigid (fig 2B) scaffolds after 10 days in culture, respectively. These results highlight the synergistic effect of matrix rigidity and cell alignment on tenogenic cell lineage commitment.

Conclusions and recommendations

Collectively, this study provides new insights into how collagen can be modulated to create scaffolds with precise imprinted topographies and controlled rigidities. Gene expression analysis and a replicate study with hBMSCs will be carried out to support the first results and to further identify the optimal biophysical conditions for tenogenic cell lineage commitment. This potentially leads to the design of smart implants that not only restore immediate tendon functionality but also drive cellular synthesis of organized tissue-specific matrix.
Characterizing a 3D human-based in vitro arthritic joint model composed of several components

By Alexandra Damerau (Charité-Universitätsmedizin Berlin) Moritz Pfeiffenberger (Charité-Universitätsmedizin Berlin) Frank Buttgereit (Charité-Universitätsmedizin Berlin)

Abstract Id: 4951
Event: EORS 2019
Topic: Bone

Introduction

Rheumatoid arthritis (RA) is a chronic systemic autoimmune disease primarily affecting the lining of the synovial joints and is associated with progressive disabilities and socioeconomic burdens. A better understanding of how pathological mechanisms drive RA progression in individuals is required to develop therapies that effectively treat patients at every stage of disease progression. Many animal models have already been developed to investigate RA pathogenesis. To date, none of these models allow sufficient or complete extrapolation to the human patient. In addition, there are only few in vitro models considering immunological.

Goal

Our ultimate goal is to study the influence and efficacy of potential drug candidates in an experimental setup for arthritis. Therefore, we first aim at developing a valid human in vitro 3D joint model in order to simulate the features of arthritis by applying sorted immune cells and pro-inflammatory cytokines. This in vitro 3D joint model consists of different components including an osteogenic and chondrogenic part, the joint space with synovial fluid the synovial membrane.

Method

Based on human bone marrow derived mesenchymal stromal cells (hMSCs) we developed the different 3D tissue components of the joint that are characterized in detail (e.g. cell vitality, morphology, structural integrity, phenotype) using histological, biochemical and molecular biological methods as well as µCT and scanning electron microscope. For the osteogenic component, we populated β-tricalcium phosphate (TCP) – mimicking the mineral bony part, while the 3D cartilage component was generated scaffold-free (fzmb GmbH). A confluent hMSC layer formed on a polycarbonate membrane on top of a cavity filled with hyaluronic acid represents the synovial membrane and the synovial fluid component. In order to simulate an inflamed joint we applied sorted neutrophils to the synovial membrane and cytokines (e.g. TNF, MIF, IL6) into the synovial fluid, analyzed using qPCR, multiplex immunoassay and flow cytometry.

Results
As a result, we confirmed the osteogenic phenotype of hMSCs successfully seeded on the TCP by the expression of bone-related genes and μCT. Mimicking the cartilage component, we verified its chondrogenic phenotype by HE and Alcian Blue staining as well as by the reduced mRNA expression of COL1A1 and an abundant expression of COL2A1. Co-cultivation of both components looks promising showing a close alignment and cell interaction. Modelling the synovial membrane, we successfully and reproducibly created a confluent hMSC cell layer, with a high cell viability even after 3 weeks of cultivation on top of the synovial fluid component. When injecting cytokines into the synovial fluid the synovial membrane showed an upregulation of IL6, HIF and MMP13 expression on mRNA level, whereby applying neutrophils to the synovial membrane component improved their survival.

Conclusions and recommendations

Results from the analysis of the single components confirm viability, integrity and morphology pointing towards an ultimately successful development of the anticipated in vitro 3D joint model. By combining the different components in a standard 96 well format, we aim to provide a mid-throughput system for preclinical drug testing as well as a valid in vitro human-based 3D disease model to study the pathogenesis of arthritis.

Understanding why people with chronic post-surgical pain following knee replacement don’t consult healthcare professionals

By Andrew Moore (University of Bristol) Rachael Gooberman-Hill (University of Bristol)

Abstract Id: 4950
Event: EORS 2019
Topic: Arthroplasty

Introduction

In the UK and USA in 2016 more than 263,000 primary knee replacements were performed. Around 20% of patients report chronic post-surgical pain (CPSP) at three or more months after total knee replacement (TKR). A large proportion of adults with all types of chronic musculoskeletal pain do not use services for a number of reasons, despite being in constant or daily pain. Given the high prevalence of CPSP, there is potentially a large hidden population with an unexpressed need for care, experiencing ongoing pain and disability; understanding why they do not use health services may herald further insight into why many remain dissatisfied with knee replacement surgery.

Goal

The aim of this study is to understand why some people with CPSP after TKR do not access services or make little use of healthcare.
Method

We conducted face-to-face in-depth interviews with 34 patients from 2 high-volume orthopaedic hospitals in England, to investigate their experience of long-term pain after knee replacement; their knowledge and understanding of CPSP; and their decisions about consulting for CPSP. The sample size was based on achievement of saturation and participants provided written informed consent. Interviews were transcribed and analysed using an inductive thematic approach with double coding for rigour. Ethical approval for the study was granted by the West Midland—Solihull Research Ethics Committee (15/WM/0469).

Results

A core theme within the analysis suggests that participants do not seek healthcare because they believe that nothing further can be done, either by themselves or by healthcare professionals. Surgeons’ satisfaction with the knee surgery and reassurances that pain would improve, left patients feeling uncertain about whether to re-consult, and some assumed that further consultation could lead to further surgery or medication, which they wish to avoid. Some participants’ comorbidities took precedence over their knee pain when seeking healthcare. Others felt they had received their ‘share’ of healthcare resources and that others were more deserving of treatment. People’s descriptions of pain varied, from dull, or aching to shooting pains. Many described their pain as ‘discomfort’ rather than pain. The majority described pain that was better than their pre-surgical pain, though others described pain that was worse, which they believed to be nerve damage. Many expressed disappointment in the outcome of their TKR. Expectations of pain varied, where most had expected some post-surgical pain, others underestimated it, and some had expected to be completely pain free following their TKR.

Conclusions and recommendations

Our analysis suggests that the reasons that some people with CPSP after TKR do not consult are varied and complex, spanning psychosocial, structural, moral, and organisational domains. There was an overriding sense that further consultation would be futile or may lead to unwanted treatment. Results suggest that improved information for patients about CPSP and appropriate post-surgical healthcare services may help patients and clinicians to manage this condition more effectively.

Patient experiences of recovery from one- and two-stage revision surgery for prosthetic hip infection

By Dr Andrew J Moore (University of Bristol) Dr Cecily Palmer (University of Bristol) Dr Charlotte Mallon (University of Bristol)

Abstract Id: 4943
Prosthetic joint infection (PJI) is an uncommon but serious complication of hip replacement. Over 1,000 operations are performed annually in the United Kingdom for PJI following hip replacement, using either one- or two-stage revision arthroplasty. It is unclear which is preferred by patients and which has the best long-term outcome.

This qualitative study aims to describe patients’ experiences of treatment and recovery following one- and two-stage revision arthroplasty for PJI within the context of a pragmatic randomised controlled trial comparing these two approaches.

Semi-structured interviews were conducted with 32 patient participants undergoing one- or two-stage revision treatment for PJI as part of a UK multi-centre randomised controlled trial. Patients were recruited from 12 participating National Health Service (NHS) Orthopaedic Departments and were interviewed 2-4 months after their first revision surgery and again approximately 18 months later. Final sample size was justified on the basis of thematic saturation. All patients consented to the interview being audio-recorded, transcribed, anonymised and analysed using an inductive thematic approach. Ethical approval was provided by NRES Committee South West- Frenchay, 14/SW/116.

Patients in both the one- and two-stage treatment groups described prolonged hospital stays, with burdensome antibiotics and brief physiotherapy treatment. However, following discharge home and during recovery, differences between one-stage revision and two-stage revision with an ‘empty hip’, spacer, or (custom-made articulating spacer) CUMARS became more evident. Our analysis suggests that participants undergoing two-stage revision with an ‘empty hip’ or with a spacer reported being physically restricted in almost every aspect of their daily life, resulting in inactivity and confinement to home. Mobility aids were not sufficiently available through the health service for these patients. A key difference is that those with a spacer reported more pain, while those without reported little pain. Approximately one year following their second-stage revision, participants described being more independent and active, but two directly attributed muscle weakness to the lengthy period without a hip and described resulting falls or dislocations that had complicated their recovery. In contrast, those undergoing one-stage revision and CUMARS appeared to be more alike, reporting better mobility, functionality and independence, although still limited. Participants in these groups also reported minimal or no pain following their revision. A key difference between CUMARS and one-stage revision was the uncertainty of whether a second operation was necessary, which participants described as ‘hanging over them’, while those in the two-stage empty hip or spacer group described a more positive anticipation of a second definitive operation as it marked an end to what was described as a detachment from life.
Our findings highlight the differences between patients’ experience of recovery following revision arthroplasty, and how this is influenced by the surgical approach and presence or lack of spacers. An understanding of lived experiences following one- and two-stage surgical interventions will complement knowledge about the clinical effectiveness of these different types of revision surgery.

**Osteoarthritic Changes in Chondrocytes Influence the Response to Mechanical Stimulation**

By Janine Lückgen (Research Centre for Experimental Orthopaedics, Heidelberg University Hospital, Heidelberg, Germany) Elisabeth Krämer (Research Centre for Experimental Orthopaedics, Heidelberg University Hospital, Heidelberg, Germany) Tobias Reiner (Department of Orthopaedic and Trauma Surgery, Heidelberg University Hospital, Heidelberg, Germany)

**Abstract Id: 4942**

**Event: EORS 2019**

**Topic: Cartilage**

**Introduction**

Osteoarthritis (OA) is the most common joint disease, which is characterized by a progressive loss of proteoglycans and the destruction of extracellular matrix (ECM), leading to a loss of cartilage integrity and joint function. During OA development, chondrocytes alter ECM synthesis and change their gene expression profile including upregulation of hypertrophic markers known from the growth plate. Although physiological mechanical loading can support cartilage formation and maintenance, mechanical overload represents one major risk factor for OA development. So far, little is known on how an OA-like hypertrophic chondrocyte phenotype alters the response of cartilage tissue to mechanical loading.

**Goal**

The aim of this study was to investigate whether a hypertrophic phenotype change of chondrocytes affects the response to physiological mechanical loading and to reveal differences compared to normal control cartilage.

**Method**

Cartilage replacement tissue was generated using human articular chondrocytes (normal control cartilage, n=3-5) or human mesenchymal stromal cells which develop a hypertrophic phenotype similar to the one observed in OA (OA cartilage model, n=3-6). Cells were seeded in a collagen type I/III carrier and attached to a β-TCP bone replacement phase, building an osteochondral unit for simulation of natural conditions. After 21 and 35 days of chondrogenic (re)differentiation, a single physiological mechanical compression episode (1 Hz, 25 %, 3 h)
was applied, imitating three hours of normal walking in ten minute intervals. Proteoglycan and collagen synthesis, gene expression and activation of signaling pathways were assessed.

Results

Cartilage replacement tissue of both groups had similar proteoglycan and collagen type II content as well as hardness properties. During (re)differentiation, both cell types showed a comparable upregulation of the chondrogenic marker genes COL2A1 and ACAN. As expected, hypertrophic marker genes (COL10A1, ALPL, MEF2C, IBSP) were only upregulated in the OA cartilage model. Mechanotransduction in both tissues was confirmed by load-induced activation of pERK signaling. While the 3 h loading episode significantly increased proteoglycan synthesis in normal control cartilage at day 35, the same protocol resulted in a suppression of proteoglycan and collagen synthesis in the OA cartilage model, which was accompanied by a downregulation of COL2A1 gene expression. In addition, hypertrophic marker genes COL10A1, ALPL and IBSP were significantly reduced after loading. Along lower load-induced SOX9 mRNA and protein stimulation in the OA cartilage tissue, a weaker induction of mechanosensitive BMP2, BMP6, FOS and FOSB gene expression was observed.

Conclusions and recommendations

While stable cartilage showed anabolic effects after physiological loading, the hypertrophic chondrocytes reacted with a reduced extracellular matrix synthesis which could be explained by a lower mechanoinduction of the BMP signaling cascade and insufficient SOX9 stimulation. Progressive OA development could thus be influenced by a reduced mechanocompetence of osteoarthritic chondrocytes. Part of this study was supported by DFG-grant RI707/12-1 as part of the ExCarBon Research Group FOR2407.

Influence of radiation conditions and aging duration on the wear behaviour of an vitamin E stabilized TKA bearing

By Jens Schwiesau (Aesculap AG) Bernhard Fritz (Aesculap AG) Georg Bergmann (Charité)

Introduction

Introduction: The wear behaviour of total knee arthroplasty (TKA) bearings is dominated by abrasive wear and delamination. Bearing material properties and applied stresses affect the wear mode. With increasing stress caused by high demanding daily activities of the lower limbs and degraded material properties due to aging, delamination occurs more frequently. The bearing material properties can be stabilized by blending the Ultra High Molecular
Weight Polyethylene (UHMWPE) with an aging inhibitor. Vitamin E is one substance that can reduce oxidation, the dominant aging process.

Goal

In this study high demanding daily activities are simulated to evaluate the influence of radiation condition and duration of artificial aging on the wear behaviour of an TKA bearing material with vitamin E blending.

Method

High flexion activities [Bergmann et al. 2014] predominate in the simulation (40% stairs ascending, 40% stairs descent, 10% level walking, 8% chair raising, 2% squatting). Five million test cycles are simulated with standard environmental conditions [ISO14243-1]. The tested TKA design was cruciate retaining with CoCr femoral components. Artificially aged [ASTM F2003-2] UHMWPE knee bearings with and without 0.1% vitamin E were tested. The gravimetric wear was evaluated according to ISO 14243-2. The wear mode was analysed optically.

Results

The weight reduction for the tested material groups are shown in Fig. 1. Abrasion is the predominate wear mode. No case of delamination was observed.

Conclusions and recommendations

Based on the simulation of daily patient activities it was possible to differentiate the wear behaviour between the radiation conditions of the bearing materials. The influence on the wear rate was not significant for the duration of artificial aging.

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**Demineralized cortical bone functionalized with bioactive TDSC-derived ECM enhance proliferation and tenogenic differentiation of TDSCs in vitro**

By He Shu-Kun (Laboratory of Stem Cell and Tissue Engineering, State Key Laboratory of Biotherapy/Collaborative Innovation Center for Biotherapy, West China Hospital, Sichuan University) Ning Liang-Ju (Laboratory of Stem Cell and Tissue Engineering, State Key Laboratory of Biotherapy/Collaborative Innovation Center for Biotherapy, West China Hospital, Sichuan University) Yao Xuan (Laboratory of Stem Cell and Tissue Engineering, State Key Laboratory of Biotherapy/Collaborative Innovation Center for Biotherapy, West China Hospital, Sichuan University)

Abstract Id: 4935
Introduction

Demineralized cortical bone (DCB) is a scaffold consisting of the type I collagen and several growth factors. Several studies show that DCB could promote entheses regeneration. However, new studies indicate that DCB does not improve the healing of enthesis. Cell-derived extracellular matrix (ECM) could regulate stem cell fate and promote the regeneration of specific tissues. Some authors have successfully developed scaffolds coated with ECM from bone marrow mesenchymal stem cells (BMSCs), and these scaffolds can promote bone regeneration. Tendon-derived stem cells (TDSCs) show higher proliferative capacity and tenogenic differentiation potential than BMSCs. However, the use of ECM from TDSCs for tissue repair is still lacking.

Goal

Our goal is to develop a DCB scaffold functionalized with bioactive TDSC-derived ECM. We hypothesize that the DCB with TDSC-derived ECM (DCB-ECM) would enhance proliferation and tenogenic differentiation of TDSCs in vitro.

Method

Fresh cortical bones were manufactured into bone slices, which were immersed in hydrochloric acid for demineralization. Next, the samples were degreased by methanol and ethanol and decellularized by Triton X-100, sodium deoxycholate and nucleases. After treating with hydrogen peroxide, the DCB was successfully prepared. In order to construct the DCB-ECM scaffold, passage three TDSCs from SD rats were seeded on the DCB. After culturing two weeks, DCB with TDSCs (DCB-TDSC) were decellularized by Triton X-100 and ammonia. The histology of DCB, DCB-TDSC and DCB-ECM scaffolds were examined with H&E staining. The surface topographies of DCB and DCB-ECM were observed with scanning electron microscope (SEM). To select the appropriate time for secondary decellularization, the DNA concentration in each sample was quantified using dsDNA Assay Kit. Cell proliferation of TDSCs cultured on scaffolds were evaluated with Cell Counting Kit-8 (CCK-8), and the cell viability was assessed by Live/Dead staining. Cell morphology of TDSCs on scaffolds were detected by fluorescent staining. The expression levels of tendon-specific and osteogenic genes in TDSCs on DCB and DCB-ECM were assessed by quantitative PCR.

Results

The H&E staining and SEM images showed that the ECM secreted by TDSCs existed on the surface of DCB-ECM scaffold (Fig.1 A and B). DNA quantification results exhibited that chemical treatment 10 mins significantly reduced the DNA content compared with that of chemical treatment 2 or 5 mins (Fig1 C). Chemical treatment 10 mins was more effective than chemical treatment 15 mins (Fig.1 C). When TDSCs were seeded on the DCB-ECM for 5d and 7d, the CCK-8 assay showed significantly higher cell viability of the cells (Fig.1 D). After incubating the cells for 48 hours on the scaffolds, TDSCs attached well to the surface of the DCB and DCB-ECM as demonstrated by Live/Dead and cytoskeleton staining (Fig.1 E). The expression levels of osteogenic genes (RUNX2, ALP and OPN) in the DCB-ECM group
Conclusions and recommendations

DCB-ECM could enhance proliferation and tenogenic differentiation of TDSCs, while it reduces osteogenic differentiation of TDSCs. Maybe, DCB-ECM could be a potential material for repairing tendons.

A scaffold-free graft for large critical size bone defect: preclinical evidence to clinical proof of concept

By Docquier (University hospital Saint-Luc, Orthopedic surgery service) Thirion (Novadip Biosciences, R&D department) Vériter (Novadip Biosciences, R&D department)

Abstract Id: 4933
Event: EORS 2019
Topic: Translational research

Introduction

Large critical size bone defect is one of the most challenging pathologies in orthopaedic surgery. The direct application of adipose stem cells (ASCs) remains limited in vivo by a low homing efficiency associated to a low survival rate at the implantation site.

Goal

This study aims to demonstrate the role of the ASCs function in a scaffold-free approach in terms of in vivo osteogenesis.

Method

Before transplantation, the molecular characterization (for skeletal development/angiogenesis) of the osteogenic human ASCs was performed on the 3D scaffold-free grafts. The bioactivity of the ASCs/matrix of the scaffold-free graft was in vivo studied in 2 nude rat models: (i) the comparison of fresh and decellularized grafts in term of angiogenesis promotion following the transplantation (up to 1 month) in a fibrotic tissue (in a cauterized muscular pocket, n=20); (ii) the in vivo osteogenicity of the scaffold-free graft (in comparison to HA/bTCP bone substitute) was assessed, at 1/2/3 months post-implantation, in an irreversible femoral critical size bone defect (n=28). Angiogenesis was investigated by histomorphometry, cellular engraftment by HLA-I staining, the mineralization by micro-CT scan and the osteogenic genes expression by Q-RT-PCR on graft explants. A 5-year-old boy with congenital pseudarthrosis of the tibia (previously treated by nailing and grafting without success) was proposed for the scaffold-free graft approach (made of autologous ASCs) in combination with the induced membrane technique. The pseudarthrosis area (at the fibula and the tibia) was firstly resected...
and filled by a cement spacer. Then, the adipose tissue (AT) was procured in view to isolate the ASCs and to produce the 3D scaffold-free graft. At 3 months post-AT procurement, the cement was removed and the 3D-graft was placed into the defect in view to be followed clinically and radiologically.

Results

After intra-muscular transplantation in nude rats, cellular survival (with major osteogenic genes expression) of human ASCs and the promotion of angiogenesis (in a fibrotic and hypoxic site) was found at 1 month post-implantation. A complete integration and bone fusion were found (at 4-8 weeks post-implantation in the femoral defect) for the 3D graft in comparison to the bone substitute alone which revealed a lack of tissue remodelling and osteogenesis. Specific genes of the skeletal development were overexpressed in the bone defect treated with the 3D grafts (at 4 and 8 weeks post-implantation) while no osteoinduction was found for the HA/bTCP alone. A large volume (>15cm³) of the 3D graft was manufactured in GMP conditions and then implanted without any modification of the surgical procedure. The graft was easily handled and implanted after the cement removal. The graft demonstrated a continuous remodeling (with bone formation) during the first year post-implantation to obtain a sufficient bone fusion (allowing walk without pain) and no recurrence of the disease.

Conclusions and recommendations

In conclusion, the scaffold-free 3D-graft (made of ASCs) play a major role to promote ASCs engraftment and consequence to induce osteogenesis in a fibrotic environment and to recover a bone fusion in a critical-sized bone defect.

BICONDYLANAR TIBIAL PLATEAU FRACTURES: A RETROSPECTIVE REVIEW OF 64 CASES

By Alexander Matthews (Plymouth Hospitals NHS) Nathan Moore (Royal Devon & Exeter Hospitals) Christoph McAllen (Plymouth Hospitals NHS)

Abstract Id: 4929
Event: EORS 2019
Topic: Other

Introduction

Bicondylar tibial plateau fractures are complex injuries without a clear standard of optimal treatment. We examined the outcomes of such fractures managed with peri-articular locking plates in the largest single centre consecutive series to date.

Goal
To evaluate our experience in the management of bicondylar tibial plateau fractures and to determine if treatment recommendations can be made on the basis of our results.

**Method**

Between October 2011 and August 2018 a total of 64 fractures in 63 patients were treated by fixation using periarticular locking plates. A retrospective review of medical records, plain radiographs and CT scans was performed. Patient-reported outcome measures using the WOMAC index, Short Form 36 and Oxford knee score were obtained at a minimum follow up period of eight months.

**Results**

We achieved good clinical and radiological outcomes with a similar early complication rate to that shown in the literature. Our deep infection rate was 7%. Only two patients experienced loss of fixation and collapse of the joint of >4mm. Nine patients (14%) underwent subsequent removal of symptomatic metalwork and one amputation occurred.

**Conclusions and recommendations**

Our study supports the use of locking plates as a safe and effective way to treat these fractures.

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**Occurrence frequency of cyst formations after meniscal repair using the FasT-Fix.**

By Toshihiro Seki (Yamaguchi university Hospital)

**Introduction**

The importance of meniscal preservation is widely understood for knee function. Thus, arthroscopic meniscal repair has been a common technique for a meniscus tear. Recently, cyst formations after meniscal repair has been described by several orthopaedic surgeons.

**Goal**

The purpose of this study was to investigate the occurrence frequency of cyst formations after meniscal repair using FasT-Fix device.

**Method**

Between January 2015 and July 2017, 64 patients underwent arthroscopic meniscal repair using FasT-Fix device. The patients were mean age at 30.2 years; and 38 male and 26 female.
All patients were evaluated with magnetic resonance imaging (MRI) preoperatively. In addition, all patients were received MRI postoperatively. Comparison was made between cyst formation group and non-cyst formation group. Follow-up assessment included number of FasT-Fix devices used, MRI. MRI outcomes were assessed with occurrence of cyst formations, evaluation of meniscal healing.

Results

The mean MRI follow-up was 14.9 months (range, 8 to 25). The occurrence frequency of cyst formations was 5 patients (7.8%). There were 4 males and 1 female. There was a significant difference in sex. There was no significant difference in meniscal healing in each group. In cyst formation group, 4 patients had no complaint that seemed to be caused by FasT-Fix device, but cyst formation was allowed on MCL. One patient had an expansion trend and was symptomatic.

Conclusions and recommendations

Because of the development of implants for the all-inside technique, the indication of meniscal repair has expanded. However, complaints due to implant remain, several surgeons reported that it was necessary to remove the implant. It is thought that interference of anchors tends to occur easily as pumping action increases in highly active men and the number of FasT-Fix device increases. In this study, cyst formation was significantly larger in male. In 4 patients, cyst formations were generated on the MCL and it was thought that caution was required when using FasT-Fix.

Examination of the Site of Bone Bruises in Anterior Cruciate Ligament Injury

By Kei Sasaki (Department of Orthopedic Surgery, Yamaguchi University Hospital)

Abstract Id: 4924
Event: EORS 2019
Topic: Tendon

Introduction

One of the findings associated with anterior cruciate ligament (hereinafter referred to as ACL) injury is bone bruises, and its association with meniscal injury or cartilage injury has been reported.

Goal

We report bone bruises on ACL injury, (about the appearance frequency of and the presence of bone bruises and the localization) We also investigated the relationship between the presence or absence of bone bruise, localization, and the presence or absence of meniscal injury according to the period of MRI scan from injury.
Method

We underwent the study used a total of 76 knees who underwent ACL reconstruction at our hospital and related hospitals from January 2014 to December 2017. On MRI images taken after injury, it was defined as low intensity in T1 image and high intensity in STIR image as bone bruises and we evaluated in sagittal and coronal sections. Meniscal injuries were evaluated by intraoperative findings.

Results

The average age at injury was 25.8 years old (13-48 years old) in 44 males and 32 females. Bone bruises were found in 54 of 76 knees (71%). Among them, the ratio of non-contact type was higher in the group with bone bruises than in the non group (83% in the group with bone bruise, 64% in the group without bone bruises), resulting in a shorter period from injury to MRI (bone bruises group: 12.4 days, no bone bruises group: 23 days). Looking at the appearance frequency of bone bruises according to the period from injury to MRI imaging, the appearance frequency of bone bruises decreased as the time to imaging became longer (within 2 weeks of injury: 76%, injury from 2 weeks to 1 month: 65%, injury 1-3 months: 53%). With regard to the localization of bone bruises, in the coronal section, both femurs and tibias frequently had bone bruises on the outside. In the sagittal section, it occurred in front of the femur, in particular. On the tibial side, many cases of bone bruises occurred in the rear. In addition, the association between bone bruises and meniscal injury was significantly complicated with lateral meniscal injury in the group without femoroconstriction in the group with lateral femoral bone bruises and in the group with posterior tibia bone bruises. There was no significant association between bone bruises and meniscal injury among the other groups.

Conclusions and recommendations

Bone bruises was found in 54 of 76 knees (71%). Regarding the occurrence of many lateral developments, it is thought that the tibia is sub-dislocated anteriorly due to mild flexion, valgus force, and external rotation injury, and injury is caused by axial pressure applied to the outside of the femur and posterior of the tibia. It was done. As a result, it was considered that the external meniscal injury was injured. The medial unilateral development of bone contusion was observed in 3 knees on the medial femur and 1 knee on the medial tibia. All internal single-cased cases are contact-type injuries, the result of which may be different in the mechanism of bone contusion development.

THE IN VITRO EXPRESSION OF THE HYPOXIC INDUCIBLE FACTOR (HIF): ITS ROLE IN CLINICAL OSSOEINTEGRATION

By Akintunde George (University of Bath) Marianne Ellis (University of Bath) Richie Gill (University of Bath)
Introduction

Hypoxic Inducible Factor and Hypoxic mimicking agents (HMA) trigger the initiation and promotion of angiogenic-osteogenic cascade events. However, there has been paucity of studies investigating how HIF could be over expressed under chronic hypoxic conditions akin to that seen in sickle cell disease patients to help form a template for tackling the matter of macrocellular avascular necrosis. Angiogenesis and osteogenesis are tightly coupled during bone development and regeneration, and the hypoxia-inducible factor-1 alpha (HIF-1) pathway has been identified as a key component in this process studies have shown. There are still no established experimental models showing how this knowledge can be used for the evaluation of bone implant integration and suggest ways of improving osseointegration in sickle cell disease patients with hip arthroplasty and thereby prevent increased implant loosening.

Goal

AIMS The aim of this study is to help develop an in vitro experimental model which would mimic the in vivo pathologic state in the bone marrow of sickle cell disease patients. It also seeks to establish if the hypoxic inducible factor (HIF) could be over expressed in vitro and thus enhancing osseointegration.

Method

METHODS MG63 osteoblastic cells were cultured under normoxia and hypoxic conditions (20%; and 1% oxygen saturation) for 48 and 72 hours. Cobalt chloride was introduced to the samples in order to mimic true hypoxia. Cells cultured under normoxic conditions and without cobalt chloride was used as the control in this study. The expression of the hypoxic inducible factor was assessed using the reverse transcriptase qualitative polymerase chain reaction (RT-qPCR).

Results

RESULTS There was increased expression of HIF1-alpha at 72hours as compared to 48hours under the various conditions. The level of expression of HIF increased from 48hrs (mean rank= 4.60) to 72hrs (mean rank =5.60) but this difference was not statistically significant, X2(1) = 0.24, p =0.625. The mean rank fold change of HIF in hypoxic samples decreased compared to the normoxic samples but this difference was not statistically significant, X2(1) = 0.54, p= 0.462. Therefore, the expression of HIF is only increased with prolonged hypoxia as seen in the 72hours samples. The expression of HIF increased in samples with CoCl2 (mean rank=5.17), compared with samples without CoCl2 (mean rank 4.67), however this was not statistically significant, X2(1) = 0.067, p=0.796, p value > 0.05.

Conclusions and recommendations

CONCLUSION The over expression of HIF was achieved within a few days (72hours) with the introduction of Cobalt Chloride, which is a mimetic for hypoxia similar to the in vivo
environment in sickle cell disease patients. This is an in vitro model which could help investigate osseointegration in such pathologic bone conditions.

Design and characterisation of a three-layer collagen-based scaffold to modulate BMSC behaviour for enthesis regeneration

By Eugenia Pugliese (Regenerative, Modular & Developmental Engineering Laboratory (REMODEL), National University of Ireland Galway, Ireland)

Abstract Id: 4920
Event: EORS 2019
Topic: MSC's

Introduction

The enthesis is a specialised zonal tissue interface between tendon and bone, essential for adequate force transmission and composed by four distinct zones, namely tendon, fibrocartilage, mineralized fibrocartilage and bone. Following injuries and surgical repair, the enthesis is often not reestablished and so far, traditionally used tissue substitutes have lacked to reproduce the complexity of the native tissue.

Goal

In this work, we hypothesised that a collagen-based three-layer scaffold that mimic the composition of the enthesis, in combination with bioactive molecules, will enhance the functional regeneration of the enthesis.

Method

A three-layer sponge composed of a tendon-like layer (collagen I), a cartilage-like layer (collagen II) and a bone-like layer (collagen I and hydroxyapatite) was fabricated by an iterative layering freeze-drying technique. Scaffold porosity and structural continuity at the interfaces were assessed through SEM analysis. Bone-marrow derived stem cells (BMSCs) were seeded by syringe vacuum assisted technique on the scaffold. Scaffolds were cultured in basal media for 3 days before switching to differentiation media (chondrogenic, tenogenic and osteogenic). BMSCs metabolic activity, proliferation and viability were assessed by alamarBlue, PicoGreen and Live/Dead assays. At D21 the scaffolds were fixed, cryosectioned and Alizarin Red and Alcian Blue stainings were performed in order to evaluate BMSC differentiation towards osteogenic and chondrogenic lineage. The presence of collagen I and tenascin in the scaffolds was evaluated by immunofluorescence staining at D21 in order to assess tenogenic differentiation of BMSCs. Subsequently, the cartilage-like layer was functionalized with insulin growth factor 1 (IGF-1), seeded with BMSCs and cultured in basal media up to D21.

Results
Structural continuity at the interfaces of the scaffolds was confirmed by SEM and scaffold porosity was assessed as >98% (Fig.1). The scaffolds supported cell proliferation and infiltration homogeneously throughout all the layers up to D21 (Fig.2). Osteogenic differentiation of BMSC selectively in the bone-like layer was confirmed by Alizarin red staining in scaffolds cultured in basal and osteogenic media (Fig.3). Alcian blue staining revealed the presence of proteoglycans selectively in the cartilage-like layer in scaffolds cultured in chondrogenic media but not in basal media (Fig.4). Increased expression of the tenogenic markers collagen I and tenascin was observed in the tendon-like layer of scaffolds cultured in tenogenic but not in basal media for 21 days (Fig.5). The presence of IGF-1 increased osteogenic and chondrogenic differentiation of BMSCs, whereas no difference was observed for tenogenic differentiation.

Conclusions and recommendations

In conclusion, a 3-layer collagen sponge was successfully fabricated with distinct but integrated layers; the different collagen composition of the non-functionalized 3-layer sponge was able to regulate BMSC differentiation in a localized manner within the scaffold. The scaffold functionalization with IGF-1 accelerated chondrogenic and osteogenic BMSC differentiation. Ongoing work is evaluating gene expression relevant to the enthesis and it is establishing the synergistic effect between IGF-1 and platelet-derived growth factor functionalized within the tendon-like layer. Overall, functionalization of the 3-layer scaffolds holds promising potential in developing novel and more efficient strategy towards enthesis regeneration.

Synergy in Movement Systems

By Zohreh Shafizadegan (Rehabilitation Research Center, Department of Physical Therapy, School of rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran) Reza Salehi (Rehabilitation Research Center, Department of Rehabilitation Management, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran)

Abstract Id: 4919
Event: EORS 2019
Topic: Biomechanics

Introduction

Movement is the identity of physiotherapy profession, as progress in motor control, learning and developmental sciences is associated with professional progress and clinical practice. Human body has many degrees of freedom that results in the multiple redundant motor solutions for achieving a motor task. It seems that elimination of degrees of freedom approach and selection of unique motor solution due to the increased risk of system damage cannot be correct. While, based on the principle of abundance, the redundant degrees of freedom are not eliminated; Rather, to ensure the stable behavior of the system, and with respect to motor task, the specific variables associated with that activity are being used. Synergies are in fact a set of motor solutions and neural organizations that will lead to stability in motor task. Given that the need for stability in performance requires changes in the activity of the elements involved,
so variability is one of the signs of system health, so that the main purpose of synergy is to create the highest degree of good variability in the system. The computational method of synergy strength analysis is expressed in the Uncontrolled Manifold (UCM) approach. The purpose of this approach is to understand the central nervous system behaviors in the selection of appropriate musculoskeletal elements associated with motor activity. If UCM variance is more than orthogonal, synergy is stable and flexible and is considered as an important and useful feature in facing unexpected disturbances. In addition, due to increased motor patterns, it leads to compatibility and adaptation of the motor system. Walking is one of the most important daily activities and different challenges to gait may result in different modifications in the kinematic synergies.

Goal

Considering that awareness of synergy strength may provide a complete picture of the integrity of the system, so in this study we review the kinematic features of gait based on UCM method for studying the variability characteristics of synergy.

Method

Electronic databases including PubMed, Scopus and Science Direct were searched from their inceptions until December 2018 using keywords “synergy”, “gait”, “UCM” and “variability”. Published studies written in English were included. The methodological assessment of the studies was performed based on the Newcastle-Ottawa Scale (NOS).

Results

Seven studies were included for final analysis. The mean NOS score for study quality was 6.4 ± 0.97 out of a possible total score of nine points. The results of the review showed that UCM could be a good approach to examine the synergy index and walking variability, because it represents the system and its function.

Conclusions and recommendations

Based on the results, the synergy index does not change relative to age, walking speed and roughness of the surfaces, but diseases can affect it.

Self-assembled collagen-rich constructs for tendon enthesis repair

By Stefanie Korntner (1. Regenerative, Modular & Developmental Engineering Laboratory (REMODEL), National University of Ireland Galway (NUI Galway) 2. Science Foundation Ireland (SFI) Centre for Research in Medical Devices (CÚRAM), National University of Ireland Galway (NUI Galway) 3. Proxy Biomedical Ltd., Coilleach, Spiddal, Galway, Ireland)Andrea De Pieri (1. Regenerative, Modular & Developmental Engineering Laboratory (REMODEL), National University of Ireland Galway (NUI Galway) 2. Science Foundation Ireland (SFI) Centre for Research in Medical Devices (CÚRAM), National University of Ireland Galway (NUI Galway) 3. Proxy Biomedical Ltd., Coilleach, Spiddal, Galway, Ireland)Zhuning Wu (1. Regenerative, Modular & Developmental Engineering Laboratory (REMODEL), National University of Ireland Galway (NUI Galway)
Introduction

The fibrocartilaginous enthesis displays a complex interface between two mechanically dissimilar tissues, namely tendon and bone. This graded transition zone consists of parallel collagen type I fibres arising from the tendon and inserting into bone across zones of fibrocartilage with aligned collagen type I and collagen type II fibres and mineralised fibrocartilage. Due the high stress concentrations arising at the interface, entheses are prone to traumatic and chronic overuse injuries such as rotator cuff and anterior cruciate ligament (ACL) tears. Treatment strategies range from surgical reattachment for complete tears and conservative treatments (physiotherapy, anti-inflammatory drugs) in chronic inflammatory conditions. Generally, the native tissue architecture is not re-established and mechanically inferior scar tissue is formed. Current interfacial tissue engineering approaches pose scaffold-associated drawbacks and limitations, such as foreign body response.

Goal

Using a thermo-responsive electrospun scaffold that provides architectural signals similar to native tissues and can be removed prior to implantation, we aim to develop an ECM-rich, cell-based implant for tendon-enthesis regeneration.

Method

The chondrogenic differentiation potential of human adipose-derived mesenchymal stem cells (hADSCs) was investigated in pellet culture, collagen type I scaffolds, collagen type II scaffolds and electrospun thermos-responsive fibres using chondrogenic differentiation media. To assess tenogenic differentiation potential of hADSCs, cells will be seeded on collagen type I scaffolds and aligned electrospun thermoresponsive fibres. Thermoresponsive electrospun fibres (pNIPAAm/NTBA) with random and aligned fibre orientation were used to produce multilayer cell sheets. Collagen scaffolds were created via a freeze-drying technique. Pore size, fibre diameter and orientation were assessed through scanning electron microscopy (SEM). Tissue construct samples were collected on day 7, 14 and 21 and chondrogenic differentiation was assessed via Alcian blue and Safranin O stainings. ECM deposition and collagen alignment of constructs was assessed using Picrosirius red staining and polarisation microscopy. To identify the presence of collagen proteins, immunohistochemical stainings were performed. A glycosaminoglycan assay was performed for the quantitative analysis of sulfated glycosaminoglycans (sGAG). Gene expression analysis was carried out for the enthesis related marker genes COL1A1, COL2A1, COL3A1, COL10A1, SOX9, ACAN, COMP, GLI1, SCX, MKX and TNMD.

Results

Alcian blue staining revealed highest sGAG deposition in cell sheets grown on random electrospun fibres and lowest sGAG deposition in collagen type I sponges. Cells did not show
an equal distribution throughout the collagen type II scaffolds but tended to form localised aggregates. Thermo-responsive electrospun fibres with random and aligned fibre orientation provided an adequate three-dimensional environment for chondrogenic differentiation of multilayer hADSC-sheets shown by high ECM-production, especially high sGAG deposition. Chondrogenic cell sheets showed increased expression of SOX9, COL2A1, COL1A1, COMP and ACAN after 7 days of chondrogenic induction when compared to pellet culture. Anisotropic fibres enabled the generation of aligned chondrogenic cell sheets, shown by cell and collagen fibre alignment.

Conclusions and recommendations

Thermoresponsive electrospun fibres showed high chondro-inductivity due to their three-dimensionality and therefore pose a promising tool for the generation of scaffold-free multilayer constructs for tendon-enthesis repair within short culture periods. Aligned chondrogenic cell sheets mimic the zonal orientation of the native enthesis as the fibrocartilaginous zone exhibits high collagen alignment.

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**Short initial WNT/β-catenin stimulation improves cell survival and tissue yield during chondrogenic differentiation of iPSCs**

By Ursula Kreuser (Research Centre for Experimental Orthopaedics - Heidelberg University Hospital)Prof. Dr. Wiltrud Richter (Research Centre for Experimental Orthopaedics - Heidelberg University Hospital)Dr. Solvig Diederichs (Research Centre for Experimental Orthopaedics - Heidelberg University Hospital)

Abstract Id: 4909
Event: EORS 2019
Topic: Cartilage

**Introduction**

Induced pluripotent stem cells (iPSCs) are a promising cell source for cartilage tissue engineering as they are available in virtually unlimited quantities and have the ability to differentiate along all embryonic lineages towards every adult tissue. We have established a protocol to differentiate iPSCs towards chondrocytes, which robustly deposit cartilaginous matrix. However, tissue yield is currently low due to cell loss during differentiation. Cell survival and proliferation are known to be regulated by the canonical WNT/β-catenin pathway during embryonic development. Moreover, activation of the WNT/β-catenin pathway initiates mesoderm commitment and hence might be important for chondrocyte differentiation.

**Goal**
We therefore aimed to improve cell survival and tissue yield during chondrogenesis of iPSCs by stimulation of WNT/β-catenin signaling.

Method

Differentiation of two human iPSC lines towards chondrocytes was initiated by generating an intermediate mesoderm population. During the first 24h of mesoderm differentiation WNT/β-catenin signaling was activated by treating cells with 5µM GSK3-β inhibitor CHIR99021. β-catenin levels were determined by Western blot. Cell proliferation was assessed by cell count and DNA quantitation at day 14 using PicoGreen during mesoderm expansion. Expression of the early mesoderm marker PDGFRα was analyzed by flow cytometry at day 7 of mesoderm differentiation. At day 14, cells were subjected to chondrogenesis in 3D micromass pellet culture treated with TGF-β for 42 days. Pellets were examined for DNA content at day 7 and day 42 and for matrix deposition using histological staining for proteoglycans and collagen type II at day 42.

Results

In the non-treated control group, β-catenin levels inclined at day 1 and remained high. 24h of CHIR treatment further increased β-catenin levels strongly at day 1. When CHIR treatment was discontinued, β-catenin levels declined back to control levels by day 7. In CHIR-stimulated cells the mesoderm marker PDGFRα was significantly upregulated at day 7 compared to control, indicating enhanced mesoderm differentiation. Furthermore, CHIR treated cells displayed 5-fold increased cell numbers and DNA amounts at day 14, demonstrating pro-proliferative effects of WNT/β-catenin signaling. Enhanced cell survival was also observed during subsequent chondrogenic differentiation, according to significantly higher DNA content and increased pellet size at day 42. Proteoglycan and collagen type II deposition remained similar to control, implying that the fraction of chondroprogenitors was unaltered by WNT/β-catenin activation.

Conclusions and recommendations

Our study demonstrated for the first time the benefits of short initial WNT/β-catenin stimulation on iPSCs differentiation towards chondrocytes. One pulse using WNT activator appeared to enhance mesoderm formation and strongly improved tissue yield by enhancing cell proliferation and survival during iPSCs chondrogenesis. This study is an important step to advance our understanding of the intricate in vitro differentiation of iPSCs towards chondrocytes and will help to further improve differentiation protocols of iPSCs for the use in cartilage tissue engineering. Therefore, we endorse WNT/β-catenin activation at the beginning of mesoderm induction to improve cell survival and tissue yield.

Cell response to novel nanostructured titanium scaffolds – a pilot study

By Theresia Stich (Laboratory for Experimental Trauma Surgery, Department of Trauma Surgery, University Regensburg Medical Centre, Regensburg, Germany) Tomáš Křenek (New Technologies Research Centre, University of West Bohemia, Pilsen, Czech Republic) Tomáš
Numerous implanted hip and knee joint arthroplasties have to be replaced due to early or late loosening of the implant, a failure of osteointegration with fibrous tissue at the bone-implant-interface. This could be counteracted by ensuring that cells which attach to the implant surface differentiate towards bone cells afterwards. For this reason, human mesenchymal stem cells (hMSCs) will be included in this study. These cells are naturally available at the bone-implant-interface, multipotent and therefore ideal to study the osteoinductivity of a material.

Goal

The goal of this pilot study was to test the cell response towards three different titanium grades with a novel surface structuring – as a first step towards achieving an improved implant surface for enhanced osteointegration.

Method

Disk-shaped titanium scaffolds with a diameter of 12 mm and a height of 1.2 mm were used. The surface topography (500 μm x 500 μm x 300 μm pores) was generated via laser treatment of the surface. By using nanosecond pulsed laser technique, a rough surface with micro- and nanostructural (titanium droplets) features is automatically formed. Three different batches made of commercially pure titanium grades 1 and 2 (Ti1/Ti2) or Ti6Al4V alloy grade 5 (Ti5) were produced. Four cell types were analysed on these batches: primary hMSCs from one donor (m, 25 y), periosteum derived cells (PDCs; H Chang et al. 2013), human osteoblasts (hOBs; PromoCell GmbH) and periodontal ligament cells (PDLs; D Docheva et al. 2010). Cells were seeded on Ti1, Ti2 and Ti5 scaffolds in triplicates. Resazurin assay to examine cell viability was conducted with all cell types. Measurements were executed on several days after seeding, from day one up to day 14. Actin staining as well as live/dead staining were performed with hMSCs cultured on titanium for 1, 3, 5 or 7 days.

Results

The cell viability assay revealed early turning points of growth for osteogenic hOBs (day 3) and PDCs (day 7). HMSCs grew steadily on the material and non-osteogenic PDLs stayed in plateau throughout the cultivation period. With respect to the material, cells demonstrated better proliferation on Ti1 and Ti2 than on Ti5. Live/dead staining showed a high survival rate of hMSCs at each time point and on all three titanium grades, with a neglectable amount of dead cells. Actin staining confirmed an enhanced spreading and stretching of hMSCs on Ti1 and Ti2 compared to hMSCs on Ti5.

Conclusions and recommendations
Our pilot data indicates that cells react to different titanium compositions, revealed by increased proliferation on commercially pure titanium (Ti1/2). Furthermore, our results demonstrate that osteogenic cells prefer the novel surface structuring in comparison to non-osteogenic PDL cells, which stayed in plateau. The turning points of growth (hOBs/PDCs) suggest an osteosupportiveness of the surface. Although hMSCs did not show a turning point in growth, their expansion was steady and resulted in the highest amount of cells along with a well-stretched morphology. Due to their good proliferation and response to the material, hMSCs are currently being used for evaluating the osteogenic potential of the novel scaffolds.

Femoral Impaction Bone Grafting in Staged Revision Total Hip Arthroplasty for Infection: Clinical and Radiostereometric Analysis.

By Mukai Chimutengwende-Gordon (Royal Adelaide Hospital) Stuart Callary (Royal Adelaide Hospital) Jerome Davidson (Royal Adelaide Hospital)

Abstract Id: 4904
Event: EORS 2019
Topic: Arthroplasty

Introduction

Femoral impaction bone grafting (IBG) may be used to restore bone stock in revision total hip arthroplasty (THA) and allow use of a shorter, than otherwise, length prosthesis. This is most beneficial in young patients who are more likely to require further revision surgery.

Goal

To assess the results of femoral IBG for staged revision THA for infection.

Method

A prospective cohort of 29 patients who underwent staged revision THA for infection with femoral IBG and a cemented polished double-tapered (CPDT) stem at the final reconstruction was investigated. The minimum follow-up was two years (2 - 10 years, median 6 years). Stem subsidence was measured with radiostereometric analysis. Clinical outcomes were assessed with the Harris Hip, Harris Pain, and Société Internationale de Chirurgie Orthopédique et de Traumatologie Activity (SICOT) Scores.

Results

The original infection was eradicated in 28 patients. One patient required a repeat staged revision due to re-infection with the same organism. At two-year follow-up, the median subsidence at the stem-bone interface was -1.70 mm (-0.31 to -4.98mm). The median Harris...
Hip Score improved from 51 pre-operatively to 80 at two years (p=0.000), the Harris Pain Score from 20 to 44 (p=0.000) and the SICOT Score from 2.5 to 3 (p=0.003).

Conclusions and recommendations

As successful eradication of infection was achieved in the majority of patients and the stem migration was similar to that of a primary CPDT stem, this study supports the use of femoral IBG during the final reconstruction of the femur after staged revision THA for infection.

An osteochondral culture platform to screen the bone forming potential stimulated by biomaterials

By N.A.P. van Gestel (Orthopaedic Biomechanics, Department of Biomedical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, the Netherlands AND Institute for Complex Molecular Systems, Department of Biomedical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, the Netherlands)M.W.A. Kleusken (Orthopaedic Biomechanics, Department of Biomedical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, the Netherlands AND Institute for Complex Molecular Systems, Department of Biomedical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, the Netherlands)D. Wanders (LifeTec Group BV, Kennedyplein 10-11, 5611 ZS Eindhoven, the Netherlands)

Abstract Id: 4903
Event: EORS 2019
Topic: Bone

Introduction

Novel biomaterials are being developed and studied, intended to be applied as bone graft substitute materials. Typically, these materials are being tested in in vitro setups, where among others their cytotoxicity and alkaline phosphatase activity (as a marker for osteoblastic differentiation) are being evaluated. However, it has been reported that in vitro tests correlate poorly with in vivo results and therefore many promising biomaterials may not reach the clinic as a bone graft substitute product (Hulsart-Billström et al., 2016). One of the reasons for the poor correlation, may be the minimal complexity of the in vitro tests, as compared to the in vivo environment. Ex vivo models, mimicking the natural tissue environment whilst maintaining control of culture parameters, may be a promising alternative to assess biomaterials for bone formation.

Goal

Assess the possibility of an ex vivo culture platform to test biomaterials on their potential to stimulate new bone formation.
Method

Osteochondral plugs (cylinders n=10, ø 10 mm, height 15 mm) were drilled from fresh porcine knees, from the slaughterhouse. A bone defect (ø 6 mm) was created and which was filled with a biomaterial graft (S53P4 bioactive glass (n=3); collagen sponges loaded with BMP-2 (n=3, as positive control)) or kept empty (n=4). The explants were cultured in custom-made two-chamber bioreactors for six weeks (LifeTec Group BV, (Schwab et al., 2016)). Cartilage and bone were physically separated, similar to the in vivo situation, by a sealing ring. The two tissues were cultured in separate compartments, allowing for specific culture medium for each tissue. Medium was changed every 2-3 days and weekly micro computed tomography (µCT) images were obtained to longitudinally monitor the formation of new bone. An MTT assay was performed on half of the samples after six weeks of culture. The other samples were fixed for histology, to determine which cells were present after six weeks.

Results

The MTT metabolic assay showed that a number of cells in the bone were viable after six weeks. The further away from the border, the fewer living cells were observed. The cells in the cartilage also survived. No significant bone formation was observed with µCT in either of groups, even though abundant bone formation was expected in the BMP-2 group (Geiger, Li, & Friess, 2003). Explanations of the negative results of the positive group might be that too few viable cells remain after six weeks, or that the cells that are still present are not able to form bone.

Conclusions and recommendations

No significant bone formation was observed in the bone defects in osteochondral explants that were cultured with, or without, biomaterials for six weeks. However, the platform showed that it is capable to successfully culture osteochondral explants for six weeks. Histology needs to be performed to evaluate which cells were present at the end of the culture and this will be compared to the cells present directly after drilling the explants.

FID-134: A HYALURONAN-BISPHOSPHONATE MACROMOLECULAR DRUG DELIVERY SYSTEM FOR INTRA-ARTICULAR TREATMENT OF OSTEOARTHRITIS WITH POTENTIAL COMBINED CARTILAGE AND SUBCHONDRAL BONE TARGETING
Abstract Id: 4901  
Event: EORS 2019  
Topic: Cartilage

Introduction

Osteoarthritis (OA) is a degenerative disease of the joint leading to chronic pain and disability, and consequently resulting in a major socioeconomic health burden. OA, which has long been believed to be a cartilage disease, is now considered a whole-joint disorder that affects various anatomical structures, including subchondral bone. Hyaluronic Acid (HA) is commonly used as intra-articular viscosupplementation therapy for its mechanical features and biological effects. Bisphosphonates (BPs) are anti-resorptive agents that inhibit the recruitment and maturation of osteoclast precursors and the activity of mature osteoclasts in the bone. Pre-clinical evidences are reported in the literature showing that intra-articular BPs could have an impact in slowing down or reversing OA progression.

Goal

The combination of the biological and mechanical role of HA and the antiresorptive effect of Alendronate (ALD) could be an interesting strategy for OA treatment. The present study describes the synthesis and characterization of FID 134, a new chemical derivative of HA, conjugated with ALD by means of a covalent bond, cleavable in physiological condition.

Method

FID-134 was synthesized starting from 500 kDa HA: the chemical structure and functionalization degree with ALD were investigated by NMR and ICP-OES. Kinetics of ALD release from FID-134 was determined in TRIS buffer at 37°C and compared to a simple mixture of HA+ALD. 20mg/mL formulations of FID-134 and HA+ALD were investigated for viscoelastic properties, in absence and presence of Ca2+ ions. The cytotoxicity of FID-134 and of free ALD were tested on Saos-2 osteoblasts (ATCC HTB-85) and on primary bovine chondrocytes (PBC) at 1, 3 and 7 days. The efficacy of FID134 was assessed in an in vitro model of inflammatory arthritis, where bovine cartilage biopsies were exposed to IL-1β/OSM (10ng/mL) for 3 weeks; at the same time, cartilage explants were treated with FID-134. Collagen release in the surnatants was quantified and compared to controls.

Results

The structure of FID-134 was confirmed by NMR and the 20% mol/mol functionalization degree was determined by ICP-OES. Only about 50% of total bound ALD was released from FID-134 within 7 days, slower compared to HA+ALD mixture. In presence of Ca2+ ions, viscoelastic properties of FID-134 dramatically improved, while HA+ALD formulation remained unaffected. The cytotoxicity of ALD was evident at 100 µM on Saos-2 and PBC after 3 days, while no cytotoxicity was observed at 7 days with FID-134. In the cartilage explant model, a strong collagen release was detected in inflammatory conditions after 3 weeks; this tendency was reversed and collagen release halved when FID-134 was added to the biopsies.
Conclusions and recommendations

The synthesized HA-ALD adduct, FID-134, opens the door for a new approach for OA treatment, as it combines viscosupplementation and biological effect due to HA presence with the pharmacological activity of BPs. The obtained results suggest that FID-134 could be beneficial in both cartilage degradation and restoration of subchondral bone function, as previously reported in the literature for HA and ALD. Finally, local administration and controlled BP release would likely overcome the drawbacks of ALD oral administration, such as unspecificity and long-term toxic side effects.

Coronal alignment after total knee arthroplasty significantly influences in vivo knee kinematics during deep knee bend activity

By Shinichiro Nakamura (Kyoto University)

Abstract Id: 4900
Event: EORS 2019
Topic: Arthroplasty

Introduction

Coronal alignment of total knee arthroplasty (TKA) is thought to be one of key factors for success in postoperative clinical outcomes and long-term durability. The mechanical alignment technique, which obtains neutral alignment at the mechanical axis, has been the standard method for aligning components. Several clinical studies showed that the postoperative objective knee indicator score was significantly lower in the valgus group and that that patients with preoperative varus had better clinical and functional outcome scores when the alignment was left in mild varus than when the alignment was adjusted to neutral position.

Goal

So far, limited information is available on the effect of limb and component alignment on in vivo knee kinematics after TKA. The purpose of the study was to analyze the effect of the coronal alignment on in vivo knee kinematics during a deep knee bend activity.

Method

In vivo knee kinematics were assessed after implantation with a tri-condylar TKA in 36 knees (25 patients: 19 women [26 knees] and 6 men [10 knees]). The average age of the patients was 74.4 years (standard deviation [SD] = 8.4 years). All knees were implanted with the Bi-Surface Knee System developed by Kyocera (Kyoto, Japan). This implant has a ball-and-socket joint in the mid posterior portion to induce femoral rollback, which works as a post-
cam mechanism in previous biomechanical and kinematic studies. The postoperative femorotibial angle (FTA) for limb alignment, $\alpha$ and $\gamma$ angle for femoral component alignment, and $\beta$ and $\delta$ angle for tibial component alignment were measured according to the Knee Society. The FTA was based on the angles at the lateral side between the anatomical axes of the femur and the tibia. Each patient was asked to perform a weight-bearing deep knee bend activity under fluoroscopic surveillance. Individual video frames were digitized at 30° increments from full extension to maximum flexion. A 3D model fitting approach was used for kinematic analysis. After the relative position of each component was reconstructed, the femorotibial axial rotation were determined. Pearson correlation coefficients were calculated to determine the correlations between the alignment data and kinematic factors.

Results

The correlation analysis showed that coronal alignment was significantly correlated with knee kinematics in the mid to deep flexion range. The FTA was positively correlated with the axial rotation full extension to maximum flexion, whereas the $\beta$ angle had opposing correlation. The varus alignment of limb and tibial components led to greater axial rotation throughout the deep knee bend activity.

Conclusions and recommendations

Postoperative coronal alignment of limb or component after TKA were significantly correlated with rotational in vivo knee kinematics during a weight-bearing knee bend activity using a 3D model fitting approach. Varus alignment of the limb or tibial component resulted in greater external rotation of the femoral component from full extension to maximum flexion, which could represent normal knee kinematics with better clinical outcomes. The current study can be a kinematic rationale reporting worse clinical and functional outcomes in the valgus aligned TKA and better outcomes with kinematic alignment TKA.

Human trabecular lacunocanalicular fluid pressure: Cancellous bone biology

By Taekyeong Lee (Korea University) Junghwa Hong (Korea University)

Abstract Id: 4891
Event: EORS 2019
Topic: Bone

Introduction

Remodeling of the cancellous bone is more active than that of the cortical bone. It is known that the remodeling is governed by the intracancellous fluid pressure. Particularly, the lacunocanalicular pore (PLC) fluid pressure (FP) is essential for survival of the osteocyte and communication of remodeling signals between the PLC and intertrabecular pore (PIT). As a result, knowledge about the PLCFP generation of trabeculae is required to understand human cancellous bone biology. At this moment, the PLCFP measurement of human trabeculae is not reported.
Goal

The purpose of this study was a direct measurement of PLCFP generation of human proximal femoral trabeculae in the direction of superior-to-fovea.

Method

Twenty one microscopic cylindrical trabecular specimens from trabeculae of five fresh human proximal femur (75 to 77 years) were fabricated using a micro-milling machine composed of the laser (Teemphotonics: 532nm), 3-dimensional PZT stage (PI Gmbh, resolution: 0.5nm), and microscope (lens: Navitar, and CCD: Hitachi) with the image processor. The fabrication resolution of the micro-milling machine was 0.4 μm. Based on the trabecular trajectory of femoral head, the specimens were obtained in the direction of superior-to-fovea. The cylindrical specimen size had 120 μm in diameter and 240 μm in length. The test methods described in the previous study were utilized. The used undrained uniaxial strain condition could induce the maximum PLCFP within the trabecular elastic limit.

Results

The measured trabecular PLCFP (±SD) at the strain of 0.4% was 693.7±79.1 kPa.

Conclusions and recommendations

Since this experiment is equivalent to the instantaneous response of PLCFP with free flow boundaries after application of an extremely fast loading speed such an ideal step loading, a PLCFP generation in the physiological condition will be much less than the results obtained in this study. Based on the linear isotropic poroelasticity, the obtained Skempton’s coefficient is almost 0. Thus, the load bearing capability by trabecular PLC fluid is negligible. The Biot coefficient is 0.35 which is higher than that of the cortical tissue (0.14). As a result, the intraosseous fluid communication through trabecular surfaces is active compared to that through Haversian canal surfaces. This imply that mass transports from the trabecular PLC into the PIT and from the PIT into the trabecular PLC could be significantly affected by the PITFP (the physiological blood systolic and diastolic pressure: 16 and 11 kPa, respectively) that acts as the FP boundary condition for the PLC flow. It is known that the PLC flow generates the electrical charges on the trabecular surface (+ for being spouted into the PIT and – for being flown into the PLC), which control differentiation and proliferation of the osteoblast and mesenchymal stem cell. Thus, significant changes in the PITFT could cause changes in the intra-trabecular PLC flow characteristics, mass transports between the PLC and PIT, and electrical charges on the trabeculae. Eventually, these could result in pathologies related to the trabecular remodeling.

An audit on the use of a calibration marker on neck of femur fracture X-rays: a useful but forgotten tool.

By Rebecca Martin (Royal Victoria Infirmary) Sami Anjum (Royal Victoria Infirmary)
Introduction

Neck of femur fractures are an extremely common orthopaedic presentation and are prevalent in elderly osteoporotic patients. People have increasingly longer life expectancies and if a patient presents with an intracapsular fracture who is independent with minimal co-morbidities they can be considered for a total hip replacement. To receive a total hip replacement the original pelvic X-rays should be templated to determine the appropriate prosthesis and a common way this is performed is by including a calibration marker on the X-ray.

Goal

The aim of this study was to assess and improve upon the radiological investigations performed for neck of femur fractures in the Royal Victoria Infirmary. This study set out to determine what proportion of patients admitted with a neck of femur fracture had a calibration marker on their initial X-ray as well as the impact of a missing calibration marker. We also set out to determine what proportion of these patients had a chest X-ray performed with initial X-rays.

Method

Details of all patients admitted with a neck of femur fracture from January 1st 2018 until December 31st 2018 were gathered and used to review each initial trauma X-ray and determine if a calibration marker was included and if they had a chest X-ray performed.

Results

376 patients were admitted with a neck of femur fracture over the one year period and all patients were included in the audit. 36% of patients did not have a calibration marker on their initial pelvic X-ray and 11% did not have a chest X-ray performed. An intracapsular pattern of injury was the most common effecting 215 patients and, of these, 39 went on to have a total hip replacement. 12 of the patients who received a total hip replacement were lacking a calibration marker on their original X-ray and required a repeat X-ray.

Conclusions and recommendations

In conclusion, a significant proportion of patients did not have a calibration marker on initial X-rays. 30% of patients who received a total hip replacement required repeat X-rays as they were missing the calibration marker on initial X-rays. The need to repeat X-rays meant more radiation for the patient, use of X-ray appointment slots which could have been used by other patients and increased expense for the NHS. In order to promote the use of the calibration marker we have produced a visual aid in the form of a poster placed in the radiographer booth and are in the process of re-auditing to hopefully show improvement in its use and reduce the need for repeat X-rays. 11% of patients who did not have a chest X-ray performed at the time of the initial X-ray received a chest X-ray at a later time as this was required by the
anaesthetic team for pre-operative assessment. This poster also reminds staff to perform a chest X-ray at the time of initial imaging.

Boron-Containing Nano-Hydroxyapatite Composites Alters Mesenchymal Stem Cell Proliferation and Osteogenic Differentiation

By Merve Gizer (Hacettepe University, Graduate School of Science and Engineering, Department of Bioengineering) Sevil Köse (Atilim University, Faculty of Medicine, Department of Medical Biology) Beren Karaosmanoglu (Hacettepe University Faculty of Medicine, Department of Medical Genetics)

Abstract Id: 4872
Event: EORS 2019
Topic: Biomaterials

Introduction

Bone tissue deterioration or loss is linked to increased morbidity and mortality. Nano-hydroxyapatite (nHAp) is the inorganic component and replaces the ECM of bone with collagen type I [1]. Boron (B) is a trace element with positive effects on bone homeostasis [2]. The molecular pathway on how B-nHAp effects bone tissue, however, has not been reported. We aimed to evaluate the molecular mechanism of B-nHAp composites on bone cells.

Goal

We aimed to evaluate the molecular mechanism of B-nHAp composites on bone cells.

Method

Boron release from the composites was evaluated by inductively coupled plasma spectrometry at 0.9 µg/ml dose. Effects on human osteoblast SaOS-2 cell line were determined for 0.9 µg/ml B-nHAp, nHAp and 0.006 µg/ml boric acid with WST-1 analyses on days 1, 3 and 5. Molecular effects of B-nHAp composites in osteoblasts were evaluated by transcriptome analysis. For this, 0.9 µg/ml B-nHAp, nHAp composite and 0.006 µg/ml boric acid were prepared in the medium specific for osteoblasts. Osteoblasts were incubated with prepared biomaterials on day one. After incubation, RNA was isolated and the purity was determined with a spectrophotometer. Complementary DNAs were synthesized and libraries were constructed. Data were classified using the PANTHER tool and according to the biological processes, signal pathways and molecular functions. Release and proliferation studies were conducted in triplicate. Data were analyzed with Friedmann and Three-Way ANOVA test, respectively.

Results
B released from 0.9 µg/ml B-nHAp composite from 15 minutes to an hour (p=0.043) and kept its releasing profile up to 5 days. B-nHAp composites did not affect osteoblast proliferation on days 1 and 3. On day 5, B-nHAp composites significantly reduced the proliferation rate compared to untreated osteoblasts (p<0.001). B-nHAp composites altered gene expressions of Wnt, TGF-β, and stress signaling pathways compared to the control groups. B-nHAp composites increased CCND2 expression levels.

Conclusions and recommendations


Predictors for progression of osteoarthritis of the hip

By Daisuke Chiba ()Yoshiyuki Kuwahara ()Kazuyoshi Baba ()

Abstract Id: 4871
Event: EORS 2019
Topic: Imaging

Introduction

Acetabular dysplasia is most common etiology of osteoarthritis (OA) of the hip and the natural course of OA of the hip is variable. It would be extremely useful to be able to predict the progression of osteoarthritic change for planning better therapeutic strategies.

Goal

The purpose of this study was to investigate predictors for progression of OA of the hip.

Method

The material consisted of 115 patients (165 hips) who underwent nonoperative treatment in their asymptomatic or symptomatic hip with OA over five years. 105 females and 10 males were included. The average follow-up was 13.5 years (range 5–34.5 years), and the average age at the first visit was 47.9 years (range 13–79 years). Radiographically we assessed CE angle (CE), acetabular angle of Sharp (Sharp), acetabular head index (AHI), acetabular roof
obliquity (ARO) and head lateralization index (HLI) at the first visit. Variation of joint space (JS) and roof osteophyte (RO) were also assessed. The Japanese Orthopaedic Association pain score for OA of the hip (JOA pain score) and the Japanese Orthopaedic Association classification for OA of the hip (JOA class) were assessed at the first visit and at the final follow-up. The hips were divided into 2 groups by pain score (group A: JOA pain score not worsened, group B: JOA score worsened) and by the degree of radiographical OA progression (group C: JOA class not progressed, group D: JOA class progressed). Radiographical parameters (CE, Sharp, AHI, ARO, HLI, JS, RO) were compared between groups.

**Results**

There were significant differences in CE (group A: 21.7 degrees, group B: 17.3 degrees, p

**Conclusions and recommendations**

In association with the severity of the acetabular dysplasia and rapid progression of hip joint space narrowing, the clinical pain score had a tendency to deteriorate. Radiographical progression of OA of the hip was related with the higher degree of HLI. Femoral head lateralization causes a stronger shearing force and progression of OA may be much more influenced by femoral head lateralization than by the acetabular side factors. Especially young patients with the severe acetabular dysplasia and with the higher degree of femoral head lateralization should be observed carefully. It may be necessary to perform the joint preserving surgery for the patients before OA progresses.

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**Isolation and Comparative Characterization of Exosomes from Human Mesenchymal Stem Cells by Ultracentrifuge and MACS Methods to enhance Bone Healing**

By Eda Çiftci Dede (Hacettepe University, Institute of Science, Department of Bioengineering)Feza Korkusuz (Hacettepe University, Faculty of Medicine, Department of Sport Medicine)Petek Korkusuz (Hacettepe University, Faculty of Medicine, Department of Histology and Embriology)

Abstract Id: 4870
Event: EORS 2019
Topic: MSC's

**Introduction**

Mesenchymal stem cell (MSC) exosomes are intracellular vesicles, which can regulate transcription and control gene expression through the molecules they carry, easily enter into the target cell, contain no regenerative effect, and do not produce an immune response (1).
There are different methods in the literature to obtain these vesicles (2). However, studies on the isolation of MSC-derived exosomes and their comparative characterization using magnetically active cell sorting (MACS) and ultracentrifugation methods are lacking. The most appropriate isolation method for MSC-derived exosomes can be determined by comparing the isolation and characterization parameters of mesenchymal stem cells using magnetically active cell sorting and ultracentrifugation methods.

**Goal**

The aim of this study was to define the advantages and disadvantages of the methods used for determining the purpose-oriented method.

**Method**

Human bone marrow-derived mesenchymal stem cells were cultured in standard MSC culture conditions (37°C and 5% CO₂). Exosomal contamination was prevented by removal of exosomes from the serum that used in the standard growth medium. For exosome isolation of the cells reaching sufficient density, the media were replaced with new ones every two days, the old media were collected in liquid refrigerated with liquid nitrogen and stored at -80°C. Part of the accumulated exosomes were isolated by using the MACS method, while the other was isolated by using the ultracentrifugation method, which included serial centrifugation steps. The amount of protein contained in the phosphate buffer solution in which the exosomes were reconstituted was determined by microplate reader using the BCA kit. Based on the protein concentration obtained, exosomes were read by means of a dye flow cytometer with fluorescent antibodies attached to surface markers specific to CD9, CD63, and CD81 specific for exosomes by latex beads. Finally, the exosomes were stained with uranyl acetate and phosphotungstic acid and then placed on 200 mesh and formvar-carbon film coated grids.

**Results**

Exosomes were isolated using both ultracentrifugation and MACS methods. While ultra-large amounts of exosomes can be isolated by ultracentrifugation method, MACS method provides a lower amount of isolation. Exosomes with magnetically active cell sorting are selected with specific surface markers, therefore, exosomal purity is thought to be higher. Exosomes which were isolated by both ultracentrifugation and MACS methods were monitored by using transmission electron microscopy and they were not found to be morphologically different.

**Conclusions and recommendations**

Posttraumatic cartilage degradation progresses following anterior cruciate ligament reconstruction: A second-look arthroscopic evaluation

By Takaaki Hiranaka (Department of Orthopaedic Surgery, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences)Takayuki Furumatsu (Department of Orthopaedic Surgery, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences)Yusuke Kamatsuki (Department of Orthopaedic Surgery, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences)

Abstract Id: 4869
Event: EORS 2019
Topic: Cartilage

Introduction

Several studies have demonstrated that posttraumatic knee osteoarthritis progresses even after anterior cruciate ligament reconstruction. Few reports described zone-specific cartilaginous damages after anterior cruciate ligament reconstruction.

Goal

This study aimed to compare the status of articular cartilage at anterior cruciate ligament reconstruction with that at second-look arthroscopy.

Method

This study included 20 patients (20 knees, 10 males and 10 females, mean age 22.4 years, Body mass index 24.4 kg/m2) second-look arthroscopy. Mean periods from injury to reconstruction and from reconstruction to second-look arthroscopy were 3.4 and 15.3 months, respectively. Cartilage lesions were evaluated arthroscopically in the six articular surfaces and 40 articular subcompartments independently, and these features were graded with the International Cartilage Repair Society Articular cartilage injury classification; comparisons were made between the grades at reconstruction and at second-look arthroscopy. Furthermore, clinical outcomes were assessed at reconstruction and at second-look arthroscopy, using the Lysholm knee score, Tegner activity scale, International Knee Documentation Committee score, Knee injury and Osteoarthritis Outcome Score, side-to-side difference of the KT-2000 arthrometer and pivot shift test.

Results

Each compartment showed a deteriorated condition at second-look arthroscopy compared with the pre-reconstruction period. A significant worsening of the articular cartilage was noted in all compartments except the lateral tibial plateau and was also observed in the central
region of the medial femoral condyle and trochlea after reconstruction. However, each clinical outcome was significantly improved postoperatively.

Conclusions and recommendations

This study demonstrated that posttraumatic osteoarthritic changes in the patellofemoral and medial compartments progressed even in the early postoperative period, although good knee stability and clinical outcomes were obtained. Care is necessary regarding the progression of osteoarthritis and the appearance of knee symptoms in patients undergoing anterior cruciate ligament reconstruction.

Water jet drilling can safely be applied to microfracture talar chondral defects in the goat

By A.C. Kok (Amsterdam UMC) S. den Dunnen (Delft University of Technology) K. Lamberts (Amsterdam UMC)

Abstract Id: 4868
Event: EORS 2019
Topic: Cartilage

Introduction

Surgical microfracture is considered a first line treatment for talar osteochondral defects. Pain reduction, functional improvement and patient satisfaction are described to be 61-86% in both primary and secondary osteochondral defects. However, limited research is available whether improvement of the surgical technique is possible. We do know that the current rigid awls and drills limit the access to all locations in human joints and increase the risk of heat necrosis of bone. Application of a flexible water jet instrument to drill the microfracture holes can improve the reachability of the defect without inducing thermal damage.

Goal

The aim of this study is to determine whether water jet drilling is a safe alternative compared to conventional microfracture awls by studying potential side effects and perioperative complications, as well as the quality of cartilage repair tissue in a caprine model.

Method

6 mm diameter talar chondral defects were created bilaterally in 6 goats (12 samples). One defect in each goat was treated with microfracture holes created with conventional awls. The contralateral defect was treated with holes created with 5 second water jet bursts at a pressure of 50 MPa (Figure 1). The pressure was generated with a custom-made setup using an air compressor connected to a 300 litre accumulator that powered an air driven high pressure pump (P160 Resato, Roden, The Netherlands, www.resato.com) (Figure 2). Postoperative
complications were recorded. After 24 weeks, analyses were performed using the ICRS macroscopic score and the modified O’Driscoll histological score. Wilcoxon ranked sum tests were used to assess significant differences between the two instrument groups using each goat as its own control (p≤0.05).

Results

One postoperative complication was signs of a prolonged wound healing with swelling and reluctance to weight bearing starting two days after surgery on the water jet side. Antibiotics were administered which resolved the symptoms. The median total ICRS score for the tali treated with water jets was 9.5 (range: 6-12) and 9 (range 2-11) for Observer 1 and 2 respectively; and for the tali treated conventionally this was 9.5 (range 5-11) and 9 range (2-10) (Figure 3). The median total Modified O’Driscoll score for the tali treated with water jets was 15 (range: 7-17) and 13 (range: 3-20) for Observer 1 and 2 respectively; and for the tali treated conventionally was 13 (range: 11-21) and 15 (range: 9-20) (Figure 4). No differences were found in complication rate or repair tissue quality between the two techniques.

Conclusions and recommendations

The results suggest that water jet drilling can be a safe alternative for conventional microfracture treatment. Future research and development will include the design of an arthroscopic prototype of the water jet drill. The focus will be on stability in nozzle positioning and minimized sterile saline consumption to further the decrease the risk of soft tissue damage.

The use of vancomycin-impregnated cancellous bone grafting in one-stage surgery for periprosthetic joint infection and fracture-related infection.

By Karen Dendoncker (Tissue bank az groeninge, az groeninge, President Kennedylaan 4, 8500 Kortrijk, Belgium) Guy Putzeys (Tissue bank az groeninge, az groeninge, President Kennedylaan 4, 8500 Kortrijk, Belgium)

Introduction

The use of cancellous bone allografts is an established technique in reconstructive orthopaedic surgery, unfortunately its use is generally avoided in the presence of local infection. Impregnating cancellous bone grafts with antibiotics has shown their effectiveness as an antibiotic delivery system and could therefore be used in an infected environment even in a
one-stage procedure. However there are only very few clinical reports on the results of this technique.

Goal

In this clinical study, we report our first personal experience with the use of vancomycin-impregnated cancellous bone grafts in one-stage surgery for periprosthetic joint infections (PJI) and fracture-related infections (FRI).

Method

Between December 2015 and October 2018 eight patients were treated with vancomycin-impregnated cancellous bone grafting during a one-stage surgery. Vancomycin-impregnated bone grafting were obtained from the European Cell and Tissue Bank (ECTB) and contains a uniform concentration of 1g vancomycin per 10cc bone. Regular clinical, laboratory and radiographic follow-ups were performed for at least 6 months after surgery.

Results

The procedures included revision of 4 PJIs (Pelvis, Humerus and Femur) and 4 FRI (Tibia/Fibula and Femur). Preoperative and/or intraoperative cultures were collected from infected wounds. Following micro-organisms were identified: Propionibacterium acnes, several Staphylococcal species (S. capitis, S. aureus ssp aureus, S. epidermidis, S. haemolyticus, S. hominis), Streptococcus dysgalactiae and Bacteroides fragilis. There was one tibia which required further revision because of recurrent infection, however the remaining 7 patients stayed free from infection during a follow-up of at least 6 months. This observation was also reflected in the C-reactive protein value which returned back to baseline. Interestingly, in one patient the vancomycin concentration was determined in the drainage fluid from the wound 17 and 24 days post-surgery and was respectively 280mg/l and 90mg/l. Radiographic examination revealed no signs of osteolysis or loosening, good incorporation of the bone graft and progressive consolidation. So far, there is no sign of active infection during the period of follow-up in the involved patients.

Conclusions and recommendations

Within the limits of the study, the use of vancomycin-impregnated cancellous bone grafting in one-stage surgery to treat PJI and FRI yielded positive outcomes in terms of clinical, laboratory and radiographic follow-up. The use of cancellous bone grafting as an antibiotic delivery system in one-stage surgery might offer new treatment strategies of which a shorter and single hospital stay and lower economic burden are the most important benefits.

Patient-specific finite element computer models improve fracture risk predictions in cancer patients with femoral bone metastases compared to clinical guidelines
Introduction

Patients with cancer and bone metastases can have an increased risk of fracturing their femur. Treatment is based on the impending fracture risk: patients with a high fracture risk are considered for prophylactic surgery, whereas low fracture risk patients are treated conservatively with radiotherapy to decrease pain. Current clinical guidelines suggest to determine fracture risk based on axial cortical involvement of the lesion on conventional radiographs, but that appears to be difficult [1]. Therefore, we developed a patient-specific finite element (FE) computer model that has shown to be able to predict fracture risk in an experimental setting [2] and in patients [3].

Goal

To determine whether patient-specific finite element (FE) computer models are better at predicting fracture risk for femoral bone metastases compared to clinical assessments based on axial cortical involvement on conventional radiographs, as described in current clinical guidelines.

Method

45 patients (50 affected femurs) affected with predominantly lytic bone metastases who were treated with palliative radiotherapy for pain were included. CT scans were made and patients were followed for six months to determine whether or not they fractured their femur. Non-linear isotropic FE models were created with the patient-specific geometry and bone density obtained from the CT scans. Subsequently, an axial load was simulated on the models mimicking stance. Failure loads normalized for bodyweight (BW) were calculated for each femur. High and low fracture risks were determined using a failure load of $7.5 \times \text{BW}$ as a threshold [3]. Experienced assessors measured axial cortical involvement on conventional radiographs. Following clinical guidelines, patients with lesions larger than 30 mm were identified as having a high fracture risk. FE predictions were compared to clinical assessments by means of diagnostic accuracy values (sensitivity, specificity and positive (PPV) and negative predictive values (NPV)).

Results

Seven femurs (14%) fractured during follow-up. Median time to fracture was 8 weeks. FE models were better at predicting fracture risk in comparison to clinical assessments based on axial cortical involvement (sensitivity 100% vs. 86%, specificity 74% vs. 42%, PPV 39% vs. 19%, and NPV 100% vs. 95%, for the FE computer model vs. axial cortical involvement, respectively).
Conclusions and recommendations


Physioxia preconditioned Mesenchymal Stem Cells improve cartilage regeneration for the treatment of early osteoarthritis defects

By Girish Pattappa (Laboratory for Experimental Trauma Surgery, Department of Trauma Surgery, University Medical Centre Regensburg, Regensburg, Germany) Jonas Krueckel (Laboratory for Experimental Trauma Surgery, Department of Trauma Surgery, University Medical Centre Regensburg, Regensburg, Germany) Brian Johnstone (Oregon Health & Science University, Orthopaedics and Rehabilitation, Portland, Oregon, USA)

Abstract Id: 4823
Event: EORS 2019
Topic: Cartilage

Introduction

Osteoarthritis (OA) is a progressive and degenerative joint disease resulting in changes to articular cartilage. Autologous chondrocyte implantation (ACI) has been used to treat focal early OA defects but there is a 2-fold failure rate due to poor graft integration and presence of inflammatory factors (e.g. Interleukin-1β) (1). Bone marrow derived mesenchymal stem cells (MSCs) are an alternative cell source for cell-based treatments due to their chondrogenic capacity. However, MSC chondrogenesis leads to bone formation upon in vivo implantation (2). In vivo, chondrocytes reside under an oxygen tension between 2-7% oxygen or physioxia. Previous studies have demonstrated that physioxia enhances MSC chondrogenesis with reduced hypertrophic marker (collagen X and MMP13) expression compared to hyperoxic conditions (20% oxygen) (3).

Goal

The present investigation sought to understand whether implantation of physoxic preconditioned MSCs would improve cartilage regeneration in an early OA defect model compared to hyperoxic MSCs.

Method
Bone marrow extracted from New Zealand white rabbits (male: 5-6 months old; n = 6) was split equally for expansion under 2% (physioxia) or 20% (hyperoxia) oxygen. Chondrogenic pellets (2 x 105 cells/pellet) were formed at passage 1 and cultured in the presence of TGF-β1 under their expansion conditions. Pellet wet weight and GAG content was measured after 21 days culture. During bone marrow extraction, a dental drill (2.5mm diameter) was applied to medial femoral condyle on both the right and left knee and left untreated for 6 weeks. Following this period, physioxia and hyperoxia preconditioned MSCs were seeded into a hyaluronic acid (TETEC) hydrogel. Fibrous tissue was scraped and then MSC-hydrogel was injected into the right (hyperoxic MSCs) and left (physioxia MSCs) knee. Additional control rabbits with drilled defects had fibrous tissue scrapped and then left untreated without MSC-hydrogel treatment for the duration of the experiment. Rabbits were sacrificed at 6 (n = 3) and 12 (n = 3) weeks post-treatment, condyles harvested, decalcified in 10% EDTA and sectioned using a cryostat. Region of interest was identified, sections were stained with Safranin-O/Fast green and evaluated for cartilage regeneration using the Sellers scoring system4 by three blinded observers.

Results

Rabbits MSCs showed significantly shorter doubling time and greater cell numbers upon physioxia culture compared to hyperoxia (*p < 0.05). Physioxia enhanced MSC chondrogenesis, as demonstrated by significant increases in pellet wet weight and GAG content (*p < 0.05). Implantation of physioxic preconditioned MSCs showed significantly improved cartilage regeneration (Mean Sellers score = 7 + 3; *p < 0.05) compared to hyperoxic MSCs (Sellers score = 12 + 2) and empty defects (Sellers score = 17 + 3).

Conclusions and recommendations


The Use of 3D Printing in Preoperative Planning in Orthopaedic Trauma Surgery: a Systematic Review and Meta-analysis

By Catrin Morgan (Imperial College NHS Trust)Chetan Khatri (Imperial College NHS Trust)Sammy Hanna (Barts and the London NHS Trust)

Abstract Id: 4822
Event: EORS 2019
Topic: 3-D Printing

Introduction
With the increasing complexity of surgical interventions performed in orthopaedic trauma surgery and the improving technologies used in three-dimensional (3D) printing, there has been an increased interest in the concept. It has been shown that 3D models allow surgeons to better visualize anatomy, aid in planning and performing complex surgery. It is however not clear how best to utilize the technique and whether this results in better outcomes.

**Goal**

This study aimed to evaluate the effect of 3D printing used in pre-operative planning in orthopaedic trauma surgery on clinical outcomes.

**Method**

We performed a comprehensive systematic review of the literature and a meta-analysis. Medline, Ovid and Embase were searched from inception to 8th February 2018. Randomised controlled trials (RCTs), case-control studies, cohort studies and case series of greater than five patients were included across any area of orthopaedic trauma. The primary outcomes were operation time, intra-operative blood loss and fluoroscopy used.

**Results**

Seventeen studies (922 patients) met our inclusion criteria and were reviewed. The use of 3D printing across all specialties in orthopaedic trauma surgery demonstrated an overall reduction in operation time of 19.85% (95% CI -22.99, -16.71), intra-operative blood loss of 25.73% (95% CI -31.07, -20.40) and number of times fluoroscopy was used by 23.80% (95% CI -38.49, -9.10).

**Conclusions and recommendations**

Our results suggest that the use of 3D printing in pre-operative planning in orthopaedic trauma reduces operative time, intraoperative blood loss and the number of times fluoroscopy is used. Better quality evidence is required to further enhance our knowledge of the role of 3D printing in orthopaedics and its application to daily clinical practice. 3D printing should be considered as an adjunct to improve patient care by minimizing operative insult in orthopaedic trauma surgery.

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**A pilot study on the effect of tenomodulin deficiency in knee osteoarthritis in physically active and aged mice**

By Sara Steinmann (Laboratory for Experimental Trauma Surgery, Department of Trauma Surgery, University Medical Center Regensburg Regensburg, Germany)Girish Pattappa (Laboratory for Experimental Trauma Surgery, Department of Trauma Surgery, University Medical Center Regensburg Regensburg, Germany)Peter Angele (Laboratory for Experimental Trauma Surgery, Department of Trauma Surgery, University Medical Center Regensburg Regensburg, Germany; Sporthopaedicum Regensburg, Regensburg, Germany)
Introduction

Knee osteoarthritis (OA) is an insidious degenerative disease of the whole knee joint, characterized by a complex pathology including degeneration of articular cartilage, changes in subchondral bone, osteophyte formation and synovial hyperplasia causing severe pain and joint dysfunction. In association with OA pathology, tendons and ligaments (T/L) of the knee apparatus are substantially under-investigated. Loss of tenomodulin (Tnmd), a well-known T/L marker, results in self-renewal phenotype of endogenous tendon cells coupled with changes in the collagen fibril structure and biomechanics. The aim of this pilot-study was to investigate whether Tnmd knockout may lead to OA development in mice that were kept sedentary or subjected to running exercise.

Goal

The aim of this pilot-study was to investigate whether Tnmd knockout may lead to OA development in mice that were kept sedentary or subjected to running exercise.

Method

For this, 12 months-old Tnmd wildtype (WT) and Tnmd knockout (KO) male littermates, after one week of acclimatization, were subjected to 60 min of forced endurance training on a treadmill at a constant speed of 10 m/min and angle of –10° for 5 days per week for 4 consecutive weeks. Following PFA-fixation, decalcification and cryo-embedded, cryo-sections of murine knee sections were histologically stained with hematoxylin-eosin to study the overall tissue morphology and with Safranin O/Fast Green to evaluate the quality of the murine articular cartilage. Knee OA grading was carried out accordingly to Nicolae et al. (2007).

Results

Our pilot study of histomorphometric analysis of the tibial articular cartilage revealed that loss of Tnmd leads to augmented damage of the articular cartilage. Both genotypes showed at this age OA development. However, we observed the worst phenotype in sedentary Tnmd KO animals displaying thinner cartilage, abnormal organization of chondrocytes characterized by loss of columnar structure and enlarged cell territories and hypocellularity, as well as decreased Safranin O-positive staining. Interestingly, the applied running protocol improved the overall integrity of WT articular cartilage and improvement was also detected in knees of Tnmd KO mice.

Conclusions and recommendations

Our pilot study demonstrates that loss of Tnmd in T/L results in perturbation of articular cartilage integrity. For the first time, we suggest that Tnmd, which is an important mechanosensitive factor for proper functional performance of T/L, might act in a secondary manner as protective factor in knee OA. Further studies determining how T/L quality, force transmission and stability of the knee may be linked to OA progression are necessary.
Risk factors for dislocation after primary total hip arthroplasty.

By Itsuki Oizumi (Tohoku University School of Medicine) Daisuke Chiba (Tohoku University School of Medicine) Kazuyoshi Baba (Tohoku University School of Medicine)

Abstract Id: 4806
Event: EORS 2019
Topic: Arthroplasty

Introduction

Dislocation is one of the most frequent complications and a significant reason for surgical revision following primary total hip arthroplasty (THA).

Goal

The purpose of this study was to assess the risk factors of dislocation after THA.

Method

From 2009 to 2017, 259 hips in 222 patients were included in this study. Two hundred sixteen hips were female and 43 hips were male. The mean age at operation was 65.6 years old and the mean follow up period was 3.7 years after surgery. Dislocation rate, radiographic parameters, post-operative ROM, and surgical approach were assessed. As radiographic parameters, inclination of acetabular component, the rate of change of femoral offset and limb length changes were assessed. All patients were divided as dislocation group and non-dislocation group. We compared with two groups for evaluating the risk factor of dislocation after THA.

Results

The dislocation rate was 5.8%. Inclination of dislocation group was 46 degree. That of non-dislocation group was 43.2 degree. The rate of change of femoral offset of dislocation group was 1.4. That of non-dislocation group was 1.2. Limb length changes of dislocation group was 13.8mm. Non-dislocation group was 21.6mm. Limb length changes of dislocation group was significantly lower than that of non-dislocation group. In post-operative ROM of dislocation group, flexion was 95.8 degree, extension was 2.3 degree, abduction was 30.0 degree and internal rotation was 22.0 degree. That of non-dislocation group, flexion was 89.9 degree, extension was 1.9 degree, abduction was 27.6 degree and internal rotation was 18.2 degree. There was no significant difference about post-operative ROM (flexion; p=0.07, extension; p=0.2, abduction; p=0.1, internal rotation; p=0.1). two hundred eight hips were performed in posterolateral approach (PL), 23 hips were in anterolateral supine approach (AL-
S), 23 hips were in OCM and 4 hips were in direct anterior approach (DAA). The dislocation rate was 6.2% in PL, 0% in AL-S, 8.3% in OCM, 0% in DAA.

Conclusions and recommendations

The dislocation rate was 5.8% in this study. Limb lengthening compared with dislocation and non-dislocation group, there was the tendency that flexion angle of hip joint of dislocation group were greater than that of non-dislocation group post-operatively. There were no dislocation cases in AL-S and DAA. To avoid dislocation after THA, offset and limb lengthening in other words, tension of soft tissue around hip joint, and surgical approach are important matter.

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**Between the medial and lateral gap differences at 90° flexion position predict knee kinematics in total knee arthroplasty**

By Shin Masuda (Okayama University)Shinichi Miyazawa (Okayama University)Yuya Kodama (Okayama University)

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**Abstract Id:** 4803  
**Event:** EORS 2019  
**Topic:** Arthroplasty

**Introduction**

In total knee arthroplasty (TKA), patients with medial pivot (MP) pattern (intraoperative kinematics) have improved knee range of motion and satisfaction. We hypothesized that intraoperative kinematics could be predicted by the difference between the medial gap (m-gap) and the lateral gap (l-gap) at extension and flexion.

**Goal**

This study aimed to evaluate the association of intraoperative kinematics with the difference between the m-gap and l-gap using a navigation system.

**Method**

For TKA with a posterior stabilizer (PS) type implant, we measured the m-gap, l-gap, and difference between the m-gap and l-gap at 0° knee extension and 90° knee flexion positions and identified the intraoperative kinematics using the navigation system. Patients were divided into the following groups according to their intraoperative kinematics: roll back (RB) group, MP + RB group, and MP group.

**Results**
In the knee-flexed position, a significant difference in was found between the RB and MP+RB groups in the m-gap and l-gap difference (p

Conclusions and recommendations

In TKA, medial tightness of approximately 1 mm and 1.5 mm at 90° knee flexion should be achieved to obtain MP+RB and MP patterns, respectively. We should perform medial tight TKA.

Intraoperative evaluation of cup height using radiography in total hip arthroplasty

By Kazuhiko Sonoda (Iizuka Hospital) Toshihiko Hara (Iizuka Hospital)

Abstract Id: 4795
Event: EORS 2019
Topic: Arthroplasty

Introduction

During preoperative planning of total hip arthroplasty (THA), correcting the length of the legs should be considered because leg length discrepancy has several potential negative consequences for the patient, including hip dislocation, the need for a shoe raise, and limping. Although cup height affects postoperative leg length, postoperative cup height can be different from planned one. If we can recognize this difference intraoperatively, we can control leg length by tuning stem positioning, or repositioning the cup.

Goal

Our aim is to determine whether intraoperative radiography is useful for intraoperative evaluation of cup height.

Method

This study was approved by our institutional review board. We prospectively evaluated 21 hips in 21 patients who underwent primary THA. The diagnosis was osteoarthritis in 19 patients and osteonecrosis of the femoral head in 2 hips. Preoperative planning was performed based on computed tomography (CT) using 3D-dimensional template software (Kyocera Medical, Osaka, Japan). The functional pelvic plane was used as the standard plane of the pelvis. ISB coordinate system was used as the standard plane of the femur. Then cup positioning and stem positioning were determined. Planned cup height was presented by vertical distance between top of the cup and that of contralateral femoral head (or contralateral cup). Surgeries were performed using common posterolateral approach. Just before surgery, anteroposterior radiograph was obtained in the lateral position. With reference to digitally reconstructed radiograph images obtained by 3D template software, we made the position to the functional pelvic plane as well as possible. Surgery was performed using combined anteversion technique. The preparation of the femur was performed first so that
femoral anteversion was confirmed prior to the cup placement. Then the cup was placed according to the stem anteversion so that the combined anteversion ranged from 40-60°. Then intraoperative radiography was obtained in the same way as that obtained just before surgery. Based on this radiography, intraoperative cup height calibrated by cup size was measured. Referring to intraoperative cup height, tuning stem positioning was performed. After surgery, postoperative cup height was evaluated in the same way as planned cup height based on postoperative CT. Then difference of each cup height was evaluated.

Results

The average difference between planned cup height and postoperative cup height was 2.4 mm (range: 0.1-6.9 mm). On the other hand, the average difference between intraoperative cup height and postoperative cup height was 1.0 mm (0.0-3.0 mm). Using intraoperative radiography, we could recognize 1.4 mm on average of intraoperative error. The maximum intraoperative error decreased from 6.9 mm to 3.0 mm.

Conclusions and recommendations

This study suggested that intraoperative radiography allow us to recognize the difference between planned cup height and intraoperative cup height, which is useful for avoiding unexpected leg length after THA.

Does U nail Improve cerclage wire stability in femoral fractures? A Comparative Biomechanical study of a new designed implant

By Mehmet Nuri Konya, Feza Korkusuz, Teyfik Demir (nurikonya@hotmail.com)

Abstract Id: 4782
Event: EORS 2019
Topic: Biomechanics

Introduction

The ideal method of periprosthetic fractures is still unknown. Different fixation methods can be used for periprosthetic fractures such as locking-nonlocking plates, cable plates, strut grafts with cables. Screw insertion during periprosthetic fracture treatment may be distressed. Unicortical screw fixation in prosthesis level can cause implant failure. Cerclage wire fixation can cause rotational instability. we aimed to design a new implant to overcome these troublesome situations. U- nail (staples) use in orthopeadic practice is not rare. U nail generally use in Tendon transfer operations, deformity correction, ACL fixation etc. In this newly design implant, we combined U nail and cerclage wire in plate. The aim of this study is to compare and evaluate stability of Cerclage cable, U nail and combination of these two
method on fractured artificial bone model Synbone 2162 (Length 450mm, Neck Angle 122 degree, Head diameter 48 mm, Canal diameter 9.5 mm).

Goal

Our goal is to improve a new designed implant.

Method

Serial Number of 2015EMY01 test machine was used for tests. The ISO 7206-4:2010 (E) specifies the test method to be used to determine the endurance properties of 18 plates with three groups under laboratory conditions. The test conditions were defined by considering the important parameters that affect the components. The laboratory conditions were 50% humidity, 250°C, and no fluid applied. The implant was mounted in a specific position, and the load was then applied using a frequency of 10 Hz and a sinusoidal loading wave.

Results

In group 1; only cerclage wire applied plate was examined. Six different femoral model were tested. 4 samples were succeeded test results under 80, 100, and 120 N load bearing. One sample were broken under 9 cycle and 150 N. In group 2 and 3, 3 samples were examined. Under 100 and 150 N tests were succeeded. Under 200N, one sample was failed in group 2 under 1523 cycle and under 1771 cycle in group 3.

Conclusions and recommendations

According to our final results, cerclage wire fixation was found less effective than the other group. In group 2 and 3 there were no significant differences were found.

Do the radiographic parameters influence the postoperative patient reported outcomes of Stage 2 acquired adult flatfoot deformity.

By Kensei Yoshimoto (Orthopaedic Foot and Ankle Center, Shiseikai Daini Hospital) Masahiko Noguchi (Orthopaedic Foot and Ankle Center, Shiseikai Daini Hospital) Akifumi Yamada (Orthopaedic Foot and Ankle Center, Shiseikai Daini Hospital)

Abstract Id: 4699
Event: EORS 2019
Topic: Tendon

Introduction

There are few reports which evaluated the postoperative patient reported outcomes of acquired adult flatfoot deformity (AAFD), and the influence of the radiographic parameters
including the medial arch height on the postoperative clinical outcomes of AAFD was unclear.

**Goal**

This report is aimed to evaluate the postoperative patient reported outcomes of AAFD stage 2, and examine whether the radiographic parameters influence the postoperative patient reported outcomes.

**Method**

From 2012 to 2017, 28 feet of 28 patients underwent surgery for AAFD stage 2. Six patients were male and 22 were female with a mean age at surgery and follow-up period of 60 years and 30 months, respectively. Per the stages defined by Bluman and Myerson, 3, 12, 7, and 6 feet were stage 2A1, 2A2, 2B and 2C, respectively. Clinical outcome was evaluated using a self-administered foot evaluation questionnaire (SAFE-Q). The medial cuneiform height, lateral talo-first metatarsal angle, and talonavicular coverage angle were measured as radiographic parameters. Univariate analysis was performed to examine the influence of the radiographic parameters on the postoperative SAFE-Q.

**Results**

The all SAFE-Q subscales significantly improved after surgery (p < 0.0001). In the patients with AAFD stage 2A, the postoperative lateral talo-first metatarsal angle was significantly associated with the postoperative social functioning scores of the SAFE-Q (p=0.0146). In the patients with AAFD stage 2B and 2C, the postoperative medial cuneiform height was significantly associated with the postoperative physical functioning scores and general health scores of the SAFE-Q (p = 0.0172 and 0.0095, respectively).

**Conclusions and recommendations**

We found the significant improvement of SAFE-Q after surgery for stage 2 AAFD. Correction of the medial longitude arch height could result in good clinical outcome.

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**Integrating learning effects at the surgeon and system level into the interpretation of a surgical RCT**

By Werner Vach (Dept. of Orthopaedics & Traumatology, University Hospital Basel) Franziska Saxer (Dept. of Orthopaedics & Traumatology, University Hospital Basel)

Abstract Id: 4681
Event: EORS 2019
Topic: Other

**Introduction**
Learning effects are a thread to the generalizability of the results of a surgical RCT. So far the focus has been on analysing learning effects at the level of a single surgeon. However, learning can also happen at the system level. Understanding the magnitude of such effects can assist in interpreting the results of a surgical RCT.

Goal

We try to get insights into learning effects at the system level and learning effects at the level of a single surgeon for a specific surgical RCT.

Method

We consider statistical methods to estimate learning effects at both levels. We apply these methods to data from an RCT comparing the lateral transgluteal Harding approach with the anterior minimally-intensive Hueter approach in elder patients suffering from a femoral neck fracture. The study involves 38 surgeons performing 179 operations.

Results

No evidence for learning effects at the surgeon level could be found. At the system level, there is little evidence for a positive learning effect under the experimental treatment, but in contrast some evidence for a negative learning effect under the standard treatment.

Conclusions and recommendations

A systematic investigation of learning effects can assist in interpreting treatment effects estimated in an RCT. We recommend such analyses as a part of the standard evaluation of a surgical RCT.

Investigation of The Effect of Static and Electric Fields on Bone Healing Process: An experimental tibial fracture model study in wistar male rats.

By Ahmet Aslan (Alanya Alaaddin Keykubat University) Mehmet Nuri Konya (Afyon Sağlık Bilimleri University) Vecihi Kırdemir (Süleyman Demirel University)

Abstract Id: 4614
Event: EORS 2019
Topic: Bone

Introduction

The role of electric field on bone healing is still unknown. In this study, we want to investigate the effect of two different electric field on bone healing.
Goal

In this experimental study, we aimed to investigate whether 0 Hz-Static and 50 Hz-Electric field have an effect on bone healing.

Method

A total of 45 male Wistar-Albino rats were equally and randomly separated into three groups as follows: 0 Hz-Static electric field (SEF), 50-Hz low frequency electric field (LFEF) and control groups. Manual fracture was performed in left tibia diaphyses of all rats, and fractures were fixed by using circular plaster over knee. The LFEF group was exposed to 50 Hz electric field for 30 minutes a day and five days a week, with eight weeks in total. The SEF group was exposed to 0 hz electric field within the same time interval. Control group was held in identical environmental conditions without exposure to electric field. Periodic radiographs were taken from whole rats. In the end of the study, rats were sacrificed and mechanical / histopathologic examinations were performed.

Results

Radiologic, mechanical and histologic scores of LFEF group were lower than those of the SEF and control groups however, no significant difference was found in group comparisons in terms of average histologic and radiologic scores (P>0.05).

Conclusions and recommendations

Results gathered from the current study suggest that 0-hz static and 50-hz electric field exposures may have no effect in bone healing tissue of tibial fracture model in rats.

Influence of the processing temperature on the thermal and mechanical properties of Vitamin E blended UHMWPE crosslinked by x-rays

By Marie Anne Mulliez

Abstract Id: 4595
Event: EORS 2019
Topic: Biomaterials

Introduction

At the beginning of the 1970s Oonishi et al introduced the radiation crosslinking to improve the wear resistance of polyethylene used in hip arthroplasty. With their excellent penetration and moderate dose rate x-rays offer a valid alternative to gamma-rays and electron-beam (e-beam). In 2011 Oral et al described the significant advantages of processing the polyethylene...
under elevated temperature. However the combined impact of radiation source and
temperature on the material properties has not been explored so far.

Goal

The purpose of this work is the investigation of the influence of the processing temperature on
the thermal and mechanical behavior of Ultra High Weight Molecular Weight Polyethylene
(UHMWPE) blended with vitamin E and irradiated by x-rays. The hypothesis was that at
same temperature and same dose the material would exhibit equivalent properties
independently of the ionizing source.

Method

UHMWPE blended with 0.1% Vitamin E was crosslinked by x-rays at 80 kGy and 100 kGy.
The irradiation was performed both at room (RT) and at elevated temperature (100°C) leading
to following groups: X (80 kGy)-RT, X (100 kGy)-RT, X (80 kGy)-warm and X (100 kGy)-
warm. The reference Vitelene® was irradiated by e-beam with 80 kGy at 100°C. The uniaxial
tensile strength according to ASTM D638 and the thermal properties (crystallinity and
melting temperature) according to ASTM F2625 were determined.

Results

The warm processed polyethylene displayed decreased crystallinity and yield strength. The
degree of crystallinity ranged from 52.3±1.4 %, 51.1±1.1 % and 53.0±0.7 % respectively for
Vitelene®, X (80 kGy)-warm and X (100 kGy)-warm to 55.9±1.0 % and 58.0±0.7 % for X
(80 kGy)-RT and X (100 kGy)-RT. The achieved yield strength was respectively 21.7±0.1
MPa, 21.7±0.7 MPa and 20.7±0.4 MPa for Vitelene®, X (80 kGy)-warm and X (100 kGy)-
warm; 23.6±0.3 MPa and 23.8 MPa for X (80 kGy)-RT and X (100 kGy)-RT. An increased
elongation at break was registered for the warm processed material as well: respectively
393±8%, 402±6% and 390±4% for Vitelene®, X (80 kGy)-warm and X (100 kGy)-warm;
348±13% and 321±6% for X (80 kGy)-RT and X (100 kGy)-RT.

Conclusions and recommendations

The temperature (RT vs. 100°C) had a bigger influence than the dose (80 kGy vs. 100 kGy).
The introduction of heat during irradiation resulted in a loss of crystallinity followed by
decreased yield strength and increased elongation at break. When crosslinked at 80 kGy at
elevated temperature UHMWPE blended with 0.1% Vitamin E showed similar mechanical
and thermal properties regardless of radiation source. The determination of the fatigue
resistance, fatigue crack propagation and Small Angle X-ray Scattering (SAXS) would be
helpful to better understand the relationship between microstructure and the bulk mechanical
properties and provide some worthwhile information to further enhance UHMWPE used in
orthopedic implant material.

Differences between horn and root cells of human medial meniscus in cellular
characteristics and responses to mechanical stress

By Yuki Okazaki (Department of Orthopaedic Surgery, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences) Takayuki Furumatsu (Department of Orthopaedic Surgery, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences) Takaaki Hiranaka (Department of Orthopaedic Surgery, Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences)

Abstract Id: 4589
Event: EORS 2019
Topic: Cartilage

Introduction

The meniscus is a fibrocartilaginous tissue that plays an important role in controlling the complex biomechanics of the knee. Many histological and mechanical studies about meniscal attachment have been carried out, and medial meniscus (MM) root repair is recommended to prevent subsequent cartilage degeneration following MM posterior root tear. However, there are only few studies about the differences between meniscus root and horn cells.

Goal

The goal of this study was to clarify the differences between these two cells.

Method

Tissue samples were obtained from the medial knee compartments of 10 patients with osteoarthritis who underwent total knee arthroplasty. Morphology, distribution, and proliferation of MM root and horn cells, as well as gene and protein expression levels of Sry-type HMG box (SOX) 9 and type II collagen (COL2A1) were determined after cyclic tensile strain (CTS) treatment.

Results

Horn cells had chondrocytic morphology, whereas root cells were fibroblast-like. The number of horn cells positive for SOX9 and COL2A1 was considerably higher than that of root cells. Although root and horn cells showed similar levels of proliferation after 2-h CTS (5% and 10% strain), root cells were more resistant to this stress than horn cells. SOX9 and COL2A1 mRNA expression levels were significantly enhanced in horn cells compared with those in root cells after 2- and 4-h CTS (5%) treatment. This study demonstrates that MM root and horn cells have distinct characteristics and show different cellular phenotypes.

Conclusions and recommendations

Our results suggest that physiological tensile strain is important for activating extracellular matrix production in horn cells. Restoring physiological mechanical stress may be useful for promoting healing of the MM posterior horn.
ISOLATED PRIMARY BONE TUMOURS OF THE LESSER TROCHANTER: DEMOGRAPHICS, DIAGNOSIS AND MANAGEMENT

By Ahmed Isam Saad (The Royal Orthopaedic Hospital) Umar Hanif (The Royal Orthopaedic Hospital) Scott Evans (The Royal Orthopaedic Hospital)

Abstract Id: 4553
Event: EORS 2019
Topic: Bone

Introduction

Primary bone tumours of the lesser trochanter (LT) are rare and the literature describing them is sparse. In this paper, we describe the largest series of LT tumours describing the demographics, diagnosis and management.

Goal

We report the largest case series of isolated primary bone tumours of the LT. All isolated primary bone tumours of LT are benign. Osteochondroma is the most common. The diagnosis can be made with on radiological investigations in most patients.

Method

A retrospective search of prospectively maintained radiology and oncology databases was performed to identify bone tumours of the LT diagnosed between 2007 and 2018. Metastatic lesions were excluded. All cases were re-reviewed by a senior Consultant Radiologist and all case of benign isolated tumours of the LT were included.

Results

23 cases of isolated LT tumours were identified. There were 15 males and 8 females. Median age of our cohort was 32 (14 - 63) years. Most (n=19, 82.6%) cases had classic radiological (Radiographic, MR Imaging and CT) features and therefore did not undergo biopsy. 4 patients had equivocal radiological investigations that required biopsy to confirm the diagnosis. MR imaging was the most commonly used imaging modality for diagnosis (n=17, 73.9%) There was a broad range of tumour subtypes, and osteochondroma (n=17, 73.9%) the most frequently diagnosed. Surgical excision was performed in 4 patients (all osteochondromas) and 4 patients underwent therapeutic radiological guided hip injections for symptomatic relief. The remaining cases were managed conservatively and where they were identified incidentally, no intervention was required.
Conclusions and recommendations

We report the largest case series of isolated primary bone tumours of the LT. All isolated primary bone tumours of LT are benign. Osteochondroma is the most common. The diagnosis can be made with on radiological investigations in most patients.

Flexor Hallucis Longus – The Unsung Hero of the Foot and Ankle

By Ahmed Isam Saad (Royal Orthopaedic Hospital)

Abstract Id: 4552
Event: EORS 2019
Topic: Tendon

Introduction

Flexor hallucis longus (FHL) tendon transfer is the method of choice in reconstructing chronic neglected Achilles tendon rupture (ATR). In routine FHL tendon transfer surgery, the FHL is excised at the level of the Master knot of Henry and transferred into a bone tunnel in the calcaneus bone. Using this technique, only the distal FHL tendon is visualised and abnormalities of the FHL muscle belly and proximal tendon may be missed.

Goal

Provide a pictorial review of the pathology affecting the FHL muscle and tendon Discuss the clinical relevance of the FHL tendon in patients with chronic Achilles rupture

Method

In our institution, a tertiary orthopaedic referral centre, we have encountered a varied spectrum of abnormalities involving the FHL on MRI and therefore, the FHL is an important review area for the musculoskeletal radiologist. We decided to specifically analyse fatty infiltration of the FHL and performed a retrospective review of 225 consecutive MR images of ankle performed at our institution during 2017 for ankle pain and analysed the extent of fatty infiltration of the FHL muscle using a modified Goutallier classification.

Results

We performed a retrospective review of 225 consecutive MR images of ankle performed at our institution during 2017 for ankle pain and analysed the extent of fatty infiltration of the FHL muscle using a modified Goutallier classification. The average age of the cohort was of the cohort was 44 years (10-82 years) with a female predominance (130 female and 95 males). 44% of the cohort had normal FHL, 42.7% demonstrated grade 1 fatty atrophy and further small proportion of patients with grade 2 (8.4%), grade 3 (3.1%) and grade 4 (1.8%) fatty atrophy.
Conclusions and recommendations

Preoperative radiological assessment of the FHL tendon is important to establish that the FHL muscle and tendon are normal and intact and hence suitable for transfer surgery. The FHL is an important review area for the musculoskeletal radiologist. With our findings, we can also hypothesise that fatty infiltration is a common finding in the FHL muscle. We suggest cross sectional imaging to assess the muscle belly prior to tendon transfer surgery for chronic ATR.

Anterior tibiotalar fat pad morphology and signal intensity on magnetic resonance imaging are correlated with patient characteristics and joint pathology

By Stijn Arnaert

Abstract Id: 4515
Event: EORS 2019
Topic: Cartilage

Introduction

Ankle sprains are the most frequent form of trauma in the ankle and up to 33% of patients experience ongoing pain 1 year after the initial trauma. In the ankle, trauma is the primary etiology of osteoarthritis with an overwhelming proportion of 70-78%. Recently, our group completed a small pilot study that suggested that the anterior tibiotalar fat pad (ATFP) should be investigated as a source of inflammation and pain.

Goal

In this study, we tried to investigate the innovative concept of the ATFP as missing link in the pathogenesis of persistent complaints and potential source driving inflammation in the development of osteoarthritis.

Method

The present study is a secondary analysis of an observational case control study by Van Ochten et al. We included 106 patients with a Kellgren & Lawrence score of 0 in the tibiotalar joint on x-ray. T1 MRI scans were assessed for the signal intensity and area of the ATFP by mapping the fat pad in ‘Mimics 18.0’. After importing those mapped scans in the program ‘MATHLAB’, quantitative values of intensity and area were generated. Those values were statistically tested for correlations with patient characteristics and structural abnormalities by univariate and multivariate linear regression.

Results
MRI signal intensity of the ATFP is associated with BMI (p= 0.03), sex (p

Conclusions and recommendations

This study demonstrates the involvement of the ATFP in hindfoot joint pathology. ATFP MRI characteristics were also influenced by patient characteristics. Further research should confirm these findings in a more elaborate population including OA patients, focus on histological validation and determine underlying pathogenic processes that may explain the observed correlations.

Evaluation of Gender-Related Morphological Differences in the Femoral Trochlea Using Magnetic Resonance Imaging

By Yong-Gon Koh (Yonsei Sarang Hospital)Ji-Hoon Nam (Yonsei University)Kyoung-Tak Kang (Yonsei University)

Abstract Id: 4307
Event: EORS 2019
Topic: Bone

Introduction

Trochlear dysplasia is an abnormality of the shape and depth of the trochlear groove, a primary predisposing factors for patellar instability. Many measures of trochlear anatomy have been developed, and there is no consensus concerning which should be used to diagnose trochlear dysplasia or to manage treatment. Parameters such as the sulcus angle, anterior and posterior condylar angles, and the heights of the lateral and medial femoral condyles are used to describe the morphology of the trochlear anatomy. The alignment of the trochlear groove, and its relationship to the axes of the distal femur, are also important when designing total knee arthroplasty (TKA) and for the analysis of patellar tracking. The aim of this study was to analyze gender differences in the femoral trochlea anatomy using 3D MRI of 975 osteoarthritis patients. The following morphological parameters were evaluated for three flexion angles (15°, 30°, and 45°) of the femoral trochlea: the sulcus angle, condylar height, trochlear groove orientation, and mediolateral (ML) groove position. It was anticipated that the 3-D image reconstructions could provide a more accurate description of the relationships between the gender based morphological difference.

Goal

This study aimed to elucidate the primary differences in trochlear morphology between men and women utilizing three-dimensional magnetic resonance image reconstruction of the femoral trochlea.
Method

Differences in anthropometric femoral trochlea data of 975 patients (825 women, 150 men) were evaluated. The following morphological parameters were measured at three flexion angles (15°, 30°, and 45°) of the femoral trochlea: the sulcus angle, condylar height, and the trochlear groove orientation and mediolateral groove position.

Results

The sulcus angle was significantly greater in women than in men at 15° and 45° flexions (P < 0.05). However, there was no gender difference found in the sulcus angle at 30° flexion. Medial and lateral condylar height values were greater in men than in women for the three flexion angles (P < 0.01). The trochlear groove orientation and mediolateral groove position showed no gender-related differences.

Conclusions and recommendations

The most important finding of this study was that gender-specific differences were identified for the sulcus angle and the condylar height, but not for the groove orientation of the ML groove position of the femoral trochlea. Therefore, our hypothesis was confirmed by the present study. The strength of this study was that the morphological parameters of the femoral trochlea were measured in a large number of patients. The methodology was consistent and position and orientation in all patients were measured in an accurate and reproducible manner. This study provides guidelines for the design of a suitable femoral component for total knee arthroplasty, considering gender-specific differences in the Korean population. Biomechanical guidelines for total knee arthroplasty in Korean individuals can be optimized using our finding, so as the risk of patellar dislocation to be decreased. Surgeons should be aware of gender differences in femoral trochlear to optimize choice of implant.

Morphometric differences of femoral posterior condylar offset on 3-dimensional magnetic resonance imaging according to gender

By Yong-Gon Koh (Yonsei Sarang Hospital) Ji-Hoon Nam (Yonsei University) Kyoung-Tak Kang (Yonsei University)

Introduction

The concept of restoration of the femoral posterior condylar offset (PCO) of the knee during total knee arthroplasty (TKA) to maximize range of motion (ROM) and avoid impingement
originally was first introduced by Bellemans et al [1]. The PCO is the maximum thickness of
the posterior condyle projecting posteriorly to the tangent of the posterior cortex of the
femoral shaft. Subsequent studies have shown that restoration of the relationship between the
posterior articular surface of the femur and the femoral shaft is important to prevent
impingement, improve knee kinematics, maximize ROM, and minimize flexion instability.
Although Asian and Middle Eastern populations have greater demands on deep flexion,
literature reviews have shown that contemporary TKA does not improve knee flexion in
Asian patients and leads to similar maximal flexion angles of the knee to those of Western
patients. Recently, the ethnic features of the knee have been reported in several studies to
understand if contemporary TKA designs are compatible with the anatomies of patients of
different races and genders. A better understanding of knee morphology can lead to
improvements in TKA through the development of prostheses that adequately reflect the
diversity of the global anatomy.

Goal

This study aimed to analyze the morphometric data from magnetic resonance images of
arthritic knees in Korean adults, and to identify the existence of morphological differences of
femoral posterior condylar offset (PCO) between genders.

Method

The differences in anthropometric PCO data in 975 patients (825 female and 150 male) were
evaluated. The distances from the anterior and posterior femoral shaft cortex line to the most
posterior femoral condyle tangent line were defined as the anterior-posterior dimension (AP)
and the PCO. The PCO ratio (PCOR) was calculated as PCO/AP.

Results

The medial PCO was greater than the lateral PCO (26.3 ± 2.2 vs. 24.3 ± 2.3 mm, p < 0.01).
This difference was observed in both female patients (medial: 26.2 ± 2.2 mm vs. lateral: 24.2
± 2.2 mm, p < 0.01) and male patients (medial: 26.8 ± 2.3 mm vs. lateral: 24.8 ± 2.4 mm, p <
0.01). The medial and lateral PCO values were also greater in male patients than in female
ones (p < 0.01). In contrast, PCOR was greater in female patients than in male ones, both in
the medial and lateral femoral condyles (p < 0.01).

Conclusions and recommendations

The most important finding of this study was that the medial PCO is always greater than the
lateral PCO. This trend in PCO was observed regardless of gender. The PCO difference was
significant between genders. PCO and AP were significantly greater in male patients than in
female ones; however, PCOR was significantly greater in female than in male patients. The
observed gender difference related to morphological differences of the femur in this study
may help facilitate changes in the implant design in TKA; however, further evaluation is
required to determine whether these design changes, such as gender- or patient-specific TKA,
would improve the clinical outcomes.
Assessing the efficacy of educating patients on a day-to-day basis with a smartphone or tablet app in the first 4 weeks after total knee replacement surgery

By Thomas Timmers (Interactive Studios / Radboud UMC) Loes Janssen (Maxima Medisch Centrum) Walter van der Weegen (St. Anna Ziekenhuis)

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Introduction

In modern medicine patients are often being discharged from the hospital within 2 or 3 days after their total knee replacement surgery. In order for patients to be able to manage their new home situation, they are provided with information about pain management, physiotherapy exercises, wound care and everyday things like taking a shower. This information is provided to patients by doctors, nurses and physio therapists. Patients however are merely capable of processing all the information and therefore often leave the hospital with limited knowledge and confidence to take care for themselves.

Goal

Using an app to offer patients day-to-day education might allow them to be better capable of managing themselves.

Method

Multicentre (5 hospitals) RCT, totalling 202 patients who have had primary total knee replacement surgery. Patients in the intervention group receive, in addition to standard of care, an app that educated them on a day-to-day basis in the first 4 weeks after discharge from the hospital.

Results

At baseline, 2 weeks prior to surgery, there were no significant differences in patient characteristics such as age, gender, education, home situation, EQ5D and Knee Osteoarthritis Outcome Scores (KOOS PS). Patients received PROMS questionnaires on a weekly base to see differences in self-management (primary outcome), pain management, performing physiotherapy exercises, satisfaction with information and perceived involvement by the hospital in the patients' process of recovery. After 4 weeks EQ5D and KOOS PS were once again assessed. From week 1 onwards, patients in the app group had significantly better scores for satisfaction with information, self-management and perceived involvement. From week 2 onwards, significant differences in favour of the app group were also present in pain
management and physiotherapy exercises. Finally, after 4 weeks, patients in the app group had a significantly higher KOOS PS score, as well as a non-significant higher EQ5D score.

Conclusions and recommendations

Providing patients with an app to offer them day-to-day education after their total knee replacement surgery, seems to be a valuable addition to the standard of care.