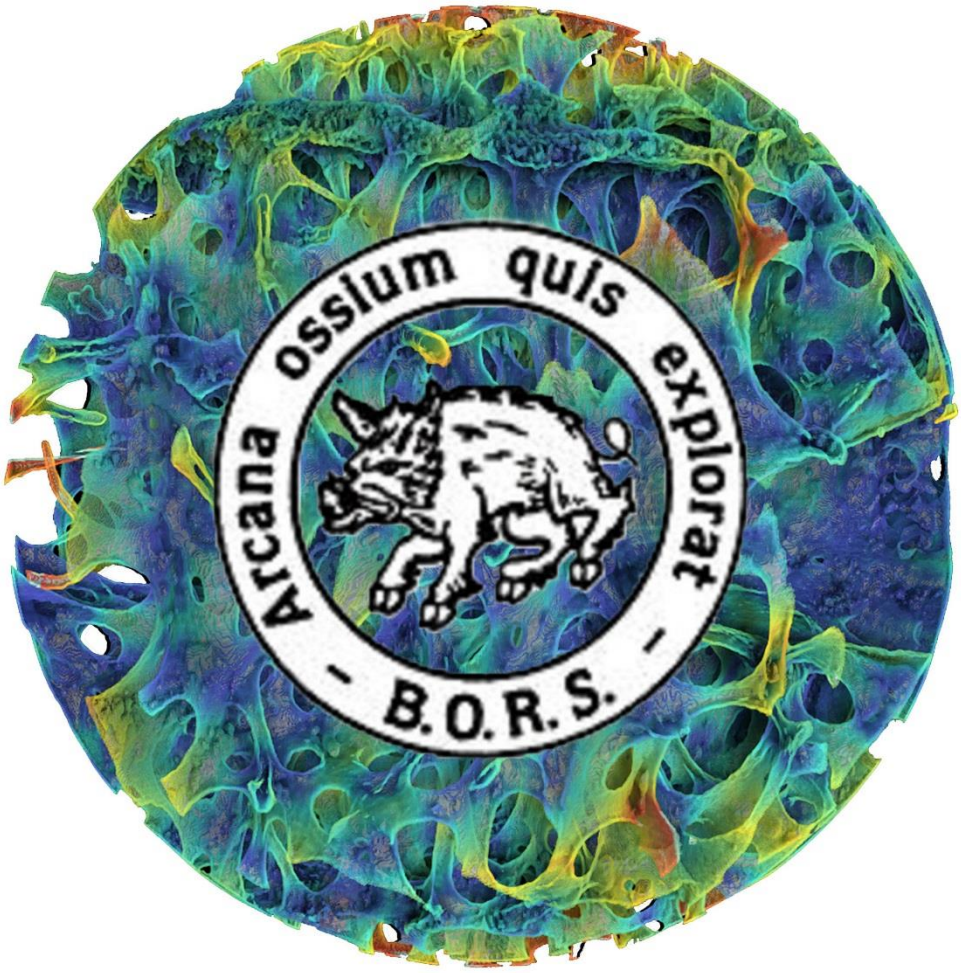
BORS 2017 Abstract Booklet



Monday 4th September

08:00-08:50 Conference Registration and Refreshments

08:50-09:00 Welcome to BORS 2017

09:00-10:30 **Morning Session: "Big Data"**

Chaired by: Arash Aframian and Sophie Williams

09:00-09:30 Keynote: **Professor Daniel Prieto Alhambra**

09:30-10:30 Free Papers

1. COMPLICATION AND SURVIVAL RATE OF CEMENTED HEMIARTHROPLASTIES WITH TAPER SLIP STEM CONFIGURATION: EXETER TRAUMA STEM AS AN EXAMPLE

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Background: Hip fractures are a major health problem among the elderly; costing the UK taxpayer over 2 billion pounds annually. Intracapsular hip fractures are often treated surgically with hemiarthroplasty. NICE recommends the use of "proven femoral stem designs" such as Exeter Trauma Stem (ETS). ETS is based on Exeter THRs. It is a triple tapered slip femoral stem. It differs from Exeter THRs by higher surface roughness, and different head size configuration (monoblock). This study aims to assess ETS implant failure-free survival rates to examine whether these design differences have altered survival. Methods: This is the largest single institute prospective study to date of ETS (1123 stems; 36 patients received bilateral ETS). Patient characteristics were: mean age 82 years; 70% females, 72% with an abbreviated mental test ≥ 7. The mean observation period was 2.5 years (range; 0 days - 8 years). Dislocation, periprosthetic fracture, re-admission with severe hip pain, deep infection and revision surgery were considered events of interest in Kaplan-Meier analysis. Results: Out of the 1123 implanted ETS, only 29 implants failed. Stem failure-free survival years 97.2% at eight years (CI 95.9%-98%). Dislocation occurred in 10 patients (1%), periprosthetic femoral fracture in 4 (0.4%), and deep infection in 11 patients (1.2%). Patient survival rates were 75% and 48% at one and five years respectively. Conclusion: ETS has high implant failure-free survival rates when used as a treatment for hip fractures. ETS design changes have not altered survival compared with the published literature of Exeter THR.

2. PREDICTION OF POSTOPERATIVE PAIN AFTER TOTAL KNEE REPLACEMENT SURGERY USING FUNCTIONAL BRAIN MRI, PSYCHOLOGY, KNEE IMAGING AND ASSESSMENT OF CENTRAL SENSITIZATION. A PROSPECTIVE STUDY.

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Temporal summation of pain (TSP) is the perception of increasingly augmented pain evoked by repetitive noxious stimuli and a measure of central sensitization. It has been recently shown to predict postoperative pain after TKR. Understanding the neural mechanisms involved in TSP may explain why up to 20% of patients undergoing TKR surgery develop persistent postoperative pain. This study aimed to assess the neural correlation of TSP using fMRI in healthy individuals and OA patients using a cuff algometer. 28 patients with knee OA pain and 17 healthy volunteers underwent a BOLD fMRI scan. Five runs of 10 x 1 second stimuli (temporal summation of pain) during fMRI were achieved using cuff inflation applied on the calf muscle ipsilateral to the most affected knee or the left side in healthy volunteers. The stimulation intensity of the cuff pressure was set to each individual's pain tolerance. The pain intensity increase during repeated stimulations was assessed on a numerical rating scale. Brain activation was averaged across noxious stimuli, and the differential activation comparing the 1st vs. 10th stimulus (TSP) was assessed. Cuff stimuli induced the expected brain activity in known pain processing areas. TSP-related brain activity in the chronic OA patients displayed higher BOLD signal within the default mode network and the somatosensory regions. These results indicate that enhanced TSP in knee OA pain may be linked with augmented responses in emotional circuitry. This may have implications for understanding the central sensitization to improve clinical outcomes for OA patients.

3. IDENTIFICATION OF NINE NOVEL OSTEOARTHRITIS SUSCEPTIBILITY LOCI THROUGH THE UK BIOBANK RESOURCE

Zengini E, Hatzikotoulas K, Tachmazidou I, Hackinger S, Styrkarsdottir U, Suveges D, Killian B, Gilly A, Ingvarsson T, Jonsson H, Babis G, Thorsteinsdottir U, Stefansson K, Zeggini E, Wilkinson JM
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Osteoarthritis is a strongly heritable disorder, yet the heritable underpinnings of the disease are poorly characterised. We conducted large genome wide association studies (GWAS) using the UK Biobank resource to identify novel OA susceptibility loci. GWAS were performed using five different case definitions: 1) self-reported OA at any site n=12 658; 2) hospital-diagnosed OA at any site based on ICD10 and/or ICD9 hospital records codes n=10 083; 3) hospital-diagnosed hip OA n=2 396; 4) hospital-diagnosed knee OA n=4 462; and 5) hospital-diagnosed hip and/or knee OA n=6 586. For the control datasets we used approximately 4 x the number of cases. In silico replication of promising signals was carried out in deCODE dataset across four OA phenotypes: any OA site, hip OA, knee OA and hip and/or knee OA. We identified 7 genome-wide significant novel OA loci and two loci just below this threshold. Significant loci were located within TGFA, ANXA3, PLEC, MAP2K6, JPH3, ZNF345 and near SLC30A10. Most of these signals reside in or near genes reported to be associated with skeletal and OA relevant phenotypes by functional and animal model studies, making them potential therapeutic OA targets. The 2 signals just below the significance threshold were between MPB3B and EQTN and near LTN1 respectively. Seven out of 9 variants were common at frequency and all exerted small effects, in line with a highly polygenic model underpinning OA risk. Our findings contribute to a better understanding of OA pathophysiology taking the number of established OA loci from 20 to 29.

4. DEVELOPING A PERSONALISED DECISION AID FOR JOINT REPLACEMENT: WHICH SURVIVAL MODEL TO CHOOSE?

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Introduction: The development of tools to aid surgical decision making for joint replacement will improve patient understanding and facilitate participation in the consent process. At its core, a decision-support aid requires an outcome predictor based on patient demographics, prosthesis choice and various other fixed and modifiable risk factors. Here, we use the UK National Joint Registry dataset to compare the performance of different survival models. Methods: The dataset contains records of knee replacements for osteoarthritis between 2003 and 2015, including 388 607 total knee replacements (TKR), 37 718 unicondylar knee replacements (UKR) and 5316 patellofemoral arthroplasties (PFA). For each procedure, we fitted parametric and flexible parametric models and random survival forests (RSF) using a set of risk factors. The candidate models were compared using the Akaike information criterion, Brier score, c-index and calibration plots where appropriate. Results: The averages of survival probability estimates obtained using the flexible parametric model and the RSF approach were in good accordance with the observed values. The c-index of the flexible parametric model was 70% (TKR), 63% (UKR) and 59% (PFA). This was 65% (TKR), 61%; (UKR) and 58% (PFA) for the RSF approach. The average observed-to-predicted ratios were 1.133 (TKR), 1.135 (UKR) and 1.03 (PFA) for the flexible parametric model and 1.49 (TKR), 1.2 (UKR) and 1.06 (PFA) for the RSF approach. Conclusion: Development of a personalised decision-support tool for joint replacement necessitates the selection of an appropriate survival model. The flexible parametric model was found to be the most favourable model amongst commonly used models.

5. DIFFERENCES IN THE METABOLIC PROFILE OF HUMAN SYNOVIAL FLUID IN VARIOUS OSTEOARTHRITIS SUBGROUPS

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Introduction: Osteoarthritis (OA) is now the most disabling condition in western populations, affecting approximately 10% of the UK population. The metabolic basis of OA remains understudied. Metabonomics has developed into a powerful tool for studying metabolic disease, environmental exposure, nutrition and cancer. Studies of osteoarthritis and synovial fluid using these techniques have been sparse. Our aim was to demonstrate that the metabolic constitution of synovial fluid is altered in OA subtypes, comorbid diseases and treatment responses. Method: 110 synovial fluid samples were collected from patients undergoing hip/knee aspiration, knee arthroscopy, hip/knee arthroplasty & revision arthroplasty. OA subgroups were formed assessing multiple variables including diet, lifestyle, symptoms, treatment response, medical history and drug history. Nuclear Magnetic Resonance (NMR) data was acquired and multivariable logistic regression was used to examine any correlation with NMR findings and the tested variables. Multivariate analysis was performed using Principle Component Analysis (PCA). Results: Preliminary results suggest differences in the metabolic profile of synovial fluid in different subgroups, when corrected for confounding factors such as age. Specifically, the PCA demonstrates differences in the metabolic profile of hip versus (vs) knee and diabetic vs non-diabetic synovial fluid. Conclusion: Preliminary data suggests metabolic variances in the synovial fluid metabolic profile amongst different OA subgroups, specifically hip vs knee and diabetic vs non-diabetic synovial fluid. Further statistical analysis is required to correlate these metabolic variances to clinical factors including response to treatment, symptoms and functional outcome.

6. VITAMIN D DEFICIENCY PREVALENCE ACROSS DIFFERENT ETHNO-RACIAL GROUPS: CROSS SECTIONAL ANALYSIS FROM A LARGE INNER-CITY COHORT, LONDON, UNITED KINGDOM

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Introduction: Vitamin D deficiency is a common condition worldwide with an estimated 1 billion people affected. There is evidence to suggest hypovitaminosis varies by ethnicity, but this relationship is not well understood and has not been investigated in the United Kingdom (UK) population. Method: A cross-sectional analysis of routinely collected data in a central London hospital was undertaken. Ethnic groups were subdivided into three categories: Caucasian, African/Afro-Caribbean and Asian. Inpatient and outpatient encounters routinely capture body height and weight. Descriptive analyses were undertaken, with parametric and non-parametric tests. A multivariable logistic regression including age, gender and average body mass index (BMI), was used to assess the relationship between vitamin D deficiency and ethnicity. Results: Data were available for 5830 patients. The mean age of the cohort was 52 years (SD 18) and 67% were female. The index BMI was 29.8 (SD 7.6). The African descent population had the highest mean BMI (29.9, Kruskal-Wallis p< 0.001). Vitamin D deficiency was detected in 29.0% of patients and a raised BMI was a significant independent predictor. In the multivariate regression model, the African descent and Asian populations were more likely to be vitamin D deficient (odds ratios 1.37 (95% CI 1.21 to 1.55) and 1.38 (95% CI 1.15 to 1.67) respectively). Conclusion: Ethnicity and body weight are statistically significant independent predictors of vitamin D. Our data quantifies the risk of vitamin D deficiency in the UK African and Asian populations with an almost 40% increased risk of deficiency compared to the Caucasian population.

10:30-11:00 Coffee and Refreshments

11:00-12:30 **Mid-morning Session: "LIFELONG HEALTH"**

Chaired by: Valerie Sparkes and John Churchwell

11:00-11:30: Keynote address: **Professor Elaine Dennison**

11:30-12:30: Free Papers

7. A NOVEL SCORING SYSTEM FOR PREDICTING EARLY MORTALITY IN PATIETNTS WITH METASTATIC PROXIMAL FEMORAL FRACTURES

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Background: Early mortality in patients with hip fractures due to bony metastases is unknown. The aim was to quantify 30 and 90-day mortality in patients with metastatic hip fractures and identify biochemical markers associated with early death. Methods: Consecutive patients referred to orthopaedics with a metastatic proximal femoral fracture/impending fracture over a six-year period were compared with a matched control group of non-malignant fractures. Minimum follow-up was 1 year and data was analysed using the student´s t-test (significance p<0.05). Results: From Jan 2010-Dec 2015, 163 patients were referred with metastatic proximal femoral lesions. 90-day mortality was three times higher compared to controls (44% 14/33 vs 12% 4/33, p<0.01). Time from referral to surgery was longer in impending versus complete fractures (average 11 and 4 days respectively, p<0.05). Multiple biochemical markers were associated with 30-day mortality in the metastatic group. Patients who died early were more likely to demonstrate low haemoglobin and albumin, and high c-reactive protein, platelets, urea, alkaline phosphatase and calcium (p<0.05). Several biochemical markers associated with early mortality reached clinical and statistical significance. These markers were combined into a score out of 7 and indicated a higher early mortality in metastatic patients compared to controls. Patients with a score of 5-6/7 were 31 times more likely to die within 90 days. Conclusions: This scoring system could be utilised to predict early mortality and guide management. The average delay to surgery of 4 days (completed) and 11 days (impending fractures) suggests a window for intervention to correct these abnormalities and improve survival

8. THE EFFECT OF DOUBLE COUNTING IN ARTHROPLASTY REGISTERS: BILATERAL PROCEDURES AND THE ANALYSIS OF MORTALITY

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Introduction: Survival analysis methods that estimate mortality after arthroplasty assume that each procedure is independent. Patients who undergo bilateral procedures contribute two correlated observations, and therefore one death can be associated with two operations, violating this assumption. A number of methods have been proposed to account for this dependency. Our aim is to investigate the effect of violating these assumptions when analysing mortality within the National Joint Registry. Methods: We identified bilateral hip replacements including procedures that occurred on the same day and different days. We compared four approaches: 1) including all procedures in the analysis, 2) only unilaterals, 3) unilaterals and first bilaterals, and 4) unilaterals and second bilaterals. We fitted flexible parametric survival models assuming proportional hazards. Variables of interest included age, sex, ASA grade, BMI and fixation. We then compared and contrasted the results of the four approaches. Results: Comparing approaches 1 and 3, i.e. all procedures vs unilateral and first bilateral procedures, resulted in similar effects. The greatest difference in coefficients was 0.014 (=0.598, SE=0.051 vs Î²=0.584, SE=0.053) for the effect of having a BMI less than 18.5 relative to a BMI between 25 and 30. Overall the greatest difference was 0.029 for ASA 1, between the models including all procedures and including only unilateral procedures (Î²=-0.406, SE=0.029 vs Î²=-0.377, SE=0.031). There was negligible difference in the precision of estimates. Conclusion: Including both operations from bilateral hip replacements, without accounting for dependency, did not appear to affect the results or adversely inflate the precision of estimates.

9. GENOME-WIDE EXPRESSION ANALYSIS CONFIRMS HIF-1 SIGNALLING AS THE PRIMARY RESPONSE TO COBALT AND CHROMIUM EXPOSURE IN HUMAN OSTEOBLASTS

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Systemic concentrations of cobalt (Co) and chromium (Cr) are persistently elevated in patients with metal-on-metal hip replacement (MOMHR). Several studies by us and others have described the detrimental effects of metal exposure on survival and function of osteoblasts *in-vitro,* but the mechanisms for these effects remain unclear. In this study, we use whole genome microarray to assess differential gene expression in primary human osteoblasts following exposure to clinically relevant concentrations of Co and Cr. Human mesenchymal cells obtained from explant cultures of bone fragments from 3 patients undergoing joint replacement surgery were differentiated into osteoblasts using osteogenic media. Subsequently, cells were treated with a combination of Co^{2+}:Cr^{3+} at 5µg/L and 500µg/L to simulate systemic and periprosthetic concentrations respectively. Following 24hr exposure, RNA was extracted and hybridized to SurePrint-G3 Gene Expression Microarray. 'Limma' package on R-Bioconductor was applied to normalise probe signals and differential gene expression assessed with empirical Bayes approach ($Log_2FC>1.00$, $P<0.001$ for differentially expressed genes). Treatment with 5µg/L Co^{2+}:Cr^{3+} did not significantly alter gene expression compared to untreated cells, whilst 11 genes were upregulated with 500µg/L Co^{2+}:Cr^{3+}. Of these, 4 were associated to HIF-1 signalling based on KEGG pathway analysis. Specifically, genes associated with anaerobic metabolism and reduction in oxygen consumption (*PFK2*, *PDK-1* and *Glut-1*), and increase in oxygen delivery (*VEGFA*) were upregulated. Other known HIF-1 targets such as *ANKRD37* and *BNIP3* were also upregulated. The study provides a genome-wide assessment of osteoblast response to clinically relevant concentrations of Co and Cr, and identifies HIF-1 signalling as the primary pathway involved.

10. AGE-SPECIFIC BONE DENSITY DISTRIBUTION IN THE FEMUR

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Bone mineral density (BMD) measured by dual-energy x-ray absorptiometry (DXA) underpins the current diagnostic guidelines for osteoporosis. In the conventional analysis, spatial BMD values are averaged in larger regions of interest to cope with anatomic and positioning variability between scans. This data averaging limits our understanding of more focal BMD changes. The aim of this study was to model age-specific BMD changes in the femur at a high resolution. Pixel-by-Pixel BMD maps were restored using Hologic Apex v3.2 software. To eliminate shape variability, bone maps were aligned to a reference template using a deformable registration technique. Pixel-wise BMD changes with ageing were analysed using the LMS quantile regression in 'R' (Yee 2004, Statistics in Medicine). The new technique, called DXA region free analysis (DXA-RFA), was applied retrospectively to a cohort of 5112 elderly women (age:75-97) who were recruited as part of a previous pharmaceutical clinical trial. Average age-specific BMD changes were visualised using heatmaps. Pixel BMD values vary from 0 to 2.1 g/cm2 across the population. Taking the youngest group as the reference, cortical thinning was observed consistently with ageing around the shaft with the maximum bone loss of 0.5 g/cm2. Bone density seems to be preserved in the superior cortex of the femoral neck albeit it starts off at a pretty low value of 0.55 gr/cm2. A widespread bone loss was also observed in the greater trochanter (0.15 g/cm2). The new technique shows promising results to characterise spatially-complex BMD changes, for which a region-based technique may not be sufficient.

11. PRE-SURGICAL NEUROPATHIC PAIN AND CENTRAL PAIN FACILITATION IN END STAGE OSTEOARTHRITIS PREDICTS POOR OUTCOME 6 MONTHS AFTER TOTAL KNEE REPLACEMENT SURGERY. A PROSPECTIVE OBSERVATIONAL STUDY.

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Neuropathic pain (NP) in patients with OA listed for TKR surgery is under recognized by orthopaedic surgeons worldwide. Recent evidence has reported that up to 34% patients with chronic OA have NP and up to 20% of all patients continue to suffer chronic postoperative pain. We conducted a prospective observational study in patients awaiting TKR surgery to identify the structural, psychological, functional and pain sensitization characteristics in those patients with this pain phenotype and assess their outcomes 6 months postoperatively. Fifty patients with knee OA awaiting TKR surgery and 22 healthy volunteers with no OA or chronic pain condition were also recruited for comparison. All subjects underwent a 3-Tesla knee MRI scored using the semi-quantitative MRI Osteoarthritis Knee Score for severity of synovitis, effusion size and bone marrow lesions. All subjects completed questionnaires to assess for NP, depression, anxiety, pain catastrophizing and function as well as a quantitative sensory testing assessment to identify peripheral and central sensitization. Fifteen out of 50 (30%) pre TKR OA patients had evidence of NP. Facilitated temporal summation and widespread hyperalgesia indicative of central sensitization was higher in the NP patients (Group A) than those OA patients with predominantly nociceptive of mixed pain phenotype (Group B) or healthy volunteers (Group C) $p<0.001$. Patients with preoperative NP continued to suffer chronic pain (VAS 4.3) and maintain central sensitization 6 months post TKR. Identification of NP in pre TKR OA patients and individualized medical treatment may improve clinical outcome for this under-recognized cohort of patients.

12. DEVELOPING AND TESTING A NOVEL DELIVERY SYSTEM FOR THE GLUTAMATE RECEPTOR ANTAGONIST NBQX TO TREAT JOINT PAIN AND DISEASE

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Synovial fluid (SF) glutamate concentrations increase in arthritis. When injected into the joint space in antigen induced arthritis rats, AMPA/kainate glutamate receptor (GluR) antagonist NBQX has been shown to significantly reduce knee swelling ($P<0.001$, days 1-21), end stage cartilage destruction ($P<0.05$), synovial inflammation ($P<0.001$), gait abnormalities (days 1-3) and mRNA expression of meniscal IL-6 ($P<0.05$). MRI and X-ray imaging revealed less inflammation, fewer bone erosions and smoother articular surface after NBQX treatment. This project aims to develop progressively less invasive methods of NBQX delivery, to improve therapeutic effect, patient comfort and ease of application. Current work focuses on utilising poly(lactic-co-glycolic acid) (PLGA) nanoparticle delivery to allow for sustained release of NBQX. An alternate GluR antagonist DNQX was used for optimisation of nanoparticle formation techniques. Microfluidic nanoparticle synthesis resulted in a 250% increase in particle size from 10mM to 30mM DNQX load. Increased DNQX caused undesirable agglomeration with this technique. Single emulsion nanoparticle formulation resulted in 80% loss of DNQX during particle synthesis. Water soluble DNQX disodium salt was utilised with double emulsion nanoparticle formation to improve encapsulation through manipulation of drug solubility. Following this initial formulation stage the project will now focus on determining the release of DNQX into human SF using PLGA nanoparticles synthesised using the double emulsion method. Subsequently, the effect of sustained release of DNQX from PLGA nanoparticles will be assessed in established in vivo arthritis models. The potential for using less invasive delivery methods, including microneedle delivery and topical therapy, will also be explored.

12:30-12:40 **Ceramic for Hip Resurfacing: Why Re-invent the wheel?**
Carolina Avila Carrasco - Senior Development Engineer Mat**Ortho**

12:40-14:00 Lunch

13:10-14:00 AGM - All BORS Members Welcome
Hosted by Mark Wilkinson and Sabina Gheduzzi in SAF Room G34

14:00-15:30 **Afternoon Session: "Personalised Orthopaedics"**
Chaired by: Oliver Boughton and Richard Jan van Arkel
14:00-14:30: Keynote address: **Professor Justin Cobb**
14:30-15:30: Free Papers

13. COMBINATION OF CAM FAI AND HIGH PELVIC INCIDENCE REDUCES SAGITTAL HIP MOTIONS

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Many individuals with large cam-type morphologies remain asymptomatic and impingement-free, while others with small-to-moderate morphologies experience reduced sagittal motions. This may be attributed to other anatomical hip and spinopelvic characteristics, thus we examined which parameters could predict sagittal hip and pelvic range of motion (ROM), during walking and squatting.

Sixty-four participants underwent CT imaging and were clinically diagnosed as either symptomatic (22, cam with pain), asymptomatic (22, cam with no pain), or control (20, no cam or pain). Sagittal hip and pelvic ROMs, during walking and squatting, were recorded using a ten-camera motion capture system. CT data were measured for multiple hip and spinopelvic parameters and discriminant function analyses determined that radial cam morphology, femoral neck-shaft angle, and pelvic incidence were best to classify participants with their subgroups ($\lambda = 0.218$).

Symptomatic individuals demonstrated reduced hip and pelvic ROMs. Both the symptomatic and asymptomatic groups had larger cam morphologies than the controls ($p < 0.001$). The symptomatic group also had smaller neck angles (124 ± 3°) than the asymptomatic and control groups (127 ± 3°, 127 ± 2°; $p < 0.001$); however, had higher pelvic incidences (57 ± 11°) than the asymptomatic (50 ± 10°, $p = 0.086$) and control groups (47 ± 7°, $p = 0.008$). Entering the three classification parameters into a multiple linear regression, significant regressions were achieved for hip ROM only when pelvic incidence was included, for walking ($\beta = –0.617$, $p = 0.007$) and squatting ($\beta = –0.317$, $p = 0.04$).

Individuals with symptomatic FAI tend to have higher pelvic incidences; which, combined with a cam morphology and varus neck, can alter the musculature of the psoas major and iliacus, contributing to the reduced ROM.

14. THE EFFECT FEMORAL STEM LENGTH HAS ON HIP FUNCTION; A PROSPECTIVE GAIT STUDY AT HIGH SPEEDS AND INCLINES

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Introduction: Orthopaedic innovation has evolved since Charnley's low friction arthroplasty. Shorter stemmed total hip replacements (THR) have been used for half a century with good outcomes. However, it is unknown what everyday advantages are afforded by increasingly shorter stemmed THR. The primary aim of this prospective study is to determine the extent of improvement different lengths of THR can have on gait. The secondary aim is to determine the effect implant alignment has on this improvement. The null hypothesis was patients with restored hip geometry, irrespective of THR stem length, would demonstrate no functional gait advantage. Method: A total of 42 prospective ipsilateral THR patients with different stem lengths were analysed on an instrumented treadmill. All 42 patients had no other lower limb operations or disease. Post-operative X-rays were used to measure hip length and offset. A healthy control group (n=35) were analysed to compare. All subjects' gaits were assessed at fast walking speeds and steep slopes to determine a difference. Analysis was done with Matlab™. Results: Both control and THR groups were matched for age and gender. All THR patients had excellent hip scores and were more than 12 months postop. THR hip measurements revealed near normal restoration for all groups. The improvement in gait was evident postoperatively with more symmetrical and faster walking with greatest improvement in increasingly shorter stemmed devices. Conclusion: THR clearly improves pain and function. Shorter stemmed devices demonstrate significant advantages in terms of top walking speed and gait pattern in the early postoperative phase.

15. DO SUBCHONDRAL BONE CHANGES PREDICT ANKLE OSTEOARTHRITIS?

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Introduction: Subchondral bone changes including altered levels of mineralisation and protein conformational change have been identified using Raman spectroscopy in hip and knee osteoarthritis (OA) and may serve as predictors of disease onset. Ankle OA in contrast is less common and linked with a prior history of trauma. The hypothesis of our study was that subchondral bone changes are also associated with ankle osteoarthritis. Methods: Subchondral bone specimens were obtained from the tibiae of 22 patients undergoing surgery for ankle osteoarthritis (varus and symmetrical wear patterns). Samples were analysed using Raman spectroscopy. Age, sex and laterality matched non-OA cadaveric specimens served as controls. Chemical markers of subchondral bone (phosphate:amide I, carbonate: amide I and carbonate:phosphate ratios) were deduced and analysed for statistical difference using the Mann-Whitney U test. Principal component analysis (PCA) was also employed to detect inherent differences within the Raman spectra. Results: Differences in the mean phosphate:amide I and carbonate:amide I ratios were detected within Varus OA (20.91 and 3.52 vs controls 22.19 and 3.69 $p<0.05$)) and symmetrically worn OA (19.99 and 3.40 vs controls 22.01 and 3.67 ($P<0.05$)). PCA also revealed significant differences in the structure of spectra from OA specimens. Discussion: Our results imply that subchondral bone is altered in patients with ankle osteoarthritis. This raises the possibility that individuals with certain bone chemistry may be at risk of developing ankle osteoarthritis and that the detection of such markers may predict the onset of disease in asymptomatic individuals.

16. GENERIC COGNITIVE TASK ANALYSIS (GCTA) WIZARD: "A TOOL TO TRAIN ORTHOPAEDIC SURGEONS OF THE FUTURE"

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Background: Innovative and accessible training adjuncts are required to help meet training needs in the current environment of reduced training hours. Cognitive Task Analysis (CTA) has been used extensively to train pilots and in other surgical specialties. However, the use of CTAs within orthopaedics is in its infancy. Aim: To develop an online generic orthopaedic trauma CTA wizard that can be used by experts to design procedure-specific CTAs. Methods: 3 expert orthopaedic trauma surgeons were interviewed independently to generate a list of operative steps, decision points and errors that are applicable to any orthopaedic trauma procedure. Using the modified Delphi technique, the CTAs obtained from each expert was analysed by an independent reviewer, until a consensus was reached. An online web-based wizard tool was designed to incorporate this information and accompanying videos and images. Results: 26 technical steps and 29 decision points were identified in the final CTA following the Delphi process. These were subdivided into 7 phases ranging from pre-operative planning to post-operative follow-up. The wizard tool has 4 sections: (i) technical steps, (ii) decision points, (iii) errors and (iv) videos/images for each phase. The learning tool includes the written information on the left and the video clips on the right of a split screen. Conclusions: This study has led to the design of a novel web-based orthopaedic trauma generic CTA wizard tool. This allows experts to impart complex cognitive knowledge to trainees in a simple, structured manner utilizing written and audio-visual stimuli simultaneously to teach surgical steps.

17. THE EFFECTS OF BISPHOSPHONATE THERAPY ON BONE NANOSTRUCTURE

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Bisphosphonates (BP) are the frontline therapy for osteoporosis and are thought to increase bone mass and mineral density by suppressing remodelling. Recent research reports that BP can oversuppress turnover leading to accumulation of microcracks and stress fracture. BP may also reduce the energy required to initiate and propagate microcracks by increasing tissue age, stiffening bone by increasing the number of collagen crosslinks and size of mineral crystals. The aim of this paper is to test the hypotheses that BP therapy is associated with crosslink accumulation, lower maturity and larger mineral crystal size. Collagen-mineral matrix structure was compared across 3 groups: BP treated fracture patients, fractured and non-fractured controls. Collagen cross-link maturity and mineral crystallinity were compared using Raman spectroscopic. The 1362cm^{-1}, band represents the amount of advanced glycation end products (AGEs). The ratio of the Amide I bands around 1660 $cm^{-1}$and 1690cm^{-1}, corresponds to the ratio of mature and immature crosslinks. The full-width-at-half-maximum (FWHM) of the phosphate peak at 960cm^{-1} describes mineral crystallinity, a parameter that indicates mineral crystal size (i.e. plate length). BP treated bone and fractured controls were associated with a significantly younger matrix maturity ($p=0.0420$) in comparison to on fracture controls. AGE accumulation ($p=0.8544$) and mineral crystal size ($p=0.6750$) were not significantly different. BP therapy did not prevent AGE accumulation and was not associated with an improvement in bone material properties. In fact, lower matrix maturity could result in decreased bone strength and toughness and, ultimately, decreased resistance to crack propagation.

18. CAN WE RESTORE STABILITY TO COLLATERAL LIGAMENT-DEFICIENT TOTAL KNEE ARTHROPLASTY BY USING A SOFT-TISSUE KNEE RECONSTRUCTION?

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Collateral ligaments are important stabilisers in cruciate-retaining and posterior-stabilised total knee arthroplasty (TKA). Further work has found that the medial collateral ligament (MCL) is also important in a constrained-condylar (CC) TKA, commonly used in a revision setting. It was hypothesised that in CC-TKA with severe medial deficiency, a soft-tissue reconstruction could restore stability and be an alternative to a hinged revision, which is associated with greater interface stresses and bone stock loss. Eight cadaveric knees with CC-TKA (Sigma TC3; DePuy Synthes) were tested in a robotic system at 0°, 30°, 60°, and 90° of flexion with ±50 N anterior-posterior force, ±8 Nm varus-valgus and ±5 Nm internal-external torques. After the MCL and posteromedial capsule were transected and their relative stabilising contributions quantified, a medial reconstruction was performed using an autologous semitendinosus graft (attached to the pes anserinus, proximally fixed anterior to the femoral epicondyle, and distally fixed at the semimembranosus insertion point). The knees were re-loaded and the kinematic behaviour was assessed under equivocal conditions to the intact soft-tissue state. Near-normal stability was restored by the medial soft-tissue reconstruction, with no significant differences found between the rotational laxities of the reconstructed knee to the pre-deficient state at any flexion angles ($p>0.05$). Other than under valgus rotation at 60°, the relative contribution of the reconstruction was similar to that of the MCL. Therefore, in the event of MCL deficiency, the soft-tissue reconstruction would not be overloaded and may be considered with CC-TKA as an alternative to hinged implants to restore stability.

15:30-16:00 Coffee and Refreshments

16:00-16:40 **Late Afternoon Session: "Tissue Engineering & Regenerative Orthopaedics"**

Chaired by: Rob Wallace and Rahul Bhattacharyya

16:00-16:40 Free Papers

19. STABLE MECHANICAL FIXATION OF OSTEOCHONDRAL SCAFFOLD SUPPORTED OVERLYING CARTILAGE REGENERATION: OBSERVATION FROM A CLINICAL DOG SHOULDER STUDY

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Osteoarthritis (OA) is a degenerative joint disease[1], typified by alterations in the osteochondral unit[2], resulting in pain and reduced mobility. For large osteochondral defects, there is currently no available effective treatment apart from joint replacement. We believe that ill mechanical fixation and poor bone ingrowth, as observed in the conventional osteochondral scaffolds, are the main issues in the repair of large osteochondral defects. To address this unmet clinical need, we developed a biomimetic multi-layered osteochondral scaffold based on titanium matrix-reinforced-PLGA/collagen system with an aim to provide a stable mechanical and an appropriate physical environment to support the overlying cartilage regeneration. A clinical dog shoulder model was used to test our theory. *In vitro* mechanical fixation was assessed by push-in/push-out tests in sheep explant condyles and Sawbones© and was determined to be 0.351±0.096MPa and 0.767±0.067MPa, respectively (n=3). The *in vivo* performance of the scaffold in conjunction with autologous chondrocytes was assessed in dog shoulder. Bone ingrowth into porous structure of titanium and a stable mechanical fixation was confirmed using CT examinations. Cartilage formation and integration with the surrounding tissue were observed arthroscopically 12 weeks post-operation. The shoulder function was completely restored as no lameness was observed and the dog returned to her normal pre-operation activity level. More clinical animal studies are planned in the future to establish long term clinical efficacy of the scaffold.

Financial support by ARUK (grant no: 21160) and Rosetrees Trust (project no: A1184) is acknowledged.

1.Bijlsma JWJ, Berenbaum F, Lafeber FPJG, The Lancet, 377, 2115-2126

2.Burr DB, Gallant MA, *Nat Rev Rheumatol*, 2012, 8, 665-673

20. HARNESSING SURFACE TOPOGRAPHY TO ENHANCE OSTEOGENESIS AND OSSEOINTEGRATION.

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Background: Following uncemented prosthetic device implantation, the implant/bone interface retains deficiencies, requiring bone infill through the process of de novo osteogenesis. Contact osteogenesis is the appositional bone formation on the implant surface. It is enabled by implant surface colonisation by the osteogenic cells, including Skeletal Stem Cells (SSCs), and deposition the extracellular bone matrix. Surface nanotopographies provide physical cues capable of triggering SSC differentiation into osteoblasts, thus inducing contact osteogenesis, translated clinically into enhanced osseointegration and attainment of secondary stability. Study aim: To investigate in vitro and in vivo biological effects of unique nanotopographies on SSC phenotype and function. Study design: TiAl6V4 substrates were treated with thermal oxidation resulting in surface nanowire formation. Passage one STRO 1 SSCs were cultured on nanotopographies in vitro, while in vivo examination of nanotopographies was conducted in calvarial rat models. Analysis of SSC osteogenic response included assessment of bone-specific gene activation and extracellular bone matrix protein synthesis in vitro, and radiological and histological evaluation of bone/implant interface in vivo. Results: Nanowire topographies generated significant enhancement of osteogenic gene expression (ALP, Collagen type I, OPN and OCN), osteogenic morphology, and OPN and Collagen type I protein synthesis in vitro. Significant enhancement of bone volume deposition at implant/bone interface, coupled with evidence of enhanced de novo appositional osteogenesis, were observed in vivo. Conclusions: Nanowire topographies trigger an enhanced SSC osteogenic differentiation in vitro and contact osteogenesis in vivo, providing a clear rationale for their potential application in orthopaedic implant fabrication.

21. A DECELLULARISED BIOLOGICAL SCAFFOLD FOR THE REPLACEMENT OF DEGENERATE INTERVERTEBRAL DISCS

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A major cause of back pain is the degeneration of the intervertebral disc (IVD). Replacement of the degenerated disc with a natural decellularised scaffold may overcome the limitations of current surgical interventions (small studies have shown some promise with allograft IVD tissue). Decellularisation technologies aim to remove cellular components from tissues leaving an acellular extracellular matrix scaffold which is non-immunogenic when implanted into the recipient. This proof of technical concept study investigated methods for the decellularisation of bovine bone-disc-bone (BDB) units for future translation to human IVDs for use in the replacement of degenerate human IVDs. Decellularisation methods based upon the use of hypotonic low concentration sodium dodecyl sulphate plus proteinase inhibitors with freeze/thaw and nuclease treatments were applied to bovine tail BDB units. The effects of the methods on the tissue were assessed histologically and biochemically. The most effective method investigated reduced total DNA content of the nucleus pulposus (NP), inner annulus fibroses (iAF), outer annulus fibrosus (oAF) and growth plate-endplate (GP/EP) regions to 37.03 (± 10.44 95% CL), 21.69 (± 8.53 95% CL), 16.68 (± 5.50 95% CL) and 60.56 (± 17.63 95% CL) ng.mg- 1 dry weight tissue respectively (n=6). Some whole nuclei were observed in the GP/EP region and in the notochord cell clusters of the NP after decellularisation, though these regions would not be present in human donor IVDs. Encouragingly, the glycosaminoglycan content was preserved in the NP. Further work is now being undertaken to investigate the biomechanical performance of the decellularised scaffold.

22. EVALUATION OF THE MECHANICAL PROPERTIES OF 3D PRINTED MICROCRYSTALLINE CELLULOSE-POLYCAPROLACTONE SCAFFOLDS.

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In this study, microcrystalline cellulose (MCC) is proposed as an additive able to improve the mechanical properties of 3D printed polycaprolactone (PCL) scaffolds. Blends with different concentrations of microcrystalline cellulose (0, 2, 5 and 10% wt/wt) were obtained by thermal blending. Afterwards, this material was processed to obtain filaments suitable to be fed to a commercial fused deposition modelling 3D printer. Porous structures were manufactured using this technique and then they were subjected to 3 point bending testing, compression testing and X-ray microtomography scanning. The flexural modulus increases significantly ($p<0,05$) for samples containing 2 and 5% of MCC, but remains constant for samples with 10% of additive when compared to pure PCL ones. On the other hand, the compression modulus values are in the interval for other structures already reported for bone regeneration and similar to the typical values of spongy bone for the samples containing less than 10% of the additive. The compressive strength is increased if the concentration of cellulose is 2 or 5%. However, for the samples with a concentration of 10% microcrystalline cellulose, it is possible to observe a decrease on the compressive modulus and the compressive strength. The scanning of the samples through X-ray microtomography allowed to find out an explanation for the upper-limit of the microcrystalline cellulose concentration to obtain a reinforcement effect. The presence of numerous voids in the filaments in the samples containing 10% cellulose deteriorate the adhesion between layers and, therefore, their mechanical properties. Acknowledgement: Financial support from H2020-MSCA-RISE-2016-734156 BAMOS project.

16:50-17:45 **Public Lecture by Professor Julian Jones**

17:45-18:15 **Presidential Award by Professor Sean PF. Hughes**

18:15 Close and Thanks in Lecture Theatre G34

19:30 Conference Dinner at Ognisko restaurant (see map on page)

Tuesday 5th September (Room G34)

08:30-09:00 Coffee and Refreshments

09:00-10:50 **Morning Session: "Structure, Maintenance and Repair"**

Chaired by: Allie Gartland and Iain Murray

09:00-09:30 Keynote: **Dr Chantal Chenu**

09:30-10:50 Free Papers

23. KIF26B IS NECESSARY FOR OSTEOGENIC TRANSDIFFERENTIATION AND MINERALISATION IN AN IN VITRO MODEL OF PATHOLOGICAL OSSIFICATION.

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Background: Heterotopic ossification (HO) is lamellar bone formation in the soft tissues following trauma or joint replacement. A genome wide association study of HO patients after total hip arthroplasty has identified Kinesin Family Member 26B (KIF26B) as a gene associated with HO severity. Hypothesis and aims: We hypothesised that Kif26b regulates the osteogenic trans-differentiation of myoblasts; a possible mechanism of HO. Using an in vitro model, we wished to establish whether Kif26b is involved in HO formation and to explore the molecular mechanism. Methods: We developed CRISPR/Cas9 mediated Kif26b knockout (KO) C2C12 myoblasts. Wild type (WT) and KO cells were transdifferentiated towards an osteogenic lineage using BMP-2 for 24 days. The effect of Kif26b KO on mineralisation was quantified by calcium staining. The mean difference (±SEM) in gene expression between WT and KO lines was compared with ANOVA. Results: qPCR and western blotting confirmed Kif26b knockout. Kif26b deficient cells produced substantially less mineral versus WT in response to BMP-2 (34.71% ±3.62%, n=12, p<0.0001). At day 8 of osteogenic differentiation, loss of Kif26b abrogated Osterix (113.6 ±6.781 n=5, p<0.0001), Osteocalcin (737.9 ±84.25, n=5, p<0.0001) and Alkaline phosphatase (6989 ±365.7, n=5, p<0.0001) expression, and down regulated Runx2 (2.725 ±0.7724, n=5, p<0.0052) and Collagen type I (7.25 ±1.154, n=5, p<0.0001) expression relative to WT. The knockout cells also appeared morphologically different. This mechanism appeared to be independent of COX-2. Conclusion: Our findings demonstrate an undescribed function for Kif26b as a critical regulator of pathological ossification, with a putative role in HO pathogenesis.

24. ANISOTROPIC EFFECTS OF COLLAGEN REMOVAL ON CORTICAL BONE MECHANICAL PROPERTIES

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Introduction: The risk of fracture from a fall increases with age and disease. Bone has been demonstrated to be anisotropic and this risk of fracture is greatest when loads are applied outwith the principal loading axis of the bone. Bone is a hierarchical composite material made of organic and inorganic phases. In order to determine the mechanical consequences of collagen deficiencies we assessed the the effects of three levels of protein content on the mechanical strength of bovine cortical bone in longitudinal and transverse directions. Methods Bone samples were prepared from the mid-shaft of a bovine tibia. Deproteinisation was achieved by immersion in containers with 40ml of 6% NaOCl at 37â°C. Samples were machined transversely and longitudinally and were allocated to zero, 10% or 30% collagen removal groups (n=5). Mechanical testing was performed in four-point bending at a loading rate of 0.1mm-s. Results ANOVA was utilised to determine statistical significance (p<0.05). Statistically significant differences between the levels of collagen removal were observed in longitudinal failure and yield stress but not with transverse loading. Resilience was also statistically significantly reduced in longitudinal but not transverse loading. No statistically significant differences were found for yield strain in either loading direction. Conclusions This study shows that reduction in the collagen content has a greater effect on longitudinal than transverse bending properties. A fall to the side creates longitudinal bending in the femoral neck. The reduction in longitudinal strength and toughness from collagen loss could explain the increased susceptibility to femoral neck fracture that occurs with age.

25. INHIBITION OF THE PKR SIGNALLING PATHWAY RESULTS IN INCREASED BONE FORMATION IN VITRO AND IN VIVO

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Background & aims: Protein kinase R (PKR) has been implicated in the pathogenesis of arthritis. Emerging evidence suggests that PKR is important in osteoblast differentiation and bone formation. This study investigated whether inhibition of PKR results in changes in bone formation. Study design: In vitro studies used primary human osteoblasts obtained from two patients undergoing knee replacements, following informed consent. Cells were treated for twelve to fourteen days in mineralising medium in the presence or absence of a PKR inhibitor (PKRi; 1µM; n=3) prior to staining with Alizarin Red; colour was removed with 10% cetylpiridinium chloride and absorbance read at 562 nm. Data were analysed by ANOVA. In in vivo studies, PKRi (1µg/kg) or vehicle control were injected into the right knees of anaesthetised twelve-week old C57Bl6 mice (n=3). Mice received analgesia prior to injections and procedures complied with the Animals (Scientific Procedures) Act 1986. Mice were culled at three weeks and processed for histology. Results: Osteoblasts, from both patients, significantly increased their level of mineralisation following inhibition of PKR up to 3.7-fold ($p<0.001$). Two-thirds of mice receiving the intra-articular injection of PKRi had increased osteophytes, ectopic bone formation in the medial ligaments, and subchondral bone thickening. Contralateral knees (no injection) and control knees (vehicle control) were normal. Discussion: This data supports the idea that PKR plays a fundamental role in bone formation; the mechanism regulating PKR-dependent osteogenesis remains unknown. Modulating the activity of PKR may provide novel therapies for the treatment of musculoskeletal diseases where bone changes drive the pathology.

26. INTER-TRABECULAR ANGLE ANALYSIS OF HUMAN HETEROTOPIC AND FOETAL BONE

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Heterotopic bone is osseous tissue that develops at extraskeletal sites. It is a common sequela of amputation following exposure to high-energy trauma such as blast injury. The mechanisms of formation and subsequent development of human heterotopic bone remain poorly understood. In this study we aim to characterize the trabecular fabric of human heterotopic bone and compare it to normal developing foetal bone using Inter-Trabecular Angle (ITA) analysis. ITA is a recently proposed topological parameter of trabecular bone that measures the angles between connected trabeculae. Mean ITA values appear highly conserved across individuals and anatomical locations, and may represent a generic topological blueprint for normal trabecular bone. MicroCT data from 15 ex vivo human heterotopic bone samples and 73 foetal long bones were collected. Volumes of interest containing only trabecular bone were digitally selected, binarized, and skeletonized using standard three-dimensional image analysis tools, and ITA values were calculated using a custom Matlab script. Mean ITA values for foetal bone are similar to those for adult bone, which suggests the normal topological blueprint for trabecular bone is evident early in development. However, heterotopic bone has significantly lower mean ITA values than either foetal or adult bone ($p < 0.0029$ for all comparisons). This abnormal topology of heterotopic bone is therefore likely due to aberrant bone formation, perhaps resulting from poor spatial and/or temporal coordination of growth.

27. RADIATION-INDUCED CHANGES TO BONE QUALITY EXTEND BEYOND PERIOSTEAL BONE

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Cancer patients receiving radiotherapy for soft tissue sarcomas often risk injury to underlying bone because of accelerated bone loss and potential compromises in bone mineral and matrix quality. In this study, a mouse model of limited field irradiation is used to determine if radiation-induced changes to bone composition extend beyond periosteal bone and into the mid-cortex and endosteal bone. Radiation was delivered unilaterally to hindlimbs of 12-wk old female BALB/cJ mice as four consecutive daily doses of 5Gy each. Irradiated (RTx) and non-irradiated (Ctrl) hindlimbs were harvested at 0, 2, 4, 8, and 12-wks post-RTx (n=9 mice/group/time point). Transverse sections at the tibial metaphysis were prepared for Raman spectroscopic analysis of cortical bone at endosteal, mid-cortex, and periosteal regions. Means of spectroscopic measures of bone quality were calculated: mineral crystallinity, mineral/matrix ratio, collagen crosslinks ratio, and lipid/collagen ratio. Statistically significant differences between RTx and Ctrl groups by bone region were calculated using related-samples Wilcoxon signed rank tests (p <0.05). Significant decreases in mineral/matrix ratio existed in the mid-cortex of bone at 8- and 12-wk post-RTx relative to Ctrl groups, as well as in periosteal and endosteal bone. No significant differences in mineral crystallinity between RTx and Ctrl groups were found in any bone region. Many cortical bone regions at 8- and 12-wks post-RTx exhibited consistent significant increases in collagen crosslink and lipid/collagen ratios. The results support our hypothesis that radiation impacts bone quality, leads to compositional changes throughout cortical bone, potentially impacting bone quality in this small-animal irradiation model.

28. THE IONIC CONTRIBUTION OF PROTEOGLYCANS TO MENISCAL LOAD TRANSMISSION

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Load transmission is an important function of the meniscus. In articular cartilage, proteoglycans help maintain hydration via negatively charged moieties which generate Donnan osmotic pressures. A similar role for proteoglycans in meniscal tissue has not been established. We aimed to investigate the role of proteoglycans in meniscal tissue. 8mm diameter, 5mm thick circular samples were cut in the axial plane from bovine menisci. Samples were placed within a confined compression chamber, permeable top and bottom. The apparatus was bathed in distilled water, 0.14M PBS or 3M PBS before being subjected to 5% ramp compressive strain and held for 300 seconds. 3M PBS solutions negate Donnan osmotic pressures whilst deionised water negates mobile ion gradients. FEBio (v2.4, Univ of Utah) finite element modelling software was used to fit results to a non-linear poroviscoelastic model with strain dependent Holmes-Mow permeability. Analysis was conducted using one-way ANOVA with Tukey post-hoc analysis. 10 samples were tested in each solution. Significant differences ($p<0.05$) were observed between the values for Young's modulus, strain dependent permeability and the viscoelastic coefficient for samples tested in 3M PBS as compared to deionised water / 0.14M PBS. No significant differences were observed in the strain dependent/stiffening coefficients or the relaxation time. Approximately 35% of the stiffness of the meniscus appears attributable to ionic effects. These results suggest that ionic effects play a significant role in modulating the mechanical behaviour of meniscal tissue. It is important to include the influence of ionic effects when developing mathematical models of this tissue.

29. MOLECULAR RESPONSES IN DAMAGED CARTILAGE: BMP-7 SIGANLLING IN OA.

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Introduction: The current understanding of the molecular mechanisms involved in osteoarthritis (OA) remains ill defined. The role or utility of bone morphogenetic protein-7 (BMP-7), a cartilage-associated anabolic mediator, in the maintenance or repair of cartilage is of interest in OA. BMP-7 transcript was found in OA cartilage; however little is known about the BMP-7 protein levels and the expression and localisation BMP receptors; ALK 2 (type I) and BMPR2 (type II). We aimed to address this by investigating the expression of BMP-7 protein and BMP receptors in the eroded and non-eroded areas of cartilage in a small OA cohort. Methods: Cartilage from OA patients receiving arthroplasty was graded via Outerbridge scoring and either subject to immunohistochemistry (N=5) for BMP-7 expression or qPCR (N=4) for BMP receptors. Results: BMP-7 protein was predominantly detected within chondrocyte clusters found in the superficial area of eroded cartilage. Transcriptional analysis of cartilage revealed that there was an increased level of the BMP receptors ALK2 and BMPR2 in eroded compared to non-eroded cartilage. Furthermore, cohort analysis revealed a strong positive correlation between the expression of ALK2 and BMPR2 ($R2=0.62$, $P<0.0001$). The expression of both receptors also strongly correlated with the expression of type II collagen (ALK2 $R2=0.3$, $P=0.0051$, BMPR2 $R2=0.47$ $P=0.0004$). Conclusion: Taken together our data suggest that in damaged cartilage there is an up-regulation of anabolic mediators to counterbalance the erosion. Targeting this pathway may enhance the cartilage repair in OA patients.

30. PROTECTION OF CHONDROCYTES AGAINST STAPHYLOCOCCUS AUREUS BY ANTIBACTERIALS IN A BOVINE CARTILAGE MODEL OF SEPTIC ARTHRITIS.

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Septic arthritis is a destructive disease typically caused by joint infection with Staphylococcus aureus which produces alpha-toxin known to cause chondrocyte death. The choice of antibacterial might be important as bactericidal antibiotics (penicillin-G, flucloxacillin) could release stored alpha-toxin exacerbating cell injury/death. Alternatively, bacteriostatic antibacterials (linezolid, erythromycin) might be preferable, as they inhibit bacterial growth limiting additional alpha-toxin release. We have assessed alpha-toxin activity following treatment of S. aureus cultures with bactericidal or bacteriostatic antibiotics. Additionally, we have tested these antibiotics on an in vitro bovine cartilage model of septic arthritis. S. aureus wild-type strain 8325-4 was cultured and biologically-active alpha-toxin determined using a rabbit erythrocyte haemolysis assay. Chondrocyte viability was assessed using fluorescent indicators and confocal microscopy. Linezolid suppressed S. aureus alpha-toxin levels rapidly (within minutes). Penicillin had a similar effect, however the time course of the increased toxin levels was significantly slower ($P<0.05$). In cartilage cultures over approximately 2hrs, there was no significant difference between linezolid and penicillin at fully protecting chondrocytes against further death caused by S. aureus ($P>0.05$). The results suggest that linezolid reduced alpha-toxin levels from S. aureus more rapidly compared to penicillin-G and thus might be the preferred antibiotic. However, in the cartilage model over a longer time course, there was no difference between bacteriostatic or bactericidal antibiotics in their capacity to protect chondrocytes against S. aureus. Furthermore, there was no evidence of a marked increase in alpha-toxin levels which might be expected following the death of S. aureus after treatment with a bactericidal antibiotic.

10:50-11:20 Coffee and Refreshments

11:20-12:30 **Mid-morning Session: "Stem Cell Approaches"**

Chaired by: Dawn Groves and Kara Shah

11:20-11:50 Keynote: **Professor Agamemnon Grigoriadis**

11:50-12:30 Free Papers

31. MINIMUM REPORTING REQUIREMENTS FOR CLINICAL STUDIES EVALUATING BIOLOGICS: PLATELET-RICH PLASMA AND MESENCHYMAL STEM CELLS

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Clinical studies evaluating platelet-rich plasma (PRP) and mesenchymal stem cells (MSCs) are limited by inadequate reporting of scientific details critical to outcome. We developed minimum reporting guidelines for evaluating PRP and MSCs using Delphi consensus methods. The need for minimum reporting requirements for studies evaluating biologics was identified at the American Academy of Orthopaedic Surgeons (AAOS) and the American Orthopaedic Society for Sports Medicine (AOSSM) Biologics Symposia in 2015. A working group facilitated the development of two expert consensus checklists for PRP and MSCs using Delphi techniques. Exhaustive lists of items were generated by searching the published literature. PRP and MSC expert groups, each comprising 24 invited speakers at the AAOS and AOSSM symposia, were surveyed on three occasions to establish consensus on the inclusion of each item within minimum reporting guidelines. In addition to rating agreement, experts were encouraged to propose further items or modifications. Predefined criteria were used to refine item lists after each survey. For PRP, 93 experimental items were identified from the literature. Twenty-three experts (96%) completed three rounds of surveys. After three rounds, 58 items generated consensus with >75% agreement and <5% disagreement. These items were compiled into a 23-statement checklist. For MSCs, 103 items were identified from the published literature. Twenty-three experts (96%) completed three rounds of surveys. After three rounds, 61 items for which consensus was reached were compiled into a 25-statement checklist. This study has established expert consensus on the minimum reporting requirements for clinical studies evaluating PRP and MSCs.

32. BONE FORMATION IN OSTEOPEROSIS CAN BE IMPROVED BY STEM CELLS TRANSFECTED WITH CXCR4

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Osteoporosis is a skeletal disorder that reduces the bone mass and interferes with the micro-architectural structure of bone tissue, reducing its mechanical strength. Chemokines play significant roles in controlling cellular migration. SDF-1 and its ligand CXCR4 improve the migration of cells to the bone marrow[1,2]. The aim of this study was to investigate the effects of CXCR4 transfected MSCs on bone formation in osteopenic rats. The hypothesis of this study was that MSCs genetically modified to over-express CXCR4, when injected intravenously in ovariectomised (OVX) rats would reduce the effects of bone resorption by improving bone formation compared to those injected with saline.

Rats were ovariectomised and left for 4 months to become osteopenic. MSCs were harvested from femora of young and OVX rats, genetically modified to over-express CXCR4 and administered intravenously through the tail vein(n=6) in OVX rats. Saline was also administered as a control. Bone mineral density (BMD) of the femur and stiffness of the vertebrae retrieved from rats was analysed after 12 weeks.

OVX rats injected with young-CXCR4 MSCs (694.0±80.1mg/ccm) had significantly higher BMD ($p<0.05$) in comparison to rats injected with saline. The femora from rats injected with OVX-CXCR4 MSCs (645.4±79.3mg/ccm) had a higher BMD in comparison to those femora from rats injected with OVX MSCs (631.4±69.5mg/ccm) and saline (563.4±82.9mg/ccm). The L4 vertebral stiffness was also higher in rats treated with young-CXCR4 MSCs in comparison to those treated with saline. CXCR4 genetically modified MSCs from young as well as OVX sources may therefore help in boosting bone formation in osteoporotic patients.

33. PERIPHERAL BLOOD MESENCHYMAL STEM CELLS MOBILISED POST ADMINISTRATION OF VEGF AND AMD3100 UNDERGO OSTEOBLASTIC AND NOT ADIPOGENIC DIFFERENTIATION

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A significant number of fractures develop non-union. Mesenchymal stem cell (MSC) therapy may be beneficial in their treatment, however this requires acquisition, culture and then delivery of the cells. Hypothesis: Administration of VEGF and CXCR4 antagonist AMD3100, will endogenously mobilise MSCs into the peripheral circulation, that could enhance bone formation. Rats received daily VEGF 165 (100ug/kg) for four days followed by one dose of AMD3100 (0.5mls/100g), or sham PBS for five days. One hour post-administration, terminal cardiac venipuncture was performed. After red blood cell lysis nucleated cells were seeded in flasks. Colonies were counted and cells passaged to P3 for analysis of CD31, VEGFR2, CD29, CD90, CD34, CD45 expression using flow cytometry. The osteogenic and adipogenic differentiation potential of these cells was determined. Cells from the mobilised group formed CFU-Fs (spindle form fibroblastic cells) in 6/8 cultures. The median CFU-F/ml for the mobilised group (3.0 CFU/ml) was significantly higher than controls (0.0 CFUs/ml), P=0.029 (Mann Whitney-U). Cell surface (median) expression of CD34 was 1.8%, CD45 35%, CD29 61%, CD90 78%, VEGFR2 2%, CD31 1%, and combined CD34-CD45- was 61%, combined CD34-CD45+ 36%. All cell groups were proficient at osteoblastic differentiation with copious deposits of calcium mineral, however they were unable to undergo adipogenic differentiation. Treatment with VEGF AMD3100 mobilises a heterogenous group of plastic adherent fibroblastic colony forming cells, with mixed markers for MSCs and haematopoetic markers (CD45), and selective osteoblastic differentiation potential. Unlike bone marrow MSCs, they could not differentiate into adipocytes, however these cells may enhance bone formation

34. DEMINERALISED CORTICAL BONE MATRIX AND MESENCHYMAL STEM CELLS IN A CHRONIC ROTATOR CUFF TEAR MODEL.

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Background: Demineralised bone matrix (DBM) has been demonstrated in vivo to regenerate a fibrocartilaginous enthesis capable of resisting physiological forces. Hypothesis: The use of DBM and mesenchymal stem cells (MSCs) will result in a higher bone mineral density at the tendon insertion and enhances the regeneration of a morphologically superior enthesis when compared to acellular human dermal matrix. Methods: Eighteen female Wistar rats underwent unilateral detachment of the supraspinatus tendon. Three weeks later, tendon repair was carried out in animals randomized into three groups: Group 1 received augmentation of the repair with cortical allogenic DBM (n = 6); Group 2 received augmentation with non-meshed, ultra-thick acellular human dermal matrix (n = 6); and Group 3 underwent tendon-bone repair without a scaffold (n = 6). All animals received 1×10^6 MSCs delivered in fibrin glue to the repair site. Specimens were retrieved at six weeks postoperatively for histological analysis and evaluation of bone mineral density. Results: All groups demonstrated closure of the tendon-bone gap with a fibrocartilaginous enthesis. Although there were no significant differences between the Modified Movin scores, repairs augmented with dermal matrix + MSCs exhibited a disorganised enthesis, abnormal collagen fiber arrangement, and greater cellularity compared to the other MSC groups. Only repairs augmented with DBM + MSCs reached a bone mineral density not significantly lower than non-operated controls. Conclusions: DBM enhanced with MSCs can augment rotator cuff healing at six weeks and restore bone mineral density at the enthesis to its pre-injury levels.

12:30-12:40 **BORS/BJR International Travelling Research Fellowships**
(hosted by **Professor Hamish Simpson**)

12:40-14:00 Lunch

14:00-15:30 **Afternoon Session: "Patient Specific Implants & Additive Manufacturing"**
(Lecture Theatre G34)
Chaired by: Kartik Logishetty and Kathryn Kneale
14:00-14:30 Keynote: **Dr Jonathan Jeffers**
14:30-15:30 Free Papers

35. THE FRETTING CORROSION BEHAVIOR OF ZIRCONIUM OXIDE AT THE TAPER JUNCTION IN MODULAR TOTAL HIP ARTHROPLASTY

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Introduction: Fretting corrosion at the head-stem interface is an important cause of failure in total hip arthroplasty. The material combination at this interface is important in this corrosion. Aim: To compare the fretting corrosion behaviour at the taper junction in Zirconium Oxide (ZrOx), Delta Ceramic (DC) and Cobalt Chrome (CoCr) heads in combination with a titanium alloy stem in a 10 million-cycle test. Methods: ZrOx, DC and CoCr femoral heads were assembled with titanium stems. Heads with no offset and with +8mm offset were used. The implants were mounted in test fixtures in Ringer's acetate solution. A sinusoidal cyclical load between 300-2300 N at a frequency of 3Hz was applied to the centre of femoral head. A potentiostat was used to measure the fretting current and current amplitude every million cycles. Results: CoCr heads produced significantly higher currents than ZrOx and DC heads with titanium stems. ZrOx samples consistently demonstrate lower currents than the DC heads over 10 million cycles. Increase in head offset from +0 to +8 produced four fold increase in fretting currents in CoCr heads but this change was significantly less with ZrOx and DC heads. Discussion: The ZrOx and DC taper junctions showed lower fretting corrosion compared with the CoCr taper junction. This was particularly evident with higher bending moments associated with the off-set heads. The use of a ZrOx or a DC head with a titanium stem reduces taper corrosion and results suggest that ZrOx may be more be corrosion resistant than DC heads.

36. OPTIMISATION OF 3D PRINTED POROUS STRUCTURES FOR BONE INGROWTH

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Background: Selective laser sintering (SLS) is able to produce highly porous implants, however the factors that control bone ingrowth deep into porous implants are not well understood. Finite element models based on strain energy density (resulting in bone density changes) are not able to predict adventitious bone growth or the effects of osteoconduction. Aims To investigate the osseointegration of scaffolds with different pore sizes and stiffness in an in vivo model and compare results with a finite element model that uses new algorithms designed to predict bone formation into porous implants. Methods: Porous hydroxyapatite coated and uncoated cylinders were implanted into ovine femoral condyle defects. Samples were retrieved after 6 weeks and analysed. FE algorithms that combine the effects of adventitious bone growth with osteoconduction have been developed and were used to predict bone formation in porous implants used in the in vivo model. Results Non-coated plugs osteointegrated only at the implant surface, whereas, coated plugs exhibited significantly greater osseointegration on all internal surfaces ($p<0.001$). FE analysis showed that the titanium alloy internal porous structure were stress shielded and that bone ingrowth within coated implants was due to osteoconduction associated with electrochemical HA coating. FE simulation of similar PEEK structures showed that bone formation is maintained even when the effect of osteoconduction is reduced. Discussion: This study is important because using the new FE algorithms we can predict, in a time dependant manner, the effects of osteoconduction, adventitious bone formation and implant stiffness on bone ingrowth deep into porous implants.

37. SURFACE CHARACTERISATION OF MOBILE BEARING TOTAL ANKLE REPLACEMENT: EXPLANTS VS. IN-VITRO SIMULATION.

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Pre-clinical testing regimes for total ankle replacement (TAR) should be validated against in-vivo wear and deformation behaviour. This study compared the surface characteristics of retrieved mobile-bearing TARs with devices tested in an in-vitro ankle joint wear simulator.

Forty-four mobile bearing TARs were retrieved (HRA ethics: 09/H1307/60). Mean implantation time was 88 months (4-168 range). Concurrently, six unimplanted Zenith (Corin, UK) TARs were wear tested sequentially for 3 million cycles (Mc) optimally aligned, 2Mc with 7.5° coronal malalignment and 2Mc with edge-loading. An InfiniteFocus microscope (Alicona, AT) measured the superior polyethylene insert surface of each explant and each in-vitro-tested insert after the separate in-vitro conditions. Form-change was identified visually, quantified using 3D surface characterisation parameters (ISO 25178-2:2012) and compared (retrieved vs. simulation) statistically.

Fifteen explants (34.1%) were impinged showing material destruction, 21 (47.7%) were edge-loaded, identified by an inflection of deformed material, and eight (18.2%) showed no signs of either damage mode and were considered 'normal'. Well-aligned simulator-tested inserts were not significantly different to 'normal' explants for all surface height parameters ($p>0.05$), however one insert had experienced edge-loading. Likewise, after in-vitro edge-loading, there was no significant differences between 'edge-loaded' explants and simulator inserts and the deformation was visually comparable. The greatest surface deformation was caused by impingement which cannot be replicated by conventional simulation methods. Three in-vivo TAR conditions were highlighted, of which 'normal' articulation and edge-loading were replicated in-vitro. Only 18% of explants were considered 'normal', the remainder featured edge-loading or impingement which may negatively affect device function and patient outcomes.

38. PUSH FIT IMPLANT FIXATION WITH SCREW STRENGTH PULL OUT

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Background: Additive manufacturing has offered exciting new possibilities for improving long-term cementless implant fixation in bone through enabling open porous structures for bony ingrowth. The aim of this research was to investigate how the technology could also improve initial implant fixation, a precursor to successful long-term fixation. Methods: A new active fixation mechanism, relying on flexible, bone gripping struts was proposed and manufactured as a push-fit peg. The technology was optimised using a synthetic bone model and compared against controls, which were based on total joint arthroplasty technology and were tested over a range of interference fits. Optimum designs were subsequently tested in a cadaveric femoral condyle model. Results: The active fixation surface provided more than double the pull-out force for less than a third of the insertion force compared to the best performing conventional press fit peg ($p<0.001$). Indeed, it provided screw strength pull-out force from a push-fit device (1,120 Â± 146 N). Conclusion: This step-change in initial implant fixation also offers new capabilities for low-profile, minimally invasive metallic implant design, and new options to simplify surgery, removing the need for modularity. Also, through requiring lower insertion force, the technology could reduce the risk of fracture when implanting a cementless device.

39. ASSESSMENT OF THE BIOCOMPATIBILITY OF ALPHA, BETA AND AMORPHOUS SILICON NITRIDE FOR ORTHOPAEDIC APPLICATIONS

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Silicon nitride (Si_3N_4) is currently being investigated as a potential orthopaedic biomaterial in its bulk form and as a ceramic-like coating. This is the first study to investigate whether the biocompatibility of Si_3N_4 particles is affected by its internal phase structure; alpha, beta or amorphous. The cytotoxicity, genotoxicity and oxidative stress potential of to Si_3N_4 particles each of these states were evaluated at both low (0.5 μm^3/cell) and high (50 μm^3/cell) particle doses in L929 fibroblasts. Clinically relevant cobalt-chromium (CoCr) wear debris served as a positive control. Si_3N_4 particles in the three phases were found to be non-cytotoxic at low and high doses up to 7 days as measured using the ATPLite assay, whereas CoCr induced significant cytotoxicity. Assessment of DNA damage using the Comet assay also showed that Si_3N_4 did not cause significant levels of damage in any phase compared to the cell only control when measured at days 1, 3 and 6. In contrast, high dose CoCr wear debris induced significant DNA damage at all time points. A similar observation was noted when the levels of oxidative stress induced by a 2 day incubation of L929 cells with these particles was evaluated using the IMAGE-IT Live kit. Results indicated that whilst CoCr stimulated significant production of reactive oxidative species, Si_3N_4 in its alpha, beta and amorphous phases did not. In conclusion, the results from this study indicate that Si_3N_4 has similar biocompatibility in the different crystalline phases tested, increasing the current understanding of this potential implant material.

40. FEMORAL NECK CORTICAL BONE STIFFNESS MEASURED BY RESONANT ULTRASOUND SPECTROSCOPY CORRELATES STRONGLY WITH ITS DENSITY

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Introduction: The cortical bone at the femoral neck is of crucial importance during joint replacement surgery, yet there is little information in the literature about its elastic properties. We take advantage of a technique that can measure the elastic properties of small samples of material, resonant ultrasound spectroscopy (RUS).
Methods: Femoral neck cortical bone was harvested from the femoral heads of 19 patients who underwent elective total hip arthroplasty (8 male, 12 female, median age 69, range 49-82). One 6x3x3 mm rectangular parallelepiped cortical bone sample was cut from the medial femoral calcar of each femoral neck. Specimens were orientated with their long axis parallel with the osteons. RUS was performed as per the protocol published by Bernard *et al*., 2013.
Results: The mean apparent Young's modulus in the longitudinal direction of the bone was 17.7 (±3.1) GPa. The correlation, r^2, between density and stiffness was 0.75, 0.78 and 0.70 for the C11, C22 and C33 directions of the stiffness tensor, respectively. Femoral cortical bone had an anisotropy ratio of 1.5 (±0.05), 1.5 (±0.04) and 1.0 (±0.02) when comparing the C33:C11, C33:C22 and C22:C11 directions of the stiffness tensors, respectively.
Discussion: Femoral neck cortical bone stiffness strongly correlated to its density in this study and had an anisotropy ratio of 1.5 between its compressive and radial axes. The results from this study can be used to inform finite element models of the proximal femur and may aid in the development of novel hip surgery implants and devices.
1. S.Bernard, Q.Grimal and P.Laugier (2013)*J.Mech.Behav.Biomed.Mater*.18:12-19

15:30-16:00 Close, Thanks and Awards

POSTERS

41. BIOLOGICAL IMPACT OF CERAMIC HIP REPLACEMENTS

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High volumes of alumina ceramic wear particles, associated with catastrophic hip implant failure, have been reported to induce cytotoxic effects and osteolytic cytokine production. However, a comprehensive evaluation of the biological impact has not been reported for zirconia-toughened, platelet reinforced alumina (ZTA) hip replacements. The aim of this study was to investigate the biological impact of pure alumina and ZTA model particles on primary human monocytic cells. Alumina (BIOLOX® Forte) and ZTA (BIOLOX® Delta) powder was obtained from CeramTec, Germany. Cobalt-chromium (CoCr) wear particles were generated using a pin-on-plate wear simulator. Peripheral blood mononuclear cells (PBMNCs) isolated from human blood (three donors) were cultured with CoCr or ceramic particles at volumes ranging from 0.05µm^3-50µm^3/cell for 24 hours. The biological impact of the particles was assessed in terms of cytotoxicity, TNF- α production, DNA damage and oxidative stress. Significantly elevated levels of TNF- α and increased DNA damage was observed when stimulated with 50µm^3/cell of CoCr nano-particles (all donors), whereas no inflammation was associated with the alumina or ZTA ceramic particles. Alumina ceramic particles at 50µm^3/cell, significantly increased DNA damage (two donors), whereas no DNA damage was caused by the ZTA ceramic particles at concentrations tested. The production of reactive oxygen species was significantly increased with CoCr nano-particles, however, no oxidative stress was induced in response to alumina or ZTA ceramic particles (all donors). This comprehensive study indicated that the latest generation composite ceramic hip replacement materials had lower biological impact which may enhance long-term clinical performance.

42. KNEE ARTHROSCOPY SIMULATION: A RANDOMISED CONTROLLED TRIAL EVALUATING THE EFFECTIVENESS OF THE IMPERIAL KNEE ARTHROSCOPY COGNITIVE TASK ANALYSIS (IKACTA) TOOL

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Background: Cognitive Task Analysis (CTA) has been used extensively to train pilots and in other surgical specialties. However, the use of CTAs within orthopaedics is in its infancy. Aim: To evaluate the effectiveness of an innovative CTA tool to train novice surgeons in diagnostic knee arthroscopy. Methods: Design - 3 expert knee surgeons were interviewed independently to generate a list of technical steps, decision points and errors for diagnostic knee arthroscopy. A modified Delphi technique was used to generate the final CTA. A video and a voice over were recorded for each phase of this procedure. These were combined to generate the IKACTA tool. Validation - Randomized double-blind controlled trial. 16 novice orthopaedic trainees (performed <10 diagnostic knee arthroscopies) were randomized into 2 equal groups. Group 1 was given the IKACTA tool and group 2 had no additional learning material. They were assessed objectively (validated ASSET global rating scale) on a high fidelity phantom limb simulator. All participants, using the Likert rating scale, subjectively rated the tool. Statistical analysis was undertaken using the Mann Whitney U test. Results: The mean ASSET score in group bhA was 19.5 (51.3% ±3.7) compared to 10.6 (27.9% ±2.3) in group B. The improvement in the mean ASSET scores was 8.9 (23.4%; p = 0.002; 95% CI = 7.63-10.1). All participants (100%) agreed that the CTA learning tool was a useful training adjunct to learning in the operating theatre. Conclusion: We have designed a new user-friendly, inexpensive CTA tool that has significant benefits in knee arthroscopy training.

43. SYNERGISTIC EFFECT OF MICROSTRUCTURE AND PERFUSION CULTURE ON DIFFERENTIATION OF BONE MARROW DERIVED MESENCHYMAL STEM CELLS (HMSCS)

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Silicon substituted hydroxyapatite (SiHA) with a hierarchical structure being used as bone graft scaffold (BGS) is an excellent promotor of bone ingrowth and repair; higher levels of strut porosity of SiHA show increased osteogenic behaviour in vivo. However, the significant differences between SiHA with different strut porosities in traditional static culture was not observed. We hypothesised that the osteogenic sensitivity to strut porosity is linked to its influence on local fluid shear environment. This was tested in a perfusion culture system. Three groups of irregularly shaped SiHA granules with strut porosity of 13.5 ± 0.7% (SiHA-14), 22.3 ± 0.5% (SiHA-22) and 28.4 ± 2.7% (SiHA-28) were synthesised, characterized and used for in vitro experiments. hMSCs were seeded onto each group, cultured under static conditions in well-plates, or in a perfusion culture system, receiving continuous cell culture medium at a rate of 0.07ml/min. In static culture, cell proliferation and markers of differentiation (i.e. specific activity of alkaline phosphatase (ALP) and osteogenic gene expression) showed no statistical difference between the three groups. However, after perfusion culture, ALP specific activity and gene expression of osteogenic markers of hMSCs were significantly higher when cultured on SiHA-22 and SiHA-28 compared with SiHA-14. Immunofluorescence staining indicated that perfusion culture facilitated the translocation of phosphorylated ERK1/2 to the nucleus in all three groups of scaffold. This study demonstrates that perfusion culture is important for a fuller characterization and evaluation of the bioactivity of BGSs.

44. EVALUATING THE OSTEOCONDUCTIVITY OF LASER SINTERED Ti6Al4V ELECTROCHEMICALLY COATED SCAFFOLDS

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Background: Selective laser sintering (SLS) is able to fabricate porous metallic alloy implants that cannot be produced by more conventional manufacturing techniques. Hydroxyapatite is used to enhance osteointegration of implants, but with more porous structures a line-of-site plasma spraying technique can only coat the outer surface. Aim: To investigate bone ingrowth into SLS titanium alloy porous structures with different electrochemical coatings that coated the inner surfaces. Methods: SLS porous cylinders (8 x15 mm) with different pore sizes (700µm, 1500µm) and three different electrochemical coatings: hydroxyapatite (EHA), silicon-substituted HA (ESiHA), strontium-substituted HA (ESrHA), were implanted into ovine femoral condyle critical sized defects. Samples were retrieved after 6 weeks and histologically analysed. Results: Coatings with a Ca:P, Ca:(P+Si) and (Ca+Sr):P ratios of 1.53, 1.14 and 1.32 respectively were produced with a 1.13 Si wt% and a 4.08 Sr wt%. Non-coated plugs only osteointegrated at the outer pore surface, whereas, electrochemically coated plugs exhibited significantly greater osseointegration on all internal surfaces than uncoated plugs ($p<0.001$) with coatings and pore sizes. EHA coated plugs showed significantly greater osseointegration than uncoated and plasma sprayed plugs ($p<0.001$). Sub-group analysis reveals small pore EHA scaffolds exhibited the highest rates of integration and bone content within pores ($p<0.05$) than controls. Conclusions: We have developed an electrochemically HA coated SLS porous Ti6Al4V scaffold that exhibited significantly greater osseointegration than uncoated and plasma sprayed control groups. This coating has the potential to be utilised to increase bone ingrowth deep within a porous structure, which does not occur with uncoated implants.

45. ARE STATIC JOINT MANIPULATON TESTS EFFECTIVE IN DETERMING THREE-YEAR POST-OPERATIVE FUNCTION?

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Background: Current tests for determining function in unstable total knee replacement (TKR) patients are crude and subjective. Static joint manipulation does not always predict functional instability. The purpose of this study was to examine the efficacy of static clinical tests in association with pre-op and three-year post-op functional outcome scores (FOS). Methods: Forty-two primary TKR patients (female = 12; age = 73±8.1 years; implant age = 46.26±8.02 months) were recruited from surgical pre-assessment clinic. Joint manipulation was performed in sagittal and coronal planes. Power output was measured in the operated leg during unilateral leg extension using the Nottingham Power Rig. Functional ability was determined through the Aggregate Locomotive Function Test (ALF), which included timed get-up-and-go, stairs ascent and descent, and 8m walk. Knee flexion and Oxford Knee Scores were also measured. One way ANOVA tests were performed to show differences in FOS across the range of knee laxities. Statistical significance was set at $p<0.05$. Results: All patients reported satisfaction with their operation, however, manipulation showed ranging laxity in both planes. Thus, patients were grouped accordingly: loose = 6°-10°/>10°; normal = 1°-5°; tight = 0°. Nevertheless, FOS were not statistically different across groups except for pre-to-post-op change in ALF score between sagittal tight and loose groups ($p=0.0156$). Summary: Increased laxity upon manipulation has previously been associated with knee instability and poor function. Results confirm that static tests are inadequate in determining post-op functional ability. This suggests that some patients may develop coping strategies to optimise function following TKR regardless of laxity.

46. REPURPOSING GLUTAMATE RECEPTOR ANTAGONISTS FOR THE PREVENTION OF POST-TRAUMATIC OSTEOARTHRITIS.

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Synovial fluid glutamate concentrations increase in arthritis, AMPA/kainate glutamate receptors (GluRs) localise to osteoarthritic knees and NBQX (AMPA/kainate antagonist) reduces swelling, gait abnormalities and joint destruction in inflammatory and post-traumatic osteoarthritis (PTOA) models. NBQX is not approved for human use, therefore we have sought to repurpose successful Phase-1 clinical trial AMPA/kainate GluR antagonists. We hypothesise that these drugs will have similar therapeutic effects to NBQX in an ACL-rupture PTOA model. Due to confidentiality purposes, drugs are anonymised A-D. For ACL rupture, load (12N, 4Hz, ElectroForce® 3200, BOSE) was applied to right knees of anaesthetised 12-week-old C57Bl6 mice. A single intra-articular injection of drug or vehicle was administered (n=5) immediately following ACL rupture. Over 21 days, knee swelling was measured (days 0, 1, 2, 3, 7, 14, 21). On day 21, animals were culled and knees harvested. By day 2, drug A reduced knee swelling ~50% to levels similar to day 0. Vehicle knee swelling remained higher until day 7 ($p<0.01$). Drug C reduced knee swelling to day 0 levels by day 2, whereas drug D ($p<0.05$) and vehicle ($p<0.001$) remained increased until day 7, and drug B ($p<0.05$) until day 14. Drug A reduced end-stage knee degradation score by ~40% compared to vehicle. Drugs B, C and D had no effect. We show that AMPA/kainate GluR antagonists, approved for human use, are effective at relieving inflammation and degradation in PTOA. Repurposing of these drugs offers a rapid route to treatment of human PTOA, often occurring within 4 years of discovery.

47. FRACTURE PREDICTION TOOL FOR LONG BONES BASED ON BEAM THEORY USING QUANTITATIVE COMPUTED TOMOGRAPHY

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Current methods to diagnose bone diseases like avascular necrosis and osteoporosis are not reliable in assessing the fracture risk. There is potential to improve the assessment of the fracture risk by using a combination of density-calibrated computed tomographic (QCT) imaging and engineering beam theory. The femur was approximated with a beam model loaded with a joint contact force. The beam axis was defined by the neck and the shaft axis with a hyperbolic curve between those two to allow for a smooth transition. The curvature led to a stress concentration which was addressed by using curved beam theory. The von Mises stress was calculated for bone cross-sections which were perpendicular to the beam axis. The maximum joint loading at which each bone cross-section was likely to fracture was calculated using a strain based failure criterion. The approach was verified against compression tests of twelve 3D-printed femur models. A fracture prediction tool was developed based on the described methodology to identify the fracture risk of femurs by simulating mechanical stress in-vivo. The operability of the tool was tested utilising clinical QCT-scans of human femurs. Material properties were assigned to the beam model by using a density-modulus relationship. The tool correctly identified the femoral neck and the stem of the 3D-printed models as fracture sites. The chosen beam axis fitted well to the locations of the measured centroids. The developed tool was able to objectively identify the location of fracture which may increase clinical efficiency as there is potential for further automation

48. INVESTIGATING THE MECHANICAL FATIGUE PROPERTIES OF VERTEBROPLASTY TREATMENT IN AN IN VITRO BOVINE TAIL MODEL

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Osteoporotic vertebral fractures are prevalent in post-menopausal women, and can result in pain and a reduced quality of life. Vertebroplasty is used as a treatment but remains controversial, with work needed to optimise mechanical performance for different patient cohorts. The aim of this study was to investigate the fatigue behaviour of vertebroplasty to further understand its mechanisms and efficacy. Thirty-one bovine tail vertebrae were loaded axially to 9.5kN or failure. Eleven specimens were then injected with PMMA bone cement, and 20 were left untreated. Untreated vertebrae were cyclically tested in four groups at loads of 60%-90% of the initial failure load. Treated specimens were tested at 80% failure load, all were tested up to 10000 cycles or until failure. Specimens were microCT scanned before and after each test. A relationship was seen between initial vertebral strength and fatigue performance, with significant differences between the 60% group and other groups. No significant difference was seen in fatigue performance between treated and untreated specimens (average cycles to failure = 2634 and 1176 respectively), however there was a correlation between vertebra volume and cycles to failure (Pearson's R2 = 0.68). Large variations were seen in the mechanical response of all specimens; in some cases initial testing did not cause failure, and variation was seen in injected cement volume. This study demonstrates variation in the outcome of vertebroplasty even in a comparatively controlled environment. It provides useful data for finite element modelling, and fatigue testing methods for human vertebra for investigating further vertebral therapies.

49. LOWER LIMB CT ANGIOGRAM IN THE PREOPERATIVE ASSESSMENT OF TRAUMATIC KNEE INJURIES

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Aim: Assess the utility of routine preoperative lower limb CT angiography (CTA) for patients with traumatic knee injuries, undergoing surgery and/or ligamentous repair. Methods: We have retrospectively reviewed all acute traumatic knee injuries at our Level 1 Acute Trauma Centre over the last 10 years requiring surgical management. There were 72 injuries consisting of 57 proximal tibial plateau fractures, 4 intercondylar femoral fractures and 11 traumatic knee dislocations without associated fractures. All patients underwent routine CTAs as part of the current preoperative surgical protocol, to exclude any popliteal arterial injury. Results: All injuries resulted from blunt trauma. The majority of cases demonstrated no associated vascular injury on CTA. Four cases of arterial injury were seen in the 57 proximal tibial plateau fractures (Schatzker IV-VI), 2 involving the popliteal artery (both reported on clinical assessment) and 2 the proximal anterior tibial artery. No popliteal vascular injury was demonstrated in any of the 4 intercondylar femoral fractures. Large haematomas occluding the popliteal artery were seen in 2 traumatic knee dislocations. Both were clinically apparent on secondary survey. Conclusion: Pre-operative lower limb CTA should not be routinely performed in all acute traumatic knee injuries, but selectively in cases of significant clinical suspicion. Furthermore, the popliteal fossa can be assessed when characterising the fracture on an unenhanced surgical planning CT. Avoiding routine use of contrast-enhanced lower limb CTA in the preoperative assessment of traumatic knee injuries, limits radiation doses and IV contrast burden on the acutely injured patient, as well as cost.

50. MECHANICAL PROPERTIES OF THE ACTIFIT MENISCAL SCAFFOLD IN CONFINED COMPRESSION

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The Actifit meniscal scaffold (Orteq Sports Medicine) is designed to augment meniscal repair through encouraging ingrowth of meniscal tissue. It is composed of polyester and polyurethane components and is designed to mimic the mechanical properties of meniscal tissue. There has been no independent characterisation of the mechanical properties of the scaffold. We aimed to determine the mechanical properties of the Actifit in confined compression. 5mm diameter, 4mm thick circular samples of an Actifit scaffold were placed within a confined compression chamber, permeable top and bottom. The apparatus was bathed in distilled water before being subjected to 5% ramp compressive strain. The hold phase lasted for 3600 seconds. FEBio (v2.4, Univ of Utah) software was used to fit results to a non-linear poroviscoelastic model with strain dependent Holmes-Mow permeability. The mechanical parameters derived using the finite element analysis software suggested the prosthesis to have an average Young's modulus of 0.62 (s.d. 0.15) MPa, strain dependent permeability of 0.66 (s.d.0.23) $x10^{-15}$ m4/Ns, exponential strain coefficient of 0.006 (s.d. 0.00), exponential stiffening coefficient of 1 (s.d. 0.88), viscoelastic coefficient of 0.15 (s.d. 0.09) and relaxation time of 138.38 (s.d. 77.63) seconds. The equilibrium modulus was calculated at 0.84 (s.d.0.2) MPa. Whilst the values for Young's modulus and permeability presented here are similar to those present in the literature for meniscal tissue tested in confined compression, the value for the equilibrium modulus is somewhat higher. Similar mechanical properties to the native meniscus are likely to help encourage ingrowth of meniscal tissue into the scaffold.

51. EDTA ENHANCES ANTIMICROIBAL EFFICACY IN METHYLENE BLUE MEDIATED PHOTODYNAMIC THERAPY FOR PROSTHETIC JOINT INFECTION (PJI) TREAMTENT

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Prosthetic Joint Infection (PJI) leads to high patient morbidity, mortality and healthcare costs. Photodynamic Therapy (PDT) uses a photosensitiser, visible light and oxygen to create reactive oxygen species which can kill bacteria. Ethylenediaminetetraacetic acid (EDTA) is a permeabilising agent known to reduce thiazine dyes such as Methylene blue (MB), which under red light creates free radicals that kill bacteria. Hypothesis: MB supplemented with EDTA will increase the effectiveness of PDT in destroying P. aeruginosa biofilms and this will have no harmful effect on human synovial cells. Methods: P. aeruginosa biofilms on titanium alloy surfaces received either MB-PDT or MB-EDTA-PDT. In the second part of this study, human synovial tissue was co-cultured with P. aeruginosa labelled with green fluorescent protein. Frozen sections through the synovial tissue before and after PDT treatment were taken and a live dead stain used to assess the viability of the human cells. Results: MB-PDT was effective with a 3.6 log CFU/mL reduction of P. aeruginosa in biofilms whilst the addition of EDTA to MB further reduced biofilm by a 4.4 log CFU/mL ($p<0.001$). PDT is also effective in reducing GFP P. aeruginosa biofilms onto the surface of human tissue, as verified by fluorescent microscopy. Although the upper-most surface layer of cells in the synovium were killed by PDT, cells below the surface remained viable. These results indicate that MB and MB-EDTA mediated PDT is an effective treatment to reduce P. aeruginosa biofilms on titanium alloy surfaces and adjacent tissue with little effect on the human cells.

52. ABNORMAL CHONDROCYTE MORPHOLOGY FOLLOWING IMPACT INJURY OF BOVINE CARTILAGE IN THE PRESENCE OF FETAL CALF SERUM AND ITS REVERSAL BY HYPEROSMOLARITY.

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Joint trauma leading to cartilage injury may cause posttraumatic osteoarthritis (PTOA). The application of mechanical force to cartilage explants is a useful model for understanding some of the processes involved. Here, we have investigated the response of chondrocytes within bovine cartilage explants to a single impact load in the presence or absence of fetal calf serum (FCS) at normal or elevated osmolarity. Bovine osteochondral explants suspended in the presence/absence of FCS (10%) at normal (340mOsm) or high osmolarity (600mOsm), were subjected to a single impact load from a drop tower. In situ chondrocyte viability and morphology were assessed using fluorescent dyes and confocal microscopy. Chondrocyte death which was marked along cartilage fissures, was significantly ($P<0.001$) reduced by raised osmolarity. When cultured over 20 days in the presence of FCS at 340mOsm, chondrocytes developed abnormal morphology with long (up to 60um) cytoplasmic processes and significantly increased in volume ($P<0.01$). However raising the osmolarity to 600mOsm (sucrose addition) abolished these abnormal changes with chondrocytes reverting to normal (rounded) morphology. The morphology and viability of chondrocytes distant from the impact-induced fissures was normal in the presence or absence of FCS or hyperosmolarity. The results suggested that the cartilage fissures arising from impact injury provided a route for factors in FCS which stimulated chondrocytes to develop a fibroblastic-like morphology. Raised osmolarity was chondroprotective against impact injury, and prevented the development of abnormal morphology induced by FCS. Hyperosmolarity might therefore protect chondrocyte viability and morphology against the damaging effects of impact injury.

53. THE IMPACT OF A THERAPY TWILIGHT SERVICE ON OUTCOMES FOLLOWING JOINT REPLACEMENT SURGERY

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Purpose: To facilitate mobilisation on the day of surgery for all patients following joint replacement surgery. Methods: Restructuring of the working patterns for the therapy team enabled redistribution of the working day to encompass a later finishing time for selected team members. Development of the Twilight Service (TS) ensured therapists were available to treat patients returning late from theatre. Results: Following introduction of the TS, patients mobilised on day of surgery increased from 9% to 89%. Length of stay (LOS) subsequently improved from mean 6.7 days to 2.7 days for THR, and from 5.7 to 3.2 for TKR. As a by-product of the introduction of a TS, therapists were also able to discharge day case patients on the late theatre lists. An additional 362 patients were discharged by the TS. Patient experience was monitored throughout the implementation. Patients mobilised on the day of surgery reported feeling less anxious with better pain control. These patients were more motivated to engage in rehabilitation the morning after surgery than those mobilised the following day. Conclusion(s): Implementation of a Therapy Twilight Service is cost effective with potential to save a significant number of bed-days. Therapy Twilight Services improve patient experience with reduced anxiety and pain scores with quicker return to independence, underpinning reduced LOS. This improves bed utilisation and bed capacity by improving patient flow from admission to discharge. This may have a direct impact on cancellations on the day of surgery and theatre utilisation.

54. ESTABLISHING OPTIMUM SCREW TIGHTENING TO MAXIMISE PULLOUT FORCE IN FRACTURE FIXATION

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Introduction: Fracture fixation is one of the most common operations performed around the world. Despite this, fixation failure is seen in 15-40% of cases, especially in osteoporotic bone. Evidence shows that screw insertion technique can be poor, with surgeons inaccurately predicting the stripping torque. There is limited information on the optimum range between seating torque and stripping torque with regards to construct stability and fracture healing. The aim of this project was to identify what is the optimum tightness (percentage of the maximum torque) as a function of pullout force. Methods: Juvenile bovine tibiae diaphyses were used to create 43 samples. 3.5 mm screws (Stryker, Newbury, UK), were inserted using a torque measuring screwdriver. Stripping torque was deduced using preliminary drill holes and with theoretical calculations. Axial tensile testing was performed at differing torques, at 5 mm/min displacement, recording at 20 Hz until the maximum force was seen. Results: Cortical thickness was found to directly correlate with pullout force ($R2=0.754$, $p<0.001$) and this was used to perform linear regression to adjust for differences in cortical thickness. Results were grouped by percentage of maximum torque (40-60%, 60-80% and 80-100%). Maximum pullout force was seen with insertion torques of 40-60% of the maximum ($p<0.001$), with torques past this point leading to reduced axial pullout force ($R2=0.461$). Discussion: Whilst further assessment is needed regarding the effect of known confounding factors, such as cortical thickness, density and stress relaxation, this data shows that exceeding 60% of the stripping torque reduces the chance of obtaining the optimum screw-bone construct.

55. EFFECT OF ABSORBED FATTY ACIDS ON PHYSICAL PROPERTIES OF ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE

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Studies have demonstrated fatty acids diffuse into ultra-high molecular weight polyethylene (UHMWPE) prosthetic components (Costa, Biomaterials, 2001), but their effect on the physical properties remains poorly understood. One of the main fatty acids present in synovial fluid is octadecadienoic acid. We compared the properties of UHMWPE tensile test samples doped with *cis*-9,*cis*-12-Octadecadienoic acid (Sigma Aldrich) for 24 h at 100 ^{o}C to control samples heated to 100 ^{o}C for 24 h in air. Both cross-sectional area and weight increased after doping (area increase: 1.3% ±0.2, weight increase: 3% ±0.28). Infrared spectroscopy (Perkin-Elmer Frontier with ATR, 32 scans, from 4000 to 600 cm^{-1}) confirmed the presence of octadecadienoic acid (peak at 309 cm^{-1}). Differential scanning calorimetry results showed doping significantly decreased the crystallinity ($p=0.015$, $n=3$) and the melting temperature ($p=0.001$, $n=3$). Tensile tests ($n=5$) were carried out in accordance with ISO527 using an electromechanical testing machine (Instron 5965) and a contact extensometer, at a rate of 50 mm/min. The doped samples had significantly lower yield stress ($p\leq0.0001$) and elongation at failure ($p=0.03$), but no change was found in modulus or ultimate stress. The results demonstrate the absorption of octadecadienoic acid, which happens over time *in vivo*, alters UHMWPE dimensions, reduces crystallinity, melting temperature, yield stress, and elongation at failure. Consequently, it is important that the effect of fatty acid absorption is taken into account when performing *in vitro* tests of UHMWPE components, such as wear testing. The dimensional change also has implications for close fitting component designs.

56. EVALUATING THE SCREW FASTENING TORQUE REQUIRED TO GENERATE APPROPRIATE PRELOAD IN OSTEOPOROTIC BONE

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Surgeons generally use subjective feel to tighten bone screws as much as possible without stripping the threads; however, subsequent fixation failures are common, particularly in osteoporotic bone. We hypothesise that if the preload generated in healthy and reduced density bone and its dissipation over time was better understood, some of these failures could be avoided through the use of more appropriate fastening torques or a different number of screws. This ongoing study aims to develop a validated finite element model capable of predicting the preload generated for different bone densities and cortical thicknesses. To date, experimental tests (n=10) were conducted using bovine tibiae (4-5 months) to evaluate the bone-implant pressure (LLW Prescale FujiFilm) and surface strains (Ncorr v1.2) for a range of tightening torques. The bone density (assessed using CT-images) and cortical thickness of each specimen were recorded. An axisymmetric finite element model was developed based on the experimental tests (Ansys 17.0). Our early simulations predicted the equivalent strain at the edge of the implant-bone interface to be 0.062%, which was within the range of the experimentally observed values (0.04-0.07%). The predicted bone-implant pressure also compared favorably with pressures up to 2.5 MPa. Using an experimentally derived relationship between fastening torque and bone-implant pressure, the model has the potential to predict preload for any bone quality and geometry. Our intention is to develop this model, in combination with established formulas to calculate stripping torque, into a patient-specific tool providing surgeons with appropriate screw fastening guidance to avoid early fixation failure.

57. CHARACTERISATION OF MECHANICAL PROPERTIES OF FEMORAL HEADS WITH AVASCULAR NECROSIS

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Avascular necrosis (AVN) is a debilitating disease affecting the femoral head (FH) which may cause mechanical failure [1]. This study aimed to characterise structural and mechanical properties of FHs with AVN in relation to AVN lesion volume. FHs from patients undergoing hip arthroplasty for AVN and non-pathological cadaveric FHs were scanned using computed tomography to analyse for presence/volume of AVN lesions. Bone plugs (9mm diameter) from load-bearing (LB) (n=28), and non-load bearing (NLB) (n=6) regions of nine AVN FHs and LB (n=5) and NLB (n=3) regions of three control FHs were tested in compression (1mm/min). Mean lesion volume percentage for AVN FHs was significantly greater than control FHs ($p<0.0001$). Most samples in the AVN group (12/20) had lesions that were >30% total FH volume. The mean elastic modulus and yield stress of LB AVN FH bone plugs were significantly lower than that of control FHs (79% and 77% respectively; Kruskal-Wallis, $p<0.05$). However, for NLB samples, mean elastic modulus and yield stress of AVN FHs were significantly higher than control samples (153% and 123% respectively; Kruskal-Wallis, $p<0.05$). Mechanical properties in LB regions of AVN FHs were significantly less than those of control FHs, correlating to a previous study [2], an increase in mechanical properties in NLB regions was observed in heads with AVN. This may be due to adaptation of these NLB regions to support loads following AVN, or may be due to the presence of denser sclerotic tissue. [1] Conzemius, *et al.* 2002, *J.Orthopaedic Research*. [2] Brown, *et al*. 1981, CORR.

58. OPTIMISING THE COMPOSITION OF IRRIGATION FLUID TO MINIMISE THE POTENCY OF STAPHYLOCOCCUS AUREUS ALPHA TOXIN

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Septic arthritis may be caused following joint infection by *Staphylococcus aureus* which produces a potent alpha toxin capable of causing rapid chondrocyte death. Irrigation of the joint with normal saline (0.9%) will reduce alpha toxin levels, however it might be possible to modify the irrigation fluid to suppress the activity of the alpha toxin more rapidly and effectively by optimising its composition. We have determined the biological activity of alpha toxin using a rabbit erythrocyte haemolysis assay and altered the composition of normal saline by varying the osmolarity, temperature, divalent cation concentration or pH. Pre-incubation of erythrocytes with the osmolarity of saline raised from normal (300mOsm) to 900mOsm (sucrose addition) markedly suppressed alpha toxin potency by over 70% ($P<0.0001$). Addition of hyper-osmotic saline directly to erythrocytes also conferred immediate protection against the damaging effects of alpha toxin ($P<0.0001$). Reducing temperature to 4^{o}C was also protective and abolished haemolysis when compared to the control (37^{o}C; $P<0.0001$). Pre-incubation with a divalent cation (calcium or magnesium) also reduced haemolysis due to alpha toxin ($P<0.01$), however there was no difference between them in their efficacy. Alkalinity also demonstrated a minor protective role as alpha toxin potency decreased between pH6.5 and 8.0 ($P=0.0016$). Thus, a cooled, slightly alkaline, hyperosmotic irrigation saline containing sucrose as the osmolyte with a divalent cation, could markedly reduce the potency of *S. aureus* alpha toxin and thus may be of value in joint irrigation for the treatment of septic arthritis.

59. THE EFFECT OF MALALIGNMENT ON THE WEAR OF A TOTAL ANKLE REPLACEMENT

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Malalignment of total ankle replacements (TARs) is a potential result of surgical technique, failure to correct existing natural varus/valgus malalignment, ligament laxity or further degeneration of the hindfoot. Malalignment of a TAR can result in edge loading of the component, deformity, and has been associated with increased wear and higher failure rates. Good alignment is considered instrumental for long term success. To replicate the malalignment in vitro six Zenith (Corin Group) unconstrained TARs were tested in a knee simulator in 25% bovine serum. First a standard gait was applied for 3 million cycles (Mc) to correctly aligned TARs. The tibial components were then offset with 7.5° coronal malalignment and underwent 3Mc malaligned. The wear rate was quantified gravimetrically every Mcs and the superior surface profile imaged with an InfiniteFocus microsope (Alicona). The first Mc with components neutrally aligned showed an initial wear rate of 31.2±5.4mm³/Mc while the inserts bedded in. This reduced significantly to 18.9±2.4mm³/Mc over the following 2Mc in the neutral alignment. With the addition of 7.5° coronal malalignment the wear rate reduced further to 11.9±1.8mm³/Mc and the centre of rotation (CoR) moved medially under malalignment. Implementing coronal malalignment alone resulted in a significant decrease in the wear rate. This is potentially due to the reduced contact area or improved lubrication with the component lift. Malalignment is associated with failure but may not be mediated by surface wear and the resulting osteolysis. More investigation is required to understand the other factors at play and develop a suitable adverse condition TAR preclinical test.

60. STUDY OF IMPACT LOADING ON THE CERVICAL SPINE USING DIGITAL IMAGE CORRELATION

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Digital Image Correlation (DIC) has become a staple of structural engineering. DIC is also particularly appealing in biomechanical studies as, contrary to other more traditional techniques, it allows visualisation of specimen strains and deformation over a large area. DIC has been successfully used by our group to study Cervical Spine Injuries (CSIs). The aim of this study was to assess strain and deformation patterns of cervical specimens under impact loading conditions using DIC. Six porcine cervical spines (containing C2 to C6 vertebrae bodies) were dissected, potted in PMMA bone cement, mounted in an impact cage and tested using a custom vertical impact rig. Impacts were applied via falling mass of 12.86 kg constrained within a linear bearing assembly. A drop height of 250 mm was used producing an impact velocity of 2.2 m/s. Image data was captured with two high-speed cameras and viewer software (Photron Europe Ltd, UK) and digital image correlation of the video data was performed (Vic-3D, Correlated Solutions, USA). The results showed that five out of six specimens demonstrated buckling behaviour, with two specimens presenting visible vertebral fracture injuries in C4 and C5. Higher strains were seen around C4/C5 in most of the specimens, with a mean of 2.4 +/- 1.3 % and peaks of 4%. The pattern of observed deformation, i.e. buckling, is consistent with literature data attributing injury of the cervical spine to this deformation mode. This study illustrated the capability of DIC of analysing fractures in CSIs and re-enforced the theory of injury by buckling.

61. WEAR OF CrN COATED CERVICAL TOTAL DISC REPLACEMENTS IN SIMULATOR TESTS

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Cervical total disc replacement (CTDR) is a surgical intervention indicated for patients suffering from symptomatic cervical pathology and is an alternative, motion preserving, treatment to anterior cervical discectomy and fusion (ACDF). Clinically available bearing combinations for CTDR include metal on ultra-high molecular weight polyethylene (MoP) and less commonly metal on metal (MoM). Wear debris from MoP bearings in orthopaedic implants has been associated with osteolysis and subsequent loosening of the implant, while the cytotoxic effects of MoM wear debris are of clinical concern. Coated implants offer the potential to achieve improved biocompatibility and wear resistance. Three high carbon CoCr bearings for CTDRs were coated with CrN and tested in a six-axis spine simulator for 3 million cycles (Mc) using an ISO testing protocol (ISO-18192-1). The components were assessed every Mc for wear using gravimetric methods and damage using optical and SEM microscopy and energy dispersive x-ray analysis (EDX). The mean wear rate for the CrN-on-CrN bearings at 3Mc was 0.033 mm3/Mc (SD=0.024), which is lower than previously reported for MoM CTDRs and MoP CTDRs. Damage indicative of edge loading was observed on the bearing surface of the convex component and the rim of the concave components. The presence of cobalt in these areas, which may suggest wear through to the substrate, was detected with EDX analysis. These initial findings suggest that CrN coatings for CTDRs are very low wearing but edge loading may compromise the integrity of the coating.

62. OPTIMISING ACETABULAR FIXATION USING A VALIDATED CEMENTED SOCKET MODEL

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The THR is the second most successful and cost-effective surgical procedure of all time. Data shows that hip cup failure is a significant problem. The aim of this study is to improve methods of cemented cup fixation through validation experiments and FEA. Testing was conducted on five Sawbones composite pelves with cemented UHMWPE cups. Each pelvis was instrumented with triaxial strain gauges at four different locations of high predicted strain. Each sample was bolted in a uniaxial testing machine and loaded up to 500 N in the direction of the peak force during walking, for five repetitions. The directional surface strains were used to evaluate the equivalent strain. Specimen specific finite element models were developed based on CT scan data using ScanIP. Each mesh consisted of an average of 2.5 million linear tetrahedral elements and was solved in ANSYS. The experimentally measured strains were compared against the finite element predictions – the mean linear gradients and SD of the mean at each location were: 1.00 (16%), 0.78 (17%), 0.90 (13%) and 1.05 (4%). The agreement between the predicted and experimental equivalent strains was good, but varied across the group. This could be caused either by the variation in mechanical properties, or the sensitivity of the gauges to positioning. This specific methodology of conducting finite element analyses of the pelvis based on CT image data has been validated. Future work is to apply this to a patient specific model, including a bone remodeling algorithm and muscle forces, to optimize the cemented fixation.

63. CLINICAL OUTCOMES AND DISLOCATION RATES AFTER HIP RECONSTRUCTION USING THE BIOBALL SYSTEM

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Instability accounts for one third of revision total hip arthroplasty (rTHA) performed in the United Kingdom. Removal of well-fixed femoral stems in rTHA is challenging with a risk of blood loss and iatrogenic damage to the femur. The Bioball Universal Adaptor (BUA) (Merete, Germany), a modular head neck extension adaptor, provides a mechanism for optimisation of femoral offset, leg length and femoral anteversion. The aim of this study is to present the clinical results and rate of instability following revision with this head neck adaptor at a minimum of two years' follow up. A review of our prospectively collected database was performed. Clinical and radiologic review were performed pre- and post-surgery. The Oxford Hip Score (OHS), Euro-Quol (EQ-5D) score and WOMAC scores were also recorded. Thirty-two rTHA procedures were performed using the Bioball device between 2013 and 2016. Two patients (2/28, 7%) complained of recurrent dislocations following their rTHA procedure. One patient complained of instability but no dislocation. The median pre-operative EQ-5D was 0.195 (range -0.07 to 0.85), OHS was 20 (range 5 to 43) and WOMAC was 29.8 (range 15.5 to 52.3). The median EQ-5D was 0.85 (range 0.59 to 1), OHS was 39 (range 21 to 48) and WOMAC was 91.1 (range 44.5 to 99.2) at final follow up. There were significant improvements in the EQ-5D ($p = 0.0009$), OHS ($p = 0.0004$) and WOMAC ($p = 0.0001$). The Bioball Head Neck Adaptor is associated with significant functional improvement and relatively low dislocation rates in revision THA.

64. PROTEOGLYCAN DIGESTION OF BOVINE OSTEOCHONDRAL EXPLANTS TO IMPROVE IN SITU CHONDROCYTE CRYOPRESERVATION; POTENTIAL FOR IMPROVED JOINT RESURFACING

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Degenerative diseases of articular cartilage (AC), such as osteoarthritis (OA), impair joint function. Effective joint resurfacing is essential in the management of OA, with cartilage transplantation invaluable. However, supply of graft material is limited, in part due to lack of storage options. Cryopreservation, with a cryoprotective agent (CPA), has been tried unsuccessfully due to poor post-freezing cell viability due to poor CPA penetration. We propose digesting AC proteoglycan will improve CPA permeability, and result in increased cell viability. Osteochondral explants (OCEs) were harvested from four skeletally-mature bovine metacarpo-phalangeal joints. OCEs were incubated with papain (0-2mg/ml) for 18 hours to remove AC proteoglycan and then exposed to the CPA DMSO (0-3M; 1-30mins; 37degC; 5%CO_2:95%air). Those exposed to 2.2M DMSO for 15mins were subjected to a freeze (1degC/min) to -80degC, and thawing at 37degC. AC proteoglycan was measured using standard histological techniques (alcian blue), and cell viability was assessed using CMFDA/propidium iodide staining and confocal laser scanning microscopy imaging. Papain digestion reduced AC proteoglycan ($P=0.01$; One-way ANOVA). Incubation with the DMSO only caused cytoxicity at 3M ($P=0.019$ Two-way ANOVA) but no significant difference with increasing exposure times ($P>0.05$ Two-way ANOVA). Cryopreservation was not detrimental to cell viability ($P=0.59$ Two-way ANOVA), with 87.5% of cells surviving freeze-thaw. Exposure of OCE to papain and 2.2M DMSO fort 15 minutes did not affect cell viability. Subsequent freeze/thaw protocol demonstrated a step change improvement in cells survival compared with previous research. This approach to AC cryopreservation may therefore be beneficial for joint resurfacing procedures.

65. MOST PATENTS DO NOT NEED ADDITIONAL POST-DISCHARGE PHYSIOTHERAPY FOLLOWING TOTAL HIP AND KNEE ARTHROPLASTY

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Variation exists in the provision of post-discharge physiotherapy following joint arthroplasty. This study evaluates a 'needs based' system, where patients rehabilitate with home exercises and attend additional out-patient physiotherapy as required. The aim was to determine the rates and impact of out-patient physiotherapy and whether the need for additional therapy could be predicted from pre-operative variables. Methods: 1395 THA patients and 1374 TKA patients performed over a 2 year period were reviewed. Access of post-discharge physiotherapy was reported at 6 months post-op. Linked demographic and outcomes data was accessed. Likelihood ratio regression models were constructed to predict access to out-patient physiotherapy. Results: 493 (35.3%) THA and 662 (48.2%) TKA patients accessed post-discharge out-patient physiotherapy. THA patients accessing physiotherapy were younger (64.9 vs 69.1 years, $p<0.001$) and more likely to be female ($p<0.001$). Patient outcomes ($p<0.001$) and satisfaction ($p=0.001$) were superior in those patients that did not access post-operative physiotherapy. TKA patients accessing physiotherapy were younger (68.2 vs 71.0 years, $p<0.001$) and more likely to live in a less deprived area ($p=0.028$). Patient outcomes ($p<0.001$) and satisfaction ($p<0.001$) were superior in those that did not access post-operative physiotherapy. Pre-operative symptom and demographic data were able to classify accessing of post-discharge therapy with an accuracy of only 17% greater than chance in THA and 7% greater than chance in TKA. Conclusions: Only a third of THA and half of T7KA patients accessed post-discharge physiotherapy. The patients that did not reported superior outcome scores and satisfaction, suggesting variation in requirement for post-arthroplasty physiotherapy. It was not possible to reliably predict which patients would seek access to additional therapy from pre-operative symptom data.

66. INFLUENCE OF FEMORAL HEAD DIAMETER ON GAIT PARAMETERS AFTER HIP ARTHROPLASTY

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Background: Gait analysis has demonstrated that hip resurfacing (HRA) results in more normal gait than Total Hip Arthroplasty (THA). Reasons may include larger, more anatomic head diameters or preservation of the femoral neck thus restoring hip centre and normal proprioception. Methods: We retrospectively analysed the gait of 33 controls and 50 patients with unilateral hip replacement. In 27 hips a small femoral head size was used (<=36mm), in 23 hips a large head size was implanted (>36mm). The small size group included 11 long femoral stem THA and 16 short-stem THA, the large group 5 long-stem THA, 8 short-stem THA and 10 HRA patients. There were 22 females and 5 males in the small size group, 19 males and 14 females in the large size group. Results: Step-length differed significantly between small sizes and controls ($p<0.01$) but not between large sizes and controls. Differences in maximum speed, weight acceptance, push-off, mid-stance, impulse and cadence between groups were not significant. Maximum speed differed significantly ($p=0.021$) between long-stem THA (6.338 km/h±1.542) and HRA (7.756km/h±0.760). Weight acceptance ($p=0.009$) and mid-stance ($p=0.041$) of HRA was better than short-stem THA. Impulse was significantly higher for HRA compared to long-stem THA ($p<0.05$). Males had higher maximum speeds than females ($p=0.017$) and lower gait impulse ($p<0.01$). There was no significant difference in PROMs. Conclusions Gait analysis demonstrated a significant smaller step length in hip arthroplasty patients with a femoral head size <=36mm compared to controls. HRA still revealed higher maximum speeds and better weight acceptance than larger head THA.

67. THE EFFECT OF PELVIC MOTIONS ON THE EDGE CONTACT IN TOTAL HIP REPLACEMENT

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In vitro studies have investigated the effects of adverse conditions, including edge contact, on the tribological performance of total hip replacement (THR) bearings[1]. However, these tests used walking profiles[2] and excluded pelvic motions. The aim of this study was to mathematically analyse the effect of pelvic motions on the position of the contact centre and consequential risk of edge contact during various activities. Gait data from four THR patients (HIP98[3]) which included joint contact forces, the location of joint centres, and acetabular cup orientations. A finite element model of a 32mm featureless hemispheric polyethylene cup was used to obtain contact area from contact force. The profiles for various walking speeds, stairs up and down, standing, chair up and down, and knee bend were tested with and without the pelvic motions. The risk of edge contact was measured as a "proximity angle" between the cup edge and the closest contact area point. The results show that pelvic motions increase the risk of edge contact occurrence, in all subjects for all walking speeds. In the worst case, the proximity angle decreased by 10°. Increased risk was also identified for three patients during stair climbing with consideration of pelvic motions. The proximity angle values for chair activities were substantially affected by pelvic motions but were highly patient-specific. Therefore, pre-clinical testing of THRs specifically to create adverse conditions, such as edge contact, should consider the role of pelvic motion. 1.Al-Hajjar, M., *et al*., J Biomed Mater Res BAppml Biomater,2013.101:.213-22. 2.Paul, J.P., Proceedings of the RSML,1966.59(10):p.943-7. 3.OrthoLoad, 2015, Julius Wolff Institute

68. CONCURRENCE OF CARTILAGE DEGENERATION AND SUBCHONDRAL BONE REMODELLING IN OSTEOARTHRITIC HIP JOINTS

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Introduction: Osteoarthritis (OA) is a degenerative joint disease that affects both cartilage and subchondral bone (SCB). With progression of OA, as results of changes in the loading pattern, bone remodelling and resorption occur[2], which affect the physical environment supporting the overlying cartilage. In this study, we report the changes in local distribution of volumetric bone mineral density (vBMD) with OA and biomechanical properties of the degenerated cartilage to evaluate any concurrence of cartilage degeneration and SCB remodelling. Methods: Human femoral heads (n=4) were collected during total hip replacement operation due to OA. Cartilage was graded using ICRS classification[3], and the mechanical property of cartilage was measured by non-destructive cyclic indentations. To determine the remodelling of the subchondral bone, a peripheral quantitative CT (pQCT) was used to assess the vBMD distribution within the SCB. Non-parametric Kruskal-Wallis was used for statistical analysis with significance level at 0.05. Results and discussion: The examination of retrieved tissues revealed cartilage in different stages of degeneration, from normal to severely abnormal. Subchondral vBMD decreased with cartilage ICRS grade from 576 to 253mg/cm^3 confirming bone remodelling in all samples. Dynamic modulus of cartilage was mapped and showed a weak positive correlation to ICRS grades (3.34±0.93, 2.86±1.11, 4.64±4.37 and 5.56±1.83 N/mm for grade I, II,II and IV respectively), and a moderate positive correlation to subchondral vBMD (r=0.59), confirming the concurrence of cartilage biomechanics, degeneration and SCB remodelling. Financial support by ARUK and Rosetrees Trust is acknowledged. 1. Bhatia, *Pharm Bioallied Sci*, 2013 2. Wright, *Bone Joint Surg Am*, 2014

69. MEASUREMENT AND REPLICATION OF MECHANICAL BOUNDARY CONDITIONS OF THE ACETABULUM AND FEMUR DURING ARTHROPLASTIC IMPACTION

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Appropriate seating of acetabular and femoral components during Total Hip Arthroplasty (THA) is essential for implant function and longevity, both at implant/bone and taper connections. Currently impaction forces and energies used during THA are poorly understood. In-vivo testing is challenging and current literature is sparse. However no current method dictates how to test in-vitro while representing important intraoperative boundary conditions, with testing often carried out using unrepresentative, rigid testing apparatus. This study aims to determine in-vivo conditions and replicate them in a laboratory impaction rig. Bi-lateral THA was performed on 4 soft embalmed full-body cadavers using the posterior approach. An acetabular implant was seated and a custom femoral insert cemented within the intramedullary canal, providing secure fixation to the bone. A custom surgical mallet and introducer were used to measure hammer displacement, introducer displacement and force of hammer strike. Introducer and hammer displacements were transformed to the axis dictated by loading direction. From displacement, hammer velocity was derived and combined with hammer impulse to determine input energy. A voigt model was fitted to introducer displacement in order to determine an effective mass, spring and damping constant of in-vivo boundary conditions. All measured values were used to produce a validated impaction rig. For the first time the mechanical boundary conditions of the acetabulum and femur during hip arthroplasty have been measured and quantified. Low, medium and high THA impaction forces, energies, impulses and velocities were determined. Both sets of parameters are represented in a bespoke testing rig.

70. EVALUATION OF TRABECULAR TISSUE STIFFNESS IN PATIENTS WITH ATRAUMATIC VERTEBRAL FRACTURES

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Atraumatic vertebral fractures (AVF) occur due to compromised trabecular architecture. Little is known about the effects of osteoporosis on tissue mechanical properties, particularly with respect to AVF. The acoustic impedance (Z) obtained from scanning acoustic microscopy (SAM) is an excellent surrogate for tissue stiffness in the probing direction. Transpedicular biopsies were obtained from fractured (FxFx, N=71) and non-fractured vertebrae (Fx, N=53) of the same donors and from non-fractured controls (Ko, N=68). Embedded (PMMA) specimens were scanned with a custom-made SAM using a 100-MHz focusing transducer. The reflection amplitude was measured at each scan point and converted into Z using calibration scans. A probability density functions (PDF) of Z was computed for each scan and four quantification parameters defined (Zlow, Zpeak, Zmean and Zhigh). One hundred scans had to be withdrawn due to small bone tissue area, callus or false section of trabeculae. The final number of PDFs was: Fx (N=26), FxFx (N=26) and Ko (N=40). One-way ANOVA revealed that all PDF parameters were significantly lower ($p < 0.05$) in non-fractured vertebrae (Fx) compared to controls (Ko). The parameters of the fractured vertebrae (FxFx) were also significantly reduced ($p < 0.05$) compared to controls (Ko), except for Zpeak. No significant difference in tissue stiffness between fractured (Fx) and non-fractured vertebrae of the same donors was detected (FxFx). We found that the trabecular tissue of patients with AVF is softer than that of non-fractured controls and different vertebral bodies of the same donors had similar mechanical tissue properties, indicating systemic underlying mechanisms.

71. A NOVEL APPROACH TO INTRAOPERATIVE DETECTION OF PRIMARY BONE CANCER MARGINS USING RAMAN SPECTROSCOPY

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Primary bone cancer is a devastating disease that predominantly affects children and young people. Outcomes of these cancers are poor with a mean 5-year survival rate of less than 60%. Due to major advances in oncology and surgery, functional limb salvage is possible by removing the cancerous bone and replacement with an endo-prosthesis. Intraoperative decision making on providing a safe resection margin during limb salvage surgery is difficult and subjective. Mistakes can lead to incomplete excision marked by local recurrence and metastases. Alternatively, excessive removal of healthy tissue compromises limb function. Currently postoperative histopathology takes around two weeks to assess the success of surgery and validate resection margins. A novel technique that would grant a rapid and objective determination of safe tumour margins at the time of tumour resection in theatre, in addition to classifying tumour type, would be most beneficial. One potential technique is Raman spectroscopy. In this work, we have explored the hypothesis that Raman spectroscopy can be used to detect tumour margins on untreated excised bone in addition to exploring the possibility of tumour type classification using principal component analysis (PCA). So far we have detected tumour margins for osteoblastic, chondroblastic and telangiatatic osteosarcomas. To date we have observed clustering of the different sarcoma subtypes in PCA scores plots, although additional data from further samples is required to confirm the significance of this exciting and translational finding. Furthermore, initial biochemical analyses have highlighted differences in the composition of bone from the different bone cancer subtypes.

72. DOES MORPHOLOGY AND DISEASE SEVERITY FOR HIP OSTEOARTHRITIS CORRELATE TO A TYPE OF GAIT PATTERN?

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Introduction: Hip osteoarthritis (OA) is well known to affect gait. Certain hip morphologies (cam and pincer) are widely accepted risk factors predisposing them to OA. However the literature is not clear if there is a correlation between these morphologies and gait. The aim of this gait study was to determine the effect hip disease severity and morphology has on function. We hypothesised no difference would be seen with varying morphology. Methods: 59 hip OA patients and 35 healthy control subjects were analysed. Patients were allocated radiographically, classifying patients for disease severity and morphology. Tönnis classification was used for severity; alpha and centre-edge angles were measured for cam and pincer morphologies respectively. Participants were analysed on an instrumented treadmill at high speed and inclines. Results: The hip OA patients and control subjects were reasonably matched for gender, age, BMI and height. Both groups had almost identical top walking speeds (7.1 vs 7.0 km/h). However hip OA patients incline walking function posed difficult compared to healthy controls. Greater hip OA severity caused greater walking dysfunction and asymmetry. Discussion: OA of the hip is a degenerative condition of the articular cartilage with high prevalence. We found degeneration leads primarily to pain and to a lesser extent, dysfunction, as observed in the OA group with similar top walking speed. With increasing severity (higher Tönnis score) there is greater shift from the normal joint kinematics during gait, which may affect the biomechanics of the joint and possibly impact on disease progression.

73. CHONDROCYTIC DIFFERENTIATION OF MSCs AND TENOCYTES SEEDED ON DEMINERALISED BONE MATRIX

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INTRODUCTION: Complete Rotator Cuff (RC) tears occur at the enthesis, however repairs fail by 30%-90%. We have previously demonstrated that enthesis regeneration is enhanced in-vivo by using Demineralised Bone Matrix (DBM). We speculate that DBM induces endochondral ossification that leads to the formation of fibrocartilage and mineralized fibrocartilage at the enthesis. Hypothesis: MSCs and tenocytes will differentiate into chondrocytes when seeded on DBM compared with denatured DBM. MATERIALS & METHODS: Sheep tibiae were demineralised using 0.6N HCl. Samples were washed, cut into 1cm discs, freeze-dried and gamma-irradiated (≈27kGy). Half of the discs were heat-treated (55-60°C, 2h) to denature the growth factors responsible for DBM biological properties. MSCs and Tenocytes from n=3 sheep, passage 3-4, were seeded at 30 000 cells per disc. Samples were cultured for 3 weeks (LG-DMEM, 10% FCS) and an Alamar Blue assay was performed to measure proliferation at different times and then discs were processed for wax histology. Collagen II expression was assessed using immunohistochemistry. RESULTS: MSCs and Tenocytes seeded on discs differentiated into chondrocytes, producing collagen II. The collagen II production was greater on non-heat treated discs. Significantly lower ($p<=0.05$) Alamar Blue readings on non-heat treated discs at 1, 2 and 3 weeks suggest a greater differentiation of cells in this group. DISCUSSION: The hypothesis is supported and DBM may potentially lead to the formation of a normal enthesis in regeneration of complete RC tears. Further work is needed to study the influence of different DBM growth factors on chondrocytic differentiation.

74. DEVELOPMENT OF A CADAVERIC MODEL OF VERTEBROPLASTY TO EVALUATE BIOMECHANICAL EFFECTS OF AUGMENTATION VARIABLES

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An estimated 65,000 osteoporotic vertebral compression fractures are reported per annum in the UK, leading to pain, loss of vertebral height and increased risk of adjacent level fracture. Vertebroplasty has allowed reductions in pain experienced for many; however, controversy remains over outcomes including which patient groups benefit most. The aim of this study was to develop an in vitro cadaveric model to understand the relationships between cement fill location and volume with the post augmentation stiffness. Nine human lumbar vertebrae were isolated and tested under axial compression to determine their initial stiffness. Augmentation was then carried out using an oblique approach, to avoid damaging the dense bone where the vertebral body joins the pedicles, with an attempted 20% fill volume. The specimens were imaged under microCT and retested. The change in stiffness of the specimens following augmentation was variable (-11% to +26% of the intact stiffness). The CT images showed considerable variation in the cement location (between the anterior and mid portions), shape (dispersed and concentrated) and volume (between 10% and 42% fill). While clinically this may be aided with the use of fluoroscopy, the precise locations of cement volumes remain difficult to predict. Despite this variability, trends between percentage fill, location, damage caused prior to augmentation and the change in stiffness following augmentation could be seen. Further work is now underway to create and validate computational models of the specimens, enabling parametric analysis of how the variables described above affect the mechanical outcomes of vertebroplasty.

75. IN VIVO EVALUATION OF A NOVEL METHOD TO ISOLATE LOW VOLUMES OF WEAR DEBRIS FROM PERIPROSTHETIC TISSUE

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Joint replacement wear debris limit device lifetime. Current methods to isolate wear debris from tissue often do not allow clear imaging of the particles for analysis. The aim of this research was to test a novel method for isolating low particle volumes from tissue using a rat model. Volumes of 0.018mm^3 of commercial silicon nitride particles or clinically relevant cobalt chromium or titanium particles, generated by pin-on-plate simulation, were injected into the right stifle joint of each rat (N=3) for 7 days *in vivo*. Tissue from treated and non-treated joints was harvested, minced and digested with papain (1.56mg.mL^{-1} and proteinase K (1mg.mL^{-1}, with two subsequent replenishments). Digested protein was removed from particles by density gradient ultracentrifugation using sodium polytungstate (SPT). Residual SPT was removed with further ultracentrifugation and particles were filtered and analysed by SEM coupled with EDX. Imaging software (imageJ) was used to determine size and morphologies (aspect ratio and circularity) of the particles. Particles not subjected to the isolation procedure were analysed for comparison. Particles were recovered from all samples, clearly imaged, and verified by EDX. The particles were absent in non-treated stifle joints. Size and morphologies of cobalt chromium and silicon nitride particles were statistically unchanged by the procedure (KS tests, $p>0.05$). Titanium particles were too few and irregular before and after isolation to statistically analyse, though size and morphologies were similar. Initial particle and tissue quantities were low compared to human samples, demonstrating technique sensitivity. Overall results indicate an improvement to current isolation methods from tissue.

76. IN VIVO BIOCOMPATIBILITY OF SILICON NITRIDE, COBALT CHROMIUM AND TITANIUM WEAR DEBRIS

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To improve joint replacements, low-wearing materials which produce wear debris of increased biocompatibility are required. The aim of this research was to test the biocompatibility of silicon nitride (SiN) particles, in comparison to wear debris of widely used orthopaedic materials 'in vivo'. SiN is of particular interest as its unique dissolution properties may reduce adverse biological reactions to wear debris over time. A relatively high dose (equivalent to 6-12mm^3.70kg^{-1} in humans) of commercial SiN particles or clinically relevant cobalt chromium (CoCr) or titanium particles, generated by pin-on-plate simulation, were injected into the right stifle joint of each rat (N=3) for 7 days 'in vivo'. Rats were euthanised by increasing CO_2 concentration. Treated and non-treated stifle joints were harvested, decalcified using concentrated EDTA, processed and embedded whole in paraffin wax. Serial tissue sections were taken from each stifle joint, stained with haematoxylin and eosin, and observed under normal Köhler illumination. Particles were observed in each sample from each material group, deposited beneath the patella, within the ligament and fat pad, though dissolution of SiN particles may have occurred during the decalcification procedure. Inflammatory cell infiltrates surrounded each material, to a lesser extent in SiN and titanium groups. Necrosis was present in CoCr samples but was absent in SiN and titanium samples. Particles and biological reactions were absent in control, non-treated stifle joints. Results indicate that SiN particles were more biocompatible than CoCr particles. Future work aims to characterise cellular infiltrates and analyse joint changes, including synovial thickening

77. FIXATION OF THE CEMENTLESS OXFORD UNICOMPARTMENTAL KNEE REPLACEMENT

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Background: The Cementless Oxford Knee's tibial component's primary stability depends on interference. Optimal interference guarantees fixation while minimising seating load. Aim: To investigate interference levels and fixation achievable using current instrumentation combinations. Method: Slots were cut into solid polyurethane blocks using: (1) Old blade (n=9), (2) Old blade and pick (n=9), (3) New blade (n=9), (4) New blade and pick (n=9). Slot dimensions were measured to calculate interference with a size C tibial component. This component was pushed into/pulled out of slots using a Dartec materials testing machine and forces measured. A One-way ANOVA compared these forces. Results: Mean interferences were: (1) 1.03mm, (2) 0.97mm, (3) 0.93mm, (4) 1.07mm. Mean push in forces were (1) 1750 N (SD 191), (2) 771 N (SD 382), (3) 1057 N (SD 75), (4) 1191 N (SD 132). The new saw slots required lower push in forces ($p<0.001$) than old saw. The pick reduced push in forces for old saw slots ($p<0.001$) but had no effect on new saw slots. Pull out forces were 1) 205 N (SD46), (2) 90.5 N (SD40), (3) 248 N (SD39), (4) 205 N (SD48). No differences in pull out forces between the old and new blade slots existed. Pick usage after a bumper blade cut reduced the pull out force ($p=0.001$) but not after a non-bumper blade cut. Conclusions: Interference currently ranges from 0.9mm-1.1mm. New blade slots have reduced interference with similar fixation, and reduced push in forces compared to old blade slots, suggesting reduced risk of fracture.

78. THE USE OF FLUROSCOPY AT DIFFERENT ALIGNMENTS FOR MEASURING BEARING WEAR IN THE OXFORD KNEE

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Background: Measuring wear in the Oxford knee is important to compare wear in different types of polyethylene bearings. In vivo bearing wear can be assessed using model-based roentgen stereometric analysis (RSA) or model-based roentgen fluoroscopic analysis (RFA). The accuracy of RSA for measuring bearing wear of the OUKR is 0.1mm. The accuracy of RFA is unknown. Aim: To investigate whether RFA can reliably measure thickness on anteroposterior and lateral images. Method: Anteroposterior/lateral fluoroscopic images were taken of a phantom model with a 3.9 mm thick perspex block between tibial and femoral OUKR components. First an orthogonally aligned anteroposterior/lateral image was obtained followed by adjustment by 1 degree in: (1) External rotation (2) Internal rotation (3) Flexion (4) Extension (5) External rotation and flexion (6) External rotation and extension (7) Internal rotation and flexion (8) Internal rotation and extension. Images were analysed using model-based RFA. Results: Orthogonally aligned anteroposterior/lateral radiographs measured 3.87mm and 3.81mm respectively. Results in the previously numbered positions for anteroposterior images were; (1) 4.08mm (2) 4.02mm (3) 4.22mm (4) 5.61mm (5) 4.03mm (6) 4.08mm (7) 4.07mm and (8) 3.35mm. For lateral radiographs; (1) 5.07mm (2) 3.89mm (3) 3.83mm (4) 3.55mm (5) 3.74mm (6) 4.35mm (7) 3.89mm (8) 3.55mm. Conclusions: Model-based RFA could not measure thickness reliably. One degree deviations in radiographic alignment changed thickness measurements by more than 0.1 mm. The current version of RFA is not accurate enough and further development is needed.

79. AN IN VITRO MODEL OF MAGNETIC TRAPPING OF MESENCHYMAL STEM CELLS FOLLOWING INTRAVENOUS INJECTION

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Background: The specific trapping of cells to sites of tissue damage in vivo is a major challenge and others have shown magnetic trapping in spinal cord injury and heart infarct. The effects of blood on stem cell trapping are unclear due to properties of red blood cells (RBCs). Our aim was to provide an in vitro model to study the magnetic trapping of mesenchymal stem cells (MSCs) at different concentrations of red blood cells. Methods: The flow system developed and used in this study consists of a peristaltic pump and PVC tubing passing over magnets to create a flow circuit. MSCs were labelled with magnetic nanoparticles (MNPs) and then triplicates of one million cells were introduced into the flow system of different concentrations of blood. Cells trapped over the magnet were assessed quantitatively using the PICCO green system. Results: Trapping efficiency was measured at 0%, 1%, 5%, 10%, 20% and 40% RBCs and the results were respectively 54%, 62%, 31%, 37%, 27% and 23% trapped cells. A 2-way ANOVA showed that the application of an external magnetic field to cells labelled with MNPs does allow trapping due to the magnetic interaction. Conclusion: We have shown that mesenchymal stem cells can be magnetically trapped at different concentrations of blood, however, the trapping efficiency is reduced with increased concentrations of blood, and other parameters should be assessed to improve this.

80. LESS IS MORE: THE OPTIMAL DURATION BETWEEN STAGES IN TWO STAGE REVISIONS FOR INFECTION

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Background: Two stage revision is considered the gold standard for managing infected total hip and knee arthroplasties. The aim was to assess the effect of duration between stages on reinfection rate at one year. Methods: A systematic review and meta-analysis was conducted on all studies investigating reinfection rate with documented interval between first and second stage revision. Both total hip (THR) and total knee replacements (TKR) were included but were analysed separately. The effect size of studies was stratified first according to sample size then with study quality. Results: The systematic review included all studies published up until November 2015 including non-English language studies. From 3827 papers initially identified, 38 groups from 35 papers were included (23 THR and 15 TKR). Average study quality was 5.6/11 (range 3-8). Funnel plots were calculated and indicated bias at lower sample sizes in both groups. In the THR group, studies with 3 months or less between stages showed a significantly lower reinfection rate compared to 3-6 months (6.1% 14/229 vs 10.7% 58/541, $p<0.05$). A similar trend was seen in the TKR group (9.5% 21/222 vs 20.7% 28/135, $p<0.01$). Conclusions: There is no consensus in the literature regarding the most appropriate duration between stages in a two-stage revision for infection. Studies stratified by sample size and study quality indicate no additional benefit from delaying second stage surgery past three months for both revision THR and TKR.

81. CORRELATION OF THE RANGE OF MOTION AND FUNCTIONAL PERFORMANCE OF UPPER LIMB IN CEREBRAL PALSY

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Introduction: Upper limb deformities in cerebral palsy greatly affect the children's function of daily activities. Range of motion of upper limb joints is usually limited in children with cerebral palsy. However, there was little evidence on the relation between range of motion and functional outcomes of upper limb in children with cerebral palsy. The purpose of this study was to determine the correlation between the Upper Extremity Rating Scale (UERS) and the Manual Ability Classification System (MACS) and between the UERS and Box and Block Test (BBT). Methods: Fifty-seven children with cerebral palsy were enrolled in this cross-sectional study. The range of motion was rated using the UERS. The ability to handle objects in daily activities was demonstrated using the MACS, and manual dexterity of upper limb was determined using BBT. The more-affected side of each child was evaluated. Correlations were assessed using Pearson's and Spearman's test. Results: The pronation contracture and wrist flexion deformity were commonly found in this study. There were statistically significant correlations found (1) between the UERS and BBT (Pearson's correlation, $r= 0.5188$; $p< 0.0001$) and (2) between UERS and MACS (Spearman's correlation, $r= -0.5217$; $p< 0.0001$) in children with cerebral palsy. Conclusion: This study demonstrated the significant correlation between range of motion and functional performance of upper limb in cerebral palsy. It is suggested that strategies to improve the range of motion of upper limb joints should be emphasised in order to improve the functional performance in children with cerebral palsy.

82. BIOMECHANICS OF TWO EXTERNAL FIXATORS USED FOR LONG BONE FRACTURE FIXATION IN RODENTS

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Due to the rigidity of different fixation methods, it is difficult to accurately compare studies of fracture healing in rodent models. Our aim was to compare the biomechanics of two external fixators in vivo and using finite element analysis (FE) METHODS: ExFix 1 was made of Ti alloy; ExFix 2 was made of PEEK. In an experimental model an osteotomy of 2.75mm was used in a Tufnol replicate of a rat femora. Fixators were tested under compression (40N) and torsion (0.3Nm). A FE model of each fixator construct was developed. The pin-bone interface was modeled as fully fixed or with motion (relaxed conditions). RESULTS: The axial stiffness of ExFix 1 was 29.26N/mm± 3.83 compared to ExFix 2 that was 6.31N/mm± 0.67 ($p<0.05$). The fixed FE model predicted axial values of 79.95N/mm and 31.57N/mm for ExFix 1 and 2 respectively; and under relaxed conditions produced values of 46.12 N/mm and 7.52 N/mm respectively. Torsional stiffness of ExFix 1 was 47.5Nmm/º ± 2.71 compared to ExFix 2 that was 19.1Nmm/º ±1.18 ($p<0.05$). The fixed FEA model predicted values of 98Nmm/º and 50Nmm/º for ExFix 1 and 2 respectively; whilst under relaxed conditions values of 89.8Nmm/º and 27Nmm/º were seen respectively. DISCUSSION: Differences in rigidity between the fixators were seen and should be considered when comparing experimental data on fracture healing. Simulated motion of the pins mirrored the comparative stiffness between the two fixators. A computational protocol that includes motion at the pin-bone interface best predicts the stiffness of different fixators.

83. AUGMENTED REALITY HEADSETS COMPARED WITH CONVENTIONAL TRAINING TO DELIVER TECHNICAL SKILLS IN HIP ARTHROPLASTY: A RANDOMISED CONTROLLED

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Background: Accurate implant orientation is associated with improved outcomes after artificial joint replacement. We investigated if a novel augmented-reality (AR) platform (with live feedback) could train novice surgeons to orientate an acetabular implant as effectively as conventional training (CT). Methods: Twenty-four novice surgeons (pre-registration level medical students) voluntarily participated in this trial. Baseline demographics, data on exposure to hip arthroplasty, and baseline performance in orientating an acetabular implant to six patient-specific values on a phantom pelvis, were collected prior to training. Participants were randomised to a training session either using a novel AR headset platform or receiving one-on-one tuition from a hip surgeon (CT). After training, they were asked to perform the six orientation tasks again. The solid-angle error in degrees between the planned and achieved orientations was measured using a head-mounted navigation system. Results: Novice surgeons in both groups performed with a similar degree of error prior to training (AR: 14.2°±7.0°, CT: 15.7°±6.9° ($p>0.05$)). After training, average error was 10.7°±5.8° for AR participant and 7.2°±4.4° for CT participants. The average improvement per student was 3.5°±7.2° and 8.5°±8.0° respectively ($p>0.05$). Conclusions: A novel AR platform delivered training for acquiring skills to orientate an acetabular cup implant. After one session, novices trained by a hip surgeon outperformed those trained using AR. In both groups, accuracy remained below 'expert' level proficiency (<5° error). Further investigation is required to evaluate if novices retain skills, continue to improve with further training, and can transfer this to clinical practice.

84. FRACTURE ANGLE INFLUENCES PRIMARY HEALING OF DISTAL FEMORAL FRACTURES BEING TREATED WITH LESS INVASIVE LOCKING PLATE

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Introduction: In the treatment of fractures, it is recognised that primary bone healing through osteonal remodelling requires a rigid fixation with a less than 0.01mm interfragmentary motion. This study uses finite element (FE) analysis to investigate the influence of fracture angle on primary healing in distal femoral fractures treated with unilateral locking plates. AO classification does not differentiate between fractures with different angles with respect to the transverse plane. Methods: FE models of laterally implanted femur with different fracture angles were developed. Axial loading corresponding to a single-legged stance phase was applied. Healing was estimated using interfragmentary motion. Results: For -20°, 0° and 20° cases, the maximum gap openings are relatively small; most of the area is satisfied by the healing criterion. For larger fracture angles, -60°, -40° and 40°, the maximum gap openings are significantly larger than 0.01mm, most of the gap area is beyond the healing criterion. The study also found that healing is influenced not only by the magnitude if the fracture angle but also by its direction. Conclusion: The fracture angle orientation changes the biomechanical environment to which primary healing is sensitive and should be included when considering treatment options.

85. THE ASSOCIATION OF NERVE CONDUCTION WITH FUNCTIONAL MOVEMENT ABILITY IN PATIENTS WITH LOWER LIMB OSTEOARTHRITIS

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Background: Lower limb instability may be linked to increased risk of falls in the elderly. It is proposed that neuromuscular impairments and poor lower limb control are associated with falls, particularly in osteoarthritic patients. The purpose of this study was to determine the correlation of nerve conduction (NC) with joint position sense (JPS), muscular power output (PO), balance, and functional ability. Method: Fifteen patients (female = 6; age = 68±7.11) with unilateral hip or knee OA were recruited from surgical pre-assessment clinic. Skin-surface NC tests were performed on the peroneal nerve of the non-affected leg to generate motor latency and amplitude, and F-wave data. JPS was examined about the knee with eyes open and closed. PO was measured in both legs during unilateral leg extension using the Nottingham Power Rig. Balance ability was assessed using the 14-task Berg Balance Test (maximum score 56). Functional ability was determined through the Aggregate Locomotive Function Test (ALF), which included timed get-up-and-go, stairs ascent and descent, and 8m walk. Scores were associated using a Pearson's Correlation. Statistical significance was set at $p<0.05$. Results: No significant correlations were found between NC (motor latency = 4.16±0.70 ms; motor amplitude = 3.20±1.84 mV; F-wave latency = 53.91±8.38 ms) and any variables measured. Balance scores (49.8±4.3) were also not significantly correlated with other measures. Summary: Impaired NC in osteoarthritic patients was expected to be associated with decreased proprioception, PO, balance and locomotive function. However, skin-surface measures of NC were not effective in elucidating neuromuscular and functional movement insufficiencies.

86. EFFECT OF MULTIPLE TESTING REPETITIONS ON THE MECHANICAL PROPERTIES OF THE INTERVERTEBRAL DISC

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In vitro testing is widely used to further our understanding of the mechanical properties of the spine. Many studies compare the effect of different parameters, such as frequency, on the behaviour of the spine by retesting the same specimen. However, retesting a specimen will result in fluid flow from the intervertebral disc (IVD), which may cause a change in mechanical properties between tests. The aim of this study was to investigate the change in stiffness of the IVD when tested over a 4h period, by repeating a test five times. Tests were performed on 12 porcine lumbar specimens at a frequency of 0.1Hz under 400N preload. Half the samples were tested using displacement control and the other half using load control, at equivalent loading amplitudes. Data was not normally distributed, therefore the Kruskal-Wallis test was performed to compare the main diagonal stiffness coefficients for the first test and the additional four repetitions. No statistically significant difference in stiffness was present, except for tests performed under displacement control in anterior-posterior shear ($p=0.012$) and lateral bending ($p=0.013$). Additional Mann-Whitney tests showed the difference in stiffness was between the first test and the consecutive repetitions, with no significant difference between the four repetitions. For a study that consists of more than one test per specimen, load control is recommended to ensure no variation in stiffness over time, however the data may have more spread. Additionally, the change in stiffness over time may be influenced by the frequency, preload, loading amplitude and testing environment.

87. DBM SOLUBLE FACTORS INDUCE CHONDROCYTIC DIFFERENTIATION OF MSCS IN-VITRO

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Introduction: Growth factors associated with Demineralised Bone Matrix (DBM) induce endochondral-ossification in-vivo (Urist 1965), but their concentration varies depending on the method of production and sterilisation as well as donor related factors (age and medical history). Aim: To test the different concentrations of soluble factors from DBM. Hypothesis: Higher concentrations of soluble factors will induce greater chondrocytic differentiation of MSCs in-vitro. Materials and Methods: Ovine tibiae from 3 sheep were demineralised (0.6N HCl), freeze-dried and powdered using a cryo-mill. After gamma irradiation the soluble factors in DBM powder were extracted in 50mls of LG-DMEM (37ÂC, 48h) to produce media a. Serial dilutions of a were prepared: b=a/2, c=b/2, d=c/2, e=d/2, f=e/2. MSCs from n=3 sheep (passage 3-4) were cultured (20 000 cells/cm^2) for 3 weeks using a-f. Collagen II expression was assessed by immunohistochemistry. DNA quantification and Alamar-Blue assays were performed at day 1, 4 and 7. Data were analysed using non-parametric testing. Cells morphology was assessed by light-microscopy at 24h and 1 week. Results and Discussion: All media solutions with DBM soluble factors induced chondrocytic differentiation and had higher DNA content compared with the Controls (no DBM) ($p<=0.05$). Normalized Alamar-Blue was lower for a, b and c compared with Control ($p>0.05$). This may suggest greater differentiation in a-c. At 24h all groups (including Control) had stem-cell morphology however at 1 week, cells in media with DBM soluble factors (a-f) adopted a more rounded chondrocytic cell shape.

88. RADIOGRAPHIC APPEARANCE OF MALE AND FEMALE CAM-TYPE FEMOROACETABULAR IMPINGEMENT

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Cam-type femoroacetabular impingement (FAI) can cause hip osteoarthritis due to abutment of the cam against the acetabulum. Female cams are reported to be smaller than males[1], suggesting gender-related radiographic characteristics may exist. This study aimed to investigate this hypothesis using statistical shape models (SSMs) and patient specific 3D surfaces created retrospectively from volumetric CT data. The study group contained scans from male (n=41) and female (n=26) cam-FAI patients, and the control group comprised n=22 male and n=20 female participants. Researchers were blinded to the origin of the scan/3D model data, and on the 3D surfaces where cams were observed, the underlying radiographic appearance was categorised as cortical thickening, subcortical lucency or extracortical bone, and these were classified as study group participants. Male and female SSMs were subsequently created for each category. Cortical thickening was observed in 48% of female cams, extracortical bone growth was observed in 45% of male cams, and subcortical lucency was observed in both genders. In total, 89% of the 3D surfaces were classified into the group they had been recruited into (study/control), and visual analysis of the SSMs supported previous findings that female cams were generally smaller than male cams. The results support the hypothesis that gender-related radiographic characteristics may exist. This could explain the cam morphology differences previously observed in males and females and may have important implications for improving the clinical outcome of cam-type FAI, particularly in females who may be at risk of being underdiagnosed/treated. 1. Groves D *et al*. ISHA. USA, 2016.

89. ESTABLISHING AND VALIDATING AN OSTEOPOROTIC MODEL USING JUVENILE BOVINE TIBIAE

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Introduction: Osteoporosis is the most common bone disease, contributing to nine million fractures annually worldwide. Models of osteoporosis can be expensive and hard to create. Human specimens require ethical approval and have higher variability than animal specimens; alternatives such as artificial bone models fail to adequately represent animal and human bone properties. Previously, an osteoporotic model using bovine vertebrae has been created using acid demineralisation. However, no long bone model of osteoporosis has been created using these techniques. Aim: To establish and validate a model of osteoporosis using juvenile bovine long bone. Methods Juvenile bovine long bones were sectioned and quantitatively CT scanned to assess volumetric bone mineral density (vBMD). Twelve 15 mm sections were placed into control solution and into three hydrochloric acid concentrations (0.6 M, 1.2 M and 2.4 M). Tensile testing of samples was performed using 3.5 mm cortical screws, tested axially at 5 mm/min until maximum force was demonstrated. Independent one-way ANOVA, with Tukey adjustment for post-Hoc comparisons were used. Results: The vBMD of juvenile bovine long bones was 1.90±0.07 g/cm3 (mean±SD), with insignificant differences between the four diaphyseal regions (range: 1.88+/-0.08 to 1.93 +/-0.08 g/cm^3 (p=0.17-1)). Demineralisation produced significant ($p<0.005$) reductions in vBMD with decreases of 23%, 32% and 38% for 0.6 M, 1.2 M and 2.4 M respectively; with significant reductions in pullout force at all acid concentrations. Discussion: Juvenile bovine bone provides a suitable model for biomechanical and osteoporosis research. Significant reductions in vBMD and pullout force are produced using acid demineralisation, creating a validated model for osteoporosis research.

90. DIFFERENCES IN THE METABOLIC PROFILE OF HUMAN VERSUS POOLED BOVINE CALF SERUM FLUID

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Introduction: Metabonomics has developed into a powerful tool for studying metabolic disease, environmental exposure, nutrition and cancer. Studies of osteoarthritis and synovial fluid using these techniques have been sparse and frequently reliant upon animal models. Typically, pooled bovine calf serum (BCS) has been used as a substitute in prosthetic model testing and also as a model for human synovial fluid. Our aim was to examine the differences in the molecular constitution of human synovial fluid and compare this to the BCS model. Method: 110 synovial fluid samples were collected from patients undergoing hip/knee aspiration, knee arthroscopy, hip/knee arthroplasty & revision arthroplasty. 10 samples of pooled BCS were also used. Nuclear Magnetic Resonance (NMR) data was acquired and a multivariable logistic regression including age and gender was used to examine any correlation with NMR findings and the tested variables. Multivariate analysis was performed using Principle Component Analysis (PCA). Results: Data demonstrated a significant difference ($P<0.05$) in the metabolic profile of human vs pooled BCS. A spectrum of metabolites were found to be responsible and consistently different. Conclusions: Pooled BCS has been used as a substitute for human synovial fluid and also in prosthesis testing. Our findings show that the pooled BCS model is significantly different in terms of the small molecule composition. This finding raises significant questions upon the validity of pooled BCS as a suitable model for human synovial fluid.

91. STAFF AWARENESS OF INTIMATE PARTNER VIOLENCE (IPV) IN ORTHOPAEDIC PATIENTS

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Background: International literature reports a 32-36% lifetime prevalence of intimate partner violence (IPV). Guidelines recommend that staff be trained to identify vulnerable patients, but it is unclear how well educated staff are. The aim was to quantify how much orthopaedic staff know about IPV and the support available. Methods: Orthopaedic staff in several national centres completed an anonymous online survey. Respondents from a variety of domains including medical, nursing, and physiotherapy participated. Results: There were 121 respondents with an average 10 years' experience. Most respondents predicted a 2-5% prevalence of IPV in orthopaedic patients. 49% of respondents had never treated a patient who was a known victim of IPV. Doctors and nurses were equally likely to have cared for IPV patients (50% vs 56%), but doctors thought abuse was less common (41% 15/37 doctors predicted 1-2% prevalence of IPV compared to 12% 7/58 nurses, $p<0.01$). 74% of respondents reported asking patients about abuse (77/104) but only 24% (29/121) knew about the support available. Staff who didn't know about available support were less likely to ask about abuse (46% 12/27 vs 22% 17/77, $p<0.05$). 74% of respondents felt it was important/very important to ask about IPV. Conclusions: This is the first study investigating IPV in UK orthopaedics. Less than a quarter of staff knew about available support and those who did not know were less likely to ask patients. Orthopaedic staff are well placed to identify vulnerable patients and need more training on how to manage a disclosure of abuse.

92. PROXIMAL HUMERUS FRACTURES: RELIABILITY OF NEER VERSUS AO CLASSIFICATIONS ON PLAIN RADIOGRAPHS AND COMPUTED TOMOGRAPHY

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Introduction: Several classifications for proximal humerus fractures exist, with excellent reliability being desirable. We aimed to, a) Compare the reliability and clinical utility of Neer (original 16, abbreviated 6-type) and AO classifications, and b) assess plain radiograph (XR) reliability of classifications based on computed tomography (CT). Methods: Single-centre retrospective study identifying trauma proximal humerus fractures between Feb 2016-Feb 2017. Neer 16-type, Neer 6-type and AO classifications were used. Intra- and inter-observer reliabilities were obtained using Kappa co-efficient, and comparison of classifications using CHI squared ($p < 0.05$ significant). Results: Twenty-two patients were included. Mean age was 62 years (SD 14.5). Management changed in 9/22 patients based on CT. Computed tomography changed Neer-16 type in 16% observations, Neer-6 in 10% and AO in 23%. This was significant when comparing Neer-6 and AO classifications ($p = 0.04$). Neer-6 had best inter-observer reliability (0.737) with management of one patient changing after CT. On XR and CT, Intra-observer agreement was substantial, >0.7, using Neer-16 and Neer-6 ($p<0.005$). Inter-observer agreement for Neer-16 and Neer-6 was substantial, >0.7 ($p<0.005$). In comparison, intra and inter-observer agreements for AO were lower on XR and CT, 0.4-0.6, ($p<0.005$). Conclusion: Our study showed significantly higher reliabilities using Neer classifications compared to AO. Neer-6 is significantly more clinically accurate and reliable than AO. The authors recommend using Neer classification for reliability and reproducibility in proximal humerus fractures.

93. CAPSULAR LIGAMENT FUNCTION AFTER TOTAL HIP ARTHOPLASTY

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Background: The hip joint capsule passively restrains extreme range of motion (ROM), protecting the natural hip against impingement, dislocation and edge loading. These functions would be advantageous following total hip arthroplasty (THA), thus we investigated if capsular biomechanics were preserved following THA. Methods: In vitro, THA was performed through the acetabular medial wall preserving the entire capsule, avoiding targeting a particular surgical approach. Nine hips were examined and capsular function was measured by rotating the hip in five positions. Three head sizes (28, 32, 36mm) with three neck lengths (restored native 0, +5, +10mm) were compared. Results: ROM increased following THA, indicating late engagement of the capsule and reduced biomechanical function ($p<0.05$). Internal rotation was affected more than external. Increasing neck length restored ROM more towards the native condition, but too much lengthening over-constrained external rotation. Increasing head size had a small beneficial effect. Conclusions: Following THA, the capsular ligaments were unable to wrap around the femoral head to restrain excessive hip movement. This inhibited the posterior capsule more than the anterior, indicating native posterior capsule preservation is not advantageous. Decreased neck length could cause capsular dysfunction, whilst increased neck length could over-tighten the anterior capsule. Clinical relevance: Increased understanding of soft tissue balancing following THA could help prevent instability, a frequent and long-standing THA complication. This study illustrates how the capsule will function according to its preservation or repair following THA.

94. UNDERESTIMATION OF STAPHYLOCOCCUS AUREUS CARRIAGE ASSOCIATED WITH STANDARD CULTURUING TECHNIQUES

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Nasal carriers of methicillin sensitive Staphylococcus aureus (MSSA) have an increased risk for health-care associated infections. There is currently no national screening policy for the detection of MSSA in the UK. This study aimed to: evaluate the diagnostic performance of molecular and culture techniques in MSSA screening, determine the cause of any discrepancy between the diagnostic techniques, and model the potential effect of different diagnostic techniques on MSSA detection in orthopaedic patients. Paired nasal swabs for PCR assay and culture of S. aureus were collected from a study population of 273 orthopaedic outpatients due to undergo joint replacement surgery. The prevalence of MSSA nasal colonisation was found to be between 22.4-34.4%. The current standard direct culturing methods for detecting S. aureus significantly underestimated the prevalence ($p=0.01$), failing to identify its presence in 1/3 of patients undergoing joint replacement surgery. Modelling these results to national surveillance data, it was estimated that 800-1100 MSSA surgical site infections could be prevented annually in the UK by using alternative diagnostic methods to direct culture in pre-operative MSSA screening and eradication programmes.

95. RHEUMATOID ARTHRITIS AND THE RISK OF ADVERSE OUTCOMES FOLLOWING JOINT REPLACEMENT: EVIDENCE FROM ROUTINELY COLLECTED DATA

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The aim of this study was to assess the association between rheumatoid arthritis (RA) compared to knee/hip osteoarthritis (OA) and the risk of adverse events following total knee and hip replacement (TKR and THR). A cohort of individuals diagnosed with RA or OA who received a TKR or THR were identified using primary care linked to hospital records (CPRD linked to HES). Risks of myocardial infarction or stroke (CVD), venous thromboembolism (VTE), infection and mortality were estimated over 90 days following surgery and risk of revision over 10 years. Cox models were adjusted for age at surgery and gender. 10,767 individuals who received TKR and 11,212 who received THR informed the analysis. Up to 90 days following surgery, RA was associated with odds ratios of 2.57 (95% confidence interval of 1.26 to 5.27) and 1.69 (0.67 to 4.26) for CVD for TKR and THR respectively; 1.15 (0.58 to 2.32) and 0.70 (0.31 to 1.60) for VTE; 1.81 (0.53 to 6.17) and 3.17 (0.89 to 11.3) for infection; and 0.94 (0.29 to 3.04) and 3.10 (1.47 to 6.54) for mortality. Across 10 years post-surgery, RA was associated with odds ratios of 0.62 (0.39 to 1.00) and 1.42 (0.94 to 2.14) for revision. RA was associated with increased risk of CVD following TKR and mortality following THR. In addition, although not statistically significant, estimated risk of infection was substantially higher for individuals with RA following both procedures while risk of revision was lower after TKR but higher following THR.

96. THE EFFECTS OF EXPERIMENTAL CONDITIONS ON THE STRUCTURAL AND MATERIAL PROPERTIES OF PORCINE PATELLAR TENDON

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Several studies have performed mechanical characterisation of tendinous/ligamentous tissues under varying experimental conditions. The effect of freeze-thaw and strain rate is understood however the effect of tissue hydration is disputed and freezing pre-dissection vs post-dissection is not widely reported. The aim of the study was to validate experimental testing conditions of future human ligaments. Twenty-four porcine patellar tendon bone-ligament-bone specimens were dissected, placed into small independent groups (n=3) and tested using an Instron E10000 under a range of experimental conditions including differing number of freeze-thaw cycles, strain rates, hydration levels and specimen storage conditions identifying the effects on the structural and material properties. Freezing pre-/post-dissection had no significant effects on the structural and material properties. Both higher strain rates (100%.s^{-1}) and submerged in, rather than sprayed with, phosphate-buffered saline, resulted in the transition point between the toe and linear region to be extended and elevated for both structural and material results. The toe-region elastic modulus was on average 31% larger for specimens submerged in rather than sprayed with phosphate-buffered saline. Mid-substance failure occurred for 51.8% of specimens, where typically some weak fibrous attachment remained after failure, and an avulsion of the patellar enthesis occurred for the remaining 48.2%. Strain rate effects are an important observation for future human ligament testing of sprain scenarios. Although slightly limited by the intrinsic variability of soft tissues the results suggest that neither tissue hydration nor freezing pre-/post-dissection have a significant effect on structural and material properties of ligamentous tissue.

97. THE USE OF ARTHROCENTESIS IN THE MANAGEMENT OF TEMPOROMANDIBULAR DISORDERS

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Background and Aim: Temporomandibular disorders (TMD) is divided into arthritic, internal derangement and myofascial relating to whether the joint itself, the articular disc or the muscles of mastication are affected, respectively. This often results in pain and limited jaw function. Management of the arthritic and internal derangement subgroups is conservative at first. If patients fit the appropriate selection criteria, then surgical techniques, including arthrocentesis can be used as part of a stepwise approach. This can help by removing inflammatory mediators, readjusting intra-articular pressure, and through manual manipulation of the joint. We report our experience of arthrocentesis of the Temporomandibular Joint (TMJ) in 70 patients diagnosed with internal derangement and/or arthritic TMD. Method: Prospective data collection took place between 01/2015-12/2016. The patients' self reported pain scores were measured before surgery and at 4-6 weeks post-operative using a Visual-Analog-Scale (VAS) from 0 (no pain) to 100 (worst possible pain). This included; - The amount of pain the patients felt at rest, on movement and on chewing - Mouth opening pre and post-operatively - The effect TMD had on patients' quality of life Results: On average the postoperative pain scores decreased by 12 VAS points at rest and 17 on function. The patients' average quality of life score improved by 20 points. The extent the patient could open their jaw increased on average by 3mm. Conclusion: This approach appears to be benefitting patients with internal derangement and/or arthritic TMD with regards to reduced pain, improved jaw function and quality of life.

98. PREDICTIVE FACTORS INFLUENCING COMPLICATIONS AND LENGTH OF STAY IN FRACTURED NECK OF FEMUR PATIENTS

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Purpose: To explore predictors to longer length of stay (LOS) in patients following hospital admission with fractured neck of femur (#NOF). Methods: A retrospective review of 50 patients admitted to Central Manchester Foundation Trust with #NOF, was conducted. The aim being to explore if any of the pre-existing co-morbidities had a predictive link to post-operative complications and increased LOS. Results: 52% of patients had a LOS greater than the national average of 21 days at that time. 42% of patients with a medical admission in the past 12 months had increased LOS (>21 days) and 81% risk of post-operative compilations. Only 15% of patients with a length of stay less than 21 days had a previous admission in last 12 months. 22% of patients with a pre-existing respiratory condition developed postoperative chest Infections. 66% of patients with pre-existing chronic kidney disease developed acute renal failure post-operatively. 48% of patients had a LOS over 21 days due to non-medical factors with 41 % awaiting intermediate care. Conclusion(s): Pre-existing medical co-morbidities that were active and significant enough to require admission to hospital in the past 12 months, were key indicators of post-operative complication and increased LOS, particularly respiratory and renal conditions. Implications: It is our recommendation that patients with co-morbidities requiring admission to hospital in the past 12 months have early optimisation input from physicians within the specialty of their co-morbidity as a priority. Using previous admission to predict and correctly manage potential complications should reduce morbidity, mortality and subsequent LOS.

99. OPERATIVE vs NON-OPERATIVE MANAGEMENT OF ANTERIOR CRUCIATE LIGAMENT (ACL) INJURIES IN ADULTS- A SYSTEMATIC REVIEW

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Anterior cruciate ligament (ACL) rupture is the most common cause of acute, traumatic haemarthrosis of the knee. A rupture of the ACL compromises the stability of the knee in active individuals resulting in chronic instability, recurrent injury, and associated intra-articular pathology. Aim: To compare the operative and non operative management of ACL injuries in adults and to determine which management is most effective in the treatment of these injuries. Methods: A Systematic review was undertaken. Studies that compared operative versus non-operative management of acute anterior cruciate ligament injuries above the age of 17 years were included. Electronic databases were searched including EMBASE, MEDLINE, CENTRAL, in addition to grey literature by hand search, conference and meeting proceedings and trial registries. Study selection, data extraction and analysis and quality assessment were done by two authors and later discussed to arrive at a common consensus. 215 studies were identified during the search and after various exclusions 3 studies were included which satisfied the criteria with a total of 388 patients. Discussion: All three studies did not have an exclusive non operative group to compare with operative intervention. Two studies followed outdated surgical techniques. One study randomised their patients well and they could not find any significant differences in the change of KOOS scores after 2 years. Conclusion: No conclusive evidence to suggest that one intervention is better than another due to many limitations involved in studies, and none actually compared a strict operative versus non-operative intervention.

100. SYNOVIAL FLUID COMPOSITION AND WEAR OF ARTIFICIAL JOINT IMPLANT MATERIALS

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Artificial joints are essentially tribological devices where the bearing surfaces articulate under load, thus they are susceptible to problems of high friction, wear and corrosion which can contribute to early failure. Surface wear of joint materials is partly determined by the properties of the synovial fluid (SF) lubricating film forming during articulation, however SF properties vary potentially affecting risk of failure. The objective of this study was to measure wear properties of human SF compared to model SF compositions. Human SF has been procured along with a database containing patient's clinical information and any factors possibly affecting the properties. A small scale rubbing test was developed to investigate effect of SF properties on CoCrMo wear. Test solutions include human SF and 25% Bovine Calf Serum as a reference. FTIR surface analysis is used to investigate the chemistry of organic deposits formed during rubbing. By combining these results an understanding of the lubrication and wear process is gained. In some cases high wear volumes have been recorded for patient SF which is not predicted by the reference fluid (25%BCS). These results are being correlated with different patient cohorts to understand the effect of pathology and composition and whether this correlates with wear. By collating this unique set of results we can then begin to ask ourselves the questions; do certain synovial fluid chemistries/diseases promote wear and risk of revision? Can we identify optimum material combinations for specific chemistries allowing surgeons to make an informed choice to reduce the risk of revision?

101. PLAN OF INVESTIGATION TO STUDY A CHEMOTACTIC RESPONSE OF MSCs TO SILICATE-SUBSTITUTED HYDROXYAPATITE

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Compared with phase pure stoichiometric hydroxyapatite, silicate-substituted hydroxyapatite (SiHA) has an enhanced stimulatory effect on bone regeneration in vivo. However, it is unclear through which mechanism(s) such an effect is brought about. One possible route would be increased recruitment of cells to the graft site. The aim of this project will be to investigate the effect of SiHA granules with 80% total porosity and 20% strut porosity on the migration of primary bone marrow MSCs. The ion exchange of calcium, phosphate and silicate, sequestering and enrichment of native signalling molecules in proximity to SiHA will be measured. Using a modified transwell migration system, the effect of chemotactic factors, such as BMP and TGF-α, in the presence of SiHA on cell migration, proliferation and differentiation will be determined. This will be done under static conditions using 50, 100 and 150mg of SiHA granules over a 24 hour period. Measurements will be taken at 7 time points with n=6 per time point. The same parameters will be measured under dynamic conditions using an in-house 3D flow to waste perfusion system containing 450mg of SiHA over 14 day period with measurements taken every 24 hours, n=4 per time point. CT scan data demonstrates that 25% of the perfusion chamber is occupied by SiHA granules. Due to high ion concentrations in basal media, ionic exchange data indicates little variation occurring over time. Further work is underway.

102. MRI VASCULAR MARKS AND OSTEOARTHRITIS

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A previously undescribed pattern of veins in upper tibial MRI scans was observed. We studied the frequency, depth and distribution of the marks. Plain x-rays of the same knees were scored for OA. 56 patients with an antero-posterior knee x-ray and an axial PD_SPAIR MRI scan of the same knee within one year were included. Their mean age was 53.1 years (range 22- 85) with 27 males and 29 females. The medial and lateral compartments of each knee were scored for OA by Kellgren-Lawrence grading. Veins were counted by layer and quadrant position. The axial scans were 3mm thick slices spaced 0.3mm apart. The upper slice was taken as the first slice showing only cancellous bone. The marks appeared to be venous, were present in the first subchondral slice, peaked between 6-10mm and were absent by 16mm depth. There were more marks antero-laterally than postero-medially. There was no association with age, left or right knee, BMI or weight. There was a strong inverse correlation between the number of marks and the grade of osteoarthritis both medially (p=0.001) and laterally (p=0.002). We demonstrate previously undescribed subchondral veins on MRI scans of the upper tibia. They are present in healthy bone but are lost in early osteoarthritis. The onset of osteoarthritis is closely associated with loss of these veins. This offers a new means of earlier diagnosis of OA and an insight into the aetiology of osteoarthritis.

103. CAN TASK-ORIENTATED REHABILITATION IMPROVE KNEE FUNCTION AND SATISFACTION IN PATIENTS 12 MONTHS AFTER KNEE REPLACEMENT SURGERY FOR OSTEOARTHRITIS?

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Total knee arthroplasty (TKA) usually relieves pain in end-stage osteoarthritis, but some patients are disappointed with their mobility, possibly resulting from an abnormal gait pattern. Post-operative physiotherapy following TKA is essential, although little consensus exists regarding longer-term rehabilitation. Typical rehabilitation has an internal focus on specific muscles or joints, but task-orientated rehabilitation (TOR) may be more effective. To test the hypothesis that TOR can improve gait quality and quantity and therefore patient satisfaction following TKA. A cohort of 76 patients was studied 12 months after TKA surgery during follow up at the Royal National Orthopaedic Hospital, Stanmore. Patient satisfaction was assessed using the Oxford knee Score (OKS) and gait characteristics were measured using inertial measurement units (IMUs). A subset of 21 patients, exhibiting abnormal gait, entered a 4-week TOR programme, based on daily walking and stair climbing. Patients were then re-assessed with OKS and IMUs, and gait quantity compared pre- and post-intervention using pedometers. Statistical analyses were performed using SPSS Version 22. OKS showed a significant negative correlation with hip, thigh, knee and calf range of motion in the sagittal plane for both the operated and non-operated limb suggesting that patients who are least satisfied are walking with shorter steps. Multiple regression analysis showed that stride duration significantly predicted OKS (p<0.0001). OKS also showed a significant positive correlation with knee flexion in stance in the non-operated limb (p<0.01) and knee flexion in swing in the operated limb (p<0.01). Following TOR, 21 patients exhibited a statistically significant increase of 3.5 points in OKS (p=0.001), a decrease by 0.06 seconds in stride duration (p=0.02), and for the operated leg an increase in thigh, knee, and calf sagittal range of motion (by 2.6°, p=0.005; 3.4°, p=0.009; 4.0°, p=0.0001 respectively), and knee flexion in stance (by 4.9°, p=0.0001). A significant increase in these parameters for the non-operated leg was also recorded. The results indicate that there is scope to improve rehabilitation of patients after TKA. TOR has the potential for improving gait quality and satisfaction in patients.

104. WHAT ARE THE RESULTS OF MINIMALLY INVASISVE PLATE OSTEOSYNTHESIS FOR FEMORAL AND TIBIAL COMMINUTED FRACTURES?

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Aim: Comminuted fractures happen frequently due to trauma and accidents. Recently fixation without opening the fracture site known as Minimally Invasive Plate Osteosynthesis (MIPO) has become prevalent. Due to lacking accurate, evidence-based outcomes on comminuted fractures, we performed this study to assess the results and complications of this way of treatment for tibial and femoral comminuted fractures. Methods: In this cross-sectional study 60 patients were treated with MIPO. 11 patients excluded due to lack of adequate follow-ups. Data including union time, infection in the fracture site, hip and knee range of motion and any malunion or deformities like limb length discrepancy were collected after the surgery from every patient in every session. Results: 32 and 17 femoral tibial fractures were evaluated respectively. In 48 patients, union was fully completed. Mean union time was 18.57±2.42 weeks. Femur fractures healed faster than tibia (17.76±2.36 and 19±2.37 weeks, respectively). None of our patients suffered infections or fistula. The range of motion in hip and knee remained intact in all of our patients. Malunion happened in 3 patients, 10-degree internal rotation in 1 patient and 1 centimeter limb shortening in 2 patients. Conclusion: According to the result of this study, it can be drawn that MIPO is a simple and effective method of fixation for comminuted fractures of long bones. It has a high rate of union with minimal complications. Infection is rare, and malunion or any deformity is incredibly infrequent. MIPO appears to be a promising and safe treatment alternative for comminuted fractures.