

## 23.6

### Confined perfusion increases the tissue quality of large size tissue engineered constructs

S. Concaro<sup>1</sup>, F. Gustavsson<sup>2</sup>, A. Lindahl<sup>3</sup>, P. Gatenholm<sup>4</sup>, M. Brittberg<sup>5</sup>;

<sup>1</sup>Ort, Sahlgrenska University Hospital, G, Sweden, <sup>2</sup>Department of Biopolymer Technology, Chalmers institute of technology, Göteborg, Sweden, <sup>3</sup>University, Gothenburg, Göteborg, Sweden, <sup>4</sup>Biopolymer Technology, Chalmers University of Technology, Göteborg, Sweden, <sup>5</sup>Orthopaedic Department, Cartilage Research Unit, G, Kungsbacka, Sweden

**Purpose:** The aim of this study was to evaluate the effect of confined perfusion on the ECM synthesis of human adult chondrocytes cultured in large size chitosan scaffolds and to explore basic methods to monitor the metabolic activity of the cultured cells.

**Methods and Materials:** Human chondrocytes were seeded into chitosan scaffolds (15 cm<sup>2</sup>). The constructs were cultured statically for two days and after this period direct perfusion was initiated in the dynamic group. The mass flow was calculated. pCO<sub>2</sub>, pO<sub>2</sub>, Bicarbonate, PH, and oxygen saturation levels were recorded and compared to determine if there were differences after perfusion of the constructs. After day 14 days the 3D scaffolds were evaluated using histology and the results were semi quantified using the Grogan score.

**Results:** During the period of evaluation there was a significant difference between the different metabolic parameters evaluated. The levels of pCO<sub>2</sub>, pO<sub>2</sub>, Bicarbonate, PH, and oxygen saturation were affected by the cell metabolism thus increasing or decreasing. We found considerable histologic differences between the perfused and the static group. The perfusion group showed viable cells with abundant matrix production and areas of early chondrogenic differentiation. The static group showed cell necrosis and no matrix production.

**Conclusions:** Confined perfusion increased the quality of the tissue engineered constructs. A defined media with low concentrations of TGF B allowed differentiation under the described experimental conditions. It is possible to monitor the metabolic activity of the constructs using non destructive assays.

## 23.7

### The wear-resistance of repaired human articular cartilage

M.J. Furey<sup>1</sup>, M. Brittberg<sup>2</sup>, H.P. Veit (deceased)<sup>3</sup>, N.A. Steika<sup>4</sup>;

<sup>1</sup>Biomedical Engineering & Science, Virginia Polytechnic Institute & State University, Blacksburg, VA, United States of America, <sup>2</sup>Orthopaedic Department, Cartilage Research Unit, G, Kungsbacka, Sweden, <sup>3</sup>Pathobiology, Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, VA, United States of America, <sup>4</sup>Design, Automation Creations, Inc., Blacksburg, VA, United States of America

**Purpose:** How well does the repaired cartilage resist wear? How long will it last? To address the questions, a collaborative study was carried out using a biotribologic device and techniques designed to measure wear and friction of cartilage specimens in sliding contact against polished stainless steel.

**Methods and Materials:** Sixteen 2 mm diameter biopsy specimens taken from the knee joints of eight Swedish patients. Two samples, one from the repair and one from „normal“ surrounding cartilage, were taken from each patient who had undergone either Autologous Chondrocyte Implantation (ACI), abrasion arthroplasty, mosaicplasty, carbon fiber induced repair, or spontaneous repair. Wear tests were carried out using a modification of a biotribology device to accommodate the small specimens involved under reciprocating sliding against polished stainless steel at 22C, 6.08N applied load, (1.94 MPa average pressure), 30 cycles/sec., 1.6 cm amplitude, and 3-hour duration using a buffered saline solution as the lubricant. At the end of a test, cartilage wear debris was collected from the washings as well as from any transferred material to the disk. Cartilage wear was determined from hydroxyproline analysis.

**Results:** The ACI specimens produced less wear than that obtained with „normal“ cartilage from the same joint. Other repair methods produced higher wear with the wear ratio of repaired/normal varying from 1.2 to 3.4. In line with our past experience, there is no correlation between cartilage wear and friction. Low friction does not mean low wear.

**Conclusions:** In considering the cartilage wear data from a statistical viewpoint, the authors suggest caution in making sweeping generalizations due to the limited number of specimens tested. However, we have demonstrated that it is indeed possible to carry out „in vitro“ human cartilage wear studies under controlled conditions--the first, to our knowledge.

## 24.3

### Simultaneous acquisition of morphology and quantitative T2 values in patients after microfracture in the knee using a Double Echo Steady State (DESS) approach at 3 Tesla

G.H. Welsch<sup>1</sup>, T.C. Mamisch<sup>2</sup>, S. Marlovits<sup>3</sup>, T. Hughes<sup>4</sup>, M. Deimling<sup>5</sup>, S. Trattnig<sup>6</sup>;

<sup>1</sup>Center Of High Field Mri, Medical University of Vienna, Vienna, Austria, <sup>2</sup>Orthopaedic Surgery, Inselspital, University of Berne, Berne, Switzerland, <sup>3</sup>Vienna, Austria, <sup>4</sup>Mri, Siemens Medical Solutions, Erlangen, Germany, <sup>5</sup>Medical Solutions, Siemens Medical Solutions, Erlangen, Germany, <sup>6</sup>Radiology, Medical University Vienna, Vienna, Austria

**Purpose:** Cartilage repair procedures demand for advanced MR sequences. Here a fast Double Echo Steady State (DESS) permits accurate analysis of cartilage morphology in the knee joint. Based on the theory of Bruder et al., the simultaneous acquisition of two MR contrasts within the DESS sequence, T<sub>2</sub>~ values can be calculated from the combined image. In this study we used those combined possibilities of the DESS sequence and compared it to a standard T<sub>2</sub>~ multi-echo spin-echo (SE) sequence in patients after cartilage repair procedure using microfracture technique (MFX).

**Methods and Materials:** 15 patients after MFX underwent 3T-MRI (Trio, Siemens, Erlangen, Germany). 3D DESS imaging and SE T<sub>2</sub> imaging was performed. For comparability, imaging parameters in terms of field of view and resolution were kept identically. T<sub>2</sub>~ maps were calculated for both techniques and sites of cartilage repair tissue and healthy appearing cartilage were compared using region-of-interest assessment. Statistical analysis of variance for differences between groups and correlation of both T<sub>2</sub>-techniques on the coefficient level of Pearson was achieved.

**Results:** We found a significant correlation between both quantitative T<sub>2</sub>-measurement methods in healthy and MFX areas (p<0.05). Mean T<sub>2</sub>~ values [ms] in MFX areas compared to sites with healthy cartilage were significantly decreased using our new T<sub>2</sub>~ DESS approach and the standard T<sub>2</sub>~ SE technique (p<0.05).

**Conclusions:** T<sub>2</sub>~ mapping based on a DESS sequence correlates with standard SE T<sub>2</sub>~ mapping. Hence the presented DESS option gives the opportunity to combine morphological and functional imaging in one clinical sequence to assess cartilage and cartilage repair tissue.

## 24.4

### Femoral condylar-tibial plateau angle correlates to cartilage lesion in knee osteoarthritis at an early stage

M. Kobayashi<sup>1</sup>, Y. Nakagawa<sup>1</sup>, Y. Okamoto<sup>1</sup>, K. Nishitani<sup>2</sup>, H. Kuroki<sup>3</sup>, T. Nakamura<sup>4</sup>;

<sup>1</sup>Orthopaedic Surgery, Kyoto University, Kyoto, Japan, <sup>2</sup>Orthopaedic Surgery, Graduate school for Medicine, Kyoto University, Kyoto, Japan, <sup>3</sup>Department Of Physical Therapy, School of Health Sciences, Faculty of Medicine, Kyoto University, Kyoto, Japan

**Purpose:** To explore the radiographic parameters that correlate well to the severity of cartilage lesion in early stage of knee osteoarthritis (OA).

**Methods and Materials:** Twenty-four patients (29 knees) who had medial knee pain and demonstrated radiographically mild knee OA were retrospectively reviewed. All patients underwent arthroscopic knee surgery and the severity of articular cartilage damage was graded 0-IV by International Cartilage Repair Society grading (ICRS grading) system. Tibio-femoral OA stage was graded by Kellgren-Lawrence grading (K/L grading) using plain radiographs. Using standing antero-posterior radiograph, femoro-tibial angle (FTA), tibial plateau-tibial shaft angle (TP-TS), femoral condyle-femoral shaft angle (FC-FS), femoral condyle-tibial plateau angle (FC-TP), medial joint space narrowing (LC-MC) were measured. And from coronal plain MRI, medial displacement (subluxation) of medial meniscus was graded as 0-4.

**Results:** Eighteen knees were grade as K/L-1 and 11 were as K/L-2. And in 18 knees graded as K/L-1, ICRS grade was widely distributed from 0 to IV. Average FC-TP angle of the knee whose maximum ICRS grade either at medial femoral condyle or medial tibial plateau was ICRS-III or IV was significantly higher (3.3±1.7°) than ICRS-0, I, or II (1.5±1.0°) (P=0.009). Average FC-TP/FTA in the knees with ICRS-III or IV was significantly higher (0.018±0.009) than ICRS-0, I, or II (0.008±0.005) (P=0.009). Subluxation of medial meniscus was not significantly correlated to ICRS grading.

**Conclusions:** K/L grading does not always reflect severity of cartilage lesion in early stage OA. Attention should be paid to the symptomatic knee with larger FC-TP angle even though the radiological grading of OA is not so high.