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Intraoperative acoustic evaluation of living cartilage of the elbow and knee during mosaicplasty for osteochondritis dissecans of the elbow

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Purpose: Autologous osteochondral mosaicplasty for osteochondritis dissecans of the capitellum (OCD)is being used increasingly in adolescent patients. The purpose of this study is to evaluate the living articular cartilage of the elbow and knee and to examine the validity of the mosaicplasty for elbow OCD.
Methods and Materials: We studied 10 young males with OCD who underwent mosaicplasty. All patients were baseball players. Using an acoustic probe and our wavelet transform method, we measured three parameters of acoustic properties: signal intensity (index of cartilage stiffness), signal duration (index of cartilage roughness), and signal interval (index of cartilage thickness).
Results: The cartilage of the radial head had significantly lower signal intensity and higher signal duration than other sites. The cartilage of the OCD lesion had a lower signal intensity compared with the intact part. Although the macroscopic view showed that the cartilage surface was nearly intact in all patients, the signal intensity was significantly lower in cartilage of the radial head in late stage patients than in early stage patients or intact part of the capitellum. The acoustic properties did not differ significantly between the plug and the intact part of the capitellum.
Conclusions: This study demonstrates the acoustic differences of the cartilage between the capitellum, radial head, and knee. To prevent further cartilage damage, early detection of OCD is important. After fixation of the plug, the condition of the plug and intact part of the cartilage was similar. We found no particular problems associated with transfer of the osteochondral plug from the knee to the capitellum

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Osteochondral autologous transplantation surgery (OATS) in lapin models

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Purpose: Osteochondral autologous transplantation surgery (OATS) is used to treat isolated cartilage defects. In-vitro studies suggest the impact force used in OATS can cause chondrocyte death. The objective of this project is to determine the degree and type of chondrocyte death (necrosis or apoptosis) following OATS in a lapine model.
Methods and Materials: Twenty New Zealand White rabbits underwent unilateral OATS procedures and 10 underwent bilateral sham surgeries. A 2.7mm diameter, 4.0mm deep osteochondral plug was harvested from the right medial femoral condyle and impacted into a defect created in the left medial femoral condyle. Fifteen animals were sacrificed immediately (10 OATS0 and 10 Shamo limbs), 15 were sacrificed at 4 days (10 OATS4 and 10 Sham4 limbs). Cartilage degeneration was determined using modified Mankin Scores, chondrocyte viability/necrosis was determined using cell vital stains, and chondrocyte apoptosis was determined by TUNEL assay. Statistical analyses were performed using Student's t-test and two-way ANOVA with significance level 0.05.
Results: There were higher modified Mankin Scores in the OATS groups compared to the Sham groups at both 4 days and time zero (OATS4=2.8±1.1 vs Sham4=1.0±0.6, p=0.003; OATS0=1.6±1.1 vs Shamo=0.0±0.0, p=0.002). The OATS4 group had fewer viable chondrocytes (51.6±11.6%) as compared to the Sham4 group (74.2±5.1%. p=<0.001). A similar decrease in cell viability was found in the OATS0 group (63.3±7.2%) compared to Shamo (81.0±5.0%, p=<0.001). There were more TUNEL positive cells in OATS4 group (27.8±9.6%) compared to all other groups (p<0.001).
Conclusions: This study suggests the OATS procedure results in significantly more chondrocyte necrosis and apoptosis compared to controls.

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Tissue engineering combined with mosaicplasty technique to promote healing and integration of the osteochondral defects

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Purpose: To explore a new method combining BMSCs-mediated tissue-engineering and mosaicplasty technique, for repair of osteochondral defects and integration of gaps.
Methods and Materials: Autologous BMSCs from 18 goats were cultured and proliferated in vitro. Prior to cells harvest, osteochondral defects with 5mm in diameter and 3mm in depth, were created in the femoral medial condyle of both hind limbs. When the osteochondral autograft transplantation (mosaicplasty) was performed, the BMSCs, which had been harvested and compounded with hyaluronic acid, were injected into the gaps between osteochondral autografts. The defects which only received mosaicplasty served as blank control, and those received mosaicplasty plus hyaluronic acid injection served as negative control. At 2, 4, 8 and 16 weeks post-operatively, samples were harvested and assessed by histological evaluation, immunohistochemical analysis and glycosaminoglycan(GAG) quantification.
Results: The cartilage autografts in all groups survived with hyaline cartilage and represented no significant difference with surrounding native cartilage. In BMSCs group, the gaps disappeared and were replaced by regenerated hyaline cartilage; in control groups, the gaps were replaced by fibrous tissue or fibrous cartilage and still distinct. Immunohistochemical analysis of typeII collagen and aggrecan showed positive staining in the regenerated gap cartilage in BMSCs group. Alcian-blue method also confirmed a significant less GAG content in the regenerated tissue in gaps of control groups than in that of BMSCs group and in normal cartilage.
Conclusions: The strength of this study was to resolve the gaps integration and improve cartilage healing effect. BMSCs-mediated tissue-engineering combined with mosaicplasty could be an ideal way for osteochondral defects repair.

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Articular cartilage repair using in situ polymerizable hydrogel implant in osteochondral defects

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Purpose: Bioactive and biodegradable materials in an osteochondral defect can promote the repair of the articular cartilage surface through induction and synchronized implant biodegrading. We applied a biodegradable hydrogel made from PEGylated fibrinogen and polyethylene glycol (PEG) to an osteochondral defect in a sheep knee joint. The high composition of PEG relative to fibrinogen provided a non-porous structure with slow surface-based biodegradation matching the healing response of the osteochondral injury.
Methods and Materials: Four osteochondral defects (6-mm dia.) were created in the weight bearing zone of the femoral condyles of skeletally mature sheep and the acellular implants were polymerized in situ. The cartilage regeneration was assessed after six months and one year follow-up.
Results: Defects treated with the hydrogel implant exhibited regeneration of articular cartilage and bone around the eroding implant after 6 months. Empty defects exhibited fibrocartilage and excessive scar tissue formation. The extent of biodegradation of the implanted hydrogels was dependent on the ratio of PEG to fibrinogen; hydrogels with more PEG exhibited slower biodegradation. Histological sections stained for type II collagen and proteoglycans showed characteristic staining of hyaline cartilage above the newly formed boney bridge overtop the eroding implant. The implants were completely degraded from the injury site after one year follow-up.
Conclusions: We speculate that the fragments of fibrinogen released from the proteolytically degradable hydrogels induce mild but sustained normal tissue healing around the implant for several months. Our results underscore the importance of synchronizing the proteolytic responsiveness of the non-porous implant with the normal healing kinetics of the osteochondral injury.