Single Site Osteochondral Resurfacing – An in vivo Caprine Study

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Introduction:
Focal cartilage defects not caused by osteoarthritic changes are a common clinical finding. Repair of these often traumatically induced lesions has been and continues to be challenging. Current surgical options range from debridement and lavage, osteochondral autograft transplantation, mosaicplasty while others focus on stimulating repair from the subchondral bone such as microfracture, abrasion and drilling. These treatments typically provide short-term pain relief, however long-term healing is often characterized by a fibrocartilaginous repair with poor integration to the host tissue that often leads to chronic pathological consequences. This study reports long-term results of an evaluation of a novel, bi-phasic scaffold used to treat a single site osteochondral defect in a load-bearing area of the caprine stifle joint.

Materials & Methods:
For this study, 24 skeletally mature female nubian cross goats with an average weight of 55 kg were utilized. Unilateral stifle arthrotonies were performed and 6 x 6 mm osteochondral defects in the central weight bearing aspect of the medial femoral condyle were created using a trephine tool (Figure 1). Fourteen defects were treated with the implant, a bi-phasic scaffold consisting of type I collagen with a composite of β-tricalcium phosphate and polylactic acid (Kensey Nash Corporation, Exton, PA), which was hydrated with autologous bone marrow aspirate prior to being press-fit into the defect using a customized insertion tool (Figure 1). The remaining 10 defects were left empty to act as controls. All of the goats were placed into either 6, 12, or 18 month survival groups.

Figure 1: (a) 6 x 6 mm osteochondral defect created on the medial femoral condyle of the caprine stifle. (b) Implant press-fit into osteochondral defect.

Radiographs were obtained pre- and post-operatively, and again at end term, which were scored blindly. Lameness evaluations were carried out and scored for the duration of the study. At the designated time points, animals were sacrificed and a complete necropsy was performed prior to harvesting tissues of interest. Soft tissues examined histologically, included regional lymph nodes and organs. All stifles were examined grossly and surface morphology of the articular surfaces was evaluated with India Ink before histological and immunohistochemical evaluation. Repairs were evaluated histologically by a blinded reviewer using a modified O’Driscoll scoring system. Pre-operative data for all groups and all scored characteristics were analyzed using analysis of variance.

Results:
All goats underwent surgery and completed the study without complications. There was no difference between the pre-operative data for either group. There was no local or systemic deposition of foreign material from the device within any animal. At the 6 month time point, control and treated defect histology scored 8.3 and 14.6, respectively (out of 25) with treated defects having a greater intact articular cartilage surface. All control defects had subchondral bone cysts and cartilage defects. There was no evidence of device migration on post-operative radiography. There was a trending towards smoother hyaline cartilage grossly as well as significantly less degenerative changes histologically compared to controls (p=0.02). Lameness and radiographic scores were not significantly different between either group post-operatively. There was no significant difference in the histological scoring of the 12 month defects. The treatment group had an overall higher score (17.2) than the control group (15.5). At the 18 month time point the treated group, with a histology score of 19.1, demonstrated repair cartilage similar to normal articular cartilage. Immunohistochemical evaluation showed Type II collagen expression in treated group repairs in 6, 12, and 18 month time points. Control stifles showed a greater expression of Type I collagen in the repair tissue.

Discussion:
Osteochondral defects treated with a novel biphasic cartilage repair device underwent repair more rapidly than control defects. This was evidenced by formation of smoother cartilage at 6 months post-operatively. No systemic or local inflammation occurred in response to the device, demonstrating that it can be implanted in vivo without causing an adverse immunologic response. Subchondral bone defects were evidenced in all control stifles. From 6 to 18 month time points, there was a decrease in the size of areas in which the bone continued to remodel and the device was being resorbed. Histological evaluation of this device at the longer 12 and 18-month time points confirmed the trend of rapid repair as well as the durability and sustainability of the repair seen at 6 months. Immunohistochemical analysis further demonstrated the quality of the repair with no evidence of fibrosis or fibrocartilaginous repair in the repaired regions of the articular cartilage plate. This research evaluated a novel cartilage repair device in a large animal model and demonstrated the device to produce a more rapid repair of the articular surface, with that repair being maintained out to 18 months. These results warrant further evaluation of this resorbable scaffold for the treatment of focal osteochondral defects.

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References: