**CARTILAGE REMODELING AFTER INTRA-ARTICULAR FRACTURE**


**Introduction:** In the treatment of intra-articular fracture, restoring the normal contours of the joint without interrupting the blood supply of the subchondral bone or causing excessive scar tissue around the ligaments and capsule of the joint has been the primary concern for orthopaedic surgeons. Although cartilage defects do not heal with replacement of the hyaline cartilage, nondisplaced fractures of the articular surface remain congruent whereas displaced articular fractures form an incongruent joint surface that appears to cause changes within the cartilage to adapt to the altered load. Pertinent clinical questions include: how successful is the remodeling to a given deformity of the articular surface, by what mechanism is the cartilage altered to improve the congruency of a displaced articular surface, and is there a critical displacement in terms of distance and geometry (gap and step) that will adversely affect the patient’s outcome? The purpose of this study was to evaluate histologic and mechanical changes across a joint after a small intra-articular osteotomy of the tibia in a sheep weight bearing model to determine the mechanism by which cartilage increases congruency during fracture healing.

**Method:** An intra-articular step-off was created in medial tibial plateaus of the knees of 12 adult, domestic sheep after IRB approval. A sagittal osteotomy was made through the middle of the weight-bearing surface, displaced distally by one mm and rigidly fixed. Four animals were sacrificed at six weeks; the others at twelve weeks. All animals were labelled with oxytetracyline (50mg/kg) and calcein (12 mg/kg) 9 and 11 1/2 weeks after surgery. The knees were loaded in a MTS machine using pressure sensitive film to record joint contact pressures. The articular surfaces were sectioned and prepared for both decalcified and non-decalcified histology as well as imaging by scanning electron microscopy.

**Data Analysis:** A repeated measures analysis of variance was used to determine whether significant differences existed between any of the three groups tested in the pressure study: control, time zero osteotomy and 12 week post-osteotomy. Fisher’s PLSD test was used to establish significant differences in the mean values at p < 0.05.

**Results:** The knees with an intra-articular step-off had two major contact areas with an intervening zone of reduced load corresponding to the edge of the depressed fragment (arrow Fig. 2). Histologically, coronal sections through the articular surface demonstrated the presence of thinning and fibrillation on the high side of the step-off and some compensatory hypertrophy of the cartilage at the edge of the low side (Fig 3). No significant remodelling was seen in the subchondral bone. The rate of bone production was 1.85 µm/day on the low side and 1.67 µm/day on the high side of the osteotomy. Scanning electron microscopy demonstrated partial cartilage remodeling by deformation of the high side cartilage to partially overlap the low side cartilage and by bending of the vertical collagen fibrils on the high side cartilage even in the unloaded state (Fig 4).

**Conclusions:** In this animal model, a one millimeter intra-articular step-off caused a net loss of contact area. Examination by both light and electron microscopy revealed morphologic changes suggesting compensation by the cartilage, although incomplete, to accommodate the height discrepancy. **Significance:** Although the maximum amount of acceptable incongruity has not yet been established, this study provides a useful animal model of cartilage remodeling after intra-articular fracture.

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