Cartilage Degeneration in the Goat Knee caused by Treating Localized Cartilage Defects with Metal Implants

**Introduction**

Currently, the surgical treatment of localized cartilage defects has its limitations. Alternatively, localized cartilage defects may be treated with small biocompatible metal cartilage tacks. The purpose of this study was to investigate the safety, in terms of effects on opposing cartilage, of using defect-size femoral implants in a 1-year follow-up goat-model.

**Materials and Methods**

In 13 Dutch milk goats, a medial femoral condyle cartilage defect (Ø 5.0 mm) was created in both knees in the weight bearing area. These defects were randomly left untreated or treated by placing an oxidized zirconium (OxZr) or cobalt-chromium (CoCr) implant (Ø articulating surface 5.0 mm; fixing pin of 13.5 mm in length). Six un-operated knees served as a control for baseline cartilage metabolic and histological parameters. The animals were sacrificed after 1 year. The joint was evaluated macroscopically (Macroscopic Articular Joint Evaluation1). Cartilage quality was analysed macroscopically using the Macroscopic Cartilage Score2 and microscopically using the OARSI Osteoarthritis Cartilage Histopathology Assessment System3 (OOCHAS, including subchondral bone) and the modified Histological Histochemical Grading System4 (HHGS, not including subchondral bone). Cartilage repair was scored macroscopically using the Cartilage Repair Score5 and osseointegration was measured by automated histomorphometry6. Cartilage proteoglycan incorporation was determined by 4 hours incubation in the presence of 35SO4 after which the explants were cultured for another 72 hours in the absence of 35SO4. Incorporation of radiolabelled GAGs was measured by liquid scintillation analysis of tissue digests. GAG release and total GAG content of explants were measured by Alcian blue assay of conditioned medium and tissue extracts, respectively (Figure 1).

![Figure 1](image1.png)

A. CoCr (left) and OxZr (OxZr) implant.  
B. Scheme of sample harvesting

**Results**

One goat was excluded from the study due to an intra-articular infection (CoCr implant). The remaining implants showed a bone-implant contact of 39.5 ± 9.9 % (OxZr) and 42.3 ± 11.1 % (CoCr)(p > 0.05) and a bone formation surrounding the implant of 51.0 ± 4.6 % for OxZr and 51.1 ± 6.6 % for CoCr, which also was not significantly different (p > 0.05). The mean cartilage repair score of the defects was 13.3 ± 1.0 out of a maximum of 24 points. Macroscopically and microscopically, empty defects and implants caused considerable damage to the articulating cartilage of the medial tibia compared to the untreated control knees (p < 0.05) (Figure 2). 35SO4 incorporation was lower in the cartilage of the lateral tibia and medial femur of untreated knees or knees treated with implants as compared to healthy control knees and GAG release was higher at these locations (p < 0.05) (Figure 3).

![Figure 2](image2.png)

A. Macroscopic articular joint evaluation.  
B. Microscopic cartilage score (OOCHAS).  
C. Macroscopic cartilage score.  
D. Microscopic cartilage score (HHGS).

![Figure 3](image3.png)

A. 35SO4 incorporation (expressed as nmols incorporated per hour per gram wet weight of the cartilage tissue).  
B. GAG release (calculated from the total amount of GAG released into the medium and the total GAG content of the explants after 72 hours).

**Conclusions**

One year after treatment of a critical-size cartilage defect with a small metal implant, made of either OxZr or CoCr, macroscopic and microscopic cartilage degeneration was observed of the opposing articulating medial tibial cartilage, similar to the damage caused by untreated defects. Additionally, also the lateral tibial and medial femur showed signs of biochemical degeneration. Osseointegration of implants was good. Although one single time point after treatment was evaluated, the current study demonstrates that the use of defect-size implants needs further development to make this a therapy of choice for the long-term treatment of local cartilage defects.

**References**