Fixation of Hydroxyapatite Coated Revision Implants is Improved by Cracking the Sclerotic Bone Rim

Introduction
Revision joint replacement implants have shorter longevity, poorer functional outcome, higher costs, and longer rehabilitation times than primary implants. In previous studies, we showed that fixation of revision implants was significantly improved with a low energy surgical technique that locally disrupts (cracks) the sclerotic bone rim that typically forms during the process of aseptic loosening (1,2). Hydroxyapatite (HA) coated implants are osteoconductive and may be used in revision surgery. We hypothesized that the revision procedure to locally crack the sclerotic bone rim followed by insertion of HA coated implants will increase the mechanical fixation and osseointegration compared with HA coated implants using a standard revision procedure.

Methods
Following approval of the Animal care and use committee, we implemented our previously established controlled revision protocol in 8 mongrel dogs (3). Specifically, for 8 weeks in the 16 knees a 6.0 mm loaded polymethylmethacrylate (PMMA) implants axially pistoned 0.5mm concentrically in a hole, surrounded by a 0.75mm gap. The implants were in the presence of PE (0.5 – 50µm; 0.5 x 108; 85% < 12µm). At a second operation at eight weeks, one of two surgical techniques was used to insert revision HA porous coated implants into the revision cavity (Fig. 1).

Fig. 1. Experimental protocol.
Standard revision procedure (left): The fibrous membrane is removed, the sclerotic surface is cleaned and lavaged, and a porous coated HA implant is inserted. The implant is constrained to be stable. Crack revision procedure (right): Following the same procedure to remove the fibrous membrane and lavage the sclerotic endosteal surface, an 8.2 mm (outer diameter) tool with 12 evenly spaced 0.2 mm pointed splines is axially advanced (with hammer blows) over a guidewire into the revision cavity, thereby producing controlled cracking and local perforation of the sclerotic endosteal rim. Following this procedure, an identical stable porous coated HA implant is inserted.

Results
No infections were seen. Results from push-out testing and histomorphometry are seen in Table 1 and Figure 2 respectively.

Discussion
This current study demonstrates that cracking the sclerotic bone rim markedly improves revision implant fixation of HA coated implants. The cracking procedure results in significant two-fold increases in revision implant fixation (shear strength, stiffness and energy absorption). Bone ongrowth was significantly increased and fibrous tissue fixation markedly reduced. HA coated implants are osteoconductive and known to stimulate bone ongrowth and prevent fibrous fixation. The results of this study show that the sclerotic bone rim created during aseptic loosening reduces the osteoconductive effect of HA. The positive effect of the rim cracking technique is likely due to increased access to blood supply and growth factors. These studies indicate that the local perforation of the sclerotic rim is beneficial and suggests that it should not be left intact during revision surgery. The new technique of local perforation of the sclerotic rim is bone sparing and represents an alternative to complete removal of the sclerotic rim by reaming.

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