INTRODUCTION
Revision hip replacement implants have poorer clinical outcome than primary implants. The fixation of the implants is often compromised by the formation of an endosteal sclerotic bone rim during the process of aseptic loosening. The cracking procedure is a bone sparing, low energy surgical technique which produces a controlled local perforation of the sclerotic bone rim.

In previous studies, we showed that fixation of revision implants significantly improved by the cracking technique for both titanium (Ti) and hydroxyapatite (HA) coated implants with and without the use of bone graft(1). In this study we compared the cracking technique with the common technique of reaming, which completely removes the sclerotic bone rim. We hypothesized that the crack revision procedure would result in superior mechanical fixation of titanium implants compared to those inserted with the reaming procedure.

METHODS
Following approval of the Animal Care and Use Committee, we implemented our established controlled revision protocol in 10 mongrel dogs (2). Briefly, in 20 knees a 6.0 mm loaded polymethylmethacrylate (PMMA) implants axially pistoned 0.5mm for eight weeks. The implants surrounded by a 0.75mm concentric gap and were in the presence of PE (PMMA) implants axially pistoned 0.5mm for eight weeks. The implants dogs (2). Briefly, in 20 knees a 6.0 mm loaded polymethylmethacrylate (PMMA) implants axially pistoned 0.5mm for eight weeks. The implants surrounded by a 0.75mm concentric gap and were in the presence of PE (PMMA) implants axially pistoned 0.5mm for eight weeks. The implants dogs (2).

At a second operation at eight weeks, one of two surgical techniques was used to insert revision Ti porous coated implants into the revision cavity. Following both procedures the cavity was irrigated with 10 cc saline, suctioned and a stabilized 6.0 mm porous coated Ti implant was inserted.

Animals were euthanized and specimens obtained after 4 weeks. Mechanical push-out tests (5.0 mm/min) were performed on 3.0 mm transverse sections of the implants (MTS Mini Bionix 858, Eden Prairie, MN). Ultimate shear strength, apparent shear stiffness and energy absorption were calculated from force-displacement curves. Data was compared using Students’ paired t-test. Significance for two-tailed test was p<0.05.

RESULTS
One animal had clinical signs of joint infection in one knee at the time of revision surgery and was excluded from the study. Results from push-out testing are seen in Table 1.

<table>
<thead>
<tr>
<th>Revision technique (n=9)</th>
<th>Shear Strength (MPa)</th>
<th>Energy abs. (J/m²)</th>
<th>Stiffness (MPa/ mm)</th>
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<tbody>
<tr>
<td>Cracking</td>
<td>1.3 ± 0.3</td>
<td>170 ± 47</td>
<td>6.7 ± 2.0</td>
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<tr>
<td>Reaming</td>
<td>0.34 ± 0.2</td>
<td>50 ± 29</td>
<td>1.6 ± 0.9</td>
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</table>

Table 1 Results from push-out test, presented as mean and standard error of mean. *p<0.05,**p=0.07.

DISCUSSION
This study demonstrates that cracking of the sclerotic bone rim improves the mechanical fixation of Ti revision implants compared to a reaming procedure. Shear strength and stiffness was consistently higher for all implant pairs, while in seven of nine implant pairs the cracking technique had markedly higher total energy absorption.

We have previously demonstrated that the sclerotic bone rim is a barrier for bone ingrowth and that implants inserted with an intact sclerotic bone rim will have a poor biomechanical fixation. We have also shown that revision implants inserted with the cracking technique obtained a mechanical fixation comparable to non-revision, primary implants.

Reaming procedures are often used in hip revision surgery. However, as loss of bone stock is a common feature of revision cavities, the reaming procedure may not always be an optimal preparation method of the bone. Excessive removal of bone by reaming (for example with conical reamers) may compromise the long term implant stability or increase the risk of peri-implant fractures.

The cracking technique may be an alternative or supplemental procedure to reaming. The technique provides access to the vascular compartments which seems necessary for bone ingrowth, and at the same time it minimizes the removal of bone.

The cracking procedure can clinically be performed with simple tools such as a curved osteotome, however more standardized tools are under development.

Although these experimental implants and procedures are clinically based, the results of this study must be interpreted with the constraints of this particular loaded experimental revision protocol. The primary focus is improvement of metaphyseal and acetabular fixation of uncemented revision implants. We recognize that some revision implant systems for the femur component are exclusively based on distal fixation.


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