LOCAL ALENDRONATE TREATMENT INCREASES FIXATION OF IMPLANTS INSERTED WITH BONE COMPACTION. 12 WEEKS CANINE STUDY

INTRODUCTION:
Early implant fixation is important for long-term survival of total joint replacements. In previous studies, we showed that a new bone preparation technique, bone compaction, enhanced early implant fixation in vivo [1,2]. The bone compaction technique compacts the cancellous bone before the implant is inserted. Hereby an autograft with osteoconductive properties surrounding the implant is created. It would be of interest to investigate whether preservation of the autograft by the use of alendronate further increases implant fixation by means of osteoconduction. Alendronate is a bisphosphonate that can inhibit bone resorption. We hypothesized that local alendronate treatment would increase biomechanical fixation, bone-to-implant contact, and peri-implant density of implants inserted with bone compaction.

METHODS:
Following approval by our Animal Care and Use Committee, we used ten skeletally mature dogs in a paired study. One porous coated titanium implant was inserted into proximal part of each tibia. The implants were cylindrical with a height of 10.0 mm and a diameter of 8.0 mm. In the right femur 10 mg alendronate dissolved in 5 cc saline was topically administrated prior to bone compaction. On the left side the same amount of saline was used as control prior to bone compaction.

Surgery
By use of sterile technique we drilled a 10 mm deep hole in the proximal part of tibia. The initial diameter of the hole was 5.0 mm. After applying alendronate or saline solution the hole was prepared for implantation by use of bone compaction. The compaction protocol gradually expanded the cavity by use of a special designed bone compactor [2]. The final result was a cavity with a diameter of 8.0 mm, into which the 8.0 mm implant was inserted.

Evaluation
All dogs were killed after 12 weeks. Two bone-implant sections were cut of each proximal tibia perpendicular to the long axis of the implant. The section closest to the surface was used for biomechanical push-out test. The other section was used for histomorphometrical analysis. We used Student’s paired t-test to test for differences between the two groups, since data were normally distributed. Two tailed p<0.05 were considered significant.

RESULTS:
No implants were excluded and no infections were seen. Biomechanical fixation: We found a significant (p<0.05) two-fold increase in all biomechanical parameters (Table 1). Bone-to-implant contact: Local alendronate treatment significantly (p<0.05) increased the amount of bone in contact with the implants with 30 % (Figure 1). Peri-implant density in a 1 mm zone around the implant (Figure 2): We found a 140 % increase in peri-implant bone density around the implants in the alendronate group (p<0.05).

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<thead>
<tr>
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<th>Alendronate</th>
<th>Control</th>
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<tbody>
<tr>
<td>Max shear strength (MPa)</td>
<td>7 (5-8)*</td>
<td>3 (2-4)</td>
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<tr>
<td>App. Shear stiffness (MPa/mm)</td>
<td>24 (18-29)*</td>
<td>12 (7-17)</td>
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<tr>
<td>Total energy absorption (kJ/m2)</td>
<td>17 (12-21)*</td>
<td>10 (5-14)</td>
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Table 1. Biomechanical results. Presented as mean and 95%CI. (*p<0.05)

DISCUSSION:
This study was designed to investigate the effect of local alendronate treatment on implants inserted with bone compaction in a large animal model. The model is designed to imitate porous coated titanium prosthesis inserted into cancellous bone. The limitations of the study are the use of non weight-bearing implants, and the short term observation time of 12 weeks. Local application of alendronate had a pronounced effect on biomechanical fixation (100% increase), bone-to-implant contact (30% increase), and peri-implant density (140% increase) of implants inserted with bone compaction. We have, in a similar study with four weeks observation period, found an increase in the amount of bone, but no increase in biomechanical implant fixation [3]. So, we explain our increased implant fixation with the preservative effect of alendronate on the autograft generated during bone compaction. Osteoconduction is an intrinsic property of autograft, and by preserving our autograft, we elongate the period in which osteoconduction can occur. The increased osteoconduction is likely followed by an increased osseointegration and thereby an improved implant fixation.

In conclusion, the results of this study are encouraging. However, long-term studies are needed in order to investigate the effect on alendronate on the bone remodeling.

REFERENCES:

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