HYDROXYAPATITE-COATED UNICORTICAL SCREWS IMPROVE FIXATION AND GAP HEALING OF THE LOCKING COMPRESSION PLATE: A COMPARATIVE ANIMAL STUDY

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Introduction
Studies have shown that fixation of the bone-screw interface deteriorates over time. This deterioration may cause reduction in fixation stiffness, implant failure, loss of reduction and fracture nonunion. With standard metal screws, the strength of the bone-screw interface is limited by the fibrous tissue formation around the screw threads. Deterioration of the fixation strength of the bone-screw interface can be avoided by using hydroxyapatite (HA)-coated screws. Because of the optimal osteointegration ability of the coating with HA-coated screws, direct bone-screw contact occurs. Another concept to improve implant fixation in fracture treatment is the locking compression plate (LCP). With this technique, the plate and screws act as a single mechanical unit, thus providing better stability. Firstly, we hypothesized that the LCP can be improved further by using HA-coated screws. Secondly, improved stability at the bone-implant interface may be beneficial for bone healing. Given this background, we compared LCP fixation with both standard and HA-coated screws.

Materials and Methods
A 1cm transverse resection osteotomy was performed in the medial part of the right tibia. Sheep tibiae (n=10) were fixed with an 8-hole titanium LCP. Group A LCPs were fixed with standard titanium unicortical screws (n=5) and Group B LCPs were fixed with HA-coated titanium unicortical screws (n=5). All screws were locked to the plate at the same insertion torque of 4000 N/mm. The sheep were euthanized 3 months postoperatively. Biomechanical, radiographic analyses, extraction torque and tibial torque resistance were evaluated.

Results
One case of fixation failure in Group A occurred because of pull-out of the four proximal screws. Mean screw extraction torque was 438 ± 288 N/mm in Group A and 2317 ± 657 N/mm in Group B (p < 0.0005). Radiographic and macroscopic analyses showed that all the gaps were filled by newly-formed bone (Fig. 1, 2, 3). In Group A, tibial torque resistance was 24 ± 8 N/m in the treated tibia and 56 ± 2 N/m in the intact tibia (p < 0.0005). In Group B, tibial torque resistance was 31 ± 3 N/m in the treated tibia and 52 ± 4 N/m in the intact tibia (p < 0.0005). Tibial torque resistance of the intact tibia did not differ between the two groups. Tibial torque resistance of the treated tibiae was higher in Group B than in Group A (p = 0.045). Fracture patterns of the two groups were different. Group A tibiae failed through a transverse fracture line at the point of the resection osteotomy. Group B tibiae failed through an oblique fracture line similar to the failure mode of the intact tibiae.

Discussion
This study demonstrated that HA-coated unicortical screws used with LCP provide better fixation than standard titanium screws. The better fixation provided by these screws was beneficial for the healing of the resection osteotomy and led to greater ultimate tibial stability.

Conclusion
This study showed that HA-coated screws are an effective method of improving LCP fixation.

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Figure 1. Callus formation at 3 months with standard screws.
Figure 2. Callus formation at 3 months with HA-coated screws.
Figure 3. X-rays of callus formation with HA-coated screws at 3-months.