Introduction
AO cortical screws are considered the golden standard for bone screw internal fixation. However, in some clinical situations, as in the osteoporotic bone, the holding power of these screws to the bone is not strong enough. Furthermore, it was demonstrated that the bone screw interface strength deteriorates progressively after implantation (1). The inadequate initial bone screw fixation and the progressive deterioration of the bone screw interface strength may lead to implant failure and fracture non union. A significant improvement of the bone screw stability was recently demonstrated in external fixation screws coated with hydroxyapatite (HA) in both animal and clinical studies (2,3,4,5). However, no data on internal fixation AO cortical screws coated with materials with the ability to promote osteointegration are available yet. The purpose of this paper is to compare four types of AO cortical screws differing for surface materials.

Material and Methods
Eighty 4.5 mm AO cortical screws with a length of 3 cm were divided into 4 paired groups. Group A was made of standard AISI 316L uncoved screws, Group B of AISI 316L screws coated with a highly crystalline HA, Group C of AISI 316L screws coated with a low crystalline HA and Group D of Titanium (Ti) screws coated with Ti. Coating thickness of the Groups B, C and D ranged from 30 to 60 µm and roughness was Ra=0.5-2.5 µm. The screws were bilaterally implanted at random in the femurs and tibias of 6 adult sheep perpendicularly to the longitudinal axis of the bones according to the standard AO technique. Screws were implanted 2.5 cm apart from each other. Each sheep received 16 screws. All the screws were tightened with a torque wrench to an insertion torque of 2,000 N/mm. Following surgery, the sheep were placed in recovery rooms in heated cages and closely monitored over 24 hours. Unrestricted weight-bearing was allowed immediately after the operation as tolerated. The sheep were euthanized 1, 3 and 12 months after surgery. Two sheep were euthanized at each euthanization period. X-rays were taken immediately after surgery and when the sheep were killed. The postmortem X-rays were examined for the presence of screw rarefaction which was defined as any radiolucency around a screw at the entry or exit cortex or both. Extraction torque was measured on 12 screws from each sheep. Four screws from each group were used for histological and histomorphometric analyses. Histomorphometric analyses were performed by an independent investigator on photographs taken at 16 times magnification and the percentage of bone screw contact was measured on the entry and exit cortex. Data comparisons between pin groups were made by Anova-Duncan test and Student’s t test at p<0.05 significance level.

Results
All the sheep recovered from surgery and no major postoperative complications occurred. There was no radiographic rarefaction around any screw. At 1 month screw extraction torque was 359±285 N/mm in Group A, 3792±909 in Group B, 4124±1359 in Group C and 2854±759 in Group D (AvsB, p<0.001; AvsC, p<0.001; AvsD, p>0.02; BvsD, p>0.03). At 3 months screw extraction torque was 968±318 N/mm in Group A, 6802±691 in Group B, 626±396 in Group C and 559±568 in Group D (AvsB, p<0.001; AvsC, p<0.001; AvsD, p=0.001; BvsC, p>0.02). At 12 months screw extraction torque was 1079±481 N/mm in Group A, 6870±576 in Group B, 6560±918 in Group C and 5246±964 in Group D (AvsB, p>0.001; AvsC, p>0.001; AvsD, p>0.001; BvsC, p>0.02; BvsD, p<0.02). In conclusion, it was demonstrated that coating the AO cortical screws with either titanium or hydroxyapatite is an effective method to improve the bone screw interface strength. The best results were found in the highly crystalline HA coating compared to the low crystalline HA and Ti. The AO cortical screws coated with HA should be recommended when the risk of inadequate fixation is high. Clinically, in some internal fixation treatments including plating and locked intramedullary nailing, the achievement of a more rigid bone implant interface is very important. This is particularly necessary in the early period of the fracture treatment, which corresponds to the crucial time of the fracture instability and in the osteoporotic bone. Other clinical advantages of these screws could be: they could be loaded earlier and more securely given their higher stability at one month. Furthermore, a reduction in the number of implanted screws and consequently in the size of the surgical approach could be possible. In conclusion, it was demonstrated that coating the AO cortical screws with either titanium or hydroxyapatite is an effective method to improve the bone screw interface strength. The best results were found in the screws coated with the highly crystalline hydroxyapatite. The higher bone screw interface strength and osteointegration of these screws is expected to lead to a significant improvement of the internal fixation clinical results.

REFERENCES

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