INTRODUCTION: Advances in limb salvage surgery for bone tumours have resulted in the replacement of large bony defects with massive endoprostheses. The attachment of tendons and ligaments to these implants remains a clinical challenge due to the difficulty in achieving a functional soft tissue – implant interface. We have previously used a titanium alloy implant to model patellar tendon re-attachment to a proximal tibial replacement showing mechanical and biological attachment after twelve weeks. Resorbable biomaterials have been used widely in surgery, including use for augmentation of bone and soft tissue regeneration. In this study we have tested the hypothesis that tendon attachment to an implant with resorbable Vicryl® (Polyglactin 910) mesh can be used to achieve mechanical and biological fixation in the absence of compression from a tendon clamp.

MATERIALS AND METHODS: In six skeletally mature Friesland ewes (Mesh Group), a spiked titanium alloy (TiAlV) implant with a 70-micrometre thick coating of dense hydroxyapatite (Figure 1) was attached to the site of a tibial tubercle osteotomy to simulate the surface of a proximal tibial replacement. An autologous cancellous bone chip and marrow graft (1.5g wet weight) was harvested from the ipsilateral iliac crest and packed onto the hydroxyapatite-coated implant. A four-ply sleeve of Vicryl® mesh was sutured to the free patellar tendon. The tendon was pressed onto the implant spikes (1mm diameter, 4mm length), and the mesh extension was screwed to the implant. All animals underwent Kistler force plate analysis of both hind limbs pre-operatively and at six and twelve weeks post-operation. Animals underwent euthanasia at twelve weeks and specimens were harvested and processed for histology. The vertical component of the peak Ground Reaction Force (GRF) was expressed as a percentage of the operated to the non-operated (control) limb, and as a change in maximum GRF; normalized for weight (Fmax/weight) over time. Quantitative analysis of collagen fibre orientation to the implant surface was carried out and compared with the non-operated intact limbs. A comparison was also made with two other groups, each of six animals, in which the tendon was fixed to the same implant with a spiked compressive clamp lid. In the Autograft Group, the attachment was augmented with an autologous cancellous bone chip and marrow graft (1.5g wet weight), whilst the Hydroxyapatite (HA) Group served as a non-augmented control group.

RESULTS: At twelve weeks post-operation animals had reached functional weight bearing through the operated limb at a level of 69.07% +/- 7.15 of the control limb. In the Mesh Group animals, the increase in Fmax/weight between six and twelve weeks was 6.46 +/- 1.30. This compares with 0.81 +/- 0.80 and 5.31 +/- 0.86 for the HA and Autograft Groups respectively. The Mesh and Autograft Groups both showed a significantly greater increase in Fmax/weight compared with the HA Group (p < 0.05) (Figure 2). In the Mesh Group, the mean collagen fibre orientation to the implant was 30.83 degrees +/- 2.10 which was not significantly different compared with the mean intact tendon-bone fibre insertion angle (34.96 degrees +/- 2.55) (p > 0.05). In comparison the mean angle of collagen fibre orientation for the HA Group (15.49 degrees +/- 0.90) and the Autograft Group (16.50 degrees +/- 1.13) were both significantly lower than the mean intact tendon-bone fibre insertion angle (p < 0.05) (Figure 3). By twelve weeks no mesh fibres could be identified under light microscopy, nor was there any foreign body reaction observed. No interface failure due to tendon pull – out was observed. Bone graft retention to the hydroxyapatite surface was variable, however, a developing interface was observed with tendon collagen fibres penetrating actively remodelling bone (Figure 4).

DISCUSSION: The use of a resorbable Vicryl® mesh provided mechanical fixation statistically equivalent to, and greater than that achieved with a spiked compressive clamp lid in the Autograft and HA Groups respectively. The collagen fibre orientation to the implant was similar to a native tendon – bone enthesis. The mesh had been completely resorbed, and there were no obvious adverse consequences of its use. Vicryl® mesh has a potential role as a tendon augmentation biomaterial in the field of soft tissue attachment to metal implants.

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Figure 1: Implant.
Figure 2: Change in Fmax/weight between six and twelve weeks.
Figure 3 Collagen fibre orientation at interface.
Figure 4: Histology of interface (x100 toluidine blue / paragon).