Demineralized Bone Matrix augments tendon attachment to a metal implant

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Introduction: Massive segmental replacement for bone cancer often involves the removal of tendon insertions and tendon attachment to metal endoprostheses remains a challenging clinical problem. Failure to attach the muscles can lead to abnormal kinematics. Studies have also demonstrated the formation of bone on the surface of a metal implant at the sites of tendon insertion when bone graft or hydroxapatite coating has been used (1,2). Demineralized Bone Matrix (DBM) has been shown to augment tendon-bone healing (3). In this study we have tested the hypothesis that tendon attachment to an implant can be augmented with DBM providing superior functional and histological outcomes by 12 weeks post operation.

Materials and Methods: 7 skeletally mature Friesland ewes (Mesh DBM group) underwent patellar tendon reattachment using a spiked (1mm diameter, 6mm length) titanium alloy implant coated with a 70 micrometer thick layer of HA as previously reported (2). Autologous cancellous bone chip and marrow graft was harvested from the ipsilateral crest at the time of surgery and packed on the HA coated base plate. DBM was then pressed on to the spikes to be interposed between the bone graft and the tendon. A four-ply sleeve of Vicryl mesh was sutured to the free patellar tendon and pressed on to the implant spikes with the remainder of the mesh sleeve screwed to the implant. Animals underwent Kistler force plate analysis of both hind limbs pre operation, 6 and 12 weeks post operation. The peak vertical component of the Ground Reaction Force (Fmax) was recorded, normalised for weight (Fmax/weight), and expressed as a percentage of the unoperated limb, which served as a control, to give Functional Weight Bearing (%FWB). Animals were euthanased at 12 weeks and specimens were harvested and processed for undecalcified histology. Data were compared with 6 non-DBM augmented controls animals which were similarly treated and referred to as the Mesh Group (2).

Results: 1 failure was observed in the Mesh DBM group due to pull out immediately post operation. All other animals recovered well post operation.

At 6 weeks post operation, the animals reached functional weight bearing of 46.91 (±3.68) and 68.72 (±4.70) for the Mesh and Mesh DBM groups respectively and at 12 weeks, 67.05 (±7.16) and 86.95 (±4.05) (Figure 1). At 6 weeks, Mann Whitney U tests showed that the Mesh DBM group significantly outperformed the Mesh group (p=0.002).

Histology showed the Mesh DBM group exhibited a mature direct type enthesis at 12 weeks post operation (Figure 2) which compared to a predominantly indirect morphology observed in the Mesh group (Figure 3). There was no sign of the mesh or any inflammatory response. Bone graft appeared to undergo significant remodelling with large amounts of fibrocartilage observed and with chondrocytes in their lacunae orientated in rows aligned with the direction of tensile strain of the tendon. There was no organisation of fibrocartilaginous tissue in the Mesh Group.

Discussion: The Mesh DBM group significantly outperformed the Mesh group functionally at 6 weeks post operation and showed a morphology that more closely resembles that of an organised direct type enthesis by 12 weeks when compared with the Mesh group. DBM may play a role in augmenting tendon attachment to metal endoprostheses.