MECHANICAL AND HISTOLOGICAL EVALUATION OF A COLLAGEN BONE ANCHOR

Introduction
A number of techniques are available for the repair soft tissue to bone including suture fixation through bony tunnels and suture anchors that allow direct fixation to bone. Materials currently used for the fabrication of bone anchors have potential complications. Metallic anchors may obscure radiological investigations and risk dangerous migration. Degradable synthetic polymeric orthopaedic devices can suffer unpredictable rates of hydrolysis, residual cysts and when used around joints may fragment causing locking symptoms. Type I collagen may be a suitable biomaterial for a suture anchor for soft tissue to bone repair. This study examined the biomechanical and histological properties of patellar tendon repairs using metallic (Mitek) or a biodegradable type I collagen bone anchor (CBA) in a loaded in vivo sheep patella tendon insertion model.

Methods
Collagen bone anchors (CBA) were 3-part devices prepared from hollow cylinders of dehydrated gluteraldehyde cross-linked fibrillar purified bovine collagen, pre-threaded with a loop of braided 2 polyester suture, and a terminal PMMA washer. The assembled devices were gamma sterilised. Fifty-two skeletal mature cross-bred merino wethers were used with the approval of the University of New South Wales Animal Care and Ethics Committee (permit 96/7). Six animals were sacrificed immediately following surgery (time zero). Bilateral procedures were performed on the time zero subjects for mechanical testing. Unilateral procedures were performed on all other animals.

The surgical procedure entailed dividing and reattaching the patella tendon at the tibial insertion. The tibial tuberosity was denuded of all tendon, insertion fibrocartilage and periosteum with a high speed burr. A pair of holes was drilled 5 mm medial and lateral to the centre of the tuberosity. Two CBA’s or Mitek Rotator Cuff Anchors were used for each repair. A whip stitch of alternating 2 and 4 mm bites was applied to each edge of the tendon. A modified Robert Jones bandage was applied from the hoof to the groin and removed at 3 weeks.

Animals were sacrificed for mechanical evaluation at 0, 6, 12 and 26 weeks. Isolated patella - patella tendon - tibia constructs were tested in uniaxial tension (100 mm/min) using a custom jig on an MTS 858. Peak load, stiffness, energy to failure and mode of failure were analysed with two way ANOVA. Two animals were sacrificed for histological studies at 6, 12, 26 and 52 weeks. The PT – tibia samples were fixed in formalin and processed in glycolmethacrylate. Sections (50 microns) were cut parallel to the PT and stained with toluidine blue. Samples mechanically tested were embedded in paraffin. Five micron sections were cut and stained with H&E or Trichrome.

Results
No devices pulled out either at time of insertion or mechanical testing. The time zero repairs failed at the suture interface. Non-operated control sides failed by bone fracture. The 6 and 12 week repairs failed at the tibial insertion site. By 26 weeks the operated samples failed by bone fracture. Peak load, stiffness and energy to failure for the Mitek and the CBA repairs increased with time. There was no significant difference in peak load or energy to failure between the two devices at any time point. The Mitek repairs were significantly stiffer than CBA only at 12 weeks p=0.025.

Discussion
Histologically, the CBA and Mitek anchors produced similar cellular and tissue responses. Newly formed woven and lamellar bone were present in direct apposition to the surface of both bone anchors. From 6 weeks occasional continuous collagen fibres could be seen crossing from the CBA to the bone. Minimal resorption of the CBA was seen until 52 weeks, at which time it was being replaced by bone. At earlier timepoints the CBA appeared intact with the occasional osteoid vesicles. The initial hypercellularity of the tendon interface decreased with time, but still had not formed a mature direct tendon insertion at 12 months.

References

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