Biomechanical Comparison of Two Extensor Mechanism Reconstruction Techniques

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INTRODUCTION:

Extensor mechanism disruption is a devastating complication that can occur following total knee arthroplasty. Reconstruction can be performed with synthetic mesh; however, the best tibial fixation technique remains unresolved. This study compares the biomechanical properties of the trough versus intramedullary techniques for attaching the mesh construct to the tibia.

METHODS:

Synthetic mesh constructs were implanted using two techniques. A polypropylene mesh sheet (Marlex 26cm x 36cm) was folded in the longitudinal direction upon itself eight times and secured with a running locking stitch. Bone cuts were made to receive a NexGen keel tibial component on six matched pair of fresh frozen human tibiae.

Tuberosity trough technique

After cementing the tibial component, a 30mm x 15mm window was burred above the tuberosity. Cement was applied to the mesh construct and into the trough before seating the mesh within the cavity. After curing, a bicortical screw was passed obliquely through the construct to avoid the keel.

Intramedullary technique

A 5mm x 25mm recess was burred through the anterior cortical rim. The mesh was inserted anteriorly into the medullary canal in line with the tibial crest, followed by a cemented tibial component with the keel posterior to the mesh.

Biomechanical testing

Tibias were mounted in a custom loading fixture after attaching a polyethylene bearing to the tray. A joint reaction force of 667N was applied vertically to the tibial insert via matching femoral component. A tensile load was applied to the mesh construct via a cable/pulley system. Specimens were preconditioned with 25 cycles of loading from 50N to a peak value of 650N, followed by uniaxial loading to failure at a rate of 25mm/min. The 3D displacements of the tibial tray and the point of load application at the patellar level were tracked using a six-camera motion analysis system.

RESULTS:

There were significant differences between the two constructs. Overall, the IM technique was 3 times stiffer (107±11 N/mm vs 42±12 N/mm, p=0.018) and 54% stronger (1143±31N vs 741±85N, p=0.003) than the trough technique. There was also a trend towards increased yield strength, but not statistically significant (729±9N vs. 542±78N, p=0.075) (Figure1). Failure of the trough method predominantly occurred at the mesh insertion site whereas failure of the IM technique was along the mesh midways between the insertion site and patellar clamp.

DISCUSSION AND CONCLUSION:

This study shows a potential biomechanical advantage to implanting under the tibial baseplate, with higher stiffness, yield force, and ultimate load to failure. While our model does not incorporate soft tissue ingrowth, it does compare insertion techniques where ingrowth has minimal effects.

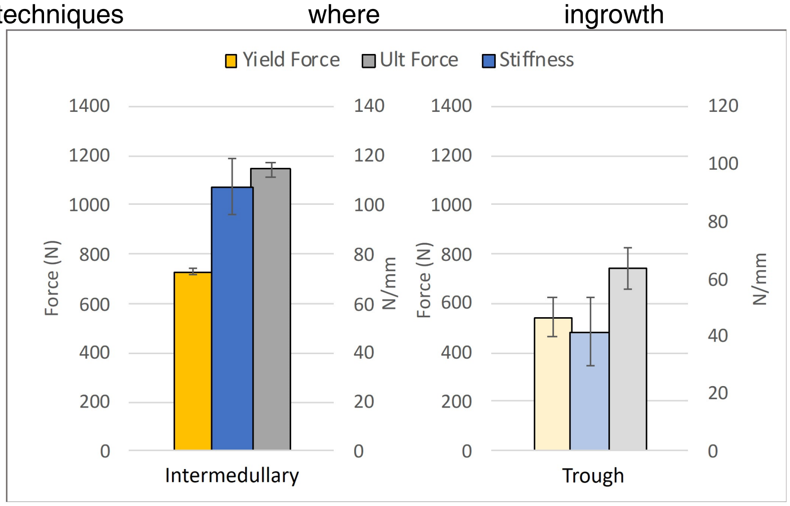

Figure 1. Graph comparing the mechanical properties of each technique