Titanium Mesh as a Low-profile Alternative for Treatment of Patella Fractures: A Feasibility Study

Christina Salas, MS, Aaron Dickens, MD, LeRoy Rise, MD, Mahmoud Reda Taha, PhD, Richard Gehlert, MD.
University of New Mexico, Albuquerque, NM, USA.

Disclosures:

Introduction: The most common treatment for transverse patella fractures is the tension band technique characterized by passing tension band wire in a figure-of-8 configuration through cannulated screws passing from distal to proximal ends of the patella. The wire ends are twisted, cut, and rotated to lie flush with the anterior surface of the patella. Though this technique has been proven effective at maintaining stability of simple two part fractures, the prominent ends of the twisted tension wire are subcutaneous and have been known to cause irritation to the overlying soft-tissue of the treated patient. Using a non-inferiority test model we investigate the stiffness and strength of titanium mesh for treatment of simple transverse patella fractures. We hypothesize that titanium mesh is not inferior in stiffness or strength to tension band wiring, but may offer clinically relevant advantages such as few complications and versatility in application for multifragmented fractures.

Methods: Twenty four synthetic medium left patellae were used in this study (Pacific Research Inc., Vashon, WA). All specimens were osteotomized transversely and a nylon band was placed around the proximal and distal segments representing the patellar tendon. Twelve specimens were treated with the tensioned band wiring technique described above and twelve were treated with 0.6mm titanium mesh fixed with four 2.3mm screws (Universal Neuro 2 Cranial Fixation System, Stryker Osteosynthesis, Germany) and cannulated screws passing proximal to distal through the patella. A custom designed test fixture was developed to produce a simulated 60 degree knee flexion with the patella positioned on the femoral component of a total knee prosthesis. Loads were applied through a cable and pulley system attached to a servohydraulic actuator (Model 858, MTS systems, Eden Prairie, MN). Outcome measures from the testing machine were actuator displacement and load cell force. These values are used to provide stiffness as a measure of stability and ultimate load sustained by the bone/implant construct prior to failure. High definition video was positioned to capture the entire fracture event. Custom designed software was developed to allow for analysis of images and fracture gap measurement at the instant before catastrophic failure. All images were calibrated individually with a measurement tool placed in the plane of the anterior surface of the patella. Outcome measure from the video was fracture gap displacement prior to failure to determine the potential for malunion of the bone. (Figure 1)

Results: A two-sample t-test was used to determine significance in the stiffness and ultimate load results (p=0.05). Mean stiffness of tension band wiring treated patellae is 19.42 +/- 1.34 N/mm and stiffness of mesh treated patellae is 19.49 +/- 1.35 N/mm. Stiffness of mesh constructs is not significantly different from stiffness of tension band treated patellae (p=0.89).

Ultimate load at failure for tension band treated patellae is 624.66 +/- 99.99 N and for mesh treated patellae is 601.67 +/- 135.04 N. Ultimate load at failure for mesh constructs is not significantly different from ultimate load of tension band constructs (p=0.64). Mean fracture gap in the mesh constructs prior to failure is 1.35 +/- 0.83 mm and for the tension band wire constructs is 2.97 +/- 1.53 mm. Fracture gap is significantly less in the mesh constructs compared to wire constructs (p=0.02).

Discussion: Non-inferiority testing was used to compare the titanium mesh with tension band wiring for treatment of simple transverse patella fractures. This statistical technique is commonly used when introducing a new treatment for an existing problem when the new treatment may offer clinically relevant advantages over the current option. Results of the present study showed a non-significant difference in stiffness or ultimate load at failure between constructs showing the mesh technique to be a viable alternative to the commonly used tension band wiring technique. Additionally, a significantly reduced fracture gap prior to failure in the mesh constructs may reduce the potential for bone malunion or non-union. Another advantage of the mesh construct includes the ability to gather multiple fragments for containment within the mesh plate region with or without the need for additional screws. Figure 2 shows an example of the wire mesh used in a multi-fragmented cadaver model. This figure additionally provides a good example of the mesh ability to contour the surface of the patella without prominences such as found in the wire constructs which may irritate the surrounding soft tissue of the patient. Complications due to tension band techniques have been shown to require hardware removal in up to 52% of patients[1]. It should be noted that the mesh used in this study is marketed for craniofacial fixation and is not designed to withstand high tension loading. We do not recommend off-label use of this device. We present a feasibility study of titanium mesh to inspire innovative designs for robust, low-profile plating for subcutaneous fracture fixation.

Significance: Anteriorly placed mesh plating is proven a viable alternative to tension band wiring for treatment of transverse patellar fractures. This technique provides bone stability equivalent to the tension band technique and has potential for reduced complication rates owing to its ability to contour the patellar surface with no prominent features while allowing for fixation of multi-fragmented fractures.
Acknowledgments: We would like to acknowledge James Love for development of the custom software tool for calibrated measurements of fracture gap.

Figure 1 (left): Accurately placed mesh construct on custom-built testing device. Images taken at the instant before failure showing minimal fracture gap. Measurement tool is placed in the plane of the patella for image calibration. (right) Tension in the wire construct showing significant fracture gap at the instant before failure.
Figure 2: Titanium mesh in a cadaveric model showing potential for fixation of multi-fractured patella fractures. Though larger screws were used in this fixation compared with our present study, the image shows no prominent fixtures exist in the construct compared with the tension band wiring. This may reduce the potential for soft tissue irritation known to result from tension band treatment.

ORS 2014 Annual Meeting
Poster No: 1707