MECHANICAL EVALUATION OF TENSION BAND ORIENTATION

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INTRODUCTION

The modified AO tension band method is commonly used for the fixation of transverse patellar fractures. Despite its wide spread use, the orientation of tension bands has not been tested directly. Free body diagrams of a tension band suggest that the vertically oriented figure eight *(*Fig. 1A*)* that has traditionally been used does not provide as much compression across the fracture fragments as would a horizontally oriented figure eight (Fig. 1B*)*. Based on the free body diagrams, a simple rotation of 90 degrees of the tension band will more than double the compressive force between fracture fragments. The objective of this study is to experimentally evaluate the mechanical effect of orientation of the patella tension band.

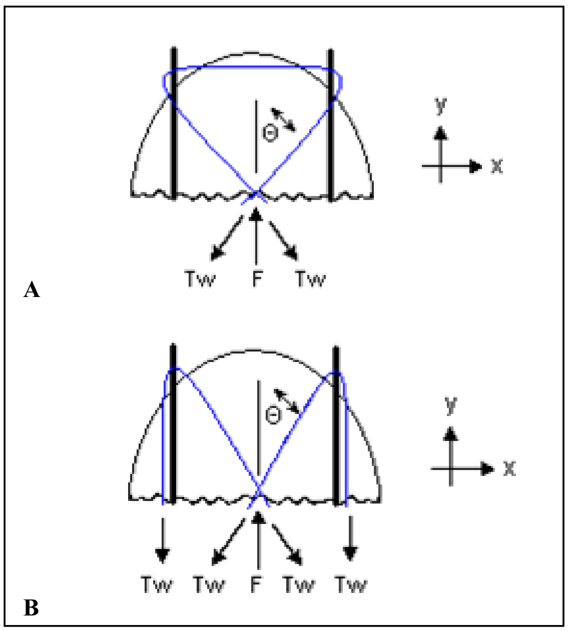

Figure 1: Free body diagrams of a vertically (A) and horizontally (B) oriented patella tension band

METHODS

Tension bands of both orientations were tested on a model constructed to simulate patellar fracture fragments. Two parallel aluminum cylinders were mounted on an Instron 5865 material testing machine (Instron, Canton MA, USA) by perpendicular lag screws. 5.0cm segments of 2.0mm Kirchner wires (K-wires) were inserted perpendicularly into the aluminum cylinders into pre-drilled holes to simulate the free ends of the K-wires in the proximal and distal patellar fragments. The K-wires were located on the anterior slope of the cylinders to simulate the curvature of the anterior surface of the patella. A tension band of 316L 18 G monofilament stainless steel wire was applied to the construct using either in the vertical or horizontal orientation. The ends of the tension

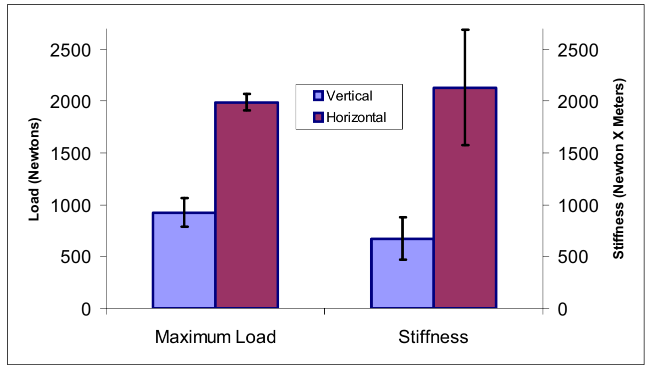

Figure 2: Comparison of the experimental maximum load and stiffness values of a horizontally and vertically aligned patellar tension band construct (Mean values and standard deviations are shown).

bands were twisted until each specimen had a pre-tension of 40N. The cylinders were then distracted on the material testing machine at a rate of 25 N/sec to a preload of 250N and held for ten seconds to allow tension to equalize throughout the tension band. The load was then increased at a rate of 50 N/sec until failure of the wire. Maximum load, stiffness, and mode of failure were recorded for fifteen trials of each wire orientation.

Limited cyclic testing was also performed using this model. The tension bands were subjected to 50 cycles consisting of increasing the load from the preload (250N) to 500N and back to the preload in four seconds. Five samples were tested in each orientation. Statistical comparisons between both models were performed using Student's t-test.

RESULTS AND DISCUSSION

In load to failure testing the horizontal construct was found to have a significantly higher maximum load and stiffness than the vertical construct ($p<0.0001$, Figure 2). Cyclic testing showed significantly less extension for the horizontal figure eight, with a mean value of 1.1 mm, than for the vertical figure eight, with a mean value of 2.7 mm ($p<0.0001$). For both constructs, over 80% of the extension was seen in the first fifteen cycles.

There is much debate over the proper method of patellar fracture fixation including methods with screws, and a combination of screws and wires. This study strengthens the position of tension bands in patellar fracture fixation and may require that this improved method be evaluated against other methods in use.

CONCLUSIONS

Overall, the results from this study confirm the theoretical advantages of the horizontal figure eight tension band compared to the vertical orientation