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Comparison of Pedicle Screw Spinal Fixation for Fractures: Bridge vs. Tension Band Construct

D. Giannitsios[1], C. Richards[2], J. Ouellet[2], P. Jarzem, T. Steffen[1]

[1]*Orthopaedic Research Laboratory, Montreal, CA*

[2]*Division of Orthopaedic Surgery, McGill University, Montreal, CA*

INTRODUCTION: Posterior osteosynthesis of thoraco-lumbar fracture has been shown to settle in kyphosis if classic posterior Tension Band (T-B) type of fixation is utilized (Fig. 1a). This study compared the initial stability and pull out strength of parallel versus divergent posterior screw orientation within the vertebral body for posterior spinal fixation. It is believed that a divergent screw construct, creating a bridge-type (Bridge) fixation (Fig. 1b), is safe, significantly stronger, and will resist failure in kyphosis and screw pull-out significantly more then a parallel screw construct, which acts like a tension-band.

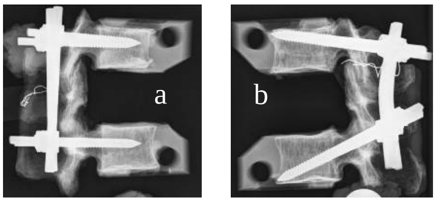

Fig. 1a,b:Radiographs of T-B (a) and Bridge (b) constructs. (levels T11-L1)

METHODS: We tested our hypothesis using: a finite element analysis (FEA); six synthetic models using the ASTM standard for vertebrectomy[1]; and six human cadaveric models quantifying construct stiffness and ultimate strength using an MTS machine.

The FEA (Finite Element Analysis) models were loaded at 100N, 300N, & 600N and the resulting displacements were generated for each load. With this data, stiffness curves for each construct were created.

For the ASTM corpectomy model, UHMWPE blocks with a tensile strength of 40 ± 3 MPa were fabricated to the standards dimensions with three models having T-B constructs. For the Bridge constructs, the pedicle screw orientation, with respect to the horizontal plane, were altered to 16.5° superiorly 26.4° inferiorly. The specimens were loaded using MTS Load under displacement control at a rate of 0.4mm/s.

For the cadaveric models, six human fresh frozen spines were dissected and instrumented between T11-L1, and then had a corpectomy of at the T12 level. Three specimens of each construct were built. For the Bridge construct, a guide was designed to provide consistent placement of the schanz screw. The cadaveric model testing duplicated the ASTM model testing protocol.

RESULTS: All three modalities showed greater stiffness with the Bridge type fixation Fig. 2. The cadaveric model failure load was greater for the Bridge Construct compared to the T-B (Fig. 3).

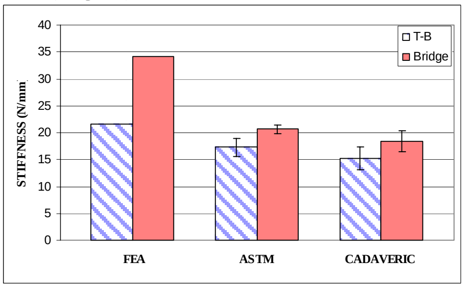

Fig. 2: Construct Stiffness comparison between FEA analysis, ASTM UHMWPE standard, and Cadaveric Model.

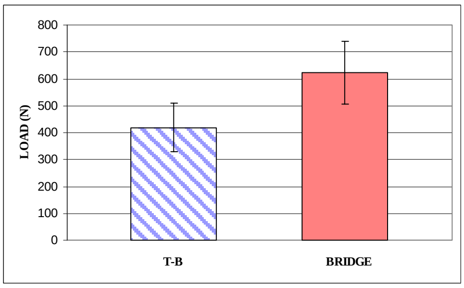

Fig.3: Cadeveric ultimate strength load for T-B and Bridge constructs.

DISCUSSION & CONCLUSIONS: If the added mechanical advantage of Bridge type fixation can off load the anterior column allowing it to heal before kyphosis occurs, then the added morbidity of anterior column reconstruction is not warranted in management of thoraco-lumbar fractures.

REFERENCES: [1] ASTM Designation: F1717-04, Standard Test Methods for Spinal Implant Constructs in a Vertebrectomy Model