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Original Article
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Finite Element Analysis and Biomechanical Comparison of Short Posterior Spinal Instrumentation with Divergent Bridge Construct versus Parallel Tension Band Construct for Thoracolumbar Spine Fractures

The ideal treatment for unstable thoracolumbar fractures remains controversial with posterior reduction and stabilization, anterior reduction and stabilization, combined posterior and anterior reduction and stabilization, and even nonoperative management advocated. Short segment posterior osteosynthesis of these fractures has less comorbidities compared with the other operative approaches but settles into kyphosis over time. Biomechanical comparison of the divergent bridge construct versus the parallel tension band construct was performed for anteriorly destabilized T11-L1 spine segments using three different models: (1) finite element analysis (FEA), (2) a synthetic model, and (3) a human cadaveric model. Outcomes measured were construct stiffness and ultimate failure load. Our objective was to determine if the divergent pedicle screw bridge construct would provide more resistance to kyphotic deforming forces. All three modalities showed greater stiffness with the divergent bridge construct. The FEA calculated a stiffness of 21.6 N/m for the tension band construct versus 34.1 N/m for the divergent bridge construct. The synthetic model resulted in a mean stiffness of 17.3 N/m for parallel tension band versus 20.6 N/m for the divergent bridge ($p = 0.03$), whereas the cadaveric model had an average stiffness of 15.2 N/m in the parallel tension band compared with 18.4 N/m for the divergent bridge ($p = 0.02$). Ultimate failure load with the cadaveric model was found to be 622 N for the divergent bridge construct versus 419 N ($p = 0.15$) for the parallel tension band construct. This study confirms our clinical experience that the short posterior divergent bridge construct provides greater stiffness for the management of unstable thoracolumbar fractures.data to guide future research studies, benchmarking, public health policy, and efficient resource allocation for the management of spine trauma.

胸腰椎骨折的短後路脊柱內固定的分叉橋結構相對並行張力帶結構的有限元素模態分析和生物力學比較

對不穩定胸腰椎骨折的最理想的治療仍然是有爭議的: 後路復位和穩定，前路復位和穩定，結合後路和前路復位和穩定，甚至主張非手術治療。這些骨折的短段後路骨縫合術與其他手術方式相比有比較少合併症，但隨著時間會發展出脊柱後凸症。前方不穩定的 T11-L1 脊柱段使用三種不同模型對分叉橋結構相對並行張力帶結構進行生物力學比較：（1）有限元素模態分析（FEA），（2）合成模型，和（3）人類屍體模型。結果是測量結構的剛度和最終破壞負荷。我們的目標是確定分叉椎弓根螺釘橋結構是否能對後凸變形力提供更多的阻力。這三種方式均顯示分叉橋結構有更大的剛度。FEA 計算的張力帶結構剛度是 21.6 N / m 相對分叉橋結構剛度是 34.1N / m。合成模型的結果是並行張力帶結構平均剛度是 17.3 N / m 相對分叉橋結構的平均剛度為 20.6 N / m（P = 0.03），而屍體模型的並行張力帶結構平均剛度為 15.2 N / m 相對分叉橋結構的平均剛度為 18.4 N / m（P = 0.02）。屍體模型的最終破壞負荷在分叉橋結構是 622 N 相對並行張力帶結構是 419 N（P =0.15）。這項研究證實了我們的臨床經驗是短分叉橋結構對治理胸腰椎不穩定骨折提供了更大的剛度資料，並用以指導未來的研究，基準評價，公共衛生政策和對治理脊椎創傷更有效的資源分配。