Evaluation of Vertically Oriented Femoral Neck Fracture Fixation in a Clinically Relevant Biomechanical Model

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Purpose: Surgical fixation of vertically oriented femoral neck fractures continues to be associated with high rates of fixation failure. Recent literature has further defined the true morphology of these fractures, specifically axial plane obliquity and the presence of posterior-inferior comminution. The purpose of this study was to evaluate the effect of these features using commonly implemented fixation strategies. We hypothesized that axial obliquity and posterior comminution would decrease the structural integrity of both fixation constructs.

Methods: Biomechanical testing was performed on 4 vertical femoral neck fracture models: (1) 90° coronal plane fracture, (2) 90° coronal plane fracture with -24° of axial obliquity, (3) 90° coronal plane fracture with posterior-inferior comminution, and (4) 90° coronal plane fracture with -24° of axial obliquity and posterior-inferior comminution. In each group (n = 10), 5 specimens were fixed with 3 cannulated screws in an inverted triangle arrangement (CS) and 5 were fixed with a sliding hip screw (SHS) with supplemental anti-rotation screw. Load to failure through a custom jig that provided an axial preload and torsional loading was performed. Torque at failure and angular displacement were recorded.

Results: The pure coronal plane osteotomy demonstrated the greatest torque before failure and resistance to displacement with load, regardless of fixation construct ($P < 0.03$). All models failed at a significantly greater torque after fixation using 3 cannulated screws versus an SHS with anti-rotation screw ($P < 0.02$). While axial fracture obliquity alone resulted in increasing fracture instability, once posterior comminution was introduced, axial obliquity was not a contributing factor to stability.

Conclusion: Axial fracture obliquity and the presence of posterior comminution had a significant effect on construct stability after fracture reconstruction; this was observed in both the SHS and CS fixation groups. While axial fracture obliquity increased instability, the addition of posterior comminution negated this effect. In our model, the CS group performed significantly better than the SHS group in all measurements. This study represents the first creation of a model that accurately represents in vivo fracture morphology and demonstrates the contribution of axial fracture obliquity and posterior comminution on fixation strength.

See pages 401 - 442 for financial disclosure information.