Δ Medial Column Screw Supplementation of Lateral Locking Plate for Distal Femur Fractures: A Biomechanical Study

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Purpose: Lateral locking plate fixation of supracondylar femur fractures continues to have complications such as nonunion, delayed union, and implant failure as high as 32%. Increased fixation with medial-sided plating or intramedullary nailing has recently been shown to improve fixation stiffness and prevent varus collapse, yet these adjuncts can increase operative time, cost, and patient morbidity. We propose supplementation of lateral locked plating with a single large cannulated medial column screw placed percutaneously. Our purpose was to assess the biomechanical stability of medial column screw supplementation in a synthetic distal femur fracture model.

Methods: 24 low-density synthetic femora modeling osteoporotic, intra-articular distal femur fractures with medial metaphyseal comminution were split into 2 fixation groups of 12 models each: (1) lateral 4.5-mm locking distal femur plate alone (PA group – plate alone) and (2) lateral 4.5-mm locking distal femur plate with a 6.5-mm fully threaded medial cannulated screw (PWS group – plate with screw). Cyclic biomechanical testing included 5 steps with 10,000 cycles each. The first-round maximum axial load started at 1.5 x BW (body weight; BW = 80 kg). Subsequent step maximum axial load increased by 0.25 x BW until 2.5 x BW was reached on the fifth step. Outcomes of interest were cumulative stiffness measured as the slope of the force versus displacement curves across the entire testing protocol and interval stiffness measured during each step.

Results: Five of the PA models had propagation of the fracture during testing. All other models reached runout of the testing protocol without failure. PWS was found to have 19.8% higher cumulative stiffness compared to PA across the entire testing protocol (809.8 N/mm vs 676.3 N/mm; P = 0.014). Interval stiffness during the first 2 steps of testing showed <1% differences between groups. However, when maximal axial load reached 2 x BW, the stiffness of PWS was found to be greater than PA (1072 N/mm vs 1043 N/mm; P = 0.53). This absolute difference increased at 2.25 x BW (1024 N/mm vs 971.9 N/mm; P = 0.26) and by 2.5 x BW, the PWS group showed 12% greater stiffness than the PA group (983.8 N/mm vs 879.1 N/mm; P = 0.028).

Conclusion: This is the first study to evaluate the biomechanical contribution of a medial column screw in a distal femur fracture model. Our results show superior stiffness when supplementing a lateral locked plate with a medial column screw. Applied clinically, a medial column screw can increase construct stability in the setting of complex distal femur fractures with minimal increase in operative time, patient morbidity, and cost.

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