Orthogonal Plating of Distal Femur Fractures: A Biomechanical Comparison with Plate-Nail and Parallel Plating Constructs

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Purpose: Recent studies on supplemental fixation of distal femur fractures have demonstrated superior biomechanical properties of lateral-medial plating and plate-nail constructs compared to lateral locked plating alone. Orthogonal plating through a single lateral approach may provide comparable stability without disrupting the remaining soft-tissue envelope around the knee. The purpose of this study was to compare the biomechanical properties of orthogonal plating with plate-nail and parallel plating constructs for supracondylar distal femur fractures.

Methods: A supracondylar distal femur fracture with medial metaphyseal comminution was simulated using 15 synthetic osteoporotic composite femurs. The specimens were divided into 3 groups: (1) plate-nail construct with a lateral locked distal femoral plate and a retrograde intramedullary nail, (2) parallel plating with a lateral locked distal femoral plate and a medial 4.0-mm compression plate, and (3) orthogonal plating with a lateral locked distal femoral plate and a posterior one-third tubular plate. Each specimen was mounted reversibly on a multiaxial Bionix Testing System (MTS) and underwent nondestructive cyclic loading along the mechanical axis of the femur in torsion to 10 Nm, and then axial compression to 800 N. Gapping at the fracture site was measured using infrared markers and a 3-dimensional motion capture system. Torsional stiffness and axial stiffness were determined and compared using a Kruskal-Wallis one-way analysis of variance. Strain at the fracture site during axial loading was also determined.

Results: The plate-nail, parallel plating, and orthogonal plating constructs had a mean torsional stiffness of 74.5 ± 20.7, 81.2 ± 23.7, and 66.2 ± 31.1 Nm/degree, respectively, with no significant difference among the 3 groups ($P = 0.51$). There was also no difference in axial stiffness among the 3 groups ($P = 0.53$), and strain at the fracture site during axial loading was <1% in all specimens. There was no difference in strain among the 3 groups ($P = 0.20$).

Conclusion: Orthogonal plating of supracondylar distal femur fractures demonstrated comparable torsional and axial stability to plate-nail and parallel plating constructs. All specimens had <1% strain at the fracture site at peak load, suggesting sufficient stabilization for bone healing. These biomechanical results suggest that the benefit of enhanced stability from dual-implant fixation to allow for earlier weight bearing can be achieved through orthogonal plating using a single incision approach. Orthogonal plating warrants further investigation as a novel alternative for fixation of osteoporotic distal femur fractures, particularly for periprosthetic fractures with a preexisting midline incision and a femoral component that is not amenable to nailing.