Supplemental Fixation of Supracondylar Distal Femur Fractures:
A Biomechanical Comparison of Dual- Plate and Plate-Nail Fixation Techniques

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Purpose: Fixation of complex distal femur fractures remains a challenge. Supplemental fixation techniques have been proposed to address fractures in the setting of bone loss or poor-quality bone. The purpose of this biomechanical study was to investigate the effectiveness of dual-plate and plate-nail combinations for supplemental fixation of supracondylar distal femur fractures. We hypothesized that dual-plate constructs would be more stable in torsion, while plate-nail constructs would be more stable in axial compression.

Methods: 24 synthetic osteoporotic femurs were used to compare 4 constructs in an extra-articular supracondylar distal femur fracture gap model (OTA/AO type 33-A3). Constructs were as follows: (1) lateral distal femoral locking plate (LDFLP), (2) retrograde femoral nail (RFN), (3) dual-plate construct with LDFLP + medial 3.5-mm LC-DCP [limited contact dynamic compression plate], and (4) plate-nail construct with LDFLP + RFN. Specimens were cyclically loaded along the mechanical axis of the femur in both torsion and axial compression using an Instron testing machine. Fracture displacement was measured using video tracking software. Following synthetic model testing, dual-plate and plate-nail constructs were directly compared using 7 matched pairs of cadaveric femurs (range: 64-72 years). The primary outcome was construct stiffness in both torsion and axial compression in cadaveric specimens. Stiffness was calculated using the average slope of the force-displacement curve. Analysis was performed using a Kruskal-Wallis one-way analysis of variance with post-hoc Dunn test for synthetic femurs and a paired-samples t-test for cadaveric femurs.

Results: In cadaveric specimens, the dual-plate construct was nearly twice as stiff as the plate-nail construct across all torsional loads (8.41 ± 0.58 Nm/deg vs 4.24 ± 0.41 Nm/deg, $P < 0.001$), and over 2.5 times stiffer across all axial loads (3762.1 ± 337.1 N/mm vs 1448.9 ± 190.1 N/mm, $P < 0.001$). There were no construct failures. These cadaveric results were consistent with trends observed in the synthetic osteoporotic femurs, although not all differences were statistically significant in the synthetic models.

Conclusion: This study demonstrates that dual-plate constructs are significantly stiffer than plate-nail constructs in both torsion and axial compression in an extra-articular supracondylar distal femur fracture model. In the clinical setting, consideration must be given to the effect of increasing stiffness on fracture healing, as well as the biological impact of placing a second femoral intramedullary or medial surface implant. This study provides an important biomechanical profile of supplemental fixation techniques that have been proposed to improve fixation in complex distal femur fractures.

See the meeting app for complete listing of authors' disclosure information.