Noninvasively Quantifying in Vivo Distal Femur Fracture Motion

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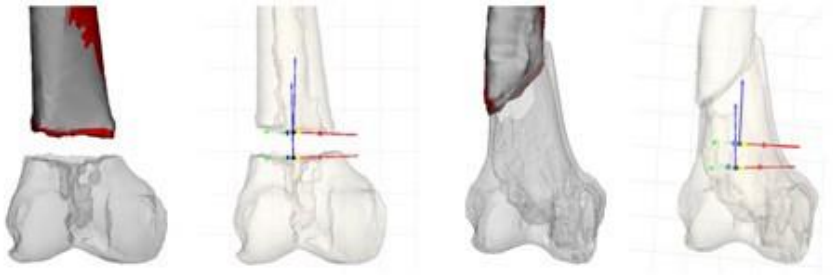
Purpose: We sought to develop noninvasive methods of quantifying in vivo distal femur (AO/OTA 31-A, B, C) fracture motion via weightbearing CT (WBCT) to aid future research into mechanotransduction of fracture healing.

Methods: We employed bone-based tracking of non-WBCT and WBCT for 7 osteotomized cadaveric specimens and 2 human subjects with distal femur fractures. Bone segments from pre-fixation CT (devoid of metal artifact) were registered to post-fixation imaging. Motion was assessed via planes registered to proximal and distal bone segments (parallel within non-WBCT and tracked during WBCT).

Results: Figures 1A (cadaveric) and 1C (in vivo) overlay non-WBCT (gray) and WBCT (red). Figures 1B and 1D demonstrate the position of the planes under load. Cadaveric and in vivo patterns of motion were similar (medial compression dominated with lateral plating). Cadaveric testing (Fig. 1B) demonstrated twice the motion medially as laterally (3.4 mm medially vs 1.5 mm laterally), and a 10-fold difference in vivo (2 mm medially and
0.2 mm laterally). Cadaveric testing demonstrated less and more symmetric motion for nailing than plating (Fig. 2), as did in vivo assessment after intramedullary nailing (<1-mm motion throughout the fracture).

Conclusion: Our results support that lateral plating is not “too stiff”, but dominated by asymmetric motion and shear, particularly with longer bridge spans. This method will allow objective assessment of motion for various clinical scenarios.



1A 1B 1C 1D
Figure 1: Cadaveric Results (Figure 1A and B) Mirrored by In Vivo Results in Human Subjects (Figure 1C and D).

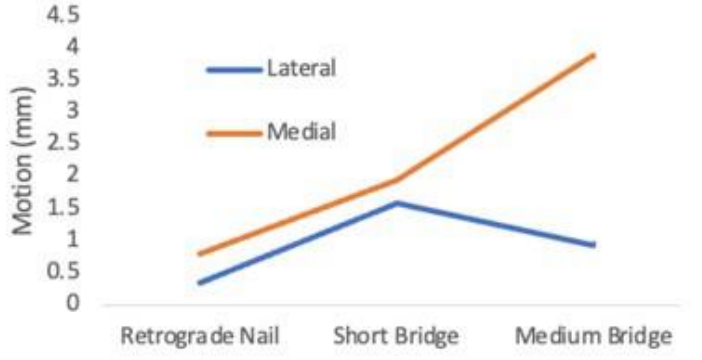


Figure 2: Cadaveric Data Demonstrate Greater and More Asymmetric Motion with Lateral Plating Relative to Nailing