Simulation-Enabled Measurement of Interfragmentary Strain in Distal Femur Fracture Fixation

Ajith Malige, MD; ***Andrew Jordan Kantzos, MD****; Jordan Inacio, BS;*
Hannah L. Dailey, PhD; Chinenye O. Nwachuku, MD, FAAOS
Lehigh University, Bethlehem, Pennsylvania, UNITED STATES

PAPER ABSTRACTS

Purpose: The objective of this study was to use patient-specific finite element analysis to assess interfragmentary strain in distal femur fractures that successfully united after lateral plating.

Methods: Distal femur fractures (OTA/AO 33-A/B/C) treated at a Level I trauma center over a 10-year period were retrospectively reviewed. Eight representative cases (6 males, 2 females; ages 22-95 years) treated with lateral bridge plating were selected for virtual mechanical testing. Preoperative CT scans were segmented in Mimics (Materialise). Bone fragments were virtually realigned, the articular surface reconstructed if necessary, and a 4.5-mm variable angle (VA) curved condylar locking compression plate (LCP) (DePuy Synthes) was added. Fixation was matched to the postoperative radiographs, with bridge spans of 21 to 126 mm. Models were loaded representing 20% to 100% static body weight in a single-leg stance. All simulations were performed in ANSYS.

Results: Models for all cases are shown in Figures 1A/B, with color bands highlighting regions experiencing effective (von Mises) strains >10% under 100% (1x) static body weight. As the bridge span and applied load increased, so did the maximum strains and the total volume of elements with strains greater than 10% (Fig. 1C).

Conclusion: Clinical rules of thumb for fixation biomechanics have long indicated that achieving 2% to 10% effective strain is an ideal goal. The patient-specific models in this study showed that some regions of the interfragmentary zone are likely experiencing strains much higher than 10%, even with very modest weightbearing, yet these patients all successfully united their fractures. This suggests that in vivo healing of distal femur fractures may be more robust to localized large strains than has been previously appreciated.