A Novel Fluoroscopic Sequence to Reveal Residual Elbow Instability Secondary to Medial Collateral Ligament Disruption

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Introduction

Specific indications for surgical fixation of the medial collateral ligament (MCL) remain controversial, including effective intraoperative assessment of residual medial elbow instability. Here, we propose a standardize stress fluoroscopic exam sequence to thoroughly evaluate for elbow instability and help identify unstable MCL injuries.

Methods

Eight paired cadaveric specimens (4/4 M/F, N = 16) were mounted to simulate intraoperative positioning. Fluoroscopic images were acquired using the following sequence: full extension, 45-degree flexion, 90-degree flexion and full flexion with the forearm in neutral/pronation/supination. These were acquired at "baseline", and following destabilization of the lateral ulnar collateral ligament (LUCL) and MCL. The proposed fluoroscopic sequence was then repeated following surgical fixation of the LUCL ("post-LUCL repair") followed by MCL repair ("post-LUCL & MCL repair). Blinded Images were fitted using a best-fit circle method onto the ulnohumeral joint (**Fig.1A**) to compute ulnohumeral distance (UHD, scaled to millimeters), and determine residual lateral (supination) and medial (pronation) instability defined by the presence of a "drop sign" (UHD>4 mm). Radiocapitellar ratio (RCR) was also computed to determine radiocapitellar instability (RCR > 10%). Blinded images were also qualitatively evaluated for the "drop sign" and radiocapitaller instability against the contralateral baseline, in order to simulate intraoperative setting.

Results

Baseline UHD did not differ across matched paired cadavers (P>0.05). Apparent instability in supination status-post destabilization resolved following LUCL repair with evident residual medial-sided instability showed in pronation (**Fig.1 A-C**), which disappeared after MCL fixation. Evaluation at 45 and 90 degrees of flexion showed comparable sensitivity (97% and 98%) for the "drop sign," unlike in full extension or full flexion (sensitivity <35%). Quantitative sensitivity was to 81% and 88% for RCR at 45 and 90 degrees of flexion. Qualitative clinical evaluation for the drop sign and RCR at 45 and 90 degrees was 93%, 92%, 68% and 72% sensitivity, respectively.

Discussion

The proposed fluoroscopic sequence provides reliable intraoperative assessment to evaluate for residual medial-sided instability in multiligamentous elbow injuries, following surgical repair of the LUCL. Radiocapitellar malalignment has more inherent variability both clinically and quantitively in comparison to the drop sign. The incorporation of this simple sequence into surgical workflows may improve intraoperative decision-making and help detect clinically relevant ligament injuries

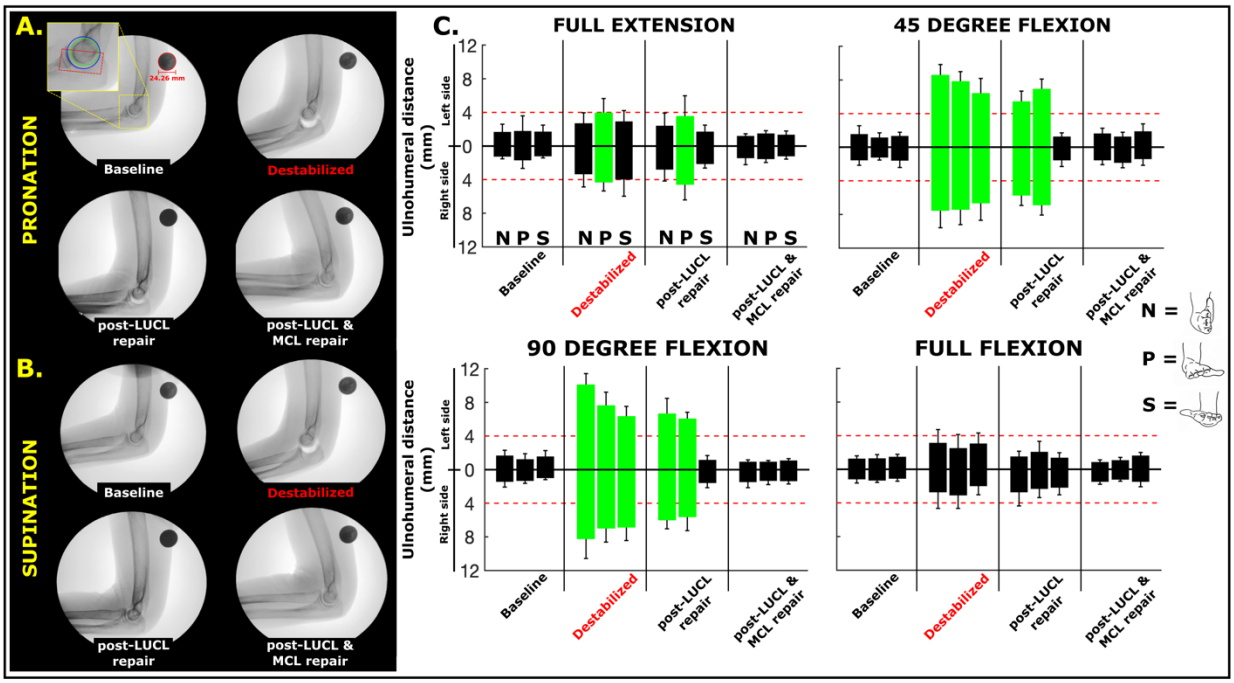

FIGURE 1. (A-B) Representative cadaveric specimen showing sample best-fit circle method (top left; green, capitellum; blue, ulnar notch; region of interest box, red) with scaled marker, as well as proposed fluoroscopic sequence including residual instability in pronation (A, bottom left), in comparison to supination (B, bottom left) after LUCL fixation (MCL disrupted). This resolved following MCL fixation. **(C)** Mean ulnohumeral distance (mm) derived from best-fit circle method for each elbow position (full extension, 45 degree flexion, 90 degree flexion and full flexion), following each staged intervention (x-axis), acquired with the forearm in neutral (N), pronation (P) and supination (S). Top left plot is labeled for reference and remainder of plots follow the same organization. Green bars indicate ulnohumeral distance > 4 mm, consistent with drop sign, as index for residual ligamentous instability.