The Effect of Distal Radius Translation in the Coronal Plane on Forearm Rotation: A Cadaveric Study of Distal Radius Fractures

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Purpose To determine the effect of lateral translation of the distal radius in the coronal plane on forearm rotation after distal radius fracture.

Methods Ten fresh cadaveric limbs underwent distal radius osteotomy just proximal to the distal radial-ulnar joint to simulate an extra-articular distal radius fracture. We used an Agee Wrist Jack external fixator to create increasing magnitudes of distal fragment lateral translation in 2-mm increments. Forearm rotation was measured using a 3-dimensional camera at each magnitude of lateral translation.

Results Total forearm rotation for the intact specimen and 2, 4, 6, and 8 mm (maximal) radial translations was 186° ± 53°, 188° ± 54°, 189° ± 55°, 190° ± 57°, and 193° ± 59°, respectively. There was no significant difference for any magnitude of radial translation. The average maximal radial translation possible before radioulnar abutment was 8 ± 0.5 mm.

Conclusions In this cadaveric model, translation of the distal radius fragment in the lateral direction had no effect on forearm rotation.

Clinical relevance At the level of the proximal border of the distal radioulnar joint, isolated distalradius translation does not significantly affect forearm rotation. *(J Hand Surg Am. 2014; 39(4):651–655. Copyright © 2014 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Distal radius fractures, forearm rotation, radial translation.

A potential complication in the treatment of distal radius fractures is malunion resulting in altered wrist mechanics,[1] loss of function, and the possible need for corrective osteotomy.[2]

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Radiographic parameters identified as predictive of functional outcome include radial height, radial inclination, ulnar variance, dorsal-palmar tilt, carpal alignment, and articular congruity.[3] To date, little attention has been paid to translation in the coronal plane.

In extra-articular distal radius fractures (AO 23–A2), the pull of the brachioradialis is a deforming force resulting in lateral translation of the distal fragment.[4] This deformity can be difficult to treat closed, although various techniques have been suggested.[5] Bronstein et al[6] performed a cadaveric analysis on the effects of a variety of distal radius fracture deformities on forearm rotation. In their limited model assessing a number of variables, 5 or 10 mm of lateral translation did not produce a significant change in forearm rotation. In our study, we aimed to test the hypothesis that extra-articular distal radius fractures with lateral translation of the distal fragment in the coronal plane result in restricted forearm rotation in a cadaveric model.

MATERIALS AND METHODS

Cadaveric model

We used 10 paired, fresh-frozen cadaver upper limbs from 5 cadaveric donors with intact hands, wrists, and elbows. There were 2 male and 3 female cadaver donors. Average age was 76 years (range, 55–92 y). Each specimen was thawed and screened radiographically for evidence of prior fracture or other bony abnormality. One specimen had evidence of a prior distal radius fracture with old screw holes from a volar plate, which was healed in anatomic alignment and had no baseline passive range of motion deficit, and was therefore included in the study. The specimens were sectioned at the level of the proximal humerus. We inserted a large threaded rod into the humerus to assist in mounting the extremity.

We then applied an Agee WristJack Fracture Reduction System (Hand Biomechanics Lab, Inc, Sacramento, CA) external fixator directly to the lateral aspect of the radius. Two pins were placed into the radial shaft. A single pin was placed into the distal radius using fluoroscopic assistance (Figs. 1, 2). The carpus and hand were left free. Baseline forearm rotation measurements were then taken as described in detail subsequently.

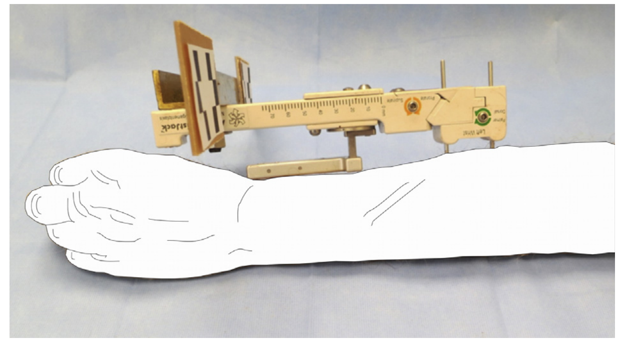

FIGURE 1: Experimental setup with external fixator applied to the distal radius. Camera markers are affixed to the external fixator via a rigid frame. The humerus is secured with a large intramedullary metal rod to facilitate mounting the specimen.

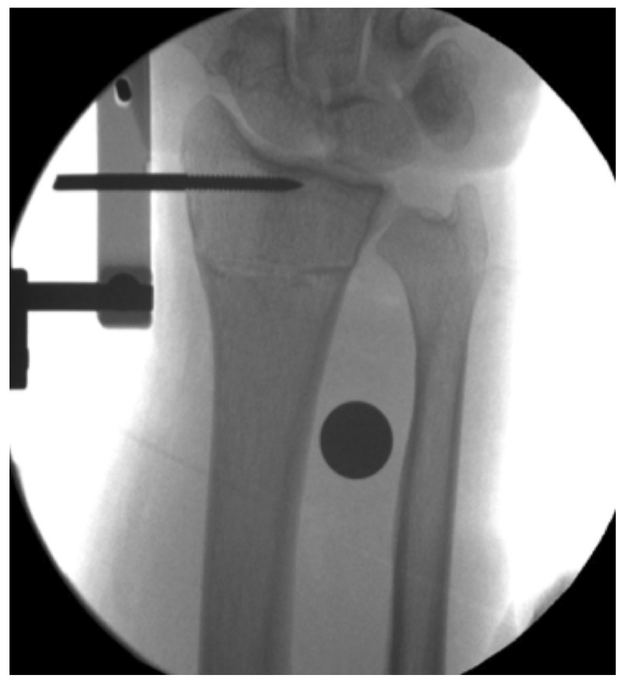

FIGURE 2: Radiograph before translation of the distal fragment. The osteotomy has been performed just proximal to the DRUJ. A radiopaque marker is present as a reference to measure the magnitude of translation. A single pin is present in the distal fragment. Two pins are placed in the shaft (not pictured).

We made a transverse dorsal incision directly over the planned osteotomy site. The third and fourth extensor compartment tendons were retracted medially. The second extensor compartment tendons were retracted laterally to expose the entire dorsal surface of the distal radius. We used a sagittal saw to create a complete distal radius cut that exited the medial border of the radius just proximal to the sigmoid notch and immediately adjacent to the distal radioulnar joint (Fig. 2). Special care was taken to avoid damaging the surrounding soft tissues.

Using the functionality of the Agee WristJack external fixator, we were able to laterally translate the distal radius fragment in 2-mm increments. Maximum translation occurred when the ulnar head and neck impinged on the radial shaft (Fig. 3). Translation was measured radiographically with a mini C-arm image intensifer. The external fixator translation screw was turned several turns, and translation was checked with the C-arm. We added turns of the translation screw until we arrived at each 2-mm increment of translation. A 12.7-mm-diameter radiopaque stainless-steel ballbearing marker was used to control for image magnification. The bearing was attached to each specimen in the same spot and was included in every C-arm image. We used a stainless-steel ruler to take scaled measurements directly on the screen of the C-arm image intensifer in real time. All images were saved digitally as Digital Imaging and Communications in Medicine files for possible later analysis. We saw no noteworthy motion