CONTACT AREAS AND LIGAMENT LENGTHS ARE ABNORMAL IN PATIENTS WITH MALUNITED DISTAL RADIUS FRACTURE DESPITE NORMAL RADIOULNAR KINEMATICS

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INTRODUCTION

Altered kinematics of the distal radioulnar joint (DRUJ) and/or bone impingement are considered causes of long-term complications associated with malunited distal radius fractures. However, a recent CT image-based *in vivo* study of patients with malunited distal radius fractures found that malunion did not alter forearm kinematics and that limitations of pronosupination were not caused by bony impingement (Moore et al., *in press*). In this study, data from the previous study was reanalyzed to explore focal changes in the articulation at the DRUJ (location and area of bone contact) and potential soft tissue constraints ('length' of the dorsal and palmar radioulnar ligaments).

METHODS

The bony surfaces and kinematics of both radii were obtained from the CT image volumes of nine volunteers with unilateral distal radius fractures (3M, 6F, age 55 ± 15.4 yrs.) scanned in neutral and multiple positions of supination and pronation (Moore et al., *in press*). The dorsal angulation and radial shortening of the injured wrists averaged 20.9 ± 5.8 degrees and 4 ± 3 mm, respectively. Focal changes in the articulation of the distal radius and ulna were assessed by comparing the area and location of bony contact. Contact area was estimated using a distance field representation thresholded to distances less than 5 mm. The location of the centroid of the contact area was described in a coordinate system with the origin at the ulna-carpal surface and positive in a proximal direction. Potential soft tissue constraints were assessed by calculating the 'length' of the dorsal and palmar radioulnar ligaments, defined as the shortest paths between insertion points constrained to avoid bone penetration. Paired Student's t tests were used to compare the uninjured and malunited DRUJs. P values = 0.05 were considered to be statistically significant. The data reported here are for the neutral positions.

RESULTS

Ulna contact area was smaller and was located more proximally in the malunited forearms than in the uninjured contralateral forearms (Figure 1, Table 1). The length of the dorsal radioulnar ligament paths was on average 27% longer in the malunited forearms; the palmar ligament path lengths did not differ. In seven of the nine malunited forearms, the dorsal radioulnar ligament curved around the head of the ulna as it passed from the ulna to the radius. The average deflection of the dorsal radioulnar ligament in the malunited forearms was 0.65 mm. No dorsal deflection was found for uninjured forearms.

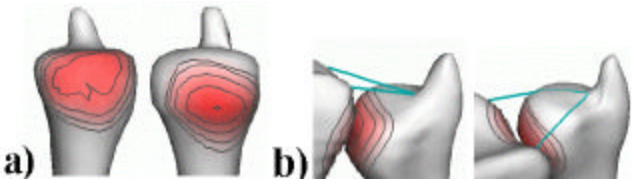

Figure 1. a) Contact areas on both ulnas from a single volunteer. The shading and contours (1 mm apart) show distance to the radius. Note proximal shift and decreased size for malunited (right). **b)** Ligament paths for two forearms, same volunteer. Note ligament deflection for malunited (right).

Table 1. Contact area (5 mm threshold), location of the centroid of the contact area, and dorsal and palmar ligament lengths in neutral pronosupination.

	Uninjured	Malunited	P < 0.02
Contact Area (mm^2)	208.1 ± 46.8	170.4 ± 43.0	Yes
Centroid location (mm)	3.7 ± 0.8	5.3 ± 0.4	Yes
Dorsal lig. length (mm)	12.1 ± 1.9	15.4 ± 2.1	Yes
Palmar lig. length (mm)	14.8 ± 1.2	15.0 ± 2.8	No

DISCUSSION

Although Moore et al. found no significant differences in the pronosupination kinematics of the malunited and uninjured wrists evaluated, this study found significant differences in the size and location of the joint contact area, and in the soft tissue constraints of the DRUJ. The significant change in the dorsal radioulnar ligament length, but not in palmar ligament length, is consistent with the original malunion (all tilted dorsally). The proximal shift in the location of the centroid of the contact area is consistent with the radial shortening. The changes reported here present a possible etiology for the development of degenerative joint disease, and the change in ligament length may be one mechanism for the limitation of pronosupination.

REFERENCES

Moore et al., *J Hand Surgery* (*in press*)

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