SCIENTIFIC ARTICLE

Predicting a Safe Screw Length for Volar Plate Fixation of Distal Radius Fractures: Lunate Depth as a Marker for Distal Radius Depth

Karin L. Ljungquist, MD, Sonya P. Agnew, MD, Jerry I. Huang, MD

Purpose We hypothesized that the lunate depth as measured on plain lateral radiographs can be used to predict distal radius depth radially and ulnarly and serve as a useful reference for intraoperative screw placement in volar plate fixation of distal radius fractures.

Methods Plain radiographs and magnetic resonance imaging (MRI) of the wrists of 30 patients were reviewed. The lunate depth and the maximal depth of the distal radius were determined from plain lateral radiographs. Depth of the distal radius, measured in quartiles, was determined from axial MRI images, and the lunate depth was obtained from sagittal MRI images. The depth of the distal radius in each quartile was then calculated related to the lunate depth.

Results The mean depth of the lunate on plain radiographs and MRI was 17.5 mm and 17.4 mm, respectively. The depth of the distal radius from ulnar to radial was 18.4 mm, 20.2 mm, 19.4 mm, and 15.1 mm for the 1st through 4th quartiles, respectively. The depth of the distal radius is the least radially (4th quartile), with a mean 87% of the lunate depth, and greatest in the 2nd quartile, with a mean 116% of the lunate depth.

Conclusions The depth of the lunate as measured on plain radiographs can be used as a marker for drilling and placement of safe screw lengths during volar plate fixation of distal radius fractures. We recommend that surgeons use the lunate depth as an estimate for the length of their longest screw when fixing distal radius fractures with volar plate techniques to avoid extensor tendon irritation and rupture. *(J Hand Surg Am. 2015;40(5):940–944.*

Type of study/level of evidence Therapeutic III.

Key words Distal radius depth, distal radius fracture, extensor tendon rupture, lunate depth, volar plating.

Extensor tendon rupture is a recognized complication of volar plate fixation of distal radius fracture. It may result from direct trauma to the tendons during drilling of the dorsal cortex or from attritional rupture due to placement of excessively long screws. Reported incidence of rupture varies between 2% and 9%.[1–5] The extensor pollicis longus (EPL) tendon is at the highest risk of direct injury or attritional rupture. EPL tendon ruptures can also occur with nonoperative management of distal radius fractures, with reported rupture rates of 1% to 5%.[3,6]

Cadaver studies attempting to determine the precise locations of structures have been helpful in defining anatomy but are flawed in that relationships between structures are altered by surgical dissection. Use of advanced imaging in patients without prior surgery would provide more accurate measures of the distance between structures. An ideal method to avoid excessive screw length would be to determine

From the Department of Orthopaedic Surgery, University of Washington, Seattle, WA.

Received for publication July 14, 2014; accepted in revised form January 8, 2015.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: K.L. Ljungquist, MD, Department of Orthopaedic Surgery, Kaiser Permanante Northwest, 3500 N. Interstate Ave, Portland, OR 97227; e-mail: kljun01@gmail.com.

0363-5023/15/4005-0010$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2015.01.008

the depth of the distal radius at different locations with a technique using each individual patient's unique anatomy. The surgeon would be aided by an ability to determine the expected screw length preoperatively based on an individual patient's radiographs, ensuring that the dorsal cortex is not penetrated during screw drilling and placement.

We hypothesized that the depth of the lunate could be used as a proxy to predict the ideal screw length in volar plating of distal radius fractures, thereby decreasing the risk of extensor tendon rupture. The objectives of this study were to determine the average depth of the lunate and the depth of the radius at 4 points moving from ulnar to radial and correlate those measurements to the depth of the lunate. This would allow for prediction of the depth of the radius across its width, based on information easily attainable from a lateral radiograph of the wrist. This would allow the surgeon to preoperatively predict the expected and safe length of screws in volar plate fixation of distal radius fractures.

MATERIALS AND METHODS

With approval from our institutional research board, we evaluated magnetic resonance imaging (MRI) scans and plain radiographs of 30 wrists without lunate or distal radius pathology. There were 10 men and 20 women, with a mean age of 42 years.

The depth of the lunate was measured on lateral plain radiographs (Fig. 1) and was compared to the maximal lunate depth as measured on sagittal MRI scans. The maximal depth of the distal radius on lateral radiographs (Fig. 1) was recorded and compared to the maximal depth on sagittal MRI cuts. The sagittal and axial MRI images were linked, and the axial cut that corresponded to the watershed line on the sagittal image was selected for measurements. The depth of the distal radius was measured on axial MRI images at 4 evenly divided locations (quartiles), 1 mm proximal to the watershed line as correlated on sagittal images. We measured starting ulnarly at the sigmoid notch and moved radially. The first quartile width measurement was done 2 mm lateral to the medial edge of the radius, representative of maximally medial screw placement. Each subsequent quartile was then based off of the total width of the radius from this point divided into 4 equal portions, so that the radius was divided into 4 evenly spaced portions across its width, starting 2 mm lateral to the medial edge of the bone (Fig. 2). The first and second quartiles corresponded to the lunate facet, and the third and fourth quartiles corresponded to the scaphoid facet. Independent measurements were taken by 2 of the authors at different time points and compared for interobserver reliability.

FIGURE 1: Lateral wrist radiograph demonstrating location of measurements for *A* lunate depth and *B* maximal radius depth.

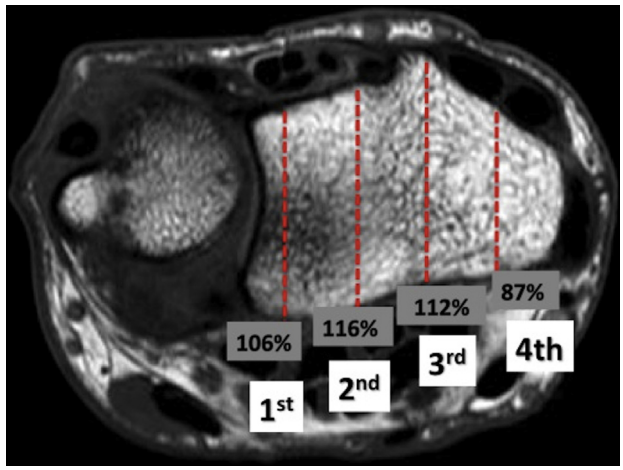

FIGURE 2: Measurement location of each depth quartile moving across the distal radius ulnar–radially on axial MRI.

Statistical analysis comparing the measurements from plain radiographs and sagittal MRI cuts from the same patients was performed with the Student paired *t* test with significance set at *P* less than .05.