Predicting Alignment After Closed Reduction and Casting of Distal Radius Fractures

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Purpose We sought to independently validate the McQueen equation and LaFontaine's criteria as predictors of instability in a large series of distal radius fractures treated nonsurgically. In addition, we hypothesized that restoring the volar cortical integrity (ie, volar hook) would be another factor that would independently predict the maintenance of a closed reduction in a cast.

Methods We screened 546 consecutive distal radius fractures with 168 meeting all inclusion criteria. Dorsal tilt, radial height, radial inclination, ulnar variance, and carpal malalignment were measured on initial postreduction and final radiographs. A univariate analysis evaluated the predictability of the McQueen equation, Lafontaine's criteria, and volar hook on each radiographic parameter. A multivariate analysis was performed using the significant results from the univariate analysis.

Results In the univariate analysis, the McQueen formula, the number of Lafontaine criteria, and age all correlated with radial height, radial inclination, and ulnar variance. In the multivariate analysis, age correlated with the most radiographic factors including radial height, radial inclination, ulnar variance, and carpal alignment at healing. Volar hook correlated with dorsal tilt and carpal alignment at healing, and dorsal comminution correlated with dorsal tilt.

Conclusions In the nonsurgical treatment of distal radius fractures, we were able to validate the McQueen equation and Lafontaine's criteria in predicting the final radial height and inclination and final ulnar variance. Neither method was predictive of final dorsal tilt or carpal malalignment. However, restoring volar cortical continuity by hooking the volar cortex in the initial reduction proved to be the strongest predictor of final volar tilt, the change in volar tilt, and carpal malalignment at union. *(J Hand Surg Am. 2015;40(5):934–939.*

Type of study/level of evidence Therapeutic III.

Key words Alignment, casting, distal radius, fracture.

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ALTHOUGH DISTAL RADIUS FRACTURES account for approximately 16% of all fractures treated by orthopedic surgeons, controversy exists in trying to determine which fractures are best treated surgically. Two commonly used approaches have been used to predict the loss of reduction in distal radius fractures treated nonsurgically and as such are used as operative indications. In 1989, Lafontaine et al[1] identified 5 criteria (4 radiographic; 1 demographic) that predicted malunion. They concluded that any patient with 3 or more of these criteria would

likely lose position in a cast despite adequate initial closed reduction. More recently, McQueen et al[2] devised a formula to predict the probability of developing a malunion in distal radius fractures treated nonsurgically. Both methods are used extensively to guide the treatment of distal radius fractures. In addition, although both methods use dorsal comminution as a component in predicting loss of reduction, no definition was provided to guide others in applying this criterion.

In our study design, we sought to independently validate the McQueen equation and Lafontaine's criteria in a large series of distal radius fractures treated nonsurgically. In doing so, we specifically defined dorsal comminution, and we applied our definition in evaluating all fractures. We hypothesized that the McQueen equation and Lafontaine's criteria would correlate with the radiographic outcomes at final healing. In addition, based on the senior author's (P.T.) experience, we hypothesized that restoring the volar cortical integrity (volar hook) would aid in maintaining volar angulation and reduction in distal radius fractures treated closed with a standard 3-point molded cast. We sought to evaluate the effect of the volar hook as one of the many factors that would predict the final reduction and change in reduction over time in this patient cohort.

PATIENTS AND METHODS

After obtaining institutional review board approval, we used our prospectively collected departmental database to identify 546 distal radius fractures that were treated at our institution from January 2005 to April 2011. Every patient presented with prereduction injury wrist films (posteroanterior, oblique, and lateral views). Initial treatment of all closed fractures in the emergency room consisted of application of weighted traction with closed reduction and placement of a 3-point molded short-arm circumferential plaster cast with the wrist in slight flexion and ulnar deviation. All reductions and cast applications were performed by an orthopedic surgery resident, ranging from postgraduate year 2 to postgraduate year 5. Immediately after reduction, casted plain films for the same views were obtained in all cases.

Inclusion criteria for the study were skeletally mature patients with complete metaphyseal (extra-articular and intra-articular; AO classification 23-A2, 23-A3, 23-C1, 23-C2) distal radius fractures with a minimum of 10° of dorsal tilt on the lateral radiograph at presentation who had adequate presentation, postreduction, and final union anteroposterior and lateral radiographs.[3] A minimum of 10° of dorsal tilt was required for 2 reasons. First, fractures with less angulation rarely lose volar cortical alignment on the lateral radiograph, meaning we would not be able to assess the effect of restoring lost volar cortical alignment on the postreduction lateral radiograph. Second, we sought to eliminate those fractures on each end of the spectrum (absolute operative and absolute nonsurgical) and isolate only those fractures that generate controversy in deciding on the appropriate route of treatment. In addition, this same criterion was used in the study that developed the McQueen equation.[4] Union was defined as the 6-week follow-up visit or the date of final cast removal. For anatomically reduced fractures (or near anatomical), an adequate lateral radiograph was defined as a standard scaphoid-pisiform-capitate radiograph. For nonreduced fractures in which the carpus was rotated, an adequate lateral radiograph was defined as having at least 50% overlap of the distal radius on the distal ulna. Exclusion criteria consisted of skeletally immature patients, inadequate radiographs, patients lost to follow-up prior to fracture union, patients going on to operative treatment, distal radius fractures with associated ulnar metaphyseal fractures, partial articular injuries (ie, volar Barton, radial styloid; AO classification 23-B1, 23-B2, 23-B3), and open distal radius fractures.[3] Each patient was evaluated with x-rays by an orthopedic trauma surgeon every other week in clinic until final healing. Those patients who presented for follow-up with a loose cast or minor shift in fracture position within the first 2 weeks were recasted to help prevent further translation.

In screening 546 consecutive distal radius fractures, we eliminated 271 patients who did not have a minimum of 10° of apex volar angulation or had partial articular fractures. Of the remaining 275 fractures, 74 went on to surgery or chose surgery after a discussion of options, 14 displaced in the cast after 2 weeks and went on to surgery, and 19 had incomplete or inadequate radiographs, leaving 168 who were treated nonsurgically and had adequate follow-up radiographs to be included in the statistic analyses. This group formed the basis of the study. One hundred sixteen were women and 52 were men. Patient ages ranged from 18 to 96 years with an average age of 52 years.

For these 168 patients, we used both radiographic data and the prospectively collected data from the database to calculate the McQueen malunion equation and Lafontaine's criteria for instability.[1,2] The McQueen equation requires the patient's age, presence