Lunate–Lunate Facet Ratio and Variance to Predict Articular Gap After Distal Radius Fracture

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Purpose Intra-articular gap is a well-defined prognosticator of outcome after distal radius fracture. However, it is often difficult to assess on plain radiographs, particularly in the sagittal plane, as visualized on the lateral view. The purposes of this study were to establish normal values for the lunate–lunate facet ratio (LLFR) and to evaluate whether the LLFR and lunate–lunate facet variance (LLFV) are reliable plain film measures of sagittal articular gap in distal radius fractures compared with sagittal reconstructions of computed tomography (CT) scans.

Methods We studied 35 uninjured, skeletally mature wrist radiographs to establish the normal LLFR value. The LLFR was defined as the ratio of the maximum width of the lunate (A) to the width of a line spanning the maximum distance from dorsal to volar across the articular surface of the lunate facet, defined by the end point of the radiographically thickened line representing the subchondral bone (B). The LLFV was determined as measurement B minus measurement A. Interobserver and intraobserver reliability for 2 observers were examined by the intraclass correlation coefficient (ICC) for measurements of the uninjured wrists and for the same measurements of 20 intra-articular distal radius fractures. For 12 of the subjects with fractures, the LLFR and LLFV were correlated with the intra-articular gap as measured on CT scan using simple linear regression.

Results The mean value of the LLFR in the normal subjects was 1.00 ± 0.04 for observer 1 and 1.00 ± 0.02 for observer 2. There was significant intraobserver reliability for both uninjured (ICC = 0.83, $p < .001$) and fractured wrists (ICC = 0.87, $p < .001$), as well as significant interobserver reliability for uninjured (ICC = 0.69, $p < .001$) and fractured wrists (ICC = 0.64, $p = .015$). The LLFR was significantly associated with articular gap on sagittal CT reconstructions ($R^2 = -0.81$, $p < .01$). The LLFV correlated highly with articular gap on sagittal CT reconstructions ($R^2 = 0.83$, $p < .01$).

Conclusions The LLFR, measured on the lateral radiograph of the wrist, exhibits high intraobserver and interobserver reliability, with a normal value of 1.0. Both the LLFR and the LLFV are significantly related to articular gap on sagittal CT reconstruction images. The LLFR decreases with increasing intra-articular gap formation. The LLFV allows a direct estimation of articular gap size. *(J Hand Surg 2009;34A:1625–1632. © 2009 Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand.)*

Type of study/level of evidence Diagnostic III.

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Outcome after distal radius fracture has been closely linked to the quality of reduction of the articular surface.[1–4] Radiographic methods currently used to assess articular reduction include measurement of articular step-off and articular gap. These measurements are frequently used as surgical indications by surgeons[5]; thus, accurate assessment of radiographs is critically important. Whereas some radiographic measurements have been shown to be accurate and reproducible in a cadaveric model,[6] other studies have demonstrated considerably less reliability of radiographic measures in the clinical setting.[7,8] Kreder et al. determined that a single observer will differ by more than 2 mm in his or her measurement at least 10% of the time, and 2 observers will differ by more than 3 mm at least 10% of the time. They summed up their findings by stating that "even experienced clinicians did not readily agree on the size of step and gap deformity."[8]

We have observed that, although articular gap and step-off may be well appreciated on the anteroposterior (AP) wrist radiograph in many instances, it is routinely difficult to assess these measures on the lateral film. Consequently, displacement in the sagittal plane is often underappreciated compared with displacement in the coronal plane. Distal radius fractures with displacement primarily in the sagittal plane may appear minimally or even nondisplaced when viewed on the AP film.

Given the difficulties in assessing sagittal plane articular step-off and gap on plain radiographs, we believe a new method of plain film measurement is desirable. This measurement should be easily reproducible and correlate with articular involvement. With this interest, we have developed the lunate–lunate facet ratio (LLFR) and measurement of the lunate–lunate facet variance (LLFV). These measurements use readily identifiable bony landmarks as a surrogate measure of articular displacement. Instead of attempting to measure the amount of articular gap directly, this technique moves the site of measurement away from the zone of the fracture, allowing one to find more reliable radiographic landmarks, which should result in increased reliability. The purposes of this study were to determine the normal values and intra- and inter-observer reliability of these measurements, the LLFR and LLFV, and to determine whether they are reliable indicators of articular gap formation after distal radius fractures compared with computed tomography (CT). No comparison was made in the current study between direct measurements of articular gap on x-ray and on CT scan, because this comparison has been evaluated previously, with CT scan shown to be superior.[7]

MATERIALS AND METHODS

All radiographic review was performed after we obtained institutional review board approval.

Definition of LLFR

All measurements are made on a standard lateral wrist radiograph, taken with the wrist placed in neutral rotation and deviation. The radiographic beam is oriented perpendicular to the long axis of the radial shaft. The quality of the radiograph may be determined by evaluating the relative position of the pisiform to the distal pole of the scaphoid, as described by Medoff.[9] On a true lateral the pisiform should overlap the distal pole of the scaphoid. All radiographs used in the current study satisfied this criteria. The 10° lateral projection described by Medhoff was not employed in this study because the standard lateral wrist radiograph is more frequently encountered in evaluating emergency department films, and we have noted considerable variability in technique of specialized views.

On the lateral radiograph, the following measurements are obtained (Fig. 1): Measurement A is the maximum width of the lunate, as measured perpendicular to its longitudinal axis. Measurement B is the maximum width of the lunate facet of the distal radius. The lunate facet is measured as a line spanning the maximum distance between the volar and dorsal end points of the articular surface. The articular surface can be defined by its thickened underlying subchondral bone. The most dorsal and volar points are marked where this thickening of the subchondral bone ends. These points are distinct from the most volar and dorsal cortical margins. In almost all cases, one may identify this distinction between the cortical margin and the actual lunate facet surface, which is visible on the radiograph as a distinct line that is more radiographically dense than the intervening cancellous bone. This line is visible on radiographs of fractured wrists, as it courses dorsally, outlining the articular surface. The authors measured the lunate facet as the distance between the dorsal and volar points. The identification of these points may be enhanced by inverting the image contrast (Fig. 1). It is important not to mistake the scaphoid facet for the lunate facet; the radiographic line demarcating the scaphoid facet generally maintains a gross conformity with the scaphoid, even in the fractured wrist. This line is distinguished from the lunate facet because it may contact or even overlie the lunate. In Figure 2B, this margin is seen just above the volar arrow-