

Inter- and Intra-rater Reliability of Ulna Variance Versus Lunate Subsidence Measurements in Madelung Deformity

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Purpose To assess inter- and intra-rater reliability of both ulna variance and lunate subsidence measurement methods in a large consecutive series of children with Madelung deformity.

Methods Ulnar variance and lunate subsidence were measured on 41 standard anteroposterior wrist radiographs from 31 patients with Madelung deformity. The patients had a mean age of 13 years (range, 5–25) at the time of presentation. Two pediatric orthopedic hand/upper limb surgeons evaluated all radiographs twice in a 4-week interval using standard digital imaging software. Intraclass correlation coefficients (ICCs) were calculated for inter- and intra-rater reliability, and results were reported using the Landis and Koch criteria.

Results The interrater ICC for the ulna variance measurements was substantial, and for the lunate subsidence almost perfect. The intra-rater ICC for ulna variance was substantial for both raters. In contrast, the intra-rater ICC for lunate subsidence was almost perfect for both raters.

Conclusions Measurement of lunate subsidence showed both superior interrater and intra-rater reliability compared with the ulnar variance method. Whenever relative ulna length is assessed in children and adolescents with Madelung deformity, the lunate subsidence should be the preferred method to characterize deformity. (*J Hand Surg Am.* 2015;40(1):62–66. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)

Type of study/level of evidence Diagnostic IV.

Key words Lunate subsidence, Madelung deformity, reliability, ulnar variance.



MADELUNG DEFORMITY IS A GROWTH disturbance of the distal radial physis eventually leading to a progressive deformity of the wrist during growth.¹ As a consequence the majority of

patients develop relative ulna overgrowth and may subsequently develop ulnar-sided wrist pain. The prominent ulna, caused by the premature closure of the volar–ulnar radial physis, is therefore one of the pathognomonic clinical findings in moderate to severe cases.

Although ulnar variance can generally be measured using anteroposterior (AP) wrist radiographs for many pediatric and adult wrist pathologies, the utility of this measurement in Madelung deformity remains controversial.² There is a risk of measurement error when evaluating this deformity; the radial plateau and particularly the lunate fossa may be severely tilted and thus, the horizontal reference line, which defines the length of the radius, is difficult to identify. McCarroll et al proposed measurement of lunate subsidence as a better method for characterizing this pathological

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FIGURE 1: Ulnar variance in this patient is +1 mm (arrow). Note, however, that the ulnar border of the distal radius physis is rather round and not a distinct edge.

deformity.³ Nevertheless, many pediatric hand surgeons still prefer to measure ulnar variance when defining the deformity and/or deciding when an ulnar shortening osteotomy is indicated.

The lunate subsidence, in contrast, is relatively easy to measure because it compares ulna length to the (normal) anatomy of the proximal pole of the lunate, which migrates proximally with the entire carpus. Patients with Madelung deformity and normal controls showed a wide overlap of subsidence from lacking 5 mm to 3 mm.⁴ A subsidence threshold of 4 mm has been found to be characteristic for this deformity.⁵ The lunate subsidence method has shown to be reliable between observers.³ The purpose of this study was to assess inter- and intrarater reliability of both ulnar variance and lunate subsidence measurement methods in a large consecutive series of children and adolescents with Madelung deformity.

METHODS

This retrospective study was approved by our institutional review board prior to the chart review. All patients with the diagnosis of Madelung deformity who underwent surgery between 1999 and 2013 were identified using an electronic medical record database. After exclusion of cases with insufficient or missing digital imaging, 31 patients (41 wrists) remained for evaluation and inclusion in this study. The included patients represented a wide range of radius deformity, ranging from mild to severe alteration of their wrist geometry. Two independent, fellowship-trained pediatric orthopedic hand surgeons performed a standardized assessment of



FIGURE 2: The arrow indicates where the radial plateau is tilted downwards. This particular, often sclerotic-appearing, point was chosen as the reference point for placement of the horizontal measurement line.

ulnar variance and lunate subsidence according to previously established criteria.^{3,6} First, both observers familiarized themselves independently with the methodology of the measurement methods. Then, a pilot series of measurements built consensus regarding measurement methodology before study radiographs were rated individually. All study measurements were performed using AP wrist radiographs, which were obtained in the same institution in a standardized manner prior to wrist surgery. Measurements were made on digital images using standard software (Synapse PACS, Fujifilm, Stamford, CT). Thereafter, measurements were repeated after a 4-week interval by both raters in order to assess intrarater reliability. For this reason, the raters were blinded to their first readings, and all radiographs were evaluated in random order for the second evaluation.

Ulnar variance was assessed using a modified method of perpendiculars (Fig. 1).⁶ First, a line was placed along the longitudinal axis of the ulna. Then, a perpendicular line at the most distal aspect of the articular surface of the ulna, excluding the ulnar styloid, was drawn. We then measured the longitudinal distance from this perpendicular line to the most ulnar aspect the radial plateau. Given the fact that the ulnar border of the radius in Madelung deformity is often distorted and/or tilted, the observers agreed on the following radius reference point: the most ulnar sclerotic aspect of the radial plateau (lunate facet) beneath

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