EDITOR'S CHOICE

Intrarater Reliability of Range of Motion Measurements of the Uninjured Wrist in Women After Distal Radius Fracture

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Purpose To determine the intrarater reliability of serial wrist and forearm range of motion (ROM) measurements of the uninjured limb, by 1 evaluator using a standardized technique of measurement, in women who have sustained a distal radius fracture.

Methods From December 2007 to December 2014, skeletally mature women who had sustained an isolated distal radius fracture routinely had sequential measurements of wrist extension and flexion as well as forearm supination and pronation in both their injured and their uninjured limbs, at a minimum of 3-week intervals. The senior author (G.H.F.J.) used a standardized technique of measurement of ROM throughout this period, and these data related to the uninjured wrist and forearm were retrospectively reviewed.

Results Of 508 women who had a distal radius fracture, 506 had the measurements made of the uninjured wrist and forearm on 2, 300 on 3, and 128 on 4 separate occasions. The average age of the women was 61 years, with a range from 16 to 94 years. The intraclass correlation coefficients between measurements over time for extension, flexion, and supination measurements were 0.71, 0.63, 0.68, respectively, and 0.47 for pronation. The intraclass correlation coefficient varied according to patient age, but without specific progression in any age group for any ROM. Extension, flexion, and supination decreased significantly as age increased, whereas forearm pronation did not.

Conclusions Measurement of wrist and forearm motion of the uninjured limb can be reliably reproduced by a single rater, most so for extension, flexion, and supination, and less so for pronation. Interrater reliability assessment remains to be evaluated.

Clinical Relevance Given the intrarater reliability of wrist and forearm motion measurement, the opposite (uninjured) wrist probably represents a useful reference metric for motion restoration for recovery from injury to the opposite limb. *(J Hand Surg Am. 2017;■(■):■−■.*

Key words Motion, reliability, uninjured, women, wrist.

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DISTAL RADIUS FRACTURES (DRFS) are common among adult women, and the evolution of treatment has seen a shift from nonsurgical cast management in favor of surgical care. Debate, however, continues as to which of many treatments is most appropriate for each individual patient. Restoration of wrist and forearm range of motion (ROM) anticipated from an intervention is an important consideration in this debate, yet the method and reliability of measurement are generally not cited,

raising uncertainty as to the validity of authors' conclusions[1–7]— many features can influence the measurements including examiner-related and patient-related factors, which in turn might put at risk the interpretation of how ROM has been restored after a DRF.

Furthermore, to determine the extent of restoration of wrist and forearm ROM, a reader should have a reference as to what the injured wrist's motion ought to be. In the absence of known pathology, the opposite uninjured wrist and forearm should lend itself to this function.

With these concerns over method and reliability of measurement and reference ROM in mind, the principal purpose of this study was to evaluate the reliability of 1 examiner's (G.H.F.J.) measurement of active wrist extension and flexion, as well as forearm supination and pronation, using a standardized measurement technique, of only the uninjured wrist and forearm in a cohort of women who had sustained a DRF. Secondary outcomes were to quantity the limits and changes of wrist and forearm ROM associated with age and hand dominance.

MATERIALS AND METHODS

Institutional research ethics board approval was obtained to review measurements of ROM of the uninjured wrists of women treated in the DRF clinic before the review was conducted.

From December 2007 to December 2014, skeletally mature women who had sustained an isolated DRF were seen in a dedicated DRF outpatient clinic, generally within 1 to 2 weeks of their fracture and initial treatment, regardless of whether they had undergone surgical or nonsurgical management. During their subsequent fracture care, serial distal radial radiographs were taken, and clinical examination findings (bilateral wrist extension and flexion, bilateral forearm supination and pronation, and grip strength) and Patient-Rated Wrist Evaluation[8] scores were recorded. Hand dominance was recorded.

Patient-related features that might contribute to inconsistent serial ROM measurements in the uninjured limb, such as pain from injury or arthritis, excluded patients from the study. Although scaphotrapeziotrapezoid and thumb basal joint arthrosis were observed frequently in the injured wrist radiographs in the older patients, screening radiographs of the uninjured wrists to exclude these, and any other unidentified abnormalities, were not performed. Presence of asymptomatic clinical features of these conditions, especially related to the thumb basal joint, did not disqualify patients from the study. No congenital deformities of the bones of the wrist or forearms were identified in the radiographs of the injured limbs.

Serial wrist and forearm ROM measurements were made at a minimum of 3-week intervals. Having observed substantial variation in ROM measurements between examiners, the senior author (G.H.F.J.) sought to first evaluate his own measurement reliability. For this study, only those measurements made by the senior author (G.H.F.J.), an upper extremity subspecialist orthopedic surgeon, were included. Measurement of the uninjured wrist ROM was started while the patient's opposite wrist and forearm were immobilized in a cast (during the first 5–6 weeks postreduction), and then at 9 weeks and beyond, concurrent with measurement of the ROM of the injured wrist.

All measurements were made with a 12-inch transparent plastic goniometer (Model G300; Whitehall Manufacturing, City of Industry, CA). A standardized technique for measurement of active ROM was established *a priori*. With the patient seated, the shoulder in approximately 90° of forward elevation and internal rotation, and the elbow flexed to a right angle, an ulnar technique for wrist motion measurement was chosen, using the ulnar shaft as the forearm axis reference.[9] Easy identification of the tip of the olecranon and ulnar head and its shaft's subcutaneous nature make it relatively easy to align the goniometer. In this study, the technique was modified by electing to measure wrist extension and flexion with the patient maintaining a closed fist—in both directions, the reference third metacarpal was easier to visualize with a fist made (Figs. 1, 2). It was acknowledged that patients could measurably further increase their wrist flexion, but not extension, by extending their fingers, a phenomenon attributed to the limited excursion of the finger extensors. To eliminate this variation, all measurements were made in this closed-fist standardized fashion.

For forearm rotation measurement, the patients were asked to sit upright and to secure both elbows to their sides, with the elbows flexed roughly to a right angle. The proximal wrist crease was used as a reference point for supination, not only to eliminate the contribution of carpal supination but also to better reflect the rotation within the forearm radioulnar complex, specifically the distal radioulnar joint (Figs. 3, 4).

In all circumstances patients were encouraged to use maximal effort in reaching the limits of ROM.