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Normal Ranges of Ulnar and Radial Deviation with Reference to Ulnar Variance

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We aimed to determine the normal ranges of radial and ulnar deviation of the wrist in relation to the ulnar variance. A total of 102 healthy subjects (204 wrists) were included in the study. The ranges of radial and ulnar deviation of the wrists were measured using a universal goniometer. Ulnar variance was assessed manually or radiographically, and recorded as ulna minus, ulna plus or ulna minus/plus. When the ranges of radial and ulnar deviation were compared with ulnar variance, ulnar deviation was greater in ulna minus subjects and radial deviation was greater in ulna minus/plus subjects. There was no significant difference in the total range of radio-ulnar deviation. The results of this study indicate that ulnar deviation is greater in ulna minus wrists, and we suggest that ulnar variance should be recorded alongside measurements of radial and ulnar deviation.

KEY WORDS: Wrist joint; Ulnar variance; Ulnar deviation; Radial deviation; Range of motion; Goniometry; Measurement; Wrist disorders

Introduction

Measurements of the range of motion (ROM) of joints are commonly recorded in a patient's medical information, as they are considered to be acceptable clinical data for evaluating impairment.[1,2] A number of reports have provided estimates of the normal ROM of the wrist joint,[1,3,4] but there are no data in the literature concerning the range of ulnar and radial deviation of the wrist with reference to the relative lengths of the radius and ulna (i.e. ulnar variance). Variations in ulnar variance have been suggested to be involved in the aetiology of several disorders, including Kienböck's disease,[5,6] post-traumatic scapho-lunate dissociation,[7] ulno-carpal impingement syndrome[8] and Essex–Lopresti proximal radial fractures.[9]

We undertook this study to determine the normal range of radial and ulnar deviation of the wrist in relation to the ulnar variance.

Subjects and methods

SUBJECTS

Volunteers (medical students and nurses) aged 18 – 24 years who did not have a history of illness or wrist joint injury were recruited to this study. The local ethics committee approved the study protocol and all subjects gave informed consent.

MEASUREMENT OF RANGE OF WRIST MOTION

Both right and left wrist joints were examined in all subjects. The active range of wrist motion was measured using a full-circle manual goniometer made of flexible clear plastic with arms 30 cm in length. This device fulfilled the requirements of a universal goniometer as described by Moore.[10] The protractor portion was divided into 1° increments, and a scale on one of the arms made it possible to obtain measurements to the nearest degree. During measurement the subject's forearm was flexed at the elbow joint to 90° and the forearm was fully pronated. For comfort, the subject was positioned with approximately 20° of abduction at the shoulder joint. The forearm and hand were kept on a stabilizer platform throughout the testing procedure.[4] In the starting or neutral position the hand was in line with the midline of the forearm. The fulcrum of the goniometer was placed on the dorsal aspect of the wrist joint over the capitate bone. The stationary arm of the goniometer was placed along the midline of the forearm and the movable arm along the third metacarpal.[4] The subject was then instructed to move the hand to maximum ulnar and radial deviation, and the degree of deviation measured.

MEASUREMENT OF ULNAR VARIANCE

Ulnar variance was assessed by manually palpating the most distal parts of the radius and ulna to assess the relative lengths of the bones at the carpal surface.[11] In uncertain cases, standard postero-anterior radiographs of the wrist were taken and direct measurements were made.

The ulnar variance of each wrist was recorded as ulna minus (ulna shorter than the radius), ulna plus (ulna longer than the radius), or ulna minus/plus (ulna and radius of equal length).

ASSESSMENT OF OBSERVER RELIABILITY

Two examiners independently evaluated the ROM and ulnar variance. There were 15 subjects evaluated as part of a pilot study to assess intra-observer reliability. Measurements were repeated 1 week apart and the intra-observer reliability calculated.

Inter-observer reliability was assessed at the end of the study using the data from all of the subjects.

STATISTICAL ANALYSIS

Statistical analysis was performed using independent and paired *t*-tests as appropriate. Intra- and inter-observer reliabilities were assessed using Kappa values. A P-value < 0.05 was considered significant.

Results

A total of 102 healthy volunteers (204 wrists) were included in the study. Fifty-five subjects were female, 47 were male and all were functionally right-handed.

The mean Kappa values for the intra- and inter-observer reliabilities were 0.95 and 0.92.

On assessment of the ulnar variance, 59 subjects (118 wrists) were ulna minus, while the remaining 43 (86 wrists) were ulna minus/ plus. No ulna plus wrists were present in the population studied. In 13 subjects, there was uncertainty in determining the ulnar variance clinically; radiographs revealed ulna minus/plus variant wrists in all these cases.

When the ranges of radial and ulnar deviation were compared with ulnar variance, ulnar deviation was greater in ulna minus subjects (39.87 ± 5.16° versus 37.12 ± 5.69°, $P = 0.02$), and radial deviation was greater in ulna minus/plus subjects (25.63 ± 6.13° versus 23.91 ± 5.43°, $P = 0.035$). There was no significant difference in the total range of radio-ulnar

deviation (ulna minus, 63.93 ± 6.46°; ulna minus/plus, 62.76 ± 6.85°).

There was no significant difference in the ROM of the wrist with regard to side or gender.

Discussion

Objective measurements of joint function are being required with increasing frequency as indices of improvement following treatment. They are also often an essential component of impairment ratings. There are several reports in the literature concerning the normal ulnar and radial deviations of the wrist joint,[1,4,12,13] but there are little data on the relationship between ulnar variance and these movements.

In our study, ulnar deviation of the subjects was significantly greater in ulnar minus subjects, and radial deviation was greater in ulna minus/plus subjects. The total range of radio-ulnar deviation was the same in the two groups, but ulnar variance affected the relative contributions made by the radial and ulnar deviations to the total range. This should be kept in mind when assessing the ROM of the wrist.

Negative ulnar variance has been proposed as a predisposing factor in the development of Kienböck's disease;[5,6] the joint levelling procedures used to treat this condition are based on this observation.[14] It has been suggested that increased compressive loads are placed on the lunate in individuals with negative ulnar variance, which may account for the development of trabecular bone collapse and aseptic necrosis.[12] This view, however, is not universally held.[15,16]

During daily activities such as holding and manipulating objects, the wrist joint is more ulnarly deviated[17,18] and the lunate bears a greater load.[19] Since grip strength is increased in the ulnar-deviated wrist,[18] tools tend to be designed for use in ulnar deviation,[20] and wrist fusion is performed in this position.[21] In our opinion, ulna minus individuals are more prone to develop Kienböck's disease because they can deviate their wrists more ulnarly, placing a greater load on the lunate[19] and increasing the risk of aseptic necrosis. Joint levelling procedures used to treat Kienböck's disease probably act by limiting ulnar deviation. The ranges of ulnar and radial deviation are not included in the commonly used evaluation criteria for this type of surgery.[22] Some reports, however, highlight the decrease in ulnar deviation after joint-levelling procedures.[14,23]

The position of the upper extremity significantly affects the amount of radial and ulnar deviation at the wrist joint. In a literature review, Spilman and Pinkston[4] found that radial and ulnar deviations ranged from 14.5 – 50.9° and 25.0 – 66.1°, respectively, depending on the position of the arm. It is, therefore, important to use the same test position when making intra- and inter-observer comparisons. In our study, measurements were performed with the subject's elbow at 90° of flexion, the shoulder at 20° of abduction and the forearm fully pronated, which is the most comfortable position.

Our results clearly indicate that ulnar deviation is greater in ulna minus wrists. We suggest, therefore, that ulnar variance should be recorded alongside measurements of radial and ulnar deviation.

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