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A Review of Factors Playing a Role in the Assessment of Ulnar Variance

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Abstract

Context: Ulnar variance (UV) is attributed to the natural history of several wrist disorders. Thus, its reliable measurement is of considerable clinical importance. Several factors are proposed to affect the UV measures; the current study aimed at discussing these factors to further clarify their role in the evaluation of UV.

Evidence Acquisition: The evidence of the current review was derived from literature published in English in PubMed to identify papers discussing the factors affecting UV measurement. The title and abstract of the articles published prior to October 2017 were checked. After the exclusion of non-relevant studies, 16 articles were found eligible for investigation.

Results: Based on the available evidence, the perpendicular technique is the most reliable method of UV assessment. Magnetic resonance imaging (MRI) is also reported as the best imaging method for UV measurement. Moreover, the most increase in UV is expected when the position changes from relaxed supination to pronation and grip status. It seems that aging affects UV, at least until maturity, with a shift toward less ulnar minus position. In addition, ulnar plus wrist position seems to be more frequent in females. Repetitive minor wrist trauma can also change wrist radiologic parameters, especially ulnar variance.

Conclusions: Among several potential factors affecting the UV, the role of some factors such as positioning, imaging, and measurement technique are well defined, while the role of some others such as age and gender needs further clarifications in future investigations.

Keywords: Ulnar Variance, Assessment, Techniques

1. Context

Ulnar variance (UV) refers to the relative lengths of the distal articular surfaces of the radius and ulna, not a constant ratio among individuals or during lifetime. The UV is considered neutral when the difference between ulnar and radius length is less than 1 mm, positive when UV ulna projects more distally, and negative when it projects more proximally (1).

UV is attributed to the natural history of several wrist disorders including carpal instability (2), the Kienbock disease (3, 4), and ulnocarpal impaction syndrome (5). Thus, its reliable measurement is of considerable clinical importance. However, several factors may affect the quality of this evaluation (6), and several aspects of this assessment remain controversial. Due to the importance of UV in correct wrist function and its associated pathologic disorders, factors playing role in UV should be more codified.

2. Evidence Acquisition

A search of literature published in English prior to October 2017 in PubMed was performed to identify citations related to UV. The following MeSH (Medical Subject Headings) terms were employed: "Ulnar Variance OR Hulten variance". Subsequently, a title and abstract search was conducted to identify appropriate articles discussing the UV assessment. Following the elimination of non-relevant and duplicate articles, a total of 16 articles related to factors affecting the UV assessment were included in the current study.

3. Results

3.1. Measurment Techniques

To date, several methods are advocated to evaluate UV. Project-a-line technique (Figure 1A), concentric circles (Figure 1B), and perpendiculars (Figure 1C) are considered as the most common methods of UV measurement. Steyers et al. compared the reliability of these 3 methods. According to their report, although all the 3 methods were highly reliable, perpendiculars technique was the most reliable one with respect to inter and intra-observer reliability. They suggested that clinicians may use whichever techniques of these 3 they prefer (7).

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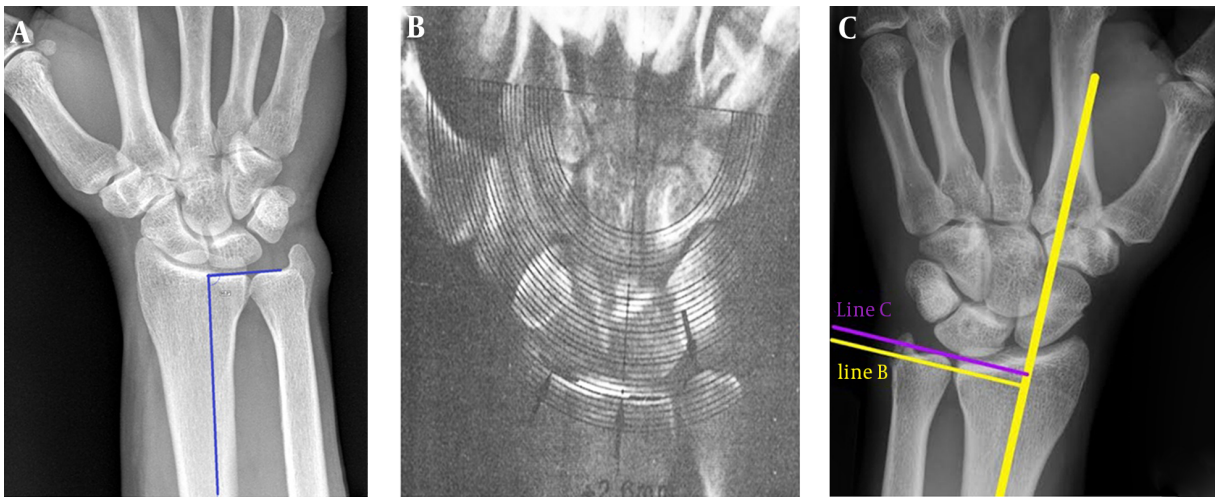
Figure 1. The Most Common Methods of Ulnar Variance Assessment



A, Project-a-line technique; B, Concentric circles method; C, Perpendiculars method.

3.2. Imaging Modality

Emergence of the new imaging modalities such as computed tomography (CT) scan and magnetic resonance imaging (MRI) seem to make the difference of various techniques less meaningful. Laino et al. evaluated the correlation of different imaging modalities including plain radiograph, CT, and MRI on UV assessment. Their results demonstrated excellent inter-observer reliability for all imaging systems, and MRI was the best (8). Kadzielski et al. retrospectively assessed UV on MRI and compared it with UV on radiographs; they showed that in spite of no difference in UV between different hand positions in MRI, plain radiographs significantly underestimated the magnitude of negative UV (9). Yoshioka et al. also showed that high-resolution MRI can clearly demonstrate triangular fibrocartilage complex and cartilage of wrist and ulnar variance and it is a useful tool to assess ulnar side structures and UV relationship (10).

3.3. Grip and Positional Changes

Forearm position is known as a factor that significantly affects the UV measures. Sonmez et al. defined a mean increase of 1.81 mm in UV measures during a shift from supination to pronation state (11). Yeh et al. reported a 0.6 mm increase in UV measures in full pronation compared with full supination position (12). Jung et al. reported maximum value of UV when gripping in pronation and minimum value of UV when relaxed in supination (13). Tomaino et al. reported an average UV increase of 2.5 mm using pronated grip view as well, with a maximum increase of 4 mm (14). Choi et al. evaluated the change of the UV regarding the forearm rotation in patients with ulnocarpal impaction syndrome. According to their report, the maximum change of UV was observed in supination to pronation position and grip status for all cases (15). Epner et al. also demonstrated that while supination increased the measures of negative UV, pronation decreased the value of this measure. Furthermore, their study showed that wrist deviation and alterations of the x-ray beam in the longitudinal plane influenced the UV measurement. They advised the use of standard wrist roentography techniques for all wrist films (16).

The provided evidence supported measuring UV both in standard and pronated grip views in patients with ulnar side wrist pain.

3.4. Age and Gender Differences

During fetal growth, UV shows a trend from ulna-negative to an ulna neutral state (17). This phenomenon seems to continue later in life; therefore, there is a significant UV change toward less ulnar minus state with aging (18). After maturity, this trend stops and no significant alteration in UV is observed afterward (19). Since young adolescent males have greater degrees of negative UV, compared with their female counterparts, no significant differences was observed in older adolescent groups (20). Nakamura et al. reported a positive correlation between UV and age in normal wrists of Japanese population, which was lower in males than females. A significant gender related difference in UV was also confirmed even when the difference in age was considered. In this respect, they detected

negative ulnar variance in 36.1% of males and 13.1% of females. Accordingly, they suggested that studies comparing UV in abnormal and normal wrists required carefully selected age- and gender-matched controls (6).

3.5. Right versus Left Side Asymmetry

The study by Freedman et al. on 100 skeletally mature healthy volunteers showed an average dynamic UV of 0.93 $\pm$ 1.5 mm on the left and 0.82 $\pm$ 1.5 mm on the right wrists. Furthermore, when compared individually, a $\geq$ 1 mm side to side difference was observed in UV of 37% of the subjects under static and 38% under dynamic conditions, according to wrist radiography. According to these results, they suggested that the application of normal wrist radiographs as baseline for static UV measurement is valid in only 63% of the cases (21). Hollevoet et al. studied the standard radiographs of both wrists of 50 healthy volunteers. According to their results, the average differences between the right and left wrists were 1.5 for radial inclination, 0.5 for UV, and 2.5 for palmar tilt. They concluded that both wrists of an individual can be regarded symmetrical for these parameters, and UV of contralateral wrist provided a better reference than those of the population data (22).

3.6. Aquired Positive UV

Excessive repetitive compression loading could result in premature closure of the radial physis and differential growth of the radius and ulna, giving rise to an acquired positive UV. Such a positive UV is reported following chronic epiphyseal injuries such as the ones in adolescent gymnasts. Chang et al., evaluated the effects of repetitive stress on Chinese opera school students attending vigorous morning activities. Based on their results, mean UV and frequency of ulnar plus wrists increased in the study subgroups. Moreover, widening of physis was regarded as the most common finding. According to their results, chronic repetitive stress in the wrists of adolescent gymnasts resulted in growth disturbance of the distal radius with subsequent ulnar-plus variance, causing permanent sequelae, even in asymptomatic individuals (23). Smet at al. also reported a considerable increase in the ulnar length in immature gymnasts compared with nonathletes. Repetitive injury and compression of the wrist was reported as the cause of this premature closure of the distal radial growth plate resulting in secondary ulnar overgrowth (24).

4. Conclusions

According to the current review, several factors might affect the UV measures and should be considered to evaluate UV. The roles of some of these factors such as positioning, imaging, and measurement technique are well defined, while the effects of others such as gender and age should be clarified further.

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