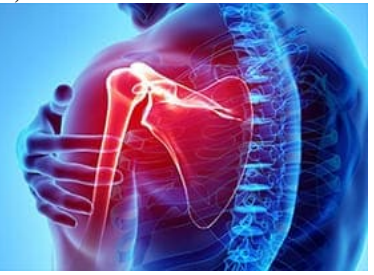


International Journal of Orthopaedics and Traumatology



ISSN Print: 2664-8318
ISSN Online: 2664-8326
Impact Factor: RJIF 5.42
IJOT 2023; 5(1): 46-49
www.orthopedicsjournal.in
Received: 01-04-2023
Accepted: 06-05-2023

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Scapholunate distance (SLD) measurement and defining a normal range of SLD in Non-Traumatic wrist X-rays

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DOI: <https://doi.org/10.33545/26648318.2023.v5.i1a.27>

Abstract

Background: Scapholunate dissociation is a common condition in wrist injuries, necessitating precise radiological assessment. The scapholunate distance (SLD) on posteroanterior (PA) wrist radiographs is a critical parameter in diagnosing this condition. However, variations in measurement methods and definitions of "normal" values have led to a need for standardization.

Methods: We conducted a study to establish a standardized protocol for wrist radiographs and determine normal SLD values in a non-traumatic population. A total of 100 wrist radiographs, primarily taken for non-traumatic indications, were included in the study. Patient positioning, technical factors, and measurement methods were standardized. Demographic data, including age, sex, hand dominance, and diagnosis, were recorded.

Results: The mean SLD for all 100 wrists was 3.435 mm, with a standard deviation of 1.398 mm. Male wrists had a mean SLD of 3.767 mm (SD 0.27 mm), while female wrists had a mean SLD of 3.178 mm (SD 1.813 mm). A statistically significant difference in SLD was observed between male and female subjects. However, no significant differences were found based on age, handedness, or diagnosis. None of the radiographs exhibited the scaphoid "cortical ring" sign.

Discussion: The study highlights the variability in SLD measurement methods and the lack of consensus on normal values. Our proposed normal limits, based on gender, are SLDs of up to 5 mm in males and 4.5 mm in females. This research emphasizes the importance of standardized protocols for wrist radiographs and provides valuable reference values for clinical practice.

Conclusion: Standardizing wrist radiographs and establishing gender-based normal SLD values are essential steps towards accurate diagnosis and management of scapholunate dissociation. Our findings contribute to the improvement of clinical assessment protocols for wrist injuries, ensuring more reliable and consistent results in patient care.

Keywords: Scapholunate dissociation, wrist instability, scapholunate distance, standardized protocol, patient positioning, cortical ring sign, carpal instability, radiological assessment

Introduction

The scapholunate distance is one of the most critical radiological parameters to consider when assessing a wrist injury for scapholunate dissociation and carpal instability. Poster anterior wrist radiographs are commonly employed to evaluate this parameter. Various sources in the literature describe a distance greater than 2, 3, or 4 mm as indicative of scapholunate dissociation [1, 7]. This variability can be attributed to different measurement methods. With the widespread availability of digital radiography, we made an attempt to standardize this measurement. This involves defining the patient's position during X-ray imaging, insisting on a Postero-anterior (PA) view, maintaining a standardized distance between the X-ray tube and the wrist, ensuring the wrist is in a neutral position with the 3rd metacarpal and radius axially aligned, and watching for any foreshortened appearance of the scaphoid [10, 11]. Additionally, we recommend looking for the 'cortical ring' sign in wrist radiographs, which should raise a high index of suspicion for scapholunate dissociation, regardless of the scapholunate distance.

Materials and Methods

We have standardized the protocol for taking wrist radiographs in our facility as follows:

a) Standardized patient position: (Figure 1)

- The patient is seated alongside the table.
- The affected arm is abducted 90° so that the arm and wrist can rest on the table at shoulder height, aligning the radius and ulna in parallel.
- The affected hand is placed palm down on the image receptor.

b) standardised technical factors: (Figure 2)

- Utilize a posteroanterior projection.
- Center the X-ray beam over the midcarpal region.
- Implement collimation as follows:
 - Laterally to the skin margins.
 - Distally to the midway point of the metacarpals.
 - Proximally to include one-quarter of the distal radius and ulna.
- Keep the orientation in portrait mode.
- Use a detector size of 18 cm x 24 cm.
- Set the exposure to 50-60 kVp and 3-5 mAs.
- Maintain a Source Image Distance (SID) of 100 cm.

Following this protocol, we included 100 radiographs taken at our facility during March to May 2023. Our study exclusively incorporated radiographs taken for non-traumatic indications, such as de Quervain's tenosynovitis, ganglion cysts, carpal tunnel syndrome, or radiographs of normal wrists taken as controls for comparison with contralateral side. Furthermore, in instances of bilateral wrist radiographs, only one side was included in the study, resulting in a total of radiographs obtained from 100 different patients. The study comprised 43 males and 57 females. Information on age, sex, hand dominance, and diagnosis was meticulously recorded. All radiographs were meticulously reviewed using the Phillips Vue Motion PACS software. The measurement of the distance from the proximal ulnar-most corner of the scaphoid to the proximal radial-most corner of the lunate (figure 3) was conducted by a senior radiologist using the software.

Results

The mean scapho-lunate distance for all 100 wrists was 3.435 mm, with a standard deviation of 1.398 mm (Table 1).

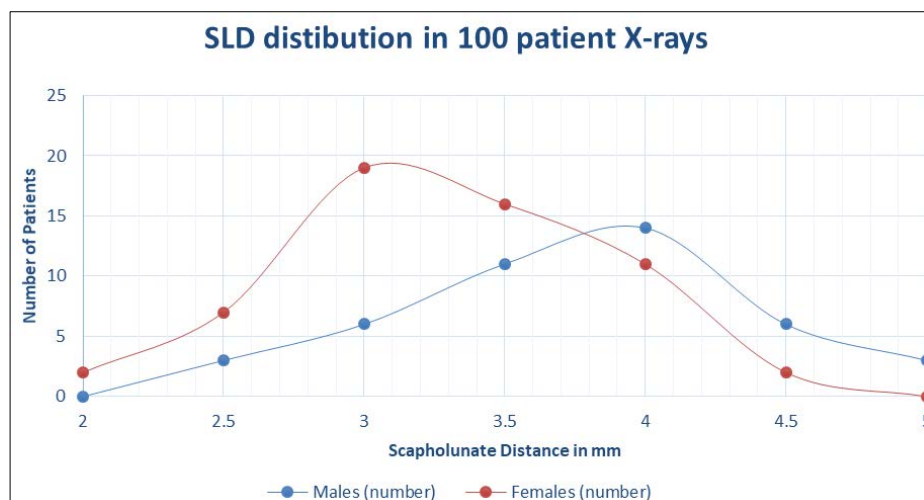
The measurements ranged from 2 to 5 mm. Among the 43 male wrists, the mean measurement was 3.767 mm, with a standard deviation of 0.27 mm. In contrast, the mean distance for the 57 female wrists was 3.178 mm, with a standard deviation of 1.813. Notably, the standard deviation in females was significantly higher than in males, indicating greater variability in values, while in males, it remained relatively uniform. No significant differences in measurement were observed with respect to age, handedness, or diagnosis, as confirmed by the Student t test ($p > 0.05$). However, regarding gender, there was a statistically significant difference in measurements between male and female subjects, as indicated by the Student test ($p < 0.05$). None of the radiographs demonstrated a scaphoid "cortical ring" sign.

Table 1: The mean scapho-lunate distance for all 100 wrists

Scapholunate Distance (in mm)	Males (number)	Females (number)	Total (%)
2	0	2	2
2.5	3	7	10
3	6	19	25
3.5	11	16	27
4	14	11	25
4.5	6	2	9
5	3	0	3
Total	43	57	100

Discussion

Scapholunate instability is the most common type of carpal instability associated with distal radius fractures [1, 2]. Scapholunate Distance (SLD) on radiographs has been a widely used radiological parameter for assessing scapholunate ligament injury and scapholunate instability. Dobyns *et al.* [3] and Linscheid *et al.* [4] reported that an SLD greater than 2 mm indicated scapholunate dissociation. Belsole [5] suggested that an SLD greater than 3 mm was abnormal. Gilula and Weeks [6] reported that an SLD less than 2 mm was normal, while an SLD greater than 4 mm was abnormal. Moneim [7] employed "tangential" radiographs with the forearm pronated in eight volunteers to establish the scapholunate gap, considering 0-2 mm as normal. Suzuki *et al.* suggested the use of CT for evaluating SLD [8].



Graph 1: Graphical representation suggests female patients have average lesser Scapholunate distance [mean 3.178], with a relatively wider spread [SD 1.813] as compared to male who have average more Scapholunate distance [mean 3.767] with a narrower spread [SD 0.27]

Pliefke *et al.* [12] reported that both the Scapholunate Distance (SLD) and scapholunate angle on standard wrist radiographs were significantly larger in cases of scapholunate dissociation compared to control cases. Conversely, Kwon *et al.* [13] found that among 49 wrists with unstable distal radius fractures (DRF), 17 had an unstable scapholunate joint with Geissler grade 3 or 4, and there were no significant differences in the scapholunate angle or SLD between the group with unstable scapholunate joints (Geissler grade 3 or 4) and the group with stable scapholunate joints (Geissler grade 2 or less).

The variability in the method of measuring the SLD and the inconsistency in suggested 'normal' SLD values in asymptomatic wrists with no history of trauma underscore the need for evaluating normal wrists with a standardized protocol for wrist radiographs in the posteroanterior (PA) view, using standardized patient positioning and technical factors. This approach would provide non-pathological control values, assisting in defining what might constitute pathology.

We propose that utilizing posteroanterior radiographs of the wrist in a neutral position, along with the measurement method described in this study for scapholunate dissociation, can yield reproducible results. Our findings indicate that the mean scapholunate distance for male wrists is 3.767 mm, while for female wrists, it is 3.178 mm. Notably, the standard deviation in males (0.27 mm) is considerably less than in females (1.813 mm), suggesting greater variability in normal wrists among females in terms of this measurement. (Graph 1)

Emphasizing the importance of maintaining a neutral wrist position with the 3rd metacarpal and radius axially aligned cannot be overstated, as it helps prevent scaphoid flexion in the presence of scapholunate dissociation. Additionally, the presence of a foreshortened scaphoid or the 'cortical ring sign' on X-rays takes precedence over the SLD measurement and strongly indicates scapholunate instability, regardless of the SLD [14].



Fig 1: Patient positioning for wrist PA view with A) SID (source image distance) 100 cm, with arm abducted 90 (B), and elbow flexed 90 degrees (C)

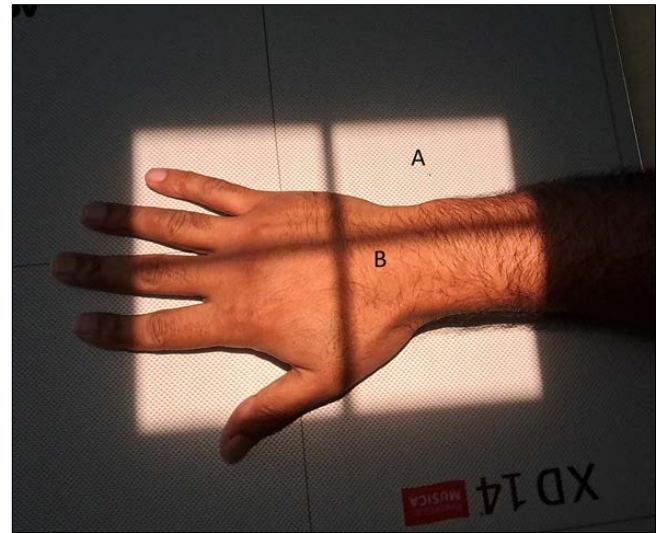


Fig 2: PA view with A) portait mode and B) wrist in neutral with 3rd metacarpal and distal radius axially aligned



Fig 3: Measurement of scapholunate distance on PA view of wrist xray from the proximal ulnar-most corner of the scaphoid to the proximal radial-most corner of the lunate

Conclusion

In conclusion, we suggest that scapholunate distances of up to 5 mm in males and 4.5 mm in females should be considered within normal limits, as long as there is no evidence of a foreshortened scaphoid or the presence of the 'cortical ring sign' with the wrist in a neutral position.

Conflict of Interest: Authors have no conflict of interest to declare

Financial Support: Not available

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How to Cite This Article

Batra A, Khan IA, Batra J, Battala S. Scapholunate distance (SLD) measurement and defining a normal range of SLD in Non-Traumatic wrist X-rays. *International Journal of Orthopaedics and Traumatology.* 2023;5(1):46-49.

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