



Morphometric and Morphological Study of Lower End of Ulna

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ABSTRACT

The human hand is a grasping tool that is adaptable for performing various complex functions. The wrist is a complex joint that serves as the link between the forearm and hand and is critical for many upper extremity movements. Lower end of ulna is made up of four main parts, viz, seat, pole, fovea and styloid process. These parts play an important role in anatomy and physiology of distal radioulnar joint (DRUJ) and wrist. Any alterations in the morphometric and morphology can produce various clinical conditions like perforation of TFCC, ulnar impaction syndrome, ulnar styloid triquetral impaction syndrome. Thus the relationship of distal end of ulna with radius & ulnar carpus are important from the functional point of view.

Keywords: Lower end of Ulna, Seat, Pole, Styloid process, Distal radioulnar joint

INTRODUCTION

The lower end of the ulna is of great anatomical and physiological significance for normal hand functioning. The distal end of the ulna consists of the articular head (POLE) of ulna, & non-articular ulnar styloid process and fovea. When describing the structure and function of the bones and joints of

the wrist and hand in the context of kinesiology, the terms 'pole' and 'seat' are mainly used in relation to the head of the ulna (Fig.1). The 'pole' (of an bean or semilunar, semicircular or comma shape) articulates with the triangular fibrocartilaginous complex (TFCC) which separates it from the wrist joint; the remaining portion, is narrow, convex

and received into the ulnar (Sigmoid) notch of the radius called "SEAT". The styloid process attaches to the ulnar collateral ligament of the wrist joint. A non-articular recess separates the articular surface of the distal-most end of the ulna from the attachment of the TFCC at the fovea of the ulnar styloid process for the attachment of the apex (ligamentum subcruciatum) sometimes contains vascular foramina, and behind by a shallow groove for the tendon of the extensor carpi ulnaris. The ulnar head is not only the fixed point of the distal forearm and wrist, around which the forearm and the carpus with the hand rotates, it is also an integral part of the ulnocarpal wrist joint and important for load transfer from the hand to the forearm. There is general agreement that the mechanism of injury in an ulnar dorsal dislocation of the DRUJ is hyperpronation and in ulnar volar dislocation is hypersupination. Galeazzi-fracture dislocations can also be associated with fracture of the ulnar shaft and styloid process in high-energy trauma.

Many reports on the diagnosis and treatment of injuries of the DRUJ under-emphasised the role of the lower end of the ulna. Many of these irreducible dislocations commonly have displaced fracture of the ulnar styloid process as an associated features.

Our anatomical studies revealed the detailed structural anatomy of the lower end of the ulna. The detailed morphometric data on regular anatomy in this study would be helpful to the design of ulnar head prosthesis.

AIM & OBJECTIVES

The aim of the study is to know structural detail of lower end of ulna i.e, variation in the shape and width (mm) of the pole, height of the seat (mm), width of fovea (mm), shape and size of styloid process (mm) which will be helpful in prosthesis formation in treatment of DRUJ injury.

MATERIALS AND METHODS

In the present study 50 dry Human ulnae (Rt 27, Lt 23) of unknown sex obtained from Department of Anatomy, Shri Sathya Sai Medical College & Research Institute, Ammapettai were used. Approval for the study was obtained from the Institutional Ethics Committee. Only bones in regular shape, without any deformities and/or trauma were selected.

Anatomical measurements were taken using digital vernier calliper. Frequencies of the data were tabulated and separated according to the side. Appropriate statistical analysis was done wherever applicable. The mean and standard deviation (SD) of measurements were noted as mean $M \pm SD$. Each ulna was studied for different features, such as the shape of the pole, maximum width of the pole along the transverse axis (mm), slope of the seat, maximum vertical height of the seat (mm), maximum width of the fovea (roughened depression at the base of the styloid process) along the transverse axis (mm). Also noted were the presence or absence of vascular foramina in the fovea, the presence or absence of styloid process, the shape and length (base to apex) of the styloid process, and the presence or absence of grooves for extensor carpi ulnaris (ECU).

RESULTS

All quantitative measurements of the pole, seat, fovea and styloid process of the 50 ulnae (27 right and 23 left sided) were taken and tabulated. The mean and standard deviation of each parameter was calculated (TABLE 1), and the various shapes of the poles and styloid process were noted. The ulna seat (sloping and non-sloping surfaces), the presence or absence of vascular foramina of the fovea and that of ECU groove were also observed and their percentage tabulated (TABLE 2).

Table 1. Quantitative analysis of various parameters of the distal end of ulnae

Component	Measurement	Mean ± SD (mm)	Mean ± SD (mm)
		Rt Side (n=27)	Lt Side (n=23)
Pole	Max width	5.9915 ± 0.65469	5.9778 ± 1.18940
Seat	Max Height	6.6641 ± 1.12164	5.9835 ± 0.87738
Fovea	Max width	2.5644 ± 0.78071	2.2991 ± 0.70233
Styloid process	Length	4.1896 ± 0.67743	4.6987 ± 0.90076

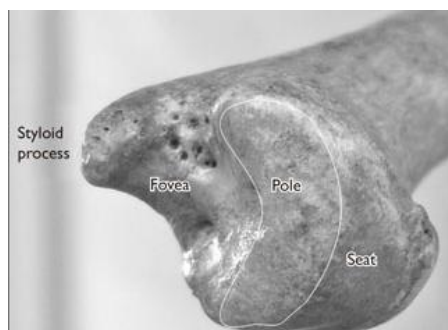


Fig:1. Showing Parts of Lower end of Ulna

Table 2. Measurements of various parts of the distal end of the ulna.

Component	Right (n=27)	Left (n=23)	
POLE			
Kidney	37.03%	52.1%	
Semilunar	37.03%	26.08%	
Semicircular	14.8%	13.04%	
Comma	11.11%	8.6%	
FOVEA (VASCULAR FORAMINA)			
Present	66.6%	82.6%	
Absent	33.3%	17.3%	
ECU GROOVE			
Shallow	48.1%	56.5%	
Deep	48.1%	39.1%	
Absent	3.7%	4.3%	
STYLOID PROCESS			
Over all	Straight	74.07%	60.86%
	Curved	22.2%	39.1%
Tip	Blunt	74.07%	82.6%
	Pointed	22.2%	17.3%
Absent	3.7%	-	

DISCUSSION

DRUJ injury can occur in association with fracture of the forearm or as an isolated phenomenon. A dislocation of this joint may be simple or complex. The possibility of DRUJ injury should be kept in mind when treating wrist, forearm and elbow injuries. The distal end of the ulna comprises the head, fovea and styloid process. The anatomical relationships of the distal ulna with the distal radius and the ulnar carpus are precise. These relationships are important from the functional point of view, eg. minor modification in these lead to significant load changes and resultant pain syndromes (ulnar-carpal abutment, ulnar styloid triquetral impaction syndrome and ulna styloid impaction)¹. These functional correlations as well as the treatment modalities of the region require detailed anatomical knowledge and morphometric data collection.

Studies conducted by Berger et al¹, Joshi et al², and Sharma A et al³ have targeted the anatomy of bony configurations on dry bones forming wrist joint which can aid in surgical approach. Keeping this relevance in mind, we compared our findings with their observations.

Pole: The size and shape of the pole (articular surface for articulation of TFCC of the wrist on the head of ulna) may guide us in the direction of transmission of forces through the ulna. We recorded the maximum width and various shapes of the pole. The average maximum width of pole along its transverse axis on right & left-sided ulnae were found as 5.99 ± 0.654 mm & 5.97 ± 1.18 mm respectively (Table 1). An earlier study, Berger¹ reported a dimension of 8.2 (range 5.1–13.2) mm, regardless of the side of the ulna, is in line with the findings of our study. Joshi et al observed the average maximum width of pole as 5.26 mm in right-sided ulnae & 4.76 mm in left-sided ulnae. Sharma et al³ observed the average max width of pole in right & left sided ulnae as 5.4 ± 0.99 mm &

6.1 ± 0.67 mm respectively. The widths recorded in the present study were varied, but they did not show such a wide range of variation. In our study the width recorded showed closer to Joshi et al² findings. It can be due to the change in the shapes of the pole which ranged from kidney, semilunar, semicircular and comma.

The variety of pole shapes may have affected the angulation between the seat and pole of the ulnar head. Oatis⁴ (2003) has described the pole as 'v' shaped being placed lateral to both the styloid process & fovea. In our study the commonest shape of the pole was kidney (44%), followed by semilunar (32%), semicircular(14%) & comma (10%) shaped (Table 2).

The most common shape observed on the right (37.03%) and left (52.1%) ulnae was kidney shape. In most studies semilunar shape was recorded the most common. The distribution of the shapes was found to be varied on both sides. The 'semilunar', the next most common shape, was found on the left side in 26.08% of ulnae and on the right side 37.03% (Table 2).

Seat: More than two-thirds of the circumference of head is formed by the seat, is the main determining factor for gliding articulation and complexity of movement at the DRUJ. In our study, the average maximum height of the seat was found to be 6.66 ± 1.12 mm on the right side and 5.98 ± 0.87 mm on the left side (Table 1). Joshi et al² observed the average maximum height of seat as 6.39 mm & 5.26 mm on right and left side respectively. Sharma et al³ has documented this as 5.9 ± 0.69 mm on right side & 6.9 ± 0.87 mm on left side. However, another study had documented the maximum height of the seat as 9.3 (range 6.8–12.6) mm. This could be attributed to the difference in the study population of the two studies. 64% sloping and 36% non-sloping surfaces on both the right and left sides were found in our study (Table 2). The height and

slope of the seat may be of great clinical significance in understanding any dysfunction of the site, as far as assessing the stability of the DRUJ is concerned.

Fovea: The fovea is a roughened depression at the base of the styloid process. The average maximum width of the fovea in right-sided and left-sided ulnae were 2.56 ± 0.78 mm and 2.29 ± 0.70 mm, respectively (Table I). Joshi et al² observed the average maximum width of fovea as 5.26 mm & 5.18 mm on right-sided & left-sided ulnae respectively & Sharma et al³ has documented this as 4.5 ± 4.7 mm in right-sided ulnae & 4.9 ± 1.1 mm in left- sided ulnae. In the present study maximum width of fovea shows much variation with other studies.

In our study 33.3% & 17.3% of Right & Left sided ulna showed an absence of any vascular foramina. Joshi et al² observed no foramina in fovea in 15.61% ulna. Sharma et al³ observed no foramina in 20% of ulna bone.

This suggests that substantial amount of nutrition reaches the TFCC of the wrist from the synovial fluid of the DRUJ (on the superior surface) and the wrist joint (on the inferior surface) and blood supply to the ligament at the medial end of the disc by the vascular foramina. Joseph et al⁵ have stated that the disc is vascularised by branches from ulnar and posterior interosseous arteries.

Styloid process: In our study the average length of styloid process was 4.18 ± 0.67 mm & 4.69 ± 0.90 mm in right-sided & left- sided ulnae respectively (Table 1). If the length of the styloid process was > 6 mm, it was considered a criterion of long ulnar styloid process. Garcia-Elias⁶ (1987) has developed a method of assessing the relative size of styloid process.

Sharma et al³ observed the average length of styloid process as 5.20 ± 0.82 mm & 5.00 ± 0.67 mm in right-sided & left-sided ulnae respectively. Joshi et

al² (2009) have classified the styloid process into long (> 5mm) which were seen in 20.16% & short (<5mm) in 75.18% ulna. Biyani et al⁷ (1990) has described the variation in shape of ulnar styloid process. In the present study we noted 68% straight and 30% curved overall shape was noted. The shape of the tip of the styloid process varied from 20% pointed and 78% blunt and we found absence of styloid process in 3.7% of ulnae. Giachino et al⁸ (2007) & Topper et al⁹ has given the importance of length of ulnar styloid process as a causative factor in ulnar styloid triquetral impaction (USTI) producing ulnar sided wrist pain.

ECU: The dorsal surface on the head of ulna showed a groove for ECU tendon. We observed absence of groove in right & left-sided ulnae was 3.7% & 4.3% respectively (Table 2). Its anatomical position is of great importance in the treatment of dislocation of DRUJ. Sharma et al³ observed a groove for ECU tendon in all left-sided ulnae and in 80% of right-sided ulnae. Joshi et al² has classified the groove for ECU tendon in shallow (found in 48.1%) and deep (found in 24.38%) and they observed no groove in 27.21% ulnae. In present study we observed the groove for ECU tendon in shallow (noted in 48.1% & 56.5% right & left side respectively) and deep (in 48.1% & 39.1% right & left respectively) and absence of groove in 3.7% & 4.3% right & left of ulnae. Bruckner¹⁰ (1995) described ECU as being unique among the compartmentalized extensors being presents in its own fibro-osseous tunnel. This arrangement allows unrestricted rotation of radius at DRUJ.

CONCLUSION

The metrical values of structural anatomy of the lower end of ulna will provide valuable information regarding reconstruction of the DRUJ with prosthesis. Detailed anatomical knowledge of the distal end of the ulna plays a pivotal role in

understanding post-injury instability and painful conditions at the distal radioulnar joint (DRUJ).

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ABBREVIATIONS

DRUJ - Distal radioulnar joint; TFCC - Triangular fibrocartilaginous complex; USTI - Ulnar styloid triquetral impaction