Original Article

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Anatomy Section

Morphological and Morphometric Analysis of Distal End of Ulna in Gujarat Region: A Cross-sectional Study

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ABSTRACT

Introduction: Distal end of the ulna is an important anatomical structure for normal hand functioning which is prone to damage such as fracture and avulsion of the ulnar styloid process, that causes distal radioulnar joint instability.

Aim: To measure the morphometry and morphological variations of the distal end of ulna.

Materials and Methods: A cross-sectional study was conducted in the Department of Anatomy, Government Medical College, Bhavnagar, Gujarat, India in August 2023. A total of 42 (21 on each side) distal end of dry human ulna of unknown gender, age and race were studied. Morphometric parameters include measurement of the Length of styloid process, Height of seat, width of pole and width of fovea with the help of digital vernier caliper. Morphological parameters include shape of styloid process and shape of pole. Descriptive statistics was used.

Results: Mean length of styloid process on right and left side was 6±0.65 mm and 5.30±0.92 mm. Mean height of seat on right and left-side was 6.56±0.98 mm and 6.12±0.88 mm. Mean width of pole on right and left-side was 4.99±0.75 mm and 5.15±0.78 mm. Mean width of fovea on right and left-side was 2.58±0.42 mm and 2.68±0.46 mm, respectively. The majority shape of a pole was kidney (57.14%), followed by semicircular (19.04%), comma (16.66%) and semilunar (4.76%). Majority of styloid process was blunt (78.57%), followed by pointed (21.42%).

Conclusion: The present study is useful for hand surgeons in dealing with distal ulnar injury and reconstruction of the distal radioulnar joint with prosthesis.

Keywords: Distal radio ulnar joint, Seat, Styloid process

INTRODUCTION

Lower end of ulna is made up of head and the styloid process. The head articulate with ulnar notch of the radius to form the inferior radioulnar joint [1]. Ulna is separated from the wrist proper by a Fibrocartilagenous disc. The ulna is an important functional element of wrist and hand. The head of ulna has two articular surfaces for articulation with the radius which is known as the "seat." The seat of the ulna encompasses two-thirds to three-quarter of the perimeter of the ulnar head and is covered with articular cartilage. Radius articular surface for ulna and the ulnar articular surface for the radius varies in shape and curvature [2].

The ulnar styloid process is a medial bony projection easily palpated on the medial aspect of the wrist with the forearm supinated [2]. The fovea is roughened depression at the base of styloid process on its radial aspect, that provide attachment for the apex of the triangular fibrocartilaginous complex (ligamentum subcruetum) [2]. The relative length of radius and ulna are variable. The difference between the length of these bones is called ulnar variance. Ulnar variance is considered abnormal if there is >1 mm difference [2].

It is widely accepted that hyperpronation is the typical mechanism of injury in ulnar dorsal dislocation of Distal radioulnar joint, whereas hypersupination is associated with ulnar volar dislocation [3]. Galeazzi fracture-dislocation may involve a fracture of the ulnar shaft and styloid process in case of high-energy trauma. During sports activity forceful impact loading on the thenar side of the hand can lead to wrist hyperextension with ulnae deviation [3].

Reduction in the length of ulna relative to the radius increases the load born by the lunate, causing compression against the distal radius. The compression is believed to initiate avascular necrosis of the lunate and this condition is known as Kienböck's disease [3]. Thus the present study aimed to assess morphometric and morphological parameters of the distal end of ulna that would help surgeons to enhance the outcome of ulnar prosthesis surgery.

MATERIALS AND METHODS

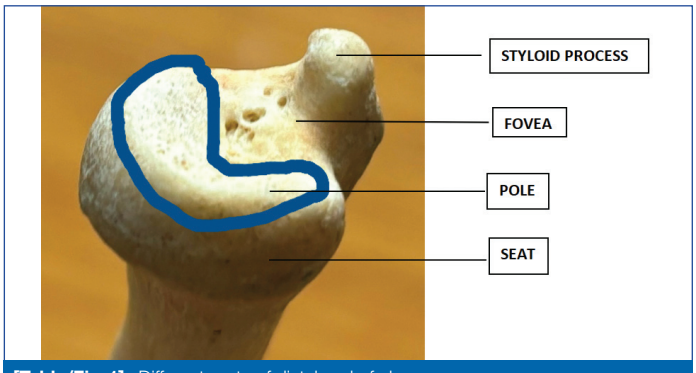
A cross-sectional study was conducted in the Department of Anatomy, Government Medical College, Bhavnagar, Gujarat, India in August 2023. A total of 42 (21 on each side) distal end of dry human ulna of unknown gender, age and race were studied. Ethical committee of the Institute exempts the study regarding dry human bone.

Inclusion and Exclusion criteria: All adult dried human ulna bones, irrespective of age, gender and race and completely intact bones were included in the study. Broken, unossified, decalcified and paediatric bones were excluded.

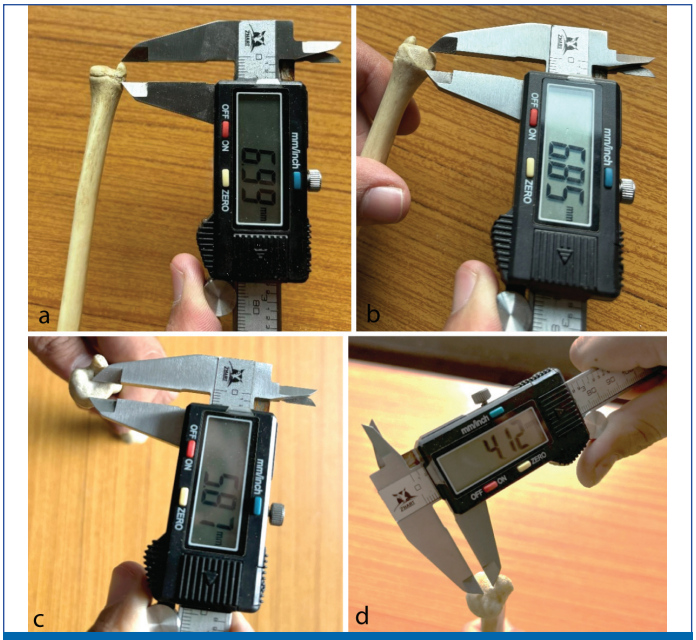
Study Procedure

Morphometric parameters include measurement of the length of the styloid process, the height of seat, the width of pole and the width of the fovea with the help of a digital Vernier caliper. Morphological parameters include shape of styloid process and shape of pole.

All measurement was done by using digital Vernier caliper (accurate to 0.1 mm sensitivity). Each measurement was performed two times by a single observer. The following parameters were studied [Table/Fig-1,2a-d].



[Table/Fig-1]: Different parts of distal end of ulna.



[Table/Fig-2]: a) Length of styloid process; b) Height of seat; c) Width of pole; d) Width of fovea.

1. The mean length of styloid process was measured from the tip to the base of the process.
2. Height of the seat was measured as the vertical distance between the upper margin and to lower margin of the seat.
3. Fovea was measured along the transverse axis meeting outermost point on the lateral margin of the fovea to the lateral end of the base of the styloid of the ulna. Width of fovea was measured in a transverse axis which is the distance between the base of styloid process to the lateral margin of fovea.
4. Pole was measured along the transverse axis as the distance between points where the transverse axis intersects the edge of the pole and the maximum width of pole was measured using a Vernier caliper.

Morphological parameters include shape of styloid process and shape of pole.

STATISTICAL ANALYSIS

Descriptive statistics was used. Continuous variables were expressed as mean and categorical variables were expressed as frequency and percentages.

RESULTS

Morphometric parameters: Mean length of styloid process on right-side was 6±0.65 mm, while on left-side it was 5.30±0.92 mm [Table/Fig-3].

Parameters	Right Mean±SD (in mm)	Left Mean±SD (in mm)	Total mean±SD (in mm)	
Length of styloid process	6±0.65	5.30±0.92	5.65	0.78
Height of seat	6.54±0.98	6.12±0.88	6.33	0.93
Width of pole	4.99±0.75	5.15±0.78	5.07	0.76
Width of fovea	2.58±0.42	2.68±0.46	2.63	0.44

[Table/Fig-3]: Morphometric analysis of distal end of ulna.

Morphological parameters: Majority shape of a pole was kidney-shaped (57.14%), followed by semicircular (19.04%) [Table/Fig-4,5a-d]. Majority of styloid process is blunt (78.57%), followed by pointed (21.42%) [Table/Fig-6a,b,7].

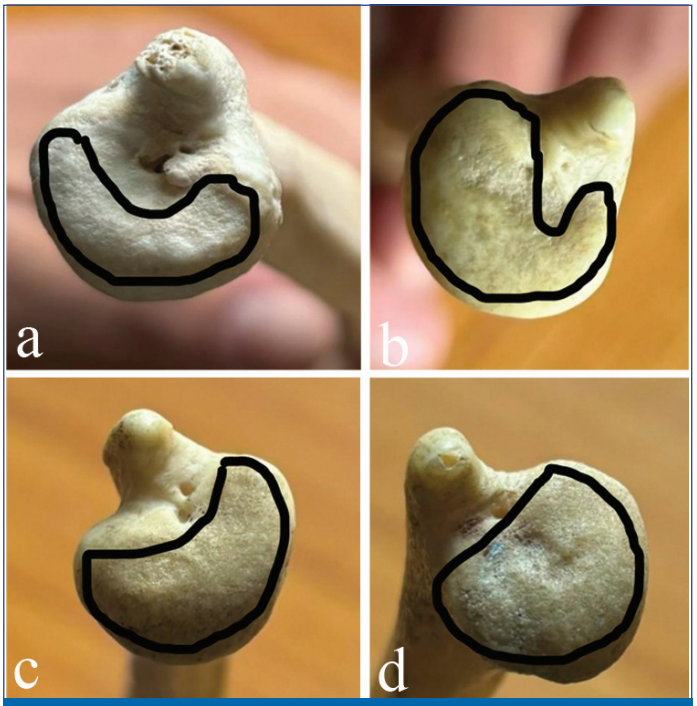
DISCUSSION

The lower end of the ulna is crucial for the proper function of the forearm and hand. The anatomical connection between the distal ulna, distal radius and ulnar carpus is highly precise and this relationship is essential for optimal functional performance. Even small change in this area leads to a significant alteration in load distribution and may result in pain syndrome and Distal Radioulnar Joint (DRUJ) instability [4].

In the present study, the average length of the styloid process was 5.65±0.78 mm. A comparison of present study data with various studies is shown in [Table/Fig-8] [4-6].

Parameters	Right-side n=21 n (%)	Left-side n=21 n (%)	Total N=42 n (%)
Kidney	11 (52.38)	14 (66.67)	25 (59.52)
Semicircular	4 (19.04)	4 (19.04)	8 (19.04)
Semilunar	2 (9.52)	0 (0)	2 (4.76)
Coma	4 (19.04)	3 (14.28)	7 (16.67)

[Table/Fig-4]: Shape of pole of ulna.



[Table/Fig-5]: a) Kidney-shaped pole; b) Comma-shaped pole; c) Semilunar-shaped pole; d) Semicircular-shaped pole.

[Table/Fig-6]: a) Pointed tip of styloid process; b) Blunt tip of styloid process.

Parameters	Right-side n=21 n (%)	Left-side n=21 n (%)	Total N=42 n (%)
Blunt	17 (80.95)	16 (76.19)	33 (78.57)
Pointed	4 (19.04)	5 (23.8)	9 (21.42)

[Table/Fig-7]: Shape of tip of styloid process of ulna.

Parameters	Side of ulna	Present study	Oommen SS (Mangaluru, Karnataka) (March 2015) [4]	Gupta C et al., (Manipal, Karnataka) (October 2019) [5]	Biradi CS et al., (Belagavi, Karnataka) (February 2019) [6]
Styloid process length	Right	6±0.65	5.80±1.24	5.6±0.01	6.21±1.11
	Left	5.30±0.92	5.50±1.28	5.5±0.09	6.01±1.06
Width of pole	Right	4.99±0.75	5.04±1.45	5.5±0.19	4.19±0.60
	Left	5.15±0.78	5±1.43	5.7±0.13	4.07±0.52
Width of fovea	Right	2.58±0.42	4.14±1.63	4.6±0.15	3.83±0.44
	Left	2.68±0.46	4.50±1.37	4.8±0.13	3.89±0.42
Height of seat	Right	6.54±0.98	6.51±0.08	6.9±0.19	3.91±0.55
	Left	6.12±0.88	6.42±0.05	7.5±0.18	3.81±0.47

[Table/Fig-8]: Comparison of present study data with various studies [4-6].

The present study shows that the styloid process was blunt in 78.57% of cases and pointed in 21.42%, while the study by Oommen SS showed 73% straight and 25% curved, which is similar to the present study [4]. In Oommen SS study, kidney-shaped pole was common (84%) and the least common was coma shape (22%) [4]. In Gupta C et al., study 48.55% of pole were kidney-shaped and 11.6% were semilunar-shaped [5].

The congruence and range of motion at the DRUJ are determined by the size and slope of the seat. The dimensions and projection of the pole are critical for force transmission through the ulna, as the rotation at the DRUJ occurs around the base of the styloid process and the fovea. The size and vascularity of fovea play a significant role in pronation and supination movements. Additionally, the prominence of the Triangular Fibrocartilage Complex (TFCC) and the ulnar styloid process affect the range of wrist adduction and the impact of styloid impingement.

Observation of the distal end of the ulna reveals four key components: the seat, pole, fovea and styloid process. Each component plays an important role in the anatomy and function of DRUJ at the wrist, with any change potentially leading to clinical conditions [7].

Limitation(s)

The present study has limitations regarding age and gender specificity of the ulna while analysing the bone, due to record constraints.

CONCLUSION(S)

The distal end of ulna interact with the distal end of radius and the proximal carpal bones to form the DRUJ and the ulno-carpal joint. These joints are crucial for normal hand and wrist function. Even minor alteration in this area can lead to significant pain and functional issues. Therefore, understanding the anatomical characteristic of distal end of ulna is essential for diagnosing defects and choosing appropriate treatment. This information assists clinicians in selecting prostheses for reconstruction surgeries.

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