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Research Paper

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Morphometrical Study of Lower End of Ulna

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ABSTRACT

Detailed anatomical knowledge of the distal end of ulna is important in understanding post-injury painful conditions at the distal radio-ulnar joint (DRUJ). So we obtained data on the morphometrical features of distal end of ulna in Gujarat region. Study of lower end of ulna has been conducted on 100 dry ulnae without any deformity. The average length of styloid process was 4.25 ± 0.53 mm and 5.28 ± 0.80 mm in right & left sided ulna respectively. The mean maximum height of seat was noted to be 6.01 ± 0.98 mm & 6.46 ± 0.93 mm on right and left sided ulna respectively. The average maximum width of pole was 5.67 ± 0.79 mm & 5.72 ± 0.80 mm on right and left sided ulna respectively. The shape of pole and other data were noted. The study provides morphometrical data of distal end of ulna, which will be helpful in management of DRUJ injuries.

Introduction:

The human hand is a grasping tool that is adaptable for performing various complex functions. 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 head, styloid process and fovea (Fig.1). The fovea is roughened depression at the base of styloid process on its radial aspect. It provides attachment to the apex of the triangular fibrocartilaginous disc (Oatis).

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. The 'pole' articulates with the triangular fibrocartilaginous complex (TFCC) of the wrist. The articular surface for articulation with radius is known as 'seat' and lies on the circumference of head of ulna. The seat occupies more than two-thirds of the perimeter of the head of ulna and is covered by articular cartilage (Oatis). This surface forms a gliding articulation with the concave sigmoid notch of the radius. At the extremes of the movement of pronation and supination, the ulnar head has little contact with the articulating sigmoid notch, making the joint vulnerable. Since the distal part of the ulna is a stable anatomical point of reference for rotation of the forearm, the distal part of the radius may dislocates either ventrally or dorsally.

There is general agreement that the mechanism of injury in an ulnar dorsal dislocation of the Distal Radio-Ulnar Joint (DRUJ) is hyperpronation, while the mechanism of injury in ulnar volar dislocation is hypersupination. Galeazzi fracture dislocation can also be associated with fracture of the ulnar shaft and styloid process in high-energy trauma. In case of sports activity specially gymnastic activity, forceful impact loading on the thenar side of the hand causes the wrist to be progressively levered into hyperextension with ulnar deviation and intercarpal supination (Tulley). Our study provides the structural detail of lower and of ulna which will be helpful in prosthesis formation in treatment of DRUJ injury.

Material & method:-

The present study was conducted on 100 (50 right sided & 50 left sided) dry ulnae without any deformity. The maximum height of seat, maximum width of pole along transverse axis, maximum width of fovea along the transverse axis & length of styloid process were measured with digital vernier calliper. Morphological parameters like shape of pole, presence or absence of vascular foramina in the fovea & presence or absence of groove for extensor carpi ulnaris (ECU) were noted.

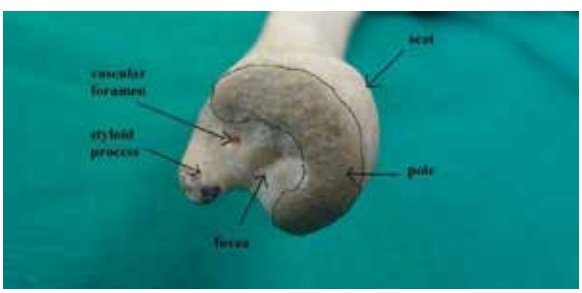

Fig. 1: showing the various parts of lower end of ulna.

Fig. 2: showing the various shapes of pole: A-semilunar, B-semicircular, C-kidney shaped and D-comma shaped.

Results:-

All the measurement taken from 100 ulnae were tabulated. The mean & standard deviation of each parameter was calculated (Table 1). The morphological parameters (Shape of pole, presence or absence of vascular foramina in the fovea, groove for extensor carpi ulnaris) were observed and their percentage were tabulated (Table 2).

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

Component	Measurement	Mean ± SD(mm)	
		Right-sided ulna	Left-sided ulna
Pole	Maximum width	5.67 ± 0.79	5.72 ± 0.80
Seat	Maximum height	6.01 ± 0.98	6.46 ± 0.93
Fovea	Maximum width	4.76 ± 0.64	4.10 ± 0.76
Styloid process	Length	4.25 ± 0.53	5.28 ± 0.80

SD: standard deviation

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Table 2 - Measurements of various parts of lower end of ulna

Component	No. (%)	
	Right (n=50)	Left (n=50)
Pole		
Comma	10 (20%)	15 (30%)
Semilunar	25 (50%)	30 (60%)
Semicircular	10 (20%)	5 (10%)
Kidney-shaped	5 (10%)	0 (0%)
Fovea (vascular foramina)		
Present	50 (100%)	45 (90%)
Absent	0 (0%)	5 (10%)
ECU groove		
Present	50 (100%)	50 (100%)
Absent	0 (0%)	0 (0%)

ECU: Extensor carpi ulnaris

Discussion:-

The ulnar head is the fixed point of the distal arm & wrist, around which forearm, carpus & hand rotate. The kinematics & biomechanics of DRUJ is unique in man. The distal end of ulna consists of head, fovea & styloid process. The ulnar head consists of two parts: pole & seat. The pole articulates with superior surface of triangular fibrocartilaginous disc. Seat articulates with sigmoid notch of radius. Fovea provides attachment to the apex of the triangular fibrocartilaginous disc. On the dorsal side, opposite to the fovea a longitudinal sulcus is located for the ECU tendon & its sheath. Thus the relationship of distal end of ulna with radius & ulnar carpus are important from the functional point of view. e.g. Minor modification in these lead to significant load changes & resultant pain syndromes. (ulnar styloid impaction, ulnar styloid triquetral impaction, ulnar carpal abutment) [Burger]. The detailed anatomical knowledge & morphometric data collection is important for treatment modality of this region. Study conducted by Joshi et al & Sharma et al have given the data regarding this matter. Keeping this relevance in mind, we compare our findings with their observations.

POLE: In our study, we recorded the maximum width & various shape of pole. The average maximum width of pole along its transverse axis on right- & left-sided ulnae were found as 5.67 ± 0.79 mm & 5.72 ± 0.80 mm respectively (Table 1).

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 al observed the average max width of pole in right & left-sided ulnae as 5.4 ± 0.99 mm & 6.1 ± 0.67 mm respectively.

Oatis (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 semilunar(55%), followed by coma shaped(25%), semicircular(15%) & kidney(5%) shaped (Table 2).

SEAT: The average maximum height of seat in our study was found to be 6.01 ± 0.98 mm on right-sided ulnae & 6.46 ± 0.93 mm on left-sided ulnae (Table 1). More than 2/3 of the circumference of head is formed by the seat. It is the main determining factor for gliding articulation & complexity of movement at the DRUJ. Joshi et al observed the average maximum height of seat as 6.39 mm & 5.26 mm on right and left side respectively. Sharma et al has documented this as 5.9 ± 0.69 mm on right side & 6.9 ± 0.87 mm on left side.

FOVEA: The fovea is roughened depression at the base of styloid process. We recorded average maximum width of fovea on right-sided & left-sided ulnae as 4.76 ± 0.64 mm & 4.10 ± 0.76 mm respectively (Table 1). Joshi et al observed the average maximum width of fovea as 5.26 mm & 5.18 mm on right-sided & left-sided ulnae respectively & Sharma et al has documented this as 4.5 ± 4.7 mm in right-sided ulnae & 4.9 ± 1.1 mm in left-sided ulnae.

In our study 5% of ulna showed an absence of any vascular foramina. Joshi et al observed no foramina in fovea in 15.61% ulna. Sharma et al observed no foramina in 20% of ulna bone.

Styloid process: In our study the average length of styloid process as 4.25 ± 0.53 mm & 5.28 ± 0.80 mm in right-sided & left-sided ulnae respectively (Table 1). Sharma et al 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. Van der heijden B et al (2005) by radiographic evaluation have measured ulnar styloid process length & found mean value of 4.4 ± 1.2 mm.

Joshi et al (2009) have classified the styloid process into long (> 5mm) which were seen in 20.16% & short (<5mm) in 75.18% ulna. Biyani et al (1990) has described the variation in shape of ulnar styloid process.

Giachino et al (2007) 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 a groove in all right & left-sided ulnae (Table 2). Its anatomical position is of great importance in the treatment of dislocation of DRUJ. Sharma et al observed a groove for ECU tendon in all left-sided ulnae and in 80% of right-sided ulnae. Joshi et al has classified the groove for ECU tendon in shallow (found in 48.1%) and deep (fond in 24.38%) and they observed no groove in 27.21% ulnae. Bruckner (1995) described ECU as being unique among the compartmentalized extensors being present in its own fibro-osseous tunnel. This arrangement allows unrestricted rotation of radius at DRUJ.

Conclusion:

Careful observation of the lower end of ulna shows that it is made up of four constituent parts: seat, pole, fovea & styloid process. All these parts play an important role in the normal anatomy & physiology of DRUJ. Any alteration can produce various clinical conditions like perforation of TFCC, ulnar styloid impaction syndrome, scaphoid impaction syndrome, etc. The dislocation of the ulnar head with concomitant fracture of the radius had been treated by implantation of prosthesis. The metrical values of structural anatomy of the lower end of ulna provided by our study, are valuable for reconstruction of the DRUJ with prosthesis.

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