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Original Research Article

Morphology And Morphometric Study Of Trochlea In Dried Humeri Of Telangana Region

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ABSTRACT

INTRODUCTION: The lower end of humerus has two articular facets, Trochlea and Capitulum. Trochlea takes part in formation of humero-ulnar joint by articulating with the trochlear notch of ulna. The shape of the Trochlea is in such a way that, it deviates the elbow to lateral side in extension and supination of forearm. Trochlear shape also plays an important role in determining the carrying angle.
OBJECTIVE: The objective of present study is to measure the various angles of Trochlea and compare the results with previous studies.
MATERIALS AND METHODS: Various angles of the Trochlea of the humerus were measured in 174 dried human humeri of unknown age and sex, in the Department of Anatomy, Mamata Medical College, Khammam, Telangana state.
RESULTS: Three types of trochlear shapes were observed. Flat lateral ridge (Type - 1) was observed in 55 bones. Small lateral ridge with shallow sulcus (Type - II) in 66 humeri and prominent lateral ridge with deep sulcus (Type - III) in 53 bones were observed. . The angles like Trochlear angle [TA], Trochlear sulcus angle [TSA], Capitillo-Trochlear angle [CTA], Inclination angle of olecranon fossa [IAOF] and Articular surface angle [ASA] were measured and statistically analyzed.
CONCLUSION: The study of various angles of Trochlea of humerus helps in proper surgical correction of the fractures of the lower end of the humerus. It helps in prevention of valgus and varus deformities during the correction of the fractures.

Key words: Trochlea of humerus, carrying angle, Trochlear angle, Trochlear sulcus angle, Capitillo-Trochlear angle

INTRODUCTION

The lower end of humerus has two articular facets, Trochlea and Capitulum. Trochlea takes part in formation of humero-ulnar joint by articulating with the trochlear notch of ulna. The trochlea is set obliquely and lies in a more anterior plane than that of the shaft of humerus. The pulley shaped trochlea consists of two flanges, medial and lateral, which are separated by a spiral groove. [1,2] The trochlea is symmetrical on posterior aspect. The medial margin is a high curving ridge, before backwards, around the lower end of humerus and this also carries a side to side concavity with it into rather more than a semicircle. [3]

The humero-ulnar joint is of hinge variety due to the fact that the medial flange is larger and lies at about 6 mm lower level than that of the lateral flange, which makes the joint slope downwards and medially. [2] Owing to the difference in the size and inclination of medial and lateral flanges of trochlea, the axis of the elbow joint is transverse between the humerus and radius whereas it is oblique between humerus and ulna. [4] Kapandji [5] observed that the trochlear groove is vertical anteriorly but runs obliquely and laterally on the posterior aspect. This results in formation of carrying angle in extension of elbow joint, as the posterior aspect of the oblique groove makes contact with the trochlear notch of ulna.

The integrity of the lateral trochlear ridge, olecranon fossa and the shape of trochlea are of great importance in determining the stability of the elbow joint in flexion and extension [6,7]

Objective

The main objective of the present study is to determine the various shapes of trochlea of dried humeri, to calculate its various angles and to compare the obtained values with previous studies.

MATERIALS AND METHODS

The present study was conducted on 174 dry humeri in the Department of Anatomy, Mamata Medical College, Khammam, Telangana state, India. Out of 174 bones 88 were right sided and 86 left sided. The bones with any deformities and pathological changes were omitted. The length of the humeri was calculated by using osteometric board. Then the shape of the Trochlea and its angles like Trochlear angle [TA], Trochlear sulcus angle [TSA], Capitillo-trochlear angle [CTA] and Inclination angle of olecranon fossa [IAOF] were measured.

Shape of the Trochlea:

The shape is assessed by evaluating the lateral flange [ridge] and depth of the sulcus based on previous study of Goldfarb et al. [8] They observed three types of trochlear shapes. Type I – Flat lateral ridge, Type II – Small lateral ridge with shallow sulcus and Type III – Prominent lateral ridge with deep sulcus [Figure No.1]

Trochlear Angle [TA]:

It is measured as the angle between the line drawn (MN) along the midpoints of AB and CD and the line drawn (XY) along the distal parts of articular surfaces of the Trochlea. [Figure No. 2] AB is the transverse diameter of upper $4/6^{th}$ of the humeral length and CD is the transverse diameter of upper $5/6^{th}$ of the humeral length. [9]

Trochlear Sulcus Angle [TSA]:

It is measured as the angle in between the medial and lateral slopes of articular surface of Trochlea [8] [figure No. 3]

Capitillotrochlear Angle [CTA]:

It is measured as the angle between the medial slope of articular surface of Trochlea and the line that joins the apex of the trochlear sulcus and most distal part of the capitulum [10] [figure No. 4]

Inclination Angle Of Olecranon Fossa [IAOF]:

It is measured as the angle between the maximum width of the Olecranon fossa and the line passing through the proximal most points on the articular surfaces of Trochlea [9] [figure No. 5]

Articular Surface Angle [ASA]: It is measured as the angle between anatomical axis [11] of humerus to the line passing through the most distal part of the articular facets of lower end of humerus

The above angles were calculated by using a scale, thread and protractor. The bones were first placed on a white paper and the angles are marked tangentially on the paper using the thread and scale. Then the angles were measured with a protractor.

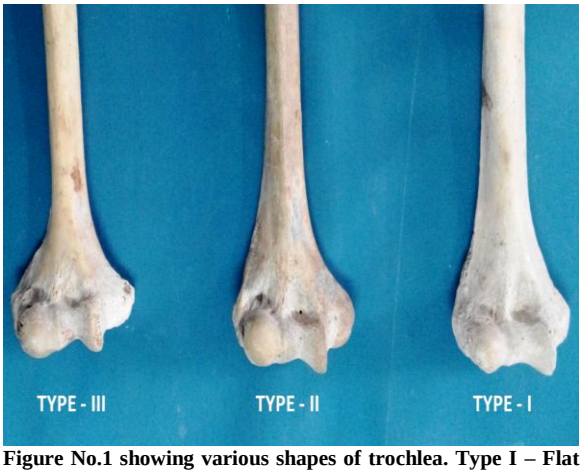

Figure No.1 showing various shapes of trochlea. Type I – Flat lateral ridge, Type II – Small lateral ridge with shallow sulcus and Type III – Prominent lateral ridge with deep sulcus

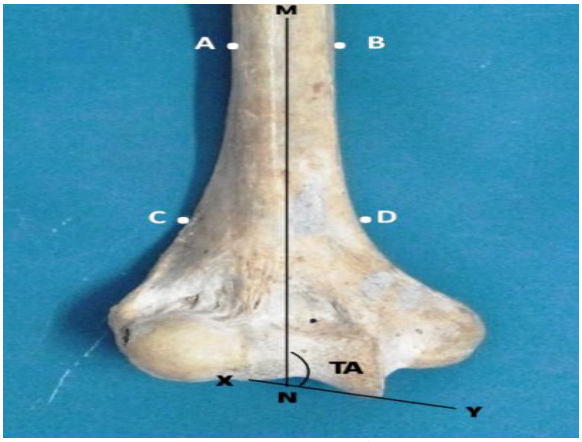

Figure No. 2, showing measurement of trochlear angle [TA], AB = Transverse diameter of upper 4/6th of the humeral length. CD = Transverse diameter of upper 5/6th of the humeral length. MN = Line drawn along the midpoints of AB & CD. XY = Line drawn along the distal articular surfaces of trochlea.

Figure No. 3, showing measurement of Trochlear-sulcus angle [TSA]

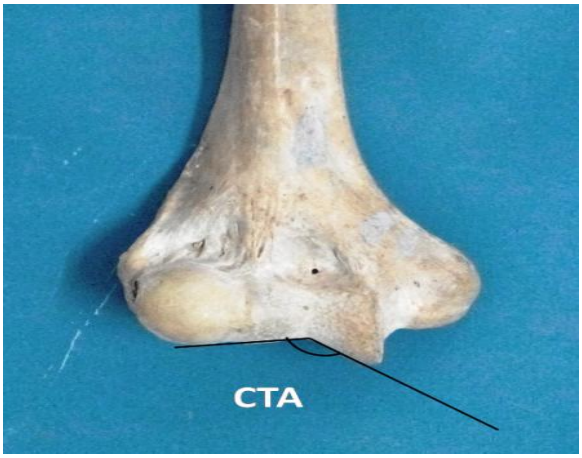

Figure No. 4, Showing measurement of capitillo-trochlear angle [CTA]

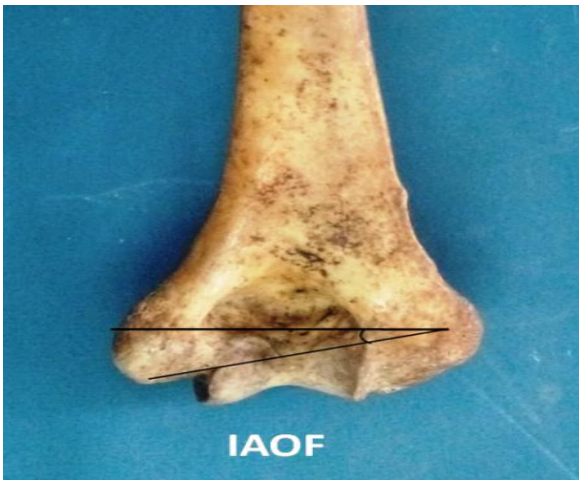

Figure No. 5, Showing Inclination angle of olecranon fossa [IAOF]

RESULTS

Shape of trochlea: In the present study we observed three types of trochlea. Lateral ridge of he trochlea was flat (Type-I) in 55 humeri, small with shallow sulcus in 66 humeri and prominent with deep sulcus in 53 humeri. [Table No. 1]

The calculated mean Trochlear angle (TA) of the humerus is observed to be 101.45^{o} with a standard deviation of 2.4 on right side and $102.1^{o} \pm 3$ on left side. The mean Trochlear sulcus angle (TSA) is about 145.8^{o} with a standard deviation of 8.3 on right side and $148.3^{o} \pm 8.02$ on left side. The mean Capitillo-trochlaer angle (CTA) is about $151.79^{o} \pm 6.35$ on right side and

152.1° ± 8.4 on left side. The mean Inclination angle (IA) of Olecranon fossa is about 14.46° ± 2 on right side and 15.17° ± 2 on left side. The mean value of articular surface angle (ASA) is 95.05° with a standard deviation of 2.3 on right side and on left side it is 95° ± 2.4. The values of present study are shown in [table No. 2].

Statistical analysis of the difference in the angles between right and left sided humeri showed that, in all the cases 'p' value is non-significant. Significance of the 'p' value is set at 0.05.

Table No. 1, showing various shapes of trochlea. Type I – Flat lateral ridge, Type II – Small lateral ridge with shallow sulcus and Type III – Prominent lateral ridge with deep sulcus.

Sl.no	Shape	No. of specimens
1.	Type I	55
2.	Type II	66
3.	Type III	53

Table No. 2, showing various angles observed in the present study with standard deviation and '*p*' values

Serial no.	Angles	Right side	Standard deviation	Left side	Standard deviation	'*p*' value
1.	Trochlear angle [TA]	101.4°	2.4°	102.1°	3°	0.6425
2.	Trochlear sulcus angle [TSA]	145.8°	8.3°	148.3°	8.02°	0.6523
3.	Capitillotrochlear angle [CTA]	151.79°	6.35°	152.1°	8.4°	0.8887
4.	Inclination angle of olecranon fossa [IAOF]	14.46°	2°	15.17°	2°	0.6047
5.	Articular surface angle [ASA]	95.05°	2.3°	95°	2.4°	0.9345

Table No. 3, showing the comparison between the various shapes observed in the present study and study according to Goldfarb et al

Serial No.	Study	Type I	Type II	Type III	Total
1.	Present study	55	66	53	174
2.	Goldfarb et al	37	109	32	178

Table – 4, showing the comparison between the various angles observed in the present study and studies by other authors.

Serial No	Study	Trochlear angle [TA]		Trochlear sulcus angle [TSA]	Capitillo-trochlear angle [CTA]	Inclination angle of olecranon fossa [IAOF]		Articular surface angle [ASA]
		Right	Left			right	left	
1.	Goldfarb et al	-	-	125°	-	-	-	84°
2.	Purkait et al	104.23°		-	-	4.88°		-
3.	B. Kumar et al	100.08°	98.39°	-	-	15.12°	7.25°	-
4.	Shrestha A et al	-	-	138.71°	145.28°	-	-	-
5.	Present study	101.4°	102.1°	147.04°	151.98°	14.46°	15.17°	95.07°

DISCUSSION

Surgical corrections of supracondylar fractures of humerus demand an appropriate knowledge on the angles of trochlea to correct the fractures without any varus or valgus deformity.

As mentioned the trochlear shapes observed in the present study are based on Charles A Goldfarb classification. [8] Goldfarb observed type I – 37, type II – 109 and type III – 32 in 178 radiographs. The present study is on dry bones and we obtained type I – 55, type II – 66, type III – 53. [Table No. 3].

According to Steel and Tomilson, [13] trochlear angle is the angle between lines drawn tangential to the medial epicondyle of humerus and distal ends of the Trochlea. With this method we can measure the inner angle. [9] Brian M. Shearer et al [14] measured three types of trochlear angle 1) a method similar to that of Steel and Tomilson. [13] 2) Modified trochlear angle – it is the angle between the line passing through the medial part of humerus and the line passing through the distal ends of trochlea and capitulum 3) Major axis trochlear angle – it is similar to the method followed by Purkait et al. [9]

B.Kumar et al [12] obtained the values of trochlear angle on right side as 100.08° ± 5.72, on left side 98.39°±5.513 in 54 radiographs. Purkait et al [9] obtained trochlear Angle 104.23° in 40 dried humeri. In the present study the Trochlear angle is about 101.45° ± 2.4 on right side and 102.1° ± 3 on left side in 174 dried humeri. The values in the present study are similar to the previous studies. .

According to Charles A Goldfarb et al [8] trochlear sulcus angle is 125° ± 8 in young adults in 53 radiographs. Shrestha A et al [10] obtained TS angle as 138.71° in 50 roentogens. Trochlear sulcus angle in the present study is about 147.04° ± 8.27. The obtained values are high compared to the previous studies.

Shrestha A et al [10] obtained Capitillotrochlear angle as 145.28° in 50 radiographs which was less compared to the values obtained in the present study. The capillotrochlear angle in the present study is 151.98° with a standard deviation of 8.4.

In the present study the values of inclination angle of olecranon fossa is 14.46° ± 2 on right side and on left side it is 15.17° ± 2, nearly similar on both sides. B. Kumar et al [12] obtained inclination angle of olecranon fossa on right side as 15.12° ± 4.663 and on left side as 7.25° ± 3.826 in 54 radiographs, which shows that the angle on the right side is twice than that on the left side. Purkait et al [9] obtained Inclination Angle of Olecranon fossa 4.88°. The value obtained on right side in present study is similar to values obtained by B. Kumar et al [12] but not on the left side. The values in the present study did not coincide with the values obtained by Purkait et al. [9]

According to Goldfarb et al [8] an increase in Articular surface angle [values nearing 90°] represent decreasing valgus of humerus. Articular surface angle in the present study is about 95.07° ± 2.73. Goldfarb et al [8] obtained 84° ± 3 in young adults and 83° ± 4 in adolescents. The angles measured in the previous study used radiographs, but in the present study dried humeri are used for measurements. There is possibility of obtaining difference in the values as certain factors come into play. In radiographs only two dimensional measurements can be obtained and ossified cartilages, if any, may interfere with the measurements. Dried bones are three dimensional and the measurements can be taken even tangentially. [Table No. 4].

Baumann angle is formed by the intersection of a line drawn along the axis of humerus and another line drawn along the growth plate of the lateral condyle of the elbow. [8] This measurement is not considered in the present study as most of the humeri belong to adults as the Baumann angle should be measured in young individuals and also in radiographs.

The trochlear angle, trochlear sulcus angle and inclination angle of olecranon fossa play a major role in determining the carrying angle of elbow.

CONCLUSION

The knowledge on the various angles of the Trochlea of Humerus is important during reconstructive surgeries of the distal end fractures of the Humerus. The deviation in the angles of trochlea of humerus during surgical correction may result in varus and valus deformity of the elbow. The trochlear angle and inclination angle of olecranon fossa determines the carrying angle of elbow. The surgeons should have an idea of these angles in determining the carrying angle and also in correction of fractures of lower end of humerus. The shape of trochlea is studied but its relation to carrying angle is yet to be evaluated.

Competing interests:

The authors declare that we have no competing interests

Ethical committee clearance:

As the study included only dried human humeri, ethical committee clearance was not taken into consideration. Authors will take the responsibility of any further allegations regarding ethical clearance that arise from the study.

Source of funding:

As the study involves dried humeri from the already existing bone bank of Mamata Medical College, no financial support from outside

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