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MORPHOMETRIC CONSIDERATIONS OF PROXIMAL RADIUS-CLINICAL IMPLICATIONS IN RADIAL HEAD IMPLANTS

Medical Science

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ABSTRACT

Pain, stiffness, foreign body reaction, loosening of radial head implant and elbow instability are most common causes of failed radial head arthroplasty. Most of these complications are due to overstuffing of radio capitulum joint due to oversized radial head or elbow instability due to undersize of radial head prosthesis. Moreover, radial head implant sizes available to orthopaedic surgeons in the market are based on studies conducted in western world, whereas Asian radial head and medullary cavity measurements are generally smaller. So we decided to conduct study on Indian radial head measurements which can be used for making radial head implants for Asian people.

METHODS: One hundred adult dry Indian radii (50 right,50 left) were chosen and various parameters of proximal radius were measured.

RESULTS-In present study the shape of the radial head was observed to be oval/ellipse in 40% and circular/rounded in 60%. The mean value of lateromedial diameter was 20.6±1.8mm on right side and 20.6±1.9mm on left side and the mean value of ventrodorsal diameter on right side was 21.3±2.3mm and 21.2±2.2mm on left side. The thickness of ventral curve >lateral curve>dorsal curve. Fovea radialis diameter was 11.2+-0.96 on right side and 11.2+_0.90 on left side. Neck diaphyseal angle was 165.70±2.5 on right side and 165.90±2.8 on left side.

CONCLUSIONS- It has been observed that morphometric parameters of proximal radius are important, and can be very useful for designing radial head implant arthroplasty and should be implicated in prosthesis design of to decrease the complication rate of radial head arthroplasty in Asian people.

KEYWORDS

radial head prosthesis, morphometric parameters, elbow joint

INTRODUCTION

Fracture of radial head are common injuries accounting for upto 5% of all fractures and over 30% of all elbow fractures (1). However concomitant injuries are reported to occur with radial head fracture. Proximal end of the bone is important because the proximal extremity of the radius participates with the fovea radialis (humeroradial joint) in elbow flexion and with the radial head circumference (proximal radioulnar joint) in pronation-supination. (2). When elbow and forearm is unstable or radial head cannot be repaired reliably, metallic radial head implants have proved to be a reliable option. Most common indications for radial head arthroplasty are in unreconstructable fracture of radial head (a) with associated unstable coronoid fracture (b) Essex Lopresti injury (radial head fracture with distal radio ulnar joint) (c) associated interosseous membrane injury. There are multiple manufacturers which provide radial head prosthesis with different sizes (DePuy's radial head, Stryker's solar radial head implant). But radial head arthroplasty is associated with lot of complications. Pain, Stiffness, elbow instability are most common causes of patient dissatisfaction. Most of these complications are due to overstuffing of radio capitulum joint due to oversized radial head or elbow instability due to undersize of radial head prosthesis. For ideal radial head prosthesis, the articular surface of radial head prosthesis should be at the level or slightly proximal to lateral edge of coronoid articular surface. The exact anatomical description of the proximal radius is imperative for the development of radial head prosthesis, that is anatomically and biomechanically correct. Moreover, radial head implant sizes available to orthopaedic surgeons in the market are based on studies conducted in western world, whereas Asian radial head and medullary cavity measurements are generally smaller so we decided to conduct study on Indian radial head measurements which can be used for making radial head implants for Asian people.

MATERIAL AND METHODS

The material for the present study comprise of 100 dry adult radii of either sex, made available from the Department of Anatomy, Government Medical College, Amritsar. All the radii were without any gross abnormality. Each radius was labeled from 1 to 100 with suffix 'R' for right and 'L' for left.

Following morphological and morphometric features of radius were observed and recorded-

THE PROXIMAL END

Head

Shape of the proximal articular surface; Articular surface of head is examined to notice its shape whether round or oval.

1. ***Lateromedial and Ventrodorsal diameters of articular surface of head***: Maximum lateromedial and ventrodorsal diameters were measured (AB and CD in Fig 1).
2. ***Thickness of ventral curve of proximal articular surface***: It was taken as maximum distance between point C and E on ventral part of the articular surface (CE in Fig 1).
3. ***Thickness of lateral curve of proximal articular surface***: It was taken as maximum distance between point B and G on lateral part of the articular surface (BG in Fig 1).
4. ***Thickness of dorsal curve of proximal articular surface***: It was taken as maximum distance between point D and F on dorsal part of the articular surface. (DF in Fig 1).
5. ***Fovea radialis diameter***: This corresponds to the area located between ventral and dorsal curve (EF in Fig 1). This maximum diameter was measured.
6. ***The* maximum *height of articular periphery;*** It was measured on the medial side of its articular periphery.
7. ***Circumference of articular periphery:*** It was taken with the help of thread winding around the articular periphery of head. The thread was divided at designated points, taken of and measured along a cm scale to find out the circumference.

Neck

1 ***Lateromedial diameter of neck***-Maximum lateromedial diameter was taken above the radial tuberosity with Vernier Caliper.

2 ***Neck-diaphyseal angle***-Angle was directly measured with a protractor between a line drawn through the axis of the neck of the radius and ventral edge of radius.

All these measurements were taken with the help of Vernier caliper. Angle of inclination was measured with the help of a protractor. Student's t- test was used to correlate all these parameters on the right and left sides. Data were analyzed using IBM SPSS Statistics for Windows version 20 USA.

RESULTS
PROXIMAL END:
SHAPE OF HEAD

Diameters of head of radius:
In the present study, latero-medial and ventrodorsal diameters of the head of radius have been studied.

TABLE I STATISTICAL RESULTS OF THE DIAMETERS OF HEAD OF RADIUS

Diameter	Side	No.	MeanSD (mm)	Range (mm)
Latero-medial	R	50	20.6±1.8	16.1-24.1
	L	50	20.6±1.9	16.9-24.2
Ventro-dorsal	R	50	21.3±2.3	16.7-30.2
	L	50	21.2±2.2	16.7-25.7

Table I showed that in present study the mean value of Lateromedial diameter was 20.6±1.8mm on right side and 20.6±1.9mm on left side and the mean value of ventrodorsal diameter on right side was 21.3±2.3mm and 21.2±2.2mm on left side. There was no significant difference between lateromedial and ventrodorsal diameters of both sides.

THICKNESS OF CURVES
Table III showed the thickness of curves of radial head as ventral curve (5.4 mm) >lateral curve (4.3 mm) >dorsal curve (4.1mm).

Fovea Radialis Diameter
The mean value of fovea radialis diameter in our study was 11.2+-0.96 mm on right side and 11.2+_0.90 mm on left side as shown in the table IV.

NECK-DIAPHYSEAL ANGLE
Neck diaphyseal angle was 165.70±2.5 on right side and 165.90±2.8 on left side.

Statistical results of neck-diaphyseal angle is depicted in Table V.

DISCUSSION
The radial head is a fundamental element of the prosthetic stability of the elbow joint Influence of radial head size on humeroradial kinematics has also been evaluated. (4,5). Knowledge of shape of radial head is necessary for creation of radial head prosthesis design.

In present study, the shape of the radial head was observed to be oval/ellipse in 40% and circular/rounded in 60%. Captier G (6) discovered that 57% specimens were having elliptical head and 43% were having circular head. Mahaisavariya and Swieszkowsky(7,8)found the radial head likely to be circular in a study of 40 and 17 specimens respectively. The difference in the results are possibly due to racial variations.

Table I showed that in present study the mean value of Lateromedial diameter was 20.6±1.8mm on right side and 20.6±1.9mm on left side and the mean value of ventrodorsal diameter on right side was 21.3 ± 2.3 mm and 21.2±2.2mm on left side. There was no significant difference between lateromedial and ventrodorsal diameters of both sides. In Popovic (9) study the minimum and maximum diameters of the radial head were 21.9 +/- 1.9 mm and 22.9 +/- 1.9 mm, respectively. The small floating cup (19 mm in diameter) was found to be too small for the large majority of adults while the large floating cup (22 mm in diameter) was closer to the radial anatomy.

Table II compares the VD and LM Diameter of radial head as observed by earlier authors, it is evident that our values are in accordance with earlier studies.

TABLE II COMPARISON OF DIAMETERS OF HEAD OF RADIUS

Author	Population	No.	Mean±SD (mm)		Range (mm)	
			VD	LMD	VD	LMD
G. Captier	French	96	21.6±2.9	21±2.7	17-34	16-28
Testut 1897	Paris	22			20-22	22-24
King et al 1999		28	23.4	23.6	-	-

The thickness of curves of radial head ventral curve (5.4 mm) >lateral curve (4.3 mm) >dorsal curve (4.1mm) found in the present study was in consonance with the earlier studies (Table III).

TABLE III COMPARISON OF THICKNESS OF CURVES OF RADIAL HEAD

Author	Thickness of curve(mm)		
	VC	DC	LC
G. Captier	5.5	4.3	4.7
Present study	5.4	4.1	4.3

Fovea radialis and center of fovea radialis form radial articular area of radiohumeral joint. The position of center of fovea radialis varies with pronation and supination movement. In supination, it is displaced backwards and in pronation it is displaced forwards. In neutral position with elbow flexed to 90 degree center of fovea radialis is medial and articulates completely with capitulo trochlear groove.(10)

Comparison of results of fovea radialis diameters depicted in Table IV with other authors. It is observed that our values are in accordance with that of G. Captier (6) while less as compared to TC Koslowsky (3).

TABLE IV COMPARISON OF STATISTICAL RESULTS OF DIAMETER OF FOVEA RADIALIS

Author	No	Mean±SD (mm)	Range (mm)
G. Captier	96	12.1±1.6	8.5-15.5
T.C.Koslowsky	36	16.7	13.6-21
Present study	50R	11.2±0.96	9.2-14.7
	50L	11.2±0.90	9.6-12.6

Table V shows the statistical values for neck diaphyseal angle were found to be in consonance with other authors (3,6,11),

Angle varied with regard to shape of the radial head. It was more acute for oval or elliptical head than for circular or rounded head. This difference must be taken in consideration in radial head prosthesis design (6).

TABLE V COMPARISON OF STATISTICAL RESULTS OF NECK-DIAPHYSEAL ANGLE

Author	No.	Mean±SD (degree)	Range (degree)
G. Captier	96	167.82±3.2	163-174
T.C.Koslowsky	36	167.8	160-178
Van Riet	27	163	152-174
Present study	50 R	165.70±2.3	160-172
	50L	165.90±2.8	162-172

Neck diaphyseal angle varied with regard to shape of the radial head. It was more acute for oval or elliptical head than for circular or rounded head. This difference must be taken in consideration in radial head prosthesis design (6).

Conclusion
The anatomical features of normal proximal radius bone are important in the light of the frequency with which surgery is performed for radial head fractures. Reconstruction of anatomical features of proximal radius is very important to improve success rate of surgery with radial head prosthesis.

The knowledge of geometry of the radial head along with its diameter is important for the design of the prosthesis for treatment of its various fractures. A thorough understanding of these roles is necessary to render appropriate treatment of radial head fracture.

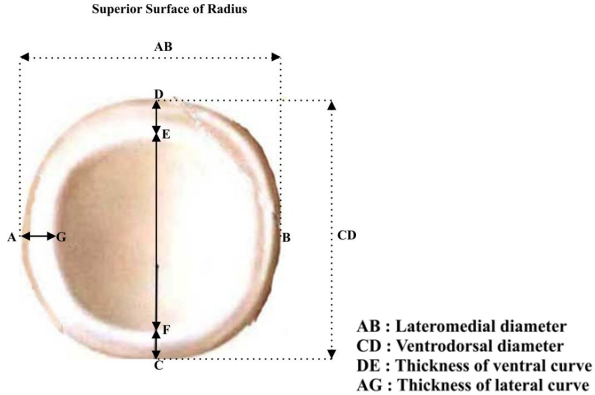

Figure-1

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