Morphometry of Distal End Radius- Surgical Implication in Colles' Fracture

Anjana Mittal[1], Gurdev L. Goyal[2], Amit Mittal[3]

[1]Associate Professor, Department of Anatomy, M. M. Institute of Medical Sciences and Research, Mullana, Haryana, India. [2]Associate Professor, Department of Physiology, M. M. Institute of Medical Sciences and Research, Mullana, Haryana, India. [3]Professor and HOD, Department of Radiodiagnosis, M. M. Institute of Medical Sciences and Research, Mullana, Haryana, India.

ABSTRACT

BACKGROUND

A reconstruction of anatomical features of normal bone is important in the light of not only the frequency with which surgery is performed for distal radial fractures but also for prosthesis designs of radial head. The fractures of distal end of the radius are significantly related to age and stress related changes. Colles' fracture is common in postmenopausal women usually accompanied by damage to ulnar collateral ligament or the ulnar styloid process. The morphometry of distal end radius has an important role in the surgical reduction of unstable fractures. The quality of reduction is assessed mainly by degree of radiological restoration of radial angle and palmar tilt. Distal radius morphometry is an important parameter in the evaluation and treatment of distal end fractures in which anatomical alignment must be corrected. The primary goal of the study is to reduce surgical complications of Distal Radial Fracture by proper anatomical alignment.

METHODS

The present study has been undertaken on a series of 100 adult radii (R: L=50:50) obtained from the Department of Anatomy, Government Medical College, Amritsar and different parameters were studied.

RESULTS

The mean length in bones was seen to be 239 ± 16 mm on right and 238 ± 15.1 mm on left side. Length of the styloid process was 12.2±1.6 on right side and 12.5 ± 1.8 on left side. Depth of the ulnar notch was 1.82± 3.9 on right side and 1.71± 5.2 on left side. The sagittal diameter was 16-7 ± 1.9 mm on right side and 16.2 ± 2.1 mm on left side and length of ulnar notch was 6.6 ± 1.3 mm on right side and 6.8 ± 1.2 mm on left side. The distance of dorsal tubercle from tip of styloid process was 19.4 ± 2.7 mm on right side and 19.8 ± 2.2 mm on left side and the mean value of distance of dorsal tubercle from posterior border of ulnar notch on right side was 15.9 ± 1.7 mm and 16.4 ± 1.7 mm on left side. SADE was found to be 21.1±3.4 on right side and 21.2 ± 3.3 on left side while FADE was 24.1±3.4 on right and 23.3 ± 3.1 on left side.

CONCLUSIONS

It has been observed that morphometric parameters of distal radius are important to reduce surgical complications of distal radius fractures by proper anatomical alignment. A thorough understanding of angulation of distal end radius plays an important role to render appropriate treatment of distal radius fractures.

KEY WORDS

Distal Radius Fractures, Morphometric Parameters, SADE, FADE

Corresponding Author:
Dr. Gurdev Goyal,
Associate Professor,
Department of Physiology,
M. M. Institute of Medical Sciences & Research, M. M. Deemed to be University,
Mullana, Ambala-133207, Haryana, India.
E-mail: drdevgoyal@gmail.com

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BACKGROUND

Colles' fracture is the second most common fracture after the fracture of the hip and vertebral body in epidemiology. In women of age group of 50 to 60 years, its incidence climbs steeply with a plateau in the rate thereafter. It might be associated with rapid bone loss after menopause. Bone density measurements in postmenopausal women suggest that osteoporosis is of definite relevance to the aetiology of Colles' fracture in postmenopausal women.[1]

Distal radius fractures are significantly related to the age and stress related changes. Repetitive stress on the distal radial epiphysis may lead to growth disturbances in gymnast. Growth disturbances lead to triangulation of the distal radius and secondary ulnar overgrowth, and eventually made lung deformity.[2] Metaphyseal fracture of distal radius can lead to growth arrest of distal radius. Adults who suffer fracture of distal radius are at increased risk of further osteoporosis related fracture.[3] Colles' fracture are common extra articular fractures of the distal radius that occurs as a result of fall on outstretched hand. This is complete fracture of distal radial metaphyseal region accompanied by dorsal angulation and impaction. Fracture incidence of the lower end of radius prevails 8-15 % among all the fracture of the upper limb.[4] A thorough understanding of angulation of distal end radius plays an important role to render appropriate treatment of distal radius fractures. In general, the better the reduction, the better is the final anatomical position of the fractures. Conservative management is commonly used for minimally displaced fracture which is described as< 2 mm loss of radial height, <5 0 change in radial inclination'<10 0 of dorsal angulation.[5]

Unstable fractures are commonly managed by open reduction and internal fixation using either dorsal or volar plates. Volar plates allow a more stable fixation and thus early mobilization with a lower incidence of tendon complications.[6] The use of radiography as a tool for evaluating the morphometric measurements of the distal end radius have been criticized by few authors. (A cadaveric study of Johnson and Sazbo found that palmar tilt is influenced by the rotation.) In a lateral view of the X Ray, the 50 of rotation is responsible for the 1.60 of alteration in palmar tilt.[7] Fractures of styloid process mainly occur from tension forces sustained during ulnar deviation and supination of wrist and it is frequently accompanied by dislocations of lunate. Surgical fixation of radial styloid process begins at its tip, which is approached through the 1st dorsal compartment. Articular reduction is best evaluated by radiocarpal arthrotomy between second and fourth dorsal compartments, just distal to lister's tubercle.[8] So distance between tip of styloid process and dorsal tubercle is an important parameter. Nutrient foramen is defined as the largest of the foramina present on the shaft of the long bones and admits a nutrient artery for that bone. Detailed data on the blood supply to the long bones and association with the areas of bones supplied has been a major factor in the development of new transplantation techniques in orthopaedics.[9] Nutrient arteries are the major blood supply to long bones especially during the active growing period in embryo and fetus and in early stages of ossification.[10] Injury to the nutrient artery at the time of fracture or at subsequent manipulation may be a significant factor to faulty union as healing is dependent on blood supply. An understanding of the location and number of nutrient foramina in long bones is important in orthopaedic surgical procedures such as joint replacement therapy, fracture repair, bone graft and vascularised bone microsurgery.[11]

METHODS

The material for the present study comprised of 100 dry adult radii of either sex made available from the Department of Anatomy, Government Medical College, Amritsar. These radii were cleaned, boiled and dried in open sunshine. All the radii were without any gross abnormality. Each radius was labelled from 1 to 100 with suffix 'R' for right and 'L' for left. Each radius was examined as a whole and possible measurements were taken. Following instruments were used for the study-

1. Osteometric board for measuring length of radius.
2. A Vernier calliper with a least count of 0.02 mm to measure the different diameters and lengths.
3. Cotton thread for measuring various circumferences.
4. Protractor for measuring various angles.
5. Scales with least count of 1 mm for various dimensions.

Study Design

A descriptive cross-sectional study was undertaken on 100 dry adult radii of either sex obtained from the cadavers of north Indian region.

Ethical Clearance

Ethical clearance was taken from the Institutional Ethics Committee of Govt Medical College, Amritsar before the start of study.

The following morphological and morphometric features of radius were observed and recorded-

1. Length of Radius- It was recorded with osteometric board. The bone was placed parallel to the long axis of the board and the length was measured from most proximal end of the head of the radius to the most distal point of the bone (AB in Fig. 1).
2. Weight of Radius- Weight of the bone was taken in grams. Shape of proximal articular surface of radial head; It is observed whether round or oval.
3. Length of the Styloid Process- It was measured as the distance between two points i.e. distal extremity of styloid process and projection of ulnar notch, shown as MN in fig. 1.
4. Sagittal diameter of Ulnar notch- Maximum antero-posterior diameter was taken with Vernier Calliper.
5. Length of the Ulnar notch- Maximum length from superior to inferior point was taken at middle of ulnar notch with Vernier Callipers.
6. Depth of Ulnar notch- It was measured by keeping a horizontal bar at the designated point. Maximum depth was measured as the perpendicular distance between the bar and the deepest point of the notch with the depth bar of Vernier Callipers.
7. Number of grooves- Posterior surface of lower end of radius was examined. Presence or absence of grooves and their number were noticed.

8. Direction of the grooves- It was noticed whether oblique or vertical.
9. Distance of dorsal tubercle from tip of styloid process- It was taken as maximum distance between most prominent part of dorsal tubercle and tip of styloid process.
10. Distance of dorsal tubercle from posterior border of ulnar notch- It was measured with Vernier Callipers, as maximum distance between most prominent part of dorsal tubercle and posterior border of ulnar notch.
11. Sagittal angle of distal extremity- It was measured as angle between the ventral and dorsal edges of ulnar notch of radius.
12. Frontal angle of distal extremity- It was measured by drawing a line through the extremity of styloid process and ulnar notch and a line tangential to the extremity of styloid process.
13. Shape of Scaphoid articular surfaces- It was examined to notice the shape of scaphoid whether triangular or quadrangular. Diameter of scaphoid articular surface. Antero-Posterior diameter of scaphoid articular surface was measured as maximum distance at base of triangular impression with vernier calliper. Medio lateral diameter was measured as maximum distance from tip of styloid process to the base of triangular impression with Vernier Calliper.
14. Shape of Lunate articular surface- It was examined to notice the shape of lunate whether triangular or quadrangular. Diameter of Lunate Articular Surface Maximum antero-posterior and mediolateral diameter of lunate articular surface was taken with Vernier Caliper.

RESULTS

The present study has been undertaken on a series of 100 adult radii (R; L=50:50) obtained from the Department of Anatomy, Government Medical College, Amritsar. Different morphological features were noted, measurements were taken, and indices were worked out. Data was compiled and statistically analysed. Various statistical results calculated (mean with standard deviation and standard error of mean). In all parameters measured, stress was laid upon the differences with respect to the side of bone and whether these were statistically significant or not.

Side	No.	Mean ± SD (mm)	Range (mm)
R	50	241±15.3	314.0-352.0
L	50	238±15.1	312.0-364.0

Table 1. Statistical Results of Length of Bone

On right side, Length of bone was 241±15.3 mm and on Left side length was 238±15.1 mm.

Population	No.	Weight (gm) Mean ±SD	Range
North Indian	100	35±10.3	12-60
	R-50	35±9.3	12-50
	L-50	35±11	14-60

Table 2. On the Right Side, Weight of Bone was 35±9.3 gm and on the Left Side Weight of Bone was 35±11 gm

Author	No	Mean ± SD	Range
Present Study	50R	12.2±1.6	9-15
	50L	12.5±1.8	9-20

Table 3. Statistical Results of Length of Styloid Process

Parameter	Side	Mean ± SD	Range
Sagittal Diameter	R	16.7±1.9	13-20
	L	16.2±2.1	12.8-20.4
Length	R	6.6±1.3	4.2-11
	L	6.8±1.2	4.4-12
Depth	R	1.82±.39	1.0-2.8
	L	1.71±.52	1.0-3.3

Table 4. Statistical Results of Dimensions of Ulnar Notch

		Side	No	Mean ± SD	Range
Scaphoid	AP	R	50	15.5±1.7	11.8-20.3
		L	50	15.7±1.9	
	ML	R	50	16.9±1.7	12.2-20.6
		L	50	17.1±1.8	
Lunate	AP	R	50	17.5±1.9	14.4-21.2
		L	50	18.1±1.8	
	ML	R	50	10.8±1.2	8.8-15.6
		L	50	10.6±1.2	

Table 5. Statistical Results of Dimensions

Parameter	Side	Mean ± SD	Range
From Tip of Styloid Process	R	19.4±2.7	14.2-25.6
	L	19.8±2.2	14.2-24.8
From Post. Border of Ulnar Notch	R	15.9±1.7	12.8-20.2
	L	16.4±1.7	10.5-20.1

Table 6. Statistical Results of Distances of Dorsal Tubercle

Population		North Indian	
No.		50R	50L
SADE	Mean(mm)	21.1±3.4	21.2±3.3
	Range(mm)	17-37	16-35
FADE	Mean(mm)	24.1±3.4	23.3±3.1
	Range(mm)	16-30	18-29

Table 7. Statistical Results of Angles of Distal Extremities

DISCUSSION

It is well known that significant differences exist in the anthropometric data of different races. The four main features of biological identity are sex, age, stature, and ethnic background.[12] The present study intends to establish the morphometric criterion of radial morphometry in North Indians. This is particularly important as radial morphometry is known to be influenced by cultural, environmental and racial factors.

Length of Bone as a Whole

Length of long bones is used for calculating the stature of the individual and the radius bone can be of use for this purpose amongst upper limb bones.[13] In the present study length of the radius bone has been studied on both right and left sides. The statistical results have been depicted in following Table I. In the present study, the mean length in bones was seen to be 239 ± 16 mm on right and 238 ± 15.1 mm on left side. Comparing sidewise, the length was found to be more on right side than on left side and this is due to better development of bones on the right side which is the dominating limb in majority of the individuals. This is attributed to larger left hemisphere which controls the body segments.[2]Also, the phenomenon of right left asymmetry in the upper limb is an inherited one and it is greater especially in length when compared with lower limb bones

Weight of Bone

Weight of the bone increases with length but for a given length weight may be different.[14] In the present study sidewise comparison showed weight on right side is more

than left side. G. Captier while studying 96 dry radii in the French population found the Weight (gm) with Mean ±SD 40.81±15.3 and the Range of 16-89. It is clear from table II that weight of North Indian bones was less as compare to studies of G. Captier.

Length of the Styloid Process

As shown in table III, the length of the styloid process was 12.2±1.6 on right side and 12.5 ± 1.8 on left side. There was no significant difference between mean values of length of styloid process of both sides. The present study was in consonance with Captier G, in which the length of styloid process was found to be 12.8±3.3 (Mean ± SD) with a range of 15-24.

Ulnar Notch

Table IV showed that in present study the mean value of Sagittal diameter was 16-7 ± 1.9 mm on right side and 16.2 ± 2.1 mm on left side and the mean value of length of ulnar notch was 6.6 ± 1.3 mmon right side and 6.8 ± 1.2 mm on left side. Depth of the ulnar notch was 1.82+_3.9 on right side and 1.71+-5.2 on left side. No significant difference was found between two sides.

Diameters of the Scaphoid and Lunate

The mean values of anterio-posterior diameter of scaphoid were found to be 15.5 ± 1.7 and 15.7±1.9 on the right and left side respectively and medio-lateral diameter of scaphoid was found to be 16.9±1.7 and 17.1±1.8 on the right and left side respectively. The mean values of anterio-posterior diameter of lunate was found to be 17.5 ± 1.9 and 18.1±1.8 on the right and left side respectively while the values for medio-lateral diameter of lunate were found to be 10.8±1.2 and 10.6±1.2 on the right and left side respectively.

Dorsal Tubercle

Table V showed that in present study the mean value of distance of dorsal tubercle from tip of styloid process was 19.4 ± 2.7 mm on right side and 19.8 ± 2.2 mm on left side and the mean value of distance of dorsal tubercle from posterior border of ulnar notch on right side was 15.9 ± 1.7 mm and 16.4 ± 1.7 mm on left side. There was no significant difference between values of both sides.

Angles of Distal Extremities

Table -VI showed that in present study the mean value of the (SADE) sagittal angle of distal extremity was less as compared to G. Captier (14.35±6.8) while mean value of (FADE) Frontal angle of distal extremity was in consonance with G. Captier (24.2±5.2) there was no significant difference between the angles when compared on two sides. Angle measurements of the DR are considered to be a valuable parameter to assess the quality of reduction of DR fracture. The quality of reduction of distal radius fracture is assessed mainly by degree of radiological restoration of radial angle and palmar tilt.[15]A thorough understanding of angulation of distal radius plays an important role to render appropriate treatment to distal radius fractures.

CONCLUSIONS

The radius bone has always been an interesting focus of anatomical study. Since distal radial fractures are most common bone fractures, the incidence rate being 2 per 1000 person-years, prior acquaintance with the anatomy of radius is practically important for the orthopaedic & plastic surgeons during the surgical reduction of fractures. The present study may be of help the surgeons in reducing the surgical complications of such fractures by establishing the morphometric criterion of radial morphometry of distal end of radius in North Indian population.

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