Original Article

A study of morphological and morphometric parameters of glenoid cavity of dry human scapulae

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Abstract

Background: It is a birth right of all vertebrates to possess four limbs. The limbs are connected to axial skeleton by means of bones known as the pectoral and pelvic girdle. The pectoral girdle articulates with thoracic cage by means of shoulder blade. The shoulder blade is called scapula in descriptive anatomy **Aims and Objectives:** To Study Morphometric Parameters of Human Scapula Concerned with Shoulder Joint. **Methodology:** One hundred and one unpaired (56 left and 45 rights sided), complete and undamaged dry human scapulae were obtained from a teaching medical institute of Mumbai. The bones were of unknown age and gender. The parameters measured were recorded in the proforma. The study was conducted after receiving approval from institutional ethics committee. Data was entered in Microsoft Excel 2007 and then transferred to SPSS version 17. Statistical analysis was done using SPSS software version 17 and mean, median; range and standard deviation were calculated. **Result:** Inverted comma shape(distinct notch) and piriform shape (indistinct notch) in glenoid cavity were noted in 52.48% and 43.56% scapulae respectively. Average maximum height of glenoid cavity is 36 ± 2.81 mm. Antero-posterior diameter of lower half of glenoid cavity was 22.9 ± 2.45 mm. Antero-posterior diameter of upper half of glenoidcavity was 16.02 ±2.32 Circumference of glenoid cavity varied from 72 mm to 124 mm with an average of 101.73 mm. Most scapulae (68.3%) had circumference of glenoid cavity in the range of 90 to 107 mm. **Conclusion:** Understanding of these different morphological and morphometric features is essential for orthopaedic surgeons while operating in this region. Knowledge of this morphometric data will be a guide for understanding the vulnerability of person for various surgical conditions, fractures, dislocations, arthritis and this data will also be of help during various diagnostic and therapeutic interventions of these conditions.
Keywords: Morphometric Parameters of Human Scapula, glenoid cavity, Shoulder Joint.

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INTRODUCTION

It is a birth right of all vertebrates to possess four limbs. The limbs are connected to axial skeleton by means of bones known as the pectoral and pelvic girdle. The pectoral girdle articulates with thoracic cage by means of shoulder blade. The shoulder blade is called scapula in descriptive anatomy.[1] The scapula connects the humerus with the clavicle. The scapula forms the posterior part of the shoulder girdle. In humans, it is a flat bone, roughly triangular in shape, placed on a postero-lateral aspect of the thoracic cage overlapping second to seventh ribs.[2] Normal anatomy and normal movements of scapula are important for the smooth functioning of the entire upper limb. Variations in scapula will not only affect shoulder girdle movements but also will have effects on movements of shoulder joint. The scapula may be subjected to fractures, dislocations, arthritis, tumors, and developmental abnormalities.[3] The shoulder joint is the most frequently dislocated joint in the body. In recurrent shoulder dislocation, there is glenoid bone loss. Glenoid

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bone loss remains a challenging issue. For the management of this condition prosthesis and arthroplasty is required. Management of glenohumeral arthrosis with total shoulder prosthesis/arthroplasty is becoming increasingly common. The shape of the glenoid cavity is closely related with shoulder stability. Variation in shape and size of glenoid cavity is of fundamental importance in understanding of rotator cuff disease, shoulder dislocation and to decide the proper size of glenoid component in the shoulder arthroplasty. However glenoid replacement remains a challenge in total shoulder arthroplasty and is the most common cause of revision surgery.[4] In total shoulder arthroplasty (TSA), the exact size and shape of the glenoid fossa is of critical importance for fitting the glenoid component.[5] There is very little anatomical data to support the need for a wide variety of sizes and shapes of glenoid prosthetic component.[6] Anatomic parameters of the glenoid relevant to prosthesis design and placement include glenoid height, width, inclination, and shape. The considerable natural variability in these parameters, as demonstrated in cadaveric studies, affects prosthesis design, instrumentation, and intra-operative implantation techniques. Various shapes of the glenoid cavity have been described based on the presence of a notch on the anterior glenoid rim. It has been found that if the notch is distinct, then the glenoid labrum is not fixed to the bony margin of the notch but bridges the notch itself. This could make the shoulder joint less resistant to dislocating forces.[7] A glenoid osteochondral defect occurs most often as a result of acute trauma and has higher association with instability, labral tear and intra-articular bodies.[8] Retrospective evaluation of roentgenograms of patients with unilateral shoulder instability showed the osseous Bankart lesion to be present in 20% of cases.[9] Burkhart and De Beer, described an inverted-pear glenoid, in which a normally pear-shaped glenoid lost enough anterior-inferior bone to assume the shape of an inverted pear.[10] A bone loss of more than 21% of the superior-inferior glenoid length would cause instability even after correct soft tissue repair. A bone loss of more than 21% in the Patients with shoulder dislocations may have erosions or fractures of the anteroinferior glenoid rim, which can cover more than 25% of the glenoid area.[13] These patients can dislocate their shoulder, even during sleep, and may slip this joint in the midrange of motion in which many of the activities of daily living are performed.[13,14] In addition to this, these patients often develop shoulder osteoarthritis.[10]In such cases, a bone graft must be placed at the anterior glenoid rim, as the arthroscopic Bankart repair may lead to a 67% recurrence rate.[13]On the other hand, the Latarjet technique used for anterior shoulder dislocations has a low recurrence rate that varies from 1% to 6%[15-18]and has a 4.9% recurrence rate when used for cases of severe glenoid bone loss.[19,20]In addition to this, Itoi *et al*.[21]demonstrated that after bone grafting a glenoid erosion (greater than 21% of the superior-inferior axis or greater than 6.8 mm of the A-P glenoid distance), there was an increase in the translation force necessary to cause a shoulder dislocation to levels similar to those without glenoid erosions.

AIMS AND OBJECTIVES

To Study Morphometric Parameters of glenoid cavity of Human Scapulae.

MATERIAL AND METHODS

One hundred and one unpaired (56 left and 45 right sided), complete and undamaged dry human scapulae were obtained from a teaching medical institute of Mumbai. The bones were of unknown age and gender. The parameters measured were recorded in the proforma. The study was conducted after receiving approval from institutional ethics committee. Anatomical measurements were taken using a wooden scale, divider, Vernier calliper of least count 0.01, 60 and 45 degree squares, non-elastic cotton threads, in white and red colour. The data was entered in Microsoft Excel 2007 and then transferred to SPSS version 17. Statistical analysis was done using SPSS software version 17 and mean, median, range and standard deviation were calculated.

RESULT

Table 1: Shape of Glenoid Cavity (n-101)

Shapes of glenoid cavity	Frequency	Percent
Inverted comma	53	52.48
Oval	4	3.96
Piriform	44	43.56
Total	**101**	**100**

Studied scapulae had various shapes of glenoid cavity. Inverted comma shaped glenoid cavity was the most common (52.48%) followed by piriform shaped (43.56%) and 3.96% of oval shaped.

Table 2 (A): Maximum Height Of Glenoid Cavity(N-101)

Variables	Mean	Median	SD	Range	Min	Max
Maximum height of glenoid cavity (in mm)	36.48	37	2.81	12	31	43

Table 2 (B): Maximum Height of Glenoid Cavity

Maximum height of glenoid cavity (in mm)	Frequency	Percent
31-35	38	37.6
36-40	58	57.5
> 40	5	4.9
Total	**101**	**100**

Maximum height of glenoid cavity varied from 31 to 43 mm, with average of 36.48mm. Most scapulae had maximum height of glenoid cavity in the range of 36 to 40 mm.

Table 3(A): Maximum Antero-Posterior Diameter of Lower Half of Glenoid Cavity (n-101)

Variables	Mean	Median	Std. Deviation	Range	Minimum	Maximum
Maximum antero-posterior diameter of lower half of glenoid cavity (in mm)	22.90	23	2.45	11	17	28

Table 3(B): Maximum Antero-Posterior Diameter of Lower Half of Glenoid Cavity

Maximum antero-posterior diameter of lower half of glenoid cavity (in mm)	Frequency	Percent
17-20	21	20.8
21-24	47	46.5
25-28	33	32.7
Total	**101**	**100**

Maximum antero-posterior diameter of lower half of glenoid cavity varied from 17 mm to 28 mm with an average of 22.9 mm. Most scapulae (46.5%) had maximum antero-posterior diameter of lower half of glenoid cavity in the range of 21 to 24 mm.

Table 4 (A): Maximum Antero-Posterior Diameter of Upper Half of Glenoid Cavity (n-101)

Variables	Mean	Median	SD	Range	Min	Max
Maximum antero-posterior diameter of upper half of glenoid cavity (in mm)	16.02	16	2.32	16	11	27

Table 4 (B): Maximum Antero-Posterior Diameter of Upper Half of Glenoid Cavity

Maximum antero-posterior diameter of upper half of glenoid cavity (in mm)	Frequency	Percent
11-15	39	38.61
16-20	60	59.41
> 20	2	1.98
Total	**101**	**100**

Maximum antero-posterior diameter of upper half of glenoid cavity varied from 11 mm to 27 mm with an average of 16.02 mm. Most scapulae (59.4%) had maximum antero-posterior diameter of upper half of glenoid cavity in the range of 16 to 20 mm.

CIRCUMFERENCE OF GLENOID CAVITY

Circumference of glenoid cavity varied from 72 mm to 124 mm with an average of 101.73 mm. Most scapulae (68.3%) had circumference of glenoid cavity in the range of 90 to 107 mm.

Table 5.5(A): CIRCUMFERENCE OF GLENOID CAVITY (n-101)

Variable	Mean	Median	SD	Range	Minimum	Maximum
Circumference of glenoid cavity (in mm)	101.73	103	8.80	52	72	124

Table 5.5(B): CIRCUMFERENCE OF GLENOID CAVITY

Circumference of glenoid cavity (in mm)	Frequency	Percent
72-89	10	9.9
90-107	69	68.3
> 107	22	21.8
Total	**101**	**100**

DISCUSSION

Normal anatomy and normal movements of scapula are important for the smooth functioning of the entire upper limb. Variations in scapula will not only affect shoulder girdle movements but also will have effects on movements of shoulder joint. In present study the various dimensions of 101 scapulae were studied. Knowledge of shape and dimensions of the glenoid cavity are important in designing and fitting of glenoid components for total shoulder arthroplasty. An understanding of variations in normal anatomy of the glenoid cavity is essential while evaluating pathological conditions like osseous Bankart lesions and osteochondral defects. There are two major shapes for glenoid component that are currently available—anatomic and oval. There are minimal data demonstrating performance for either type, while both have theoretical advantages. An anatomically shaped glenoid simulates the normal, pear-shaped glenoid. The theoretical advantage of this component design is to avoid internal impingement of soft tissues on the polyethylene component. Nevertheless, this pear shape also reduces the contact surface area and may increase the risk of dislocation.[23]The oval design, on the other hand, mimics the arthritic glenoid and theoretically utilizes the pathologically enlarged glenoid to maximize articular surface area. The increased superior wall height may decrease the risk for dislocation.[24,25] In our study, inverted comma shape(distinct notch) and piriform shape (indistinct notch) in glenoid cavity were noted in 52.48% and 43.56% scapulae respectively. It is greater than studies conducted by Hina *et al*.[26,27] Hina *et al*.[26] reported percentage of glenoid with both indistinct and distinct notch was 84% on the right side and 85% on the left side. Mamatha *et al*.[27] had found it to be 80% on the right side and 76% on the left side. Prescher and Klumpen[28] had observed the same in 55% of scapulae. In this study oval glenoid comprised only 3.96%. Whereas, Hina *et al*.[26] found 16% and 15% oval shaped glenoid cavities on the right and left sides respectively. In our study the average maximum height of glenoid cavity is 36 ± 2.81 mm. The comparison is made with Coskun*et al*.[29] who reported it as 36.3 ± 3 mm and Karelse *et al*.[30] who reported it as 35.9 ± 3.6 mm. These values are similar to values found in our study. Hina*et al*.[26] and Mamatha *et al*.[27]measured the maximum height of glenoid cavity on right and left side. Hina *et al*.[26] have reported average maximum height of glenoid cavity to be 34.76 ± 3 mm on right side and 34.43 ± 3.21 mm on left side. Mamatha *et al*. reported it to be 33.67 ± 2.82 mm on right side and 33.92 ± 2.87 mm on left side. Values reported by Mamatha*et al*.[27] and Hina *et al*.[26] are less than that of our study. In our study antero-posterior diameter of lower half of glenoid cavity was 22.9 ± 2.45 mm. Karelse *et al*.[30]observed the same to be 27.2 ± 3 mm. Hina *et al*.[26] reported the average anterior-posterior diameter of the lower half of the glenoid of the right side was 23.31 ± 3 mm and that of the left side was 29.9 2±2.8 mm. Mamatha *et al*.[27] reported the values as 23.35 ± 2.04 mm on right side and 23.02 ± 2.3 mm on left side. Anterior-posterior diameter of upper half of glenoid cavity in our study was 16.02 ± 2.32 mm which is more than that of reported by Hina *et al*.[26] Hina *et al*. reported the same as 15.1 ± 2.54mm of right glenoid and 13.83 ± 2.45 mm of left glenoid. Whereas, findings of Mamatha *et al*. are similar to findings of our study. Mamatha *et al*.[31] reported the values of the same to be 16.27 ± 2.01 mm on right side and 15.77 ± 1.96 mm on left side.

CONCLUSION

Understanding of these different morphological and morphometric features is essential for orthopaedic surgeons while operating in this region. Knowledge of this morphometric data will be a guide for understanding the vulnerability of person for various surgical conditions, fractures, dislocations, arthritis and this data will also be of help during various diagnostic and therapeutic interventions of these conditions

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