Original Research Article

Morphological and Morphometric study of Glenoid Cavity and it's Clinical Application in Western Rajasthan Population

Kataria Sushma K[1], Shekhawat Manu[2], Gehlot Kalpana[3], Goyal Samata[4*]

[1]Senior Professor and Head, M.S. Anatomy, Dr. S.N. Medical College, Jodhpur, Rajasthan, India
[2]2nd year Resident Anatomy, Dr. S.N. Medical College, Jodhpur, Rajasthan, India
[3]Senior Demonstrator, M.S. Anatomy, Dr. S.N. Medical College, Jodhpur, Rajasthan, India
[4]Senior Demonstrator, M.S. Anatomy, Dr. S.N. Medical College, Jodhpur, Rajasthan, India
Received: 10-11-2021 / Revised: 17-12-2021 / Accepted: 12-01-2022

Abstract

Background: Glenoid cavity (GC) is a shallow, concave and oval fossa at superolateral border of scapula and form glenohumeral joint with scapula. There is a notch present on its anterosuperior part which gives its different shape. When this glenoid notch is indistinct its shape is pear shaped, when it is distinct it looks like inverted comma shape and when it is absent its oval shape. Understanding morphometric and morphological variation of GC plays an important role for surgeon while designing and fitting of glenoid component for total shoulder arthroplasty. **Aims:** A morphometric study of the glenoid cavity of 120 adult dry human scapulae in Western Rajasthan Population was done to evaluate the shape and various diameters of the GC. **Material and methods:** 120 dry scapulae (60 Right and 60 Left) of unknown sex, were taken for the study. Damaged bones were excluded from the study. Supero-Inferior Diameter (SI-D), Antero-Posterior Diameters (AP-D1 and AP-D2) of both sides were analysed and compared by unpaired t-test. **Results:** Most common shape of GC was pear shaped (45.83%) followed by oval shape (35%). Least common shape was inverted comma shape (19.16%). Difference in mean SI-D of both sides were statistically insignificant while AP-D1 and AP-D2 were found statistically significant. Mean Glenoid Cavity Index on right and left sides were 64.57 ± 6.91% and 68.33 ± 6.29% respectively. **Conclusions:** The above study helps Orthopedicians in shoulder dislocation, fractures and treating shoulder pathological conditions like glenohumeral instability and rotator cuff pathology.
Keywords: Glenoid Cavity; Scapula; Arthroplasty; Glenoid Cavity Index.

Introduction

Shoulder joint between shallow glenoid fossa and hemispherical head of humerus is a ball and socket type of synovial joint. It has maximum movement but less stability. Shoulder joint is frequently dislocated inferiorly due to having less support in that region of the joint. During trauma, dislocation with fracture of glenoid are also common[1].

The shape of the glenoid cavity and the glenoid labrum, which deepens it gives it its most remarkable feature; as it precisely stabilizes the humeral head in the center of the cavity as well as allowing a vast range of movements[2,3]. Its articulation and movements, with its morphological as well as morphometric arrangements plays a vital role in balancing its mobility and stability.

A number of cadaveric studies have been done by different authors and reported that when the glenoid notch is distinct on its anterior margin, the glenoid labrum is often not attached to the rim of glenoid cavity at the site of the notch[4].Various studies have been conducted on morphometry of the glenoid cavity in different parts of our country. But, still very limited data is available on morphometry of the glenoid cavity in Western Rajasthan Population. Aim of our study is to obtain anthropometric data of glenoid cavity, specifically the diameters and various shapes of glenoid for clinical application in joint replacement surgeries in Western Rajasthan population and compare it to findings from other races of the world. Fracture in glenoid cavity is very common in shoulder injuries. The basic modalities of treatment include repair of labrum, reinforcement of capsule by an overlapping repair and rearrangement of anterior muscles. Total shoulder repair is also being used as treatment[4,5,6].

*Correspondence
Dr. Goyal Samata
Senior Demonstrator, M.S. Anatomy, Dr. S.N. Medical College, Jodhpur, Rajasthan, India
E-mail: samatagoyal19@gmail.com

Because of unusual and complex morphological features of scapula, and the lack of complete quantitative anatomic studies, the current study was undertaken to describe the glenoid cavity quantitatively with its dimensions and shape.

Material and Methods

The present study was conducted on 120 dried, fully ossified adult scapulae, which were collected from the Department of Anatomy, Dr. S.N. Medical College Jodhpur. Out of these, 60 were of right side and 60 were of left side irrespective of age and sex, belonging to Western Rajasthan population. Only clean, dried and those scapulae maintaining their anatomical features were included in the present study, in order to give correct observations. Damage in glenoid fossa due to any reason such as facture, trauma, partially broken or any pathologically damaged scapula were excluded from the study.

❖ Morphological parameters like shape of glenoid fossa was classified into three groups, as previously described by Schrmpf M et al on the basis of presence or absence of notch on the anterior margin of fossa[7]. Different shapes are:

a) Oval shape without notch
b) Pear shape with indistinct notch
c) and Inverted comma shape with distinct notch on anterior margin of fossa

❖ Morphometric parameters as previously described by Sinha P et al[8]., were calculated in millimetre (mm) using digital vernier calliper with accuracy of 0.01mm. The diameters were calculated for both right and left side of scapulae. Observed diameters are:

1. **Supero-inferior diameter (SI-D):** It was measured from point A to B as shown in fig.no.2 i.e. maximum distance between highest point on supraglenoid margin to the lowest point on infraglenoid margin.
2. **Antero-posterior diameter 1 (AP-D1):** It was measured from point C to D as shown in fig.no.2 i.e. maximum breadth of the

articular margin of the glenoid cavity which is perpendicular to the SI-D, usually taken in the lower part of the glenoid cavity.

3. **Antero-posterior diameter 2 (AP-D2):** It was measured from point E to F as shown in fig.no.2 i.e. the anterior- posterior diameter of the upper half of the glenoid cavity at the mid- point between the highest point on supra glenoid margin and the mid-equator point M.
4. **Glenoid cavity index (GCI):** Glenoid Cavity Index (GCI) was calculated by the formula[9]:- (Antero-posterior diameter-1 ÷ Supero-inferior diameter) × 100

Statistical analysis

The mean and standard error of the glenoid fossa for various diameters mentioned above were calculated. Continuous variable was expressed as mean value ± SD. Non continuous variable was expressed as percentages. Difference in continuous variables among two or more groups were analysed by unpaired t test with confidence interval 95%. $P \leq 0.05$ was considered as significant.

Results

Present study was conducted on 120 scapulae (60 right & 60 left), where we observed most common shape of glenoid cavity was pear shaped (45.83%), 2nd most common shape was oval shape (35%) and inverted comma shape was the least common shape (19.16%) in glenoid cavity of scapula.On measuring various diameters, we found mean SI-D was 34.53 ± 3.46 mm and 35.31 ± 3.10 mm of right and left sides respectively. When both the mean were statistically analysed, the difference in mean SI-D between right and left glenoid cavities was found to be statistically insignificant (p= 0.1903).On measuring AP- D1, we found mean AP- D1 to be 22.3 ± 2.9 mm and 24 ± 2.27 mm on right and left side of glenoid fossa respectively. We observed that the difference in mean AP- D1 between right and left glenoid cavity was extremely statistically significant (p= 0.0005).

On measuring AP- D2, we found mean AP- D2 was 16.13 ± 2.48 mm and 18.03 ± 2.6 mm on right and left side of glenoid fossa respectively. When both the mean were calculated, the difference in mean AP- D2 between right and left glenoid cavities was extremely statistically significant (p= 0.0001).GCI is the correlation between breadth and length of glenoid cavity, which was 64.57 ± 6.91% and 68.33 ± 6.29% on right and left side of glenoid fossa respectively. The difference in mean GCI between right and left glenoid cavity was found to be very statistically significant (p= 0.0023)

Discussion

In our study, we tried to measure the average diameters of the glenoid cavity of scapula as well as the various shapes and the glenoid cavity index. It has been attempted previously by many authors in different parts of the country, to measure the diameters of the glenoid cavity in a similar pattern. It was performed in various ways including direct measurements of dry scapula, direct measurements of fresh or embalmed cadavers, radiographic measurements of scapula or radiographic measurements in living patients. The present study was done on dried scapula and has been correlated with the other studies for any similarity or difference.In our study, most common observed shape was pear shape, which is consistent with the study of Neeta et al[10]., Saha S et al[11]., Philip SE et al[12]. and Singh A et al[13]. Some researchers including Rajput et al[6]. and Mamatha et al[14]. found oval shape as least common which contrasts with our study, where oval shape is the second common shape. Inverted comma shape was observed as second most common shape by Rajput et al[6]. and Mamatha et al[14]., whereas the same was observed as least common shape in various studies like Philip SE et al[15]. Singh A et al[16]. and our present study.There is significant difference in the size in different parts of the country, comparison of various diameters by different authors is shown in Table no. 4. The length of GC is an important factor which should be appropriately matched with the size of prosthesis during total shoulder arthroplasty in order to achieve full congruency[14,15,16].

Table 1: Distribution of scapulae on the basis of shape of glenoid cavity

	Total number of bones= 120		
S.no.	Shape	Frequency	Percentage %
1.	Pear	55	45.83
2.	Oval	43	35
3.	Inverted comma	23	19.16

Table 2: Showing mean values of various morphometric parameters

S.no.	Parameters	Right side Mean ± SD (mm)	Left side Mean ± SD (mm)	p-value	t-value
1.	SI-D	34.53 ± 3.46	35.31 ± 3.10	0.1903	1.3172
2.	AP-D1	22.3 ± 2.9	24 ± 2.27	0.0005	3.5638
3.	AP-D2	16.13 ± 2.48	18.03 ± 2.6	0.0001	4.0251
4.	GCI	64.57 ± 6.91	68.33 ± 6.29	0.0023	3.1148

Table 3: Showing various shapes observed by different authors

S.no.	Authors	Year of study	Sample size	Pear	Oval	Inverted comma
1.	Mamatha et al[14].	2011	202	90	45	67
2.	Rajput et al[6].	2013	100	47	16	37
3.	Philip SE et al[12].	2018	100	64	28	8
4.	Singh A et al[13].	2019	100	44	34	22
5.	Present Study	2021	120	55	43	23

Table 4: Comparison of Superior-inferior diameter (SI), Antero-posterior diameter (AP-D1), Antero-posterior diameter (AP-D2) by various authors

S.no.	Authors	Year of study	Sample size		Mean SI-D (mm)	Mean AP-D1 (mm)	Mean AP-D2 (mm)
1.	Rajput et al[6].	2012	Right	43	34.76±3	24.31±3.0	15.10±2.54
			Left	57	34.43±3.21	22.92±2.80	13.83±2.45
2.	Neeta Chhabra et al[10].	2015	Right	55	38.46±2.81	25.04±2.69	18.70±2.22
			Left	71	39.03±3.18	24.85±2.46	18.6±2.07
3.	Akhtar J et al[9].	2016	Right	126	36.03±3.15	23.67±2.53	16.30±2.16
			Left	102	35.52±3.12	23.59±2.47	16±2.34
4.	Pranoti Sinha et al[8].	2016	Right	21	33.64 ± 3.01	23.22 ± 2.85	18.07 ± 2.64
			Left	32	34.44 ± 3.27	23.31 ± 3.12	18.01 ± 2.56
5.	Present study	2021	Right	60	34.53 ± 3.46	22.3 ± 2.9	16.13 ± 2.48
			Left	60	35.31 ± 3.10	24 ± 2.27	18.03 ± 2.6

Table 5: Comparison of GCI by various authors

S.no.	Authors	Year of study	Sample size	GCI (right side) %	GCI (left side) %
1.	Neta Chhabra et al[10].	2015	126	65.11 ± 5.11	63.67 ± 3.76
2.	Akhtar J et al[9].	2016	228	66.13 ± 8.67	66.73 ± 7.47
3.	Ankushrao SD et al[17].	2017	107	65.13 ± 7.67	65.73 ± 8.47
4.	Singh A et al[13].	2019	100	69.87 ± 1.54	70.44 ± 7.59
5.	Present study	2021	120	64.57 ± 6.91	68.33 ± 6.29

Clinical Application

Repetitive movement combined with an excessive stress or acute traumatic event, such as a fall on an outstretched arm, on the glenohumeral joint can result in microtrauma, capsuloligamentous laxity and/or a labral tear[18,19]. Labral lesions can occur anywhere around the circumference of the labrum, with the most common site affected being the superior region during a SLAP lesion[20]. Snyder et al[18]. introduced the term SLAP lesion – indicating an injury located within the superior labrum extending anterior to posterior. They originally classified these lesions into 4 distinct categories based on the type of lesion present, emphasizing that this lesion may disrupt the origin of the long head of the biceps brachii.

Bankart lesion management, after failed conservative treatment, requires surgical reattachment of the labrum alone, or with remplissage of a humeral bony defect 'Hill-Sachs lesion'[21]. The main concern following Bankart lesion treatment is recurrent instability and/or redislocation.

Knowledge of glenoid cavity and its morphometry is important; since restoration of normal anatomy is the goal in orthopedic surgery. Its basis in injury is of great significance to sports medical professionals and its anthropometry cannot be overlooked by anatomists and medico-legal forensic experts.

Conclusion

The right glenoid cavity was slightly shorter in length as compared to the left glenoid cavity, whereas left glenoid cavity is broader, especially in its upper part as compared to the left. While evaluating defects and lesions of the glenoid, this fact could be useful. By observing the tables in the discussion, it can be implied that the values observed in the present study, coincide with that of earlier studies. A variation of normal anatomy is quite obvious and it is also essential to know the variations while evaluating the pathological conditions like osseous Bankart lesions and osteochondral defects. The above study helps Orthopaedicians and clinicians in shoulder dislocation, fractures and other shoulder associated injuries.

References

1. Patil GV, Kolagi SI, Ramdurg U. Morphometrical Study of Scapular Glenoid Cavities. Global Journal of Medical Research: H Orthopedic and Musculoskeletal System 2014; 14(2): 5-10.
2. Gray H. Anatomy, Descriptive and Surgical. 15th ed. T. Pickering Pick and Robert Howden, Eds. New York: Bounty Books, 1977.
3. UW Medicine. Mechanics of glenohumeral instability. The University of Washington Department of Orthopaedics and Sports Medicine 2013. Available at http://www. orthop. washington.edu/?q=patient-care/articles/shoulder/ mechanics-of-glenohumeral-instability .html. Accessed; 23 July, 2015.
4. Prescher A, Klumpen T. The glenoid notch and its relation to the shape of the glenoid cavity of the scapula. J Anat 1997; 190(3): 457- 60.
5. Sinnatamby CS. Last's Anatomy Regional and Applied.11th Ed. London: Churchill Livingstone; 2006 .p. 50- 52.
6. Rajput HB, Vyas KK, Shroff BD. A study of morphological patterns of glenoid cavity of the scapula. National J of Medical Research 2012; 2(4): 504-507.
7. Schrumpf M, Maak T, Hammoud S, Craig EV. The glenoid in total shoulder arthroplasty. Curr Rev Musculoskelet Med. 2011; 4(4): 191- 99.
8. Sinha P, Bhutia KL, Tamang B, Sarda RK. Morphometric study of glenoid cavity of dry human scapula. Int J Med Res Prof. 2016; 2(3): 86- 90.
9. Akhtar MJ, Kumar B, Fatima N, Kumar V. Morphometric analysis of glenoid cavity of dry scapulae and its role in shoulder prosthesis. Int J Res Med Sci. 2016; 4(7): 2770- 76.
10. Neeta C, Suraj P, Mishra BK. An anatomical study of glenoid cavity: Its importance in shoulder prosthesis. Int J Anat Res 2015; 3(3): 1419- 24.
11. Saha S, Vasudeva N. Morphological variations of glenoid cavity of human scapulae: An anatomical study with clinical relevance. Int J Anat Res 2020; 8(1.2): 7288- 7293.
12. Philip SE, Dakshayani KR. A morphometric study of glenoid cavity and its implication in shoulder arthroplasty and prosthetic designs. Natl J Clin Anat 2018; 7: 190- 4.
13. Singh A, Singh A, Agarwal P, Gupta R. A Morphological and Morphometric Study of Glenoid Fossa of Scapula and its Implication in Shoulder Arthroplasty. International Journal of Anatomy, Radiology and Surgery. 2019; 8(3): 6- 9.
14. Mamatha T, Pai SR, Murlimanju BV, Kalthur SG, Pai MM, Kumar B. Morphometry of Glenoid Cavity. Online Journal Health Allied Sciences. 2011; 10 (3): 1-4.
15. Kandemir V, Allaire RB, Jolly JT, Debski RE, McMohan PJ. The Relationship between the orientation of the glenoid and tears of the rotator cuff. JBJS. 2006; 88 (8) Aug: 1105-09.
16. Poppen NK, Walker PS. Normal and abnormal motion of the shoulder. Journal of Bone and Joint Surgery. 1976; 58A: 195-201.
17. Ankushrao SD, Dombe DD. Morphological and Morphometrical study of scapulae in Western Indian Population. Ind J Clin Anat Physiol, 2017; 4 (3): 298- 303.
18. Snyder SJ, Karzel RP, Del Pizzo W, Ferkel RD, Friedman MJ. SLAP lesions of the shoulder. Arthroscopy. 1990; 6(4): 274- 9.
19. Elattrache NS, Hodgins JL, Gonzalez-lomas G, Ahmad CS. The shoulder in athletes. In: Rockwood and Matsen's The Shoulder. Elsevier Inc, 2020. pp. 1151– 1201.e6.
20. Clavert P. Glenoid labrum pathology. Orthopaedics and Traumatology: Surgery and Research, 2015. pp. 101, S19- S24.
21. DeFroda S, Bokshan S, Stern E, Sullivan K, Owens BD. Arthroscopic bankart repair for the management of anterior shoulder instability: indications and outcomes. Current Reviews in Musculoskeletal Medicine, 2017. pp. 10, 442- 451.

Conflict of Interest: Nil Source of support: Nil