International Journal of Anatomy and Research,
Int J Anat Res 2016, Vol 4(2):2473-79. ISSN 2321-4287
DOI: http://dx.doi.org/10.16965/ijar.2016.242

Original Research Article

OSSEOUS ANATOMY OF GLENOID: CADAVERIC STUDY

Kate Deepali R *[1], Ajari Ashutosh [2], Chandanwale Ajay [3], Bahetee B H [4], Babhulkar Ashish [5].

*[1] Associate Professor, Department of Anatomy B.J.Govt.Medical College and Sassoon Hospital, Pune, Maharashtra, India

[2,5] Department of Shoulder and Sports Injury, Deenanath Mangeshkar Hospital, Pune, Maharashtra India

[3] Professor, Department of Orthopedic, B J Govt Medical College and Sassoon Hospital, Pune, Maharashtra, India

[4] Professor, Department of Anatomy B J Govt Medical College and Sassoon Hospital Pune, Maharashtra, India

ABSTRACT

Background: The shoulder joint is vulnerable for dislocation due to disproportionate articular surfaces. The morphology of shoulder bones is well investigated in the western population, whether Glenoid conforms to the same dimensions in Indian population is sparsely known. The knowledge of bony morphometry, their variation and racial differences are of paramount significance in the diagnosis and management of shoulder diseases and to produce a more anatomical result in shoulder replacement surgery.

Aim: The current investigation was aimed to study and analyze morphometric data of Glenoid in Indian population.

Materials and Methods: We studied sixty seven wet scapulae of known sex, retrieved from embalmed human cadavers age varied from sixty to eighty years. The Glenoid parameters under consideration were height, breadth and version. The data obtained was analysed and discussed with other osteological studies.

Results: The mean combined glenoid height recorded was 34.07±3.79mm and the average combined anterior-posterior diameter of the lower half of glenoid was 24.44 ±2.98 mm .The values of glenoid version showed wide distribution in our study ranging from -10^0 to $+6^0$ The mean glenoid version of the left side -1.00 ± 4.06^{0} and on the right side -3.30 ± 3.63^0

Conclusion: The glenoid version showed a wide variation ranging from (-10^0 to $+6^0$) on comparison, the right shoulders were found to be more retroverted than the left. The glenoid height and width noted was in accordance with other Indian studies. However significant variation with respect to western bone morphology has emerged.

KEY WORDS: Glenoid, Shoulder Arthroplasty, Cadavers.

Address for Correspondence: Dr. Kate Deepali R. Associate Professor, Department of Anatomy, B J Govt.Medical College and Sassoon Hospital, Pune, Maharashtra, India. Contact: +919960273531
E-Mail: drd.kate@gmail.com

Access this Article online

Quick Response code

DOI: 10.16965/ijar.2016.242

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 16 May 2016 Accepted: 14 June 2016
Peer Review: 16 May 2016 Published (O): 30 June 2016
Revised: None Published (P): 30 June 2016
Corrected and Republished: 31 December 2016

INTRODUCTION

The Glenohumeral joint is a multiaxial ball-socket synovial joint. The surface area of glenoid fossa is one third that of the humeral head. The vertical diameter is 75% and the transverse diameter is about 60% of that of the humeral head. In 75% of subjects, the glenoid fossa is retro tilted to about 7.4 degrees in relationship to the plane of the scapula. This relationship is important in maintaining horizontal stability of the joint and hence counteracting tendency toward anterior displacement of the humeral head [1,2,3] The normal glenoid morphology is described as pear shaped and only when glenoid loose enough anterior-inferior bone assume the shape of an inverted pear. A bone loss of more than 21% would cause instability despite soft tissue repair [4] The factors which pose to shoulder instability include abnormalities in the size, shape, and orientation of the articular surfaces; disruptions of the capsule, glenohumeral ligaments, or labrum; the inadequacy of the short rotator muscles, particularly the subscapularis [5,6] Arthroplasty may be indicated in osteoarthritis, rheumatoid arthritis, osteonecrosis or severe fractures of the shoulder bones. The surgery options range from resurfacing arthroplasty, hemi arthroplasty, total or reverses total shoulder arthroplasty. However despite the advancement in surgical techniques and availability of various prosthesis models, wearing down or loosening of the prosthesis components can consequence into instability and dislocation due to improper component alignment. Joint instability subsequent to shoulder arthroplasty is one of the common complications reported to occur in up to 18.2% of cases [7] Glenoid component fixing without correction of glenoid version and can lead to decentering of metallic humerus ball resulting in wearing of glenoid component and failure; rocking horse phenomenon [8] Therefore glenoid dimensions and version are vital while a surgeon prepares to resurface the glenoid during shoulder arthroplasty.

MATERIALS AND METHODS

Source of data: Adult wet scapulae were retrieved from embalmed human cadavers fixed in formalin from the department of Anatomy, B.J. Govt Medical College, Pune.

Ethical Considerations: Prior written consent was obtained and legal documentation was completed by the body donors, expressing self willingness to donate their body for medical education and research purpose. The current study has been approved by Institutional Ethics Board.

Sample size: A total of sixty seven scapulae: thirty three of the right and thirty four of the left side were studied.

Inclusion Criteria: Adult wet scapulae of both sexes were included in the study. Age varied from sixty five to eighty years.

Exclusion Criteria: The bones showing any apparent pathology, features of osteoarthritis and fractures were discarded from the study.

Study Design: Cross Sectional Descriptive and Quantitative type.

Protocol of the Procedure: The glenohumeral joints of cadavers were exposed by detaching the periarticular muscles. The soft tissue on the scapula including the glenoid labrum was removed to expose the bony surfaces, essential markings were made and various parameters were measured manually with sliding Vernier caliper and Goniometer.

Morphology of the glenoid cavity was assessed as follows:

i) Glenoid Height (A) Represents the maximum distance from the most prominent point of the supraglenoid tubercle to inferior point on the glenoid margin,

ii) Glenoid Breadth (B) Represents the maximum antero- posterior distance of the articular margin of the lower half of glenoid cavity

(A) and (B) are marked perpendicular to each other (Fig. 1)

(A1) inferior measurement from intersection on A (Fig. 2)

(A2) superior measurement from intersection on A (Fig. 2)

(B1) anterior measurement from intersection on B (Fig. 2)

(B2) posterior measurement from intersection on B (Fig. 2)

The dimensions were recorded with sliding vernier caliper (accurate 0.1)

iii) Glenoid Version (GV) is the orientation of glenoid in transverse plane of the scapula [3,9].

Anterior tilt indicates anteversion and posterior tilt indicates retroversion.

(anteversion is denoted by positive while retroversion by negative sign).

Fig. 1: Glenoid Height and Breadth Measurement.

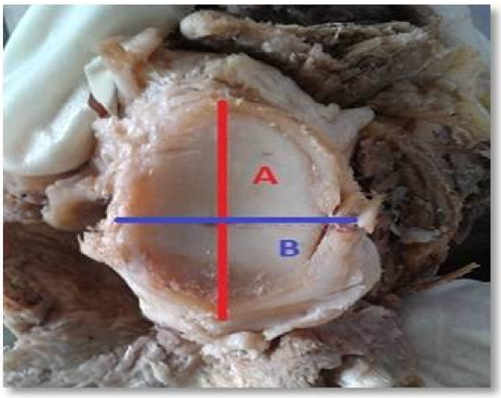


Fig. 2: Glenoid Height and Breadth Measurement.

Fig. 3: Glenoid Version Measurement.

Methods: Scapula was held fixed on mount with blade of scapula perpendicular to floor. The angle between the line connecting the most anterior and posterior point of the glenoid and line perpendicular to floor was measured with the goniometer (Figure-3) each dimension was recorded three times and mean was considered.

Statistical analysis: Data obtained was analysed using Bio-Medical Data Processor (BMDP new system 2) and applying appropriate statistical tests (Table1) The mean and standard deviation of the different parameters of glenoid cavity were calculated and summarized (Tables 2, 3, 4 and Graphs 1 to 4)

The data obtained was compared and discussed with other osteological studies (Tables 5, 6 and Graphs 5, 6)

Table 1: Showing the Statistical Aanlysis.

Objective	Descriptive statistical model	Inferential statistics
1. Estimation of morphometric parameters of glenoid of both sides.	Mean,S.D,Minimum-Maximum, 95% CI	
2.Comparison of the various parameters of glenoid between right and left side	Difference in mean,95% CI of difference in mean	Mann Whitney test.
3. Comparison of current data with that of other research workers.	Mean, S.D., 95%CI	Wilcoxon Signed Rank test

Table 2: Showing the Summary Of Glenoid Height.

GLENOID HEIGHT (mm)	N	Mean	SD	Min	Max	Median
A1 (Both sides)	67	13.47	2.14	10	21	13
Left	34	13.9	2.23	10.39	21	13.7
Right	33	13.03	1.98	10	17.89	12.5
A2 (Both sides)	67	20.6	2.99	10.5	25.89	20.6
Left	34	20.4	3.1	14	25	20.55
Right	33	20.8	2.91	10.5	25.89	21
A (Both sides)	67	34.07	3.79	21.2	42.34	34.5
Left	34	34.3	4.06	27	42.39	34.04
Right	33	33.83	3.55	21.2	40.89	34.7

Table 3: Showing the Summary of Glenoid Antero-Posterior Diameter.

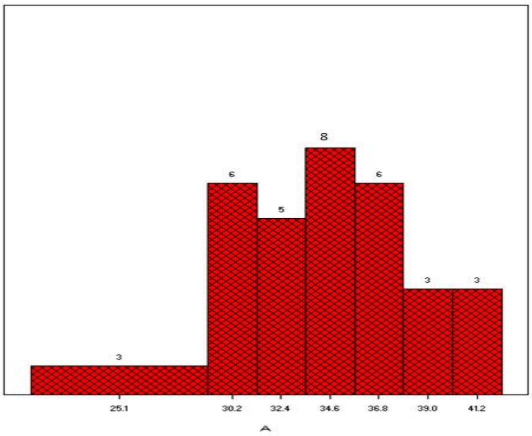
GLENOID ANTERO POSTERIOR DIAMETER (mm)	N	Mean	SD	Min	Max	Median
B1 (Both sides)	67	12.33	1.94	9	20	12.3
Left	34	12.12	1.76	9	16.2	12.15
Right	33	12.53	2.11	9.1	20	12.5
B2 (Both sides)	67	12.11	1.47	9	15.69	12
Left	34	12.05	1.53	9.6	15.69	11.84
Right	33	12.17	1.44	9	15.19	12.19
B (Both sides)	67	24.44	2.98	18.1	33	24.6
Left	34	24.18	2.92	18.79	31.5	24.45
Right	33	24.71	3.06	18.1	33	24.7

Table 4: Showing the Summary Of Glenoid Version.

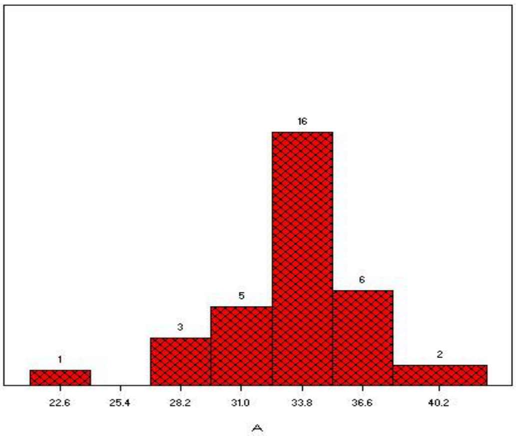
Glenoid Version (degree)	N	Mean	SD	Min	Max	Median
Both	67	-2.13	3.99	-10	6	-3
Left	34	-1	4.06	-10	6	-2
Right	33	-3.3	3.63	-10	5	-3

FREQUENCY DISTRIBUTION OF GLENOID HEIGHT (Graphs 1, 2)

Graph 1: Glenoid Height (mm) Left.

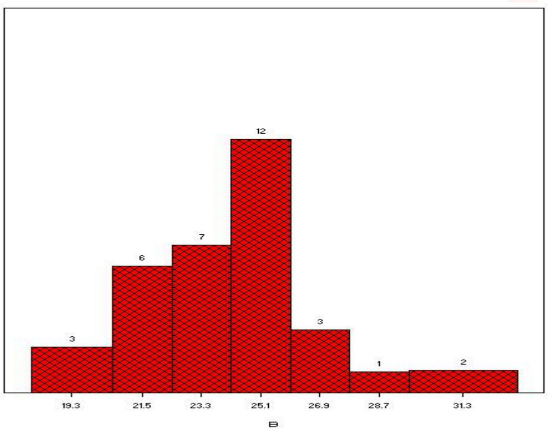


Graph 2: Glenoid Height (mm) Right.

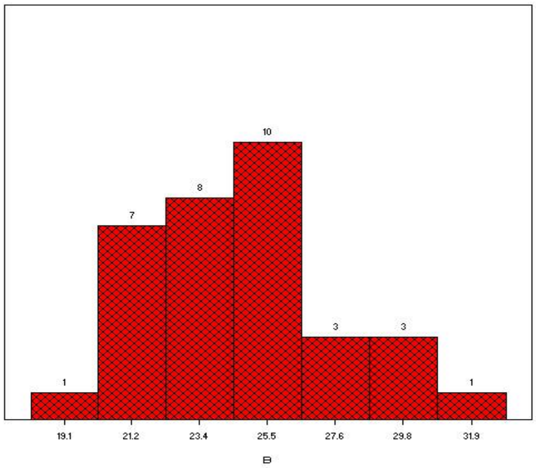


FREQUENCY DISTRIBUTION OF GLENOID BREADTH (Graphs 3, 4)

Graph 3: Glenoid Breadth (mm) Left.

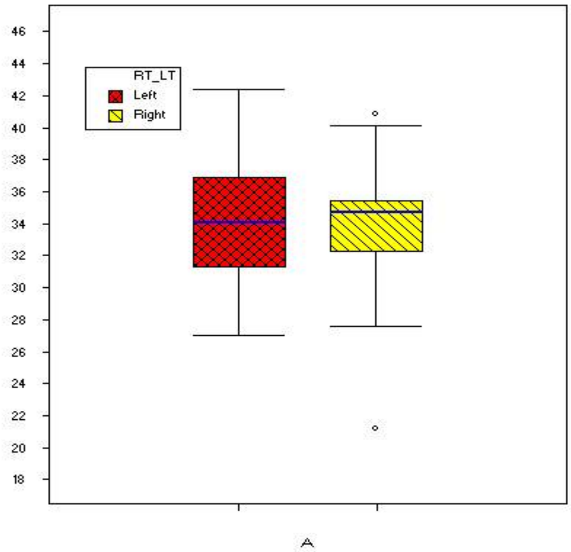


Graph 4: Glenoid Breadth (mm) Right.

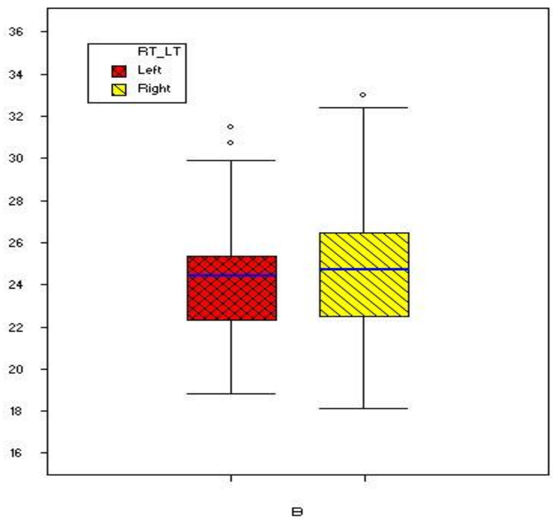


COMPARISON OF GLENOID PARAMETERS OF BOTH SIDES (GRAPHS 5, 6, 7)

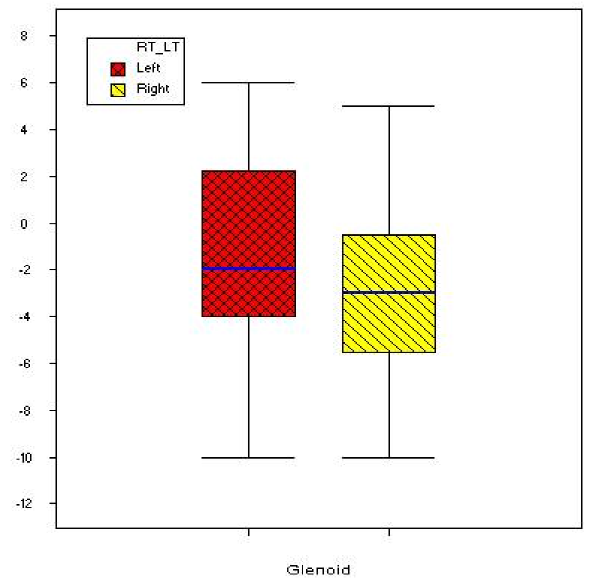
Graph 5: Glenoid height (mm)'A' right and left side by box plot.



Graph 6: Glenoid Antero-Posterior diameter 'B' (mm) right and left side by box plot.



Graph 7: Glenoid Version comparison right and left side by box plot.



RESULTS

In the present study total scapulae investigated (n=67) where the combined glenoid height ranged from 21.20mm to 42.39mm and the mean recorded was 34.07± 3.79mm The average glenoid height on left (n =34) was 34.305±4.06mm and the right (n = 33) was 33.83±3.55mm respectively. The combined anterior-posterior diameter of the lower half of ranged from 18.10mm to 33.00mm with a mean of 24.44±2.98mm .The average antero-posterior diameter of the left glenoid was 24.18±2.93mm and that of the right was 24.72±3.07mm. The values of glenoid version showed wide distribution in our study ranging from-10º to +6º the mean glenoid version of the left side recorded was -1.00±4.06 ºand on the right side was 3.30±3.63º the values of various Glenoid parameters under consideration have been summarized in (Table- 2, 3, 4 and Graphs 1, 2, 3, 4)

DISCUSSION

The current investigation is an attempt to obtain the morphometric data of scapular glenoid in the Indian population-west Maharashtra and to ascertain the difference in various parameters of both sides if any, as the sound shoulder is considered as reference for surgical correction of the pathological one. The information obtained in our search has been evaluated with studies conducted on different population. In the present study combined mean glenoid height recorded was 34.07± 3.79mm while on left (n-34) and the right (n-34) sides was 34.305± 4.06mm and 33.83± 3.55mm respectively. The glenoid height of both sides (Graph-5) was compared using Mann Whitney statistical test; p value 0.8754 where in glenoid height on left was found to be slightly higher though not statistically significant. The combined mean anterior-posterior diameter of the lower half of the glenoid measured was 24.44±2.98mm while of left glenoid was 24.18±2.93mm and that of the right was 24.72±3.07mm. On comparing Antero-posterior diameter of both sides (Graph-6) using Mann Whitney statistical test; p-value 0.4784 Our findings concurred with Mamtha et al [10] who studied 202 dried adult scapulae who reported greater average left glenoid height and broader right glenoid and did not show any statistically significant difference.

Table 5: Comparison of 'A' and 'B' with other Indian studies.

AUTHOR	YEAR	SIDE And SAMPLE SIZE	Glenoid 'A' in mm (Mean ± S.D.)	Glenoid 'B' in mm (Mean ± S.D.)	P-value for 'A'	P-value for 'B'
Mamatha et al 2011 [10]	2009	Right-98	33.67± 2.82	23.35 ± 2.04	0.339	0.0206
		Left-104	33.92 ±2.87	23.02 ± 2.30	0.626	0.0268
Rajput et al 2012 [11]	2012	Right-43	34.76±3	23.31 ± 3.0	0.2876	0.0187
		Left-57	34.43±3.21	22.92 ± 2.80	0.7388	0.017
Kavita et al 2013 [12]	2013	Right-67	35.2±3.0	25.0 ± 2.70	0.0216	0.4161
		Left-62	34.7±2.8	24.9 ± 2.40	0.5325	0.0888
Gursharan Singh Dhindsa et al 2014 [13]	2014	Right-41	34.13±3.16	24.05 ± 2.86	0.8932	0.3212
		Left-39	34.11±2.57	23.36 ± 2.22	0.925	0.1485
Gosavi S.N et al [2014] [14]	2014	Right 62	35.03 ± 5.25	24.17 ± 2.57	0.0463	0.5142
		Left 80	35.3 ± 3.41	23.9 ± 2.66	0.1583	0.7388
Present study.	2016	Right-33	33.83±3.54	24.71 ± 3.06		
		Left-34	34.30±4.06	24.18 ± 2.92		

Table 6: Comparison of 'A' and 'B' with other worldwide studies.

AUTHORS	SAMPLE SIZE	Glenoid 'A' (mm) (Mean±S.D)	Glenoid 'B' (mm) (Mean±S.D)	P-value for 'A'	P-value for 'B'
Mallon et al (1992) [15]	28 each side	35 ± 4.1	24 ± 3.3	0.0548	0.408
Iannotti et al (1992) [16]	140 each side	39 ± 3.5	29 ± 3.2	0.0001	0.0001
Von Schroeder et al (2001 [17]	30 each side	36 ± 4.1	28.6 ± 3.3	0.0001	0.001
Karelse et al (2007 [18]	40 each side	35.9 ± 3.6	27.2 ± 3.0	0.0001	0.0001
Present study (2016)	Right- 33	33.83±3.54	24.71±3.06		
	Left- 34	34.30±4.06	24.18±2.92		
	Pooled Mean	34.07	24.44		

The average values of 'A' and 'B' obtained were compared to the findings of other Indian workers [10-14] (Table-5) using Wilcoxon signed rank test and the findings were found to be almost in accordance. On comparison with the western studies as shown in (Table-6) values of 'A' and 'B' were distinctly low in our study. The parameters were compared by applying Wilcoxon signed rank test where p value was less than 0.05 when weighed against study carried out by Mallon et al [15] and was highly significant (at p value less than 0.001) when compared with the studies done by Iannotti et al [16], Von Schroeder et al [17] Karelse et al [18] On evaluating 28 cadaveric scapulae Mallon et al [15] found high mean glenoid height in men of 38mm(range 33mm-45mm) compared to 36.2mm in women (range 32mm-43mm) Similar gender difference in glenoid height was noted by Churchil et al [9] who studied 344 cadaveric scapulae and have reported high mean glenoid height in men of 37.5mm(range 30.4mm-42.6mm) compared to 32.6mm in women (range 29.4mm-37mm) In the current study gender comparison could not be established due to proportionately less number of female cadavers.

Glenoid version is the angular orientation of the axis Of the glenoid articular surface relative to the long (transverse) axis of the scapula; a posterior angle denotes retroversion and anterior angle is anteversion The values of glenoid version showed wide distribution in our study ranging from -10^0 to $+6^0$ The mean version recorded on left side was -1.00 ± 4.06^0 and on the right was 3.30 ± 3.63^0 However on comparison right glenoid were found to be more retroverted than the left side (Graph-7) Mann-Whitney test P value = 0.029 (significant at $p<0.05$)

The glenoid cavity angle in the Indian population has not been explored adequately. Uma S et al [19] studied hundred dry scapulae of each side and have noted a mean glenoid angle on the left – 5.02 ± 2.07^0 and – 6.90 ± 3.48^0 on the right with a significant difference in the glenoid version of both sides (p value < 0.001) Churchill et al [9] reported a mean glenoid retroversion of 1.2^0 (range 9.5^0 anteversion-10.5^0 retroversion) in their study glenoids from men tended to be slightly more retroverted than those from women (mean 1.5º compared with 0.9^0, respectively) while they found glenoid of white patients significantly more retroverted than those from black (mean, 2.7 compared with 0.2; P <.00001). Mallon et al [15] reported a mean glenoid retroversion of 6^0 (range 2 anteversion-13^0 retroversion) In a study of the relationship between glenoid version and glenoid pathology, Friedman et al [20] noted glenoid were oriented at a mean of 2^0 anteversion in 63 healthy control (range, 14^0 anteversion-12^0 retroversion), and those with glenohumeral arthritis were oriented at a mean of 11^0 retroversion (range 2^0 anteversion-32^0 retroversion). Cyprien et al [21] conducted a radiographic study to compare the glenoid version of 50 healthy shoulders and 15 shoulders with chronic dislocation. They reported a significant difference in the glenoid retroversion of healthy ($7.1^0 \pm 4.6$ left and $8^0 \pm 5.0$ right) and chronic dislocating ($8.9^0 \pm 5.6$ left and $13.2^0 \pm 4.0$ right) shoulders. They also observed higher retroversion on the right. Thus the glenoid version shows a wide range of variation in different geographical distribution, between males and females and on the right and left side of same individual.

This information is essential as version is altered or exaggerated in presence of glenohumeral pathology like osteoarthritis, rotator cuff tears leading to glenoid wear and bone loss and is associated with instability and ultimately dislocation of the joint.

Limitation of the study: A sexual comparison in the Glenoid parameters could not be established due to proportionately less number of female cadavers. The current study was conducted on the cadavers of the older age group and some bone wear cannot be excluded.

CONCLUSION

A large variation was observed in glenoid version ranging from (-10^0 to + 6^0) the right shoulders have shown to have significantly greater glenoid version. The glenoid dimensions observed in our study are in accordance with other Indian studies. However significant variation with respect to western bone morphology has emerged. This data would prove helpful for the assessment of percentage glenoid bone loss and for establishing criteria for anatomical restoration in shoulder surgery. Thus the smaller dimensions of shoulder bones in Indian population need to be contemplated while designing and fitting prosthesis in total shoulder arthroplasty. A mismatch in glenoid anatomy and the implants may contribute to loosening and poor performance of shoulder prosthesis, requiring a surgical revision. This variation in the shoulder morphology may prove useful in forensic science as a criterion for establishing Indian ethnicity.

ABBREVIATION

A- Glenoid Height
B- Glenoid Breadth
A1- inferior measurement from intersection on A
A2- superior measurement from intersection on A
B1- anterior measurement from intersection on B
B2- posterior measurement from intersection on B
GV- Glenoid Version (GV)

ACKNOWLEDGEMENTS

The authors acknowledge Dr. S. Sarmukaddam, BJGMC and Sassoon Hospital, Pune for his contribution in the statistical analysis. We express our deep gratitude to the Body donors for their noble decision to donate their body to the medical fraternity.

Conflicts of Interests: None

REFERENCES

[1]. Sarrafian SK. Gross and functional anatomy of the shoulder. Clin Orthop 1983;173:11-18.
[2]. Saha AK. Dynamic stability of the glenohumeral joint. Acta Orthop Scand 1971;42:491-505.
[3]. Saha AK. Mechanics of elevation of glenohumeral joint: Its application in rehabilitation of flail shoulder in upper brachial plexus injuries and poliomyelitis and in replacement of the upper humerus by prosthesis. Acta Orthop Scand 1973; 44:668-678.
[4]. Burkhart SS, DeBeer JF. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic bankart repairs:significance of the inverted pear glenoid and the humeral engaging Hill-sachs lesion. Arthroscopy .2000;16:677-694
[5]. Frankel VH, Nordin M (eds). Basic Biomechanics of the Skeletal System. Victor Hirsch Frankel Lippincott Williams & Wilkins, 2001.
[6]. Reeves B: Experiments on the tensile strength of the anterior capsular structures of the shoulder in man. J Bone Joint Surg [Br] 1968;50:858-865.
[7]. Moeckel BH, Altchek DW, Warren RF, Wickiewicz TL, Dines DM. Instability of the shoulder after arthroplasty. J Bone Joint Surg Am 1993;75(4):492-497
[8]. Walch G et al**,** Glenoid morphology in OA. Walch classification., J Arthroplasty, 1999; 14:756-760.
[9]. Churchill RS, Brems JJ, Kotschi H. Glenoid size, inclination, and version: An anatomic study. J Shoulder Elbow Surg 2001;10:327-332.
[10]. Mamatha T, Pai SR, Murlimanju BV, Kalthur SG, Pai MM, Kumar B. Morphometry of Glenoid Cavity. Online J Health Allied Scs 2011;10(3):1-4.
[11]. Rajput HB, Vyas KK, Shroff BD. A Study of Morphological Patterns of Glenoid Cavity of Scapula. Natl J Med Res 2012;2(4):504-7.
[12]. Kavita P, Singh J, Geeta. Morphology of Coracoid process and Glenoid cavity in adult human Scapulae. International Journal of Analytical, Pharmaceutical and Biomedical Sciences 2013;2(2):19-22.
[13]. Gursharan Singh Dhindsa, Zora Singh. A Study of Morphology of the Glenoid Cavity. Journal of Evolution of Medical and Dental Sciences 2014;3(25):7036-7043. DOI: 10.14260/jemds/2014/2856
[14]. Dr. Gosavi S.N, Dr. Jadhav S. D, Dr.Garud R.S. Morphometric study of Scapular glenoid cavity in Indian population.Journal of Dental and Medical Sciences. 2014;13(9):67-69.
[15]. Mallon WJ, Brown HR, Vogler JB 3rd, Martinez S. Radiographic and geometric anatomy of the scapula. Clin Orthop Relat Res 1992;277:142-154.
[16]. Iannotti JP, Gabriel JP, Schneck SL, Evans BG, Misra S. The normal glenohumeral relationships. An anatomical study of one hundred and forty shoulders. J Bone Joint Surg Am 1992;74:491-500
[17]. Von Schroeder HP, Kuiper SD, Botte MJ. Osseous anatomy of the scapula. Clin Orthop Relat Res 2001;383:131-139.
[18]. Karelse A, Kegels L, De Wilde L. The pillars of the scapula. Clin Anat. 2007;20:392-399
[19]. Uma SV,BalasubramanyamV.Rettroversion angle of Glenoid cavity in South Indian population.National Journal of Clinical Anatomy 2016;5:22-27.
[20]. FriedmanRJ et al.The use of computerised tomography in the measurement of Glenoid version.J BoneJoint Surg Am1992;74:1032-7.
[21]. Cyprein JM,Vasey HM et al.Humeral retrosion and glenohumeral relationship in normal shoulder and in recurrent anterior dislocation (scpulometry) ClincalorthopRelat Res:1983;8-17.

How to cite this article: Kate Deepali R, Ajari Ashutosh, Chandanwale Ajay, Bahetee B H, Babhulkar Ashish. OSSEOUS ANATOMY OF GLENOID: CADAVERIC STUDY. Int J Anat Res 2016;4(2):2473-2479. **DOI:** 10.16965/ijar.2016.242