ORIGINAL RESEARCH PAPER
Volume - 12 | Issue - 05 | May - 2023 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

# A CROSS-SECTIONAL ANALYTICAL STUDY ON QUANTIFICATION OF GLENOID BONE LOSS WITH CT IN PATIENTS WITH ANTERIOR SHOULDER DISLOCATION

**Radio-Diagnosis**

**Dr. Prajwaleet Gour** Professor

**Dr. Deoyani Sarjare** Associate Professor

**Dr. Nancy Jain*** Junior Resident Radiology, 3rd year *Corresponding Author

## ABSTRACT

**Background:** Glenoid bone loss is a feature of anterior shoulder dislocation. This study was undertaken to identify measurement criteria of quantifying glenoid bone loss that occurs with anterior shoulder dislocation on CT. **Method:** This cross-sectional study was conducted on 36 patients with anterior shoulder dislocation in the Department of Radiology at a Tertiary care centre in central India from September 2020 to December 2022. Unenhanced CT scan of bilateral shoulder joints was done. **Results:** There was no significant difference between right and left sided glenoid measurements for healthy subjects. None of the healthy shoulder showed flattening of anterior glenoid curvature. In patients with anterior shoulder dislocation, the maximum glenoid width and glenoid width to length ratio were significantly reduced on dislocating side. Of all parameters, maximum glenoid width and width to length ratio showed significant negative correlation with number of dislocations. Flattening of the anterior glenoid curvature was shown in most patients with anterior shoulder dislocation and showed the most significant positive correlation with number of dislocations. **Conclusion:** Reduction of glenoid width to length ratio as measured on CT scan of the shoulder joint can be used as a reliable parameter to quantify glenoid bone loss in patients of anterior shoulder dislocation, thus guiding the management strategies for these patients. It is cheaper, readily, and rapidly available in most hospitals compared with MRI and allows simultaneous evaluation and comparison of bilateral shoulder joints.

## KEYWORDS

Glenoid bone loss; Anterior shoulder dislocation; CT; Flattening; glenoid width to length ratio

## INTRODUCTION

Anterior shoulder instability being a common condition, has an estimated incidence of 8–23.1 cases/100,000 person-years in the general population [1, 2]. It is the most common cause of glenohumeral dislocation injuries, more commonly affecting young active male patients [2, 3]. Recurrence is related to several factors including glenoid bone loss, often requiring surgical intervention [2,3].

However, anterior shoulder instability leads to loss of bone from the anterior aspect of the glenoid fossa, decreasing the glenohumeral contact area. Thus, if this glenoid bone deficiency is significant, it will predispose the patient to further anterior dislocation and failure of an arthroscopic Bankart repair [4, 5].

Overall, approximately 70% of patients with first-time dislocations can expect a second dislocation within 2 years, although this is very much age-related, with further dislocation occurring in 80% of those younger than 20 years, 60% of those 20–40 years old, and fewer than 15% in those older than 40 years [1].

Recurrent dislocation of shoulder joint is both a cause and consequence of glenoid bone loss. The extent of bony defect is an indicator guiding operative intervention. The current literature suggests that if the bony defect is greater than around 16% to 20%, an open surgery with bone graft procedure or Latarjet technique to restore the normal bony arc of glenoid should be considered [1]. If it is less than 16%, then a arthroscopic repair of the labrum–capsular complex may be employed successfully [14]. Hence precise pre- operative calculation of the extent of bone loss is essential.

Arthroscopy is described as “gold standard” to determine appropriate surgical management for patients with anterior shoulder dislocation. However, arthroscopy uses crude measurement tools causing imprecise estimation of distances [1][15]. Bare spot method relies on anatomic landmark which may be absent or vary in size and position in patients, challenging its use as a reliable proxy for the glenoid's geometric center [16]. Arthroscopy is invasive and requires intraoperative rather than preoperative decision-making.

MRI is usual preoperative method of investigating anterior shoulder dislocation, but it may not allow quantification of glenoid bone loss as contralateral glenoid is not included for comparison.

As per many studies, CT is considered to be a highly sensitive and specific technique of detecting and quantifying glenoid bone loss, and the most accurate radiological modality for visualization of the cortical glenoid rim. It is readily and rapidly available in most hospitals compared with MRI. Numerous measurement methods are commonly used, including the “circle of best fit”, the “Pico” and the “Sugaya method”, as well as several involving mathematical computations using both 2D and 3D CT [1][5][14].

The aim of present study was to investigate whether CT could reveal the pattern of glenoid bone loss that occurs with anterior shoulder dislocation and to investigate methods of quantifying this bone loss.

## MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Radio-Diagnosis at tertiary care center in India during a period of 2.25 years from September 2020 to December 2022. Approval from Institutional Ethics Committee was sought and written informed consent was obtained from all the patients. Total 36 patients presenting with anterior shoulder dislocation in orthopaedic OPD, trauma OPD and ward; this includes patients of primary anterior shoulder dislocation, recurrent shoulder dislocation and patients with anterior dislocation post-surgical correction were included in the study. Pregnant women and patients not willing to participate in the study were excluded.

On the day of CT appointment, complete history and clinical evaluation of the patient was done and patient was taken up for CT examination. 20 subjects undergoing high- resolution CT of the upper thorax for unrelated reasons were also imaged for both shoulders as a reference for normal glenohumeral morphology and side-to-side variation in glenoid width and length.

**CT Imaging Protocols**:

Patients were subjected to CT after clinical evaluation and local examination of bilateral shoulders.

A] Equipment: Machine Philips -Brilliance ICT 256 Slice Machine Siemens Somatom Definition AS+

B] Protocol:

An identical helical CT protocol was used for each examination. Both shoulders were imaged simultaneously.

The scanning plane was extended from the superior aspect of the acromion to the inferior aspect of the glenoid fossa. The scanning parameters such as field of view- 50 cm; pitch- 1.0; Collimation- 1 mm;

kV- 120; mA-200; 1mm image reconstruction and standard reconstruction algorithm were applied.

The obtained images were analyzed on a dedicated CT workstation [Syngo.via, Seimens Healthineers]. Analysis included reconstruction of oblique sagittal images en face to the glenoid fossa. These images were obtained through oblique reformations with successive reconstruction in the oblique coronal and sagittal planes [Fig. 1].

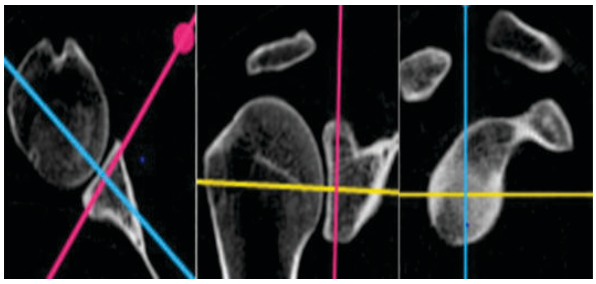


**Figure 1: Images obtained through oblique reformations with successive reconstruction in the oblique coronal and sagittal planes. A) Plane parallel to midpoint of glenoid fossa was chosen to define oblique coronal plane (B).**

**B) Using supraglenoid tubercle as a reference, vertical inclination of glenoid fossa (solid pink line) was defined on this oblique coronal image and further oblique sagittal image (C) was reconstructed.**

**C)This oblique sagittal image provided image en face to glenoid fossa.**

### Statistical Analysis

For statistical analysis data was entered into a Microsoft excel spreadsheet and analyzed by SPSS [version 27.0; SPSS Inc., Chicago, IL, USA] and GraphPad Prism version 5. Data was summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests were used for a difference in mean involved independent samples or unpaired samples. Z-test [Standard Normal Deviate] was used to test the significant difference of proportions. Correlation was calculated by Pearson correlation analysis. p-value ≤ 0.05 was considered statistically significant.

## OBSERVATIONS AND RESULTS

Table 1 shows that two sample independent t test was used to compare mean and standard deviation of glenoid parameters in healthy subjects on right and left side; all were found to be non- significant. [p=0.9356, p=0.4892, p=0.8273].

**Table 1: Glenoid measurements in Healthy Subjects**

| Glenoid measurements | | Number | Mean | SD | P Value |
|---|---|---|---|---|---|
| Maximum glenoid width in mm [on reformatted image] | Right Side | 20 | 27.57 | 2.74 | 0.9816 |
| | Left Side | 20 | 27.55 | 2.7 | |
| Glenoid Length in mm | Right Side | 20 | 39.39 | 3.18 | 0.9356 |
| | Left Side | 20 | 39.32 | 3.18 | |
| Glenoid Width to Length Ratio | Right Side | 20 | 0.69 | 0.04 | 0.4892 |
| | Left Side | 20 | 0.68 | 0.05 | |
| Cross Sectional Area [Reformatted] | Right Side | 20 | 874.9 | 122.9 | 0.8273 |
| | Left Side | 20 | 866.39 | 122.05 | |

The mean age of patients was 38.38±12.34 years, range from 19 to 67 years with male predominance.

Flattening of the anterior glenoid curvature was shown in most patients with anterior dislocation [33; 91.7%] and length of flattening ranged from 3 to 27 mm with mean length 12.70±6.9 mm. It showed the most significant positive correlation with number of dislocations as shown in figure 2 and Table 2.

The mean difference of normal side maximum glenoid width vs. dislocating side maximum glenoid width was 2.29 with 95% confidence interval [1.02 to 3.55]. It was statistically significant [p=0.0006] as depicted in Figure 3.

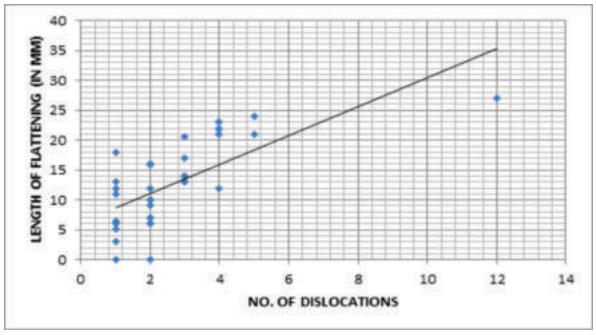



**Figure 2: Correlation between flattening of glenoid curvature and No. of dislocations.**

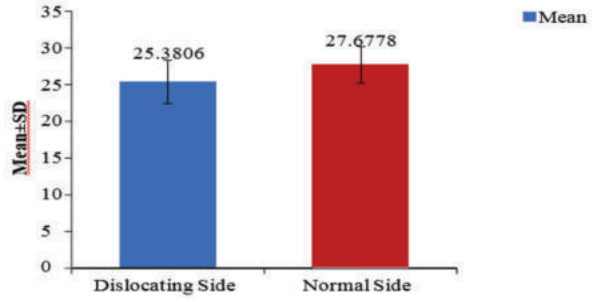



**Figure 3: Distribution of mean maximum Glenoid Width in Mm [On Reformatted Image]**

The mean difference of normal side glenoid length vs. dislocating side glenoid length was 0.11mm with 95% confidence interval [ -1.4 t 1.6]. The difference of mean normal side glenoid length vs. dislocating side glenoid length was not statistically significant [p= 0.8].

The mean difference of normal side glenoid width to length ratio vs. dislocating side was 0.05 with 95% confidence interval [ .03 to .07]. It was statistically significant [p<0.0001].

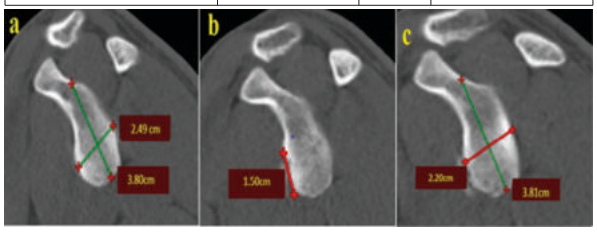
The mean difference of normal side cross sectional area [reformatted] vs dislocating side cross sectional area [reformatted] was 9.00 with 95% confidence interval [-48.2 to 66.2]. It was not statistically significant [p=0.75].

Out of all parameters, maximum glenoid width and width to length ratio showed significant negative correlation with number of dislocations. Flattening of the anterior glenoid curvature was shown in most patients with anterior shoulder dislocation and showed the most significant positive correlation with number of dislocations as shown in Table 2.

**Table 2: Correlation of number of dislocations with all parameters on dislocated side**

| Parameters | | Number of Dislocations | Remarks |
|---|---|---|---|
| Dislocating side maximum glenoid width in mm [on reformatted image] | Pearson Correlation Coefficient [r] | -.572** | Negative correlation |
| | p-value | .000 | Significant |
| | Number | 36 | |
| Dislocating side glenoid length in mm | Pearson Correlation Coefficient [r] | .003 | Positive correlation |
| | p-value | .988 | Not Significant |
| | Number | 36 | |
| Dislocating side glenoid width to length ratio | Pearson Correlation Coefficient [r] | -.685** | Negative correlation |
| | p-value | .000 | Significant |
| | Number | 36 | |
| Dislocating side cross sectional area [reformatted] | Pearson Correlation Coefficient [r] | -.073 | Negative correlation |

| | | | |
|---|---|---|---|
| | p-value | .671 | Not Significant |
| | Number | 36 | |
| Length of flattening [in mm] | Pearson Correlation Coefficient [r] | .697** | Positive correlation |
| | p-value | .000 | Significant |
| | Number | 36 | |




**Cases**

**Figure 4: 47 -year-old female with 3 episodes of anterior shoulder dislocation on left side.**

**a) Normal side [non-dislocated side]; b) Oblique sagittal CT scan shows moderate flattening of anterior glenoid curvature. Anterior straight-line measures 1.50 cm; c) Oblique sagittal CT scan shows reduced glenoid width on dislocated side. Axial width measures 2.20 cm and length 3.81 cm.**

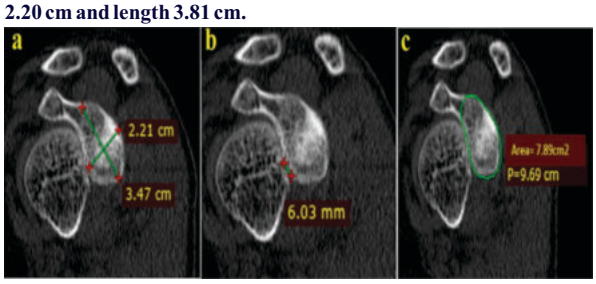



**Figure 5: 19-year-old male with single episode of anterior shoulder dislocation on right side. a) Oblique sagittal CT scan showing glenoid width 2.21 cm and length 3.47 cm on dislocated side; b) Mild flattening of anterior glenoid curvature by 6.03 mm seen; c) Cross- sectional area on dislocated side measures 7.89cm2.**

## DISCUSSION

Preoperative imaging of anterior shoulder dislocation is essential to identify the presence of glenoid bone loss, establish its location, study its morphology and quantify its extent, thus help guide appropriate surgical intervention. The present study uses CT scan to explore various glenoid parameters to quantify glenoid bone loss in anterior shoulder dislocation by simultaneously evaluating bilateral shoulder joints. The study included 36 patients with anterior shoulder dislocation. Most of the patients were from the age group of 21 to 30 (27.8%) and 41 to 50 (27.8%) years. The mean age of patients was 38.38±12.34 years, ranging from 19 to 67 years with male predominance (80.6%). These findings are comparable with the previous studies Leroux T et al [9, 10].

A statistically significant number (91%) of patients had variable flattening of anterior glenoid curvature on dislocating side [p<.00001] [Z=7.0711]. The length of flattening varied from 3 to 27 mm with mean length 12.70±6.9 mm. Positive correlation was found between number of dislocations and length of flattening (Pearson Correlation Coefficient [r] = 0.69, P-Value <0.0001). These findings are consistent with other studies done by Guity MR et al [11] and Griffith JF et al [12].

The mean of maximum glenoid width on the normal side of patients was 27.67±2.4mm and on dislocating side was 25.38±2.9mm. Their mean difference was 2.29mm with 95% confidence interval [ 1.02 to 3.55]. It was statistically significant [p= 0.0006]. Negative correlation was found between number of dislocations vs. dislocating side maximum. glenoid width (Pearson Correlation Coefficient [r] =-.572, p-Value = <0.0001). The result was statistically significant. Similar findings have been reported in study conducted by Griffith JF et al [12]. The mean glenoid length on normal side of patients was 39.88± 3.27mm and on dislocating side was 39.77±3.25mm with their mean difference being 0.11mm with 95% confidence interval [ -1.4 t 1.6]. This difference was not statistically significant [p= 0.8]. No significant correlation was found between number of dislocations and dislocating side glenoid length [r .003, p .988]. These findings are in accordance with the study done by Griffith JF et al [10] and Owens BD et al [13].

The mean glenoid width to length ratio on normal side was .69± .03 and on dislocating side was 0.64±0.05. Their mean difference was 0.05 with 95% confidence interval [.03 to .07]. It was statistically significant [p<0.0001]. Negative correlation was found between number of dislocations vs. dislocating side glenoid width to length ratio (Pearson Correlation Coefficient [r] = -.685, P-Value = <0.0001). The result was statistically significant. Similar findings are reported in study conducted by Griffith JF et al [10].

The mean cross-sectional area [reformatted] on the normal side of patients was 854.47± 121.41mm2 and on dislocating side was 845.47± 121.90 mm2. Their mean difference was 9.00 with 95% confidence interval [-48.2 to 66.2]. It was not statistically significant [p=0.75]. No significant correlation was found between number of dislocations vs. dislocating side cross sectional area [r -.073, p.671]. These findings are consistent with the findings of Griffith JF et al study [10].

## CONCLUSION

Reduction of glenoid width to length ratio as measured on CT scan of the shoulder joint can be used as the best parameter to quantify glenoid bone loss in patients of anterior shoulder dislocation, thus guiding the management strategies for these patients. It is cheaper, readily, and rapidly available in most hospitals compared with MRI and allows simultaneous evaluation and comparison of bilateral shoulder joints.

## REFERENCES

1. Burkhart SS, Debeer JF, Tehrany AM, Parten PM. Quantifying glenoid bone loss arthroscopically in shoulder instability. Arthroscopy. 2002;18[5]:488–491.
2. Burkhart SS, De Beer 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[7]:677–694.
3. Sheean AJ, De Beer JF, Di Giacomo G, Itoi E, Burkhart SS. Shoulder instability: state of the art. J ISAKOS. 2016;1[6]:347–357.
4. Rowe CR, Patel D, Southmayd WW. The Bankart procedure: a long-term end-result study. J Bone Joint Surg Am 1978; 60:1 –16
5. Itoi E, Lee SB, Berglund LJ, Berge LL, An KN. The effect of a glenoid defect on anteroinferior stability of the shoulder after Bankart repair: a cadaveric study. J Bone Joint Surg Am 2000; 82:35 –46
6. Vasiliadis AV, Kalitsis C, Biniaris G, Saridis A. Anterior Shoulder Dislocation during Breaststroke Swimming Technique: A Case Report and Review of the Literature. Case Rep Orthop. 2019;2019:9320569.
7. Phadke A, Bakti N, Bawale R, Singh B. Current concepts in management of ACJ injuries. J Clin Orthop Trauma. 2019;10[3]:480-485.
8. Carr JB, Chicklo B, Altchek DW, Dines JS. On-field Management of Shoulder and Elbow Injuries in Baseball Athletes. Curr Rev Musculoskelet Med. 2019;12[2]:67-71.
9. Leroux T, Wasserstein D, Veillette C, Khoshbin A, Henry P, Chahal J, Austin P, Mahomed N, Ogilvie-Harris D. Epidemiology of primary anterior shoulder dislocation requiring closed reduction in Ontario, Canada. The American journal of sports medicine. 2014;42[2]:442-50.
10. James F Griffith, Gregory E Antonio, Christopher W C Tong, Chan Kai Ming. Anterior shoulder dislocation: quantification of glenoid bone loss with CT.AJR Am J Roentgenol. 2003;180[5]:1423-30.
11. Guity MR, Akhlaghpour S, Yousefian R. Determination of prevalence of glenoid bony lesions after recurrent anterior shoulder dislocation using the 3-D CT scan. Medical journal of the Islamic Republic of Iran. 2014;28:20.
12. Griffith JF, IU Antonio GE, Yung PS, Wong EM, Yu AB, Ahuja AT, Chan KM. Prevalence, pattern, and spectrum of glenoid bone loss in anterior shoulder dislocation: CT analysis of 218 patients. AJR Am J Roentgenol. 2008;190:1247–1254.
13. Owens BD, Campbell SE, Cameron KL. Risk factors for posterior shoulder instability in young athletes. Am J Sports Med. 2013;41(11):2645-9.
14. Verweij LPE, Schuit AA, Kerkhoffs G, Blankevoort L, van den Bekerom MPJ, van Deurzen DFP. Accuracy of currently available methods in quantifying anterior glenoid bone loss: controversy regarding gold standard-a systematic review. Arthroscopy. 2020;36[8]:2295–2313.
15. Bernhardson AS, Bailey JR, Solomon DJ, Stanley M. Glenoid bone loss in the setting of an anterior labroligamentous periosteal sleeve avulsion tear. Am J Sports Med 2014; 42:2136–2140.
16. Kralinger F, Aigner F, Longato S, Rieger M. Is the bare spot a consistent landmark for shoulder arthroscopy? A study of 20 embalmed glenoids with 3-dimensional computed tomographic reconstruction. Arthroscopy 2006; 22:428–432.