Section: Radiology

Original Research Article

A PROSPECTIVE STUDY TO ASSESS THE ROLE OF MAGNETIC RESONANCE IMAGING IN ASSESSING GLENOID BONE LOSS IN SHOULDER DISLOCATION

Received : 22/01/2023
Received in revised form : 28/02/2023
Accepted : 13/03/2023

Keywords:
MRI; CT scan; Glenoid bone loss; Shoulder dislocation, Computed tomography

Corresponding Author:
Dr. M. Ramesh,
Email: rameshmohandoss@gmail.com

DOI: 10.47009/jamp.2023.5.2.218

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (2); 1030-1033

G. Navaneetha Kumar[1], M. Ramesh[2], K. Elavazhagan[3]

[1]Senior Resident, Department of Interventional Radiology and Imaging Science, Tamil Nadu Government Multi Super Specality Hospital, Tamilnadu, India
[2]Associate Professor, Department of Radiology, Tanjavur Government Medical College and Hospital, Tamilnadu, India
[3]Assistant Professor, Department of Interventional Radiology and Imaging Science, Tamil Nadu Government Multi Super Specality Hospital, Tamilnadu, India

Abstract

Background: Recurrent shoulder instability can cause both soft tissue injury and bone defects, requiring both computed tomography (CT) and magnetic resonance imaging (MRI) for a thorough workup. The present study aimed to assess the reliability of MRI in evaluating glenoid bone loss in shoulder dislocation. **Materials and Methods:** Our study was a prospective cross-sectional observational study of 38 patients with a history of recurrent shoulder dislocation. After a proper initial examination, patients who met inclusion and exclusion criteria were subjected to CT and MRI. The percentage of glenoid bone loss in 3D CT and 3D MRI was quantified using the PICO method. **Result:** Our study found that the mean age of dislocation was 28 years, with almost all the subjects being male. The dislocation resulted from sports-related injury (52%) and other trivial trauma (48%). The mean percentage of bone loss measured in our study by 3D CT was 16.53, and in 3D MRI was 16.03. We found no significant statistical difference between the measurement observed in both imaging modalities ($r=0.998$, $p<0.001$). **Conclusion:** The 3D MR imaging for evaluating glenoid bone loss was comparable to 3D CT in a patient with recurrent shoulder dislocation. MRI is superior to a CT scan in assessing associated soft tissue injuries in cases of shoulder dislocation.

INTRODUCTION

Anterior shoulder dislocation is a common problem in young adults.[1] As the glenohumeral joint has a large range of motion, the susceptibility to dislocation is seen more often in this joint than in any other joint.[2] Moreover, it has been revealed that shoulder dislocations usually become a recurrent problem. The recurrence rates are also found to reach as much as 90% in the case of athletes younger than 20 years.[3]
The term glenoid rim lesions were coined by bigliani, which includes glenoid rim erosion and bony Bankart lesion associated with recurrent anterior glenohumeral instability.[4] Bony Bankart lesion is generally believed to be a chronic condition followed by anterior glenoid rim fractures caused by acute glenohumeral dislocation or subluxation with relatively high external force.[5-7] Conversely, glenoid rim erosion can occur due to repetitive friction between the humeral head and the anterior glenoid margin in patients with single or recurrent shoulder dislocations. The prevalence of glenoid rim lesions has been reported as high as 90 %, including 50 % of bony Bankart lesions and 40 % of erosion in shoulders with chronic recurrent traumatic anterior instability.[8]
The recurrent anterior glenohumeral instability normally requires open or arthroscopic stabilization.[9] Hence, accurate pre-operative assessment of glenoid morphology and determining the percentage of bone loss are essential for planning operative stabilization.[10] Because failing to address either a bone defect or soft tissue injury could affect the success of the operative procedure. Per the existing protocol, 3-dimensionally reconstructed computed tomography (3D CT) images with humeral head digitally subtracted for quantifying glenoid bone loss have been considered the gold standard.[11] For assessing soft tissue injuries, Magnetic Resonant imaging is used.[12]
The purpose of the study was to show that the 3D MRI is not only excellent for evaluating soft tissue injury but also highly reliable for measuring glenoid

bone loss compared to 3D CT. Thus by avoiding 3D CT, we can prevent the patient from unwanted radiation exposure and additional monetary implications.

MATERIALS AND METHODS

The prospective observational study was conducted on 38 patients with a history of shoulder dislocation admitted to the orthopaedic surgery department at the Department of Radiodiagnosis, MIOT Hospital, Chennai, from the 1st of June 2018 to the 30th of May 2019. Institutional ethical committee approval and written consent were taken before the start of the study. Data for this study was obtained from patients who attended the orthopaedic department and were referred for CT and MRI of the shoulder joint to assess shoulder dislocation. Patients who underwent both CT and MRI were considered as a sample.

Inclusion Criteria

Patients with a history of shoulder dislocation were included.

Exclusion Criteria

Patients with contraindications for MRI and Previous history of surgery for shoulder dislocation were excluded.

Three shoulder surgeons read all CT and MRI scans for each patient at the end of their fellowship year in sports medicine, and one senior orthopaedic attended with 25 years of post-fellowship training. All readers were blinded to both patient identity and clinical history.

The PICO was used to determine the percentage of glenoid bone loss assessment:13. On the sagittal (enface) view of the glenoid, a best-fit circle was drawn along the inferior aspect of the glenoid with its borders along its intact posterior and inferior margins. A horizontal line was drawn through the circle's centre, representing an estimate of the width of an intact glenoid. An additional line was drawn between the circle's anterior margin and the remnant glenoid's anterior margin, representing the amount of bone loss. This measurement was then divided by the estimate of the intact glenoid and multiplied by 100 to generate a percentage of bone loss.

The normality of the data was assessed, and a variable considered was normally distributed when the skewness score was within ±3.29. Descriptive statistics were presented using mean± S.D of continuous variables, whereas frequency (percentage) was used for categorical variables. To compare the means between paired observations, paired samples t-test was used. The intra-class correlation was used to assess the absolute agreement between the two methods (continuous variable). A scattered diagram represents the linear relationship between two continuous variables. A p-value of <0.05 was considered statistically significant. This study used a statistical package for social sciences version 23 (IBM, Chicago, USA) for analysis.

RESULTS

The present prospective observational study was conducted on 38 patients with a history of shoulder dislocation. All the patients were male in our study. Maximum patients were observed between 20 to 30 years 25 (65%) with a mean age of 28.92±7.79 years. In our study, shoulder dislocation was observed on the right side 20 (52.6%), and sports were a major cause of 20 (52.6%) for dislocation. In our study, the mean percentage of bone loss measured in 3D CT was 16.53±11.47, and in 3D MRI was 16.03±11.06 [Table 1].

Table 1: Demographic and other parameters of patients

Parameters	Frequency (%)
Gender	
Male	38 (100%)
Age (mean ± SD)	28.92±7.79
Age Group (Years)	
10-20	1 (2.6%)
20-30	25 (65%)
30-40	8 (21%)
40-50	3 (7.8%)
>50	1 (2.6%)
Side of involvement	
Left	18 (47.4%)
Right	20 (52.6%)
Cause of dislocation	
Trauma	18 (47.4%)
Sports	20 (52.6%)
% glenoid bone loss	
3DCT (mean ±SD)	16.53±11.47
3DMRI (mean ± SD)	16.03±11.06

The means between 3D CT and 3D MRI was found statistically insignificant (p>0.05) as per paired t-test, and absolute agreement between the 3D CT and 3D MRI (continuous variable) was also found statistically significant as per intraclass correlation [Table 2, Figure 1].

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 2: Correlation between 3D CT and 3D MRI

Test	Value	Significant (p<0.05)
Paired t-test	0.999	0.001
Intra-class correlation coefficient	0.998	0.001

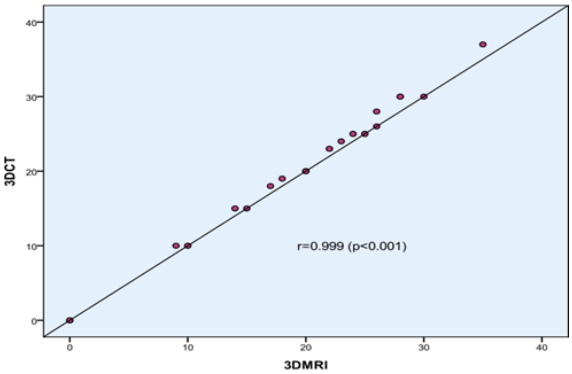

Figure 1: Scattered diagram representing the linear relationship between 3D CT and 3DMRI

DISCUSSION

Shoulder dislocations account for 50% of all major joint dislocations, in that 90% is anterior. Most anterior shoulder dislocations are usually traumatic in elderly persons or sports-related injuries in young adults.[14,15] Glenoid bone loss is a common finding after anterior glenohumeral joint dislocation, with a prevalence of 90% in the setting of multiple dislocations.[8]

There are two forms of injury: fracture of the anterior glenoid rim and flattening of the anterior glenoid margin. Fracture of the anterior glenoid rim is classified into three types: 1. Ununited fragment attached to the separated labrum, 2. Malunited fragment detached from labrum, 3A. Anterior glenoid deficiency < 25%, 3 B. Anterior glenoid deficiency > 25%.[4]

Glenoid rim lesions without fracture treated with capsular repair and with fracture treated with either capsule or bony repair depending on the percentage of glenoid bone loss. Hence, quantifying the glenoid bone loss is critical as it is associated with recurrent instability. The surgery fails standard soft tissue stabilization without bony repair in these cases. In patients with less than 25% glenoid bone loss (usually less than 5 to 7 mm of bone), recurrent instability can be successfully treated with soft tissue stabilization alone.[16] However, open repair or bone augmentation procedures are considered when bone loss is more than 25% of the glenoid sphere (more than 6 to 8 mm).[17]

Imaging plays an important role in the workup of the patient with a history of recurrent anterior shoulder instability, especially if there is suspicion of glenoid bone loss.[18] 3D CT has been the first-line imaging modality for evaluating glenoid bone loss.[16] Since 3D CT has been found to represent with great precision the extent and magnitude of injury along the glenoid margins when compared to 2D CT and MRI.[19] MRI has been the gold standard for evaluating soft tissue injuries, such as tears of the labrum and capsule, commonly seen in recurrent instability. However, many studies have shown that MRI quantifying bone loss by MRI is comparable to CT.

Our study was a prospective cross-sectional observational study of 38 patients with a history of recurrent shoulder dislocation. After a proper initial examination, patients who met inclusion and exclusion criteria were subjected to CT and MRI. Different parameters have been used in literature to describe or quantify the glenoid bone loss. Still, the most accepted one is assessing the percentage of bone loss by the Pico method.[13] This is because the PICO method can be used in a single shoulder without the need for comparison with the opposite shoulder.[13] Hence, our study quantified the percentage of glenoid bone loss in 3D CT and 3D MRI using the PICO method.

Our study found that the mean age of dislocation was 28 years, with almost all the subjects being male. The dislocation resulted from sports-related injury (52%) and other trivial trauma (48%). Similarly, Zacchilli et al. studied the epidemiology of shoulder dislocations presenting to emergency departments in the USA. The mean age was 24 years with a male-to-female ratio of 3: 1, the dislocation most commonly attributable to trauma (58%) and sports (42%).[2] The mean percentage of bone loss measured in our study by 3D CT was 16.53, and in 3D MRI was 16.03. We found no significant statistical difference between the measurement observed in both imaging modalities (r=0.998, p<0.001). Similarly, Gyftopoulos et al. compared 3D MR reconstructions with arthroscopy and found no significant difference statistically in evaluating glenoid bone loss.[18] Stillwater et al. compared 3D MR and 3D CT osseous reformated of the shoulder in patients with glenohumeral instability. They observed insignificant measurement differences between 3D CT and 3D MR post-processed images.[20]

In our study, out of the 38 patients, MRI also showed associated soft tissue injuries in patients with shoulder dislocation. Ten were found to have no glenoid bone loss on both 3D CT and 3D MR. But on MRI, they found an anterior glenoid labral tear not revealed in CT. The water-only 3D IDEAL FSPGR sequence showed better contrast between the glenoid bone marrow, the anterior labrum, and the surrounding muscle, which was good enough to detect glenoid bone lesions. We produced a 3D skeletal image of the glenoid through manual segmentation and reconstruction, comparable to 3D CT.

However, eight patients who presented with acute dislocation had joint effusion. In these cases, segmentation of 3D MRI osseous reformates was

International Journal of Academic Medicine and Pharmacy (www.academicmed.org)
ISSN (O): 2687-5365; ISSN (P): 2753-6556

difficult due to the outflow's overlapping of the bony glenoid's anterior margins. In such cases, it was observed that the 3D CT could delineate the margins of the glenoid compared to the 3D MRI. The other disadvantage we observed with MRI reconstruction was that our study's additional 3D IDEAL FSPGR sequence increased imaging time by about 4-6 min. Also, the post-processing of the acquired 3D MR osseous reformats required approximately 15 min compared to the almost instantaneous standard 3D-CT osseous reformats.

CONCLUSION

The 3D MR imaging for evaluating glenoid bone loss was comparable to 3D CT in a patient with recurrent shoulder dislocation. MRI is superior to a CT scan in assessing associated soft tissue injuries in cases of shoulder dislocation. Although with the addition of the 3D IDEAL FSPGR sequence, the time for acquisition and post-processing of MR is increased when compared to CT scan, MR imaging of glenohumeral joint, as a single modality, provides an assessment of both soft tissue and bony abnormalities.

Limitation of the study:

The small sample size and chances of selection bias in patient recruitment, as all patients selected were known to have recurrent glenohumeral instability/dislocations, were the main limitations of the present study.

REFERENCES

1. Kralinger FS, Golser K, Wischatta R, Wambacher M, Sperner G. Predicting recurrence after primary anterior shoulder dislocation. Am J Sports Med. 2002; 30: 116-20.
2. Zacchilli MA, Owens BD. Epidemiology of shoulder dislocations presenting to emergency departments in the United States. J Bone Jt Surg - Ser A. 2010; 92: 542-9.
3. Dodson CC, Cordasco FA. Anterior Glenohumeral Joint Dislocations. Orthopedic Clinics of North America. 2008; 39: 507-18.
4. Bigliani LU, Newton PM, Steinmann SP, Connor PM, McIlveen SJ. Glenoid rim lesions associated with recurrent anterior dislocation of the shoulder. Am J Sports Med. 1998; 26:41-5.
5. Sugaya H. Techniques to evaluate the glenoid bone loss. Curr Rev Musculoskelet Med. 2014; 7:1–5.
6. Rockwood CA, Matsen FA. The scapula. In Butters KP, (editor). The shoulder. WB Saunders; Philadelphia, USA; 1990; 345–53.
7. De Palma AF. Fractures and fracture-dislocations of the shoulder girdle. In: Jacob RP, Kristainsen T, Mayo K, et al., (editors). Surgery of the shoulder. Ed 3. JB Lippincott; Philadelphia, USA; 1983;366–7.
8. Sugaya H, Moriishi J, Dohi M, Kon Y, Tsuchiya A. Glenoid rim morphology in recurrent anterior glenohumeral instability. J Bone Joint Surg Am. 2003; 85:878–84.
9. Friedman LGM, Ulloa SA, Braun DT, Saad HA, Jones MH, Miniaci AA. Glenoid bone loss measurement in recurrent shoulder dislocation: Assessment of measurement agreement between CT and MRI. Orthop J Sport Med. 2014; 2: 2325967114549541.
10. Bushnell BD, Creighton RA, Herring MM. Bony instability of the shoulder. Arthroscopy. 2008; 24:1061-73.
11. Bishop JY, Jones GL, Rerko MA, Donaldson C. MOON Shoulder Group. 3-D CT is the most reliable imaging modality when quantifying glenoid bone loss. Clin Orthop Relat Res. 2013; 471:1251-6.
12. Chandnani VP, Yeager TD, DeBerardino T, Christensen K, Gagliardi JA, Heitz DR, et al. Glenoid labral tears: prospective evaluation with MRI imaging, MR arthrography, and CT arthrography. AJR Am J Roentgenol 1993; 161:1229–35.
13. Magarelli N, Milano G, Sergio P, Santagada DA, Fabbriciani C, Bonomo L. Intra-observer and interobserver reliability of the 'pico' computed tomography method for quantification of glenoid bone defect in anterior shoulder instability. Skeletal Radiol. 2009; 38:1071-5.
14. Saw R, Finch CF, Samra D, Baquie P, Cardoso T, Hope D, et al. Injuries in Australian Rules Football: An Overview of Injury Rates, Patterns, and Mechanisms Across All Levels of Play. Sports Health. 2018; 10:208-216.
15. Cameron KL, Mauntel TC, Owens BD. The Epidemiology of Glenohumeral Joint Instability: Incidence, Burden, and Long-term Consequences. Sports Med Arthrosc Rev. 2017; 25:144-149.
16. Provencher MT, Bhatia S, Ghodadra NS, Grumet RC, Bach BR, Dewing CB, et al. Recurrent shoulder instability: Current concepts for evaluating and managing glenoid bone loss. J Bone Jt Surg - Ser A. 2010; 92:133–51.
17. Burkhart SS, Danaceau SM. Articular arc length mismatch as a cause of failed Bankart repair. Arthroscopy. 2000; 16:740–4.
18. Gyftopoulos S, Yemin A, Mulholland T, Bloom M, Storey P, Geppert C, et al. 3DMR osseous reconstructions of the shoulder using a gradient-echo based two-point Dixon reconstruction: A feasibility study. Skeletal Radiol. 2013; 42:347–52.
19. Rerko MA, Pan X, Donaldson C, Jones GL, Bishop JY. Comparison of various imaging techniques to quantify the glenoid bone loss in shoulder instability. J Should Elb Surg. 2013; 22:528–34.
20. Stillwater L, Koenig J, Maycher B, Davidson M. 3D-MR vs. 3D-CT of the shoulder in patients with glenohumeral instability. Skeletal Radiol. 2017; 46:325–31.

ISSN (O): 2687-5365; ISSN (P): 2753-6556