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Original Article

Radiology Section

Evaluation of Glenoid Dysplasia and its Association with Posterior Labral Tears on Magnetic Resonance Imaging of Shoulder: A Retrospective Study

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ABSTRACT

Introduction: Glenoid Dysplasia (GD) also known as posterior glenoid rim deficiency is generally known to be asymptomatic with its incidence being greatly underestimated. Atraumatic pain is the predominant symptom in 21% of subjects with GD. GD has been associated with posterior labral tear and is generally thought to predispose to shoulder instability and consequentially to accelerate degenerative joint disease.

Aim: To determine the incidence of GD, the type and extent of GD and to study its association with posterior labral tears on Magnetic Resonance Imaging (MRI).

Materials and Methods: A retrospective observational study was done on 98 consecutive MRI shoulder studies obtained over a period of six months from January 2020 to June 2020 in the Department of Radiodiagnosis of Mysore Medical College and Research Institute. Those subjects with fractures, arthritic changes or mass lesions involving the glenoid process were excluded. The postero-inferior glenoid was evaluated for dysplasia on axial T1-Weighted, T2-Weighted and Proton Density with Fat Saturation (PDFS) images (slice thickness, 3-4 mm). Subjects were divided into four categories: Normal, Mild, Moderate, and Severe GD. Once the acquired images were reviewed and assigned in to the above mentioned four categories based on severity of dysplasia, they were further assigned into three categories defining the type of glenoid into three categories: normal curved lazy J and triangular bony deficiency or the Delta type. The caudal most axial scan image which depicted the articular cartilage of the glenoid was taken as the reference image. The Statistical software SPSS version 22.0, and (Robert and Ross) environment ver. 3.2.2 were used for the analysis of the data.

Results: In present study of 98 consecutive MRI shoulders, six were rejected due to factor such as poor image quality, infective arthritis and trauma. Of the remaining 92 subjects (75 males and 17 females, mean age 36.73±12.50 years), 54 (58.69%) had a normal glenoid fossa, 25 (27.17%) had mild dysplasia and 13 (14.13%) had moderate dysplasia. We did not have any subjects with severe dysplasia. Of the total 38 cases of GD, 21 (55.26%) cases were of the lazy J variant while 17 (44.73%) cases were of the delta type variant. Among the 38 cases of total dysplasias, 25 cases were of mild GD of which 17 (68%) were of the lazy J variant, while 8 (32%) belonged to the delta variant. Out of the remaining 13 cases of moderate GD, 4 (30.76%) belonged to the lazy J category while the remaining 9 (69.23%) belonged to the delta variant. The difference in incidence of posterior labral tears between the normal (0) and combined mild and moderate dysplasia groups (41.3%) was statistically significant ($p<0.001$).

Conclusion: In the study, it was found that the incidence of posterior labral tears was significantly increased in subjects with moderate GD versus healthy subjects even when cases of mild dysplasia were included.

Keywords: Atraumatic shoulder pain, Posterior glenohumeral instability, Posterior shoulder dislocation

INTRODUCTION

The GD also known as posterior glenoid rim deficiency encompasses a spectrum of disorders which involves deficiency of the bony aspect of the postero-inferior glenoid rim with compensatory hypertrophy of the adjacent labrum [1].

Since, this abnormality occurs in a non-weight bearing joint and combined with the fact of sparse use of musculoskeletal applications of MRI in the recent past, this condition has been underestimated in the radiology literature [2,3]. Wirth MA et al., found atraumatic pain to be the predominant symptom in 21% of subjects with GD [4]. GD has been generally found to be associated with posterior labral tear and is generally thought to predispose to shoulder instability and accelerated degenerative joint disease [5,6]. With this background the present study was done to assess the incidence of GD, the type and extent of GD and to study its association with posterior labral tears on MRI.

MATERIALS AND METHODS

A retrospective observational study was conducted on 98 consecutive Magnetic Resonance (MR) images of shoulder obtained from subjects who presented with non-traumatic shoulder pain. The study was conducted over a period of six months from January 2020 to June 2020 in Krishna Rajendra Hospital attached to the Department of Radiodiagnosis of Mysore Medical College and Research Institute. After Institutional Ethical Committee approval was obtained (ref number ECR/134/Inst/KA/2013/RR-19).

Inclusion criteria: Subjects above the age of 18 years who presented with atraumatic shoulder pain and got MR images of shoulder done during the time period of the study were included in the study.

Exclusion criteria: Subjects aged less than 18 years, those with trauma, arthritic changes and masses involving the glenoid process , or with dislocation of glenohumeral joint at the time of study, infective pathology and those with sub-optimal imaging were excluded from the study.

Informed and written consent had been obtained from all subjects at the time of the scan, as a routine protocol.

MRI was performed using 1.5 Tesla General Electric MR machine. Imaging was performed using a shoulder coil with the subjects in supine neutral position. The following sequences were obtained: Axial and coronal T1-weighted (TR range/TE range, 500–650/14–15), T2-weighted Spin-Echo images (TR/TE range, 4,000/73–73.9) (slice thickness: 4 mm) and Proton Density (PD) with Fat Saturation (FS) (TR/TE range, 1500–2200/20–40), were obtained and evaluation for dysplasia of the postero-inferior glenoid was done.

Definition of Glenoid Dysplasia (GD): It was evaluated on T2 axial images of the shoulder, excluding the lower most axial image. It was defined as sloping or rounding of the posteroinferior aspect of the glenoid, with or without thickening of the overlying labrum.

The criteria we used for grading a particular case into one of the four categories (Normal, Mild, Moderate and Severe) [5] of dysplasia included the evaluation of: Posteroinferior glenoid rim where the glenoid cortex can be clearly seen, excluding the inferior most section on T2 axial image, presence / absence of posterior tilt to the glenoid articular surface and the appearance and thickness of posterior labrum. Cases were divided into following classes:

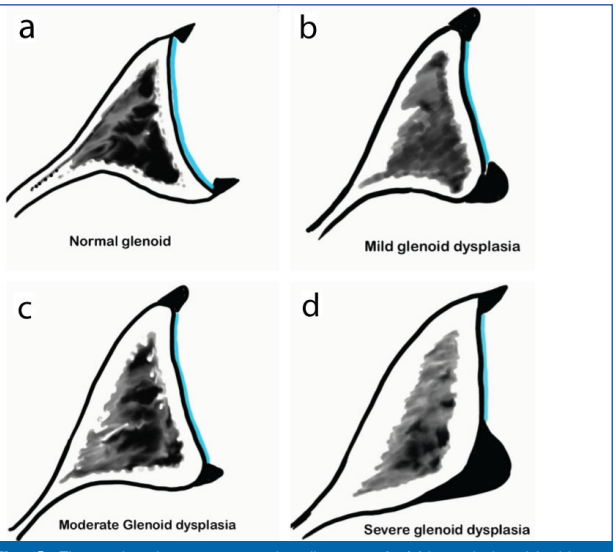
Normal: Posterior labrum was normal in size, no evidence of hypertrophy, no significant posterior sloping [Table/Fig-1a].

Mild dysplasia: Rounding or truncation of the posteroinferior glenoid rim, but normal configuration of glenoid on cephalad images [Table/Fig-1b].

Moderate dysplasia: Significant rounding or truncation of the posteroinferior glenoid rim, but extending in cephalad direction for several sections with normal configuration of glenoid only in the top most sections. Associated hypertrophied posterior labral tissue is present [Table/Fig-1c].

Severe dysplasia: Rounding or truncation of the glenoid rim in its entire extent with hypertrophied posterior labral tissue [Table/Fig-1d].

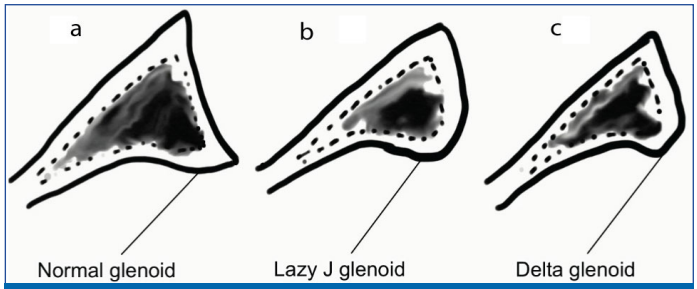
The acquired MRI images were reviewed retrospectively [6].



[Table/Fig-1]: Figure showing representative diagram of: a) Normal glenoid with normal labrum; b) Mild glenoid dysplasia with normal labrum; c) Moderate glenoid dysplasia; and d) Severe glenoid dysplasia.

Qualitative Assessment

Once the acquired images were reviewed and assigned into the above mentioned four categories based on severity of dysplasia, they were further assigned into three categories defining the type of glenoid. The posteroinferior glenoid rim was qualitatively assessed according to the criteria laid down by Edelson [7]. The caudal most axial scan image which depicted the articular cartilage of the glenoid was taken as the reference image. The posteroinferior aspect of the glenoid rim as seen on this axial image was then classified as: a) Normal; b) Curved Lazy J; and c) Triangular bony deficiency or the Delta [Table/Fig-2] [7].



[Table/Fig-2]: Figure showing thematic description of types of glenoid dysplasia [7].

STATISTICAL ANALYSIS

The statistical software namely SPSS Software version 22.0, and R environment version 3.2.2 and Microsoft word and Excel were used for the analysis of the data and to generate graphs, tables, etc. Descriptive statistics has been done in the present study. Results on categorical measurements are represented in numbers whereas outcomes on continuous measurements are represented in the form of Mean±SD. Significance is assessed at the 5% confidence interval. Student's t-test and Chi-square test was used to find the significance of study parameters with p-value <0.05 considered as significant.

RESULTS

Among the 98 consecutive MRI shoulders that were studied, six were rejected; two for bad image quality and four due to infective pathology. There were no MRI shoulder studies done with fracture involving the glenoid process. The final study group consisted of 92 subjects, 75 were males (81.52%) and 17 were females (18.47%).

In the present study, 18 years was the minimum age and 65 years was maximum. Median age was 33 years. A total of 54 subjects belonged to the 30-60 years age group [Table/Fig-3].

Age (years)	Gender		
	Male	Female	Total
<20	2 (2.7%)	1 (5.9%)	3 (3.3%)
20-30	33 (44%)	2 (11.8%)	35 (38%)
31-40	18 (24%)	4 (23.5%)	22 (23.9%)
41-50	9 (12%)	7 (41.2%)	16 (17.4%)
>50	13 (17.3%)	3 (17.6%)	16 (17.4%)
Total	75 (100%)	17 (100%)	92 (100%)
Mean±SD	35.70±12.27	41.29±12.88	36.73±12.50

[Table/Fig-3]: Figure showing age distribution according to gender of subjects studied.
P=0.097+, non-significant, student t-test; p-value<0.05 to be considered significant

As shown in [Table/Fig-4], the difference in incidence of posterior labral tears between the normal (0) and combined mild and moderate dysplasia groups (41.3%) was statistically significant (p <0.001).

In the present study, there were 54 normal glenoids. And there were a total 38 cases of GD. Twenty five cases were of mild GD of which 17(68%) were of the lazy J variant, while 8 (32%) belonged to the delta variant. Out of the 13 cases of moderate GD, 4 (30.76%) belonged to the lazy J category while the remaining 9 (69.23%) belonged to the delta variant [Table/Fig-5].

DISCUSSION

The glenoid rim usually develops from two ossification centers. The upper ossification center appears between the age of 9 and 15 years; the lower ossification center appears between 12 to 16 years of age [2,4,8]. Failure of the inferior ossification center to ossify, causes a bone defect and leaves behind an abnormal, thickened cartilage cap in its place [8].

Children are usually asymptomatic [5]. Symptoms usually present in the 2nd or 3rd decade of life when the individuals increase their level of activities [9]. Range of symptoms usually includes pain, loss of

Parameter		Normal glenoid	Mild glenoid dysplasia	Moderate glenoid dysplasia	Total	p-value
Mean age (years)		M=39.6, SD=12.5	M=33.8, SD=13.05	M=32.75, SD=11.22	-	-
Sex	Male	42 (77.7%)	20 (80%)	13 (100%)	75-males	**<0.001**
	Female	12 (22.3%)	5 (20%)	0	17-females	**<0.001**
Total		54 (58.69%)	25 (27.17%)	13 (14.13%)	92-Total subjects	-
Posterior labral tear		0	6 (24%)	7 (53.84%)	13-Total Subjects with tears	-

[Table/Fig-4]: Table demonstrating the variables studied in the two groups.
p<0.001**; significant; Chi-square test; No samples were found to be in Severe dysplasia category

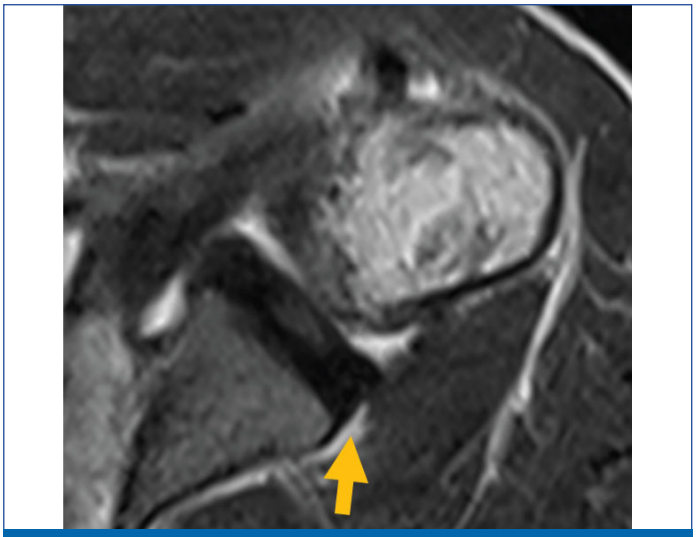
Category	Normal	Mild dysplasia	Moderate dysplasia	Total
Normal	54	--	--	
Lazy J variant	--	17 (68%)	4 (30.76%)	21 (55.26%)
Delta variant	--	8 (32%)	9 (69.23%)	17 (44.73%)
Total		25	13	38

[Table/Fig-5]: Figure showing distribution of cases into the different types of glenoid configuration.

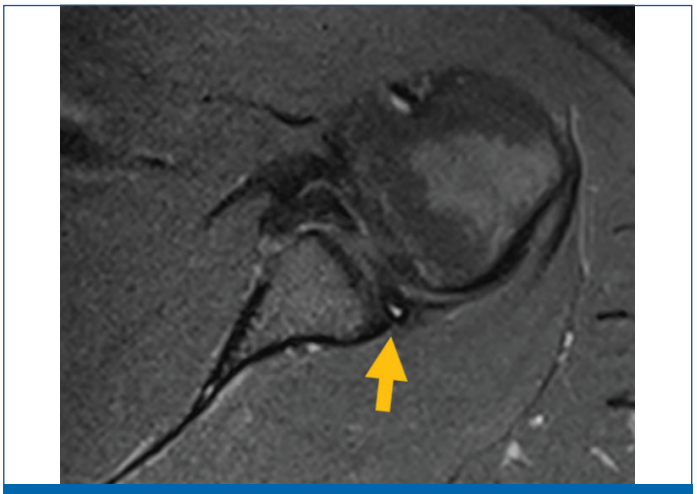
range of motion, instability and rarely shoulder dislocation [10-12]. Activities that generate large shear forces on the posterior labrum can cause injury of the posterior labrum in individuals predisposed with posterior glenoid deficiency [1].

Edelson JG studied dry bone specimens and concluded the incidence of GD in dry bone specimens to be in the range of 19% to 35% [7]. He also concluded that GD was found in Computed Tomography (CT)/MRI studies in upto 18% of subjects. According to the study conducted by Keith WH et al., the combined incidence of moderate and severe GD was 14.3% [6]. In the same study, the incidence for the combined mild and moderate groups was 39.8%. The incidence of 14.1% for moderate dysplasia and 41.3% for the combined group of mild and moderate dysplasia in the present study was similar to that reported by Keith WH et al., [6].

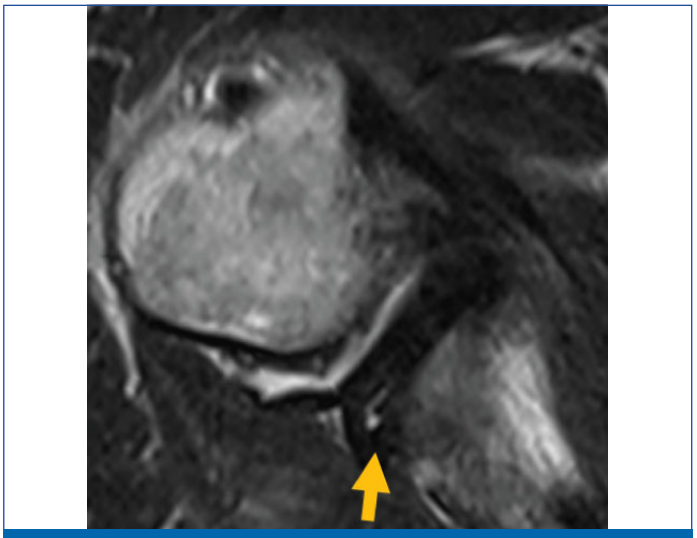
In the present study, there were 54 normal glenoids, 25 cases of mild GD of which 17 (68%) were of the lazy J variant, while 8(32%) belonged to the delta variant. Because of partial volume averaging with adjacent soft tissues, truncated appearance of glenoid rim can be seen in healthy subjects and needs to be distinguished from the spectrum of GD. Hence for this particular reason, the lower-most axial section of glenoid rim was excluded for evaluation in the present study [6]. According to the study done by Keith W et al., there were nine cases of posterior labral tears out of 84 subjects belonging to the normal/mild GD group forming 10.71% and nine cases of posterior labral tears out of 14 subjects belonging to the moderate/severe GD group accounting for 64% [6]. In the present study, out of the 25 subjects with mild dysplasia, 6 (25%) had posterior labral tears, and among the 13 subjects with moderate dysplasia, 7 (53.8%) had posterior labral tears [Table/Fig-6-8]. No labral tears were noted in the normal category.



[Table/Fig-6]: Figure showing mild glenoid dysplasia with posterior labral hypertrophy (arrow).



[Table/Fig-7]: Figure showing mild glenoid dysplasia with posterior labral tear. PDFS image showing hyperintensity in the posterior labrum (arrow).



[Table/Fig-8]: Figure showing moderate glenoid dysplasia with posterior labral tear. PDFS image showing hyperintensity in the posterior labrum (arrow).

Limitation(s)

Although arthroscopically the tears of the posterior labrum can be evaluated and confirmed, there was no surgical confirmation for the GD which might limit reproducibility.

CONCLUSION(S)

GD is a clinically significant entity which can be recognised on routine shoulder MRI. The incidence of which is highly underestimated during general reporting of shoulder MRIs. The spectrum of GD is actually more common, once adequate attention is paid to glenoids while routinely evaluating shoulder MRI. It was also concluded that the group with GD had a statistically significant higher incidence of posterior labral tears compared to the group with normal glenoids. Identifying and reporting this entity recognises those individuals at risk of posterior labral injuries and suitable precautions can be taken to avoid or reduce such complications. Considering the results of the present study, further studies with a larger population are necessary to validate the outcomes.

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