Evaluation of Glenoid and Humeral Head Bone Loss and Glenoid Track in Anterior Shoulder Dislocation Using 3D CT-scan: Comparison between Adults and Adolescents

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Abstract

Background: Shoulders instability and anterior shoulder dislocation is a common problem in adolescents especially athletes and military personnel. Young age is known as most important risk factor of recurrent shoulder dislocation. The concept of "glenoid off-track" claimed to increase risk of shoulder dislocation and failure of treatment so we hypothesized that younger patients with recurrent shoulder dislocation have more rate of glenoid off-track than adult patients.

Material and Method: 70 patients including military personnel referred with recurrent shoulder dislocation chose and 3D CT-scan of affected shoulder obtained. Then the expected glenoid diameter, glenoid defect and the Hill-Sachs lesion size measured and patients grouped as glenoid off-track or on-track. All these measurements and being off-track/on-track compared between adults (>25 years old) and adolescents (<25 years old).

Results: The mean size of expected glenoid diameter, glenoid defect and Hill-Sachs lesion show no significant difference between adolescent and adult groups, however glenoid off-track cases are significantly more in adolescent group compared to adult group (63.6% vs 37.8% p-value:0.027 CI:95%).

Conclusion: Younger patients have significantly more rate of glenoid off-track compared to adult group, which could be the reason of higher rate of recurrent shoulder dislocation and treatment failure in this group of age.

Keywords: Shoulder Dislocation, Glenoid Track, Age group, Bankart Lesions, Hill-Sachs Lesion.

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INTRODUCTION

Shoulders instability including anterior shoulder dislocation is a common problem especially in younger age including adolescent athletes and military personnel.(1-4) Young age under 20 is represented as most significant prognostic factor for recurrence of shoulder instability.(5, 6) The reason of higher prevalence of recurrent shoulder dislocation in adolescent is not specified but extreme workouts and high energy activities is assumed to be the main reason. Recently, Leroux et al reported about 20% risk of dislocation in adults following first episode of anterior shoulder dislocation with greatest risk in men and Adolescents under 20 years of age.(7)

In another study of US Army, *Owens* estimated prevalence of shoulder instability about 1.69 per 1000 person-years which is significantly higher than general population (20 times). Men gender, age under 30, lower military rank and white race introduced as risk Factors in this study.(3)

Bone loss in recurrent anterior shoulder dislocation can occur in glenoid bone, humeral head or both of them. Bone defect in glenoid usually seen in anterior inferior aspect (2 to 6 o'clock) known as Bankart fracture(8). Bone loss in humeral head (or Hill-Sachs lesion) take place in posterolateral aspect of the bone in contact with anterior glenoid.(9) Bipolar lesion defined as simultaneous bone defect in both humeral head and glenoid bones.(10)

In an article which evaluate shoulder instability with 2D CT-scan, glenoid bone loss shown in 86% of patients with shoulder instability(11), *Sugaya* et al reported 50% of prevalence.(12) Hill-Sachs lesion estimated 38 to 88% (13, 14)and Nakagawa et al shows that about 60% of patients

with traumatic anterior shoulder instability has bipolar lesion.(15)

Bone loss become an important Factor to select the therapeutic approach in patients with recurrent shoulder dislocation. *Burkhart* et al shows that 89% of athletes with failure after soft tissue repair, have significant bone loss.(16) Recently, bone repair is advised for glenoid bone loss greater than 20 to 27%.(17-21)

In 2007 Yamamoto(22) has conducted a cadaveric study to evaluate biomechanical effect in glenoid and humeral head bone loss that introduce the concept of "glenoid track" which is the coverage of glenoid over humeral head in position of maximum external rotation and extension during abduction between 0-60 degree. Regarding this explanation, extension of Hill Sachs lesion medial to glenoid track (off-track lesion) would engage with glenoid and increased risk of glenohumeral dislocation. In contrast, the risk of shoulder dislocation is less in on-track lesions, in which Hill-Sachs defect would not engage. They also measure glenoid track about 84% of glenoid width and suggest this new concept can evaluate engagement between Hill-Sachs lesion and glenoid ridge in patients with or without glenoid bone loss. Then Metzger showed that clinical glenohumeral engagement could be well predicted based on preoperative glenoid and humeral head bone loss measurements using the glenoid track method and claim younger age and a greater number of recurrences as predictive factors.(23) A recent study also claimed that The incidence of redislocation was significantly higher in patients with off-track lesion after arthroscopic Bankart repair.(24)

We know that younger age is considered as a risk factor for shoulder instability, also the new concept of glenoid track claimed that off-track shoulders have greater risk of dislocation so we hypothesize that adolescent patients with recurrent shoulder dislocation have more rates of glenoid off-track than adult patients so we could choose better diagnostic and treatment approach for them.

Material and Methods

We chose 70 patients referred with recurrent shoulder dislocation (two episodes or more) and excluded patients who have past history of shoulder surgery, posterior shoulder dislocation, generalized ligamentous laxity, osteoarthritis of shoulder or multidirectional instability, then the demographic data were collected and patients divided into adolescent (under 25 years old) and adult (over 25 years old) groups

Then all patients in both groups underwent 3D CT scan of the affected shoulder. We chose 3D CT-scan rather than 2D scan or MRI, because it is claimed to be the best modality for evaluation of shoulder instability and glenoid defect.(25) All CT-scans evaluated precisely by an expert radiologist for either size of glenoid bone loss and Hill-Sachs defect; Then the shoulders reported as off-track or on-track regarding size of glenoid defect and Hill-Sachs lesion. Finally, all these measurements compared between the two groups of Adolescents and adults.

The size of glenoid defect measured in 3D reconstruction CT-scan of glenoid surface -after elimination of humeral head- with method used by *Sugaya(12)* as rule of "best fit circle". The inferior two-thirds of glenoid assumed as a circle and the best circle fit the inferior border, then the diameter of circle calculate as the "expected glenoid width" and finally the size and percentage of bone loss calculated. (Figure 1).

The size of Hill-Sachs lesion determined by the method of Saito et al(26) in both coronal and axial CT scan of shoulder, which is measured from medial border of rotator cuff footprint to medial edge of bone defect in millimetre. From the two measurements obtained in coronal and axial planes, the larger one spotted as size of Hill-Sachs defect. (Figure 2).

After all, "glenoid track" size measures as 84 percent of expected glenoid width subtracted by glenoid bone defect if present, then the glenoid reported as off-track if Hill-Sachs defect is larger than glenoid track and on-track if Hill-Sachs defect is smaller than glenoid track. (Figure 3).

Data analysis performed using SPSS16.0 software. We use Descriptive statistics to analyse demographic data of study population then student t test and chi square analysis conducted to compare bone loss measurements and glenoid track between adolescent and adult groups.

Result

From 70 cases included in this study with mean age of 28.9 years (17-57 years old), 61 were male (87.1%) and 38 Patients (54.3%) have right shoulder instability (against 32 one with left side instability). Among these patients 33 (47.2%) are under 25 years old (Adolescent group) and 37(52.8%) have >25 years old age (Adult group). Demographic data is shown and compared in table1.

Table 1. Baseline demographic data, comparison between adolescents vs adults

	Adolescent*	Adult *	p-value
n	33	37	
Male Gender, n(%)	30(90.9%)	31(83.8%)	0.37
Age, mean	21.1	35.8	<0.001
Right Shoulder dislocation, n(%)	20(60.6%)	18(48.6%)	0.31
Weight(kg), mean	79.5	77.1	0.13
Height(cm), mean	168.5	169.5	0.75

Adolescents considered under 25 years old and adults are 25 years or more

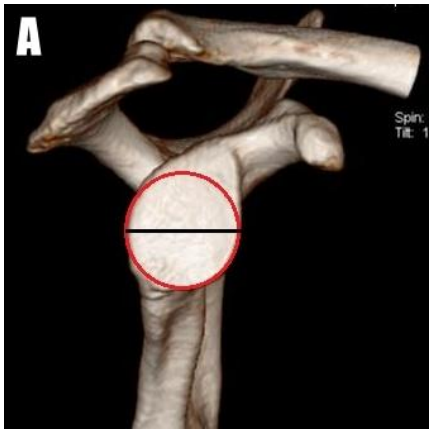
The mean size of expected glenoid diameter, glenoid defect and Hill-Sachs lesion show no significant difference

between adolescent and adult groups (table2), however Hill-Sachs defect size has marginal difference (p-value: 0.07). Also mean glenoid track size is almost equal in these two groups (19.15mm in adolescents vs. 19.26mm in adult group; p-value: 0.87), but glenoid off-track cases are significantly more in adolescent group compared to adult group (p-value: 0.027 CI:95%) There are 21 cases of glenoid off-track in 33 patients of adolescent group (63.6%) and 14 out of 37 cases in adult group (37.8%).

Table 2. Comparing mean glenoid and humeral bone defect and glenoid track between adolescent and adults

	Adolescent(<25y)	Adult (≥25y)	p-value
n	33	37	
Mean expected Glenoid diameter (mm)	27.14	27.08	0.91
Mean actual Glenoid diameter (mm)	23.49	23.60	0.89
Mean glenoid loss (mm)	3.65	3.48	0.80
Mean glenoid loss percentage (%)	13.24%	13.03%	0.92
Mean Glenoid track size (mm)	19.15	19.26	0.87
Mean Hill-Sachs lesion size (mm)	19.71	17.17	0.07
Glenoid off/on track (n)			
off-track	21	14	0.027*
On-track	12	23	

* Fisher's Exact Test



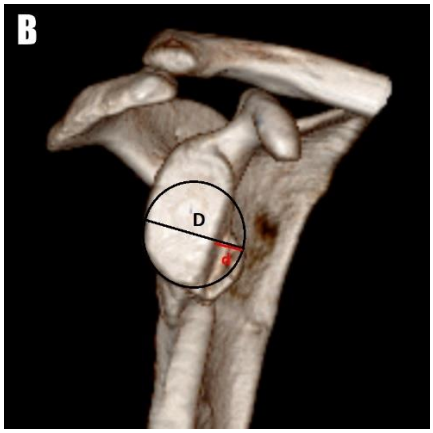


Figure 1. The "expected glenoid diameter" and glenoid defect measurement A. 3D Ct-scan of glenoid surface without bone loss; the best fit circle is shown and the diameter of circle is measured as expected glenoid diameter. B. another glenoid surface shown with bone loss; The expected glenoid diameter(D) is depicted then glenoid bone defect (d) measure from anterior edge of bone to circle line

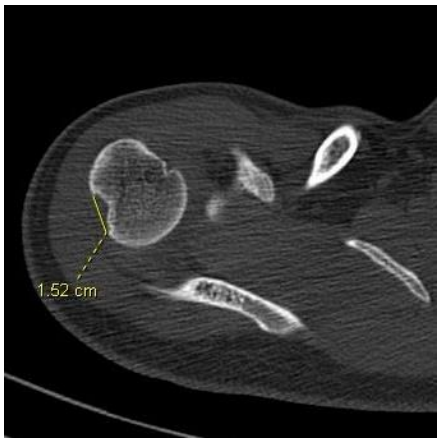


Figure 2. The Hill-Sachs lesion measures in both axial (left) and coronal (right) planes from medial edge of bone defect to footprint of rotator cuff tendon and the larger measurement defined as the size of Hill-Sachs, which is 15.9mm in this case

Figure 3. Calculating "glenoid track" size. This case has expected glenoid diameter of 24.2mm, which should be multiplied by 0.84, then glenoid defect (2.5mm) should be subtracted to get glenoid track size (17.8mm). The Hill-Sachs lesion measures 17.6mm so this case grouped as on-track because the Hill-Sachs defect is smaller than the glenoid track size

DISCUSSION

We concluded in this study that younger patients have significantly more rate of glenoid off-track compared to adult group (p-value=0.03), however no significant difference seen in size of glenoid and humeral head bone loss. Our finding is somehow the same as result of Brian et al.(27) These findings hypothesized that maybe higher risk of recurrent shoulder dislocation and failure of surgery in adolescent could be referred to more rate of glenoid off-track in this group of age, so diagnostic and treatment approach is better to be stricter in young patients. Current study suggests that glenoid concept can be used to help orthopaedic surgeons in determining which patients with bipolar lesion may not be appropriate for arthroscopic Bankart repair alone.(28)

Our study population has mean glenoid defect of 3.5mm or 13% and mean Hill-Sachs lesion size of 18.3mm which are slightly higher than some other studies.(23, 27, 29) This difference can be explained by different inclusion criteria of the studies, since we selected patients with recurrent shoulder dislocation against those studies that included first episode of shoulder dislocation. We also have 35 glenoid off-track out of 70 patients which is greater than Brian study (12 out of 75 patients) that again can be due to number of prior dislocations. All our cases experienced two or more episode of dislocation, but 45% of the Brian study have single episode of dislocation.

The advantage of this study is using 3D CT-scan of shoulder which shown to be the modality of choice especially in detection and measurement of glenoid defect; however, it has pitfall in detecting footprint of rotator cuff when measuring Hill-Sachs lesion, which can be better evaluated in MRI. A recent publication also show that determination of the Hill-Sachs lesion with MRI was more accurate than CT-scan.(30)

This study has also some limitations; the most important one is measuring Hill-Sachs lesions, which obtained in axial or coronal reconstructed CT-scan of shoulder in adduction position, but we know this data is more accurate in ABER position of shoulder. As we know Yamamoto described glenoid track concept in his article as coverage of glenoid over humeral head in abduction and external rotation, the position in which shoulder engagement and dislocation happen, so the nearest imaging position to this situation would be ABER position. To best of our knowledge none of current study evaluate glenoid tracking in ABER position.

In conclusion this study shows that younger age patients with recurrent shoulder dislocation have significantly more rate of glenoid off-track, which could be led to greater risk of re-dislocation and failure of treatment.

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