Glenoid Track Concept vs Humeral Head Engagement in Recurrent Anterior Shoulder Instability with Glenoid Bone Loss Less Than 25%


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Abstract

Background: Arthroscopic Bankart repairs are now widely used to treat patients with traumatic unidirectional anterior shoulder instability. However, several studies have shown an increased failure rate after arthroscopic stabilization when bony defects were not addressed during surgery. Engagement of hills-sachs lesion was used to evaluate the need for further surgical procedure. The "glenoid track" concept was developed to assess the risk of engagement of a Hill-Sachs lesion in a patient with anterior shoulder instability.

The purpose of our study is to evaluate and compare on/off track method versus classic engagement or non-engagement method.

Study Design: It is a retrospective/prospective study.

Methods: 62 patients were included in this study 59 males and 3 female 17 patients retrospective and 45 prospective with a Hill-Sachs lesion were included in the final Magnetic Resonance Image [MRI] and CT analysis. Bipolar bone loss measures of glenoid bone loss and multiple size measures of the Hill-Sachs injury were recorded. Based on the extent of the bipolar lesion, patients were classified with a glenoid track as off track or in track. The 2 groups were then compared with clinical evidence of engagement on Examination Under Anesthesia (EUA).

Results: All patients of this study presented with the glenoid bone defect of less than 25% glenoid diameter. By assessment of the 62 Hill-Sachs lesions, 22 (35.4%) were determined to be off track, the remaining 40 (64.5%) were on track. Arthroscopically, 17 of 22 (77.2%) lesions off track engaged in a functional position when the shoulder was externally rotated more than 90º, the Hill-Sachs lesion would engage the anterior corner of the glenoid.

Conclusion: This study demonstrates that glenohumeral engagement was well predicted based on preoperative glenoid and humeral head bone loss measurements using the glenoid track method.

Key Words: Hill-Sachs lesion – Glenoid bone loss – Shoulder instability – Glenohumeral engagement.

Introduction

THE concept of engaging Hill-Sachs lesion was first promoted by Burkhart and De Beer [1]. The engagement was defined as follows: With the arm in 90º of abduction, when the shoulder was externally rotated more than 90º, the Hill-Sachs lesion would engage the anterior corner of the glenoid [2].

The definition of engaging versus non-engaging Hill-Sachs lesions, though still very important in distinguishing significant loss, is in need of clarification in terms of how these lesions relate to the glenoid track [3]. The Hill-Sachs lesion is classically described as a compression fracture of the posterosuperolateral humeral head in association with anterior instability or dislocation of the glenohumeral joint [4]. The incidence of Hill-Sachs lesions in anterior shoulder instability ranges from 38% to 88% and is associated with up to 100% of recurrent dislocations [8]. The effect of a bony glenoid defect on the risk of recurrent instability after a Bankart repair has been well established [6]. Burkhart et al., found that defects involving over 25% of the glenoid width had unacceptably high failure rates [7]. Itoi et al., used a cadaveric model to demonstrate that defects greater than 21% would fail without bone grafting [8]. However, though many classification systems exist for Hill-Sachs lesions, the same prognostic and therapeutic parameters have not been clearly established for this defect [9]. Yamamoto et al., conceptualized the "glenoid track" concept to biomechanically quantify the effects of combined glenoid and humeral head bony defects on instability in a cadaveric model [10]. The optimal treatment of Hill-Sachs injuries is difficult to determine and is potentiated by the
finding that a Hill-Sachs injury becomes more important in the setting of glenoid bone loss, making engagement of the humeral head on the glenoid inherently easier [11]. It is thought to be important to determine if a Hill-Sachs lesion is at high risk of engaging the glenoid, thus changing potential treatment options [12]. Thus, the purpose of this study was to clinically evaluate humeral head engagement on the glenoid by utilizing glenoid track measurements of combined humeral head and glenoid bone injuries.

Material and Methods

It is a retrospective/prospective study.

62 patients were included in this study in Assiut University Hospital from 2015 to 2016.

Patients were divided into 2 groups:
- Group 1: All the retrospective cases 17 patients.
- Group 2: 45 patients from the prospective cases.

Patient selection:
Inclusion criteria:
- Patients had diagnosed traumatic unidirectional anterior shoulder instability.
- Patients underwent arthroscopic Bankart repair with or without remplissage.
- Patients with hill-sachs lesion with glenoid bone defect <25%.

Exclusion criteria:
- Open bankart repair.
- Revision surgery after failure of a previous repair.
- Latarjet procedure.

Pre-operative evaluation:
- History taking.
- Full shoulder examination and evaluation of associated injuries.
- Constant shoulder score.
- Pre-operative imaging study:
  A- MRI done for all patients.
  B- MSCT with glenoid en face view done only for 45 patients prospective cases only Group 2.
- Pre-operative assessment of glenoid bone loss in both MSCT with 3D and glenoid en face view and MRI patients less than 25% glenoid bone loss were been included in the study.
- Glenoid tract assessed by both MSCT and 3D and MRI.

Operative evaluation:
- Assessment of engaging versus nonengaging arm 90 abduction and 90 external rotation.
- Arthroscopic evaluation of glenoid track done only for 15 patients from group 2.

Choice of method of management:

All cases treated by arthroscopic management. bankart repair only or bankart repair and remplissage according to engaging or nonengaging during arthroscopic examination.

Glenoid track evaluation:

3D CT sagittal oblique with a glenoid en face view.

Glenoid bone loss:

Using the posterior view of the humeral head. We identify the medial margin of the footprint of the rotator cuff and the Hill-Sachs lesion. Then, we set a line located at a distance equivalent to 83% of the glenoid width from the medial margin of the rotator cuff footprint. If there is no bony defect of the glenoid, this line represents the medial margin of the glenoid track. If there is a bony defect of the glenoid. We subtract the distance d from the 83% line to obtain the medial margin of the true glenoid track. The Hills-Sachs interval is defined as the width of the Hill-Sachs (HS) lesion plus the width of the intact Bone Bridge (BB) that lies between the Hill-Sachs lesion and the posterior rotator cuff attachments (Figs. 1-3).

Hill-Sachs lesion:

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- MRI:
  MRI evaluates the soft tissues.

Glenoid bone loss:

Measured on the sagittal oblique view.

We used the pico method the best-fit circle width method and calculated the bone loss as before Fig. (4).
Hill-Sachs lesion measured on the coronal MR. The distance from the rotator cuff footprint to the medial margin of the hill-Sachs lesion Fig. (4).

**Arthroscopic evaluation:**

**Glenoid bone loss evaluation:**

Bare spot identified and the distance from bare spot to posterior glenoid rim measured then doubles the radius to obtain the inferior glenoid diameter Fig. (5).

**Hill-Sachs lesion evaluation:**

The length of Hill-Sachs and the length of bone bridge measured by prob to determine the hill-Sachs interval Fig. (6).

"On Track" or "Off Track" evaluation:

- Measure the Diameter (D) of the inferior glenoid, either by arthroscopy or from 3D CT scan or MRI.
- Determine the width of the anterior glenoid bone loss (d).
- Calculate the width of the Glenoid Track (GT) by the following formula: GT=0.83 D - d.
- Calculate the width of the HSI, which is the width of the Hill-Sachs lesion (HS) plus the width of the Bone Bridge (BB) between the rotator cuff attachments and the lateral aspect of the Hill-Sachs lesion: HSI=HS BB.
- If HSI >GT, the HS is off track, if HSI <GT, the HS is on track.

**Operative documentation:**

The operative approach, technique of the operation, the modality of management, and intraoperative complication.

**Post-operative data:**

Type of post-operative rehabilitation, postoperative complications, the length of the follow-up period, and residual complications as limited range of motion, instability, and pain.

**Ethical considerations:**

The study approved by the Ethical Committee of Faculty of Medicine at Assiut University.

Informed consent with risk explanation obtained from each of all participating patients.

**Results**

**Demographic characteristics:**

From 2015 to 2016, 62 patients with traumatic anterior shoulder instability were treated surgically in our department. In this study 59 males and 3 female 17 patients retrospective and 45 prospective and age was from 18-35 year (Table 1).

All patients of this study presented with the glenoid bone defect of less than 25% glenoid diameter.

By assessment of the 62 Hill-Sachs lesions, 22 (35.4%) were determined to be off track, the remaining 40 (64.5%) were on track. Arthroscopically, 17 of 22 (77.2%) lesions off track engaged in a functional position when the shoulder was externally rotated in 90° of abduction versus only 5 of 40 (12.5%) on track (Table 2).
Fig. (2): Case with no bony defect of glenoid (A) and mediumsized Hill-Sachs lesion (B). By use of the contralateral glenoid as a reference (100%), 83% width is determined, which is the distance from the medial margin of the footprint of the rotator cuff to the medial margin of the glenoid track. Dotted line G indicates the location of the medial margin of the glenoid track. Dotted line R represents the medial margin of the rotator cuff attachments. This Hill-Sachs lesion is on track because it lies totally within the glenoid track.

Fig. (3): The HSI in this right shoulder is defined as the width of the Hill-Sachs (HS) lesion plus the width of the intact Bone Bridge (BB) that lies between the Hill-Sachs lesion and the posterior rotator cuff attachments. Dotted line L1 represents the medial margin of the rotator cuff attachments, and dotted line L2 represents the medial margin of the glenoid track in this particular case.

Fig. (4): (A) The glenoid track is calculated as 84% of the actual glenoid width measured on the sagittal oblique Magnetic Resonance (MR) image. A best-fit circle is placed on the glenoid to calculate the expected width prior to bone loss. Therefore, both percentage of bone loss and glenoid track can be determined. In this case, the actual glenoid width is 24mm, with 4mm of bone loss (17% bone loss). The glenoid track is 84% of 24mm, or 20.1mm. (B) The distance from the rotator cuff footprint to the medial margin of the Hill-Sachs lesion is measured on the coronal MR. In this case, it is 23.1mm. Since the Hill-Sachs width to the footprint (23.1mm) is greater than the glenoid track measurement (20.1mm), it is considered outside the glenoid track and at high risk for engaging.

Fig. (5): Left shoulder, anterosuperolateral viewing portal. The calibrated probe, with 5-mm hash marks, has been introduced through a posterior portal. The radius of the glenoid is the distance from the bare spot of the glenoid to the posterior glenoid rim, or 15mm (3 hash marks). There has been some anterior bone loss, and the distance from the bare spot to the anterior glenoid rim is only 10mm, indicating that there has been a 5-mm anterior glenoid bone loss.
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Fig. (6): The width of the Hill-Sachs lesion is measured sequentially by the 4-mm tip of the probe. The Hill-Sachs lesion has a width equal to 3 probe tips: 3 X 4 mm /4 12 mm.

Table (1): Patients demographics.

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of patients</th>
<th>Percent</th>
</tr>
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<tbody>
<tr>
<td>Male</td>
<td>59</td>
<td>95.2%</td>
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<tr>
<td>Female</td>
<td>3</td>
<td>4.8%</td>
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<table>
<thead>
<tr>
<th>Age Range</th>
<th>Mean ± SD</th>
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<tr>
<td>18-35</td>
<td>24.68±4.24</td>
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</table>

Table (2): Glenoid track results.

<table>
<thead>
<tr>
<th>Engagement</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Non engaging</td>
<td>35</td>
</tr>
<tr>
<td>Engaging</td>
<td>5</td>
</tr>
<tr>
<td>On track</td>
<td>40</td>
</tr>
<tr>
<td>Off track</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>22</td>
</tr>
</tbody>
</table>

Discussion

Arthroscopic Bankart repairs are now widely used to treat patients with traumatic unidirectional anterior shoulder instability [13]. However, several studies have shown an increased failure rate after arthroscopic stabilization when bony defects were not addressed during surgery [14].

Our findings are consistent with Metzger et al., [15]. This is the key to this classification system because it indicates that irrespective of total Hill-Sachs size, the likely most important factor for risk of engagement and recurrent instability is humeral lesion location related to the glenoid rim [15]. This is defined by glenoid width, which is significantly affected by the amount of glenoid bone loss. Therefore, this study demonstrates the importance of viewing bone loss problems in the shoulder as a bipolar issue, where glenoid and humeral losses potentiate each other and increase the risk of recurrent instability. Of the 62 Hill-Sachs lesions, 22 (35.4%) were determined to be off track the remaining 40 (64.5%) were on track. During the arthroscopic evaluation, 17 of 22 (77.2%) off track lesions engaged in a functional position when the shoulder was externally rotated in 90 degrees of abduction versus only 5 of 40 (12.5%) on-track.

Yamamoto et al., [10] utilized a novel cadaveric model to map the rim of the glenoid in relation to the humeral head in various degrees of abduction [10]. Thus, the glenoid track concept advanced the understanding of engagement and recurrent instability by not only including the humeral head deficiency but also defining it in relation to the glenoid width and bone loss. They were also able to verify their model in 3 patients with anterior instability using 3-dimensional reconstruction Computed Tomography (CT) images.

In conclusion:

The glenoid track is a new classification system that can be utilized to assess the risk of engagement of a Hill-Sachs lesion in a patient with anterior shoulder instability.

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Compliance with ethical standards:

Conflict of interest: all of the authors declare that they have no conflict of interest. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

Ethical approval: all procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent: informed consent was obtained from all individual participants included in the study.

References

3- Di GIACOMO G., ITOI E. and BURKHART S.S.: Evolving concept of bipolar bone loss and the Hill-Sachs lesion:
From "engaging/non-engaging" lesion to "on-track/offtrack" lesion. Arthroscopy, 30 (1): 90-8, 2014.


تقييم مفهوم المسار الحقاني وطريقة تعقيبة لرأس عظمي العضد
في حالات خلع مفهوم الكتف الأمامي مع فقد عظمي
في التجويف الحقاني أقل من %25

 يعتبر إصلاح خلع الكتف المتكسر مع وجود قطع في المضروب الأمامي بواسطة المضمار الجراح من أكثر العمليات الشائعة.

دراسات علمية أكدت زيادة حدوث نسبة فشل وإعادة الجراح للاكرام في وجود فقد في رأس عظمي العضد لم يتم إصلاحه وقت العملية.

في هذه الدراسة تم إجراء البحث على 12 مريض في مستشفى جامعة أسيوط ما بين عامي 2015-2016 ومقارنة طريقة داخل وخارج المسار التي تعتبر من الطرق الجديدة مع الطريقة التقليدية التعقيبة وعدم التعقيبة وأشرحت مؤشرات البحث إلى تقارب الطريقتين في تقييم حالات الخلع الأمامي للكتف.