Quantifying Glenoid Bone Loss Arthroscopically in Shoulder Instability

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Purpose: Our goal was to establish a consistent methodology for quantifying glenoid bone loss by arthroscopic means.

Type of Study: This study was an anatomic investigation of glenoid structure and its consistent anatomic landmarks as determined by arthroscopic means in live subjects and by direct measurement in fresh-frozen cadaver specimens.

Methods: We arthroscopically evaluated and measured the location of the bare spot of the glenoid in 56 subjects that had no evidence of instability (average age, 40 years). We also measured the exact location of the glenoid bare spot in 10 cadaver shoulders (average age, 76 years).

Results: The bare spot of the glenoid was a consistent reference point from which to determine glenoid bone loss because it was located almost exactly at the center of the circle that was defined by the articular margin of the inferior glenoid below the level of the midglenoid notch. The tightly clustered standard deviations of the bare spot measurements in both the live subjects and the cadaver specimens confirmed its consistent location.

Conclusions: The glenoid bare spot can be used as a central reference point to quantify the percentage bone loss of the inferior glenoid. Such objective measurement of glenoid bone loss can be clinically useful to the surgeon in deciding whether bone grafting is necessary to restore stability to the shoulder with a bone-deficient glenoid.

Key Words: Instability—Bone defect—Glenoid bare spot—Shoulder instability—Arthroscopic instability repair.
We have recently reported on the predilection of shoulders with significant anterior-inferior bone deficiency to sustain recurrent dislocation. Glenoids with enough bone loss to convert the normally pear-shaped glenoid to an inverted pear configuration were particularly prone to redislocation after arthroscopic Bankart repair (61% recurrence rate for this configuration in our series). We concluded that the inverted-pear glenoid creates an unstable situation. However, recognition of the inverted-pear glenoid can be rather subjective. In this study, we have attempted to objectively describe and quantify glenoid bone loss by the following means: (1) determining a constant glenoid landmark from which to measure bone loss and (2) determining the amount of glenoid bone loss required to produce the inverted pear.

**METHODS**

Our hypothesis was that the glenoid bare spot was located at the center of a circle defined by the anterior, posterior, and inferior borders of the lower glenoid (Fig 1). To evaluate the bare spot, an arthroscopic evaluation of 56 normal glenoids was performed. The average age of the patients was 40 years (range, 15-56 years). Patients whose underlying diagnosis was instability were excluded from the study. An anterosuperior-viewing portal was used. A graduated probe with 3-mm calibrated marks was placed through the posterior portal across the glenoid so that its tip rested on the bare spot. The distance from the center of the bare spot to the posterior glenoid rim was then measured. The probe was next used to measure the distance from the anterior glenoid rim to the center of the bare spot. Finally, the 3-mm tip of the probe was used to measure the distance from the bare spot center to the inferior glenoid rim.

Ten fresh-frozen cadavers were used to further examine the glenoid. Five cadavers were men, and 5 were women, with an average age of 76.1 years (62-85 years). The soft tissues were stripped except for the labra, which were not included in measurements. The inferior glenoid was then measured by the same technique that we had used arthroscopically, measuring from the center of the bare spot to the anterior, posterior, and inferior glenoid rims.

**RESULTS**

The bare spot of the glenoid, when viewed arthroscopically, was virtually equidistant to the anterior, posterior, and inferior glenoid rim. That is, the bare spot was located in the center of the inferior glenoid and therefore was a constant central landmark for assessing bone loss of the inferior glenoid. The distance from the center of the bare spot to the anterior glenoid rim was 11.1 ± 0.91 mm (range, 9.0-12.0 mm). The distance from the center of the bare spot to the posterior glenoid rim was 11.4 ± 0.85 mm (range, 9.0-12.0 mm). The distance from the center of the bare spot to the inferior glenoid rim was 10.7 ± 0.98 mm (range, 7.5-13.5 mm). The bare spot on the 10 cadaver glenoids revealed similar results. The distance from the center of the bare spot to the anterior glenoid rim was 12.1 mm (range, 11-15 mm). The distance from the center of the bare spot to the posterior glenoid rim was 12.3 mm (range, 11-15 mm). The distance from the center of the bare spot to the inferior glenoid rim was 12.1 mm (range, 11-15 mm). The ages in the cadaver shoulders (62-85 years) were substantially higher than the ages of the patients treated arthroscopically (15-56 years). However, the bare spot was located in the center of the inferior glenoid in both the cadaver shoulders and the live subjects. The tightly clustered standard deviations of the bare spot measurements in both groups were low with narrow ranges, confirming the consistent location of the bare spot (Table 1).

<table>
<thead>
<tr>
<th>Distance From the Center of the Bare Spot</th>
<th>Living Subjects (n = 56; age 15-56 yr)</th>
<th>Cadavers (n=10; age 62-85 yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>To the posterior glenoid rim</td>
<td>11.4</td>
<td>0.85</td>
</tr>
<tr>
<td>To the anterior glenoid rim</td>
<td>11.1</td>
<td>0.91</td>
</tr>
<tr>
<td>To the inferior glenoid rim</td>
<td>10.7</td>
<td>0.98</td>
</tr>
</tbody>
</table>

*FIGURE 1. The bare spot of the glenoid is located at the geometric center of the inferior glenoid, with the superior glenoid (above the midglenoid notch) positioned like an oversized tubercle to which the biceps attaches.*

*TABLE 1. Location of Glenoid Bare Spot*
DISCUSSION

Glenoid bone loss has been implicated as a risk factor for recurrent instability after surgical repair. Bigliani et al. reported a 12% recurrence rate in patients with glenoid rim fractures that had undergone Bankart repairs. They recommended coracoid transfer if the glenoid rim fracture comprised greater than 25% of the anterior-posterior diameter of the glenoid. Itoi et al. performed a cadaver study to examine the effect of glenoid defects on anterior-inferior stability with and without repair after simulated Bankart lesions. They concluded that a defect measuring at least 21% of the superior-inferior glenoid length would cause instability that a soft-tissue repair alone might not be able to correct. In a recent study by the 2 senior authors (S.S.B. and J.F.D.) of 194 arthroscopic Bankart repairs by suture-anchor technique, we reported a 61% recurrence rate in patients with an inverted-pear glenoid configuration compared with a 4% recurrence rate in patients without significant bone deficiency.

There is no question that a significant glenoid bone deficiency predisposes to recurrent dislocation and that the glenoid that is deficient enough to have an inverted-pear configuration is at very high risk for recurrence because of its inability to contain the humeral head unless a bone graft is placed to restore the normal articular arc of the glenoid (Fig 2). We have previously shown in cadavers that a loss of greater than 25% of the diameter of the inferior glenoid will create an inverted pear configuration.

To know which glenoids are deficient enough to require a bone graft, the surgeon must be able to accurately measure the bone loss, particularly if there is a component of compressive bone loss. One must recognize that a significant part of the glenoid bone deficiency in recurrent dislocators may be compressive in nature, and therefore its extent can only be estimated indirectly. In dealing with acute, bony Bankart lesions that have a separate fracture fragment, one can easily determine the percentage of bone loss by directly measuring the diameter of the glenoid fragment, directly measuring the diameter of the remaining intact inferior glenoid, and then dividing the fragment diameter by the intact glenoid diameter (the sum of the fragment diameter plus the anteroposterior diameter of the remaining intact glenoid). However, compressive bone loss eliminates the possibility of direct measurement because the compressed portion of the bone is literally gone; it does not exist as a separate measurable fragment. That is precisely why the identification of the bare spot as the geometric center of the inferior glenoid is so fortuitous.

This study has shown that the bare spot is almost exactly in the center of the inferior glenoid, with very small standard deviations. One should think of the inferior glenoid as being in the shape of a circle, with the bare spot as the center of the circle, and the superior glenoid (above the midglenoid notch) being like an oversized tubercle to which the biceps attaches (Fig 1). Armed with that information, the surgeon can easily measure arthroscopically the distance from the bare spot to the posterior glenoid rim, which should equal the distance from the bare spot to the intact anterior rim before any compressive effects (i.e., the posterior measurement is half the diameter of the intact inferior glenoid). With increasing compressive effects the anterior measurement will become progressively smaller.

As an example of the use of these measurements, consider the following example. Intraoperative arthroscopic measurements of the glenoid are made in a patient with recurrent anterior dislocations (Fig 3). The distance from the bare spot to the posterior glenoid rim is 12 mm. The surgeon infers that the predislocation intact measurement from the bare spot to the anterior glenoid rim would have been 12 mm, the
same as the posterior measurement. However, when the surgeon actually measures the distance from the bare spot to the anterior glenoid rim, it measures only 6 mm, implying that there has been a compressive bone loss of 6 mm.

Expressing that bone loss (6 mm) as a percentage of the diameter of the intact anterior glenoid (24 mm) gives a deficiency of 25% of the diameter of the glenoid, a percentage at which most authors have recommended bone grafting.

CONCLUSIONS

The glenoid bare spot can be used as a central reference point to quantify the percentage bone loss of the inferior glenoid. Such objective measurement of glenoid bone loss can be clinically useful to the surgeon in deciding whether bone grafting is necessary to restore stability to the shoulder with a bone-deficient glenoid.

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REFERENCES


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