**EFFECT OF INSERTION LOCATION AND ANGLE ON FAILURE LOAD OF GLENOID SUTURE ANCHOR FIXATION**

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**INTRODUCTION:**

Suture anchors have become a valuable tool used by many shoulder surgeons to repair glenoid labral detachments. Arthroscopically, they may be inserted through an anterior portal and/or posterior lateral accessory portal to repair superior labral detachments, and through accessory anterior-inferior and posterior-inferior portals to repair Bankart and reverse Bankart lesions, respectively.

However, anatomic relationship of the glenoid to the acromion and coracoid process influence the angle of insertion of fixation devices in the superior quadrants of the glenoid. Also, the location of the axillary nerve can limit inferior placement of the accessory-inferior portal, making inferior access to the anterior glenoid rim difficult. Furthermore, the approach angles to the anterior-inferior glenoid force insertion angles for fixation devices to deviate in a superior direction as compared to the orthogonal vector to the glenoid rim at the insertion.

The present investigation was undertaken to determine if inserting screw-type fixation devices at an angle to the orthogonal to the glenoid rim affects fixation strength.

**METHODS:**

Eighteen fresh-frozen cadaveric shoulder specimens, with an average age at death of 72 years (range, 53-83 years), were thawed and underwent removal of all soft tissue, the acromion, and the coracoid process. The medial aspect was potted in dense stone up to the base of the glenoid neck. The glenoid surface was marked into 4 quadrants: Anterior Superior (AS), Anterior Inferior (AI), Posterior Superior (PS), Posterior Inferior (PI). A 3.0 mm cannulated stainless-steel screw (Synthes USA, Monument, CO) was inserted into the middle of each quadrant with the aid of a custom drill-guide. Insertion points on the glenoid articular surface. Viewed en-face, the screws were inserted at 0, 20, and 40 degrees of deviation from the orthogonal to the glenoid rim. Within each quadrant, there was a significant correlation between the amount of deviation from the orthogonal and fixation strength (p = 0.05 for the AI and PI quadrants; p = 0.03 for the AI quadrant). For the AS, AI, and PI quadrants, average load to failure was significantly less for screws inserted 40 degrees deviated for the orthogonal, as compared to those inserted with no deviation. In the AI quadrant, however, even the screws inserted 20 degrees off the orthogonal proved to have significantly lower mean pull-out strength compared to those inserted along the orthogonal to the glenoid rim.

**RESULTS:**

Data for 6 PS screws inserted at 20 degrees and 6 PS screws inserted at 40 degrees of deviation from the orthogonal were discarded, as were data from 4 screws inserted in the other 3 quadrants. The mean pull-out strength for screws inserted orthogonal to the glenoid rim was highest for the PS quadrant and lowest for the AI quadrant, with the AS and PI quadrants being quite similar to each other and in-between the other 2 quadrants (Table 1).

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**DISCUSSION:**

Initial fixation strength is vital when relying on suture anchors to maintain labrum-to-glenoid repair. Ideally, the anchor should be inserted orthogonal to the bone surface. However, anatomic factors limit ability to place devices in such manner, especially arthroscopically.

In a study investigating the effect of graft-screw divergence, Jomha et al demonstrated using a porcine model that metallic interference screw fixation of patellar tendon grafts was significantly weaker if the screw deviated 20 degrees or more from the bone block axis. Deviation of 10 degrees did not lead to any significant compromise of fixation strength. The current investigation’s findings of pullout strengths being less in the AI quadrant compared to the AS quadrant also agrees with the findings of Roth et al who cyclically tested Statak and Mitek GII anchors inserted into the AS and AI quadrants of cadaveric glenoid specimen. A limitation of this study is that a methodological error resulted in invalidating data from 12 of the PS screws (6 inserted at 20 degrees and 6 inserted at 40 degrees off the orthogonal). However, even if fixation is compromised due to insertional angle deviation, it may be better tolerated in this quadrant as the PS quadrant had the highest average pull-out values of all 4 quadrants without angle deviation.

In summary, screw-in devices provide the strongest fixation when inserted orthogonal to the glenoid rim at the point of insertion. Deviation from the orthogonal up to 20 degrees does not appear to compromise fixation in the AS & PI quadrants. Deviation of 40 degrees or more from the orthogonal significantly weakens fixation in each quadrant. In the AI quadrant, however, even 20 degrees of deviation can significantly decrease fixation strength.

**REFERENCES:**


![Figure 1. Schematic of screw insertion location and angle.](image)

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean Failure Load [N]</th>
<th>Standard Deviation</th>
<th>Mean Failure Load [N]</th>
<th>Standard Deviation</th>
<th>Mean Failure Load [N]</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Superior</td>
<td>548.7 ± 334.5</td>
<td>NA</td>
<td>364.2 ± 183.8</td>
<td>NA</td>
<td>230.5 ± 90.3</td>
<td>NA</td>
</tr>
<tr>
<td>Anterior Inferior</td>
<td>272.5 ± 68.6</td>
<td>NA</td>
<td>205.8 ± 47.2</td>
<td>NA</td>
<td>174.7 ± 51.6</td>
<td>NA</td>
</tr>
<tr>
<td>Posterior Superior</td>
<td>733.4 ± 369.4</td>
<td>NA</td>
<td>371.9 ± 151.3</td>
<td>NA</td>
<td>285.0 ± 92.0</td>
<td>NA</td>
</tr>
<tr>
<td>Posterior Inferior</td>
<td>483.6 ± 1403.8</td>
<td>NA</td>
<td>371.9 ± 151.3</td>
<td>NA</td>
<td>285.0 ± 92.0</td>
<td>NA</td>
</tr>
</tbody>
</table>

Table 1: The mean and standard deviation of the failure load.

![Image of screw insertion location and angle with Table 1 data]