Humeral Head Allograft Fixation for Reconstruction of Hill-Sachs Defects: Antegrade versus Retrograde Fixation?

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Disclosures:

Introduction: Hill-Sachs defects are impressions fractures of the posterolateral humeral head that occur as a result of an anterior shoulder dislocation. These defects have been implicated in recurrent instability and failure of soft tissue stabilization procedures(1-8). An engaging Hill-Sachs lesion may be surgically managed using humeral head allograft reconstruction with fixation provided by two screws inserted antegrade or retrograde. Antegrade fixation currently represents the standard clinical practice but does present a number of challenges, both intra-operatively and in terms of long term complications due to partial graft resorption. It has been suggested in the literature that these challenges and long term complications may be avoided through retrograde fixation(9). However, the equivalency of retrograde fixation strength to that of antegrade is currently unknown. Therefore, the purpose of this biomechanical study was to compare antegrade and retrograde screw fixation for allograft reconstruction of Hill-Sachs defects.

Methods: In sixteen fresh frozen humeral heads (eight pairs) a 40% Hill-Sachs lesion was marked using the method of Kaar et al.(10) and created using a microsagittal saw (Figure 1a). In order to ensure the best possible fit between the created defect and the tested allograft, the wedge shaped osteochondral fragment resulting from creation of the defect was used to function as the allograft. In addition, to ensure accurate fragment positioning following fixation, two screw holes were predrilled before the defect was created; however, screws were only inserted once the graft was replaced. The direction of these holes was dictated by a balanced randomization procedure which ensured that each fixation technique was applied to one of each pair of specimens. For each technique, two cannulated, partially thread 3.75mm titanium screws (Arthrex Inc, Naples, FL, USA) were used with prior placement of a guide wire, and drilling with a cannulated 2.75mm drillbit. The direction of the two drill holes was parallel to each other and bisected the articular arc of the fragment. For the antegrade technique, the screws entered the fragment at ¼ and ¾ of its longitudinal midline and at least 24mm apart. The far cortex of the humeral metaphysis was not engaged with the antegrade screws. The entry point of the drill holes on the articulation were overdrilled to allow the screw heads to countersink (Figure 1). In the retrograde technique, two parallel screws were inserted distal to proximal, one starting just lateral to the bicipital groove and the other more lateral on the greater tuberosity (Figure 1). For this technique a targeting guide (C-Ring Pin Guide, Arthrex, Naples, FL, USA) was used to place two k-wires in a manner such that they pierced the humeral head at the points corresponding to the antegrade technique. Screw length was measured in order to avoid penetration of the articular surface.

In order to permit testing of each technique’s fixation stability and strength, a slot was created in the intact humerus at the humerus-graft interface to allow insertion of a custom tool that would apply load to the graft (Figure 3). Using a Material Testing System (Instron, Norwood, MA, USA) a staircase cyclic loading protocol was performed (500 cycles at 10, 20, 30, 40N). Graft displacement was measured by an optical tracking system at 1, 100, 200, 300, 400 and 500 cycles for each load level. Failure load was taken as the force required to displace the graft by 2mm from its initial position. Paired t-tests were used to compare between fixation technique while Two-Way Repeated Measures ANOVA’s were used to assess the effects of load magnitude and number of cycles for each technique, with significance set at p<0.05.

Results: For the two techniques, graft displacement increased with increasing load and increasing number of cycles. This increase was significant within each technique across all four loading levels (p<0.05) and across increasing cycles for the antegrade technique (p=0.013) but not for the retrograde technique (p=0.054) (Figure 3). However, there was no significant difference in graft displacement between the two techniques, at any loading level or number of cycles (≤0.13mm, p=0.16-0.96) (Figure 4). Additionally, the load to failure between antegrade and retrograde techniques was not significantly different (Antegrade: 95.6N vs. Retrograde: 98.5N, p=0.706).

Discussion: These findings suggest that both techniques exhibit expected behavior of increasing displacement with increasing cycles and load magnitude. Retrograde fixation does produce slightly larger displacements than the current clinically standard antegrade technique. However, the observed differences remained small throughout testing and never reach a statistically significant level. Additionally, the ultimate strength of antegrade and retrograde screw fixation can be considered equivalent.

Significance: Therefore, both techniques can be used for the reconstruction of large Hill-Sachs defects and a surgeon’s preference for one technique over the other should be based on other factors including ease of hardware removal which may favor retrograde fixation as re-entry into the joint space is not required.
Acknowledgments:

Figure 1 - Photos demonstrating Hill-Sachs defect size and orientation (a), antegrade fixation technique (b), k-wire guide used for retrograde technique (c), and retrograde fixation (d).

Figure 2 - Testing setup with cutom tab inserted into slot in intact humeral head and optical trackers attached to intact humerus (below) and allograft fragment (above).
Figure 3 - Mean allograft displacement for the two techniques with increasing cycles and load magnitude.

Figure 4 - Mean (+ 1 SD) allograft displacement at the 500th cycle for each load level.

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