

Influence of Remplissage Anchor Position on Glenohumeral Displacement in Off-Track Hill-Sachs Lesions: A Cadaveric Biomechanical Study

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INTRODUCTION: Off-track Hill-Sachs lesions are a recognized cause of recurrent anterior shoulder instability and are best understood within the glenoid track framework [1], [2], [3], [4]. Remplissage is commonly added to address humeral-sided bone loss and convert an engaging defect to a non-engaging construct, particularly in bipolar bone loss models [5]. However, the effect of medial–lateral variation in anchor position within the Hill-Sachs defect on glenohumeral displacement under a constant anterior challenge has not been clearly defined. This study evaluated how Remplissage anchor position influences 3D humeral head displacement in a cadaveric off-track Hill-Sachs model.

METHODS: Twenty-four fresh-frozen cadaveric shoulders were mounted in a standardized position to replicate engagement and underwent creation of a Bankart lesion and an off-track Hill-Sachs lesion based on CT-derived geometry, following previously described cadaveric methods [6], [7]. Each specimen then received Remplissage at three locations within the defect—lateral, centered, and medial—using knotless all-suture anchors, in randomized order. For every condition (native, posterior capsulotomy, Bankart, Hill-Sachs, and each Remplissage configuration), the shoulder was translated to the same specimen-specific anterior subluxation target (50–60% of the humeral head past the anterior glenoid rim, fluoroscopically confirmed) to allow comparison at a fixed displacement for each subject. 3D humeral head displacement relative to the scapula was digitized, and mixed-effects regression (log-transformed, reported as estimated ratios [ER] with 95% CI) was used.

RESULTS: Average 3D displacement was 7.4±1.7 mm in the native condition, 7.7±1.7 mm after lateral Remplissage, 7.0±1.6 mm after centered Remplissage, and 3.6±0.8 mm after medial Remplissage (Figure 1). Medial Remplissage significantly reduced displacement versus native (ER=0.484, 95% CI 0.289–0.811, p=0.006), versus lateral (ER=0.463, 0.277–0.776, p=0.004), and versus centered (ER=0.513, 0.306–0.859, p=0.012). Lateral and centered repairs were not different from native (p≥0.69). Thus, only medial placement restored containment beyond native-like levels while holding translation distance constant. Changing the Remplissage anchor position within the Hill-Sachs defect produced distinct displacement patterns. Medial placement yielded the smallest 3D humeral head excursion at the same imposed anterior translation, whereas lateral and centered positions demonstrate displacement values closer to the native construct. Holding displacement constant across conditions isolated anchor location as the key mechanical variable.

DISCUSSION: These findings indicate that Remplissage does not function as a binary “on/off” stabilizer; rather, the degree of mechanical containment is sensitive to anchor medialization within the defect. Positioning that increases capsulotomies contact over the medial margin of the Hill-Sachs lesion improves control of glenohumeral displacement, which may be relevant when treating large or highly engaging defects.

SIGNIFICANCE/CLINICAL RELEVANCE: Surgeons should consider anchor position as a modifiable variable when performing Remplissage for off-track Hill-Sachs lesions. Selecting a position that maximizes containment may better limit humeral head displacement, particularly in patients at high risk of recurrent instability.

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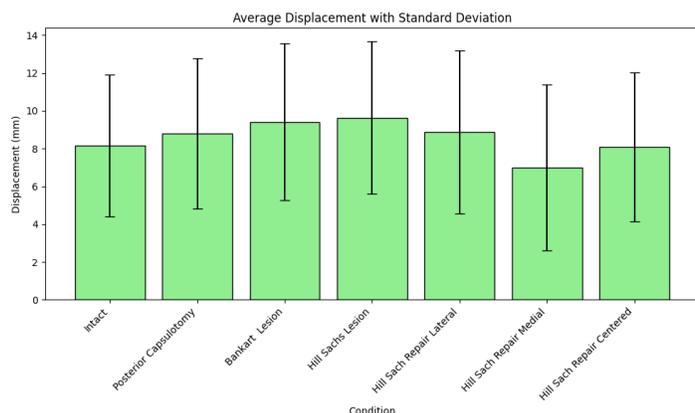


Figure 1. Mean displacement ± standard deviation across all test stages for the 24 cadaveric specimens.