

# Posterior Shoulder Stability Depends on Acromial Anatomy: A Cadaveric, Biomechanical Study

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## INTRODUCTION:

Posterior shoulder instability is becoming a better understood and increasingly recognized cause of shoulder pain and dysfunction. Posterior capsulolabral tears, glenoid retroversion and posterior glenoid bone loss are clinically and biomechanically proven factors that decrease resistance to humeral head displacement in response to a posteriorly directed force. If conservative measures fail, common surgical options include open or arthroscopic capsulolabral repair, glenoid osteotomies (+/- J-Graft) and posterior glenoid bone augmentation or combinations thereof. However, failure rates for these procedures are up to 35% for capsulolabral repairs, up to 73% for open posterior bone block procedures and up to 33% for glenoid osteotomies at long-term follow-up. A high and flat acromion has recently been associated with posterior instability. Therefore, the purpose of this study was to evaluate a potential stabilizing effect of the acromion against posterior humeral head displacement.

## METHODS:

Eight fresh-frozen human cadaveric shoulders were biomechanically tested in a shoulder simulator in the load-and-shift and Jerk test positions. Prior to testing, CT scans were performed to measure native glenoid width, glenoid retroversion, posterior acromial coverage (PAC), sagittal acromial tilt (SAT) and posterior acromial height (PAH). Each specimen underwent four testing conditions using pre-planned and 3D printed cutting and reduction guides: (1) Intact joint, native acromion; (2) Intact joint, *severe* acromial malalignment (SAT 69°, PAC 47°, PAH 26mm); (3) Intact joint, *moderate* acromial malalignment (SAT 59°, PAC 57°, PAH 20mm); (4) Intact joint, *corrected* acromial alignment (SAT 48°, PAC 70°, PAH 11mm). The degree of acromial malalignment and acromial reorientation was chosen based on a previous study that defined acromial anatomy in patients with posterior instability. The humeral head was translated posteriorly until reaching either (1) a peak force of 150N or (2) a maximum posterior displacement of 50% of the glenoid width. Forces (N), displacement (mm) and acromiohumeral contact pressures (kPa) were simultaneously recorded.

## RESULTS:

The force needed to displace the humeral head by 50% of the glenoid width decreased between 23% and 60% in moderate to severe acromial malalignment (high and flat acromion) and increased up to 122% following surgical correction of acromial alignment (low and steep acromion) when compared to the native condition. Correction of acromial alignment significantly increased stability compared to all other scenarios after ≥5% of displacement ( $p < 0.05$  for all comparisons). Furthermore, it increased acromiohumeral contact pressures compared with severe malalignment in 30° flexion and with moderate and severe acromial malalignment in 60° flexion ( $p < 0.05$  for all comparisons).

## DISCUSSION AND CONCLUSION:

The most important finding of this study is that the acromion is a relevant stabilizer against posterior displacement of the humeral head. Depending on its three-dimensional anatomic relationship with the glenoid, the force needed to displace the humeral head by 50% of the glenoid width decreased between 23% and 60% in moderate to severe acromial malalignment (high and flat acromion) and increased up to 122% following surgical correction of acromial alignment (low and steep acromion) when compared to the native condition. Surgical correction of acromial malalignment consistently improved posterior glenohumeral stability compared to all other conditions throughout the tested range of motion. Furthermore, acromiohumeral contact patterns differed in terms of pressure distribution between locations but also in terms of pressure intensity. A steeper acromion, providing more posterior humeral head coverage, exerted more pressure on the infraspinatus, especially in 30° of flexion, and combined acromiohumeral average contact pressures were lower, the flatter the acromion. In otherwise comparable and normal shoulders regarding glenoid morphology and posterior capsulolabral tissue, these results provide the first biomechanical evidence for the stabilizing role of the acromion and a possible and plausible explanation for the previously described association between a high and flat acromion and posterior instability.

