Cadaveric Biomechanical Study of 3D Printed Partial Glenoid Arthroplasty versus the Latarjet Procedure for Anterior Glenoid Bone Loss

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INTRODUCTION:

The Latarjet procedure is commonly performed in cases of severe anterior glenoid bone loss from chronic shoulder instability. However, the Latarjet procedure heavily alters the surrounding anatomy, while fixation and union issues are also common. A novel 3D printed individualized titanium partial glenoid arthroplasty (PGA) implant was developed as an alternative and was compared with the classic Latarjet procedure in this cadaveric study.

METHODS:

Fourteen matched cadaveric shoulders were allocated evenly to the PGA or the Latarjet group and were tested on a custom testing system. The PGA was 3D printed based on preoperative computed tomography scans and was fixed onto the glenoid with two 3.5mm locking screws. The coracoid graft obtained for the classic Latarjet procedure was fixed with two 3.5mm cortical screws. In all cases, capsular repair was done with sutures at the anterior glenoid edge to place the PGA/coracoid graft extracapsular.

The intact, 25% anterior glenoid bone loss, and the postoperative state were tested sequentially in both the scapular and coronal plane. The articular surface area of the glenoid, rotational range of motion (RROM), and relative position of the humeral head apex to the glenoid during humeral rotation were measured in each state, and the respective difference of the intact to the postoperative state was compared between the two groups. The offset between the glenoid and the PGA/coracoid was measured with a digitizer. The load and linear stiffness to 25% anterior translation of the humerus, and 2mm medial displacement of the postoperative construct were obtained.

RESULTS:

The baseline glenoid dimensions before and after the creation of the defect were comparable between the groups. However, the reconstructed articular surface area in the PGA group was significantly greater (digitized postoperative articular area, PGA vs. Latarjet, 880.9±123.6mm^2 vs. 765.3±129.7mm^2, P=0.006). The PGA group better approximated the intact state's external (postoperative change, PGA vs. Latarjet, -4.0±4.0˚ vs. 8.2±8.7˚, P=0.006) and total (-2.5±6.5˚ vs. 16.0±16.2˚, P=0.019) RROM in the scapular plane. The postoperative humeral apex positions during humeral rotation in the PGA group better followed that of the intact state in both scapular (postoperative change, PGA vs. Latarjet, 0.6±2.7mm vs. 3.0±5.5mm, P<0.001), and coronal planes (1.1±3.4mm vs. 5.7±7.7 mm, P<0.001). The PGA group also showed significantly less articular step-off (digitized mediolateral distance at glenoid-PGA/coracoid interface, PGA vs. Latarjet, 1.3±0.4mm vs. 2.2±0.8mm, P=0.030), greater linear stiffness (Instron measurement, PGA vs. Latarjet, 387.5±126.2N/mm vs. 197.6±75.3N/mm, P=0.031), and load for 2mm PGA/coracoid displacement (406.5±145.2N vs. 162.2±75.5N, P=0.002). Resistance against 25% of anterior displacement was greater in the PGA, though not statistically significant.

DISCUSSION AND CONCLUSION:

In addressing 25% anterior glenoid bone loss, 3D printed PGA better approximated the intact glenohumeral joint kinematics than the Latarjet procedure with greater articular surface reconstruction and less step-off. The postoperative PGA construct was also significantly more robust. Further clinical studies are warranted to validify this novel procedure.