Biomechanical Evaluation of Glenoid Reconstruction with the Subtalar Joint Allograft for Anterior Bone Loss in Recurrent Shoulder Instability

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INTRODUCTION: Bone loss on the humeral or glenoid side of the glenohumeral (GH) joint poses a major failure risk after anterior shoulder stabilization. Procedures like Latarjet and distal tibial allograft (DTA) glenoid reconstruction show positive results, but challenges in graft availability and preoperative planning need consideration for optimal glenoid reconstruction. To address these limitations, a talus graft that matches glenohumeral joint congruity could be an ideal solution. However, it is unknown how GH contact mechanics compared between Latarjet, DTA, and talus glenoid reconstruction treatment options. We aimed to compare the contact mechanics of the talus allograft as an alternative for glenoid reconstruction. We hypothesize that the talus allograft option will result in improved glenohumeral joint contact area, contact pressure, peak force, compared to the standard Latarjet coracoid graft.

METHODS: Eight fresh-frozen, unpaired, cadaveric specimens underwent biomechanical testing in five stages: intact state, glenoid bone defect, Latarjet, glenoid reconstruction using distal tibia, and glenoid reconstruction using talus. The Latarjet coracoid, the distal tibia allograft, and the subtalar joint allograft were fixed to the glenoid using cannulated titanium screws. For each testing state, the specimens were mounted to a dynamic tensile testing machine, and pressure-mapping sensors were inserted between the humerus and glenoid (Fig. 1). A compressive load of 440 N was then applied to the GH joint when the humerus was mounted in three humerus positions: 30° of abduction, 60° of abduction, and 60° of abduction with 90° of external rotation (ER). Average GH contact pressure, contact area, and peak pressure were calculated from the sensors. Data was analyzed with an analysis of variance (ANOVA) method. Pairwise group comparisons were made using Tukey's method.

RESULTS: At 30° of abduction, average pressure in the bone loss state (1.3 ± 0.2 MPa) was significantly higher than the native (0.9 ± 0.1 MPa, $p < 0.001$), Latarjet (1.1 ± 0.1 MPa, $p = 0.009$), talus (1.1 ± 0.2 MPa, $p < 0.001$), and DTA (1.0 ± 0.1 MPa, $p < 0.001$) states. At 60° of abduction, average pressure in the bone loss state (1.2 ± 0.1 MPa) was only different to native state (0.9 ± 0.2 MPa, $p < 0.001$). All repair states restored average pressure to the native state at 30° and 60° of abduction. At 60° of abduction with 90° of ER, average pressure in the bone loss state (1.3 ± 0.3 MPa,) was significantly higher than the native (0.9 ± 0.2 MPa, $p < 0.001$), talus (1.0 ± 0.1 MPa, $p < 0.001$), and DTA (1.0 ± 0.2 MPa, $p = 0.006$) states. The Latarjet state (1.2 ± 0.1 MPa) was not significantly different from the bone loss state and was significantly higher than native state ($p = 0.008$)(Fig. 2). At all humeral positions, contact area in the native state (30°: 453 ± 84 MPa; 60°: 479 ± 84; 60° + ER: 419 ± 61) was significantly higher than in the bone loss state (30°: 333 ± 88, $p = 0.001$; 60°: 342 ± 83, $p < 0.001$; 60° + ER: 310 ± 60, $p = 0.005$) and the Latarjet states (30°: $p < 0.001$; 60°: $p < 0.001$; 60° + ER: $p = 0.027$). The talus and DTA repairs restored native contact area at 30° of abduction and 60° abduction with ER. There were no significant differences in peak contact pressure between any states at any humeral position.

DISCUSSION: Glenoid reconstructions using a DTA and a talus allograft restored average contact pressure and contact area at 30° abduction and 60° abduction with ER. While the Latarjet technique restored average contact pressure at 30° abduction, the technique did not restore average contact pressure at 60° abduction with ER and failed to restore contact area at every humeral position. Notably, the technique using a talus graft was not different from the DTA technique in any outcome across all humeral positions. There were no significant differences in peak pressure across all testing states and humeral positions, which may be due to local anatomical variations of the glenoid, the coracoid, and the grafts. Further research is needed to determine if ideal size-matching of glenoid reconstruction grafts yields improvement in peak GH pressure. While the Latarjet technique as seen good to excellent clinical outcomes, this study demonstrates that complications and limitations associated to the Latarjet procedure may be avoided if glenoid reconstruction is performed utilizing a DTA or talus allograft.

CLINICAL RELEVANCE: This study provides biomechanical evidence that may guide clinicians towards reconstructing the glenoid using a DTA or talus allograft rather than performing a Latarjet to address GH bone loss after anterior shoulder stabilization.

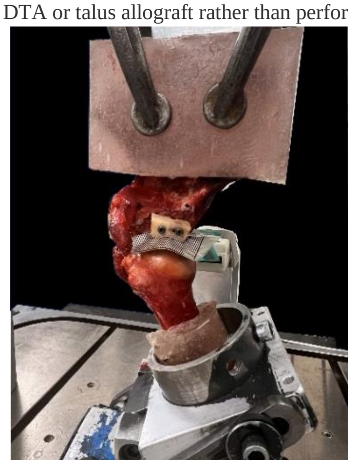

Fig 1. Mechanical testing set up.

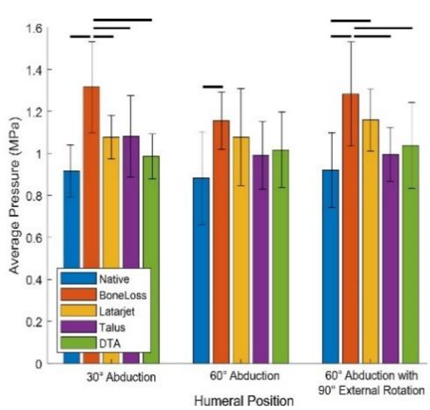

Fig 2. Average contact pressure for each state at each humeral position. Bars indicate significant difference.

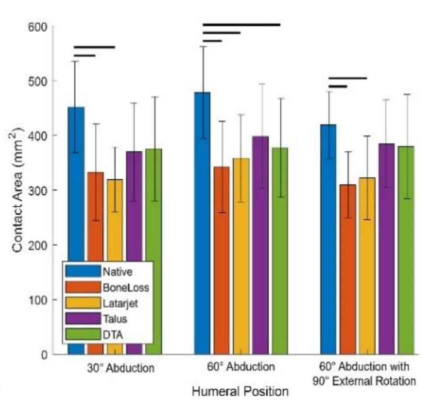

Fig 3. Contact area for each state at each humeral position. Bars indicate significant difference