The Effect of Concavity Restoration on Gelnohumeral Stability in a Glenoid Bone Loss Model: Comparing Distal Tibia Allograft vs. Medial Tibial Plateau Allograft vs. Distal Clavicle Autograft

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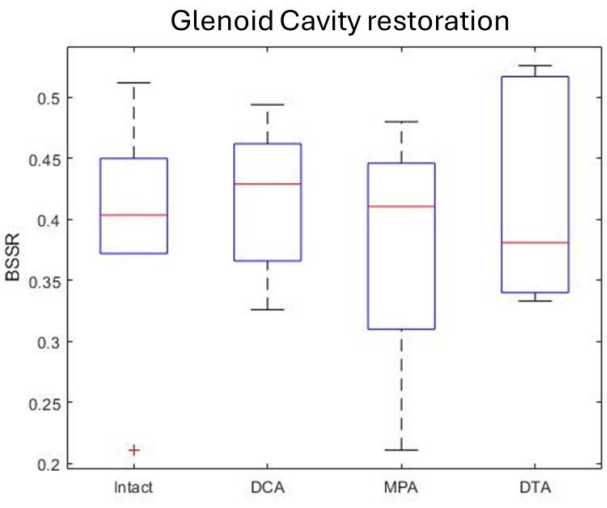
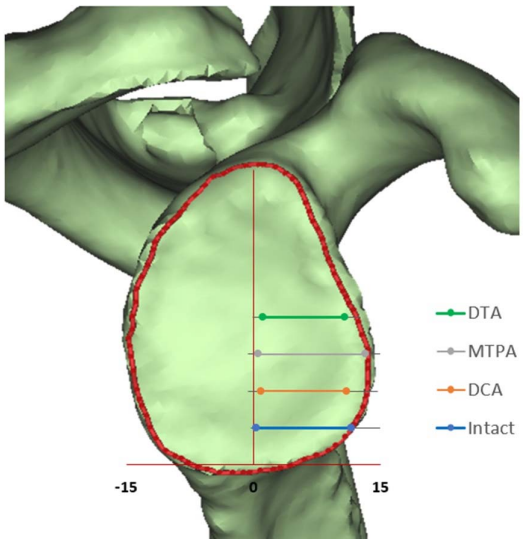
INTRODUCTION:
Glenoid bone loss is present in over 80% of patients with recurrent anterior shoulder instability, posing a significant clinical challenge. Biomechanical studies suggest that soft-tissue repair alone, in cases of 15% bone loss, can result in suboptimal stability due to increased translation and restricted rotational motion. This has led to a growing interest in bone block procedures, with the Latarjet procedure considered the gold standard. However, despite its good clinical results, there are concerns about the high complication rates and its limitations in restoring glenoid width and concavity in large defects. Alternative bone block procedures have utilized either autografts, such as distal clavicle autografts (DCA), or allografts, such as distal tibial allografts (DTA). Recently, the medial tibial plateau autograft (MTPA) has been proposed as an appropriate anatomic match to the glenoid articular surface based on topographic and computed tomography joint contact pressure analyses. No studies have yet compared the effects of these different bone block procedures on the restoration of glenoid concavity and anterior translation. The purpose of this study is to evaluate the restoration of glenoid concavity and anterior stability between DTA, DCA, and MTPA in a validated glenoid bone loss model.

METHODS: Six sets of fresh-frozen, unpaired shoulder, knee and ankle cadaveric specimens were obtained for testing (mean shoulder age: 58.6 years, range 51-63). Specimens underwent preoperative computed tomography (CT) scans to assess the glenoid depth and radius and define the shoulder stability ratio (BSSR–glenoid depth over radius). To test glenohumeral stability, a validated cadaveric shoulder simulator that allows six degrees of freedom at the glenohumeral joint was used. The specimens were placed with the scapula at 30° upward rotation and the humerus at 60° glenohumeral abduction. A constant glenohumeral compressive force was created by loading the supraspinatus, infraspinatus, teres minor and subscapularis muscles with constant loads (2 lbs, 3 lbs, 1 lbs, and 4 lbs, respectively). A Kuka robot progressively applied 50N of anterior force through the pectoralis tendon with the humerus at neutral and a motion system recorded humeral head translations. A 10 mm glenoid bone loss was created through a lesser tuberosity osteotomy. Grafts were harvested such that they would restore 100% of the native glenoid width. DCA grafts were first collected and subsequent DTA and MTPA grafts were harvested to match DCA height in the cranial-caudal and anterior-posterior dimensions. The following conditions were tested: intact state followed by DTA, MTPA, and DCA reconstruction in a randomized order. All specimens underwent post-testing CT scans to calculate the reconstructed glenoid stability ratio (BSSR). A repeated measures ANOVA test was performed to determine if there was a difference in maximum anterior translation or BSSR between the three different bone blocks.
RESULTS: The 10 mm Bone loss model resulted in (34%±3%) glenoid removal and the glenoid width was restored to (104%±2%) following the procedures. BSSR was similar between the intact (0.39±0.10) and the three reconstructed glenoid grafts (DCA: 0.42±0.06; MTPA 0.38±0.10; DTA 0.41±0.09 with $p=0.10$, $p=0.45$, $p=0.21$, respectively). Maximum anterior translations (mm) also showed no significant differences between the three grafts (DCA 11.0±3.7mm; MTPA 13.2±4.4mm; DTA 10.8±1.8mm) versus the intact state (11.6±3.4mm) ($p=0.29$, $p=0.11$, $p=0.21$, respectively).
DISCUSSION AND CONCLUSION: DCA, MTPA, and DTA provided similar glenoid concavity restoration and maximum anterior translation compared to the intact state from a biomechanical standpoint. The current data suggests that each of the graft choices can reasonably be used to help restore glenoid concavity back to the native state in the setting of significant bone loss.


Glenoid Cavity restoration
BSSR
0.5
0.45
0.4
0.35
0.3
0.25
0.2
Intact
DCA
MPA
DTA


DTA
MTPA
DCA
Intact
-15
0
15