GREATER TUBEROSITY FRACTURES: A BIOMECHANICAL FRACTURE MODEL DELINEATING THE EFFECTS ON SHOULDER MECHANICS

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INTRODUCTION: Greater tuberosity (GT) fractures have been traditionally classified and treated using the Neer system. Fragments qualify as parts if they display >= 45º angulation or >= 1 cm displacement. Recent investigators have documented abduction weakness and subacromial impingement following non-operative treatment of minimally displaced fractures (>1.0 cm). These parameters have not been previously investigated for their biomechanical significance. Using a biomechanical malunion model of the shoulder, the investigators characterized the changes of deltoid force required for abduction with various combinations of GT fracture displacement.

METHODS: Eight fresh frozen human cadaveric shoulders were tested in a static-active shoulder testing apparatus developed by the authors. Rotator cuff and deltoid tendons were meticulously dissected and clearly delineated. Cables connected to a 1000 N load cell of a MTS machine were attached to a bi-cortical screw inserted into the humerii at the deltoid insertions. Inferior scapulae were potted in PMMA blocks and bolted to the back-plate of the apparatus for stable mounting. Free-hanging weights were attached to the rotator cuff tendons approximating physiologic force ratios and centroids via interwoven high gauge suture. Force required for 90° of abduction was measured in the intact specimen. A GT osteotomy was then created and fixed with combinations of 0.5 cm and 1.0 cm superior and posterior displacement. F_{max} was measured for each displacement combination. Each F_{max} was compared to the F_{max} of the intact specimen. All data was statistically analyzed using a repeated measures ANOVA test for significance within and between specimens.

RESULTS: Average abduction force in the intact specimens was 195.08±33.23 N. Superior displacement of 0.5 cm and 1.0 cm resulted in means of 226.38±32.14 N and 248.37±39.49 N, respectively. Displacement of 0.5 cm posterior and superior required 211.25±36.55 N to abduct. Forces with 0.5 cm superior and 1.0 cm posterior displacement averaged 230.79±53.15 N. Forces with 1.0 cm superior and 1.0 cm posterior displacement averaged 252.29±35.64 N. Compared to the intact, all fracture displacements except 0.5 cm superior and posterior created a statistically significant increase in abduction force, with P-values ranging from .0001 to .0062.

DISCUSSION: The in vitro biomechanical data suggests that deltoid force required for 90° abduction at the glenohumeral joint may be significantly altered by GT malunions displaced 0.5 cm or greater. To the authors' knowledge, this is the first biomechanical evidence to suggest that shoulder mechanics may be significantly altered by minimally displaced fractures. This knowledge may affect clinical decisions and treatment protocol for GT fractures.

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