A Comparison of Acromial Plating With and Without Suture Augmentation for Treatment of Levy Type 2b Acromial Stress Fractures: A Biomechanical Study.

Ian Penvose, Trevor Lee Toavs, Rachel Schilkowsky, Janine Molino, Andrew Green, E Scott Paxton

INTRODUCTION: As the number of reverse shoulder arthroplasty (RSA) cases rise, the incidence of acromial stress fractures will continue to increase. The ability to ensure fracture site stability in the treatment of acromial stress fractures poses a unique challenge. Currently, there is no gold standard on acromial stress fracture fixation. The current study aims to compare construct stiffness and displacement of Levy type 2b acromial stress fractures fixed with acromial plating only versus acromial plating augmented with suture cerclage about the acromion and plate.

METHODS:

Sixteen fresh-frozen, human cadaveric shoulder specimens (eight matched pairs) with an average age of 70.3 ± 4.7 years were used. Donors with a history of shoulder injury and/or surgery were excluded. Specimens were carefully dissected such that the deltoid origin, insertion and joint capsule were left intact while all other soft tissue was removed. After dissection, left and right shoulders from each matched pair were randomly assigned to one of two groups: acromial plate only or acromial plate with suture augmentation. An acromial osteotomy was created to simulate a Levy type 2b fracture. The plate utilized was a pre-contoured acromial plate with an "L" shape. Suture augmentation consisted of heavy tape (nonabsorbable, polyester suture with a UHMWPE multifilament core and a braided polyester jacket) around the acromion and plate. Specimens were subjected to a cyclic staircase loading at 1 Hz which began at 50N and increased by 50N every 100 cycles until a maximum force of 700N had been reached. All specimens that survived cyclic loading were then pulled in tension at a constant displacement rate of 1 mm/s until failure. Outcome measures included fracture displacement during cyclic testing (mm), maximum fracture displacement (mm), stiffness (N/mm), and the mode of failure. Generalized estimating equations (GEE) were used to compare the study outcomes between experimental conditions.

RESULTS:

All but one specimen (15/16, 94%) survived cyclic testing. Mean fracture displacement during cyclic testing was significantly higher in the plate only group compared to the suture augmentation group [0.71mm, (95% CI: 0.36, 1.06) vs. 0.17mm, (95% CI: 0.00, 0.33), p = 0.009]. Mean maximum displacement during cyclic testing was significantly greater in the plate only group [1.20mm, (95% CI: 0.93-1.48) vs. 0.53mm, (95% CI: 0.24, 0.83), p = .003]. Stiffness was significantly higher in the suture augmentation group than in the plate only group [1268.67 N/mm, (95% CI: 943.33, 1706.2) vs. 3491.51 N/mm, (95% CI: 2443.34, 4989.31), p = 0.0003]. (Table 1)

DISCUSSION AND CONCLUSION: Plating of the acromion with suture augmentation led to significantly less displacement of the fracture site during biomechanical testing of Levy type 2b fractures. The displacement of the suture augmentation group was also much less then reported values in the two previous studies on this topic evaluating plating only constructs. Furthermore, construct stiffness was significantly enhanced with the addition of suture augmentation. This study poses a biomechanically superior treatment option to acromial stress fracture fixation. Further studies are needed to define the clinical significance of stiffness and displacement as it relates to fracture healing and patient outcomes.

Table 1: Study outcomes by experimental condition

Study Outcome	Plate Only Mean (95% CI)	Suture Augmentation Mean (95% CI)	P-value
Displacement after cyclic testing	0.71mm (0.36-1.06)	0.17mm (0.00-0.33)	**0.009**
Maximum displacement	1.20mm (0.93-1.48)	0.53mm (0.24, 0.83)	**0.003**
Maximum load (catastrophic)	1340.78 N (1229.91-1461.64)	1401.63 N (1070.36-1835.41)	0.74
Stiffness	1268.67 N/mm (943.33-1706.20)	3491.51 N/mm (2443.34-4989.31)	**0.0003**

Estimated marginal means and corresponding 95% confidence intervals along with p-values comparing experimental conditions.