Effect of Joint Position, Supraspinatus Tendon Load, Tear Size and Repair
Technique on Infraspinatus and Supraspinatus Tendon Strain Using Multiple Regression Models

INTRODUCTION:
Supraspinatus (SS) tendon tears are complex, yet common injuries. We have shown that the SS and infraspinatus (IS) tendons interact, indicated by parallel changes in strain in the SS and IS with increasing size of SS tear, load applied to the SS, and changes in the glenohumeral rotation angle. Increasing the glenohumeral abduction angle, however, resulted in a decrease in IS strain in contrast to changes in SS strain suggesting disruption in the interaction between the two tendons. While the effect of these factors considered individually is valuable, the contribution of each factor in the context of all others on strain in the SS, or on the interaction between the two tendons is unknown and has important implications in the management of rotator cuff tears. Therefore, the objective of this study was to determine the contribution of glenohumeral joint position, SS load and tear size or repair on strain in SS and the interaction between SS and IS through the development of multivariate regression models. We hypothesize that SS tear type, load and joint position are significant predictors of strain in the SS and IS; and repair technique will also be a significant predictor of IS strain.

METHODS:
Ten cadaveric human shoulders (48.7±15.1 yrs) were dissected retaining the humerus, SS and IS. Tendons were spackled to create texture for strain analysis (Vic2D). The experimental setup is shown in Figure 1. SS loading protocol was applied for the SS, intact, 33%, 66% and 100% bursal-side partial-thickness tears through the anterior 66% of the width of the SS and for two SS repairs (modified Mason-Allen fixation or 4-suture-bridge arthroscopic) on each cadaver. Each SS tear and repair was evaluated at each of the following joint positions: (1) neutral rotation with 0°, 30° and 60° abduction; and (2) 0° abduction with 0°, 30° internal and external rotation. Displacements between the SS, IS and SS load were measured and strain data was calculated using the model coefficients were not altered by random removal of data points. For equations 1, 2, 4, and 5, predicted values consistently fell within 1 standard deviation of actual values except for strain values that approximated 0%. As expected from the low r^2 associated with equation (3), this model accurately predicted 80% of predicted EP1, indicating potential improvement from inclusion of additional parameters.

DISCUSSION:
As expected, since Abd significantly impacts SS (greatest stain at 60° and lowest at 30°) and IS strain (lower at 30° and 60° than 0°), this factor was a significant predictor for IS and SS. SS load was also a significant predictor of SS and IS strain. Results emphasize the importance of joint position and shoulder loading in management of cuff tears and postoperative care. Interestingly, despite previous findings showing that SS tear size significantly affects IS strain, SS tear size was not a significant predictor of IS strain, and the importance of other factors evaluated. The r^2 value of 0.35 for EP1 in the SS (SS tear) indicates that a small portion of the variability in strain is attributable to these independent factors. Inclusion of interaction terms between the evaluated independent variables may improve this model.

DW statistics calculated either showed no correlation or a correlation but with obtained values close in value to the lower bounds of the non-correlation range. Regardless, correlation between independent variables precludes separating out the effect of significant individual factors. However, since this correlation is not an experimental artifact, but an actual reflection of the complex environment experienced by the tendon, manual removal of any factor was not conducted. Additionally, the regression analysis manages such correlations by removing strongly correlated variables in the backward elimination step, leaving the strongest predictor variables in the model. Results suggest that a better understanding of the loading environment in rotator cuff tendons necessitates a multifactorial complex model.

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