VARIABILITY OF GLENOHUMERAL EXTERNAL ROTATOR MUSCLE MOMENT ARMS

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INTRODUCTION

Glenohumeral rotator muscle moment arms have been determined in previous studies [1,2,3]. These studies did not examine the interaction between portions of the rotator cuff, or between sub-regions of cuff tendons. This study's purpose was to empirically determine rotation moment arms for sub-regions of supraspinatus, infraspinatus, and for teres minor. There were 2 hypotheses: 1) that muscles and their sub-regions possess differences in moment arm due to joint angle, and 2) that sub-regions of the cuff tendons increase their effective moment arms through connections to other sub-regions.

METHODS

Data were collected from 10 normal cadaver specimens for supraspinatus (SSP), infraspinatus (INF), and teres minor (TM). SSP and INF were divided into 3 and 4 sub-regions, respectively. The change in tendon excursion relative to humeral head rotation was measured with a custom instrument. The instrument has demonstrated error less than 0.5 mm. Data were collected for the full range of external rotation at 10^o and 60^o abduction in the scapular plane. Two conditions were tested: 1) tendon divided just up to musculotendinous junction (intact cuff), and 2) tendon divided all the way to the insertion to bone (divided cuff). Three trials were recorded for each abduction angle - tendon condition combination. Polynomials were fit to the tendon excursion vs. rotation angle data. Moment arm was determined at one degree increments as the derivative of the tendon excursion versus joint angle relationship [4]. Moment arm data were analyzed with an ANOVA model.

RESULTS AND DISCUSSION

Rotation moment arms were dependent upon abduction angle, rotation angle, cuff condition and muscle sub-region, and demonstrated significant inter-specimen variability (Figures 1&2) (Mean±S.D.). Moment arms for INF were significantly greater at 10^o abduction ($p<0.001$). Moment arms of SSP ($p<0.05$) and teres minor ($p<0.001$) were significantly greater at 60^o abduction. Moment arms of sub-regions of INF ($p<0.001$) and SSP ($p<0.001$) were significantly different. Moment arms of INF ($p<0.001$) and SSP ($p<0.001$) were significantly greater with an intact rotator cuff. TM moment arm was not significantly affected by cuff condition ($p=0.46$).

CONCLUSIONS

Moment arm differences between muscle sub-regions and for different cuff conditions have possible clinical implications. At neutral rotation the SSP has a very small rotation moment arm suggesting it contributes little to external rotation strength. Some loss of strength seen clinically with isolated SSP tears is likely due to muscle inhibition or pain. Additionally, the results of interaction between cuff regions have potential for explaining why some subjects retain strength after small cuff tear. This finding also helps explain why a partial cuff repair may be beneficial when a complete repair is not possible. Such data can help differentiate between cuff tear cases which would benefit from cuff repair and cases for which cuff repair might not be as favorable.

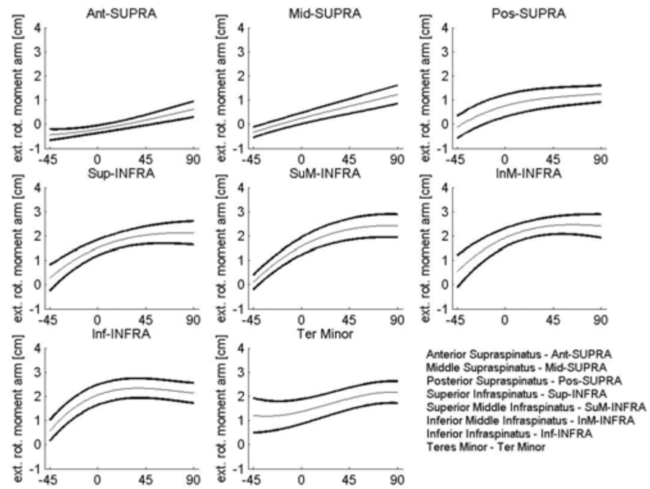

Figure 1: Moment arms, Intact cuff, 10^o abduction.

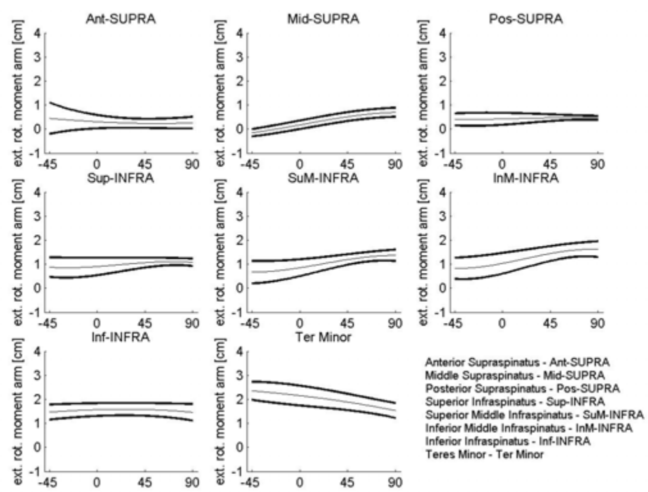

Figure 2: Moment arms, Divided cuff, 60^o abduction

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