

THE EFFECT OF PECTORALIS MINOR RESTING LENGTH VARIABILITY ON SCAPULAR KINEMATICS

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Background: Subacromial impingement is a common pathology of the shoulder. Scapular kinematic alterations have been identified in individuals with subacromial impingement including decreased posterior tipping, increased internal rotation and decreased upward rotation. Mechanisms of altered scapular kinematics should be identified to assist in treating persons with impingement.

One proposed mechanism is pectoralis minor adaptive tightness. A tight pectoralis minor would limit full scapular motion by increases in passive tension at shorter muscle lengths. The purpose of this study was to examine the effect of altered pectoralis minor lengths on scapular kinematics.

Method: Both in vitro and in vivo analyses were performed in this study. In both components, an electromagnetic motion system captured scapular orientation relative

to the trunk during arm elevation. For the in vitro analysis, surgical bone pins secured sensors to the scapula, humerus, and sternum of eleven fresh cadavers. Cadaver arms were passively elevated in the coronal and scapular planes independently under five pectoralis minor conditions: intact, intact plus dissected, shortened ten percent, maximally shortened, and cut. The cut ends of the muscle were overlapped and sutured to shorten the muscle. Analysis of the subacromial space during unique scapular rotations was performed by calculating the vector distance between the anterior-lateral acromion and the greater tubercle of the humerus.

For the in vivo analysis, fifty subjects were separated by normalized pectoralis minor resting length into long and short groups of 25 each. Motion sensors were taped over the sternum and scapula, while a third sensor was secured by a plastic cuff to the humerus.

Data were collected during active flexion, abduction, and scapular plane elevation.

Analysis: In vitro, scapular orientations relative to the trunk were analyzed at 30°, 60°, 90°, and 120° humeral elevation with a two-way repeated measures (pectoralis minor condition by angle) ANOVA. In vivo, scapular orientations were analyzed between groups at the same elevation angles with a mixed model ANOVA. For both components, significant interactions were further analyzed for significant simple effects at each elevation angle. Subacromial space estimates were compared at the extremes of scapular rotation.

Results: During in vitro abduction, there was a statistically significant interaction effect for both scapular internal rotation and tipping. For tipping, the maximum shortened pectoralis minor condition was further anteriorly tipped than the intact condition at all elevation angles. IR was not significant at separate angles. Tipping was a statistically significant main effect during elevation in both planes with maximum shortened more anterior than intact, intact plus dissected, and cut in scapular plane. The subacromial space was demonstrated to

decrease with maximum scapular anterior tipping and internal rotation. In vivo, significant interactions between group and elevation angle were present in all planes for tipping and during abduction only for internal rotation. In all planes, the short group lacked posterior tipping at both 90° and 120° of elevation. The short group demonstrated increased internal rotation at 30°, 60°, and 90° during abduction. Group was also a significant main effect for both internal rotation and tipping during all motions with the short group less posteriorly tipped and more internally rotated.

Conclusions: A relatively short pectoralis minor resulted in altered scapular motions during arm elevation both in vitro and in vivo. The shorter pectoralis minor restricted full scapular posterior tipping and external rotation. These normal scapular motions are necessary to clear the acromion from the elevating humerus. In vitro scapular rotations demonstrated that limitations in posterior tipping and external rotation will minimize the subacromial space. The combination of scapular motion limitations and a reduced subacromial space will increase the likelihood of impingement in individuals with a short pectoralis minor.