Electromyographical Differences Between Slow and Fast Closed and Open Chain Shoulder Exercises

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Objective: Previous studies have demonstrated that increasing the speed of movement increases the demand of the shoulder musculature during open chain exercise. However this has not been examined in closed chain shoulder exercises. The purpose of this study was to determine if differences exist between electromyographical (EMG) activity of glenohumeral musculature while performing open and closed chain shoulder rehabilitation exercises at two different speeds.
Design and Setting: A 3 within factor (speed, exercise, muscle) repeated measures ANOVA was performed to compare difference between speed (slow, fast); exercise (open, closed); and muscle (supraspinatus, infraspinatus, anterior deltoid, posterior deltoid, pectoralis major). A Tukey's post hoc analysis was performed on significant ANOVA findings with significance set at $p<0.05$.
Subjects: Twenty subjects with normal shoulder function volunteered to participate in this study (age = 22 ± 3 years; ht = 168.34 ± 24.74cm; wt = 74.09 ± 14.99kg). All subjects had no history of significant shoulder injury in the previous 6 months
Measurements: Bipolar surface electrodes monitored EMG activity of the infraspinatus, pectoralis major, and the anterior and posterior deltoids. A bipolar fine-wire indwelling electrode monitored the supraspinatus EMG activity. All EMG data were normalized to a maximal isometric voluntary contraction (MVIC). Subjects performed 8 trials of a horizontal reaching task performed in the scapular plane through an average ROM of (44.6°). The slow speed movement was performed in time with a metronome at 45°/sec and the fast speed at 100°/sec through the exact same arc. Open and closed chain exercises were performed for both speeds. The order of exercise was counterbalanced to prevent fatigue and bias. Total EMG activity of the exercise movement was determined as a percentage of MVIC. Three clean trial percentages of total EMG activity were used for statistical analysis.
Results: A significant interaction between speed and exercise was found {$F(1,19) = 6.95$, $p<0.05$}. Post-hoc analysis revealed significantly greater EMG activity at 100°/sec (17.7 ± 7.5) than at 45°/sec (7.2 ± 3.4). At the fast speed, open (20.0 ± 8.13) was greater than closed chain exercise (15.5 ± 6.9). A significant interaction between speed and muscle was found {$F(1,19) = 7.856$, $p<0.01$}. Post-hoc analysis revealed that the supraspinatus activity produced significantly more activity than all the other muscles at 100°/sec.
Conclusions: This study supports previous research that increasing the speed of an exercise increases the demand on the musculature. Increasing the speed of the exercise appears to specifically target the rotator cuff musculature. This provides clinicians another method to modify the demands placed on the rotator cuff during a rehabilitation progression.