The Effects of Joint Angle on the Initial Decrease in Torque During Sustained, Isometric Forearm Flexion Tasks Anchored to RPE in Women

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ABSTRACT

Ratings of perceived exertion (RPE) are often used to determine intensity for aerobic and resistance training. Previous studies have utilized the RPE Clamp Model to examine the torque responses during fatiguing tasks anchored to a perceptual intensity. It is unclear, however, if joint angle (JA) affects the torque responses during a sustained task anchored to an RPE value. **Purpose:** The purpose of the present study was to examine the effects of JA on the precipitous drop in torque from the initial value to 5% time to task failure (TTF) during sustained, isometric forearm flexion tasks to failure, anchored to an RPE of 8 (RPE = 8) on the 10-point OMNI-Res Scale. **Methods:** Nine women (age: 21.0 ± 3.0 yrs; height: 169.3 ± 8.1 cm; body mass: 68.4 ± 7.4 kg) performed 2, 3s forearm flexion maximal voluntary isometric contractions (MVIC) at randomly ordered elbow JAs of 75° (JA75) and 125° (JA125) before sustained, isometric tasks to failure at JA75 and JA125 anchored to RPE = 8. For each subject, TTF was recorded, with task failure defined as torque reduced to zero. The initial torque value was the average torque during the first 1s of the sustained tasks. All torque values were normalized to the pre-test MVIC. A 2 (JA: 75° vs 125°) x 2 (Time: Initial vs 5% TTF) repeated measures ANOVA was used to examine the mean differences in the torque values. In addition, paired t-tests were used to examine mean differences in TTF for JA75 versus JA125. Effect sizes were reported as partial eta-squared (η_p^2) and follow-up pairwise comparisons were used when necessary. An alpha value of $p \leq 0.05$ was considered statistically significant. **Results:** The results indicated that there was no significant JA x Time (p = 0.983, $\eta_p^2 = 0.000$) interaction or main effect for JA (p = 0.143, $\eta_p^2 = 0.247$), but there was a significant main effect for Time (p = 0.012, $\eta_p^2 = 0.568$). The initial torque value (collapsed across JA) was greater (60.8 ± 17.7 %MVIC; p = 0.012; d = 1.097) than the torque value at 5% TTF (43.4 ± 13.8 %MVIC). The TTF at JA75 (361.7 ± 260.0 s) was significantly greater (p = 0.018; d = 1.076) than the TTF at JA125 (152.3 ± 90.4 s). **Conclusions:** These findings indicated that when performing sustained, isometric forearm flexion tasks at short (75°) and long (125°) JAs anchored to RPE = 8, there were similar decreases in the %MVIC (24.7% at JA75 and 25.3% at JA125) from the first 1s of the task to 5% TTF. These precipitous decreases in torque were likely due to an anticipatory feedback component, comprised of previous experiences as well as physiological and psychological inputs that were processed in the brain and resulted in the subject overestimating the torque that could be maintained at RPE = 8. **Practical applications:** When using RPE to determine intensity rather than absolute load or %MVIC, coaches and practitioners should be aware that it is likely that individuals will overestimate a sustainable intensity and immediately reduce torque (or force) production to coincide with their perception of exertion. It is important to be aware that this may affect the accuracy of intensity prescription for rehabilitation or resistance training.

BACKGROUND

Ratings of perceived exertion (RPE) are often used to determine intensity for aerobic and resistance training. Previous studies have utilized the RPE Clamp Model to examine the torque responses during fatiguing tasks anchored to a perceptual intensity. It is unclear, however, if joint angle (JA) affects the torque responses during a sustained task anchored to an RPE value.

The purpose of the present study was to examine the effects of JA on the precipitous drop in torque from the initial value to 5% time to task failure (TTF) during sustained, isometric forearm flexion tasks to failure, anchored to an RPE of 8 (RPE = 8) on the 10-point OMNI-Res Scale.

METHODS

Subjects: Nine women (age: 21.0 ± 3.0 yrs; height: 169.3 ± 8.1 cm; body mass: 68.4 ± 7.4 kg) volunteered to participate in this study. All subjects were recreationally active, participating in resistance and/or aerobic exercise at least 3 d·wk^{-1}. Subjects were free of upper body pathologies that would affect performance. **Procedures:** The subjects grasped the handle of the dynamometer with their dominant hand (based on throwing preference) (Figure 1). Subjects performed 2, 3s forearm flexion maximal voluntary isometric contractions (MVIC) at randomly ordered elbow JAs of 75° (JA75) and 125° (JA125) before sustained, isometric tasks to failure at JA75 and JA125 anchored to RPE = 8. For each subject, TTF was recorded, with task failure defined as torque reduced to zero. **Signal processing:** Torque signals were sampled from the digital torque of the Cybex 6000 dynamometer (Cybex 6000, Cybex International Inc. Medway, MA). The initial torque value was the average torque during the first 1s of the sustained tasks. All torque values were normalized to the pre-test MVIC, the higher of the two repetitions were used for analyses. **Statistical Analyses:** A 2 (JA: 75° vs 125°) x 2 (Time: Initial vs 5% TTF) repeated measures ANOVA was used to examine the mean differences in the torque values. In addition, paired t-tests were used to examine mean differences in TTF for JA75 versus JA125. Effect sizes were reported as partial eta-squared (η_p^2) and follow-up pairwise comparisons were used when necessary. An alpha value of $p \leq 0.05$ was considered statistically significant.

RESULTS

The results indicated that there was no significant JA x Time (p = 0.983, $\eta_p^2 = 0.000$) interaction or main effect for JA (p = 0.143, $\eta_p^2 = 0.247$), but there was a significant main effect for Time (p = 0.012, $\eta_p^2 = 0.568$). The initial torque value (collapsed across JA) was greater (60.8 ± 17.7 %MVIC; p = 0.012; d = 1.097) than the torque value at 5% TTF (43.4 ± 13.8 %MVIC). The TTF at JA75 (361.7 ± 260.0 s) was significantly greater (p = 0.018; d = 1.076) than the TTF at JA125 (152.3 ± 90.4 s).

CONCLUSION

These findings indicated that when performing sustained, isometric forearm flexion tasks at short (75°) and long (125°) JAs anchored to RPE = 8, there were similar decreases in the %MVIC (24.7% at JA75 and 25.3% at JA125) from the first 1s of the task to 5% TTF. These precipitous decreases in torque were likely due to an anticipatory feedback component, comprised of previous experiences as well as physiological and psychological inputs that were processed in the brain and resulted in the subject overestimating the torque that could be maintained at RPE = 8.

PRACTICAL APPLICATIONS

Pre-test versus post-test measures of MVIC torque are effective for assessing performance fatigability when applying the RPE Clamp Model. Furthermore, these findings indicated that for forearm flexion, performance fatigability can be compared between studies where the fatiguing task occurred at different joint angles.

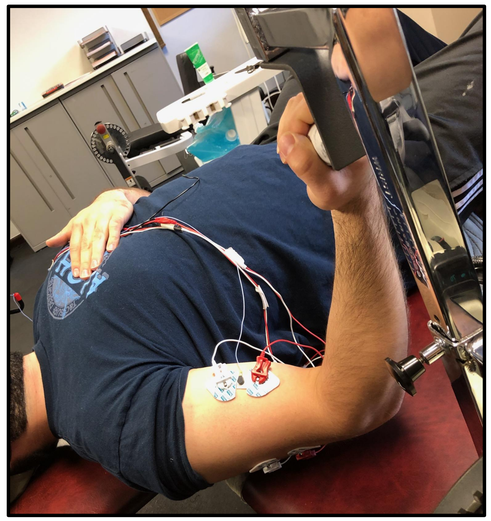

Figure 1. Experiment set up.

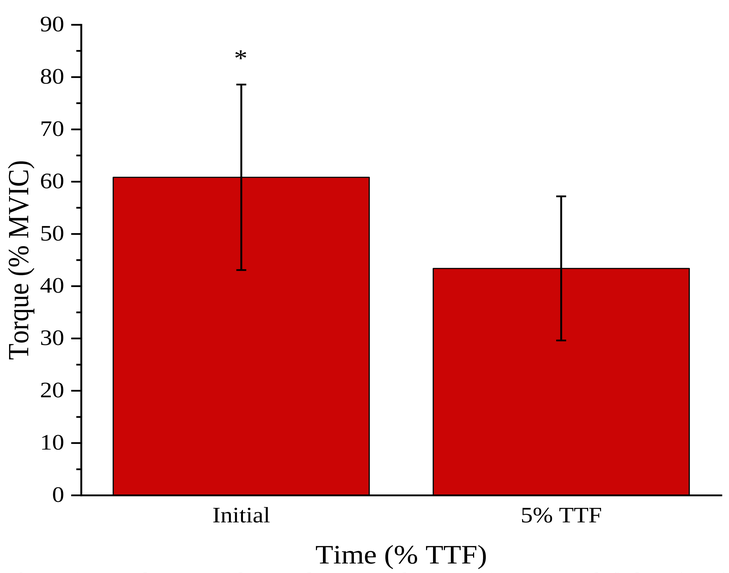

Figure 2. Initial torque values and torque values at 5% time to task failure (TTF) (collapsed across Joint Angle (JA): 75° and 125°).

* Initial values significantly (p < 0.05) greater than 5% TTF values.

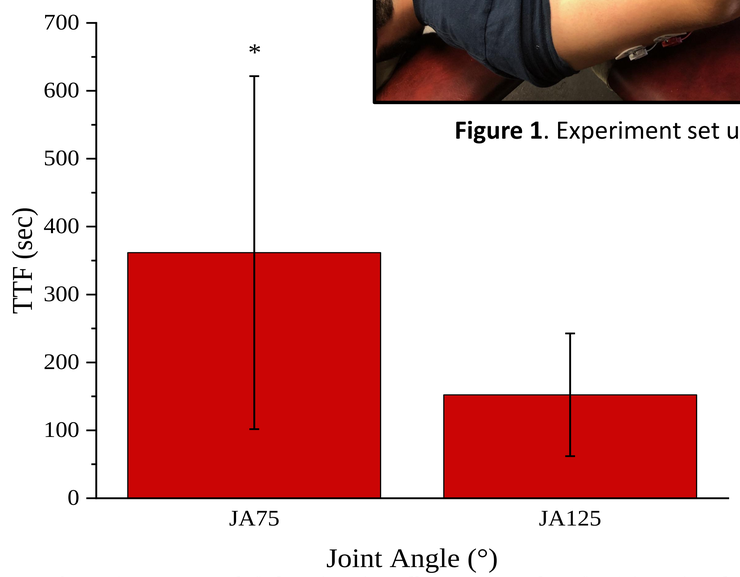

Figure 3. Time to task failure (TTF) at elbow joint angles of 75° (JA75) and 125° (JA125).

* JA75 significantly (p < 0.05) greater than JA125.