Improvements in Isometric Elbow Flexion Rate of Torque Development are Muscle Length Dependent Following 8 Weeks of Dumbbell Curls.

Rebecca Franklin[1], Zachariah Henderson[1], Shizhen Wang[1], Trisha Scribbans[1]
[1]Faculty of Kinesiology and Recreation Management, University of Manitoba, Winnipeg, Manitoba, Canada
Email: frankl10@myumanitoba.ca

Summary

Rate of torque development (RTD) is a crucial component of muscle performance, which may be influenced by muscular adaptations from resistance training (RT). Twenty untrained participants performed 2-4 sets of dumbbell curls at 70% of their estimated 1-repetition maximum three times weekly for 8-weeks. RTD at 5, 10 and 200 milliseconds (ms) was measured using isokinetic dynamometry PRE and POST 8-weeks of RT. Five repetitions were completed at 60, 90 and 120º of elbow flexion. Results revealed greater RTD improvements at 90º than 60º of elbow flexion.

Introduction

The rate of torque development (RTD), the speed that force is produced by a muscle, is a critical aspect of muscle performance. Due to changes in muscle architecture when muscles are stretched or shortened, force production varies at different muscle lengths [1]; however, RTD can be improved with resistance training (RT) [2], and may be influenced by neural and morphological adaptations from RT [3]. Indeed, greater muscle mass is generally associated with greater force generation, and recent work suggests that muscle hypertrophy and motor unit recruitment may differ across regions of a muscle depending on the RT stimulus [4]. Given that RT may affect muscle architecture, and the contractile structures of a muscle are heterogenous, it seems plausible that improvements in RTD with RT may also occur in a heterogenous fashion with respect to muscle length. As such, we examined the change in RTD at short (120º), medium (90º), and long (60º) muscle contraction lengths following 8-weeks of isotonic unilateral RT of the elbow flexors.

Methods

Twenty untrained participants (n=20, 12 females, 8 males; 24±4 years old, height: 172.6±11.3 cm, weight 73.3±18.1 kg) completed 2-4 sets of unilateral dumbbell curls at 70% of their estimated 1-repetition maximum 3 times weekly for 8-weeks.

Isokinetic dynamometry (Biodex Medical Systems) measured isometric RTD of the elbow flexors PRE and POST 8-weeks of RT. Five repetitions were completed at 60º, 90º and 120º of elbow flexion. The onset of RTD was determined as the last trough before torque rises above baseline noise [5] and calculated as the change in force/time for 5 ms, 100 ms, and 200 ms. Three, 2*3 repeated measures ANOVAs were conducted to assess the effects of time (PRE and POST) and muscle length (60, 90 and 120º of elbow flexion) on RTD at three durations (0-5, 0-100 and 0-200 ms). To maintain adequate statistical power, a compromise power was conducted, resulting in alpha being set at ≤ 0.2 and Bonferroni corrected for post-hoc comparisons ($p \leq 0.067$).

Results and Discussion

There were no interactions across time or position at 0-5, 0-100 or 0-200 ms. While 0-100 ms had a main effect of position, Bonferroni post hoc tests revealed no significance. There was a main effect of time (p = 0.101) and position (p = 0.092) on 0-200 ms (Table 1). Post-hoc tests revealed RTD at 0-200 ms at 90º was greater than 60º (p = 0.015). Consistent with previous reports, RT increased RTD at 0-200ms suggesting that peak torque was increased with RT [2,6]. Given that the RT was not performed with very high velocities, it is not surprising that changes in early RTD (0-100 ms) were not observed. As an increase in later RTD (0-200 ms) was only present at 90º, this suggests that improvements in RTD following isotonic elbow flexor RT are muscle contraction-length dependent.

Table 1: Rate of torque development before (PRE) and after (POST) training at 60 º, 90 º and 120º of elbow flexion at 5, 100 and 200 milliseconds (ms). Data represented as mean (standard deviation). * Significantly different than 60 º.

	0-5 ms		0-100 ms		0-200 ms	
	PRE	**POST**	**PRE**	**POST**	**PRE**	**POST**
60º	56.7 (148)	67.1 (137)	80.9 (132)	105 (149)	84.6 (81.1)	104 (91.3)
90º	69.9 (125)	77.2 (121)	110 (133)	130 (167)	103 (82.2)	122 (102)*
120º	60.8 (108)	80 (127)	112 (117)	118 (145)	103 (80.9)	113 (91.7)

Conclusions

8-weeks of elbow flexor RT does not improve early (0-100 ms) isometric RTD but improves later RTD (0-200 ms), with the 90º elbow flexion position producing greater improvements than the 60 and 90º elbow position, suggesting that improvements in RTD following isotonic elbow flexor RT are muscle contraction-length dependent.

References

[1] De Ruiter CJ. et al. (2004). *J. Appl. Physiol, **97(5)**:* 1693-1701.
[2] Jenkins NDM. Et al. (2016). *J Musculoskelet Neuronal Interact.* **16(2):** 135-144.
[3] Andersen LL. et al. (2010) *Scand J Med Sci Sports*, **20(1)**.
[4] Wakahara T. et al. (2013). *Med Sci Sports Exerc*. **45:** 2158–2165.
[5] Maffiuletti, NA. et al (2016). *Eur J Appl Physiol*, **116**: 1091–111.
[6] Jenkins NDM. Et al. (2014). *Int J Sports Med*. **35(14)**: 1190-5.