REST PERIOD FOR PEAK TORQUE RECOVERY DURING ISOKINETIC TESTING

Barbara L. Warren

University of New Orleans, New Orleans, Louisiana USA

The purpose of this study was to investigate the responses of females during isokinetic testing when counterbalancing the rest periods between sets. Twelve female subjects were recruited and tested on 4 separate occasions. A 4 X 5 repeated measures ANOVA was used to analyze the data ($p < .05$). There were no significant differences between rest periods or velocities as measured in peak torque values. Although peak torque values did not differ significantly it was evident that longer rest periods provided more similar peak torque values across velocities.

KEY WORDS: isokinetic, peak torque

INTRODUCTION: Numerous studies have evaluated strength by using isokinetic testing. Several populations of subjects have had their normal muscle function assessed (Bilcheck, Kraemer, Maresh, & Zito, 1993; Perrine & Edgerton, 1978), muscle force evaluated as a result of strength training (Coyle, Feiring, Rotkis, et al., 1981), and muscle strength tested to establish the results of immobility (Greenleaf, Bernauer, Ertl, Bulbulian, & Bond, 1994). In spite of the abundance of literature on isokinetic testing, there has been no standardization in number of repetitions, velocities, or the rest duration. However, in reviewing studies reporting isokinetic testing, the subjects typically performed two to four repetitions, and were tested at three to five different velocities administered in ascending order (Parcell, Sawyer, Valmor, Tricoli, & Chinevere, 2002). But, the rest period during testing protocols has been inconsistent. A study by Parcell et al. (2002) found that a 60 second rest period between sets of concentric isokinetic strength testing was sufficient for recovery in a male population. A study by Bilcheck et al. (1993) indicated that a 2.5 minute rest period between concentric/eccentric testing protocols assured adequate recovery for force production in a female population. Conversely, a study by Warren & Blazquez (2004) indicated no significant main effect of either velocity or rest period on peak torque when testing females. A more recent study by Warren and Blazquez (2005) found there was a significant effect of velocity on peak torque but there was no significant effect of rest or a significant interaction of velocity by rest. However, in both of the Warren & Blazquez studies the rest periods were counterbalanced within each testing session rather than between testing sessions. The purpose of this study was to investigate the responses of females during isokinetic testing when counterbalancing the rest periods between sets.

METHOD: Twelve female college students were recruited as subjects. The study was approved by the university human subjects review board. Subjects reported to the lab on six separate occasions. Two were familiarization sessions and four were experimental testing sessions, which included a required warm up on a bicycle ergometer at 100 W for 5 min. The familiarization sessions were to minimize the effects of learning on torque production during isokinetic testing. During the familiarization sessions, subjects were fitted on the CYBEX NORM isokinetic system for a knee extension protocol and settings recorded to ensure the same positioning for all four experimental tests. The subjects performed four maximal contractions at isokinetic velocities of 60, 180, and $300^{o} \cdot s^{-1}$ with a 3-min rest between sets.

When experimental testing began, subjects were requested to abstain from exercise 24 hours prior to each session and were tested with a minimum of 48 hours between testing sessions. Each testing session included three to four submaximal knee extension repetitions at 60, 120, 180, 240 and $300\ ^{o} \cdot s^{-1}$ for warm-up and four maximal contractions at those same velocities during experimental testing with rest periods of either 15, 60, 180, or 300 s between sets. The order of the rest periods was counterbalanced between testing sessions For example the first data collection session the subject might have had a 60 s rest period, the second session at 300 s rest period, the third session a 15 s rest period, and the fourth

session a 180 s rest period. Subjects were instructed to contract maximally during knee extension, while flexion velocity was set at 300 $^{o}\cdot s^{-1}$, which offered no resistance. Each velocity tested was considered a set and the average torque value for each set was used for analysis.
The data were analyzed using a 4 X 5 design with rest periods and velocities as the independent variables. The dependent variable was peak torque for each condition. A repeated measures ANOVA was used to analyze the data with the level of significance set at $p < .05$.

RESULTS: Analysis of the data revealed no significant effect of rest periods, velocities or interaction of rest periods and velocity on peak torque production. There were no significant pair-wise differences in either velocities or rest periods on peak torque production (Fig.1).

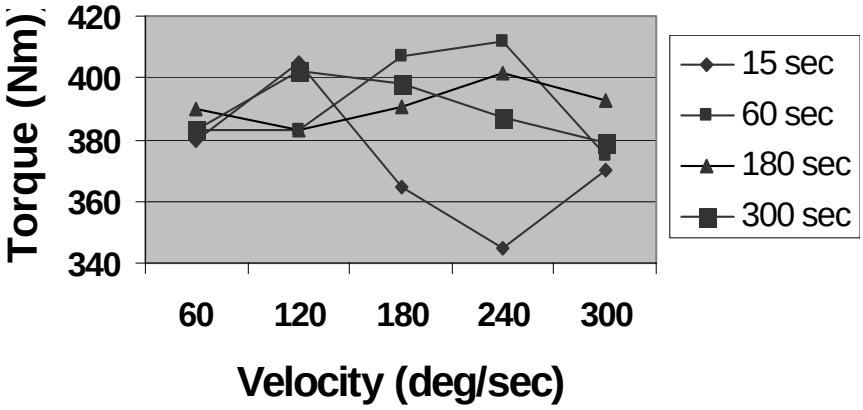

Figure 1. Torque-velocity curves from average peak torque isokinetic knee extension contractions with four different rest periods. ($p<.05$).

DISCUSSION: The results of this study were dissimilar to those reported by Parcell et al. (2002) who used a male population and found a significant effect of velocity on torque production regardless of rest period, a significant effect of rest, and a significant interaction of velocity and rest. Additionally, the results of this study differed from the findings of Bilcheck et al. (1993) who looked at rest periods in females who were performing isokinetic contractions and found that 150 s of rest was sufficient recovery for force production. In this study there were no significant differences in peak torque values regardless of velocity or rest periods. However in evaluating Figure 1, it can be seen that peak torque values seem more stable when using either 180 or 300 s of rest. Suggestions as to the reasons for the present results are numerous but could include the following: (1) females tend to need more practice bouts to achieve attenuation to the isokinetic apparatus; and (2) since most of the females tested were not athletes, they may have difficulty understanding maximal effort, therefore are more sporadic in their effort during testing. This statement is based on a basic observation of the raw data of the athletes and non-athletes who participated in this study.

CONCLUSION: Although statistically not significant, the 15 sec rest period did not allow subjects to recover sufficiently to produce true maximal torque for the subsequent testing sessions. In fact, the longer rest periods allowed for better recovery in order to produce a greater peak torque. Future research should include a greater number of subjects and more familiarization sessions. Additionally, it would be interesting to test female subjects who are athletes and non-athletes and compare those findings.

REFERENCES:

Bilcheck, H., Kraemer, W., Maresh, C., & Zito, M. (1993). The effects of isokinetic fatigue on recovery of maximal isokinetic concentric and eccentric strength in women. *J of Strength and Conditioning Research*, 7 (1), 43-50.

Coyle, E., Feiring, D., Rotkis, T., et al. (1981). Specificity of power improvements through slow and fast isokinetic training. *J Appl. Physiol*, 51, 1437-1442.

Greenleaf, J., Bernauer, E., Ertl, A, Bulbulian, R, & Bond, M. (1994). Isokinetic strength and endurance during 30-day 6 degree head-down bed rest with isotonic and isokinetic exercise training. *Aviat. Space Environ. Med*., 65, 45-50.

Parcell, A., Sawyer, R., Tricoli, V., & Chinevere, T. (2002). Minimum rest period for strength recovery during a common isokinetic testing protocol. *MSSE,* 34, 1018-1022.

Perrine, J, & Edgerton, R. (1978). Muscle force-velocity and power-velocity relationships under isokinetic loading. *MSSE*, 10, 159-166.

Warren, B. & Blazquez, I. (2004). Rest period for strength recovery during isokinetic testing. *Proceedings ISBS,* XXII, 143-144.

Warren, B. & Blazquez, I (2005). Strength recovery rest periods during isokinetic testing. *MSSE*, 37 (5) supplement, s260.