COMPARISON OF PEAK TORQUE VALUES WHEN USING REST PERIODS COUNTERBALANCED WITHIN AND BETWEEN VELOCITY SETS

Barbara L. Warren

University of Puget Sound, Tacoma, WA USA

The purpose of this study was to investigate the peak torque of two groups of females performing isokinetic tests in which one group of eleven females had rest periods counterbalanced within the velocity set while a group of twelve females had rest periods counterbalanced between velocity sets. The subjects were tested on 4 separate occasions with gravity correction incorporated in all tests. A 2 x 4 x 5 repeated measures ANOVA was used to analyze the data ($p < .05$). There were no significant differences between rest periods, velocities, or significant interactions. Although, there were significant differences between the groups, those differences seem to be consistent and not affected by rest periods.

KEY WORDS: isokinetic, peak torque, familiarization, counterbalanced

INTRODUCTION:

Isokinetic testing has been used repeatedly to assess strength and attempt to establish the optimal rest period between isokinetic sets (Bilecheck, Kraemer, Maresh, & Zito, 1993; Parcell, Sawyer, Tricoli, & Chinevere, 2002; Perrine & Edgerton, 1978; Pincivero, Gear, Moyna & Robertson, 1999; Touey, Sforzo, & McManis, 1994; Warren, 2006; and Warren & Blazquez, 2004). In spite of the abundance of literature on isokinetic testing, there has been no standardization in the number of velocities, repetitions, or the rest duration. Typically, the velocities are administered in ascending order with testing to include three to five different velocities (Parcell et al, 2002). Furthermore, the number of repetitions is often between two and four, although some studies have reported using as many as 20 repetitions (Parcell et al, 2002; Pincivero et al, 1999; Touey et al, 1994). However, the rest period during testing protocols has been inconsistent. A study by Parcell et al. (2002) in which the subjects were males, found that a 60 second rest period between sets of concentric isokinetic strength testing was sufficient for recovery in that population. A study by Bilcheck et al. (1993), which used a female population, reported findings that indicated a 150 second rest period between concentric/eccentric testing protocols assured adequate recovery for force production. A study by Pincivero et al (1999) found that their male population did exhibit significantly different peak torques in the group that had less rest between velocity sets. On the other hand, Warren & Blazquez (2004) and Warren (2006) reported no significant main effect of either velocity or rest period on peak torque when testing a female population. The purpose of this study was to compare the peak torque responses of two groups of females during isokinetic testing when counterbalancing the rest periods within velocity sets for one group and counterbalancing the rest periods between velocity sets for the second group.

METHOD:

Data Collection: Twenty-three female college students were recruited as subjects: group one (n=11) had counterbalanced rest periods within each velocity set, group two (n=12) had counterbalanced rest periods between velocity sets. The study was approved by the University Human Subjects Review Board.

The Cybex NORM was the isokinetic device used to collect data. It is a version of Cybex isokinetic machines which was manufactured and distributed by Cybex, Division of Lumex, Inc., in the mid 1990s. Isokinetic machines in general are used to assess muscular strength, power, and endurance in variety of settings such as occupational and physical therapy, hospital rehabilitation centers, and biomechanic and exercise physiology laboratories (Bemben, Group, & Massey, 1988). While there have been suggestions as to the reliability of isokinetic machines, a recent study by Pua, Koh, and Teo (2006) reported reliabilities of r=.79 when they conducted test retest on their female subjects. For the present study gravity correction was integrated in all tests and the Cybex NORM was calibrated prior to collection of any data.

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 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 a warm-up of three to four submaximal knee extension repetitions at 60, 120, 180, 240 and 300 $^{o}\cdot s^{-1}$ and four maximal contractions at those same velocities during experimental testing. For both groups the order of rest periods was randomized. The rest periods for group one were counterbalanced within each set such that the first data collection session might have included 180s, 15s, 60s, and 300s between sets of 60, 120, 180, 240 and 300 $^{o}\cdot s^{-1}$ velocities, the second session a rest of 15s, 300s, 180s, and 60s, the third session a rest of 60s, 180s, 300s, 15s, and the fourth session a rest of 300s, 60s, 15s, and 180s. For group two the rest periods of either 15, 60, 180, or 300s were counterbalanced between velocity sets of 60, 120, 180, 240 and 300 $^{o}\cdot s^{-1}$. For example the first data collection session the subject might have had a 60s rest period, the second session at 300s rest period, the third session a 15s rest period, and the fourth session a 180s 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 peak torque value for each set was used for comparison.

Data Analysis: A repeated measures ANOVA ($p < .05$) was used to analyze the 2 x 4 x 5 design with group, rest periods and velocities as the independent variables. The dependent variable was peak torque for each condition.

RESULTS:

Analysis of the data revealed no significant effect of rest periods, velocities or interaction of rest periods and velocity on peak torque production (Figures 1 and 2). However, there were significant group differences in peak torque (Figure 3).

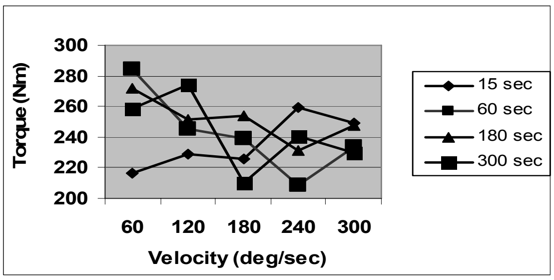

Figure 1: Peak torque-velocity curves of knee extension contractions with four rest periods counterbalanced *within* velocity sets. (p<.05)

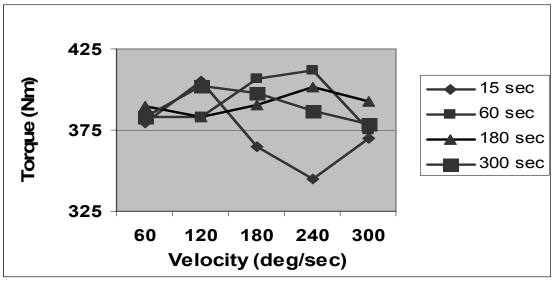

Figure 2: Peak torque-velocity curves of knee extension contractions with four rest periods counterbalanced *between* velocity sets. (p<.05)

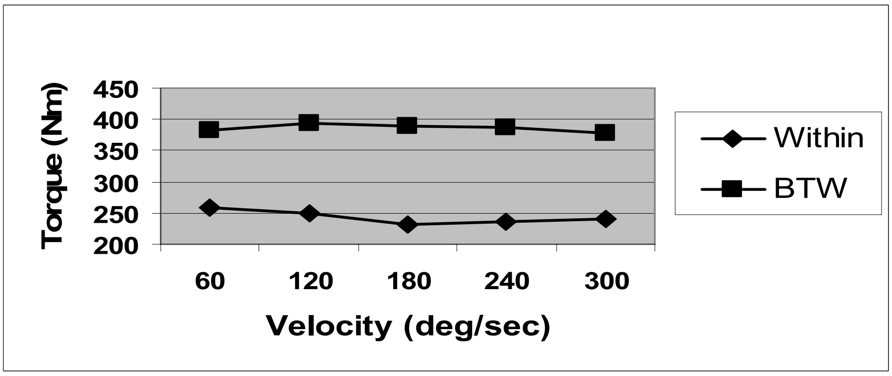

Figure 3: Differences in peak torque with rest counterbalanced between velocity sets versus within velocity sets. (p<.05)

DISCUSSION:

The results of this study indicated that the females in both groups appear to have difficulty with this isokinetic task. This could suggest that they need more familiarization sessions on this type of equipment. As noted in Figures 1 and 2, the peak torque values lacked a definite trend in either increasing or decreasing based on the velocity. In comparing the present findings to those of Parcell et al (2002) and Pincivero et al (1999), where male subjects exhibited a consistent pattern in peak torque values such that they were highest at the lower velocities and continued to decrease as the velocities increased, it appears that the women in this study had a difficult time producing those same patterns of peak torque. Additionally, it appears that rest periods had no effect on the ability to produce force regardless of the set isokinetic velocity which is unlike the results of either Bilchek et al. (1993) or Pincivero et al. (1999) who found that there were differences in peak torque based on varied rest periods. Finally, when evaluating Figure 3 in which the two groups' peak torques were compared, it appears that the groups were not similar to begin with and this would certainly be considered a limitation of this study. One thought is that when the first group was tested many of the participants were in physical education activity classes and may have participated in activities before testing sessions, rather than having a 24 hour rest prior to testing. However, it seems unlikely that the second group would be so considerably stronger than the first group unless there were some instrument problems. Moreover, it appears that both groups had the same problems in execution, so regardless of the differences in these two groups; women do not seem to produce the same peak torque patterns that males do. Therefore, the rest periods between velocity sets seemed to have no effect on the peak torque production in this female population.

Suggestions as to the reasons for the present results are numerous but could include the following: (1) these females did not understand maximal effort; (2) females may need more practice bouts to achieve familiarization to the isokinetic apparatus; or (3) subjects in the first testing group did not follow the protocol of abstinence from exercise within 24 hours of testing.

CONCLUSION:

Females have a more difficult time producing peak torque on an isokinetic system or due to lack of familiarization to the equipment; they don't understand the testing procedure. However, in a recent presentation Warren (2007), reported that female athletes who have been tested following the same protocols as used in this study do exhibit similar peak torque patterns as those reported by Parcell, et al (2002). This lends credence to the thought that athletes understand maximum effort more readily than do non-athletes. Future research should involve using more familiarization sessions, comparing athletes to non-athletes, using a greater number of subjects, and comparing the results of men and women.

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