Effect of Increasing Levels of Fatigue on Knee Proprioception

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Introduction

Ligament injuries of the knee, particularly the anterior cruciate ligament (ACL), represent a significant percentage of lower extremity injuries during athletic participation.[3] One possible factor associate with the high percentage of knee ligament injuries is a decrease in proprioception associated with fatigue. Previous research has found a decrease in proprioception following maximal fatigue of the knee musculature[2,4-6] and following low intensity work to maximum fatigue.[1] To date no investigation has examined if incremental increases in fatigue have an effect on proprioception. Therefore, the purpose of this study was to examine the effect of increasing levels of fatigue on active joint reposition sense (AJRS) of the knee.

Methods

Participants: Eighteen physically active subjects (10 females, 8 males, age = 20.11 ± 1.37 years, height = 1.77 ± 0.15 m, mass = 76.96 ± 17.18 kg) participated in this study. All subjects signed an informed consent form approved by the university's institutional review board.

Fatigue Protocol: Fatigue of the hamstring muscle groups of the subject's non-dominant leg was induced utilizing a Biodex System 3 Isokinetic Dynamometer (Biodex Medical Inc., Shirley, NY, U.S.A.). Subjects performed an isokinetic exercise protocol in a seated position through an angular range of motion of 0-90 degrees of knee flexion. Concentric isokinetic knee extension and flexion was performed at angular velocities of 90 degrees$\cdot$s^{-1} for 10 repetitions, 180 degrees$\cdot$s^{-1} for 15 repetitions, 240 degrees$\cdot$s^{-1} for 20 repetitions, and 300 degrees$\cdot$s^{-1} for 25 repetitions. A rest period of 30 seconds was provided between each of the four sets. Following a rest period of 40 seconds, subjects performed the flexion and extension movement at 180 degrees$\cdot$s^{-1} until the hamstring peak torque value fell to 10%, 30%, or 50% below the subject's peak isokinetic torque for three consecutive repetitions.

Active Joint Reposition Sense Protocol: Testing of AJRS was conducted using the Biodex isokinetic dynamometer. Subjects were blindfolded to eliminate visual cues related to joint position. The subject's leg was placed at a starting angle of 60 degrees of knee flexion for each trial. The subject's leg was then passively moved to one of the test angles (45°, 30°, or 15° of knee flexion) by the examiner. Subjects concentrated on the sensation of the presented angle for 3 seconds. The subject's leg was then returned to the starting position by the examiner. Following a 3 second rest period the subject attempted to actively reproduce the presented joint angle within 5 seconds. Once the subject felt the test leg was at the presented angle the subject depressed the hold/resume switch preventing the dynamometer from further movement. Each subject performed three trials at each angle and the average of the trials was recorded for statistical interpretation.

Test Procedures: Subjects were pre-tested for one of the AJRS angles after a 15-minute warm-up period. Following the pre-test, subjects performed knee extension and flexion isokinetic exercise as described above until the torque output was 10% (mild fatigue), 30% (moderate fatigue), or 50% (maximum fatigue) below the peak flexor torque. Subjects were then post-tested on the AJRS angle. Following a 20-minute rest period, the subject performed isokinetic exercise until torque output fell below one of the other percentages of peak torque being tested. Subjects were post-tested again on the same AJRS measure used in the pre-test. This procedure was repeated for a third exercise session at the remaining percentage of peak torque. Exercise sessions were separated by a minimum of 48 hours to allow complete recovery.

Statistical Analysis: Mean AAD values for AJRS were used for data analysis. Analysis of variance with repeated measures for exertion level at AJRS angles of 15°, 30°, and 45° was used to determine statistical significance. All tests of significance were carried out at an alpha level of $P < 0.05$. Pairwise comparisons using a Bonferroni adjustment was used to determine which findings, if any, were significant at the 0.05 level.

Results

A Statistically significant main effect for fatigue was not found for joint angles of 15 and 45 degrees (AJRS_15 $F_{3,17} = 0.402$, $p = 0.535$; AJRS_45 $F_{3,17} = 2.167$, $p = 0.159$). A statistically significant main effect for fatigue was found for AJRS at 30 degrees ($F_{3,17} = 5.367$, $p = 0.033$). Pairwise comparisons found a statistically significant difference at AJRS_30 between the pretest measure and following 10% fatigue ($p = 0.046$).

Discussion

The purpose of this study was to examine the influence of increasing levels of fatigue on AJRS at the knee. The main outcome of this study appears to be that fatigue does not have a significant effect on AJRS at the knee. Statistical significance was only found between the pre-test and following 10% fatigue of the hamstrings at 30° of knee flexion. In previous studies, Skinner et al.[6] found a decrease in the ability to reproduce joint angles after interval running sprints to fatigue. They suggested that this might be due to a loss of efficiency of muscle spindles. In contrast, Marks and Quinney[4] did not find a significant decrease in knee proprioception following 20 maximal isokinetic quadriceps contractions. The findings of the current study seem to agree with those of Marks and Quinney as primarily non-significant differences in AJRS were found in the current study.

References

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