Knee extensor and flexor moment of force and EMG following a reciprocal isokinetic fatigue test in pubertal boys

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Introduction

Understanding the effects of fatigue exercise on muscle performance may have implications for injury prevention and sport performance. A few studies (Kellis, 1999; Weir, 1998) reported consistent antagonist muscle activity during isokinetic knee extension tests. A very limited number of studies examined fatigue results during reciprocal knee extension-flexion tests (Lindstrom, 1994; Miller, 2000). Furthermore, most information on muscle activation patterns during dynamic muscular efforts of knee extensors and flexors refers to adults (Kellis, 1998). The effects of fatigue on muscle and EMG of the knee muscles in pubertal children are not clear.

The purpose of this study was to investigate the effects of an isokinetic reciprocal test of the knee extensors and flexors on maximum isokinetic eccentric and concentric moment of force, agonist and antagonist AEMG.

Methods

Seventeen pubertal boys (age = 13.7 ± 1.6 years; body mass = 52.85 ± 4.51 Kg; height 1.47 ± 0.01 m) participated in the study. The subjects performed 22 maximal isokinetic concentric efforts of the knee extensors at 60°·s^-1 (approximately 60 seconds). Standardized written and verbal instructions were given before the test. The subjects also performed, prior to and immediately after the fatigue test, 5 maximum concentric and eccentric efforts of the knee extensors and flexors at 60°/s. All tests were performed on a Cybex Norm (Lumex Corporation, Ronkohoma, NY) dynamometer.

A TEL100D (Biopac Systems, Inc., Goleta, CA) remote system was used for EMG data collection. Both Cybex and EMG systems were interfaced to a Biopac MP100 Data Acquisition unit (Biopac Systems, Inc., Goleta, CA). The EMG and dynamometer signals were fed through BNC connectors (Models CLB102 and CLB107, Biopac Systems, Inc., Goleta, CA) to a 12-bit analog-to-digital converter sampling at a rate of 1000 Hz per channel. The EMG activity of vastus medialis (VM), vastus lateralis (VL) and biceps femoris (BF) was recorded using surface electrodes. The motion ranged from 100° to 0° of knee flexion. All moment values were corrected for the effects of gravity. The average moment and average EMG (AEMG) were calculated for each repetition.

For the fatigue test, from the 22 repetitions recorded, the first and the last efforts were not used for the analysis, thus leading to a total of 20 repetitions. One-way analysis of variance (ANOVA) with repeated measures designs were used to examine the differences between the 20 moment of force values. Similar designs were used for the AEMG of the VM, VL and BF. Two-way analysis of variance designs were used to examine the differences in recorded values before and after the fatigue test, for eccentric and concentric conditions.
Results and Discussion

The results indicated that the moment recorded during the first, second and third repetition was significantly higher compared to the moments recorded after the 8th repetition. (p <0.05). The average concentric moment observed during the first repetition of the test decreased by 42% to 64.5% (knee extension) and 43% to 55% (knee flexion) compared with the last repetition. The VM and VL AEMG values at repetitions 8-20 were significantly higher compared to the respective values during the repetitions 1-3 (p <0.05). The antagonist AEMG of BF did not change significantly during the test.

Mean pre and post exercise KE and KF moment values were significantly different (p<0.05) (Figure 1). There were no significant changes in agonist AEMG and antagonist AEMG for all muscles tested (Figures 2,3).

Figure 1: Mean knee extensor (left graph) and flexor (right graph) moment before (PRE) and after (POST) exercise.

Figure 2: Mean agonist (left graph) and antagonist (right graph) AEMG before (PRE) and after (POST) exercise.
Figure 3: Mean biceps femoris agonist (left graph) and antagonist (right graph) AEMG before (PRE) and after (POST) exercise.

The decline of the moment of force during the fatigue test is in agreement with previous results similar to those recorded during reciprocal knee extension-flexion tests (Lindstrom, 1994) and isolated knee extension tests (Kellis, 1999; Weir, 1998). Similarly, the increase of the agonist AEMG and the maintenance of antagonist AEMG is in consistency with previous studies on isokinetic fatigue tests (Kellis, 1999; Weir, 1998).

The results also indicated a significant decrease of the KE and KF moments after the fatigue test. However, this was not accompanied by a significant change in either agonist or antagonist EMG values. This indicates that the activation and function of the KE and KF muscle groups during maximal isokinetic reciprocal endurance tests is such that it does not influence the balance of forces and EMG activation between the agonist and antagonist muscles in pubertal boys.

References
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