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The effects of motor learning on clinical isokinetic performance of postmenopausal women

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ABSTRACT

Objective: To analyze the effects of motor learning on knee extension–flexion isokinetic performance during clinical isokinetic evaluation of postmenopausal women.
Methods: One-hundred and twenty postmenopausal women (60.3 ± 3.2 years; BMI = 27.6 ± 4.7 kg/m^2) without knee pain or injury and that never underwent isokinetic testing, were submitted to two bilateral knee extension–flexion (concentric–concentric) isokinetic evaluation (5 repetitions) at 60°/s (Biodex^{TM} Multi-Joint System 3 dynamometer). The tests were first performed in the dominant leg, with a 1-min recovery between them, and after a standardized warm-up that included 3 submaximal isokinetic repetitions. The same procedure was repeated in the non-dominant leg. Peak torque (PTQ) was adjusted for body weight (PTQ/BW), total work (TW), coefficient of variation (CV) and agonist/antagonist (agon/antag) ratio was compared between tests.
Results: Subjects showed greater levels ($P < 0.001$) of PTQ, PTQ/BW and TW, and lower CV levels ($P < 0.01$) in test 2 of both legs. Agon/antag ratio did not change significantly between tests.
Conclusions: PTQ, PTQ/BW, TW and CV improved in the second knee extension flexion isokinetic testing of postmenopausal women. The results suggests that performing two tests, even with a short period of recovery between them, could be considered for reducing motor learning effects on clinical isokinetic evaluation of knee joint in postmenopausal women.

1. Introduction

The loss of muscle strength and power is a hallmark of aging process [1–3] that is associated with poor functional abilities among older adults [1]. Several tasks of daily living (i.e., walking, stair climbing, chair rising) has shown to be related to the ability to generate strength and power around the knee joint [4,5]. In women, the decline of estrogen after menopause contributes to imbalance and loss of muscle strength [6]. Di Monaco et al. [7] found an association between appendicular lean mass and fat mass in women after hip fracture. In this context, evaluation of muscular performance may have important implications for prescribing interventions to counteract the age-related decline in muscle strength and power and their consequences.

Isokinetic dynamometry is a gold-standard method commonly used to evaluate muscular performance, which provides many clinical variables [8–11]. For example, peak of torque, the point of maximal torque in a given range of motion and that could be adjusted for body weight, is the main variable used to represent muscular strength [8]. However, little is known about the reliable use of isokinetic tests in older populations. The few studies focused on investigating reliability of knee isokinetic test in older subjects have shown intraclass correlation coefficients (ICC) varying from 0.29 to 0.99 [12–15]. A possible explanation for this ICC large variation is the poor motor performance abilities of older subjects, which should be considered in isokinetic dynamometry protocols for older subjects [13,16]. Thus, it has been suggested that the use of a single-session isokinetic testing protocol, as commonly used for young individuals, may not be adequate for elderly [13,15].

A recent research demonstrated that a familiarization test-session performed in a separate day showed to improve isokinetic test reproducibility [13]. However, it is not useful to perform a familiarization test-session in a separate day in the clinical practice. To the best of our knowledge, there is no study analyzing the effects of a learning isokinetic test-session performed a short time before the main testing. Thus, the aim of the present study was to analyze the effects of a familiarization test-session, performed a

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Table 1
Isokinetic data.

Variable	PTQ (Nm)		PTQ/BW (Nm/kg)		TW (J)		Agon/antag ratio (%)	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
Knee extension								
Dominant	88.0 ± 20.2	95.2 ± 18.5[a]	138.4 ± 27.4	148.5 ± 31.7[a]	278.8 ± 69.4	307.9 ± 60.6[a]	49.1 ± 10.3	50.9 ± 9.8
Non-dominant	88.0 ± 18.2	94.0 ± 18.3[a]	139.1 ± 26.2	146.6 ± 28.8[a]	287.7 ± 61.2	308.8 ± 61.2[a]	49.8 ± 8.9	50.5 ± 9.1
Knee flexion								
Dominant	43.0 ± 12.3	48.1 ± 11.7[a]	67.7 ± 18.4	75.9 ± 18.3[a]	146.4 ± 49.3	167.7 ± 43.8[a]		
Non-dominant	43.5 ± 10.7	46.9 ± 11.4[a]	68.8 ± 16.3	74.2 ± 17.0[a]	152.1 ± 42.0	167.0 ± 45.1[a]		

Peak torque (PTQ), PTQ adjusted for body weight (PTQ/BW) and total work (TW).
[a] Different from Test 1 ($P < 0.001$).

short time before the main test, on knee extension–flexion isokinetic performance of postmenopausal women.

2. Methods

2.1. Sample size

For the sample size calculation, based on a pilot study with 15 post menopausal women considering the variable Peak torque adjusted for body weight. To determine the sample size to compare two means, considered a power of the test of 80% with a significance of 5%, standard deviation of 0.5 and the possibility of detecting a difference of 0.128. To meet these conditions, were needed at least 120 subjects.

2.2. Experimental design and subjects

The study was performed at the Institute of Orthopedics and Traumatology, Hospital das Clinicas, School of Medicine, University of São Paulo, with approval granted by the Ethics Committee of the University of São Paulo (CaPPesq no. 320/09). This is a cross-sectional observational study, without intervention, of 120 elderly women (60.3 ± 3.2 years; BMI = 27.6 ± 4.7 kg/m^2). The subjects had no problems related to vestibular system or any proprioceptive, auditory or neurological conditions, were not prescribed any antipsychotic medication, had no restrictions on vigorous physical activity, had not been submitted to any surgery, and did not present injury to their legs for the last six months. They would be eliminated if they presented alterations in blood pressure or if they were not able to perform the test. After the patients had been given explanations about the study and had signed the consent form, they were assessed in accordance with the evaluation protocol.

2.3. Isokinetic evaluation

The subjects were evaluated at Laboratory of Movement Studies, in the morning period, by the same professionals, in an environment with air conditioning. They were told not to participate in any physical activity 24 h before the test, they should wear confortable, light and flexible clothes and have a low-calorie diet 2 h before the test.

Knee extension–flexion (concentric–concentric) isokinetic evaluation was performed in a Biodex Multi-Joint System 3 dynamometer (Biodex Medical™, Shirley, NY, USA). The tests were first performed in the dominant leg. After a standardized warm-up, subjects were positioned in the equipment according to the manufacturer's manual (seated with arms hanging against the body, hands holding the lateral handles, and strap stabilization of trunk, hip and tested thigh). Gravitational correction was performed at 40° of knee flexion. Isokinetic testing at 60°/s concentric/concentric was used for data collection. Subjects performed three submaximal repetitions prior to data collection. Five maximal repetitions were performed twice (Test 1 and Test 2), and a 60 s rest period was used between Test 1 and 2, for all subjects. After that the same procedure was done for the non-dominant leg. Consistent verbal commands were given during the tests. All tests were conducted by the same examiner. Peak torque (PTQ), PTQ adjusted for body weight (PTQ/BW), total work (TW), coefficient of variation (CV) and agonist/antagonist ratio (agon/antag) were the variables assessed.

2.4. Statistical analyses

Kolmogorov–Smirnov test was applied to ensure a Gaussian distribution of the data. Parametric and nonparametric data are reported as means ± standard deviation and median (min – max), respectively. Two-way ANOVA with repeated measures (leg dominance *vs.* test) was used to indicate significant difference in the parametric variables, and Bonferroni post hoc analysis was used to identify significant differences indicated by two-way ANOVA. Differences between legs and tests in the nonparametric variables were analyzed by the Mann–Whitney Rank Sum and Wilcoxon Signed Rank tests, respectively. The significance level was set at $P < 0.05$. The statistical program SigmaStat™ 3.5 for Windows (Systat Software Inc., San Jose, CA, USA) was used to perform statistical analysis.

3. Results

Means and standard deviations for concentric knee extension and flexion PTQ, PTQ/BW and TW, and agon/antag ratio are presented in Table 1. Both legs displayed greater PTQ, PTQ/BW and TW levels in Test 2 than in Test 1 ($P < 0.001$). Both legs also displayed lower CV levels ($P < 0.001$) in Test 2 (Table 2). Agon/antag ratio did not change significantly between tests, and no significant difference between dominant and non-dominant legs were observed in any variable in both tests.

4. Discussion

Isokinetic dynamometry evaluates the isokinetic muscular contraction with constant velocity limb movements of a joint. This equipment allows a more direct view of the studied joint, allowing

Table 2
Coefficient of variation (CV).

Variable	CV (%)	
	Test 1	Test 2
Knee extension		
Dominant	7.55 (0.5–31.0)	5.65 (1.2–17.8)[a]
Non-dominant	6.90 (0.4–35.3)	5.60 (1.1–20.3)[a]
Knee flexion		
Dominant	6.15 (0.9–37.5)	5.65 (0.2–22.3)[a]
Non-dominant	5.50 (1.2–66.7)	5.15 (0.7–19.6)[a]

[a] Different from Test 1 ($P < 0.001$).