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Short Communication

Neuromuscular efficiency of the multifidus muscle in pilates practitioners and non-practitioners

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ABSTRACT

Background: Pilates exercises help stabilize the vertebral segments by recruiting the abdominal and spinal muscles. Pilates training may increase joint stability and improve neuromuscular efficiency (NME).
Objective: This study aimed to evaluate NME of the multifidus (MU) muscle through electromyography (EMG) analysis and torque test, applied to practitioners and non-practitioners of Pilates.
Methods: Participants included thirty women: Pilates practitioners (n = 15) and non-practitioners (n = 15). They were tested for trunk extension. Their right and left MU muscles were submitted to EMG to estimate NME. Results concerning torque, EMG, and NME from all participants were compared.
Results: Statistical analysis concerning isometric torque peak ($p = 0.0275$) and NME ($p = 0.0062$) showed significant difference (Student t test; $p < 0.05$) between practitioners and control. No significant difference ($p = 0.3387$) in EMG was observed.
Conclusion: Our results suggest Pilates exercises is effective in training spinal muscles to improve NME in women.

1. Introduction

The multifidus (MU) muscle is mono-articular and bilaterally inserted in the vertebrae. Despite its limitation towards torque, it stabilizes the spine, keeping it in a neutral position and producing eccentric contractions that aid in controlling the spinal movements.[1,2]

Pilates exercises, developed by Joseph H. Pilates, increase torque[3] and decrease lumbar pain in adult women.[4] Such exercises are known to stabilize the vertebral segments by recruiting the deep abdominal and spinal muscles[5,6] and intensify the activity of the stabilizing and mobilizing trunk muscles.[1,2]

Pilates training may increase joint stability[7] and improve neuromuscular efficiency (NME). Biomechanically, NME is calculated by the relationship between neural stimulus and the force-generating capacity of a muscle and is interpreted as an individual's ability to generate momentum in relation to their muscle activity level measured by electromyography (EMG).[8]

NME involves neuromuscular adaptation, varying according to gender, pathology, and training.[9,10] It is calculated as follows: the torque peak value divided by the EMG signal value during maximal isometric contraction.[9–15] The higher the torque value and the lower the EMG value, the better the NME.[9]

The aim of this study was to evaluate NME of the multifidus muscle through EMG analysis and torque test, applied to practitioners and non-practitioners (control) of Pilates.

2. Methods

2.1. Participants

This study was approved by the Ethics Committee of Piracicaba Dental School, University of Campinas (UNICAMP), Brazil (protocol: 5418/2017). All procedures were conducted at a laboratory of biomechanics (LABIOMEC), department of physical education, São Paulo State University (UNESP), Rio Claro, São Paulo, Brazil. Participants included thirty women: fifteen Pilates practitioners (years of practice: 4.3 ± 1.4; age: 27.6 ± 3.7 years; body mass: 58.7 ± 2.5 kg; height: 1.66 ± 0.03 cm); and fifteen non-practitioners (age: 21.4 ± 1.6 years; body mass: 62.5 ± 3.85 kg; height: 1.65 ± 0.08 cm).

As inclusion criteria, the Pilates practitioners had to have at least six months of experience — minimally twice a week[16] — with no history of orthopedic and neurologic disorders, cardiovascular diseases, and

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Table 1
Isometric torque peak (N m^{-1}), EMG activity expressed in root mean square (RMS) microvolts and Neuromuscular Efficiency (NME).

		Control	Practitioners
Isometric Peak of Torque (N m^{-1})	mean ± SD	185.7 ± 16.4	240.1 ± 28.8
	P	0.0275*	
	D	2.3	
EMG RMS (microvolts)	mean ± SD	145.4 ± 45.1	165.1 ± 55.9
	P	0.3387	
	D	0.35	
Neuromuscular Efficiency (NME)	mean ± SD	0.67 ± 0.27	1.83 ± 0.89
	P	0.0062*	
	D	1.76	

Asterisk (*) represents $p < 0.05$.

surgery of the spine or abdomen.[17] Those practicing physical activities other than Pilates exercises were excluded. The non-practitioners (control) had to be sedentary or free of regular physical activities for at least one year prior to the study.

2.2. Data collection and procedures

The electrode placement site was shaved and cleansed with 70% alcohol.[18] To measure the EMG activity of the MU, electrodes were placed bilaterally, 3 cm away from the midpoint of the line ranging from L1 to L5 vertebrae (spinous process).[19–21] After placement of the electrodes, to avoid spinal damages, all participants did a warm-up by undergoing the submaximal isometric trunk extension test.[7] EMG values were expressed as root mean square (RMS).

The isometric torque peak exerted during the extension test was measured with an isokinetic dynamometer (System 4 Pro, Biodex®, Shirley, New York, USA). A chair was attached to the dynamometer to test the spinal movements. The test involved three 5 s repetitions — with an interval of 30 s. The highest torque value was used to calculate NME. The angle of the waist and thigh was set at 90°.[4]

Before the test, starting 10 min after the warm-up,[22] the participants were instructed not to move their head and to keep their arms crossed over the chest. During the test, the participants had to statically extend their trunk to the maximum.

A direct transmission system (Noraxon®, Scottsdale, AZ, USA), with the myoMUSCLE software (TELEmyo DTS, 16 channels, 1500 Hz), was used to capture the EMG biological signals using 1-cm-in-diameter Ag/AgCl electrodes (Miotec®, Porto Alegre, Rio Grande do Sul, Brazil) set 2 cm apart. The software was set at a total gain of 2000 times (20 times for the sensor and 100 times for the equipment) with an analog-digital converter resolution of 16 bits.

EMG signals were filtered (4th-order Butterworth) at frequencies ranging from 20 to 500 Hz and analyzed using the Matlab software (version 2009, Natick, MA, United States). To calculate the NME value for MU, the extension torque value was divided by the sum of the EMG values obtained from both sides.[9–15]

2.3. Statistical analysis

Data were submitted to the Matlab software (version 2009, Natick, MA, United States) for all statistical tests. Data normality was assessed by D'Agostino test. The *t*-test was used to compare EMG, NME, and isometric torque peak between practitioners and control. The Cohen test was used to verify the power size of the comparisons. Data were expressed as mean values and standard deviation (SD). The statistical significance level was set as $p < 0.05$.

3. Results

Data concerning isometric torque peak, EMG expressed by maximum root mean square (RMS), and NME are shown in Table 1. Statistical analysis concerning the isometric torque peak ($p = 0.0275$) and NME ($p = 0.0062$) showed significant difference (Student t test; $p < 0.05$) between practitioners and control. No significant difference ($p = 0.3387$) in RMS was observed between the groups.

4. Conclusion

Although no significant difference in EMG was observed, our isometric analysis showed significantly higher values concerning isometric torque peak and NME for Pilates practitioners, suggesting Pilates exercise is effective in training spinal muscles to improve NME in women. Further studies involving both genders, anthropometric factors, and different muscles are needed to confirm our findings.

Competing interests

None.

This research was approved by the ethics committee of Piracicaba Dental School; protocol: 5418/2017.

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