Journal of Exercise Physiologyonline

April 2015
Volume 18 Number 2

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

JEPonline

Study on the Electromyographic Activation of Lower Limbs during the Menstrual Cycle Phases

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ABSTRACT

Costa PL, Santos FP, Rocha, CCD, da Silva SF. Study on the Electromyographic Activation of Lower Limbs during the Menstrual Cycle Phases. **JEPonline** 2015;18(2):52-57. The purpose of this study was to investigate the influence of the Menstrual Cycle on the activation of thigh and hip muscles using surface electromyography (SEMG). Fifteen college female students (22.2 ± 2.5 yrs old; 60.4 ± 7.5 kg; 160.8 ± 4.3 cm; 27.1 ± 2.85% fat) with regular menstrual cycle who were not taking oral contraceptives participated in this study. Samples were collected according to the menstrual cycle phases, which were divided into: (a) Follicular Phase (collected between the 3rd and 5th day); (b) Ovulatory Phase (collected between the 9th and 15th day); and (c) Luteal Phase (collected between 21st and 28th day). The test consisted of assessing muscle activation in 3 sets of 5 sec in maximum isometry using a Smith machine squat exercise. Statistical analysis indicated that the SEMG activation of the muscles did not show significant differences during the three menstrual cycle phases. Thus, the present study suggests that hormonal fluctuations arising from the menstrual cycle do not alter the EMG activation of the lower extremity muscles during the Smith machine squat exercise.

Keywords: Electromyography, Resistance Training, Menstrual Cycle

INTRODUCTION

Although the normal ovulatory menstrual cycle has an average of 28 d, it may vary between 21 to 35 d (5). Constant hormonal fluctuations (8), particularly of estrogen and progesterone, occur in the female body within the reproductive period (i.e., puberty to menopause). Such fluctuations divide the menstrual cycle into different phases according to the ovarian stage (2). Coaches are interested in knowing the role of the menstrual cycle, if any, on women's physical performance (2), with particular reference to the production of muscle strength (10,12), muscle and joint flexibility (11), anaerobic power (16), sprinting performance (17), fatigue and risk of lesions (14), sports performance (13), and on specific cardiovascular variables (15). At the present time, according to Janse de Jonge and colleagues (9), the influence of the menstrual cycle phase on muscle strength is unclear.

The introduction of resistance training to the daily lives of individuals demands manipulating and controlling variables such as intensity, volume, and recovery interval to ensure a progressive stimulus to the body (1). This is especially the case for women because the resistance training variables must be manipulated within the context of their menstrual cycle. Hence, in addition to overseeing the progressive aspects of a resistant training program, it is also necessary to measure changes, adaptations, and physiological responses (such as during muscle activation when training with surface electromyography, SEMG) (3,7).

The present study acknowledges that different methodologies (including SEMG) have led to conflicting results (4,6,14) when studying the influence of the menstrual cycle on physical performance. The purpose of the present study is to investigate a possible link between the menstrual cycle phases and muscle activations using SEMG.

METHODS

Subjects

The subjects in this study consisted of 15 female college students who were physically active for at least 2 months. All subjects had regular a menstrual cycle (28 to 31 d), and they were not taking oral and/or injectable contraceptives. Each subject was informed and signed a consent form approved by the Research Ethics Committee of the Federal University of Lavras (Protocol CAAE 01565412.0.0000.5148) in accordance with the Brazilian regulations for research on human subjects, which are in accordance with the norms proposed by the Treaty of Helsinki. Table 1 shows the physical characteristics of the subjects. The subjects' body fat percentages were determined by using the tetrapolar bioimpedance technique (Quantum BIA-II® - RJL Systems, Inc. Clinton: MI-USA).

Table 1. The Subjects' Descriptive Data.

N	Age (yrs)	Body Mass (kg)	Height (cm)	Body Fat (%)
15	22.2 ± 2.5	60.4 ± 7.5	160.8 ± 4.3	27.1 ± 2.85

Procedures

The subjects went to the laboratory on three separate occasions. Each laboratory visit met the subjects' menstrual cycle phases which are divided as: (a) Follicular Phase (collected between the 3rd and 5th d); (b) Ovulatory Phase (collected between the 9th and 15th d); and (c) Luteal Phase (collected between the 21st and 28th d), as shown in Table 2. The subjects were told not to train and/or perform any physical exercise on the day before the tests.

Table 2. Divisions of the Subjects' Menstrual Cycle Phases and Days of Tests.

Phases	Follicular	Ovulatory	Luteal
Days	1 7	17	28
Days of Tests	3rd - 5th	9th - 15th	21st - 28th

Data collection started at the 15 repetition warm-up during the Smith machine squat exercise. Subsequently, the EMG activation was analyzed by Miotool 400 electromyography (Miotec Biomedical Equipment Ltd, POA, Brazil®) attaching electrodes on the spots suggested by Merletti, over the following muscles: (a) rectus femoris; (b) vastus medialis; (c) vastus lateralis; (d) semimembranosus; (e) biceps femoris; and (f) gluteus maximus in 1 maximum voluntary isometric contraction (1MVIC) in 3 sets of 5 sec with an interval of 1 min between each set in the same exercise.

The signals were filtered in a 5th order band-pass type Butterworth filter with cutoff frequency of 20-500Hz to eliminate possible signal peaks in order to analyze the electromyographic activations. Thus, the activations' mean and maximum values were determined by RMS (Root Mean Square). The Miograph 2.0 Alpha 9 Build 5 software was used to analyze and process the data.

Statistical Analyses

The Shapiro Wilk test was used to verify data distribution. Since data distribution was normal, descriptive statistics with the determination of mean and standard deviation was used. The two-way ANOVA test was used to analyze the electromyographic activations among the MC phases, and the Scheffe's post-hoc analysis with a probability of $P \leq 0.05$ was used for statistical significance. The tests were performed using the SPSS® statistical software version 20.0.

RESULTS

The mean electromyographic activation of the rectus femoris, vastus medialis, vastus lateralis, semimembranosus, biceps femoris, and gluteus maximus muscles during the three menstrual cycle phases did not show statistically significant differences. Table 3 shows the mean values for each muscle during the phases.

Table 3. EMG Activation of Muscles during the MC Phases.

Muscles	Follicular Phase	Ovulatory Phase	Luteal Phase
Rectus Femoris	210.3 ± 98.6 µV	211.6 ± 90.9 µV	251.5 ± 72.1 µV
Vastus Medialis	247.3 ± 102.4 µV	244.4 ± 88.6 µV	232.5 ± 100.0 µV
Vastus Lateralis	241.1 ± 80.5 µV	236.3 ± 79.0 µV	227.3 ± 93.2 µV
Semimembranosus	179.7 ± 85.7 µV	185.2 ± 75.6 µV	198.5 ± 94.8 µV
Biceps Femoris	188.9 ± 82.5 µV	151.0 ± 55.7 µV	171.7 ± 75.3 µV
Gluteus Maximus	133.8 ± 54.9 µV	130.1 ± 46.2 µV	107.3 ± 31.6 µV

DISCUSSION

No significant differences were found in the activation of rectus femoris, vastus medialis, vastus lateralis, semimembranosus, biceps femoris, and gluteus maximus muscles among the menstrual cycle phases (follicular, ovulatory, and luteal). The findings suggest that the hormonal fluctuations resulting from the menstrual cycle are not able to change muscle activation. These results corroborate some studies found in the literature, such as that by Drake and colleagues (6) who evaluated the activation of the rectus femoris muscle in isometric activity during the three menstrual cycle phases and found no influences on torque, EMG, or mechanomyography in women who were not taking oral contraceptives.

Similarly, Montgomery and Shultz (12) also assessed the production of isometric strength in knee extensors and flexors during the early follicular and post-ovulatory phases in active women who did not take oral contraceptives. They found no changes resulting from the menstrual cycle phases. They highlighted that estrogen concentrations (hormone related to increased performance) are lower in active women, such as those used in the current study, than in sedentary women, which is a fact that may explain the lack of strength changes. However, they did not rule out the possibility of hormonal effects on other aspects of neuromuscular control, on functional and mechanical movement, and even on the risk of lesions.

On the other hand, the results found in the current study did not corroborate the studies by Soares et al. (15) who reported increased fatigue. Their analysis was done by EMG in the late follicular and luteal phases, which represents periods of decreased hormone levels. The authors state that the increased fatigue is associated with the risk of lesions, thus suggesting that these periods require attention in training prescription. The study by Simão et al. (14) evaluated the muscle strength of upper and lower limbs. The authors highlighted the influence of high estrogen concentrations over the ovulatory phase and stated that such concentrations are responsible for the improved performance at this phase. They also state that the opposite happens in the premenstrual phase when the progesterone rate reaches its peak (i.e., a hormone responsible for decrease in performance).

Although adopting hormone serum measurements is necessary to accurately set the menstrual cycle phases, the current research found results consistent with earlier findings influence of the menstrual cycle on physical performance. These earlier studies evaluated performance that used different procedures, including emphasizing the production of muscle strength (9,10), flexibility (11), sports performance (13), and cardiovascular variables such as heart rate at rest (15). These authors did not find significant differences during the menstrual cycle phases.

Study Limitations

The non-use of hormone serum measurements to set the menstrual cycle phases is one of the limitations faced in the current study, since such a method is the most effective in avoiding discrepancy in the results. The fact that only one cycle was used for applying the test should be taken into consideration since the cycles are different from each other. Furthermore, it is worth considering the size of the population in the present study. The individual variability can lead to failures in the results of smaller samples. Therefore, further studies should be conducted in an attempt to minimize such limitations.

CONCLUSIONS

The present study indicates that the hormonal fluctuations arising from the three menstrual cycle phases do not alter the EMG activation of the lower extremity muscles during the Smith machine squat exercise in physically active women who are taking oral contraceptives.

ACKNOWLEDGMENT

Financial Support - FAPEMIG- Fundação de Amparo a Pesquisa de Minas Gerais – Scientific Initiation Scholarship.

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