Influence of menstrual cycle phases in functional performance of healthy and young women

ABSTRACT | Female sex hormones as estrogen and progesterone are related to specific receptors located in brain regions and can influence on motor control. We analyzed the functional performance in several menstrual cycle phases in healthy and young women. The study is characterized as cross-sectional, it included 13 healthy women with regular menstrual cycle and who were not using oral contraceptive. To assess the functional performance, we used Side Hop Test (SHT), Figure of Eight Hop Test (F8T) and Modified Star Excursion Balance Test (mSEBT) applied in three phases of the menstrual cycle (menstrual, ovulation and luteal). This study established significant difference to functional tests SHT and F8T between menstrual cycle phases, with worse results for the menstrual phase. The mSEBT established no difference. We concluded that the functional performance in tests SHT and F8T was significantly worse on menstrual phase, when compared to the ovulation and luteal phases. These results can be considered for assessment and prescription of physical therapeutic conducts for women in menstrual phase, since their functional performance can be impaired.

Keywords | Menstrual Cycle; Motor Activity; Postural Balance; Proprioception; Physical Therapy.

RESUMO | Os hormônios sexuais femininos como estrógeno e progesterona têm relação com receptores específicos localizados em regiões cerebrais e podem influenciar o controle motor. Analisou-se o desempenho funcional nas diversas fases do ciclo menstrual em mulheres jovens e saudáveis. O estudo caracteriza-se como transversal e incluiu 13 mulheres saudáveis com ciclo menstrual regular e que não faziam uso de contraceptivo oral. Para a avaliação do desempenho funcional foram utilizados os testes Side Hop Test (SHT), Figure of Eight Hop Test (F8T) e Modified Star Excursion Balance Test (mSEBT) aplicados em três fases do ciclo menstrual (menstrual, ovulatória e lútea). Este estudo estabeleceu diferença significativa para os testes funcionais SHT e F8T entre as fases do ciclo menstrual, com piores resultados para a fase menstrual. O mSEBT não estabeleceu qualquer diferença. Concluiu-se que o desempenho funcional nos testes SHT e F8T foi significativamente pior na fase menstrual, quando comparado à ovulatória e lútea. Estes resultados podem ser considerados para avaliação e prescrição de condutas fisioterapêuticas para mulheres na fase menstrual, já que seu desempenho funcional pode estar comprometido.

Descritores | Ciclo Menstrual; Atividade Motora; Equilíbrio Postural; Propriocepção; Fisioterapia.

RESUMEN | Las hormonas sexuales femeninas como estrógeno y progesterona tienen relación con receptores específicos localizados en regiones cerebrales y pueden influenciar el control motor. Se analizó el rendimiento funcional en las diversas fases del ciclo menstrual en mujeres jóvenes y sanas. El estudio se caracterizó como transversal e incluyó a 13 mujeres sanas con ciclo menstrual regular y que no utilizaban anticonceptivo.
oral. Para la evaluación del rendimiento funcional se utilizaron las pruebas Side Hop Test (SHT), Figure of Eight Hop Test (FBT) y Modified Star Excursion Balance Test (mSEBT) aplicados en tres fases del ciclo menstrual (menstrual, ovulatoria y lútea). Este estudio estableció una diferencia significativa para las pruebas funcionales SHT y FBT entre las fases del ciclo menstrual, con peores resultados para la fase menstrual. El mSEBT no estableció ninguna diferencia.

Se concluyó que el desempeño funcional en las pruebas SHT y FBT ha sido significativamente peor en la fase menstrual comparándose a la ovulatoria y lútea. Estos resultados pueden ser considerados para evaluación y prescripción de conductas fisioterapéuticas para mujeres en la fase menstrual, ya que su rendimiento funcional puede estar comprometido.

Palabras clave | Ciclo Menstrual; Actividad Motora; Equilibrio Postural; Propiocepción; Fisioterapia.

INTRODUCTION

In the course of the menstrual cycle (MC), the levels of sex hormones, estrogen and progesterone, show a dynamic regulation. We know that during the beginning of MC there are low levels of estrogen and progesterone; and that in the late follicular phase, in the next ovulation, there is a peak in estrogen levels, followed by another peak in estrogen and progesterone in the middle of luteal phase.\(^\textit{1,2}\)

Over the last years, variations of these female sex hormones have been the subject of many studies. In this sense, the literature reports that the female physiology seems to be affected by cyclical hormonal changes arising from the menstrual cycle; in which estrogen and progesterone, in addition to the regulation of reproductive function, show actions on the central nervous system (CNS). Studies show that these sex hormones may influence on neurotransmitters such as GABA, serotonin, and glutamate, acting on membrane receptors,\(^\textit{1-3}\) being able to influence different brain regions with alteration of sensory perception and motor responses.\(^\textit{4-9}\)

In addition, we suggest that estrogen and progesterone influence on physiological functions such as aerobic and anaerobic capacity, changes in soft tissues, muscular strength, proprioception, neuromuscular coordination and postural control.\(^\textit{1,2,9-13}\) For example, besides acting on the CNS, the estrogen also acts on the cellular level by decreasing the production of collagen in tendons by lessening the fibroblastic activity.\(^\textit{2}\) Dedrick et al.\(^\textit{8}\) explain that estrogen receptors are present in skeletal muscle, which can change the motor control and myofascial force transmission patterns. Constantini et al.\(^\textit{5}\) report that progesterone shows central thermogenic effect, which explains the increase in body temperature (from 0.3°C to 0.5°C) during the luteal phase (LP); and still during this phase, the hormone can improve the minute ventilation and response to maximum exercise. As for Fridén et al.\(^\textit{6}\), they point out that the increase in progesterone during luteal phase, metabolized in neurosteroids, such as allopregnanolone and pregnanolone, can explain balance and motor skill disorders in this phase due to the action over GABA-A receptors.

Functional performance tests are characterized as dynamic measures used to assess the general function of lower extremities.\(^\textit{14,15,18}\) Clinically, functional tests are often used in advanced stages of rehabilitation and as criterion for the return to sport.\(^\textit{19,20}\) Moreover, the importance in using functional tests results in the fact that the function of the lower extremities include many variables such as pain, edema, crepitation, neuromuscular and postural control, muscle strength, agility and joint stability; important aspects to perform a precise movement.\(^\textit{15-19}\) Examples of functional performance tests: Figure of Eight Hop Test (FBT), Side Hop Test (SHT) e Modified Star Excursion Balance Test (mSEBT).

Considering the possible influence of the menstrual cycle phases on motor skill and the existence of few studies that relate functional performance to the menstrual cycle, the aim of our study was to analyze the influence of functional performance of young and healthy women using functional tests in different MC phases. Our hypothesis is that the functional performance can be affected by the menstrual cycle phases in which the serum concentrations of estrogen and progesterone would be low.

METHODOLOGY

The research was conducted according to Resolution 466/12 of the National Health Council,
and approved by the Ethics Committee of the Universidade Estadual de Londrina (OPINION: 492.604/2013). All volunteers signed the Informed Consent Form. This study is characterized as cross-sectional, with sample recruited from the local university.

The convenience sample was established with 13 volunteers. It was considered as inclusion criteria: age between 18 and 35 years old; regular menstrual cycle (between 21-35 days) in the last two months; and no use of any contraceptive agents. It was established as exclusion criteria: injury in the lower extremities (LE) in the last six months; presence of blisters or skin lesions on the feet; background of balance disorders, associated comorbidities and obesity. Thus, 20 volunteers were initially recruited. However, seven were excluded: three for injury on LE and four gave up during the study due to unavailability for reassessments, which resulted in a sample of thirteen (13) volunteers.

Procedures

Initially, all volunteers answered the characterization form of the sample with data on name, age, body mass, height, body mass index (BMI), dominance, in addition to background information on the menstrual cycle for the last two months (cycle length in days, pain symptoms), practice of physical activity (type and frequency), previous diseases, medication in use, including the use of contraceptive agents.

One of the problems when dealing with functional tests is the possible learning effect. Thus, all volunteers conducted a familiarization session, where they could practice the functional tests F8T, SHT and mSEBT until they felt secure and able to carry them out, to adaptation and reduction of learning effect. Functional tests were conducted with the dominant (DLE) and non dominant (NDLE) lower extremity, at random. In the F8T, it was established the distance of five meters between two cones, one volunteer in single-limb stance should perform the route of “eight” format, in the shortest time possible. The SHT demanded that volunteers performed ten lateral jumps, as soon as possible, at a distance of 30 cm demarcated by two lines on the ground. The time was timed and considered in seconds, for these two tests. The mSEBT was conducted in three directions: anterior (A), posterolateral (PL) and posteromedial (PM). In this test, volunteers should stand with the calcaneus on the intersection of the three tapes, with hands on waist, not allowed to move (raise or drag) the support foot from the ground, remove their hands from the waist or lose the balance in any form. As a result, it was considered the range of the lower extremity, in centimeters. For mSEBT normalization, the length of the LE was evaluated. The measurement was conducted from the anterior superior iliac spine to the end of the medial malleolus. The mSEBT score was calculated based on Filipa et al, where mSEBT=[(A+PM+PL)/(LEx3)x100].

The determination of the menstrual cycle phases was considered based on the study of Eiling et al. The length of each volunteers’ MC was estimated using the average of the length of previous MC. Thus, the beginning of the next cycle could be estimated. Based on this information, the Ovulation Phase (OP) was determined by counting 14 regressive days from the estimated MC. The Luteal Phase (LP) was estimated by counting 7 days from the OP. And the Menstrual Phase (MP) was established on the day of menstruation. Thus, each volunteer was assessed in three phases, always starting from the menstrual phase, followed by follicular and luteal phases; and each woman had the specific day for the tests.

After familiarization session, the functional tests in MP were applied (between the 1st and 3rd days of the cycle, where low hormone levels are expected), with randomization of LE and for the sequence of performance of functional tests. The tests were conducted in three repetitions, with 30 seconds of interval between each repetition and between each test, in which the volunteer remained seated, at rest. The volunteers received verbal and visual instructions for each test.

After data collection on MP, the collections in OP were scheduled (14th day of the cycle, characterized by elevation in estrogen levels and low progesterone levels); and in LP (with progesterone and estrogen elevation, phase defined seven days after OP). The randomization of LE and the sequence of functional tests were performed again at each stage of analysis (Figure 1). In spite of the volunteers have showed menstrual regularity over the past two months, they were contacted again after the last collection to inform when the menstrual phase of the next MC had began, to confirm the regularity of the menstrual cycle assessed.
Functional tests have been used to assess components of sports performance (strength, power and agility), to determine the return to sports, evaluate the effectiveness of interventions for neuromuscular training and predict LE injuries. Functional tests of single-limb hops, as SHT and F8T, evaluate motor functionality of individuals because they require postural and neuromuscular control, since they have lateral displacements components (SHT) and movements
that lead to rotational stress (F8T)\textsuperscript{14,15}, in addition to require quick changes of direction and cover physical components such as coordination and speed\textsuperscript{17,18}.

Our results showed performance differences in functional tests F8T and SHT in the three menstrual cycle phases. We consider that the estrogen can influence the neuromuscular performance, since the receptors of this hormone (alpha and beta) were identified in skeletal muscle, and that it also acts on the CNS, including upper motor centers\textsuperscript{2-4,6}.

The proprioceptive information derive from peripheral receptors in the joints, muscles and ligaments (such as Golgi tendon organ, free nerve endings, Pacinian corpuscle and Ruffini endings), and are conducted via dorsolateral tract, with important role in the control of muscle stiffness and joint dynamic stability\textsuperscript{10}. Moreover, the somatosensory system is a complex sensory component of the neuromuscular system that covers the perception and execution of musculoskeletal control and movement\textsuperscript{11}.

Aydog et al.\textsuperscript{27} investigated the MC effects on proprioception of 19 healthy women through the Join Position Sense Test (JPST), compared the menstrual phase (2\textsuperscript{nd}-4\textsuperscript{th} days), follicular phase (9\textsuperscript{th}-11\textsuperscript{th}) and luteal phase (16\textsuperscript{th}-18\textsuperscript{th} days), and established that proprioception had significant reduction during the menstrual phase, as a consequence of change in distal latency or on excitability of mechanoreceptors. However, in this study the measurement of serum of hormone levels was not used by blood or urine samples. Notwithstanding, the authors report that in spite of the participants being initially included by having regular MC in the last three months, the ones with irregularities in the MC to be assessed, such as delay of 2 days or anticipation of three days in menstruation were excluded.

As for Friden et. al\textsuperscript{2} they evaluated the neuromuscular control of athlete women, through the Square test, on MP (between 3\textsuperscript{rd}-5\textsuperscript{th} days), OP (9\textsuperscript{th}-11\textsuperscript{th} days) and premenstrual phase (7 days after OP), and they observed no correlation between the number of jumps and hormone levels; however, the volunteers at OP had better performance when compared with premenstrual and menstrual phases.

Our results corroborated with data from literature\textsuperscript{2,25,31} that low concentrations of estrogen can impair neuromuscular control during menstrual phase which implies worse performance in functional tests during this phase.

In addition to the estrogen analysis, studies have shown that progesterone can modulate the function of glutamate and GABA receptors in the cerebellum, which would impairment of postural balance\textsuperscript{1-3,6}. Fridén et al.\textsuperscript{1} investigated the postural control through the platform of strength in women with and without premenstrual syndrome (PMS) in the: early follicular (3\textsuperscript{rd}-5\textsuperscript{th} days), ovulation (identification by LH) and luteal phases (7 days after ovulation). These authors concluded that there were decreases in postural control during the luteal phase in women with PMS, and observed a greater displacement of the oscillation center of pressure in anteroposterior direction. These findings are explained because LP is associated with high levels of progesterone, higher than in other phases; resulting in increase in its conversion rate in neurosteroids, with consequent change in balance and motor function\textsuperscript{6}.

In this study, mSEBT was used to assess the dynamic postural balance, a low cost and high applicability test, widely used in research and clinical practice, because it provides objective measurements to identify the deficits and improvements in postural control and dynamic balance. The mSEBT has been proved to be responsive to training programs in both affected patients and healthy participants\textsuperscript{23}. However, in this study, the mSEBT showed no significant difference in dynamic balance between MC phases.

This study had limitations that should be considered. Our sample had sedentary volunteers, practitioners of gym and athlete, with different levels of physical conditions, previous training and possible muscle memory to perform exercises. Another limitation refers to accuracy of the beginning and end of each MC phase. In this study, blood samples and measurements of serum of sex hormones were not used, which are considered another standard to these analyses, and would increase the strength of the results. We suggest that future studies may use more precise measurements of hormone levels in different MC phases for a better understanding and guidance of the findings. Finally, our study conducted no prior training for functional tests used, which may have influenced on their performance. However, as a way to minimize this effect and, as suggested by Bolgla, Keskuda\textsuperscript{19} and Robinson, Gribble\textsuperscript{21}, a prior practice and familiarization with the tests were provided to the participants, as well as randomization to the order of beginning of tests on each assessment.
Nonetheless, we believe that the worst functional performance results in menstrual phase can be considered for developments of prevention programs, training and neuromuscular rehabilitation of young and healthy women, with adaptations of exercises and training. Moreover, the functional tests used have low cost and are easy and simple to apply, which allows their reproduction on any location, either for interventions or assessment in physical therapy.

CONCLUSION

The results of this study indicate that the functional performance of healthy and young women was influenced by the different phases of the menstrual cycle, with worse results in the menstrual phase for the tests SHT and FH8, and the consequent impairment of coordination and speed to achieve them. However, the dynamic balance, assessed through the mSEBT, pointed no changes regarding the menstrual cycle phases.

REFERENCES


