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Estimation of Muscle Strength in Women During the Different Phases of Menstrual Cycle

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Abstarct
In women, the menstrual cycle is associated with fluctuations in female sex hormones through thenormal 28-30 days cycle.There is a strong link between these fluctuating levels of hormones and their influence on muscle performance throughout the menstrual cycle.In present study, the muscle strength was estimated and compared during the 4 different phases of menstrual cycle in females of 18-40 years for 3 consecutive months. Material and Methods: Maximum Voluntary Contraction (MVC) indicator of muscle strength was estimated using Surface-Electromyography (S-EMG).It was measured and compared during F1(menses),F2(pre-ovulatory),L1(post-ovulatory) and L2(pre-menstrual) for 3 consecutive months.Results:The results showed statistically significant reduction in MVC during F1 and L2 phases when compared to F2 and L1 phases, during which the MVC was significantly increased. The level of significance was fixed at $p < 0.05$.Conclusion:The present study showed decline in muscle strength during F1 and L2 phases and relative better muscle strength in F2 and L1 phases. During the menses and pre-menstrual phase the estrogen levels are low when compared to high levels of estrogen with its two peaks occurring in pre and post ovulatory phases of menstrual cycle. Estrogen has a beneficial effect on muscle performance. Females are more prone to muscular injuries during those particular phases of menstrual cycle where there is a fall in estrogen levels. Hence, it should be a long term objective of clinicians, female athlete coaches and researchers to consider the factors that make women more susceptible to injuries during specific periods of menstrual cycle and consider changes in exercise and working modules to prevent these injuries and bring out the best performance.
Key words: Menstrual cycle, Maximum voluntary contraction, Surface-EMG, Estrogen.

INTRODUCTION

In females, menstrual cycle is a major biological process during their reproductive years. Menstrual cycle is associated with fluctuations in female sex hormones (estrogen, progesterone) through the normal 28-30 days cycle. Hormonal fluctuations during the course of a women's menstrual cycle, apart from reproductive system also affects the physiological and psychological component of the body, which has an influence on her day to day performance [1-4]

In women, there exists a strong link between these fluctuating hormones and muscle strength [5]. The female sex steroid hormone, estrogen has a beneficial effect on muscle performance [6-7]. Consequently, the hormonal variations occurring throughout the menstrual cycle may lead to either improved or declined muscle performance [8].

With the increased participation of females in sports, several studies have been conducted on female athletes, showing higher incidence of sports related injuries among female athletes compared to their male counterparts[9-10]. The hormonal variations during the menstrual cycle have been suggested as one of the factors associated with sports injuries in female athletes [3],[9].

Many studies have been carried out to assess the effect of fluctuating hormones on muscle performance during menstrual cycle in female athletes, with very few studies done on non-athletic eumennorheic women. The present study has been carried out on females in the age group of 18-40 years, having a normal 28 to 30 days regular menstrual cycle, to evaluate the effect of hormonal variations on muscle strength during the different phases of menstrual cycle for 3 consecutive months.

Muscle strength is an important fitness component in sporting and in everyday life. In sports such as football, rugby and baseball, the stronger the athlete, the better the performance is likely to be. Being strong one can perform daily activities in an easier way [11]

Maximum Isometric Voluntary Contraction Testing (MIVC) is the most preferred method to measure muscle strength. MVC is used as an indicator of muscle performance in various neuromuscular diseases. It assumes the recruitment of all available motor units during contraction [12-15].

Materials and methods

This is a descriptive study, in which Maximum voluntary contraction (MVC) is measured in females in the age group of 18-40 years. **50** apparently healthy female volunteers were selected for the study.

Ethical clearance was obtained from the Institutional Ethical Committee for Human research.

Inclusion criteria:

Apparently healthy females in the age group of 18-40yrs having a normal regular menstrual cycle of about 28 to 30 days every month

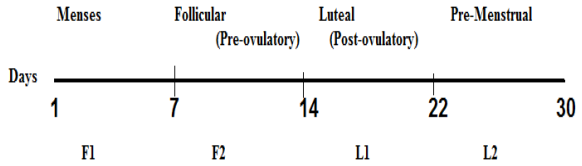
Exclusion criteria:

Females with irregular menstrual cycle, females with muscular and neurological disorders and females on long term use of drugs influencing menstrual cycle.

The subjects were informed about the procedure and written consent was taken.

The height and weight of the subject was measured using stadiometer and weighing machine with an error of 0.1 cms and 0.1 kgs respectively. After 5 minutes of rest, subject's resting pulse rate and blood pressure (sphygmomanometer) was measured. Detailed menstrual history was taken, the various phases were divided into four different phases and the study parameters were assessed during the following days of menstrual cycle of 28-30 days.F1 phase (MVC assessed on 2nd day),F2 phase (MVC assessed on 12th day),L1 phase

(MVCassessed 20th day),L2 phase (MVC assessed 26th day).



During all the four phases of menstrual cycle, the MVCwas recorded using SURAFCE EMG machine -RMS ALERON 201 EMG EP MARK-II, ISO 9001:2000 COMPANY. Surface EMG is a non-invasive procedure where in surface electrodes are attached on muscle. Study was conducted in a well lighted, quiet room and the temperature was maintained constant throughout the experiment. Whole procedure was carried out in sitting posture. BICEPS muscle was selected for the study. The subject was asked to perform isometric maximum voluntary contraction in the muscle, each contraction was held for approximately 5 seconds. Three such contractions, separated by two minutes of rest between the maneuver were measured, and the highest of the three values obtained by EMG signal analysis was taken as the MVC expressed in %.

LH-KIT (luteinizing hormone-ovulation predictor) was used to confirm for occurrence of ovulation. Early morning urine sample was collected on 12th, 13th day of menstrual cycle for the test; a pink line on the strip was confirmed as positive result for occurrence of ovulation in that particular menstrual cycle.(LH ovulation test device,ACU-check.RAPID Diagnostic Test.Mfdby:Acon Biotech Co., Ltd. Lic no. 20020050).

Statistics:

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max). Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale within each group.p value of $p \leq 0.01$ was considered to be significant.Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, were used for the analysis of the data

RESULTS

The present study has been carried out on50 females in the age group of 18-40 years. On analyzing the data, the average age in years of the study group was 27.70±6.39, average weight in kgs was 52.94±9.50, and average height in cms was 155.44±6.62 and average BMI kg/m^2 was 22.27±3.32. as shown in Table 1

Table 1: Age,Weight, Height and BMI distribution of the subjects.

Variables	Mean ± SD
Age in years	27.70±6.39
Weight (kg)	52.94±9.50
Height (cm)	155.44±6.62
BMI kg/m^2	22.27±3.32

.MVC % during the four different phases for 3 consecutive months is shown in Table 2.

Table.2: MVC % during the different phases for 3 consecutive months

Phase	Month 1 (MVC %)	Month 2 (MVC %)	Month 3 (MVC %)
F1	76.90±6.13	75.30±5.38	76.90±5.33
F2	87.30±5.99	86.20±5.67	87.80±5.54
L1	81.70±6.35	84.60±4.93	84.50±4.76
L2	75.80±5.47	76.00±5.05	76.80±4.49

When comparisons were made between the 4 different phases for 3 months.F1 and F2, F1 and L1 , F1 and L2, F2 and L1, F2 and L2, L1 and L2, total of six comparisons. MVC% was significantly higher during F2 (pre-ovulatory) phase when compared to F1 (menses) phase as showed in

Table 3. MVC% was significantly higher during L1 (post-ovulatory) phase when compared to F1 (menses) phase as showed in Table 4. No significant change was seen in MVC% during F1 (menses) phase and L2 (pre-menstrual) phase as shown in Table 5. MVC% was significantly was higher in F2 (pre-ovulatory) phase when compared to L1 (post-ovulatory) phase as shown in Table 6. MVC% was significantly was higher in F2 (pre-ovulatory) phase when compared to L2 (pre-menstrual) phase as shown in Table 7. MVC% was significantly was higher in L1 (post-ovulatory) phase when compared to L2 (pre-menstrual) phase as shown in Table 8.

Table.3: Comparison of MVC% in , F1 and F2 phase

Study variable	Phase	Month 1	Month 2	Month 3
MVC (%)	F1	76.9±6.1	75.3±5.3	76.9±5.3
	F2	87.3±5.9	86.2±5.6	87.8±5.5
	p	<0.001**	<0.001**	<0.001**

Table.4 Comparison of MVC% in F1 and L1 phase

Study variable	Phase	Month 1	Month 2	Month 3
MVC (%)	F1	76.9±6.1	75.0±5.3	76.9±5.3
	L1	81.7±6.3	84.6±4.9	84.5±4.7
	p value	<0.001**	<0.001**	<0.001**

Table.5 Comparison of MVC%, in F1 and L2 phases

Study variable	Phase	Month 1	Month 2	Month 3
MVC (%)	F1	76.0±6.1	75.3±5.3	76.9±5.3
	L2	75.8±5.4	76.0±5.0	76.8±4.49
	p value	0.207	0.367	0.904

** Significant (p value: p≤0.01)

Table.6 Comparison of MVC%, in F2 and L1 phases

Study variable	Phase	Month 1	Month 2	Month 3
MVC (%)	F2	87.3±5.9	86.2±5.67	87.8±5.5
	L1	81.7±6.3	84.6±4.9	84.5±4.7
	p	<0.001**	<0.001**	<0.001**

Table.7 Comparison of MVC%, in F2 and L2 phases

Study variable	Phase	Month 1	Month 2	Month 3
MVC (%)	F2	87.3±5.9	86.2±5.6	87.8±5.5
	L2	75.8±5.4	76.0±5.0	76.8±4.4
	p	<0.001**	<0.001**	<0.001**

Table.8Comparison of MVC% in L1 and L2 phases

Study variable	Phase	Month 1	Month 2	Month 3
MVC (%)	L1	81.7±6.3	84.6±4.9	84.5±4.7
	L2	75.8±5.4	76.0±5.0	76.8±4.4
	p	<0.001**	<0.001**	<0.001**

DISCUSSION

In the present study, the results showed, MVC (%) was significantly high during F2 phase (pre-ovulatory) and L1 phase (post-ovulatory) phase when compared to F1 (menses) and L2 phases (pre-menstrual) for all the three consecutive months. Female sex hormones (estrogen, progesterone) fluctuate radically throughout the menstrual cycle [1-4],[16]. There is a strong link betweenthese fluctuating levels of hormones and its influence on muscle strength[5]. The above obtained results suggest that, the rise in estrogen levels with its two peaks occurring during the pre-ovulatory and post-ovulatory phases of menstrual cycle has a muscle strengthening effect. The muscle strength was declined with decrease in estrogen levels during menses and pre-menstrual phases.

Study conducted by Philips et al, on women in the age group of 17-39 years, by measuring the MVF (maximum voluntary force) on adductor pollicis muscle throughout the menstrual cycle. It was found that the MVF was significantly high during the follicular phase before the ovulation occurred, suggesting that estrogen exerts a positive isotropic effect on skeletal muscle [17].

Another study by Sawar et al , in which the maximum voluntary isometric force in quadriceps muscle and handgrip strength was measured during the menstrual cycle. They showed significantly higher values of these variables during the mid-cycle (day 12-14 of the menstrual cycle) compared to the other phases, stating that rise in estrogen before ovulation has a positive relation with muscle strength [8].

Study conducted by Dawson, on females undergoing the physical training sessions, demonstrated decrease in muscle strength around the time of menstruation [16]. In another study low levels of estrogen were reported to decrease muscle strength in postmenopausal women and they suggested that this decrease may be prevented by hormone replacement therapy, henceforth confirming the estrogen strengthening action on muscle tissue [18]. Various studies done on female athletes, to assess their sports performance during the various phases of

menstrual cycle, reported that, the better performance was observed during the pre-ovulatory and post-ovulatory phases. Their performance was low during the menstruation and pre-menstrual phases when there is decrease in the estrogen levels in the body [2], [19-20]. Hence proving, estrogen has a beneficial effect on muscle, and fluctuations in levels of estrogen play a role in dynamic muscle control.

CONCLUSION

This study proves that hormones have an influence on the functioning of muscle activity throughout the menstrual cycle. Hence, we conclude that estrogen has a positive effect on muscle tissue, with its two peaks occurring in its concentration levels during the pre-ovulatory and post-ovulatory phase of menstrual cycle and decline in muscle strength with drop in its concentration levels during the menses and pre-menstrual phase. This study will help to create awareness among the sports coaches for women, clinicians and researchers, about the physiological changes occurring with variations in sex hormones and its influence on muscle efficiency during the menstrual cycle so as to achieve best performance in them and reduce the risk of injuries.

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