Physiological changes in relaxation rate and Fatiguability during the human menstrual cycle:

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ABSTRACT:

The aim of the review is to find the Physiological changes in muscle strength, relaxation rate and Fatiguability during the human menstrual cycle. From the review it’s revealed that oestrogen and progesterone concentrations were low during menstruation, but the oestrogen was elevated and progesterone low was in late follicular phase and oestrogen and progesterone were both elevated in luteal phase. Even it’s revealed that the women not taking the oral contraceptives was significant increase of about 11% in quadriceps and handgrip strength at mid-cycle compared with both the follicular and luteal phases. No changes were found in parameters in women taking the oral contraceptives. The changes in muscle function at mid-cycle may be due to the increase in oestrogen that occurs prior to ovulation.

KEY WORDS:
Physiology, women, menstrual cycle, muscle strength, quadriceps and handgrip.

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Introduction:

The female reproductive system consists of a pair of ovaries, the uterus with two uterine tubes and vagina along with associated structures situated mostly in the true pelvis. The uterus is a pear shaped organ which is hollow, thick walled and muscular situated in the true pelvis between the urinary bladder in the front and the rectum behind. The cavity of the non-pregnant uterus in slit like in sagittal section. On the luminal aspect of the uterine wall is the endometrium, the innermost layer of the uterus. The vaginal epithelium is stratified squamous and non-keratinized. After puberty it gets thicker and contains glycogen. It has no gland. The surface of the ovary is covered with a single layer of germinal epithelium. After increase in size during puberty, the thick cortex which shows a number of follicles at various stages of development and a vascular medulla can be made out. Functioning of the reproductive system in the adult female is characterized by its cyclic activity. The endocrine organs involved are the hypothalamus, anterior pituitary and ovary. Gonadotrophins released from the anterior pituitary are regulated by the hypothalamus and influence anatomical changes and hormone secretion from the ovary. The most obvious evidence of cyclical activity is the menstrual period. The average duration of the cyclic 28 days, but there is wide variation, the range being 21-35 days. The cyclic event is divided into three phases.

(a) Menstrual phase
(b) Proliferative/follicular phase
(c) Secretory/luteal phase

Changes in hormone level and other changes:

Menstrual phase:

If the hormone Levels fall below a threshold level, the superficial two-third of the endometrium necroses and its shed. This is what happens during the menstrual phase. The shed endometrium along with some mucus and blood from the spiral arteries appears as the menstrual blood.
Proliferative/follicular phase:

The oestrogen and progesterone level are the lowest just before the onset of menses. The low oestrogen level stimulates releases of Gonadotrophin releasing hormone (GnRH) from hypothalamus which in turn increase Follicle Stimulating hormone (FSH) secreted by the anterior pituitary the release FSH acts on the ovary to induce one primordial follicle to develop into a graafian. This follicle develops cavity containing a fluid, liquor folliculi. Covering the ovum and forming the innermost lining of the follicle wall are granulose cells. Outer layers of the follicular wall are made up of the theca interna and theca externa. The theca interna of the developing Graafian follicle secretes oestrogen. This rising oestrogen level brings about changes in many organs of the body. About the 12-13th day of the period, the negative feed back action of oestrogen on luthinisng hormone (LH) is converted to a positive feed back action and initiates a burst of LH secretion called the LH surge. During the LH peak, FSH also peaks and reaches its maximum concentration in the cycle. Fnhibin also shows a small rise during this time, so the FSH peak is not due to a negative feedback action with inhibin but because of strong stimulation of gonadotropes by GnRH.

Secretory/luteal phase:

After release of the ovum, the follicle is filled with blood, the theca interna and remaining granulose cells proliferate into the cavity forming lutein cells and the structure is now known as the corpus luteum. It is also an important source of hormones. LH stimulates formation of corpus luteum which in turn secretes progesterone and oestrogen. A high FSH level at the time if ovulation stimulates granulose cells to produce inhibin and oestrogen exert a negative feedback effect on FSH, LH and GnRH and bring about a decrease in the concentration of ovarian hormones(1).

Effects of oestrogen:

Naturally occurring oestrogens are 17-β oestrodial, oestriol. All are C18 isomers. Thes hormones are secreted by the theca interna and granulose cells of Graanfian Follicle, corpus luteum and placenta.
Actions:

In the female reproductive system it causes

- Growth of ovarian follicle
- Increase in the motility of uterine tubes
- Increase in the uterine blood flow
- Amount of uterine muscle and its activity is increased
- Endometrium is converted to proliferative type with oestrogen alone and subsequently by oestrogen and progesterone into the secretory type
- Cervical mucus is thin, watery, can be drawn into thread and shown “ferning” when dried
- In a vaginal smear, appearance of epithelial cells with pyknotic nuclei and infiltration with leucocytes\(^1\).

Effects of progesterone:

Progesterone is C\(_{21}\) stroid secreted in significant amounts by the corpus luteum and placenta. It is an important intermediate. In steroid hormone synthesis and is also released into circulation from the testes and adrenal cortex.

Action:

In the female reproductive system

- It decreases the excitability of the uterine smooth muscle as well as its sensitivity to oxytocin
- In the endometrium it decreases the number of oestrogen receptors and converts the proliferative endometrium into a secretory one.
- The cervical mucus becomes scanty and loses its ability to be drawn into a thread along with loss of ‘ferning’ on drying
- Vaginal smear has large, flattened epithelial cells with their edges folded\(^{(1)}\).

**Discussion:**

Muscle function was measured during three phases of the menstrual cycle with significantly different concentration of circulating female reproductive hormones. During women’s reproductive years the hormone levels in women fluctuate due to the menstrual cycle. The fluctuations in female steroid hormones affects the autonomic nervous system and metabolic functions\(^{(2)}\). Hence certain physiological parameters and athletic performance could change along with the menstrual cycle phases\(^{(3)}\). During the menstrual cycle it was tested that skeletal muscle strength, relaxation rate and fatiguability of the quadriceps found no changes in these parameters for women taking oral contraceptives \(^{(4)}\). It is reported that during the luteal phase a higher adductor pollicis strength is not clear as during the follicular phase \(^{(5)}\). It was reported that the highest quadriceps strength during the mid-luteal phase and found a positive relationship between strength and progesterone concentration \(^{(6)}\). Several other studies have found no changes in skeletal muscle strength over the menstrual cycle \(^{(7)}\). Even well-motivated subjects may not always reach full neural activation of their muscles. The extent of neural activation can be evaluated by applying a superimposed electrical stimulus to the muscle during the performance of a maximal voluntary contraction(MVC). When comparing strength over a period of time, such as in menstrual cycle research, it is especially important to ensure maximal neural activation during each test \(^{(8)}\). It was also suggested that oestrogen has a strengthening effect on skeletal muscle. They reported an increase in maximal voluntary adductor pollicis strength during the follicular phase and a drop in strength at ovulation \(^{(5)}\). Recent work has suggested that oestrogen can influence the force generating capacity of skeleton muscle. Initial evidence for such an effect came from cross-sectional studies on pre and post-menopausal women. Muscle becomes weaker following the menopause because of both a reduction in muscle size and a decline in force generating capacity (i.e. force per unit cross-sectional area (CSA)). This has been demonstrated for the adductor pollicis (AP) and quadriceps muscles \(^{(9)}\). To investigate this further they measured the isometric strength of the AP during the menstrual cycle and found that there was a peak in strength around the time of ovulation \(^{(10)}\). Together these results pointed to a fairly rapid effect of oestrogen on skeletal muscle force production. In previous studies of muscular performance during the menstrual cycle have concentrated mainly on changes in endurance.
performance, rather than strength and have usually compared the early follicular and luteal phases (11). Those studies which have looked at explosive power events have mainly measured performance levels, which are influenced by many variables other than muscle strength or power output. One study investigated the changes in handgrip strength and standing long jump during the menstrual, ovulatory and luteal phases of the cycle (12). The only significant difference found was a stronger handgrip strength during the menstrual phase, which the authors attributed to the lower oestrogen and progesterone levels (13). Thus reported that the changes in the muscle function at mid-cycle may be due to the increase in oestrogen that occurs prior to ovulation.

Fatiguability:

An adapted Burke protocol was used to measure the fatiguability of the quadriceps. The muscle was stimulated at 40 Hz for 0.25 s every second for 3 min. The fatigue index (FI) was measured as the percentage force lost the 3 min. The c.v. of the FI was <10% when care was taken to stimulate the same percentage of the muscle on each testing occasion (14).

strength: Handgrip

Grip strength was measured using a Jamar hydraulic hand dynamometer. The handle was adjusted according to hand size and the manoeuvre was carried out with the arm by the side of the body and the elbow extended (15). A number of hormonal changes take place around ovulation, including a rise in oestrogen, testosterone, luteinizing hormone and follicle stimulating hormone. Levels of oestrogen and progesterone are higher in the luteal phase of the cycle compared with the follicular phase. However, the highest oestrogen levels are seen just prior to ovulation. He suggested that it is this surge in oestrogen which may be responsible for the increase in muscle strength found at this time (13).

REFERENCES:


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