Effect of Sex Hormones on Central Nervous System during Menstruation and Pregnancy

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Abstract: It investigates that the significant effects of sex hormones on the Central Nervous System (CNS) during pregnancy and menstruation, emphasizing their profound impact on mood, cognition, and emotional regulation. Estrogen, progesterone, and oxytocin are central to reproductive functions and also play a critical role in shaping CNS responses. During pregnancy, the hormonal landscape undergoes considerable changes, which foster neuroplasticity and prepare the brain for maternal responsibilities. This period is marked by enhanced synaptic connectivity but can also lead to mood swings, anxiety, and fatigue due to elevated estrogen and progesterone levels.

Menstruation introduces cyclical hormonal fluctuations that affect neurotransmitter systems, leading to a spectrum of emotional and cognitive responses. These variations are linked to premenstrual syndrome (PMS) and premenstrual dysphoric disorder (PMDD), conditions that significantly influence women's mental health. The document further delves into postpartum depression, a condition exacerbated by hormonal shifts following childbirth.

Clinical insights and research findings underscore the complex interplay between hormonal changes and CNS functioning. Understanding these dynamics is crucial for developing effective strategies to support women's mental and emotional well-being through the different stages of their reproductive lives.

Key words: PMS (premenstrual syndrome), PMDD (premenstrual dysphoric disorder) Mother hood, Cognitive, Hormonal shifts

INTRODUCTION

Pregnancy and menstruation bring about profound hormonal changes that significantly impact the Central Nervous System (CNS), leading to notable alterations in mood, cognition, and emotional regulation.

1.1 Menstruation:

Menstruation is marked by cyclical hormonal fluctuations, particularly in estrogen and progesterone, which influence neurotransmitter systems and affect mood, cognitive function, and emotional stability. These cyclical changes can lead to variations in sleep patterns, pain perception, and stress responses. Many women experience Premenstrual Syndrome (PMS) or Premenstrual Dysphoric Disorder [1] (PMDD), conditions associated with significant mood swings, irritability, and emotional instability. The impact of these hormonal variations underscores the importance of understanding their role in mental and emotional health throughout the menstrual cycle.

1.1.1 PMS: This condition includes symptoms like mood swings, irritability, and cognitive issues such as concentration difficulties [2]. It's related to the hormonal fluctuations in the luteal phase of the menstrual cycle.

1.1.2 PMDD: A more severe form of PMS, PMDD includes intense mood swings, anxiety, and depressive symptoms [2]. The hormonal changes affecting neurotransmitter systems like serotonin and dopamine are thought to exacerbate these symptoms.

1.2 Overview of Hormonal Influence on the CNS:

The Central Nervous System (CNS) [3], which includes the brain and spinal cord, is highly sensitive to fluctuations in hormone levels, particularly during critical periods such as pregnancy and menstruation. Hormones like estrogen, progesterone, and oxytocin not only regulate reproductive functions but also profoundly affect cognitive performance, mood stability, emotional well-being, and neuroplasticity.

1.3 Hormones and Their Neurological Impact:

Estrogen:

Known for its role in reproductive health, estrogen is also a key player in modulating neurotransmitter systems, neurogenesis, and synaptic plasticity. It influences cognitive functions such as memory and learning, while its fluctuations can significantly alter mood [4].

- During pregnancy, estrogen levels rise sharply, aiding in fetal development, but it also contributes to changes in mood and emotional processing in the mother.

Progesterone:

- Progesterone has neuroprotective effects, modulating GABA receptors and enhancing inhibitory neurotransmission. It plays a crucial role in reducing anxiety, promoting relaxation, and stabilizing mood during pregnancy. However, variations in its levels can lead to mood swings and other emotional changes.

Oxytocin:

- This hormone, often referred to as the "love hormone," is integral to social bonding and emotional regulation. It plays a significant role during childbirth and breastfeeding, promoting maternal-infant bonding and reducing stress.

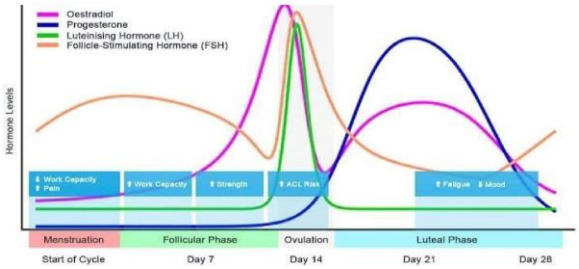

Figure 1: phases of the menstrual cycle

2. PHASES OF THE MENSTRUAL CYCLE:

2.1 Follicular Phase:

Hormonal Activity: Estrogen levels rise, leading to increased serotonin activity.

• Estrogen: Levels of estrogen (primarily estradiol) begin to rise steadily as the ovarian follicles develop in response to the secretion of follicle-stimulating hormone (FSH) by the anterior pituitary gland.

- FSH: FSH is responsible for stimulating the growth of ovarian follicles, which in turn produce estrogen.
- Luteinizing Hormone (LH): Low at the start of the follicular phase, but slowly rises toward the end of this phase in preparation for ovulation

Mechanism of action of hormones during follicular phase:

The mechanism of action (MOA) of FSH, estrogen, and LH during the follicular phase involves a coordinated hormonal interaction to stimulate ovarian follicle development and prepare for ovulation. FSH is released from the anterior pituitary, stimulating follicle development and estrogen production. Estrogen, produced by developing follicles, stimulates endometrial thickening and triggers a surge in LH, leading to ovulation. Estrogen inhibits FSH production, ensuring only the dominant follicle continues maturing. LH levels initially remain low but gradually increase as estrogen levels rise. The LH surge triggers ovulation, causing mature follicle rupture and releasing the egg.

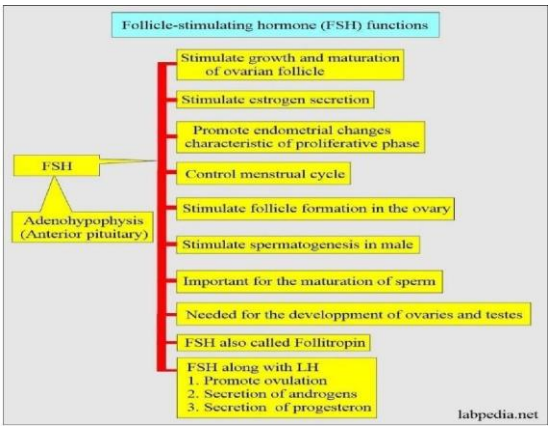

Figure 2: Mechanism of Action of FSH

Neurological Impact: Enhanced mood stability, cognitive function, and emotional regulation.

2.2 Ovulation:

Hormonal Activity: Estrogen peaks, leading to a surge in luteinizing hormone (LH).

• Estrogen Peak: Estrogen levels reach their highest point just before ovulation, signalling the brain to release a surge of luteinizing hormone (LH) [5].

- LH Surge: This surge triggers the release of the mature egg from the dominant follicle in the ovary.
- Progesterone: After the egg is released, progesterone levels start to rise as the ruptured follicle forms the corpus luteum, which secretes progesterone

Mechanism of Action of hormones during ovulation:

During the ovulation phase of the menstrual cycle, the hormones luteinizing hormone (LH), estrogen (estradiol), and progesterone play crucial roles in regulating ovulation and preparing the body for potential pregnancy. LH triggers follicular rupture,

while estrogen peaks to initiate the LH surge and prepare the endometrium. Estrogen promotes the thickening and vascularization of the endometrial lining, preparing it for implantation. Progesterone, initially low during ovulation, rises shortly after ovulation due to the formation of the corpus luteum. It prepares the endometrium for implantation by promoting secretory changes and inhibiting further ovulation. This hormonal interplay is essential for successful ovulation and early pregnancy if fertilization occurs.

Neurological Impact: Temporary improvements in mood and cognitive performance, linked to oestrogen's effects on neurotransmitter systems.

2.3 Luteal Phase

Hormonal Activity: Progesterone levels rise, preparing the uterine lining for potential pregnancy.

- Progesterone: After ovulation, the corpus luteum secretes large amounts of progesterone [5], which dominates this phase. Estrogen also remains present but at lower levels.
- Estrogen: After ovulation, estrogen levels initially drop but then experience a secondary rise mid-luteal phase, contributing to endometrial maintenance.

Mechanism of Action of hormones during the luteal phase:

During the luteal phase of the menstrual cycle, progesterone, estrogen, LH, and FSH play crucial roles through specific mechanisms of action. Progesterone promotes uterine preparation, inhibits uterine contractions, and prevents further ovulation.