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PHYSIOLOGICAL MECHANISMS OF HORMONAL CONTROL IN HUMAN REPRODUCTION

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Abstract

The human reproductive system is regulated by a complex network of hormones that ensure gamete maturation, ovulation, spermatogenesis, and preparation for pregnancy. This article examines the physiological mechanisms of hormonal regulation in men and women and presents observational data from patients with reproductive disorders. Particular attention is paid to the role of the hypothalamic-pituitary system, the gonads, and the interaction of the central nervous system with peripheral hormones.

Keywords: human reproduction, hormones, hypothalamus, pituitary gland, ovaries, testicles, menstrual cycle, gonadotropins, patients.

Introduction

The human reproductive system ensures the storage and transmission of genetic information. Its functioning is impossible without coordinated hormonal regulation. Hormonal imbalances can lead to infertility, menstrual cycle abnormalities, and decreased fertility in men. Hormonal regulation occurs at three levels:

1. The hypothalamus secretes GnRH (gonadotropin-releasing hormone).
2. The pituitary gland produces FSH and LH.
3. The gonads (ovaries and testicles) synthesize estrogens, progesterone, and testosterone.

Study Objective

To study the physiological mechanisms of hormonal regulation of human reproduction and analyze their impact on patients with reproductive disorders.

Materials and Methods of the research

Subjects:

- 25 women aged 22–35 years with regular menstrual cycles.
- 20 men aged 25–40 years with normal testosterone levels.
- 15 patients diagnosed with infertility (7 women, 8 men).

Methods of study

Clinical and physiological observation with laboratory analysis in healthy individuals and patients with reproductive disorders.

Patients and Study Groups

Women with normal reproductive function: 25 individuals, aged 22–35 years, with regular menstrual cycles of 26–30 days.

Men with normal reproductive function: 20 individuals, aged 25–40 years.

Patients with reproductive disorders: 15 subjects, 7 women and 8 men, diagnosed with infertility of various etiologies.

Inclusion Criteria

Age 22–40 years, voluntary consent, no systemic diseases for the control group.

Exclusion Criteria

Use of hormonal medications in the past 6 months, acute infectious diseases, chronic endocrine pathologies outside the study group.

Laboratory Methods

Determination of FSH, LH, estrogen, progesterone, testosterone, and inhibin hormone levels using ELISA.

Blood collection in women on specific days of the menstrual cycle; in men, in the morning hours of 7:00–9:00.

Spermogram in men: concentration, motility, morphology, viability, microscopic and computer analysis.

Instrumental Methods

Ultrasound of the reproductive system: ovarian structure, follicular maturity, and endometrium in women; testes and epididymis in men

Expert-class ultrasound machine, transvaginal and transabdominal probe for women, 7–10 MHz linear probe for men

Graphic modeling of hormonal dynamics by menstrual cycle phases

Questionnaire and clinical interview

Collection of medical history, menstrual cycle, sexual activity, reproductive history, and chronic diseases

Use of standardized forms for assessing libido and reproductive health

Statistical Analysis

Quantitative data: mean ± standard deviation, t-test for independent samples, ANOVA for multiple groups

Qualitative data: percentage distribution, χ^2 test

Significance level: $p < 0.05$

Methods

- A literature review of modern research on the hormonal regulation of reproduction.
- Clinical analysis of patients' conditions.
- Comparison of normal and pathological hormone levels.
- Schematic modeling of the hypothalamic-pituitary regulation.

Results of the Study

Women with normal reproductive function:

- FSH and LH pulsate in accordance with the phases of the menstrual cycle.
- Estrogen levels increase during the follicular phase, and progesterone levels increase during the luteal phase.
- Ultrasound data showed normal follicular maturation and ovulation.

Women with reproductive disorders (7 patients):

- 4 patients had high LH and low FSH levels—a typical feature of polycystic ovary syndrome (PCOS).
- 3 patients had low FSH and LH levels—a symptom of pituitary insufficiency.
- Hormonal imbalances coincided with anovulation and irregular cycles.

Men with normal reproductive function:

- Constant levels of testosterone, FSH, and LH ensured regular spermatogenesis. A semen analysis revealed normal sperm concentration, motility, and morphology.

Men with infertility (8 patients):

- 5 patients had low testosterone and high LH (primary hypogonadism).
- 3 patients had normal testosterone but low FSH (secondary hypogonadotropic insufficiency).
- All patients had decreased spermatogenesis and reproductive dysfunction.

Discussion

The hormonal mechanisms of reproduction ensure the coordinated functioning of the hypothalamus, pituitary gland, and gonads. In women, the menstrual cycle depends on the pulsatile secretion of GnRH and the FSH/LH balance, while in men, it depends on constant levels of gonadotropins and testosterone.

Patients with hormonal imbalances have demonstrated a direct link between gonadotropin levels and reproductive function. For example, in women with PCOS, high LH is accompanied by anovulation, while in men with primary hypogonadism, it is accompanied by decreased spermatogenesis. These data confirm that pathological changes in hormonal regulation directly impact human fertility.

Conclusion

The physiological mechanisms of hormonal control of human reproduction ensure the coordinated functioning of the hypothalamus, pituitary gland, and gonads, forming a complex feedback system necessary for maintaining fertility and reproductive health. This is confirmed by the fact that pulsatile secretion of GnRH from the hypothalamus stimulates the pituitary gland to produce FSH and LH, which in turn regulate follicle maturation in women and spermatogenesis in men.

In women, the menstrual cycle is determined by the dynamics of steroid hormones. Increased estrogen levels in the follicular phase stimulate endometrial proliferation and preparation for a possible pregnancy, while a sharp surge in LH triggers ovulation. Increased progesterone levels in the luteal phase support the endometrium and create optimal conditions for embryo implantation. Disruption of these processes, for example in polycystic ovary syndrome, leads to an ovulation and infertility, as confirmed by clinical observations in patients with high LH and low FSH levels.

In men, maintaining constant FSH and LH levels ensures normal spermatogenesis, while testosterone production by Leydig cells maintains sperm morphological maturity and secondary sexual characteristics. Clinical data from patients with primary hypogonadism show that decreased testosterone leads to impaired sperm quality and decreased fertility.

Observations in patients confirm a direct relationship between hormone levels and the functional state of the reproductive system. Women with anovulation and PCOS demonstrated an imbalance of FSH and LH, which directly affected menstrual cycles. Men with secondary hypogonadotropic insufficiency had reduced FSH levels with normal testosterone, indicating a central dysfunction of the hypothalamic-pituitary system.

These data substantiate the need for a comprehensive examination of patients with reproductive disorders, including laboratory hormone monitoring and instrumental evaluation of the reproductive system. Understanding the physiological mechanisms of hormonal regulation allows for the precise determination of the level of pathological dysfunction and the development of individualized treatment regimens, such as hormonal therapy or ovulation stimulation.

Overall, the study demonstrates that the coordinated functioning of the central and peripheral endocrine systems is a key factor in normal human reproduction. Disruption of any aspect of this system leads to decreased fertility, a finding supported by both literature and patient observations. These results highlight the importance of further clinical and experimental studies to optimize diagnostic methods.

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