MOLECULAR AND ENDOCRINE ASPECTS OF THYROID DYSFUNCTION IN FEMALE INFERTILITY AND REPRODUCTIVE DISORDERS

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Abstract: *Subclinical thyroid dysfunction is one of the most common endocrine disorders affecting women of reproductive age. Despite the absence of obvious clinical manifestations, even mild disturbances in thyroid hormone regulation may significantly influence reproductive function, fertility, and pregnancy outcomes. The endocrine and genetic mechanisms underlying these effects remain an important subject of modern reproductive endocrinology. Thyroid hormones participate in the regulation of ovarian activity, folliculogenesis, ovulation, implantation, and placental development.*

Keywords: *subclinical hypothyroidism, subclinical hyperthyroidism, reproductive health, infertility, thyroid hormones, endocrine disorders, genetic polymorphism, women's health.*

Introduction

The thyroid gland is one of the most important endocrine organs involved in maintaining metabolic and reproductive homeostasis. Thyroid hormones regulate cellular metabolism, energy balance, tissue growth, and neuroendocrine function. In women of reproductive age, normal thyroid activity is essential for menstrual regularity, ovulation, fertility, pregnancy maintenance, and fetal development[1,5].

Subclinical thyroid dysfunction refers to abnormal thyroid-stimulating hormone levels accompanied by normal free thyroid hormone concentrations. Subclinical hypothyroidism is characterized by elevated serum thyroid-stimulating hormone levels with normal free thyroxine levels, whereas subclinical hyperthyroidism is associated with suppressed thyroid-stimulating hormone concentrations despite normal circulating thyroid hormones.

Recent advances in endocrinology and molecular genetics have significantly expanded understanding of the mechanisms connecting thyroid dysfunction with female infertility and reproductive disorders. Hormonal imbalance, immune dysregulation, and genetic susceptibility collectively contribute to disturbances in ovarian function and reproductive capacity[4].

Physiological Role of Thyroid Hormones in Female Reproduction

Thyroid hormones exert important effects on the female reproductive system through direct and indirect endocrine interactions. Receptors for triiodothyronine and thyroxine are expressed in the ovaries, granulosa cells, endometrium, and placenta. These hormones regulate follicular growth, steroidogenesis, oocyte maturation, and endometrial receptivity.

Normal thyroid activity is especially important during pregnancy. Maternal thyroid hormones are necessary for embryonic implantation, placental development, and fetal neurodevelopment, particularly during the first trimester when fetal thyroid function remains immature.

Endocrine Mechanisms of Reproductive Dysfunction

Subclinical Hypothyroidism

Subclinical hypothyroidism is one of the most common thyroid disorders associated with reproductive dysfunction. Elevated thyroid-stimulating hormone levels may impair reproductive physiology through multiple endocrine pathways.

One of the major mechanisms involves hyperprolactinemia. Increased thyrotropin-releasing hormone secretion stimulates prolactin production,

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leading to suppression of gonadotropin-releasing hormone release and inhibition of ovulation. Women with subclinical hypothyroidism frequently experience oligomenorrhea, amenorrhea, or irregular menstrual cycles[3].

Several clinical studies have demonstrated increased miscarriage rates and reduced success of assisted reproductive technologies in women with untreated subclinical hypothyroidism. Levothyroxine therapy has been shown to improve fertility and pregnancy outcomes in many patients.

Subclinical Hyperthyroidism

Subclinical hyperthyroidism may also impair reproductive health despite minimal clinical symptoms. Excessive thyroid hormone activity accelerates estrogen metabolism and alters gonadotropin secretion patterns.

Women with subclinical hyperthyroidism may experience shortened menstrual cycles, decreased fertility, and ovulatory dysfunction. Increased oxidative stress within ovarian tissue may adversely affect oocyte maturation and embryonic development.

In pregnancy, excessive thyroid stimulation may contribute to placental insufficiency, preterm delivery, and fetal growth disturbances[2].

Autoimmune and Genetic Mechanisms

Autoimmune thyroid disease is one of the leading causes of subclinical thyroid dysfunction in women. Thyroid autoimmunity is characterized by the presence of thyroid peroxidase antibodies and thyroglobulin antibodies.

Polymorphisms affecting deiodinase enzymes may disrupt intracellular thyroid hormone metabolism within reproductive tissues. These abnormalities may influence follicular maturation and embryo implantation.

Genetic susceptibility involving immune-regulatory genes, including cytotoxic T-lymphocyte-associated protein 4 and protein tyrosine phosphatase non-receptor type 22, may predispose women to autoimmune thyroid disease and reproductive failure.

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Combined endocrine, autoimmune, and genetic mechanisms therefore contribute to the complex pathogenesis of reproductive disorders associated with subclinical thyroid dysfunction[1].

Clinical Importance and Diagnostic Approaches

Early diagnosis of subclinical thyroid dysfunction is critically important in women with infertility, recurrent miscarriage, menstrual disorders, and adverse pregnancy history.

Diagnostic evaluation should include serum thyroid-stimulating hormone, free thyroxine, thyroid autoantibodies, and reproductive hormone assessment. Ultrasonography of the thyroid gland and reproductive organs may additionally assist in identifying associated pathology.

Screening for thyroid dysfunction is recommended before pregnancy and during infertility treatment. Appropriate hormonal correction improves ovulatory function, implantation rates, and pregnancy outcomes[2].

Conclusion

Subclinical thyroid dysfunction significantly influences women's reproductive health through complex endocrine, autoimmune, and genetic mechanisms. Even mild thyroid hormone imbalance may impair ovulation, fertility, implantation, and pregnancy maintenance.

Early screening, comprehensive hormonal evaluation, and individualized treatment strategies are essential for improving reproductive outcomes in women with subclinical thyroid dysfunction. Further molecular and genetic research will contribute to the development of precision medicine approaches in reproductive endocrinology.

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