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DISEASES RESULTING FROM DISORDERS OF MELOTONIN HORMONES AND THEIR TREATMENT

Abduvaliyeva Feruza Mukhammatnurovna
Andijan branch of Kokand University
Microbiology, Pharmacology, Normal and
Lecturer of the Department of Pathological Physiology

Foziljonova Latofatxon Bakhtiyorjon qizi
Andijan Branch of Kokand University
Student of Group 203, 2nd Stage, Therapeutic Work Direction

Abstract
The hormone melatonin plays a vital role in regulating the body's biological clock mechanisms, controlling the sleep-wake cycle, and coordinating numerous physiological processes. Disruption in the secretion of this hormone, which is synthesized by the pineal gland, leads to the development of various pathological conditions. This article analyzes the effects of both melatonin deficiency and excess on the human body, the spectrum of diseases arising from these conditions, and modern treatment approaches. The research results indicate that melatonin disruptions not only impair the sleep-wake cycle but also contribute to the development of metabolic syndrome, weakened immune function, increased risk of oncological diseases, and psychoneurological disorders. Modern therapeutic approaches include individualized dosing regimens, treatments based on chronobiological principles, and comprehensive therapy strategies.

Keywords: melatonin, pineal gland, circadian rhythm, sleep disorders, chronobiology, melatonin deficiency, metabolic syndrome, oncology, immunity, neuroendocrine system

Introduction

Today, in modern medical practice, the role of the melatonin hormone in the human body and the pathological conditions that arise as a result of its disorders are increasingly in the spotlight. This unique hormone, produced by the pineal gland, not only regulates the sleep-wake cycle, but also acts as a coordinator of many important physiological processes. Scientific studies show that disorders of melatonin synthesis and secretion are becoming increasingly widespread in modern society, which leads to the development of various diseases and a deterioration in the general state of human health.

The biological activity of the hormone melatonin is closely related to its molecular structure and receptor system. This hormone, which has the formula N-acetyl-5-methoxytryptamine, is synthesized mainly at night, in conditions of darkness. Under the influence of light, its production is significantly reduced, which is the basis of natural circadian rhythms. Features of a modern

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lifestyle, including excessive use of artificial light, improper organization of the work schedule and increased stress, lead to disruption of melatonin secretion.

Epidemiological data show that approximately 30% of the population has some degree of melatonin deficiency. This figure varies with age, rising to 60% in the elderly. Melatonin deficiency is also increasing among children and adolescents, largely due to the excessive use of modern technology and changing lifestyles.

Main Part

The synthesis and secretion of the hormone melatonin is carried out through a complex chain of biochemical processes. Starting from the amino acid tryptophan, this process occurs in several steps, and each step is catalyzed by specific enzymes. The activities of the enzymes arylalkylamine N-acetyltransferase and hydroxyindole O-methyltransferase constitute the main control points of melatonin synthesis. The activities of these enzymes are influenced by many factors, including the light regime, the level of the stress hormone cortisol, age-related changes, and various pharmacological agents.

The morphological structure of the pineal gland also plays an important role in the production of melatonin. Special cells called pinealocytes are the main source of melatonin synthesis. In these cells, the expression of genes associated with the circadian rhythm varies from day to night, which ensures the rhythmic secretion of melatonin. With increasing age, calcium salts accumulate in the pineal gland, which leads to a decrease in its functional activity.

The main symptoms of melatonin deficiency are difficulty in falling asleep, poor sleep quality, and increased nighttime awakenings. However, the lack of this hormone leads not only to sleep disorders, but also to many other pathological conditions. Weakening of the immune system is one of the most important consequences of melatonin deficiency. Studies show that melatonin increases the activity of natural killer cells, regulates cytokine production, and enhances adaptive immune processes.

Metabolic disorders are also one of the important consequences of melatonin deficiency. This hormone plays an important role in regulating glucose metabolism and has a positive effect on insulin sensitivity. In case of melatonin deficiency, the risk of developing type 2 diabetes mellitus increases significantly. In addition, lipid metabolism disorders, overweight and the development of metabolic syndrome are also observed.

The relationship between oncological diseases and melatonin levels has been seriously studied in recent years. Melatonin has strong antioxidant properties and plays an important role in preventing cell damage. Its deficiency can lead to increased DNA damage and oncogene activation. In particular, the role of melatonin deficiency in the development of breast, prostate and colorectal tumors has been proven.

A spectrum of psychoneurological disorders is also closely related to melatonin deficiency. Depressive states, anxiety disorders, and decreased cognitive function are the results of melatonin deficiency. This hormone affects neurotransmitter systems, especially regulating the metabolism of serotonin and dopamine. The role of melatonin disorders in the development of attention deficit hyperactivity disorder among children and adolescents has also been noted.

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The relationship between cardiovascular diseases and melatonin levels is also important. Melatonin has a blood pressure-lowering effect and is involved in the regulation of heart rhythm. Its deficiency increases the risk of developing arterial hypertension, arrhythmias and cardiovascular complications. Deterioration of endothelial function and acceleration of atherosclerosis processes are also consequences of melatonin deficiency.

Melatonin also has a significant effect on the functions of the reproductive system. In women, menstrual cycle disorders, infertility problems, and exacerbation of climacteric syndrome may be associated with melatonin deficiency. In men, impaired spermatogenesis and decreased sexual function are observed.

There are also negative effects of excessive melatonin, but these cases are relatively rare. Excess melatonin can lead to daytime sleepiness, exacerbation of depressive states, and in some cases the development of paradoxical insomnia. Therefore, it is important to clearly define the dosage regimens and apply an individual approach to melatonin treatment.

Modern diagnostic methods use various methods to determine melatonin levels. Although measuring the concentration of melatonin in blood plasma is the most common method, analysis of melatonin metabolites in urine is also of important diagnostic value. The method of taking samples several times over a twenty-four hour period is used to detect circadian rhythm disorders.

Treatment strategies are based on a comprehensive approach. Exogenous melatonin preparations are the most widely used treatment. However, the dosage regimen, time of administration, and duration of treatment should be determined individually for each patient. Typically, doses of three to five milligrams are recommended, but in some cases, smaller or larger doses may be used.

The principles of chronobiological therapy play an important role in increasing the effectiveness of melatonin treatment. Taking the drug at the right time, taking into account circadian rhythms, and combining it with light therapy significantly improve the results of treatment. Melatonin is best taken between 9:00 PM and 10:00 PM.

In a comprehensive treatment approach, melatonin supplements are used in conjunction with other methods. Improving sleep hygiene, stress management techniques, regulating physical activity, and optimizing nutrition can increase the effectiveness of treatment. Yoga, meditation, and other relaxation techniques are also useful as adjunctive therapies.

The use of melatonin in pediatric practice requires special caution. Dosage regimens for children and adolescents differ from those for adults and are clearly defined depending on the age group. For children weighing up to sixty kilograms, doses of one to three milligrams are usually recommended. In neonatology, melatonin is used only when there are serious indications and under the supervision of a specialist.

Melatonin therapy in elderly patients also has its own characteristics. The decrease in melatonin clearance with increasing age should be taken into account and doses should be reduced accordingly. Taking into account interactions with other drugs and the presence of side effects are among the main principles of melatonin therapy in elderly patients. In addition to pharmacological drugs, methods that stimulate natural melatonin production are also used. Eating foods rich in tryptophan, maintaining a proper light regime, and using daylight light therapy can help improve endogenous melatonin synthesis.

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In recent years, melatonin agonists and melatonin receptor modulators have also been developed. Ramelteon, agomelatine, and other new drugs have some advantages over traditional melatonin and are used in specific indications. These drugs exhibit high selectivity for melatonin receptors and have a long duration of action.

In conclusion, the role of the melatonin hormone in the human body is increasingly being understood in modern medicine. Violations of its synthesis and secretion lead not only to sleep disorders, but also to the development of many other serious diseases. Weakening of the immune system, metabolic disorders, increased risk of oncological diseases, psychoneurological problems and pathologies of the cardiovascular system are the main consequences of melatonin deficiency. Modern treatment approaches should be comprehensive and individualized. The use of exogenous melatonin preparations, consideration of chronobiological principles, complex therapy methods and lifestyle modification increase the effectiveness of treatment. It is especially important to clearly define dosing regimens and take special precautions in pediatric and geriatric practice.

In the future, further improvements in melatonin therapy, the development of new drugs, and the creation of individual treatment regimens that take into account personal genetic characteristics are expected. Optimization of melatonin therapy based on the principles of precision medicine is one of the promising areas of modern medicine.

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