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THE IMPORTANCE OF CALCIUM METABOLISM IN WOMEN DURING MENOPAUSE AND ITS IMPACT ON THE BODY

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Abstract
This research article provides an in-depth analysis of changes in calcium metabolism in women during menopause and its effects on the body. It discusses the disruption of calcium assimilation caused by the decrease in estrogen levels, leading to bone mass loss and the development of osteoporosis from a scientific perspective. The article extensively explores the biochemical mechanisms of calcium metabolism, the physiological changes occurring during menopause, the process of bone tissue remodeling, and their overall impact on the body. The research findings highlight diseases resulting from calcium deficiency during menopause, their prevention methods, and treatment strategies. The article also provides information on the use of calcium supplements, vitamin D support, and other preventive measures.

Keywords: menopause, calcium metabolism, estrogen, osteoporosis, bone density, vitamin D, calcium assimilation, bone remodeling, postmenopause, parathyroid gormone, calcitonin, mineral metabolism, women's health, endocrine system, bone diseases.

Introduction

Menopause represents a critical phase in women's health that has garnered significant attention in medicine and endocrinology. This physiological transition is characterized by marked decreases in estrogen and progesterone hormones, which profoundly affect not only the reproductive system but also metabolic processes throughout the body, particularly calcium metabolism. Calcium metabolism constitutes one of the most essential biochemical processes supporting organismal vitality. This process ensures the integrity of bone and dental tissues while participating in nerve impulse transmission, muscle contraction, blood coagulation, and numerous enzymatic reactions. During menopause, declining estrogen levels precipitate serious disruptions in calcium assimilation and bone tissue metabolism, leading to the development of osteoporosis, bone fractures, and other mineral metabolism disorders. According to the World Health Organization, over nine million osteoporosis-related bone fractures occur annually among women over fifty years of age worldwide. These statistics underscore the urgent need to study and properly manage calcium metabolism during menopause. Scientific research has also established that calcium deficiency during menopause negatively impacts not only the skeletal system but also the cardiovascular system, nervous system, and other organ systems.

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Methodology

Calcium metabolism represents a complex biochemical process encompassing intestinal calcium absorption, renal excretion, and storage in bone tissue. This process is primarily governed by three critical hormones: parathyroid hormone, calcitonin, and calcitriol, the active form of vitamin D. Parathyroid hormone is secreted in response to decreased serum calcium levels, stimulating calcium release from bone tissue, enhancing renal calcium reabsorption, and increasing intestinal calcium assimilation. Vitamin D serves as the most important factor ensuring calcium assimilation in the organism. It is synthesized in the skin under ultraviolet radiation or enters the organism through diet. Following a series of transformations in the liver and kidneys, vitamin D converts to its active form, calcitriol, which increases synthesis of calcium-binding proteins in the intestinal wall and ensures calcium absorption into the bloodstream. Calcitonin, secreted from the thyroid gland, ensures the reduction of elevated serum calcium levels. The bone tissue remodeling process represents a complex, continuous phenomenon throughout organismal life, during which old bone tissue is destroyed and new tissue is formed. This process is accomplished by cells called osteoblasts and osteoclasts. Osteoblasts are cells that form new bone tissue, while osteoclasts are cells that degrade old bone tissue. In a balanced state, these two processes equilibrate, but during menopause this balance becomes disrupted.

The menopausal period is characterized by cessation or sharp reduction in estrogen and progesterone hormone production in the female organism. Estrogen hormone not only governs reproductive functions but also plays a crucial role in calcium metabolism. This hormone enhances intestinal calcium absorption, reduces renal calcium loss, and limits osteoclast activity in bone tissue. With declining estrogen levels, all these functions become disrupted. During the postmenopausal period, estrogen deficiency results in sharply increased osteoclast activity, leading to accelerated bone destruction processes. Simultaneously, osteoblast activity relatively decreases, resulting in the initiation of bone mass loss. Research demonstrates that women may lose twenty to thirty percent of their bone mass within the first five to ten years following menopause onset. Disrupted calcium assimilation is not solely related to estrogen deficiency. With advancing age, intestinal wall permeability decreases, vitamin D synthesis diminishes, and renal calcitriol production function weakens. The combination of these factors leads to further deepening of calcium deficiency. Additionally, increased parathyroid gland activity is observed during menopause, which further intensifies calcium release from bone tissue.

Disrupted calcium metabolism during menopause adversely affects various organismal systems. The most significant consequence is the development of osteoporosis. Osteoporosis is a disease characterized by disruption of bone tissue microarchitecture and decreased bone density, which significantly increases fracture risk. Postmenopausal osteoporosis is the most widespread type of osteoporosis among women. Osteoporosis development primarily manifests in the vertebral columns, femoral neck, and distal portions of the wrist. These locations are areas rich in trabecular bone tissue and are most sensitive to estrogen deficiency. Vertebral compression fractures result in height reduction, kyphosis development, and chronic pain syndrome appearance. Femoral neck fractures often lead to limited mobility and decreased independent quality of life. Calcium deficiency also affects nervous system function. Calcium plays an important role in nerve impulse transmission, and its deficiency may manifest through cramps, muscle weakness, and tetany signs. In the cardiovascular

system, calcium deficiency may lead to arrhythmia, disrupted cardiac muscle contraction function, and blood pressure alterations. In the endocrine system, disrupted calcium metabolism leads to parathyroid gland hyperfunction. This condition further increases osteoclast activity and accelerates bone destruction processes. Additionally, calcium deficiency increases the risk of kidney stone formation, as the organism releases excess calcium from bone tissue to compensate for calcium deficiency.

Several diagnostic methods are employed to assess calcium metabolism during menopause. Dual-energy X-ray absorptiometry is the most accurate and widely used method for measuring bone density. This method measures bone mineral density in the vertebral columns, femur, and wrist, and assesses osteoporosis risk. Laboratory examinations occupy an important position in assessing calcium metabolism. Measuring serum calcium, phosphorus, alkaline phosphatase, parathyroid hormone, and vitamin D levels enables assessment of calcium metabolism status. The urine calcium to creatinine ratio is used to evaluate renal calcium loss. Measuring bone metabolism markers holds significant importance for assessing processes occurring in bone tissue. Bone formation markers include osteocalcin, bone-specific alkaline phosphatase, and procollagen peptides, while bone resorption markers include collagen metabolites, which are widely employed. These markers are used to monitor treatment effectiveness and assess disease progression dynamics.

Results and Discussion

Treating and preventing disrupted calcium metabolism during menopause requires a comprehensive approach. First and foremost, adequate calcium and vitamin D supplementation is important. Daily calcium intake during menopause is recommended at twelve hundred to fifteen hundred milligrams. Vitamin D intake should be eight hundred to one thousand international units daily. Hormone replacement therapy is an effective method for compensating estrogen deficiency and slowing bone loss. Estrogen preparations reduce osteoclast activity and balance the bone remodeling process. However, application of this therapy must be implemented considering individual risk factors, as prolonged use may introduce certain risks.

Bisphosphonates constitute a widely used group of medications in osteoporosis treatment that reduce osteoclast activity and slow bone resorption. Preparations such as alendronate, risedronate, and ibandronate are effective for increasing bone density and reducing fracture risk. Precise adherence to administration protocols and precautionary measures for these preparations is essential. Lifestyle modifications hold significant importance for improving calcium metabolism. Regular physical activity, particularly weight-bearing exercises and resistance training, increases bone tissue strength and slows bone loss. Walking itself is beneficial for bone health, with at least thirty minutes of daily walking recommended. Sun exposure is important for vitamin D synthesis. Fifteen to twenty minutes of sun exposure several times weekly is sufficient for maintaining normal vitamin D levels. However, individuals with sensitive skin should take precautionary measures and supplement with additional vitamin D if necessary.

Increasing calcium-rich foods in the diet is important. Dairy products, green leafy vegetables, fish, nuts, and seeds serve as calcium sources. Limiting caffeine, alcohol, and excess salt consumption is recommended to reduce calcium loss.

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Changes in calcium metabolism during menopause represent a significant physiological process exerting comprehensive and long-term effects on the female organism. Disrupted calcium assimilation and bone tissue loss resulting from decreased estrogen hormone lead to the development of osteoporosis and other serious complications. Due to the complexity and multifaceted impact of this process, proper management of calcium metabolism is essential not only for preserving bone health but also for improving overall quality of life.

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