THE ROLE OF VITAMIN D AND ULTRAVIOLET RADIATION IN DEVELOPMENT OF ANATOMICAL-FUNCTIONAL CHANGES IN DIFFERENT SKELETAL PARTS AND THEIR IMPORTANCE FOR MOTOR ACTIVITY PROVISION

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Abstract*: human body is influenced by many exogenic and endogenic factors, which determine its motor activity and physical work capacity.*

Vitamin D deficiency causes anatomic and functional changes in different parts of human skeleton, followed by change in biomechanics of movements and malfunction of visceral organs.

Vitamin D deficiency provokes calcium and phosphorus metabolic imbalance and disorder of neuromuscular conductivity, which has significant impact on adequate motor activity, can cause mineral density reduction in bones of different skeletal parts that may become a reason of fractures during vigorous physical exercises.

In addition to nutritional therapy, pharmaceutical treatment and kinesitherapy, the effect of small doses of ultraviolet rays is of significant importance. They not only promote vitamin D synthesis in the skin, but also induce sympathoadrenal system activation, which is of great importance for motor activity optimization. The above-mentioned measures facilitate reduction in fall and fracture risk and promote life quality improvement.

From the prevention viewpoint, in case of vigorous physical exercises it is recommended to determine a follow-up vitamin D level, especially if risk-factors are present. The mentioned above promotes timely delivery of drug therapy, use of kinesitherapy and physiotherapy, which will improve life quality and will maintain preservation of adequate physical work capacity.

Keywords*: D vitamin, calcium, phosphorus, ultraviolet radiation, physical work capacity.*

РОЛЬ ВИТАМИНА D И УЛЬТРАФИОЛЕТОВОГО ИЗЛУЧЕНИЯ В РАЗВИТИИ АНАТОМО-ФУНКЦИОНАЛЬНЫХ ИЗМЕНЕНИЙ В РАЗЛИЧНЫХ ЧАСТЯХ СКЕЛЕТА И ИХ ЗНАЧЕНИЕ В ОБЕСПЕЧЕНИИ ДВИГАТЕЛЬНОЙ АКТИВНОСТИ

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Аннотация: *на организм человека действует множество экзогенных и эндогенных факторов, которые определяют его двигательную активность и физическую работоспособность.*
Дефицит витамина Д вызывает анатомо-функциональные изменения различных частей скелета человека, меняется биомеханика движений и нарушаются функции висцеральных органов.
Дефицит витамина Д вызывает нарушение обмена кальция и фосфора и нервно-мышечной проводимости, что оказывает значительное влияние на адекватную двигательную активность, может вызвать снижение минеральной плотности в костях различных частей скелета, что может стать причиной переломов во время интенсивных физических нагрузок.
Помимо лечебного питания, медикаментозного лечения и кинезотерапии важное значение имеет действие малых доз ультрафиолетовых лучей, которые, кроме того, что способствует синтезу витамина Д в коже, вызывает активацию симпатоадреналовой системы, что имеет большое значение в оптимизации двигательной активности. Вышеуказанные мероприятия способствуют уменьшению риска падений и переломов и повышению качества жизни.
С точки зрения превенции, при интенсивных физических нагрузках рекомендовано определение в динамике уровня витамина Д, особенно при наличии риск-факторов. Вышеуказанное поспособствует своевременному проведению медикаментозного лечения, кинезотерапии и физиотерапии, что улучшит качество жизни и будет способствовать сохранению адекватной физической работоспособности.
Ключевые слова*: витамин Д, кальций, фосфор, ультрафиолетовое облучение, физическая работоспособность.*

Human body is influenced by many exogenic and endogenic factors, which determine its motor activity and physical work capacity [1-35].

The role of vitamin D is essential for bone tissue development, neuromuscular conductivity, regulating visceral organs function and, consequently, for maintenance of physical work capacity [6, 40-50].

In absence of vitamin D, 10-15% of dietary calcium and roughly 60% of phosphorus are absorbed only. Sufficient consumption of vitamin D increases calcium and phosphorus absorption up to 30-40% and 80%, respectively. That's why prior to carry out calcium deficiency diagnostics, one has to be convinced that there is no vitamin D deficiency.

Vitamin D enters into organism along with food products. It is also generated in the skin under action of sunlight (ultraviolet irradiation). Vitamin D deficiency can be caused by its insufficient application or impaired absorption due to hepatobiliary system defect or intestinal malabsorption.

Vitamin D deficiency may occur due to disturbance of its metabolism, which takes place as a result of intake of some pharmacological agents (phenytoin, phenobarbital, rifampicin) or due to its reduced production by skin as a result of sunlight insufficiency. Vitamin D synthesis in skin is also reduced in the elderly [40-50].

Vitamin D penetrates the organism with food products. Vitamin D is ranked among fat-soluble vitamins. It exists in nature in very limited quantity of food products only, including herring (300-1600 IU (international units) per 100 gr), canned sardine (300-600 IU per 100 gr), fish (cod liver) oil (400-1000 IU per one table spoon), egg yolk (20 IU per piece), and sour cream (40 IU per 100 gr) [40-50].

Reduction of vitamin D synthesis in skin frequently becomes the reason of acquired deficiency. The acquired deficiency often emerges among those humans, who live in high northern or southern latitudes and wear clothes, completely covering a body, or frequently use sun protective means (sunblocks).

Any light can't be considered as such ultraviolet irradiation, which is responsible for vitamin D synthesis. In many countries located at 30-35 degrees of northern latitude, irradiation equals to zero in winter, even on a sunny day. That is why people residing at northern latitudes are recommended to take vitamin D additives from October to March inclusive [41-42].

Vitamin D regulates phosphorus-calcium metabolism and acts on calcium absorption by bowels. Vitamin D deficiency reduces calcium entry to organism from intestines.

Reduced penetration of vitamin D from intestines to body causes intense production of parathyroid hormone (parathormone).

Parathyroid hormone excreted by parathyroid glands, being in the norm, adjusts an adequate calcium level in blood. This regulation occurs using three mechanisms. Among them are: calcium removal from bones, calcium separation with urine, and calcium absorption by intestines.

In case, when there is a vitamin D deficiency in organism due to various reasons, increased production of parathyroid hormone promotes normal calcium level preservation in blood. Normal calcium level is maintained at the expense of several mechanisms.

First mechanism is realized at the expense of increase of calcium removal from bones. Second mechanism lies in reduction of calcium separation with urine, while the third mechanism consists in stimulation of vitamin D active form (calcitriol) generation due to increase of calcium absorption by intestines.

Parathyroid hormone increases osteoclast activity in bones, which cause bone tissue resorption that leads to reduction of bone tissue mineral density, development of osteopenia (bone density reduction), and afterwards – development of osteoporosis (fragility, brittleness of bones).

Vitamin D deficiency, besides ossification effect, causes extraosseus (ectosseal) effect. Calcitriol (active form of vitamin D) causes expressed biological effects in blood, when acting in small concentrations. Its multilateral action is explained by the fact that many different organs have receptors to vitamin D circulating in blood (for instance, blood vessels, heart, brain, immune system cells). Based on this, they are able to change their function when influenced by calcitriol. As we mentioned, calcitriol acts on muscle cells of heart, insulin-releasing pancreas cells and immune system cells, that is why their deficiency causes different symptoms.

Vitamin D dependent disorders are a consequence of absence of vitamin D transition into its active form or a result of distal organs' sensation disorder regarding adequate levels of active vitamin.

Vitamin D dependent rickets of I type (pseudo-vitamin D deficiency rickets) are transmitted by inheritance via autosomal-recessive way. It is based on mutation of enzyme 1 alpha-hydroxylase encoding gene. Enzyme 1 alpha-hydroxylase is expressed to kidneys in the norm, and transition of active form of vitamin D into inactive form – calcitriol is necessary.

In case of vitamin D dependent rickets of II type the targeted organs have no reaction on calcitriol. There are manifested vitamin D deficiency signs – hypocalcemia and acute hypophosphatemia. Muscular weakness, bone pain and their typical deformations are peculiar, as well.

Vitamin D deficiency may emerge due to kidney disease. Renal tubular diseases, including proximal and distal tubular acidosis may cause acute hypocalcemia due to abnormal calcium loss and reduction of transition of vitamin D into active 1,25(OH)2D form. Renal insufficiency may cause reduction in 1,25(OH)2D generation due to direct injury of kidney cells and 1-alpha-hydroxylase suppression by hyperphosphatemia.

Vitamin D deficiency has an effect on stages of rickets. Mild case among children is distinguished by cranial bone compliance, moderately low muscular hypotonia, sweatiness, anxiety, and irritability. In case of moderate degree of rickets, development of frontal and parietal tubers, different kinds of chest deformations, O-shaped moderate foot deformation in a great measure, "frog knee" development due to reduced muscular tone. Severe degree of rickets is distinguished by tooth eruption and sequence, expressed reduction of muscular tone, motor development delay, strong deformations of cranial bones, chest, vertebra (spinal column), antebrachium (forearm), fingers and low extremity bones [43, 44].

T-criterion, which shows bone mineral density deviation from normal value, varies from +2.5 to -1 among young people, from -1.0 to -2.5 in case of osteopenia, is below -2.5 in case of severe osteopenia with one or more fractures in anamnesis (past medical history) [46, 47].

Extra-vigorous physical exercises may cause bone softening which generates the risk of fall and fractures.

Based on the above-mentioned, those athletes, whose organism experiences vigorous physical loads have to be checked for vitamin D level in the exercise process in order to eliminate vitamin D deficit and such bone injuries as osteomalatia, osteopenia, osteoporosis and to take preventive measures if required.

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