

**OFFICIAL JOURNAL OF THE SCIENTIFIC SOCIETY OF
ANATOMISTS, HISTOLOGISTS, EMBRYOLOGISTS AND
TOPOGRAPHIC ANATOMISTS OF UKRAINE**

**DOI: 10.31393
ISSN 1818-1295
eISSN 2616-6194**

ВІСНИК МОРФОЛОГІЇ REPORTS OF MORPHOLOGY

Vol. 26, №1, 2020

Scientific peer-reviewed journal in the fields of normal and pathological anatomy, histology, cytology and embryology, topographical anatomy and operative surgery, biomedical anthropology, ecology, molecular biology, biology of development

**Published since 1993
Periodicity: 4 times a year**

Vinnytsya • 2020

ВІСНИК МОРФОЛОГІЇ - REPORTS OF MORPHOLOGY

Founded by the "Scientific Society of Anatomists, Histologists, Embryologists, and Topographic Anatomists of Ukraine" and National Pyrogov Memorial Medical University, Vinnytsya in 1993

Certificate of state registration KB №9310 from 02.11.2004

Professional scientific publication of Ukraine in the field of medical sciences (approved by the order of the Ministry of Education and Science of Ukraine No. 528 dated 12.05.2015, annex 10); professional scientific publication of Ukraine in the field of biological sciences by specialty groups 14.01.00-14.03.00 (approved by the order of the Ministry of Education and Science of Ukraine No. 747 dated 13.07.2015, annex 17)

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Approved by the Academic Council of National Pyrogov Memorial Medical University, Vinnytsya, protocol №7 від 27.02.2020

Indexation: CrossRef, elibrary.ru, Google Scholar Metrics, National Library of Ukraine Vernadsky

Address editors and publisher:

Pyrogov Str. 56,
Vinnytsya, Ukraine - 21018
Tel.: +38 (0432) 553959
E-mail: nila@vnmu.edu.ua

Computer page-proofs - Klopotovska L.O.

Translator - Gunas V.I.

Technical support - Levenchuk S.S., Parashuk O.I.

Scientific editing - editorship

The site of the magazine - <https://morphology-journal.com>

CONTENT

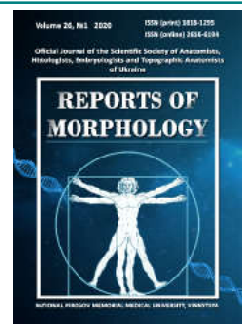
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REPORTS OF MORPHOLOGY

Official Journal of the Scientific Society of Anatomists,
Histologists, Embryologists and Topographic Anatomists
of Ukraine

journal homepage: <https://morphology-journal.com>



Electron microscopic changes in the skin of rats 1, 3, 7, 14, 21 and 30 days after thermal trauma on the background of the introduction for the first 7 days of 0.9% NaCl solution

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ARTICLE INFO

Received: 2 December, 2019

Accepted: 9 January, 2020

UDC: 616-001.17:615.451.3

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A burn wound occurs as a result of exposure to high-temperature skin or chemicals and is a serious injury with systemic effects. The problem of treatment of thermal trauma is urgent for modern medicine. Despite the fact that the overall mortality rate has dropped significantly in recent years, research about the development of new treatments and technologies for patients with skin burns is extremely important. The aim of the study is to research the features of electron microscopic changes in the skin of rats during the month after burns of II-III degree against the background of the introduction of the first 7 days of 0.9% NaCl solution. Studies were performed on 180 laboratory white rats-males weighing 155-160 g. In the course of the experiment, the animals were divided into 2 groups: 1 - rats without thermal injury, which were infused with 0.9% NaCl solution at a dose of 10 ml/kg; group 2 - rats which infused 0.9% NaCl solution at a dose of 10 ml/kg for 7 days after skin burns. Burning skin damage was caused by applying to the lateral surfaces of the trunk of rats for 10 seconds four copper plates, heated in water at a constant temperature of 100°C. The total area of skin lesion in rats was 21-23%. Shaving of the lateral surfaces of rats' trunk, catheterization of veins, staging of skin burns, and decapitation of animals (after 1, 3, 7, 14, 21 and 30 days) were performed under intravenous propofol anesthesia (calculated at 60 mg/kg body weight). Preparations for electron microscopic examination were prepared according to the standard procedure. The data obtained were studied using a PEM-125K electron microscope. Electron microscopic studies of the skin of animals after thermal trauma under the conditions of application of 0.9% NaCl solution have found that in the early stages of the experiment - the stage of shock and early toxemia (1, 3, 7 days) compensatory and adaptive changes of its structural components are combined with signs of destructive disorders. In the epitheliocytes of the epidermis of the affected area of the skin is the destruction of nuclei and cytoplasm. Vascular disorders in the dermis are combined with changes in fibroblasts, an intercellular substance of fibrous connective tissue. In the late stages of the experiment - the stages of late toxemia and septicotoxemia (14, 21 and 30 days), there is a further development and deepening of destructive-dystrophic changes of all structural components of the affected skin, they become irreversible. The processes of granulation tissue formation, its transformation into connective tissue, as well as marginal epithelialization are slow. This morphological condition of the burn wound indicates the need for the use of corrective drugs to reduce destructive changes and the activation of regenerative processes in the area of skin lesions.

Keywords: skin burns, electron microscopic changes, burn wound, epidermocytes, 0.9% NaCl solution.

Introduction

Thermal trauma, especially in its severe course, poses a great threat to human life. Violation of functions of vital organs causes the development of metabolic disorders in

the cells and tissues of the body, endogenous intoxication, impaired immune reactivity [16]. The latter, together with high contamination of burn wounds with microflora, leads

to the development of purulent processes and a high risk of generalization of infection. Microflora, spreading through the lymphatic and circulatory systems, worsens the course of the wound process. With inadequate treatment, prolonged stress leads to a transition from dysfunction to functional failure [8, 10-12]. It has been established that the pathogenic mechanism of pathological changes in burn disease is the numerical morphofunctional changes in the area of the affected area [3, 21].

The burn wound acts as a trigger mechanism that triggers all chains of pathogenesis of thermal trauma. Despite the fact that it is the systemic disorders that cause the lethal consequences and severe complications of burn disease, the treatment of the burn wound itself should be given importance, because the timely termination of pathological processes in the wound focus can significantly reduce the degree of damage to vital organs [2, 5, 13, 15, 20]. That is why it is important to study the features of skin morphological changes in conditions of thermal trauma at the optical and electron microscopic levels, which will be the basis for a better understanding of pathological processes in the burn wound and the development of effective treatments.

The purpose of the study is to research the characteristics of electron microscopic changes in the skin of rats during the month after the burn of the II-III degree against the background of the introduction of the first 7 days of 0.9% NaCl solution.

Materials and methods

Studies were performed on 180 laboratory white rats-males weighing 155-160 g. In the course of the experiment, the animals were divided into 2 groups: group 1 - rats without thermal injury which infused 0.9% NaCl solution at a dose of 10 ml/kg for 7 days; group 2 - rats, which after a thermal injury of the skin for 7 days were infused 0.9% NaCl solution at a dose of 10 ml/kg. Skin burn was caused by applying to the pre-depilated lateral surfaces of the trunk of rats for 10 seconds 4 copper plates (two plates with an area of 13.86 cm² on each side), which were pre-heated for 6 minutes in water at a constant temperature of 100°C [1, 7]. The total area of skin lesion in rats was 21-23%. All solutions were injected into the inferior vena cava after catheterization in aseptic conditions through the femoral vein. Shaving of the lateral surfaces of rats' trunk, catheterization of veins, staging of skin burns and decapitation of animals were performed under the conditions of intravenous propofol anesthesia (at the rate of 60 mg/kg of body weight of the animal) [4]. Bioethics Committee of National Pirogov Memorial Medical University, Vinnytsya (protocol №1 from 11.04.2016) found that the studies were carried out taking into account the recommendations of the European Commission on conducting animal and animal health studies, medical recommendations of the State Pharmacological Center of the Ministry of Health of Ukraine and "Rules to Clinical

Pharmacovigilance (GLP) Clinical Safety Assessment".

For further in-depth study, we selected ultrastructural changes in the skin after 1, 3, 7, 14, 21 and 30 days from the start of the experiment. For ultrastructural examination, small pieces of skin were fixed with 2.5% glutaraldehyde solution on phosphate buffer (pH 7.4). Further fixation was performed with 1% OsO₄ solution. Dehydrated in a series of alcoholic solutions of increasing concentration. Contrasted with uranyl acetate, was enclosed in a mixture of araldite with epoxy resins [9].

Electron microscopic studies were performed with the help of Doctor of Biological Sciences Prof. K.S.Volkov (Department of Histology and Embryology of the Higher Educational Institution "Gorbachevsky Ternopil State Medical University, Ministry of Health of Ukraine"). Ultrathin sections were obtained on an LKB-3 ultratome (Sweden) and contrasted them on copper support mesh uranyl acetate and lead citrate according to Reynolds. The data obtained were studied using a PEM-125K electron microscope.

Results

Electron microscopic studies of the skin of rats after thermal trauma under the conditions of application of 0.9% NaCl solution after 1 day have found that its structural components are characterized by reorganization characterizing the reactive changes of the organ to the damaging factor.

Destructive changes of the epidermocytes are found in the central areas of the affected skin burn. In cells of the basal and spinous layers pyknotic with homogeneous karyoplasm nucleus are observed. Perinuclear spaces are enlarged. Areas of destruction of karyolemma are also available. Damage to the cytoplasm is manifested by the destruction of organelles. Mitochondria are swollen with electron-light matrix and destructed cristae, some of them in the form of vacuole-like structures. The hyaloplasm is osmiophilic, the tonofilaments are clearly outlined in it, some of them are fragmented. The extracellular spaces are enlarged, the damage of desmosomal contacts is noted (Fig. 1).

Semidesmosomal contacts with the basement membrane are also damaged, it is unevenly thickened, poorly contoured.

The epidermocytes of the spinous and granular layers are destructively altered. Kernels, pyknotic, with electron-dense karyoplasm, indistinctly contoured. The cytoplasm is homogenized, osmiophilous, fragmentation and disintegration of the tonofibrils are present. In the cells of the granular layer, large, irregularly shaped keratohyalin lumps are observed (Fig. 2).

In the dermis there is swelling of the amorphous component of the intercellular substance, fragmentation and lysis of collagen fibers. In the affected areas there are lymphocytes, degranular basophils and neutrophils, which reflects the inflammatory process in the dermis.

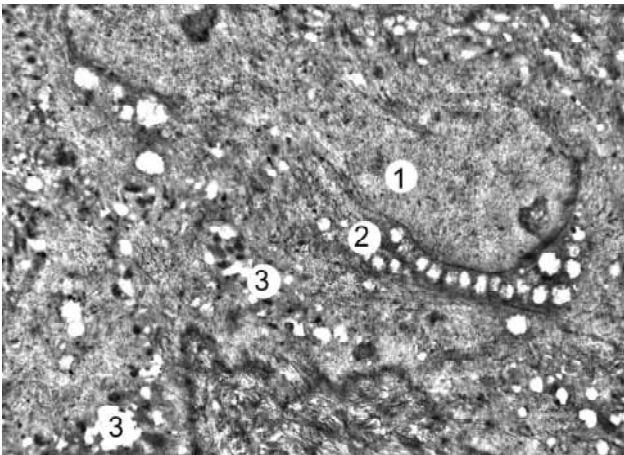


Fig. 1. Submicroscopic changes of the epidermocytes of the basal and spinous layers after 1 day after burn injury with the introduction of 0.9% NaCl solution: 1 - epidermocyte nucleus, 2 - epidermocyte cytoplasm with damaged organelles, 3 - intercellular space. x12000.

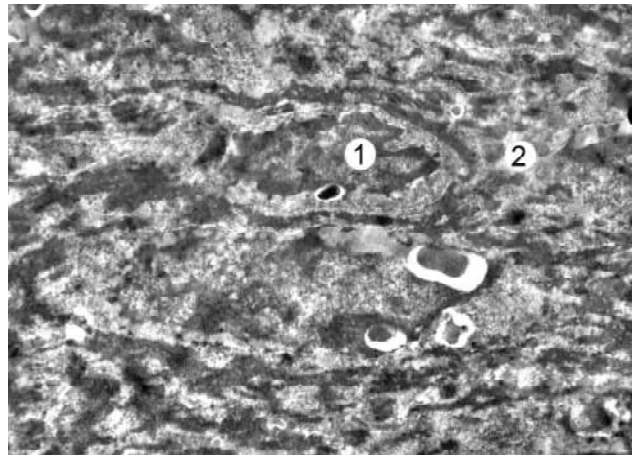


Fig. 2. Submicroscopic changes of the epidermocytes of the granular layer 1 day after burn injury with the introduction of 0.9% NaCl solution: 1 - pyknotic nucleus, 2 - homogenized cytoplasm. x12000.

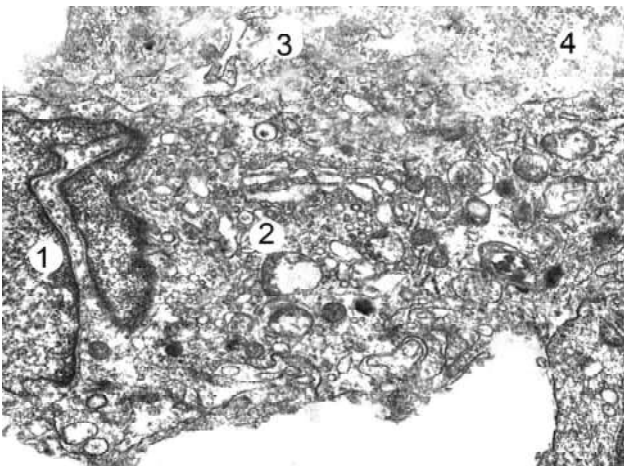


Fig. 3. Ultrastructural changes of the components of the dermis 1 day after burn injury with the introduction of 0.9% NaCl solution: 1 - destructured fibroblast nucleus, 2 - fibroblast cytoplasm, 3 - intercellular substance swelling, 4 - fibrous structures lysis. x14000.

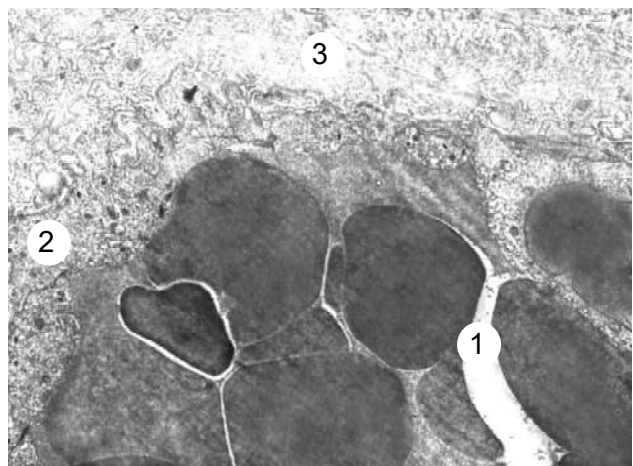


Fig. 4. Ultrastructural changes of the blood capillary of the dermis of the skin after 1 day after burn injury with the introduction of 0.9% NaCl solution: 1 - enlarged, blood-filled lumen, 2 - cytoplasm of endothelial cells, 3 - perivascular edema. x7000.

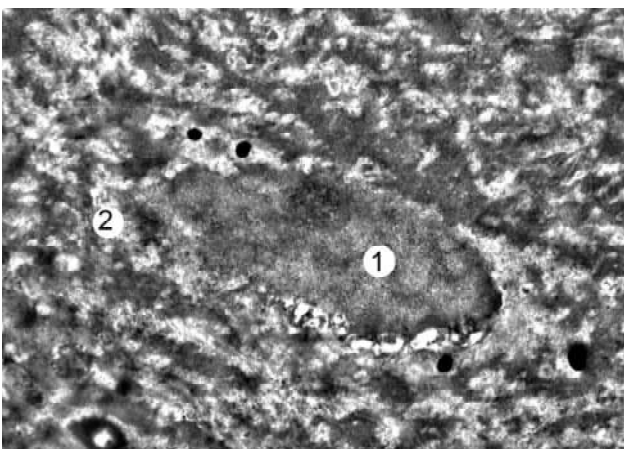


Fig. 5. Submicroscopic changes of epidermocytes 3 days after burn injury with the introduction of 0.9% NaCl solution: 1 - pyknotic nucleus, 2 - damaged cytoplasm. x12000.

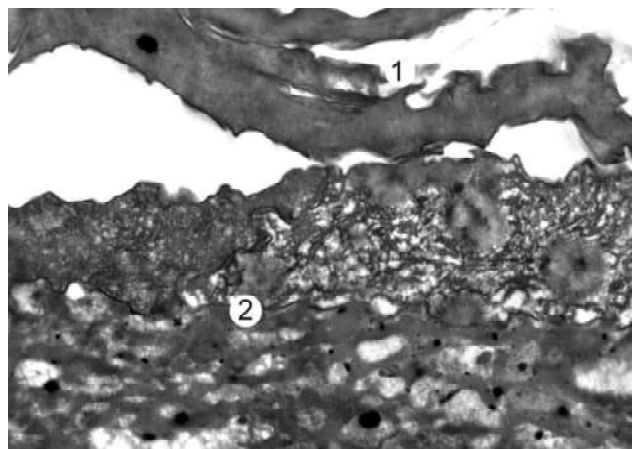


Fig. 6. Submicroscopic changes of the surface layers of the epidermis after 7 days after burn injury with the introduction of 0.9% NaCl solution: 1 - detached horn scales, 2 - damaged epidermocytes. x17000.

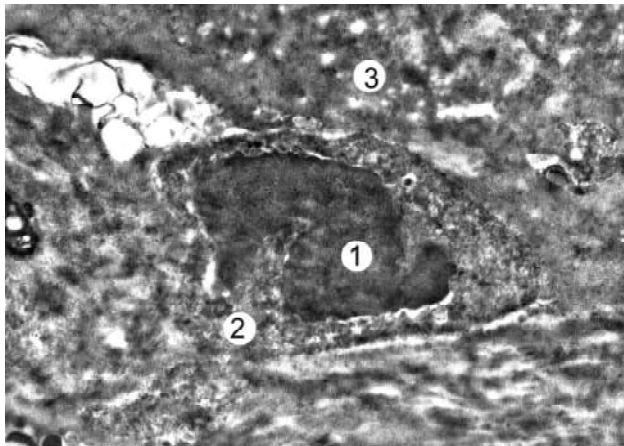


Fig. 7. Submicroscopic changes of connective tissue 7 days after burn injury with the introduction of 0.9% NaCl solution: 1 - pyknotic nucleus, 2 - damaged cytoplasm, 3 - intercellular substance. x9000.

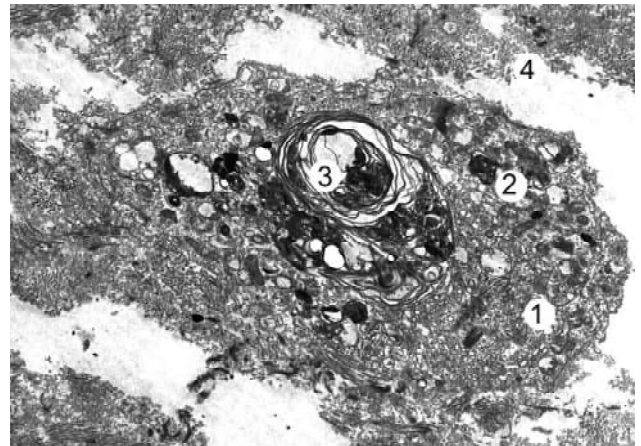


Fig. 8. Submicroscopic changes of the dermis after 7 days after burn injury with the introduction of 0.9% NaCl solution: 1 - cytoplasm of macrophages, 2 - autophagosomes, 3 - residues of the destroyed cell, 4 - intercellular substance. x9000.

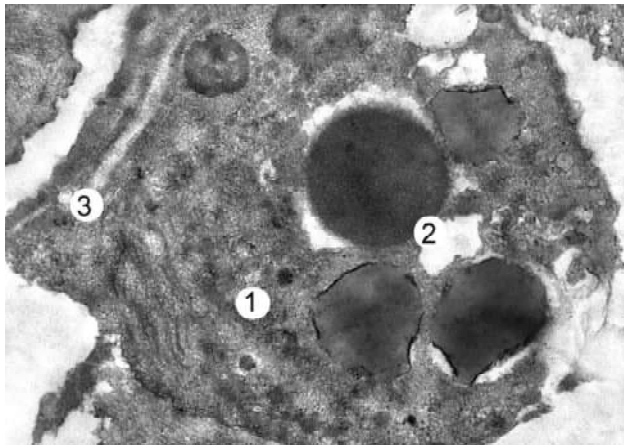


Fig. 9. Ultrastructural changes of the blood capillary after 7 days after burn injury with the introduction of 0.9% NaCl solution: 1 - swollen cytoplasm of endothelial cells, 2 - erythrocytes, 3 - damaged capillary wall. x12000.

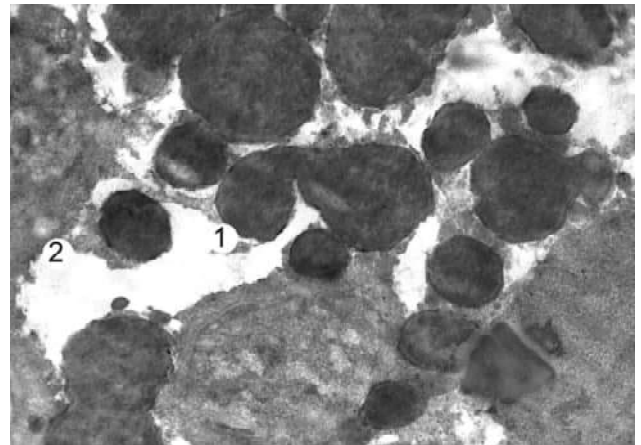


Fig. 10. Ultrastructural changes of the blood capillary of the dermis of the skin 14 days after burn injury with the introduction of 0.9% NaCl solution: 1 - capillary plethora, 2 - destroyed cytoplasm of endothelial cells. x7000.

In fibroblasts destruction of the nucleus and organelles. The nuclei are irregular in shape, dominated by heterochromatin. In the cytoplasm, the tubules of the granular endoplasmic reticulum and the Golgi cistern are unevenly expanded and vacuolated. The mitochondria are hypertrophied, the matrix is enlightened with signs of edema, the cristae are destroyed. The number of lysosomes is increasing (Fig. 3).

The gaps of the blood capillaries are full-blooded, enlarged. The cytoplasm of endothelial cells is enlightened, in the state of edema, the organelles are damaged, the number of foamy cytosol is smaller. The basement membrane is slightly contoured, unevenly thickened (Fig. 4).

Subsequently (3, 7 days of study) necrobiotic changes in the central and marginal areas of the wound grow. The epidermocytes of all layers of the epidermis are necrotically damaged, in many cells pyknosis and karyorrhexis of the nuclei are present (Fig. 5). Their cytoplasm is electron-

dense homogenized, organelles are destroyed. Intercellular spaces enlarged, horn scales flaked (Fig. 6).

In the stage of early toxemia in the central area of the wound revealed deep necrotic changes in the dermis. Fibroblasts and fibrocytes have an osmiophilic hyaloplasm in which damaged organelles are present. The tubules of the granular endoplasmic reticulum and the Golgi cisterns are irregularly expanded, fragmented on the membranes of the endoplasmic reticulum. Significantly altered mitochondria, they destroyed not only the cristae, but also the focal outer membrane. Some organelles are vacuole-shaped and have an electron-light matrix. The nuclei are pyknotic, having an osmiophilic karyoplasm, irregular shape, deep invasions of the karyolemma (Fig. 7).

The established changes in the ultrastructure of fibroblasts indicate inhibition of their synthetic activity, which significantly affects the state of the intercellular substance. The inflammatory reaction of the dermis, the formation of a demarcation shaft in the wound is accompanied by an

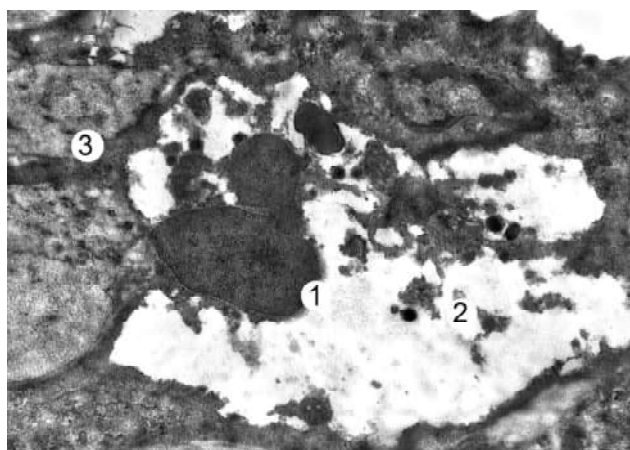


Fig. 11. Submicroscopic changes in the dermis of the skin of the animal 14 days after burn injury with the introduction of 0.9% NaCl solution: 1 - nucleus fragment, 2 - fibroblast cytoplasm, 3 - homogenized intercellular substance. x9000.

increase in the number of lymphocytes, neutrophils, macrophages. In lymphocytes osmiophilic karyoplasm of nuclei, fuzzy karyolemma, in the cytoplasm damaged organelles. The cytoplasm of neutrophilic leukocytes is degranularized, contains numerous autophagosomes. Macrophage plasmolemma forms significant outgrowths and invaginations. In their cytoplasm, phagosomes and osmiophilous residual bodies are detected (Fig. 8).

In the intercellular substance, the fibrous structures are sophisticated, fragmented. Hemocapillary lumens are full-blooded enlarged, there is swelling of the cytoplasm of endothelial cells, organelles are destructed, the basement membrane is not clearly contoured, of uneven thickness. Hemocapillaries with the ruptured wall and hemorrhage were detected (Fig. 9).

After 14 days, the burn wound under the scab is represented by a structureless dermis, which includes fragments of destroyed cells placed in the swollen intercellular substance. Fragmented collagen and elastic fibers are present in the wound. The endothelial cytoplasm and the basement membrane are disturbed in the walls of the blood capillaries. This leads to hemorrhage, and erythrocytes are often found in the extracellular substance (Fig. 10). Modified neutrophilic leukocytes and macrophages are also present in the damaged dermis. The formation of connective tissue in the wound is inhibited by the destruction of the protein synthesis organelles and energy supply in the fibroblasts (Fig. 11). In the marginal areas of the wound during this period of study, the proliferation of epidermal cells is suppressed. The nucleus and cytoplasm are destructively altered in the germinal epidermocytes. The basement membrane is poorly contoured.

Submicroscopic examination of the affected area of the animal skin in the long term (21-30 days) - the stage of late toxemia and septicotoxemia after thermal trauma showed that in the wound the structure of the epidermis and dermis

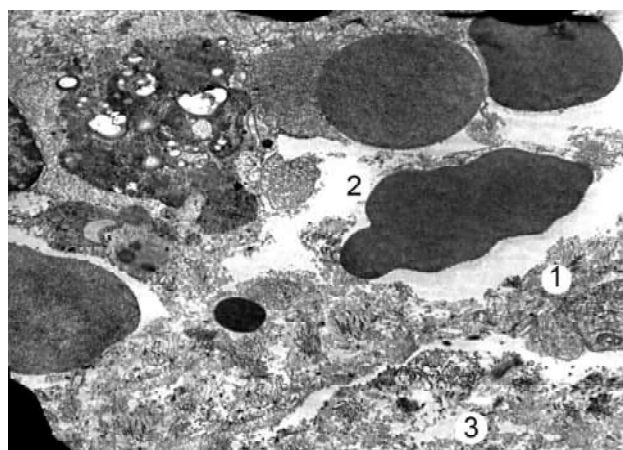


Fig. 12. Submicroscopic changes of the hemocapillary 21 days after burn injury with the introduction of 0.9% NaCl solution: 1 - destroyed endothelial cell, 2 - capillary lumen, 3 - intercellular substance. x9000.

are similar to the previous term of the experiment. In the damaged dermis, there is no boundary between the papillary and mesh layers due to the destruction of the fibrous structures and homogenization of the intercellular substance. Defective walls of many blood capillaries are present. This leads to perivascular edema and hemorrhage (Fig. 12). The established ultrastructural changes of the hemocapillaries of the burn wound aggravate its trophism, promote hypoxia, and inhibit regeneration.

In the long term, the granulation tissue is poorly formed in the wound. Destructively altered fibroblasts with osmiophilic, pyknotic nuclei are observed. Deep invaginations of their karyolemma lead to karyorrhexis. In electron-dense cytoplasm, there are destructed organelles, fragmented, thickened tubules of granular endoplasmic reticulum and cisterns of the Golgi complex. Numerous hypertrophied mitochondria have a light matrix and few cristae (Fig. 13).

The intercellular substance in the central and peripheral areas of the wound is swollen. It has lymphocytes with small pyknotic nuclei, neutrophils and basophils that degranulate. There are also macrophages, the cytoplasm of which contains different in size, mainly rounded autophagosome (Fig. 14).

In the marginal areas of the burn wound in the preserved epidermis, there is a regeneration of the epidermocytes of the germ layer, but it is insignificant. Only individual cells have nuclei with large nuclei and ribosomal granules in the karyoplasm, and the signs of mitotic division are isolated. In many epidermocytes, osmiophilic nuclei with karyolemma invaginations are noted, organelles and tonofilaments are damaged in the cytoplasm. This indicates an inhibition of intracellular regeneration in them.

The intercellular spaces are foci enlarged in some places, and the intercellular contacts are preserved only in some areas (Fig. 15). The basement membrane in the marginal area is unevenly thickened, swollen.

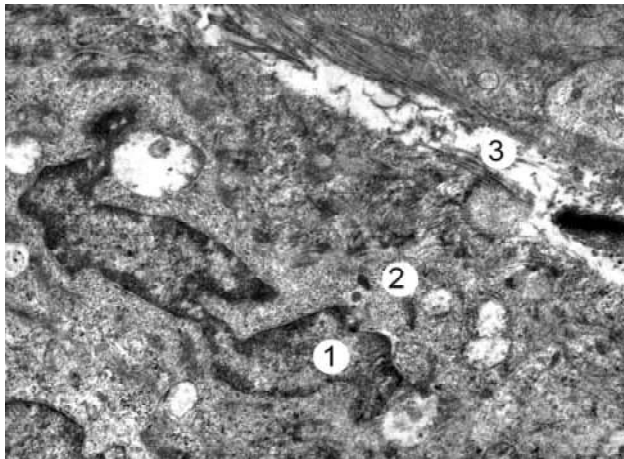


Fig. 13. Submicroscopic changes of fibroblast and intercellular substance of dermis of animal skin after 21 days after burn injury with introduction of 0.9% NaCl solution: 1 - pyknotic fibroblast nucleus, 2 - fibroblast cytoplasm, 3 - intercellular substance. x9000.

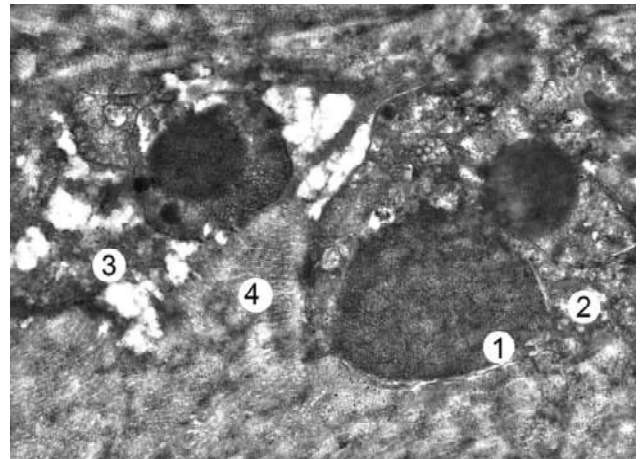


Fig. 14. Ultrastructural changes in connective tissue of the dermis of the animal's skin 30 days after burn injury with the introduction of 0.9% NaCl solution: 1 - pyknotically altered lymphocyte nucleus, 2 - lymphocyte cytoplasm, 3 - cytoplasm of macrophages, 4 - intercellular substance. x9000.

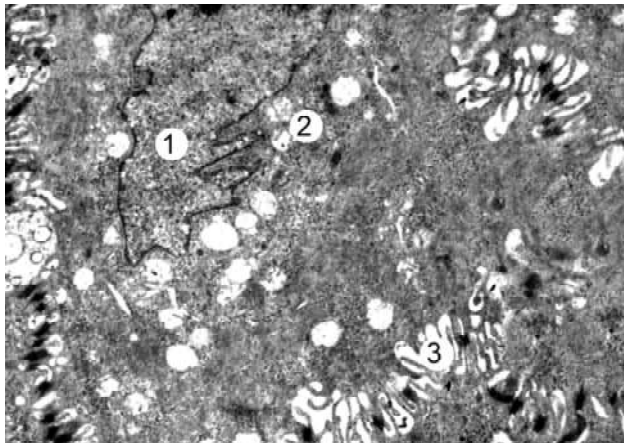


Fig. 15. Submicroscopic condition of epidermocyte of marginal area of wound of animal skin 30 days after burn injury with introduction of 0.9% NaCl solution: 1 - nucleus, 2 - mitochondria, 3 - intercellular contacts. x9000.

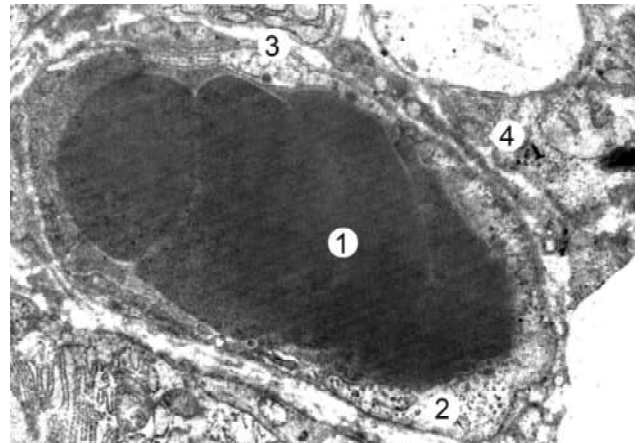


Fig. 16. Submicroscopic condition of hemocapillary of the marginal area of the skin of the animal in 30 days after burn injury with the introduction of 0.9% NaCl solution: 1 - red blood cells in the lumen, 2 - cytoplasm of endothelial cells, 3 - basement membrane, 4 - perivascular space. x9000.

Hemocapillary lumens full-blooded, expanded. The cytoplasm of endothelial cells in their walls with signs of edema. However, perivascular edema, destruction of the basement membrane and hemorrhage are less (Fig. 16).

Discussion

The revealed features of electron microscopic changes in the skin of rats at different periods after thermal trauma confirm the available data in the scientific literature. It was established that deep destruction of the epidermocytes was observed at the 7th day after skin burns in the marginal and central areas of the wound. Much of the cells of the basal and spinous layers of the epidermis had nuclei with signs of pyknosis. Intercellular contacts were broken. Deep necrosis of the dermis of the skin was combined with the destruction of the components of its vascular system. The presence of blood clots in the lumen of the capillaries was

characteristic. Violation of the permeability of their wall was observed, which was accompanied by dermal edema, cellular infiltration of the connective tissue, and significant hemorrhages. On the 14th day of this study, an unformed homogeneous mass containing fragments of destroyed cells, collagen and elastic fibers was found in the wound. The blood capillaries were destructured. In addition, the keratinocytes of the germinal layer of the epidermis showed signs of inhibition of intracellular regeneration. In later periods of thermal trauma (21, 30 days), worsening of the trophism and regeneration of the affected tissues due to disorders of microcirculation were observed, and destructive changes became irreversible [14].

The study of the effect of infusion of 0.9% NaCl solution on the peculiarities of morphological changes of organs and tissues in different periods of burn injury of the skin showed the presence of agreement with the data of our

study. Thus, it was found that in the wall of the small intestine in the period from 14 to 30 days after a thermal injury of the skin under the conditions of the introduction for the first seven days of 0.9% NaCl solution there were significant disturbances of the microcirculatory bed, which were manifested by the expansion or vice versa of narrowing of the lumps and uneven blood filling. Destructive changes in the cells of the epithelial lamina of the villi and the lamina of the small intestinal mucosa were observed. It is characteristic that these changes are not compensatory and adaptive and led to the further development of necrobiotic processes [6].

Electron microscopic examination of the components of the arohematic barrier of rats after skin burns with the introduction of 0.9% NaCl solution for the first seven days revealed significant reactive alveolar changes. Their blood capillaries are enlarged. There is a noticeable restructuring of the components of the arohematic barrier in the form of uneven thickness of its wall due to swelling and enlightenment of the cytoplasmic region of the respiratory epitheliocytes. Initial signs of inhibition of regeneration and destruction of the walls of the alveoli and blood capillaries are available. On the 7th day the thinning of the basement

membrane of hemocapillaries was characteristic. Alveolocytes II showed signs of swelling and vacuolation, had rounded nuclei with nuclear membrane invaginations. In late terms (14, 21 days) revealed profound destructive changes of the alveolar wall, hemocapillaries and alveolar macrophages. Changes in this period were irreversible [17-19].

The established morphological condition of the burn wound indicates the need for the use of corrective drugs in order to reduce destructive changes and activate regenerative processes in the skin lesion area.

Conclusions

1. Conducted electron microscopic studies of the skin of animals after thermal injury under the conditions of application of 0.9% NaCl solution found that in the early stages of the experiment (1, 3, 7 days) compensatory and adaptive changes of its structural components are combined with signs of destructive disorders.

2. In the later stages of the study (14, 21 and 30 days) there is a further development and deepening of destructive-dystrophic changes of all structural components of the affected skin, they become irreversible.

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ЕЛЕКТРОННО-МІКРОСКОПІЧНІ ЗМІНИ В ШКІРІ ЩУРІВ ЧЕРЕЗ 1, 3, 7, 14, 21 ТА 30 ДІБ ПІСЛЯ ТЕРМІЧНОЇ ТРАВМИ НА ФОНІ ВВЕДЕННЯ ПЕРШИХ 7 ДІБ 0,9% РОЗЧИНУ NaCl

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Опікова рана виникає внаслідок дії на шкіру високої температури або хімічних речовин та належить до важких травм із системними наслідками. Проблема лікування термічної травми є актуальною для сучасної медицини. Незважаючи на те, що загальний рівень смертності значно знизився протягом останніх років, надзвичайно важливими є дослідження, присвячені розробці новітніх засобів та технологій лікування пацієнтів з опіками шкіри. Метою роботи є вивчення особливостей електронно-мікроскопічних змін в шкірі щурів протягом місяця після опіку II-III ступеня на фоні введення перших 7 діб 0,9% розчину NaCl. Дослідження проведені на 180 лабораторних білих щурах-самцях масою 155-160 г. В ході експерименту всі тварини були розподілені на 2 групи: 1 - щури без термічної травми, котрим проводили інфузію 0,9% розчину NaCl у дозі 10 мл/кг; 2 група - щури, котрим протягом 7 діб після опіку шкіри проводили інфузію 0,9% розчину NaCl у дозі 10 мл/кг. Опікове пошкодження шкіри викликали шляхом прикладання до бічних поверхонь тулуба щурів на 10 секунд чотирьох мідних пластинок, нагрітих у воді з постійною температурою 100°C. Загальна площа ураження поверхні шкіри у щурів складала 21-23%. Гоління бокових поверхонь тулуба щурів, катетеризацію вен, постановку опіків шкіри та декапітацію тварин (через 1, 3, 7, 14, 21 та 30 діб) проводили в умовах внутрішньовенного пропофолового наркозу (із розрахунку 60 мг/кг маси тіла тварини). Препарати для електронно-мікроскопічного дослідження готували за стандартною методикою. Вивчення отриманих даних проводили за допомогою електронного мікроскопа ПЕМ-125К. Проведені електронно-мікроскопічні дослідження шкіри тварин після термічної травми за умов застосування 0,9% розчину NaCl встановили, що в ранні терміни експерименту - стадії шоку та ранньої токсемії (1, 3, 7 доби), компенсаторно-приспосувальні зміни її структурних компонентів поєднуються з ознаками деструктивних порушень. В епітеліоцитах епідермісу ураженої ділянки шкіри відбувається деструкція ядер і цитоплазми. Судинні розлади в дермі поєднуються зі змінами фібробластів, міжклітинної речовини волокнистої сполучної тканини. У пізні терміни експерименту - стадії пізньої токсемії та септикотоксемії (14, 21 та 30 доби) відбувається подальший розвиток та поглиблення деструктивно-дистрофічних змін всіх структурних компонентів ураженої шкіри, вони набувають незворотного характеру. Сповільнено відбуваються процеси формування грануляційної тканини, її перетворення в сполучну тканину, а також крайова епітелізація. Такий морфологічний стан опікової рани свідчить про необхідність застосування корегуючих препаратів з метою зменшення деструктивних змін та активації регенераторних процесів у ділянці ураження шкіри.

Ключові слова: опіки шкіри, електронно-мікроскопічні зміни, опікова рана, епідермоцити, 0,9% розчин NaCl.

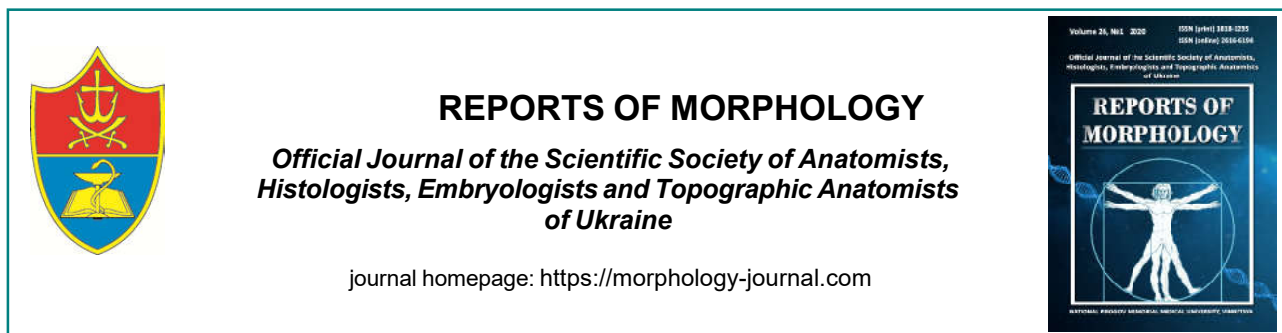
ЕЛЕКТРОННО-МИКРОСКОПИЧЕСКИЕ ИЗМЕНЕНИЯ В КОЖЕ КРЫС ЧЕРЕЗ 1, 3, 7, 14, 21 И 30 СУТОК ПОСЛЕ ТЕРМИЧЕСКОЙ ТРАВМЫ НА ФОНЕ ВВЕДЕНИЯ ПЕРВЫХ 7 ДНЕЙ 0,9% РАСТВОРА NaCl

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Ожоговая рана возникает вследствие воздействия на кожу высокой температуры или химических веществ и принадлежит к тяжелым травмам с системными последствиями. Проблема лечения термической травмы является актуальной для современной медицины. Несмотря на то, что общий уровень смертности значительно снизился в последние годы, чрезвычайно важны исследования, посвященные разработке новейших средств и технологий лечения пациентов с ожогами кожи. Целью работы является изучение особенностей электронно-микроскопических изменений в коже крыс в течение месяца после ожога II-III степени на фоне введения первых 7 дней 0,9% раствора NaCl. Исследования проведены на 180 лабораторных белых крысах-самцах массой 155-160 г. В ходе эксперимента животных были разделены на 2 группы: 1 - крысы без термической травмы, которым проводили инфузию 0,9% раствора NaCl в дозе 10 мл/кг; 2 группа - крысы, которым в течение 7 суток после ожога кожи проводили инфузию 0,9% раствора NaCl в дозе 10 мл/кг. Ожоговое повреждение кожи вызвали путем приложения к боковым поверхностям туловища крыс на 10 секунд четырех медных пластинок, нагретых в воде с постоянной температурой 100°C. Общая площадь поражения поверхности кожи у крыс составляла 21-23%. Бритье боковых поверхностей туловища крыс, катетеризацию вен, постановку ожогов кожи и декапитацию животных (через 1, 3, 7, 14, 21 и 30 суток) проводили в условиях внутривенного пропофолового наркоза (из расчета 60 мг/кг массы тела животного). Препараты для электронно-микроскопического исследования готовили по стандартной методике. Изучение полученных данных проводили с помощью электронного микроскопа ПЭМ-125К. Проведенные электронно-микроскопические исследования кожи животных после термической травмы в условиях применения 0,9% раствора NaCl установили, что в ранние сроки эксперимента - стадии шока и ранней токсемии (1, 3, 7 суток), компенсаторно-приспособительные изменения ее структурных компонентов сочетаются с признаками деструктивных нарушений. В эпителиоцитах эпидермиса пораженного участка кожи происходит деструкция ядер и цитоплазмы. Сосудистые расстройства в дерме сочетаются с изменениями фибробластов, межклеточного вещества волокнистой соединительной ткани. В поздние сроки эксперимента - стадии поздней токсемии и септикотоксемии (14, 21 и 30 суток) происходит дальнейшее развитие и углубление деструктивно-дистрофических изменений всех структурных компонентов пораженной кожи, они приобретают необратимый характер. Замедленно происходят процессы формирования грануляционной ткани,

ее преобразования в соединительную ткань, а также краевая эпителизация. Такое морфологическое состояние ожоговой раны свидетельствует о необходимости применения корректирующих препаратов с целью уменьшения деструктивных изменений и активации регенераторных процессов в области поражения кожи.

Ключевые слова: ожоги кожи, электронно-микроскопические изменения, ожоговая рана, эпидермоциты, 0,9% раствор NaCl.



Change of anthropometric indicators in qualified young women volleyball players during the annual training macrocycle

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ARTICLE INFO

Received: 10 December, 2019

Accepted: 9 January, 2020

UDC: 572.5:796.325-05:611.018.2

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Determining the indicators of the external body structure, which are inherent in highly qualified athletes of a particular sport during the annual training macrocycle, can be reliable markers in sports selection. The aim of the work is to determine the differences of anthropometric dimensions in qualified young women volleyball players at the beginning of the preparatory period and at the end of the competitive period of the annual training cycle. We examined 36 young women volleyball players of the section of sports improvement of National Pirogov Memorial Medical University, Vinnytsya and the women's volleyball team of the Super League of Ukraine "Bilozgar - Medical University". All volleyball players belonged to a juvenile age (from 16 to 20 years) and had a high level of sportsmanship. We conducted two surveys of volleyball players during the 2018-2019 study year: the first - in September 2018, which corresponded to the beginning of the preparatory period of the annual training cycle; the second - in May 2019, which was at the end of the competitive period of the annual training cycle. Anthropometric measurement was performed by the method of V.V. Bunak (1941). The analysis of the obtained results was performed in the license package "Statistica 5.5" using non-parametric methods of evaluation of indicators. At the end of the competition period, compared to the preparatory training period, volleyball players of high level of sportsmanship in adolescence showed a statistically significant decrease in body weight with a significant increase in shoulder width, chest circumference on inspiration, thighs and crus in the upper third, and a tendency to larger values of the height of the suprasternal and shoulder points, torso length and transverse mid-chest diameter. Certain somatometric features of volleyball players can be considered from two aspects: first, as a consequence of qualified prognostic sports selection, and secondly, as a result of training and competitive sports activities. Analysis of external body parameters in volleyball players during the annual macrocycle can be used as criteria for ascertaining sports selection, because when selecting at the stages of advanced specialization it is necessary to identify athletes capable of achieving high sports results, effective sports improvement in subsequent stages of training.

Keywords: anthropometry, young women volleyball players, juvenile age, preparatory and competitive periods, annual macrocycle.

Introduction

The modern methodology of sports selection [3] of volleyball players is based on sports-pedagogical concepts [15], which require the use of constitutional parameters of athletes as prognostic markers [1, 2, 19, 24, 26], indicators of motor and technical fitness [4, 5], biological inclinations of motor abilities [9, 11] and their ratio is determined, which creates the potential for an individual to achieve a high sports result. Scientists have proven the viability of using

genetic markers [6, 8, 10, 16, 17, 19] to diagnose the development of morpho-functional traits and motor skills of athletes. For all the multiplicity and ambiguity of these characteristics, their genetic component, the degree of determination and variability under the influence of phenotypic influences, remains outside the scope of research. Determination of model characteristics of total and partial body sizes, which are inherent in highly qualified

athletes of a particular sport, can be considered when conducting sports prognostic and ascertaining sports selection.

There was a significant difference in the size of anthropometric body size in women volleyball players, compared with girls who did not play sports [20, 21, 23, 26]. But, from our point of view, it was interesting to get an answer to the question of whether somatometric dimensions change in qualified women volleyball players under the influence of sports during the annual macrocycle and what anthropometric indicators can be used as criteria for ascertaining sports selection in women's volleyball.

The aim of the work is to determine the differences of anthropometric dimensions in qualified women volleyball players at the beginning of the preparatory period and at the end of the competitive period of the annual training cycle.

Materials and methods

We examined 36 young women volleyball players of the section of sports improvement of National Pirogov Memorial Medical University, Vinnytsya and the women's volleyball team of the Super League of Ukraine "Bilozgar - Medical University". All volleyball players belonged to a young age (from 16 to 20 years) and had a high level of sportsmanship. By sports categories, the distribution was as follows: 2nd adult category had 9 people (25.0%), 1st adult - 18 people (50.0%), candidates for masters of sports - 5 people (13.9%), masters of sports - 4 people (11.1%). The average sports experience was 5.65 ± 1.35 years. The coach of both teams was the Master of Sports of Ukraine, Ph.D., Associate Professor Yakusheva Y.I. The annual training cycle in both teams (student and professional) had a single-cycle structure and consisted of three periods: preparatory, which lasted about three months (August-October), competitive, which lasted for seven months (late October-early June) and a transition period of two months. We conducted two surveys of volleyball players during the 2018-2019 study year: the first - in September 2018, which corresponded to the beginning of the preparatory period of the annual training cycle; the second - in May 2019, which was at the end of the competitive period of the annual training cycle.

The beginning of the preparatory period of the annual training cycle corresponded to the stage of general training, the main task of which was to form the basis for the development of sports form. In the competitive period stabilization of a sports form at the expense of integral preparation is carried out. The main tasks of this period were to increase the achieved level of special training and achieve high sports results in competitions [14].

Anthropometric measurement was performed by the method of V.V. Bunak [7]. The analysis of the obtained results was carried out with the help of the licensed program "Statistica 5.5" using non-parametric methods of evaluation of indicators. The significance of the difference between the values between the independent quantitative indicators

was determined using the Mann-Whitney U-test.

Results

After comparing the anthropometric dimensions of volleyball players at the beginning of the training period and at the end of the competitive period of the annual training cycle, we found that in volleyball players such total dimensions as length and body surface area do not change significantly. We noted a significant decrease ($p < 0.05$) in body weight at the end of the competitive period (Table 1).

It was found that some longitudinal body sizes during the annual training cycle in adolescent volleyball players have a positive dynamic (Table 2). It is established that female athletes at the end of the year tend to have higher values of the height of the suprasternal and shoulder points. The height of the finger, pubic and trochanter points during the annual training cycle of youth volleyball players does not change significantly.

In volleyball players, the length of the arm and leg does not experience statistically significant differences during the annual training cycle, and the length of the torso has a pronounced tendency to greater values at the end of the competition period (see Table 2).

Analyzing the features of girth, transverse and anterior-posterior torso dimensions in volleyball players in different periods of the annual training cycle, it should be noted that in volleyball players waist and chest girth on exhalation and at rest, lower chest diameter, anterior-posterior mid-thoracic diameter pelvis do not undergo significant changes during the annual training macrocycle (Table 3).

Chest girth on inspiration and shoulder width in volleyball players were statistically significantly greater at the end of the competition period than at the beginning of

Table 1. Total body size of young women volleyball players in different periods of the annual training cycle ($M \pm \sigma$).

Indicators	Preparatory period	Competitive period	p
Body weight (kg)	66.89±6.36	64.16±6.48	<0.05
Body length (cm)	174.3±5.73	175.7±3.26	>0.05
Body surface area (m ²)	1.777±0.140	1.765±0.130	>0.05

Table 2. Features of longitudinal body dimensions in young women volleyball players in different periods of the annual training cycle ($M \pm \sigma$, cm).

Anthropometric dimensions	Preparatory period	Competitive period	p
Height of the suprasternal point	142.5±6.6	143.5±3.2	=0.068
Pubic point height	90.91±4.51	91.31±5.06	>0.05
Height of the shoulder point	145.7±6.4	147.1±4.3	=0.064
Height of the finger point	67.71±4.92	67.84±3.19	>0.05
Height of the trochanter points	92.25±5.71	92.52±4.28	>0.05
Arm length	79.21±3.77	80.06±1.38	>0.05
Body length	54.19±4.25	55.75±1.27	=0.056
Leg length	91.36±4.51	91.37±2.48	>0.05

Table 3. Features of girth, transverse and anterior-posterior torso sizes in young women volleyball players in different periods of the annual training cycle ($M \pm \sigma$, cm).

Anthropometric dimensions	Preparatory period	Competitive period	p
Waist circumference	70.22±5.01	69.83±4.28	>0.05
Chest girth on inhalation	95.05±5.99	97.47±7.14	<0.05
Chest girth on exhalation	85.95±6.34	86.41±6.37	>0.05
Chest girth at rest	89.95±6.29	90.07±5.60	>0.05
Transverse middle thoracic	26.61±2.55	27.94±1.48	=0.056
Transverse lower thoracic	23.68±2.31	24.15±3.38	>0.05
Anterior-posterior mid-thoracic	18.17±1.02	18.02±1.51	>0.05
Shoulder width	36.12±1.16	37.94±1.66	<0.05
Interspinous distance	25.49±2.06	24.84±1.77	>0.05
Intercristal distance	29.59±2.14	29.58±1.65	>0.05
Intertrochanteric distance	32.85±2.02	33.15±1.36	>0.05
External conjugate	19.26±1.76	19.27±1.05	>0.05

Table 4. Features of the width of the distal epiphyses of the limb segments in young women volleyball players in different periods of the annual training cycle ($M \pm \sigma$, cm).

Anthropometric dimensions	Preparatory period	Competitive period	p
Shoulder epiphysis	6.482±0.410	6.564±0.410	>0.05
Forearm epiphysis	5.324±0.331	5.383±0.301	>0.05
Thigh epiphysis	8.743±0.832	8.794±0.512	>0.05
Crus epiphysis	6.842±0.511	6.960±0.423	>0.05

Table 5. Features of circumferential sizes of extremities in young women volleyball players in different periods of an annual training cycle ($M \pm \sigma$, cm).

Anthropometric dimensions	Preparatory period	Competitive period	p
Shoulder in a tense state	28.05±2.37	29.52±1.53	<0.05
Shoulder not in a tense state	26.53±2.48	26.73±2.50	>0.05
Forearms in the upper third	23.98±1.02	23.86±1.61	>0.05
Forearms in the lower third	15.74±0.86	15.83±1.14	>0.05
Hands	18.89±0.77	18.93±1.14	>0.05
Feet	23.05±1.13	23.39±1.21	>0.05
Thigh	54.22±3.62	57.88±3.15	<0.05
Crus in the upper third	36.21±2.54	37.18±1.90	<0.05
Crus in the lower third	22.89±2.45	22.82±1.56	>0.05

the training period (in both cases $p < 0.05$). The transverse mean thoracic diameter tends to increase during the annual macrocycle ($p = 0.056$) (see Table 3).

We found that volleyball players during the annual training macrocycle did not experience significant changes in the size of the transverse dimensions of the diaphysis of large tubular bones (Table 4).

It was found that volleyball players at the end of the competitive period of the training cycle had a significant increase in the girth of the tense shoulder, thigh and crus

in the upper third (in all cases $p < 0.05$) (Table 5). The girth of other segments of the upper and lower extremities do not undergo significant changes during the annual training macrocycle in volleyball players of high skill level of adolescence.

Discussion

An important social problem is the correct assessment of the potential of each person and the optimal use of his physical abilities. Specialization in sports should be based on the adequacy of human biological capabilities to the demands of sports activities. Adequate phenotypic sports orientation will avoid many adverse consequences from the wrong choice of profile of sports specialization. New tasks of sports selection are reduced to disclosure of constitutional features of reactivity of an organism and character of its growth and development on external diagnostically significant signs. The results of research [10, 16, 23] indicate the possibility of predicting the prospects of young athletes on anthropometric traits, which due to genetic conditionality change relatively little.

The length, weight and surface area of the body are signs that must be considered when conducting prognostic and ascertaining sports selection in volleyball [21]. In our previous studies at the beginning of the annual training macrocycle, when comparing anthropometric data between groups of athletes and controls, it was found that length, weight, body surface area, all longitudinal body dimensions, chest and limb circumference, distal epiphyseal width, transverse median and lower thoracic size, anterior-posterior mid-thoracic diameter, intertrochanteric and interspinous distances in qualified volleyball players are significantly larger than in young women who do not play sports [22]. During the annual macrocycle, we did not find significant changes in the length and surface area of volleyball players, although the average group values of body length in volleyball players at the end of the year are higher. Significant weight loss at the end of the competition period can be explained by more intense physical and psycho-emotional stress in volleyball players at the end of the annual macrocycle. When analyzing the dynamics of the longitudinal dimensions of the body, our attention was drawn to a pronounced tendency to increase the length of the torso and the height of the suprasternal and shoulder points, which can be explained by the ontogenetic features of the body of young women. In the research of B. O. Nikityuk it was proved that the closure of the epiphyseal zones of growth of tubular bones in the body of young women occurs in 16-17 years [18]. The exact mechanisms of regulation of processes occurring at the level of epiphyseal germ plates are not known. Among the factors influencing these processes are genetic, vascular, hormonal and biomechanical [13]. In the middle of the XIX century the regularity of influence of the mechanical factor on longitudinal growth of bones was described (Heuter-Volkman's law). The essence of this law is that

longitudinal growth is slowed down by excessive mechanical stress, which has a compressive effect, and conversely, moderate exercise, which has a decompressive effect, stimulates growth processes [12]. Our results on the longitudinal growth of the upper and lower extremities during the annual training cycle does not contradict the previous study. At the same time, the established positive growth dynamics of torso length can be explained by the fact that during the adolescent period of ontogenesis there are processes of longitudinal trunk growth [25], most likely due to the height of vertebral bodies and increasing intervertebral disc thickness.

Thus, the analysis of external body parameters in volleyball players during the annual macrocycle can be used as criteria for ascertaining sports selection, because the selection at the stages of advanced specialization must identify athletes capable of achieving high sports results, effective sports improvement in subsequent stages of long-term training. This problem can be solved only on the basis

of a comprehensive analysis of morphological, functional and mental characteristics of athletes, their adaptive capacity, response to increased training and competitive loads.

Conclusions

1. At the end of the competitive period, compared to the preparatory training period, qualified young women volleyball players showed a significant decrease in body weight with a statistically significant increase in shoulder width, chest girth on inspiration, thighs and crus in the upper third and a tendency to greater values of chest and suprasternal and shoulder points, torso length and transverse mid-sternal diameter.

2. In order to improve the system of sports orientation it is necessary to conduct a comprehensive anthropometric examination after each stage of training athletes, so in further research it is necessary to develop a set of anthroposomatotypological features that can be used as criteria for sports selection in women's volleyball.

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ЗМІНА АНТРОПОМЕТРИЧНИХ ПОКАЗНИКІВ У КВАЛІФІКОВАНИХ ВОЛЕЙБОЛІСТОК ЮНАЦЬКОГО ВІКУ ПРОТЯГОМ РІЧНОГО ТРЕНУВАЛЬНОГО МАКРОЦИКЛУ

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Визначення показників зовнішньої будови тіла, які притаманні висококваліфікованим спортсменам окремого виду спорту протягом річного тренувального макроциклу, можуть виступати надійними маркерами при проведенні спортивного відбору. Мета роботи - визначити відмінності антропометричних розмірів у кваліфікованих волейболісток на початку підготовчого періоду та у кінці змагального періоду річного тренувального циклу. Нами було обстежено 36 волейболісток секції спортивного вдосконалення Вінницького національного медичного університету ім. М.І. Пирогова та жіночої волейбольної команди Супер ліги України "Білозгар - Медуніверситет". Всі волейболістки належали до юнацького віку (від 16 до 20 років) та мали високий рівень спортивної майстерності. Нами було проведено два обстеження волейболісток протягом 2018-2019 навчального року: перше - у вересні 2018 р., що відповідало початку підготовчого періоду річного тренувального циклу; друге - у травні 2019 р., що було у кінці змагального періоду річного тренувального циклу. Антропометричне вимірювання проводили за методом В.В. Бунака (1941). Аналіз отриманих результатів проведено у ліцензійному пакеті "Statistica 5.5" з використанням непараметричних методів оцінки показників. Виявлено у кінці змагального періоду, порівняно з підготовчим тренувальним періодом, у волейболісток високого рівня спортивної майстерності юнацького віку статистично значуще зменшення маси тіла з одночасним достовірним збільшенням ширини плечей, обхватів грудної клітки на вдиху, стегна та гомілки у верхній третині, а також виявлена тенденція до більших значень висоти надгрудниної та плечової точок, довжини тулуба та поперечного середньогрудного діаметра. Визначені соматометричні особливості волейболісток можна розглядати з двох аспектів: по-перше, як наслідок кваліфікованого прогностичного спортивного відбору; по-друге, як результат тренувально-змагальної спортивної діяльності. Аналіз зовнішніх параметрів тіла у волейболісток протягом річного макроциклу можна використовувати як критерії констатуючого спортивного відбору, тому що при відборі на етапах поглибленої спеціалізації необхідно виявляти спортсменів, здатних до досягнення високих спортивних результатів, ефективного спортивного вдосконалення на наступних етапах багаторічної підготовки.

Ключові слова: антропометрія, волейболістки, юнацький вік, підготовчий та змагальний періоди, річний макроцикл.

ИЗМЕНЕНИЕ АНТРОПОМЕТРИЧЕСКИХ ПОКАЗАТЕЛЕЙ У КВАЛИФИЦИРОВАННЫХ ВОЛЕЙБОЛИСТОК ЮНОШЕСКОГО ВОЗРАСТА В ТЕЧЕНИЕ ГОДИЧНОГО ТРЕНИРОВОЧНОГО МАКРОЦИКЛА

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Определение показателей внешнего строения тела, которые присущи высококвалифицированным спортсменам отдельного вида спорта в течение годового тренировочного макроцикла, могут выступать надежными маркерами при проведении спортивного отбора. Цель работы - определить различия антропометрических размеров у квалифицированных волейболисток в начале подготовительного периода и в конце соревновательного периода годичного тренировочного цикла. Нами было обследовано 36 волейболисток секции спортивного усовершенствования Винницкого национального медицинского университета им. Н.И.Пирогова и женской волейбольной команды Супер лиги Украины "Билозгар - Медуниверситет". Все волейболистки принадлежали к юношескому возрасту (от 16 до 20 лет) и имели высокий уровень спортивного мастерства. Нами было проведено два обследования волейболисток в течение 2018-2019 учебного года: первое - в сентябре 2018, что соответствовало началу подготовительного периода годичного тренировочного цикла; второе - в мае 2019, что было в конце соревновательного периода годичного тренировочного цикла. Антропометрические измерения проводили по методу В.В. Бунака (1941). Анализ полученных результатов проведен в лицензионном пакете "Statistica 5.5" с использованием непараметрических методов оценки показателей. Виявлено в конце соревновательного периода по сравнению с подготовительным тренировочным периодом, у волейболисток высокого уровня спортивного мастерства юношеского возраста статистически значимое уменьшение массы тела с одновременным достоверным увеличением ширины плеч, обхватов грудной клетки на вдохе, бедра и голени в верхней трети, а также выявлена тенденция к большим значениям высоты надгрудной и плечевой точек, длины туловища и поперечного среднегрудного диаметра. Определенные соматометрические особенности волейболисток можно рассматривать с двух аспектов: во-первых, как следствие квалифицированного прогностического спортивного отбора; во-вторых, как результат тренировочно-соревновательной спортивной деятельности. Анализ внешних параметров тела у волейболисток в течение годичного макроцикла можно использовать в качестве критериев констатирующего спортивного отбора, так как при отборе на этапах углубленной специализации необходимо выявлять спортсменов, способных к достижению высоких спортивных результатов, эффективного спортивного совершенствования на следующих этапах многолетней подготовки.

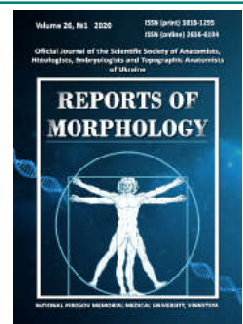
Ключевые слова: антропометрия, волейболистки, юношеский возраст, подготовительный и соревновательный периоды, годовой макроцикл.



REPORTS OF MORPHOLOGY

Official Journal of the Scientific Society of Anatomists,
Histologists, Embryologists and Topographic Anatomists
of Ukraine

journal homepage: <https://morphology-journal.com>



Submicroscopic changes in the liver of young rats with hyperhomocysteinemia

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ARTICLE INFO

Received: 12 December, 2019

Accepted: 14 January, 2020

UDC: 616-001.17:615.451.3

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To date, it has been established that hyperhomocysteinemia plays a significant role in the development and progression of many diseases. The accumulation of homocysteine occurs due to a violation of the relationship between its production and excretion from the body. The liver plays an important role in the metabolism of homocysteine, because it undergoes most of the reactions of its transmethylation, and, therefore, it is the first to be adversely affected. The aim of the study is to identify the features of electron microscopic changes in the liver structure of young rats with hyperhomocysteinemia. The experimental study was performed on 22 white nonlinear young (1-2 months) male rats, which were divided into a control group and an experimental group. A model of persistent hyperhomocysteinemia was created by administering to rats the experimental group of thiolactone homocysteine at a dose of 200 mg/kg body weight intragastrically for 60 days. The study of ultrastructural changes in the liver of rats was performed using an electron microscope PEM-125K. It was found that the introduction of thiolactone homocysteine at a dose of 200 mg/kg in rats led to the development of degenerative changes in hepatocytes. Changes in the structure of liver cells manifested themselves in the form of edema of the cytoplasm and mitochondria, destruction of mitochondrial cristae, dilation of the tubules of the granular endoplasmic reticulum and tanks of the Golgi complex. The activity of fat-accumulating liver cells and stellate macrophages is characteristically. In the lumens of the sinusoidal capillaries found sweeter shaped blood elements, the cytoplasm of endothelial cells had signs of edema. Thus, in experimental hyperhomocysteinemia revealed changes at the ultrastructural level in all structural components of the liver of young rats. The identified changes are compensatory-adaptive in nature and are reversible.

Keywords: hyperhomocysteinemia, hepatocytes, mitochondria, macrophages, sinusoidal capillaries.

Introduction

In the last few years, the amino acid homocysteine has attracted a lot of attention from researchers. This phenomenon is associated with the emergence of new research, which shows the extremely negative impact of elevated levels on the body and participation in the pathogenesis of many diseases. Homocysteine is a non-protein sulfhydryl amino acid formed during the metabolism of the essential amino acid methionine [16, 18, 19]. Intracellular homocysteine metabolism is carried out in several stages. S-adenosylmethionine is synthesized from methionine with the participation of the enzyme methionine adenosyltransferase. The latter, losing the methyl group, is converted to S-adenosylhomocysteine. Subsequently, adenosine and homocysteine are formed due to S-

adenosylhomocysteine hydrolase. The process of elimination of excess homocysteine in the body is provided by three ways - remethylation, transsulfation, desulfurization [9, 15]. The mechanism of remethylation is based on the process of resynthesis of methionine from homocysteine with the obligatory participation of vitamin B12 and methionine synthase. In the process of transsulfation, homocysteine is converted to cystathionine under the action of the enzyme cystathionine- β -synthetase. Subsequently, the formed cystathionine, already under the influence of vitamin B6-dependent enzyme γ -cystathionase decomposes into cysteine, ammonia and α -ketobutyrate [7]. Due to the transsulfation process, the excretion of up to 70-80% of excess homocysteine levels is ensured, the rest is

accounted for by remethylation and desulfation mechanisms. As a result of the latter, homocysteine is converted to hydrogen sulfide.

Many studies have been assigned to the study of the pathogenetic effects of elevated plasma homocysteine levels, but to this day this issue remains incomplete. Most researchers identify several mechanisms of adverse effects of hyperhomocysteinemia. These include: activation of oxidative stress, expression of mediators of inflammation and fibrosis, inhibition of methylation processes, homocysteine protein synthesis [9, 14, 16].

Scientists around the world have begun to actively study the effects of hyperhomocysteinemia on the structure and function of the liver. Being an important organ for life, it takes an active part in the processes of metabolism and utilization of homocysteine, which is due to the considerable interest of researchers. The pathogenesis of liver cell damage today remains poorly understood. It is established that the damage is based on endothelial dysfunction caused by hyperhomocysteinemia, lipid and protein peroxidation. There are also hypotheses about the direct toxic effects of homocysteine on the mitochondria of hepatocytes [4, 8].

Thus, the study of the features of electron microscopic changes in the structure of the liver is an important and urgent task that will expand the understanding of the pathogenesis of its lesions in hyperhomocysteinemia.

The aim of the study is to identify the features of electron microscopic changes in the liver structure of young rats with hyperhomocysteinemia.

Materials and methods

The experiments were performed on 22 white nonlinear young (1-2 months) male rats, which were divided into a control group and an experimental group. A model of persistent hyperhomocysteinemia was created by administering to rats the experimental group of thiolactone homocysteine at a dose of 200 mg/kg body weight intragastrically for 60 days. Animals were decontaminated by decapitation under thiopental anesthesia. Committee on Bioethics of National Pirogov Memorial Medical University, Vinnytsya found that the experimental study was conducted considering the recommendations of the European Commission for medical and biological research using animals, medical recommendations of the State Pharmacological Center of the Ministry of Health of Ukraine and "Rules for clinical safety assessment of pharmacological agents (GLP)".

For morphological examination, pieces of liver 0.5-1.0 mm in size were taken and fixed in a 2.5% solution of glutaraldehyde with an active reaction medium pH 7.2-7.4, prepared on phosphate buffer. Next, the material was postfixed in a 1% solution of osmium tetroxide according to Caulfield. Dehydrated in alcohols of increasing concentration (70%, 80%, 90%, 100%) and acetone [6]. Poured into a mixture of epon-araldite. Semi-thin sections were made from the obtained blocks, which were stained with toluidine blue

and Hyatt. After aiming at semi-thin sections, ultrathin sections contrast with 2% uranyl acetate solution and lead citrate were made on LKB III (Sweden) and Reihart (Austria) ultratomas. The preparations were examined and photographed under an electron microscope PEM-125K.

Results

Electron microscopic studies of the liver of young rats under conditions of hyperhomocysteinemia caused by the introduction of thiolactone homocysteine at a dose of 200 mg/kg, found the presence of moderate dystrophic changes in hepatocytes. The latter manifested as accumulations of heterochromatin in the marginal and central parts of the nucleus. The nuclear membrane was characterized by the presence of intussusception, compared with the control group (Fig. 1).

In the cytoplasm of hepatocytes there is a significant number of mitochondria, the size of which is larger than that of intact young rats. They are characterized by the presence of a fine-grained matrix and numerous cristae. It should be noted that in some places hepatocytes were found, in which mitochondria formed buds, were swollen, with signs of disorganization and destruction of the cristae. The cisterns of the granular endoplasmic reticulum are dilated, and a large number of ribosomes are present on its membranes. Hyperplasia of the membranes of the endoplasmic reticulum was detected in some hepatocytes. Their cytoplasm contained numerous ribosomes, polysomes and granules of glycogen (Fig. 2).

Cells with hypertrophied Golgi complex and high content of autophagosome and fat droplets were also detected. The lumens of the bile ducts are dilated, they have few microvilli. However, the destruction of hepatocyte microvilli in the bile capillaries and perisinusoidal spaces was not detected (Fig. 3).

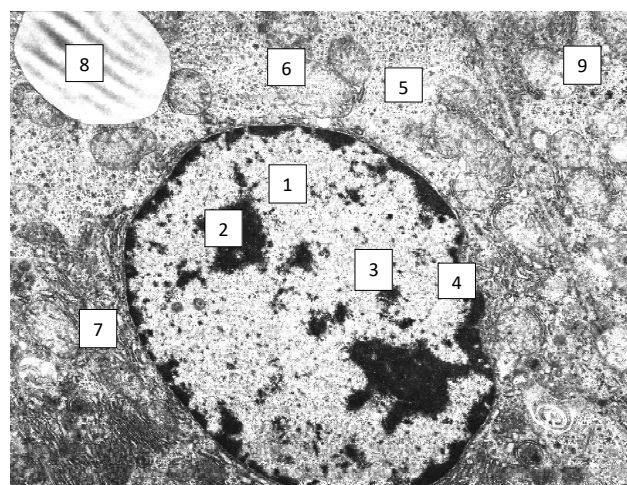


Fig. 1. Electronogram of the liver of young rats with hyperhomocysteinemia: 1 - hepatocyte nucleus, 2 - nucleolus, 3 - lumps of heterochromatin, 4 - intussusception of karyolemma, 5 - cytoplasm of hepatocyte, 6 - destruction of cristae and edema of the matrix of mitochondria, 7 - tanks of granular endoplasmic reticulum, 8 - fat droplets, 9 - glycogen granules. x4800.

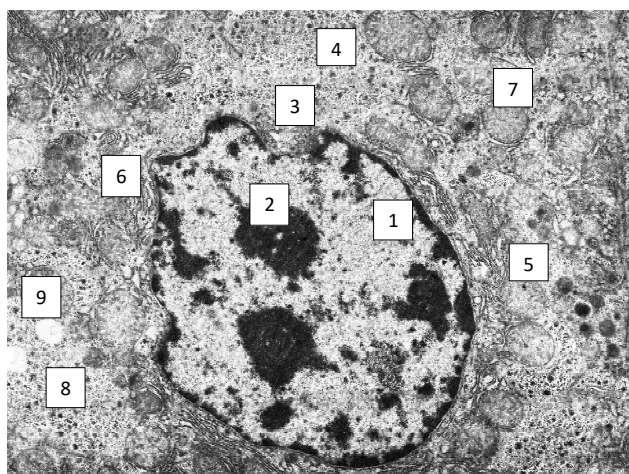


Fig. 2. Electronogram of the liver of young rats with hyperhomocysteinemia: 1 - hepatocyte nucleus, 2 - nucleolus, 3 - karyolemma intussusception, 4 - hepatocyte cytoplasm, 5 - mitochondria, 6 - granular endoplasmic reticulum tanks, 7 - lysosomes, 8 - the inclusion of glycogen, 9 - fat droplets. x4800.

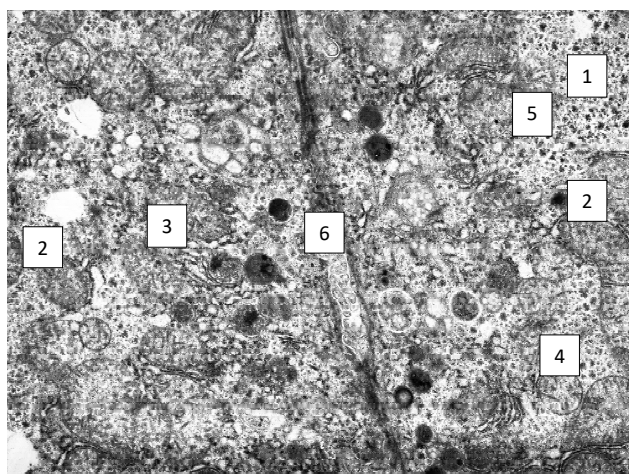


Fig. 3. Electronogram of the liver of a young rat with hyperhomocysteinemia: 1 - hepatocyte cytoplasm, 2 - mitochondria, 3 - granular endoplasmic reticulum tanks, 4 - lysosomes, 5 - glycogen lumps, 6 - bile duct lumen. x6400.

The nuclear envelope of endothelial cells in the walls of sinusoidal capillaries was moderately fluffy, had different depths of intussusception. In the cytoplasm of endotheliocytes, a small number of swollen mitochondria and electron-transparent tanks of the granular endoplasmic reticulum were found. It should be noted the increased number of cristae in mitochondria, as well as ribosomes on the membranes of the granular endoplasmic reticulum compared to those in intact young rats. Increased number of freely located in the cytoplasm of secondary lysosomes. The plasma membrane of endothelial cells formed numerous outgrowths in the lumen of the sinusoids. In the cytoplasm of stellate macrophages there are significantly more heterophagosomes and autophagosomes than in intact young rats, which indicates increased functional activity of these cells (Fig. 4).

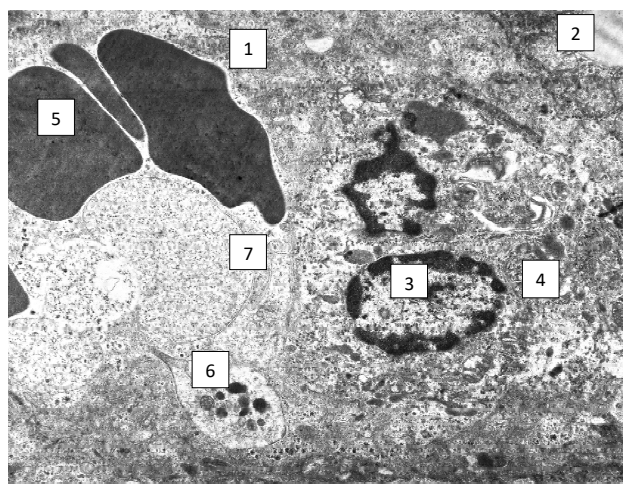


Fig. 4. Electronogram of the liver of young rat with hyperhomocysteinemia: 1 - vascular part of the cytoplasm of the hepatocyte, 2 - a drop of fat, 3 - the nucleus of the stellate macrophage, 4 - the cytoplasm of the stellate macrophage, 5 - sludge of erythrocytes in the lumen of sinusoid, 6 - platelets in the lumen of the sinusoid, 7 - swelling of the cytoplasm of the endothelial cell in the sinusoidal wall. x4800.

Discussion

The results of electron microscopic examination of the liver structure under conditions of hyperhomocysteinemia are consistent with the available data in the literature. It is established that hyperhomocysteinemia causes enhancement of biosynthetic processes in hepatocytes and is characterized by the development of dystrophic changes in them. The latter will cover in most cases the nuclear apparatus and mitochondria. Hyperhomocysteinemia also causes the appearance of so-called mitochondrial spheroids and concentric orientation of granular endoplasmic reticulum tanks. In addition, there is damage to the microcirculatory tract of the liver and the development of fibrogenesis [12].

High concentrations of homocysteine in blood plasma are associated with the development of hydropic and fatty liver disease. In addition, histological examination also reveals histio-leukocyte infiltration of the portal areas, hyperplasia of stellate cells, necrosis of hepatocytes, fibrosis in the portal areas and around the central veins [3, 11].

Hyperhomocysteinemia leads to increased energy metabolism in the mitochondria of hepatocytes, which is manifested by increased activity of lactate dehydrogenase, succinate dehydrogenase and H⁺-ATPase. This condition is characterized by impaired calcium deposition, increased carbonylation of mitochondrial proteins, a significant decrease in reserve-adaptation potential and increased superoxide dismutase activity [10, 20].

It is established that one of the reasons for the development and progression of non-alcoholic fatty liver disease may be high levels of homocysteine in the blood. Hyperhomocysteinemia is the basis for the occurrence of steatohepatitis, an increase in the lipid spectrum of the blood, and subsequently - the growth of the process into

fibrosis and cirrhosis of the liver [1, 2]. The development of fibrosis is more likely to occur due to inhibition of hepatocyte regeneration and increased proliferation of fibroblasts [5].

There are data on the negative effects of homocysteine on protein, carbohydrate and fat metabolism in liver cells [21]. At the optical level, these disorders are manifested in the form of steatosis, multilobular fibrosis with signs of parenchymal and stromal reactions [17]. Hyperhomocysteinemia also has a toxic effect on the endothelium of the hepatic vessels due to the production of significant amounts of free radicals and stress of the endoplasmic reticulum [13].

Conclusions

Experimental hyperhomocysteinemia revealed changes at the ultrastructural level in all structural components of

the liver of young rats. Hepatocytes showed signs of moderate dystrophic changes. The nuclei were characterized by the presence of compacted chromatin, and the nuclear membrane had numerous intussusceptions. There were signs of pyknosis in some places. The mitochondria of liver cells contain numerous cristae with signs of destruction, their matrix is enlightened. The expansion of the tubules of the granular endoplasmic reticulum and tanks of the Golgi complex is characteristic. Accumulation of fat and glycogen in hepatocytes was revealed. The bile duct lumens and perisinusoidal spaces were dilated. The latter contained stellate macrophages, fat-accumulating cells, fibroblasts, collagen and elastic fibers. The data obtained by us by electron microscopic examination of the structure of the liver are compensatory-adaptive in nature and are inverse.

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СУБМІКРОСКОПІЧНІ ЗМІНИ В ПЕЧІНЦІ ЩУРІВ МОЛОДОГО ВІКУ ПРИ ГІПЕРГОМОЦИСТЕЇНЕМІЇ

Галаган Ю.В.

На сьогоднішній день встановлено, що гіпергомоцистеїнемії відводиться значна роль у розвитку та прогресуванні багатьох захворювань. Накопичення гомоцистеїну виникає внаслідок порушення співвідношення між його продукцією та виведенням з організму. Печінка відіграє вагомое значення в обміні гомоцистеїну, оскільки в ній відбувається більша частина реакцій його трансметилування, а, отже, вона найпершою піддається негативному впливу. Метою дослідження є виявлення особливостей електронно-мікроскопічних змін структури печінки щурів молодого віку при гіпергомоцистеїнемії. Експериментальне дослідження проведене на 22 білих нелінійних молодих (1-2 місяці) щурах-самцях, яких було поділено на групу контролю та дослідну групу. Модель стійкої гіпергомоцистеїнемії створювали шляхом введення щурам дослідної групи тіолактону гомоцистеїну в дозі 200 мг/кг маси тіла інтрагастрально протягом 60 днів. Вивчення ультраструктурних змін в печінці щурів проводили за допомогою електронного мікроскопу ПЕМ-125К. Встановлено, що введення щурам тіолактону гомоцистеїну в дозі 200 мг/кг призвело до розвитку дистрофічних змін гепатоцитів. Зміни структури клітин печінки проявлялись у вигляді набряку цитоплазми та мітохондрій, деструкції мітохондріальних крист, розширенням канальців гранулярної ендоплазматичної сітки та цистерн комплексу Гольджі. Характерним є підвищення активності жиронакопичувальних клітин печінки та зірчастих макрофагів. У просвітах синусоїдних капілярів виявляли складні формених елементів крові, цитоплазма ендотеліоцитів мала ознаки набряку. Таким чином, при експериментальній гіпергомоцистеїнемії встановлені зміни на ультраструктурному рівні в усіх структурних компонентах печінки молодих щурів. Встановлені зміни мають компенсаторно-адаптаційний характер та є зворотними.

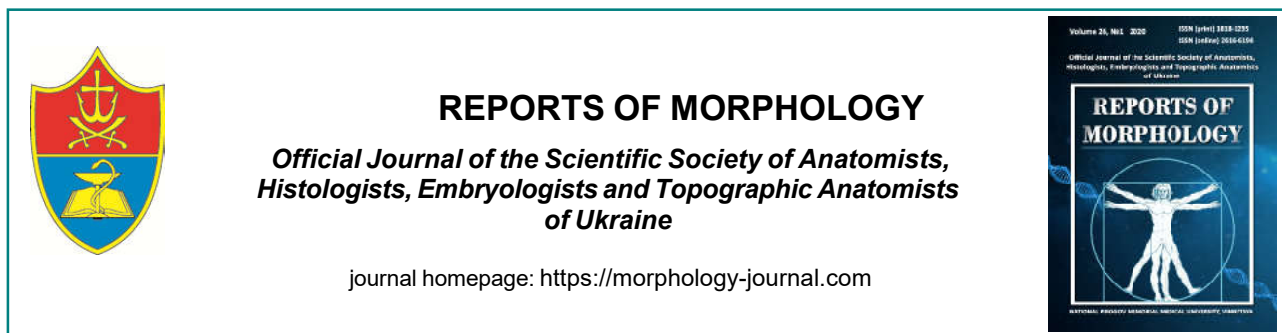
Ключові слова: гіпергомоцистеїнемія, гепатоцити, мітохондрії, макрофаги, синусоїдні капіляри.

СУБМИКРОСКОПИЧЕСКИЕ ИЗМЕНЕНИЯ В ПЕЧЕНИ КРЫС МОЛОДОГО ВОЗРАСТА ПРИ ГИПЕРГОМОЦИСТЕИНЕМИИ

Галаган Ю.В.

На сегодняшний день установлено, что гипергомоцистеинемии отводится значительная роль в развитии и прогрессировании многих заболеваний. Накопление гомоцистеина возникает вследствие нарушения соотношения между его продукцией и выведением из организма. Печень играет большое значение в обмене гомоцистеина, поскольку в ней происходит большая часть реакций его трансметилирования, а, следовательно, она первой подвергается негативному воздействию. Целью исследования является выявление особенностей электронно-микроскопических изменений структуры печени крыс молодого возраста при гипергомоцистеинемии. Экспериментальное исследование проведено на 22 белых нелинейных молодых (1-2 месяца) крысах-самцах, которые были разделены на группу контроля и исследовательскую группу. Модель стойкой гипергомоцистеинемии создавали путем введения крысам исследовательской группы тиолактону гомоцистеина в дозе 200 мг/кг массы тела интрагастрально в течении 60 дней. Изучение ультраструктурных изменений в печени крыс проводили с помощью электронного микроскопа ПЭМ-125К. Установлено, что введение крысам тиолактона гомоцистеина в дозе 200 мг/кг привело к развитию дистрофических изменений гепатоцитов. Изменения структуры клеток печени проявлялись в виде отека цитоплазмы и митохондрий, деструкции митохондриальных крист, расширением канальцев гранулярной эндоплазматической сети и цистерн комплекса Гольджи. Характерно повышение активности жиронакопительных клеток печени и звездчатых макрофагов. В просветах синусоидальных капилляров выявляли сложные форменных элементов крови, цитоплазма эндотелиоцитов имела признаки отека. Таким образом, при экспериментальной гипергомоцистеинемии установлены изменения на ультраструктурном уровне во всех структурных компонентах печени молодых крыс. Выявленные изменения имеют компенсаторно-адаптационный характер и являются обратимыми.

Ключевые слова: гипергомоцистеинемия, гепатоциты, митохондрии, макрофаги, синусоидальные капилляры.



Analysis of risk factors and stroke structure according to the hospital register of clinics in Vinnytsia for 2017-2019

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ARTICLE INFO

Received: 12 December, 2019

Accepted: 14 January, 2020

UDC: 616.71007.234:577.161.2

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Due to the analysis of a whole set of indicators of the quality of medical care for acute cerebrovascular accident (ACA), and above all, the identification of major shortcomings in the maintenance of stroke register, it is possible to reduce morbidity, mortality and disability from this nosology. The purpose of the work is to study and compare the structure and risk factors of stroke according to the hospitals of Vinnytsia for the period 2017-2019. The stroke register was created on the basis of medical documentation of hospitals of the municipal non-profit enterprise "Vinnytsia Regional Clinical Psychoneurological Hospital named after Academician O.I. Yushchenko of Vinnytsia Regional Council" (VRCPNH) and Vinnytsia City Clinical Hospital of Emergency Medical Services (VCCHEMS), which are the most typical for this region of Ukraine. Statistical processing of the results was performed using the licensed statistical package "Statistica 5.5" using parametric evaluation methods. Between the two medical institutions in Vinnytsia and in the dynamics of time there were significant differences in different age, sex, type of stroke contingent of patients. When comparing the data of the territorial-population register of stroke in hospitals in Vinnytsia in 2017-2019, it was found that in both studied institutions the percentage of young and middle-aged patients, especially men, increased. The percentage of young and middle-aged patients in VRCPNH is higher than in VCCHEMS. Modified risk factors, which are currently the most important medical and social problem, are analyzed. There were no significant differences in the dynamics of stroke in both hospitals. The percentage of patients who had a stroke in hospital has decreased over time. The meteorological dependence of stroke has been proved, which points to the importance of preventive measures for people at risk. The main shortcomings in the collection of anamnestic data are analyzed. Analysis of risk factors for stroke suggests that the disease is based on various causes.

Keywords: stroke, gender differences, stroke risk factors, register method.

Introduction

Acute cerebrovascular accident (ACA) occupies one of the leading places in the structure of vascular pathology of the brain. Stroke significantly reduces the duration, quality of life in the future and is associated with high material costs due to the high disability of surviving patients [8].

It is believed that stroke most often occurs in the elderly. In the next 10-15 years in economically developed countries, an increase in the incidence of stroke is expected due to an increase in the share of elderly people in the population [24]. The probability of getting ACA increases with age and, in fact, after 55 years, for every decade of life, it doubles. However, according to current data, only two thirds of vascular accidents occur in patients older than 60 years. And along with this there is a tendency to "rejuvenate" this pathology.

One third of ACA falls on the age period of 20-60 years [9, 13].

According to world statistics, hemorrhagic strokes are more common in young patients and ischemic strokes in the elderly. Females are more likely to have ischemic strokes, and men are more likely to have hemorrhagic strokes. There is no other gender division in strokes. Gender does not affect the severity of the condition and the quality of recovery after this pathology - it all depends on the time, adequacy of care, individual characteristics of the body and comorbidities [4, 24].

A number of studies have described the seasonality of ACA development. This concept is understood as regular fluctuations in the incidence rate during a calendar or epidemic year, due to long-term timing of rises and falls in

its levels in certain months and seasons [5, 23, 25]. The trigger for the development of ACA may be physiological processes associated with changes in weather. We can assume the influence of external and internal triggers of its development in the time period preceding the onset of stroke, and this is of great importance for prevention in a particular region [3, 19, 20].

Despite the priority of stroke prevention, most countries do not have reliable information on epidemiological indicators such as the incidence of atrial fibrillation and carotid artery stenosis. These are nosologies, a change in the approach to diagnosis and treatment of which affects the risk of stroke [1, 6]. Thus, the course of atrial fibrillation and carotid artery stenosis is difficult to predict - the process can progress very rapidly or slowly, or be stable for many years. Dispensary accounting and choice of treatment tactics for both "asymptomatic" and "symptomatic" patients is extremely important [2, 8, 16].

The prognosis for a patient with acute cerebrovascular accident largely depends on the timeliness of medical treatment. The time factor plays a significant role in both hemorrhagic and ischemic stroke. Modern doctors need to provide qualified medical care to a patient with a stroke as soon as possible, including neuroimaging diagnosis and aggressive treatment with thrombolytic therapy [18]. However, the situation may be complicated by the fact that among strokes there is a certain proportion of cases that are asymptomatic or may occur during treatment for therapeutic and surgical pathology. With timely hospitalization in specialized neurological departments, the mortality of patients in the acute period of stroke and the degree of disability is much lower than those who stayed at home or were hospitalized in a non-specialized department or transferred to a specialized department in a few days [15].

Thus, when registering, it is important to record data on the percentage of patients who had a stroke in the hospital (patients were transferred to a special hospital from other departments), who have cardiac arrhythmias and carotid artery stenosis. In addition, the formal entry of information about the time (month, season) of the symptoms of acute cerebrovascular accident and age at the time of hospitalization is unacceptable.

The purpose of the work is to study and compare the structure and risk factors of stroke according to the data of hospitals in Vinnytsia for the period 2017-2019.

Materials and methods

Data on cases of stroke were obtained on the basis of medical documentation of medical institutions (for 2017-2019), which are the most typical for the selected region of Ukraine, namely the municipal non-profit enterprise "Vinnytsia Regional Clinical Psychoneurological Hospital named after Academician O. I. Yushchenko of Vinnytsia Regional Council" (VRCPNH) and Vinnytsia City Clinical Hospital of Emergency Medical Services (VCCHEMS). In each hospital, data collection and processing were

Table 1. Distribution of men and women with ACA in stroke unit of VRCPNH or VCCHEMS for 2017-2019.

Groups surveyed	Years of research	Sex	Hospitals	
			VRCPNH	VCCHEMS
General	2017	men	307	351
		women	209	335
	2018	men	312	310
		women	187	306
	10 months 2019	men	287	182
		women	175	163
Ischemic stroke	2017	men	269	308
		women	184	296
	2018	men	267	276
		women	166	282
	10 months 2019	men	248	162
		women	152	153
Hemorrhagic stroke	2017	men	37	42
		women	25	39
	2018	men	45	34
		women	21	24
	10 months 2019	men	39	20
		women	23	10

performed by a certified neurologist. The obtained data and their reliability were checked in the journals of patients and the bureau of medical and social examination. The RES-Q report form was completed on a case-by-case basis - a special report forms in an international program developed by the European Stroke Society (ESO) ESO-EAST initiative. Data on the initial examination and medical history of the patient were recorded, the place (in the hospital, not in the hospital) and the time of year of the stroke were indicated. Atrial fibrillation, carotid artery stenosis was considered if their history was recorded.

Quantitative distribution of patients with ACA in stroke block of VRCPNH or VCCHEMS are presented in table 1.

Statistical processing of the results was performed using the licensed statistical package "Statistica 5.5" using parametric evaluation methods.

Results

When comparing the percentage of patients who had a stroke *before the age of 40*, in VRCPNH found significantly ($p < 0.05$) greater in patients with ischemic stroke and less - with hemorrhagic stroke (in 2017 - 1.4% in women in general and 1.6% with ischemic stroke; in 2019 - 3.6% in men with ischemic stroke and 0% with hemorrhagic stroke) compared with VCCHEMS (2017 - 0% in women in general and 0% with ischemic stroke; in 2019 - 0.6% in men with ischemic stroke and 10.0% with hemorrhagic stroke).

In VRCPNH, the percentage of patients *under the age of 40* in 2019 was significantly ($p < 0.05$) higher than in 2018 (in

2018 - 0.5% in women in general and 0.6% with ischemic stroke; in 2019 - 3.4% in women in general and 3.9% with ischemic stroke). In VCCHEMS also over time significantly ($p < 0.01-0.001$) increased the percentage of patients of this age (2017 - 0% in women in general and 0% with ischemic stroke; in 2018 - 0.7% in women in general; 2019 - 1.2% in women in general and 1.3% with ischemic stroke).

In VRCPNH, the percentage of patients with ischemic stroke at the age of 41-50 years was significantly ($p < 0.05$) higher (2019 - 7.4% in women in general and 8.1% with ischemic stroke) compared with VCCHEMS (2019 - 2.5% in women in general and 2.0% with ischemic stroke). In VRCPNH in 2019 the percentage of women with ischemic stroke was significantly ($p < 0.05$) higher, and in women with hemorrhagic stroke had a tendency ($p = 0.063$) to lower values compared to 2017 (2017 - 3.3% in women with ischemic stroke and 24.0% with hemorrhagic stroke; in 2019 - 7.9% of women with ischemic stroke and 4.3% with hemorrhagic stroke).

The percentage of patients who had a stroke at the age of 51-60 years in VRCPNH is significantly ($p < 0.05-0.001$) higher (2017 - 27.7% in men in general, 26.4% with ischemic stroke, 23.0% in women in general, 21.2% with ischemic stroke and 36.0% with hemorrhagic stroke; in 2018 - 30.8% in men in general and 30.3% in ischemic stroke, 20.3% in women in general and 21.1% with ischemic stroke, in 2019 - 33.4% in men in general and 32.7% with ischemic stroke, 18.3% in women in general and 38.5% with hemorrhagic stroke) compared with VCCHEMS (2017 - 19.1% in men in general and 17.9% with ischemic stroke, 7.5% in women in general, 6.8% with ischemic stroke and 12.8% with hemorrhagic stroke; in 2018 - 19.4% in men in general and 18.1% with ischemic stroke, 11.8% in women in general and 1.7% with ischemic stroke; 2019 - 16.5% in men in general and 16.7% with ischemic stroke, 6.7% in women in general and 0% with hemorrhagic stroke).

In VRCPNH, the percentage of women with ischemic stroke aged 51-60 years in 2019 was significantly ($p < 0.05$) lower compared to 2017 and 2018 (respectively 11.8% - 21.2% - 14.3%). In the same medical institution, the percentage of women with hemorrhagic stroke aged 51-60 years in 2019 was significantly ($p < 0.05$) higher than in 2018 (60.9% and 14.3%, respectively). In 2018, the percentage of patients of this age was significantly ($p < 0.001$) higher than in 2017 and 2019 in VCCHEMS (in 2018 - 11.8% in women in general and 1.7% with ischemic stroke; in 2017 - 7.5% in women in general and 6.8% with ischemic stroke; in 2019 - 6.7% for women in general and 7.2% with ischemic stroke).

The percentage of patients who had a stroke at the age of 61-70 years, in VRCPNH is significantly ($p < 0.05-0.001$) higher (in 2017 - 41.3% in men with ischemic stroke; in 2018 - 48.7% in women in general, 47.0% with ischemic stroke and 61.9% with hemorrhagic stroke; in 2019 - 44.6% in women in general and 46.1% with ischemic stroke) compared to VCCHEMS (in 2017 - 32.5% in men with ischemic stroke; in 2018 - 27.1% in women in general, 28.0%

with ischemic stroke and 16.7% with hemorrhagic stroke; in 2019 - 28.8% in women in general and 28.1% with ischemic stroke).

In VRCPNH, the percentage of women with stroke aged 61-70 years in 2017 was significantly ($p < 0.01-0.001$) lower compared to 2018 and 2019 (in 2017 - 28.2% in women in general, 28.8% with ischemic stroke and 24.0% with hemorrhagic stroke; in 2018 - 48.7% in women in general, 47.0% with ischemic stroke and 61.9% with hemorrhagic stroke; in 2019 - 44.6% in women in general and 46.1% with ischemic stroke).

The percentage of patients who had a stroke at the age of 71-80 years in VRCPNH is significantly ($p < 0.05-0.001$) lower (in 2017 - 19.5% in men in general and 20.4% in ischemic stroke, 12.0% in women with hemorrhagic stroke; in 2018 - 13.8% in men in general, 14.6% with ischemic stroke and 8.9% with hemorrhagic stroke, 21.9% in women in general and 23.5% with ischemic stroke; in 2019 - 12.5% in men in general and 12.9% in ischemic stroke, 20.6% in women in general, 23.7% with ischemic stroke and 0% with hemorrhagic stroke) compared with VCCHEMS (2017 - 29.9% in men in general and 32.2% with ischemic stroke, 35.9% in women with hemorrhagic stroke; in 2018 - 26.5% in men in general, 26.4% with ischemic stroke and 26.5% with hemorrhagic stroke, 38.2% in women in general and 39.4% with ischemic stroke; 2019 - 35.2% in men in general and 35.8% with ischemic stroke, 36.8% in women in general, 36.6% with ischemic stroke and 40.0% with hemorrhagic stroke).

In VRCPNH, the percentage of women with stroke aged 71-80 years in 2017 was significantly ($p < 0.05-0.001$) higher than in 2018 and 2019 (2017 - 19.5% for men in general, 31.6% for women in general and 34.2% with ischemic stroke; in 2018 - 13.8% in men in general, 21.9% in women in general and 23.5% in ischemic stroke; in 2019 - 12.5% in men in general, 20.6% in women in general and 12.9% with ischemic stroke). In VCCHEMS in 2018 and 2019, the percentage of patients of this age was significantly higher ($p < 0.05$) compared to the previous year (2017 - 9.5% in men with hemorrhagic stroke; in 2018 - 26.5% in men in general and 26.4% with ischemic stroke; in 2019 - 35.2% in men in general, 35.8% with ischemic stroke and 30.0% with hemorrhagic stroke).

The percentage of patients who had a stroke over the age of 80 years in VRCPNH is significantly ($p < 0.05-0.001$) lower (in 2017 - 1.6% in men in general, 1.9% with ischemic stroke and 0% with hemorrhagic stroke, 9.1% in women in general, 10.3% with ischemic stroke and 0% with hemorrhagic stroke; in 2018 - 1.0% in men in general and 1.1% with ischemic stroke, 3.2% in women in general, 3.0% with ischemic stroke and 0% with hemorrhagic stroke; in 2019 - 0.7% in men in general and 0.8% in ischemic stroke, 5.7% in women in general and 6.6% with ischemic stroke) compared with VCCHEMS (2017 - 10.5% in men in general, 10.7% with ischemic stroke and 9.5% with hemorrhagic stroke, 23.0% in women in general, 23.6% with ischemic

stroke and 17.9% with hemorrhagic stroke; in 2018 - 11.3% in men in general and 12.0% with ischemic stroke, 19.6% in women in general, 18.8% with ischemic stroke and 29.2% with hemorrhagic stroke; in 2019 - 7.1% in men in general and 7.4% with ischemic stroke, 23.9% in women in general and 24.8% with ischemic stroke).

In VRCPNH, the percentage of women with stroke *over the age of 80* in 2017 was significantly ($p < 0.05-0.01$) higher than in 2018 (2017 - 23.0% in women in general and 23.6% with ischemic stroke; 2018 - 19.6% in women in general and 18.8% with ischemic stroke).

For VRCPNH in the sex comparison of the percentage of patients of a certain age group found: significantly ($p < 0.05$) greater in men *under 40 years* of age (2018 - 3.5% in men in general), *41-50 years* (2018 - 10.6% in men in general), *51-60 years* (2018 - 30.8% in men in general and 30.3% with ischemic stroke; in 2019 - 33.4% in men in general and 32.7% with ischemic stroke), *61-70 years* (2017 - 40.1% for men in general) compared to women of similar groups (*up to 40 years* - 0.5% for women in general in 2018; *41-50 years* - 5.3% for women in general in 2018; *51-60 years* - 20.3% y women in general and 21.1% with ischemic stroke in 2018 and 18.3% of women in general and 11.8% with ischemic stroke in 2019; *61-70 years* - 28.2% of men in general in 2017). Conversely, a lower percentage of men aged *71-80 years* was found significantly lower percentage ($p < 0.05-0.01$) for VRCPNH (2017 - 19.5% for men in general and 20.4% with ischemic stroke; in 2018 - 13.8% for men in general and 14.6% with ischemic stroke; in 2019 - 12.5% in men in general and 12.9% with ischemic stroke) and *over 80 years* (in 2017 - 1.6% in men in general and 1.9% with ischemic stroke; in 2019 - 0.7% in men in general and 0.8% with ischemic stroke) compared to women of similar groups (*71-80 years*: in 2017 - 31.6% in women in general and 34.2% with ischemic stroke; in 2018 - 21.9% in women in general and 23.5% with ischemic stroke; in 2019 - 20.6% in women in general and 23.7% with ischemic stroke; *over 80 years*: in 2017 - 9.1% in women in general and 10.3% with ischemic stroke; in 2019 - 5.7% in women in general and 6.6% with ischemic stroke).

For VCCHEMS in a sex comparison of the percentage of patients of a certain age group found: significantly ($p < 0.05$) higher in men *under 40 years of age* (2017 - 1.7% in men in general and 1.6% with ischemic stroke), *41-50 years* (2018 - 6.8% in men in general and 5.8% with ischemic stroke), *51-60 years* (2017 - 19.1% in men in general and 17.9% with ischemic stroke; in 2018 - 19.4% in men in general and 18.1% with ischemic stroke; in 2019 - 16.5% in men in general and 16.7% in ischemic stroke), *61-70 years* (in 2018 - 34.8% in men in general and 36.2% with ischemia stroke) compared to women of similar groups (*up to 40 years*: 2017 - 0% in women in general and 0% with ischemic stroke; *41-50 years*: 2018 - 2.6% in women in general and 1.8% with ischemic stroke; *51-60 years*: in 2017 - 7.5% in women in general and 6.8% with ischemic stroke; in 2018 - 11.8% in women in general and 1.7% with ischemic stroke; in 2019 -

2.5% in women in general and 2.0% of ischemic stroke; *61-70 years*: 2018 - 27.1% in women in general and 28.0% with ischemic stroke).

Conversely, a lower percentage of men aged *71-80 years* was found significantly ($p < 0.05-0.01$) for VCCHEMS (2017 - 9.5% in men with hemorrhagic stroke; 2018 - 26.5% in men in general and 26.4% with ischemic stroke) and *over 80 years* (2017 - 10.5% in men in general and 10.7% in ischemic stroke; 2018 - 11.3% in men in general and 12.0% in ischemic stroke; 2019 - 7.1% in men in general and 7.4% with ischemic stroke) compared to women of similar groups (*71-80 years*: in 2017 - 35.9% in women with hemorrhagic stroke; in 2018 - 38.2% in women in general and 39.4% with and ischemic stroke; *over 80 years of age*: in 2017 - 23.0% in women in general and 23.6% with ischemic stroke; in 2018 - 19.6% in women in general and 18.8% with ischemic stroke; in 2019 - 23.9% in women in general and 24.8% with ischemic stroke).

In 2017, the percentage of patients with subarachnoid hemorrhage in VRCPNH was significantly ($p < 0.05$) lower (0% in men and women in general) compared to VCCHEMS (1.1% in men and 3.0% in women in general). In 2019, the percentage of women with ischemic stroke in VRCPNH was significantly ($p < 0.05$) lower, and with intracerebral hemorrhage - significantly ($p < 0.05$) higher (86.9% and 12.6%, respectively) compared with VCCHEMS (93.6% and 5.5%, respectively).

According to the type of ACA (ischemic, hemorrhagic stroke and subarachnoid hemorrhage) in the dynamics of 2017-2019, no significant differences were found in both hospitals.

The percentage of patients who had a stroke *not in the hospital* in VRCPNH in 2018 was significantly ($p < 0.05-0.01$) higher, and in 2019 significantly ($p < 0.05-0.01$) lower (2018 - 99.7% in men in general, 99.6% with ischemic stroke and 100% with hemorrhagic stroke; in 2019 - 87.8% in men in general and 86.7% with ischemic stroke, 88.8% in women in general and 86.2% with ischemic stroke) compared to VCCHEMS (2018 - 96.8% in men in general, 97.1% with ischemic stroke and 94.1% with hemorrhagic stroke; in 2019 - 94.5% in men in general and 94.4% with ischemic stroke, 96.3% in women in general and 96.1% with ischemic stroke). The percentage of women who had a stroke *in the hospital* in VRCPNH in 2019 was significantly ($p < 0.05$) higher (4.0% in women in general and 4.6% with ischemic stroke) compared to VCCHEMS (0.6% in women in general and 0.7% with ischemic stroke).

In VRCPNH, the percentage of patients who had a *non-hospital* stroke in 2018 was significantly ($p < 0.05-0.01$) higher than in 2017 and 2019 (2017 - 94.8% in men in general and 94.8% with ischemic stroke, 96.2% in women in general and 95.7% with ischemic stroke; 2018 - 99.7% in men in general and 99.6% with ischemic stroke, 98.9% in women in general and 98.8% with ischemic stroke; 2019 - 87.8% in men in general and 86.7% with ischemic stroke, 88.8% in women in general and 86.2% with ischemic stroke). In

VRCPNH, the percentage of patients who had a stroke in the hospital in 2018 was significantly ($p < 0.05-0.01$) lower than in 2017 and 2019 (2017 - 5.2% in men in general and 5.2% with ischemic stroke, 4.3% in women with ischemic stroke; 2018 - 0.3% in men in general and 0% in ischemic stroke, 0% in women with ischemic stroke; 2019 - 2.4% in men in general and 2.8% with ischemic stroke, 4.6% in women with ischemic stroke).

In VCCHEMS the percentage of patients who had a stroke in the hospital in 2017 was significantly ($p < 0.05-0.01$) higher than in 2018 and 2019 (2017 - 4.0% in men in general and 3.6% with ischemic stroke, 6.3% in women in general and 6.4% with ischemic stroke; 2018 - 1.3% in men in general and 1.1% with ischemic stroke, 2.0% in women in general and 1.8% with ischemic stroke; 2019 - 0.6% in women in general and 0.7% with ischemic stroke).

It is impossible to correctly compare the percentage of patients with atrial fibrillation between the two institutions and in the dynamics of each hospital due to the lack of data in case histories (no atrial fibrillation screening was performed).

In VCCHEMS the percentage of patients who had a stroke in winter was found to be significantly ($p < 0.05-0.01$) higher in 2018 and significantly ($p < 0.05-0.001$) lower - in 2019 (2018 - 30.6% in men in general and 30.4% with ischemic stroke; 2019 - 8.6% in men with ischemic stroke, 7.4% in women in general, 7.8% with ischemic stroke and 20.0% with hemorrhagic stroke) compared to VRCPNH (2018 - 21.8% in men in general and 20.6% with ischemic stroke; 2019 - 16.5% in men with ischemic stroke, 23.4% in women in general, 21.7% with ischemic stroke and 34.8% with hemorrhagic stroke).

In 2018, the percentage of patients who suffered a stroke in the spring was significantly lower in VCCHEMS ($p < 0.05-0.01$) (18.4% in men in general and 18.8% in ischemic stroke, 8.3% in women with hemorrhagic stroke) compared to with VRCPNH (26.6% in men in general and 28.5% in ischemic stroke, 33.3% in women with hemorrhagic stroke).

In 2019, the percentage of patients who suffered a stroke in the autumn was found to be significantly ($p < 0.05$) higher in VCCHEMS (21.4% in men in general and 25.0% in hemorrhagic stroke) compared to VRCPNH (13.6% in men in general and 5.1% with hemorrhagic stroke).

In VRCPNH in 2017, the percentage of women who suffered an ischemic stroke in winter in 2017 was significantly ($p < 0.05$) lower than in 2018 (2017 - 19.1% in women in general and 17.4% with ischemic stroke; 2018 - 27.8% in women in general and 28.3% with ischemic stroke). In 2019, compared to 2017 and 2018, there was a significantly lower ($p < 0.05$) percentage of men who suffered from hemorrhagic stroke in winter (2017 - 23.1% of men in general and 35.1% with hemorrhagic stroke; 2018 - 21.9% in men in general and 28.9% with hemorrhagic stroke; 2019 - 15.0% in men in general and 5.1% with hemorrhagic stroke).

In VRCPNH in 2017 and 2018, the percentage of patients who fell ill in the spring was significantly lower ($p < 0.05$)

compared to 2019 (2017 - 29.7% in men with hemorrhagic stroke; 2018 - 26.6% in men in general and 15.6% with hemorrhagic stroke, 18.7% in women in general and 16.9% with ischemic stroke; 2019 - 35.2% in men in general and 53.8% in hemorrhagic stroke, 29.1% in women in general and 31.6% with ischemic stroke). In the current season of the year, the percentage of women with ischemic stroke was significantly ($p < 0.05-0.01$) higher in 2017 compared to 2018 (2017 - 28.2% in women in general and 28.8% in ischemic stroke; in 2018 - 18.7% in women in general and 16.9% with ischemic stroke).

In VRCPNH in 2017 and 2018, the percentage of men who fell ill in the summer was significantly lower ($p < 0.05-0.001$) compared to 2019 (2017 - 26.7% in men in general and 27.5% with ischemic stroke; 2018 - 23.7% in men in general and 24.3% with ischemic stroke; 2019 - 36.2% in men in general and 35.3% with ischemic stroke). In the current season of the year, the percentage of women with ischemic stroke was significantly ($p < 0.05-0.01$) higher in 2017 compared to 2018 (2017 - 31.1% in women in general and 33.2% with ischemic stroke; 2018 - 21.9% in women in general and 22.9% with ischemic stroke).

In VRCPNH in 2018 and 2019, the percentage of patients who fell ill in autumn was significantly lower ($p < 0.05-0.001$) compared to 2017 (2017 - 18.2% in men in general, 18.6% with ischemic stroke and 16.2% with hemorrhagic stroke, 21.5% in women in general and 20.7% with ischemic stroke; 2018 - 27.9% in men in general, 26.6% with ischemic stroke and 35.6% with hemorrhagic stroke, 31.6% in women in general and 31.9% with ischemic stroke; 2019 - 13.6% for men in general, 14.9% with ischemic stroke and 5.1% with hemorrhagic stroke, 19.4% for women in general and 18.4% with ischemic stroke).

In VCCHEMS in 2019, the percentage of women who had an ischemic stroke in winter was significantly ($p < 0.001$) lower than in 2017 and 2018 (2017 - 26.5% in men in general and 27.3% in ischemic stroke, 22.7% in women in general and 23.6% with ischemic stroke; 2018 - 30.6% in men in general and 30.4% in ischemic stroke, 26.5% in women in general and 26.6% with ischemic stroke; 2019 - 9.9% in men in general and 8.6% with ischemic stroke, 7.4% in women in general and 7.8% with ischemic stroke).

In VCCHEMS in 2018, the percentage of patients who fell ill in the spring was significantly lower ($p < 0.05-0.001$) compared to 2017 (2017 - 27.9% in men in general and 26.9% in ischemic stroke, 26.9% in women in general and 28.2% with hemorrhagic stroke; 2018 - 18.4% in men in general and 18.8% in ischemic stroke, 19.6% in women in general and 8.3% with hemorrhagic stroke). In the current season of the year, the percentage of patients with ischemic stroke in 2019 was significantly higher ($p < 0.05-0.001$) compared to 2017 and 2018 (2017 - 27.9% in men in general and 26.9% in ischemic stroke, 26.9% in women in general and 26.7% with ischemic stroke; 2018 - 18.4% in men in general and 18.8% with ischemic stroke, 19.6% in women in general and 20.6% with ischemic stroke; 2019 - 34.1% in

men in general and 34.6% with ischemic stroke, 38.0% in women in general and 38.6% with ischemic stroke).

In VCCHEMS in 2018, the percentage of women who fell ill in the *summer* was significantly lower ($p < 0.05-0.001$) compared to 2018 and 2019 (2017 - 31.3% in women in general, 30.7% with ischemic stroke and 38.5% with hemorrhagic stroke; 2018 - 22.5% in women in general, 23.4% with ischemic stroke and 12.5% with hemorrhagic stroke; 2019 - 36.8% in women in general, 35.9% with ischemic stroke and 50.0% with hemorrhagic stroke).

In VCCHEMS in 2017 and 2019, the percentage of patients who fell ill in the *autumn* was significantly lower ($p < 0.05-0.001$) than in 2018 (2017 - 16.8% in men in general and 16.6% with ischemic stroke, 19.1% in women in general, 19.3% with ischemic stroke and 17.9% with hemorrhagic stroke; 2018 - 23.2% in men in general and 22.8% with ischemic stroke, 31.4% in women in general, 29.4% with ischemic stroke and 54.2% with hemorrhagic stroke; 2019 - 21.4% for men in general and 21.0% with ischemic stroke, 17.8% for women in general and 17.6% with ischemic stroke).

When analyzing case histories for 2018-2019, information on the presence or absence of symptoms of carotid artery stenosis does not reflect the real picture of this indicator. More than 90% of documents do not contain the necessary data and are marked as "unknown".

When comparing in 2017 the percentage of patients who had symptoms of carotid artery stenosis found significantly ($p < 0.05-0.001$) lower in patients of VCCHEMS (2.0% in men in general and 2.3% with ischemic stroke, 1.2% in women in general and 1.0% with ischemic stroke) compared with VRCPNH (8.8% in men in general and 10.0% in ischemic stroke, 4.3% in women in general and 4.9% with ischemic stroke).

Discussion

Stroke is considered an age-dependent disease. Ukraine is significantly ahead of not only the CIS countries, but also the countries of Eastern Europe in the number of people over the age of 65 (13.9%), so it is one of the "oldest" countries in Europe [24]. The gender and age structure of the country's population is characterized by a significant predominance of women in older age groups, due to the excessive mortality of men of working age and low rates of their ability to live to retirement age [10]. The average life expectancy of men is significantly lower than the average life expectancy of women. In addition, the influence of demographic losses in the war and post-war times is still noticeable in the oldest age groups [22].

The gender imbalance of the population increases with age. Because the average life expectancy of women is longer than that of the opposite sex, they are more likely to suffer a stroke in old age. Men get sick and die from ACA more often than women, especially under 60 years of age. The combination of a larger number of factors compared to women significantly increases the risk of stroke in men of

young working age [4].

Interesting is the fact that in the age group up to 70 years the percentage of men is higher than that of women. This difference in older age (over 70 years) becomes the opposite. In addition, it was found that in VRCPNH compared with VCCHEMS dominated by younger patients (up to 70 years). This is due to the fact that VRCPNH had more logistical and organizational conditions for thrombolysis, which is known to occur more often in young and middle-aged patients.

In the period of 2017-2019 in both hospitals we noted an increase over time in the percentage of patients aged group 1-4 and a decrease of 5-6.

Large-scale statistical studies of the number of hospitalizations with ischemic stroke among people aged 18-54 have shown disappointing results: the number of young patients has increased significantly. If earlier elderly people were considered a risk group for stroke, now 10% of all cases are young [12]. In addition, studies have shown that at a young age, stroke is more common in men (growth among all age groups is about 50%). As for females, with age the risk of developing ACA in them is 30% higher [17]. Similar trends are observed in our study: the percentage of young and middle-aged men is higher than women.

Risk factors for stroke - high blood pressure, diabetes, hypercholesterolemia, atrial fibrillation, carotid artery stenosis, unhealthy lifestyle associated with smoking, alcohol, drugs, obesity and more. If precautionary measures are not taken, ischemic stroke may soon become a typical disease of young people [11].

It is extremely important to conduct additional examinations in risk groups and to analyze the presence of ACA factors and health problems in patients who have already had a stroke.

Yu.A. Dolgusheva [6] for the first time obtained representative regional data on seasonality: hemorrhagic stroke is statistically more common in winter and spring, and ischemic stroke - in summer and autumn.

Opinions of scientists on this issue are different. One group of researchers noted an increase in the incidence of this pathology and mortality in the cold months (winter and spring) and a decrease in these indicators in summer and autumn [7, 14, 23], the other denied the seasonal frequency of its occurrence, arguing that the incidence of stroke depends not on the specific season, but on social and meteorological conditions [19, 20, 21]. Thus, the deterioration of meteorological conditions (magnetic storms, worsening weather conditions, sharp and significant changes in air temperature and atmospheric pressure) causes exacerbation or complication of the disease in people with cardiovascular pathology.

In the comparative analysis, we were interested in more differences in the dynamics of 2017-2019 within each hospital. Numerous significant differences were found between the years of the study in the percentage of patients admitted in a given season, and in both hospitals they had similar trends. This forces us to agree with the conclusions

reached by the second group of researchers (meteorological dependence of stroke).

A positive point in the organizational and diagnostic work of VCCHEMS should be noted the decrease over time in the percentage of patients whose stroke occurred in a non-specialized department.

There is a hereditary burden of ACA. The risk of stroke increases if the parents have had a stroke. However, in a global study conducted by Feigin V.L. et al. [9] in 188 countries, it was found that more than 90% of the risk of ACA is due to modified factors.

Unfortunately, in the course of our prospective study, we were only able to dispose of the anamnestic data provided by doctors during the examination and communication with the patient or his relatives. And even an attempt to analyze for factors such as atrial fibrillation and carotid artery stenosis (we are no longer talking about the full range of modified factors) was unsuccessful because the data were collected incorrectly and incompletely.

Thus, the analysis of risk factors for stroke suggests

that the disease is based on various causes, the contribution of which researchers assess differently. A serious and balanced attitude to the collection and analysis of information is important for the preventive organization of the fight against this serious disease.

Conclusions

1. When comparing the data of the territorial-population register of stroke in hospitals of Vinnytsia in 2017-2019, it was found that in both studied institutions the percentage of young and middle-aged patients, especially men, increased. The percentage of young and middle-aged patients in VRCPNH is higher than in VCCHEMS.

2. There were no significant differences in the dynamics of stroke in both hospitals. The percentage of patients who had a stroke in hospital has decreased over time. The meteorological dependence of stroke has been proved, which points to the importance of preventive measures for people at risk. The main shortcomings in the collection of anamnestic data are analyzed.

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АНАЛІЗ ЧИННИКІВ РИЗИКУ ТА СТРУКТУРА ІНСУЛЬТУ ЗА ДАНИМИ ГОСПІТАЛЬНОГО РЕГІСТРУ ЛІКАРЕНЬ ВІННИЦІ ЗА 2017-2019 РОКИ

Фікс Д.О.

Завдяки реалізації аналізу цілого комплексу показників якості надання медичної допомоги при гострому порушенні мозкового кровообігу і, насамперед, визначення основних недоліків у веденні інсультного реєстру, можливо скоротити захворюваність, смертність та інвалідність від даної нозології. Мета роботи - вивчити та порівняти структуру та чинники ризику мозкового інсульту за даними лікарень м. Вінниці за період 2017-2019 рр. Інсультний реєстр створено на основі медичної документації стаціонарів Комунального некомерційного підприємства "Вінницька обласна клінічна психоневрологічна лікарня ім. акад. О.І. Юценка Вінницької обласної ради" (ВОКПЛ) та Вінницької міської клінічної лікарні швидкої медичної допомоги (ВМКЛШМД), які є найбільш типовими для зазначеного регіону України. Статистична обробка результатів здійснена за допомогою ліцензійного статистичного пакету "Statistica 5.5" з використанням параметричних методів оцінки. Між двома лікувальними закладами м.Вінниця та в динаміці часу встановлені достовірні відмінності у різного за віком, статтю, типом інсульту контингенту пацієнтів. При порівнянні даних територіально-популяційного реєстра інсульту в лікарнях м.Вінниця в 2017-2019 рр. встановлено, що в обох досліджуваних закладах збільшилась відсоткова частка хворих молодого і середнього віку, в особливості чоловіків. У ВОКПЛ, порівняно з ВМКЛШМД, більша відсоткова частка пацієнтів молодого та середнього віку. Проаналізовано модифіковані чинники ризику, які в даний час є найважливішою медико-соціальною проблемою. За типом інсульту в динаміці в обох лікарнях суттєвих відмінностей не відмічалось. Відсоткова частка пацієнтів, у котрих інсульт виник у лікарні, з часом зменшилась. Доведено метеозалежність інсульту, що вказує на важливість превентивних заходів для осіб даної групи ризику. Проаналізовано основні недоліки при зборі анамнестичних даних. Аналіз чинників ризику інсульту дає підставу вважати, що в основі виникнення захворювання лежать різні причини.

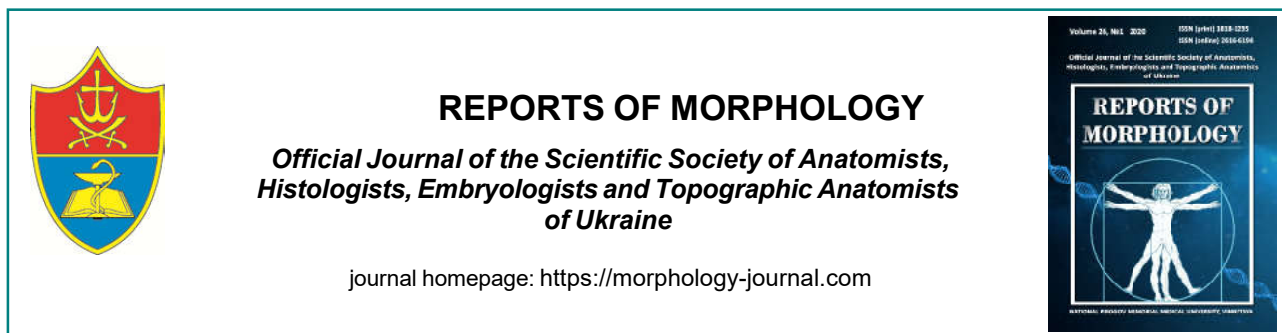
Ключові слова: інсульт, гендерні відмінності, чинники ризику інсульту, метод реєстру.

АНАЛИЗ ФАКТОРОВ РИСКА И СТРУКТУРА ИНСУЛЬТА ПО ДАННЫМ ГОСПИТАЛЬНОГО РЕГИСТРА БОЛЬНИЦ ВИННИЦЫ ЗА 2017-2019 ГОДЫ

Фикс Д.А.

Благодаря реализации анализа целого комплекса показателей качества оказания медицинской помощи при остром нарушении мозгового кровообращения и, прежде всего, определении основных недостатков в ведении инсультного регистра, возможно сократить заболеваемость, смертность и инвалидность от данной нозологии. Цель работы - изучить и сравнить структуру и факторы риска мозгового инсульта по данным больниц г.Винницы за период 2017-2019 гг. Инсультный регистр создан на основе медицинской документации стационаров Коммунального некоммерческого предприятия "Винницкая областная клиническая психоневрологическая больница им. акад. А.И. Юценко Винницкого областного совета" (ВОКПБ) и Винницкой городской клинической больницы скорой медицинской помощи (ВГКБСМП), которые являются наиболее типичными для данного региона Украины. Статистическая обработка результатов осуществлена с помощью лицензионного статистического пакета "Statistica 5.5" с использованием параметрических методов оценки. Между двумя лечебными заведениями г. Винница и в динамике времени установлены достоверные различия у разного по возрасту, полу, типу инсульта контингента пациентов. При сравнении данных территориально-популяционного регистра инсульта в больницах г. Винницы в 2017-2019 гг. установлено, что в обоих исследуемых учреждениях увеличилась процентная доля больных молодого и среднего возраста, в особенности мужчин. В ВОКПБ сравнению с ВГКБСМП большая процентная доля пациентов молодого и среднего возраста. Проанализированы модифицированные факторы риска, которые в настоящее время являются важнейшей медико-социальной проблемой. По типу инсульта в динамике в обеих больницах существенных различий не отмечалось. Процентная доля пациентов, у которых инсульт возник в больнице, со временем уменьшилась. Доказано метеозависимость инсульта, что указывает на важность превентивных мер для лиц данной группы риска. Проанализированы основные недостатки в сборе анамнестических данных. Анализ факторов риска инсульта дает основание считать, что в основе возникновения заболевания лежат разные причины.

Ключевые слова: инсульт, гендерные различия, факторы риска инсульта, метод регистра.



Micro- and ultrastructural organization of the uterine wall of a white laboratory rat under conditions of 4-week action of Nalbuphine

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ARTICLE INFO

Received: 16 December, 2019

Accepted: 20 January, 2020

UDC: 611-092.4/.9:615.212

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The world community is facing a problem that threatens the entire population of the planet - reproductive health. This is a multifactorial problem that requires an integrated approach and effective solutions. One of the important factors that is very difficult to control and which in itself is a problem, and its prevalence can be called an epidemic without exaggeration, is drug addiction. The solution of these problems determined the purpose of our work - to establish what changes occur at the micro- and ultrastructural levels under the action of opioids on the uterus of white laboratory rats. The method of hematoxylin-eosin staining was used for histological examination, and the method of electron microscopy was used for the study at the cellular level. After 4 weeks of administration of Nalbuphine to white laboratory rats on histological sections, significant changes were observed in all layers of the uterus. The vessels of the myometrium were dilated, overflowing with erythrocytes, sometimes containing neutrophils and lymphocytes, perivasally marked the appearance of macrophages, in the cytoplasm of which was golden-brown pigment. The development of vacuolar dystrophy was also observed in the myometrium. There were necrotic changes and vacuolar dystrophy in the epithelium of the uterine mucosa, and epitheliocytes in which necrotic changes occurred exfoliated into the lumen of the uterus. The outer surface of the perimetrium was uneven due to necrotic changes of the monolayer squamous epithelium. Hyperplasia of the stratified squamous epithelium was observed in the ectocervix, in the areas of which a chaotic accumulation of low-differentiated epithelial cells was found. Electron microscopy revealed that a significant number of smooth myocytes lost their characteristic process shape, their nuclei were deformed and were in the stage of apoptosis, karyopyknosis and even karyorrhexis. The nucleoplasm contained almost no nucleoli, and heterochromatin is located on the periphery of the nucleus. The enlightened cytoplasm is filled with myofilaments, which are randomly arranged in the cell. Mitochondria acquired various shapes and sizes, mostly with destroyed cristae and areas of enlightenment. Swollen connective tissue layers between myocytes testify to circulatory disorders. The damage described in the experiment at all levels indicates the destructive effect of Nalbuphine, which causes irreversible changes that lead to significant violations of the structure and function of the uterus, which leads to the conclusion that excessive drug use has a direct negative impact on the reproductive system.

Keywords: uterus, structure, opioids, experiment, reproductive health.

Introduction

Global key issues have formed in the world community, which have not lost their relevance over the years. One such issue is the problem of reproductive health. According to the UN Declaration by definition (Cairo, 2014), it is a state of complete physical, mental and social well-being in all matters concerning the functions and processes of the reproductive system, including harmony in psychosexual relations in the family and reproduction [18]. Unfortunately,

according to the WHO, Ukraine is one of the last European countries in terms of natural population growth. This situation is due not only to economic and socio-psychological factors, but also the state of reproductive health of the population and women in particular [16]. After all, a healthy woman gives birth to a healthy child, and she has healthy offspring, and so the circle closes. Along with this, modern society has acquired a much newer, but no

less global problem - the problem of drug addiction [5, 11]. In 2016, 19.5 million women (or 15.4%) aged 18 and older used illicit drugs [1, 12]. According to the report of the Center for Medical Statistics of the Ministry of Health of Ukraine for 2018, 3830 people were diagnosed with a first-time diagnosis of mental and drug-related behavioral disorders, 2299 of them used opioids, a total of 60686 people at the end of the year, including 40618 were opioid addicts. The vast majority are people of reproductive age from 15 to 35 years [6].

The aim of the study was to establish changes in the structural organization of the uterine wall of white laboratory rats at the micro- and ultrastructural levels under conditions of 4-week exposure to Nalbuphine.

Materials and methods

The study was performed on 16 adult white female rats aged 3.0-3.5 months and an initial body weight of 160-180 g. All animals were divided into 2 groups: the first (experimental) group of animals was administered intramuscularly Nalbuphine daily for four weeks (first week - 8 mg/kg, the second week - 15 mg/kg, the third week - 20 mg/kg, the fourth week - 25 mg/kg), and the second (control) group of animals during the experiment was injected with 0.9% NaCl solution.

All animals were kept in the vivarium of Danylo Halytsky Lviv National Medical University, experiments were conducted in accordance with the provisions of the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (Strasbourg, 1986), Council of Europe Directive 2010/63/EU, Law of Ukraine № 3447 - IV "On protection of animals from cruel treatment". The materials of the work were considered by the members of the commission on bioethics of Danylo Halytsky Lviv National Medical University, who reached the agreed opinion that the materials submitted for examination are scientifically substantiated (Minutes № 9 of 31.10.2017).

Animals were removed from the experiment 4 weeks after the introduction of the opioid through euthanasia by overdose of diethyl ether.

Hematoxylin-eosin staining was used for histological examination. Preparations of the uterus of a female white rat were fixed in a 10% neutral solution of formalin, and then clarified in alcohols of various concentrations. It was later immersed in xylene and then in xylene/paraffin, the paraffin blocks were poured into a mold, cooled with water and 7 µm thick paraffin sections were cut with a knife. The slice was dried in a thermostat at a temperature of 37-40°C. Staining was performed according to standard methods [7].

For electron microscopy, the samples were fixed with a 1.5% solution of OsO₄ (Osmium Tetroxide SPI - CHEM USA) in a 0.2 M solution of sodium cacodylate (Cacodylic acid Sodium salt. Fluka) at pH 7.2 for 2-2.5 hours in the cold. Dehydration in increasing concentrations of ethyl alcohol (50°, 70°, 90° and absolute) for 30 minutes each. Conduction through propylene oxide (Fluka) for 10 minutes

Pouring samples into epoxy resins Epon-812 (Fluka) and polymerization for 24 hours in a thermostat at 60°C. Sections were prepared on an ultramicrotome UMTP-6M using a diamond knife (DIATOM). Contrast sections in 1% uranyl acetate solution and in Reynolds contrast. Photographing of uterine structures was performed using a microscope UEMV-100K at an accelerating voltage of 75 kV.

Results

Histological examination of the uterus at 4 weeks of experimental administration of Nalbuphine in the epithelium of the mucous membrane of the uterine horns revealed necrotic changes and vacuolar dystrophy, namely, in the cytoplasm of epithelial cells marked enlightenment of the cytoplasm, the appearance of small rounded vacuoles. Epitheliocytes, in which necrotic changes took place, exfoliated into the lumen of the uterus. Also found the development of vacuolar dystrophy, increasing dyscirculatory changes in the vascular system of the myometrium. Small arteries and veins of the myometrium were dilated, filled with erythrocytes, sometimes containing neutrophils and lymphocytes (Fig. 1).

Due to necrotic changes of the myometrium, the outer surface of the perimetrium was uneven. The own mucosal plate was infiltrated by lymphocytes, single neutrophils and eosinophils. The appearance of macrophages in the cytoplasm of which a golden-brown pigment was localized was noted in the connective tissue stroma around the vessels (Fig. 2).

In the ectocervix of the cervix, which is represented by a multilayered squamous epithelium, its hyperplasia was observed, in the areas of which a chaotic accumulation of low-differentiated epithelial cells was seen (Fig. 3).

In the myometrium of the cervix noted hyperemia and blood stasis, as well as the progression of alternative changes in smooth myocytes. Polymorphonuclear infiltration of the myometrial stroma also developed.

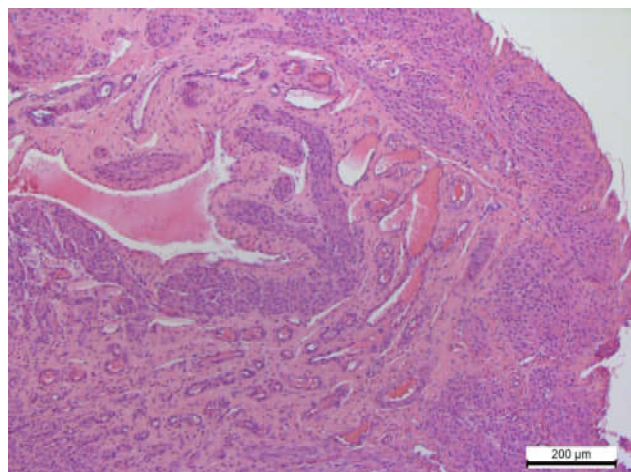


Fig. 1. The hyperemia of vessels of a myometrium of a uterine horn is expressed. Necrotic changes of the monolayer squamous epithelium of the myometrium. Hematoxylin and eosin. x100.

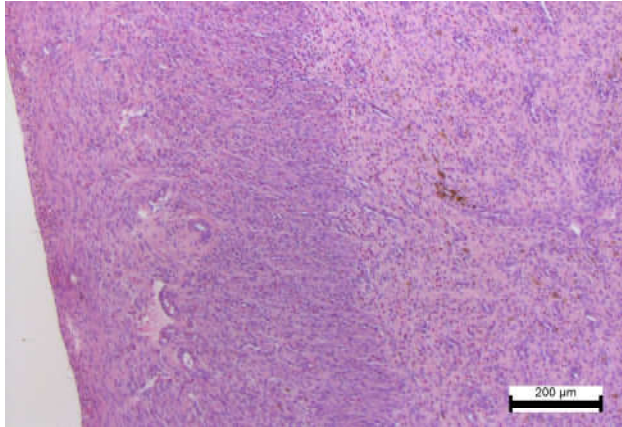


Fig. 2. Polymorphonuclear infiltration of the myometrium. Brown-yellow pigment inclusions in the cytoplasm of macrophages. Hematoxylin and eosin. x100.

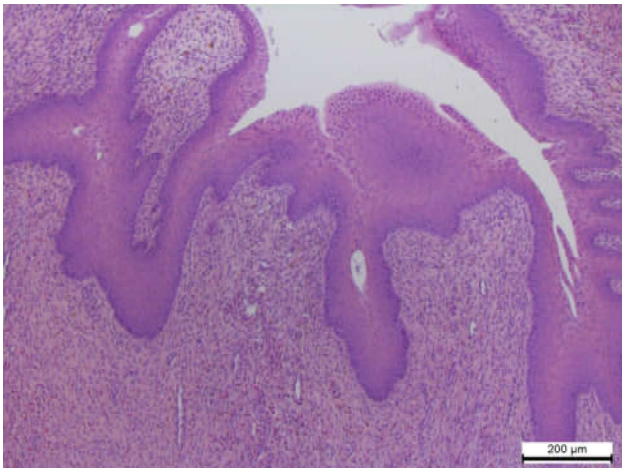


Fig. 3. Hyperplasia and violation of cell differentiation of the multilayered squamous epithelium of the vaginal part of the cervix (ectocervix). Hematoxylin and eosin. x100.

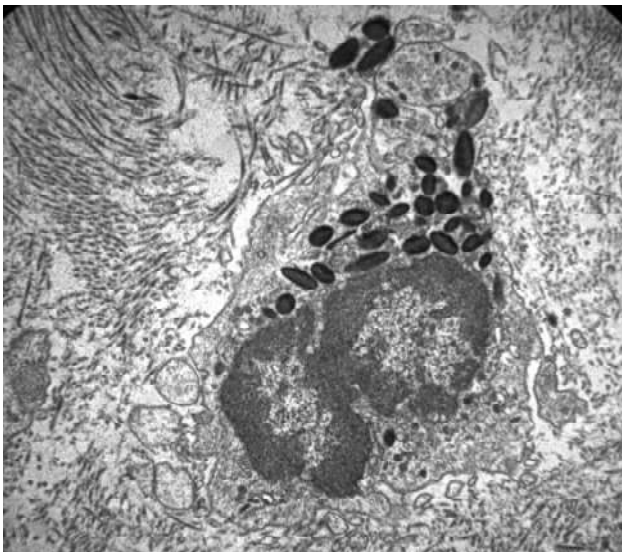


Fig. 4. Fragment of the uterine wall of a white laboratory rat after 4 weeks of Nalbuphine administration. Electronic microphotography. x8000.

Neutrophils and macrophages predominated in the infiltrates, and eosinophils and lymphocytes were somewhat less common.

The study by electron microscopy revealed significant changes in the ultrastructural organization of the uterus of white laboratory rats under conditions of 4-week administration of Nalbuphine. A significant number of smooth myocytes lost their characteristic process shape, their nuclei were deformed and were in the stage of apoptosis, karyopyknosis and even karyorrhexis (Fig.4).

In the nucleoplasm there are almost no nucleoli, heterochromatin, which predominates, is located on the periphery of the nucleus. The cytoplasm is enlightened and filled with myofilaments, which are randomly arranged in the cell. Mitochondria come in different shapes and sizes, mostly with destroyed cristae and areas of enlightenment. Connective tissue layers between myocytes are swollen, which is characteristic of circulatory disorders.

Discussion

In today's world, where there is unrestricted access to anything, the problems of drug addiction and the state of reproductive health of the population, closely intertwined with each other, are acute for the world community. Drug control over pharmacotherapy is becoming more stringent every year, and international health organizations are working intensively to develop effective programs for the prevention, control and treatment of drug addiction [14, 15]. In fact, opioids occupy a leading position among all groups of drugs that are abused, as they are widely used in medical practice.

After analyzing the professional literature, it was found that this group of drugs has a negative effect on the female genitals [2, 8]. A number of authors have described the effect of different groups of opioids on pregnant female rats, namely on the muscular membrane of the uterus - the myometrium, where a violation of the contractile ability of the uterine muscles [9, 17].

Maryam Dehghan et al., who described changes in the micro- and ultrastructural changes in the uterus of pregnant rats under the influence of morphine, made a significant contribution to the study of the female reproductive organ, the uterus. Light microscopy revealed the following histological changes: inflammatory polymorphic infiltration of the stroma, areas of apoptosis and overflowing and dilated vessels, electron microscopy observed deformation and destruction of the nuclear envelope of epithelial cells of the endometrium, the appearance of wide gaps between the nuclei and heterochromatin which is not typical in the control groups [3].

Heba Atef El-Ghawet conducted a study of the synthetic opioid tramadol on the reproductive system, which found that both the structure of the ovary and the quality of follicles in it deteriorated, ovarian dysfunction was confirmed by massive atrophy and dysfunction of the endometrial glands [4]. Changes in muscle tissue at the ultrastructural level in

the study of the effect of Nalbuphine on cardiomyocytes, showed the destruction of mitochondria, the expansion of the intercellular space, the marginal location in the nucleus of chromatin [13].

In general, the trend of negative destructive effects of opioid drugs has been observed in many scientific studies, but in order to get a complete picture and systematize the effects of opioids on the female reproductive system, including the uterus, additional targeted studies are needed [10].

In our work, a comprehensive morphological study of the uterus at the micro- and ultrastructural level on the background of long-term exposure to Nalbuphine using electron microscopic and histological methods, as well as features of the restructuring of the cell structure of this organ. The obtained results will expand the idea of quantitative and qualitative changes in the cellular composition of the uterus with the use of Nalbuphine and

its subsequent ability to perform reproductive function, as well as the ability of uterine cells to reparative and/or compensatory processes with drug withdrawal. This will allow us to review and improve the treatment of obstetric and gynecological diseases in women who are forced to use opioids for a long time or are drug addicts.

Conclusions

Prolonged exposure to Nalbuphine causes significant micro- and ultrastructural changes in the uterine wall. The injuries described in the experiment indicate a destructive effect that can cause irreversible changes, which in turn lead to significant violations of the structure and function of the uterus. Disorders that occur at all levels, from organelles to the level of organs and the system as a whole, prompt special attention to this problem, both scientists and practitioners.

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МИКРО- ТА УЛЬТРАСТРУКТУРНА ОРГАНІЗАЦІЯ СТІНКИ МАТКИ БІЛОГО ЛАБОРАТОРНОГО ЩУРА ЗА УМОВ 4-ТИЖНЕВОЇ ДІЇ НАЛБУФІНУ

Іванків Я.Т.

Світове суспільство зіштовхнулося з проблемою, яка становить загрозу для усього населення планети - репродуктивне здоров'я. Це є мультифакторіальною проблемою, яка потребує комплексного підходу та дієвих рішень. Одним із важливих чинників, який дуже складно контролювати та який сам по собі становить проблему, а його поширеність без перебільшень можна назвати епідемією, є наркоманія. Вирішення цих проблем зумовило мету нашої роботи - встановити, які зміни відбуваються на мікро- та ультраструктурних рівнях при дії опіюїду на матку білого лабораторного щура. Для гістологічного дослідження застосували метод забарвлення гематоксилін-еозином, для дослідження на клітинному рівні використовували метод електронної мікроскопії. Після 4 тижнів введення налбуфіну білим лабораторним щурам на гістологічних зрізах спостерігали значні зміни у всіх шарах матки. Судини міометрія були розширені, переповнені еритроцитами, подекуди містили нейтрофіли та лімфоцити, перивазально відзначали появу макрофагів, у цитоплазмі яких локалізувався пігмент золотисто-бурого кольору. Також у міометрії спостерігали розвиток вакуольної дистрофії. В епітелії слизової оболонки рогів матки були некротичні зміни та вакуольна дистрофія, а епітеліоцити, в яких відбулись некротичні зміни, злушувались у просвіт матки. Зовнішня поверхня периметрія була нерівною, внаслідок некротичних змін одношарового плоского епітелію. В ектоцеревіксі спостерігали гіперплазію багатощарового плоского епітелію, в ділянках якої виявили хаотичне нагромадження низькодиференційованих епітеліальних клітин. Методом електронної мікроскопії було встановлено, що значна кількість гладких міоцитів втрачала характерну відростчасту форму, їхні ядра деформовані та перебували у стадії апоптозу, каріопікнозу та навіть каріорексису. Нуклеоплазма практично не містила ядерець, а гетерохроматин розташований по периферії ядра. Просвітлена цитоплазма вповнена міофіламентами, які хаотично розташовані у клітині. Мітохондрії набували різної форми та розмірів, переважно зі зруйнованими кристами та ділянками просвітлення. Про порушення кровообігу свідчили набряклі сполучнотканні прошарки між міоцитами. Описані в експерименті пошкодження на усіх рівнях свідчать про деструктивний вплив налбуфіну, що спричиняє незворотні зміни, які призводять до значних порушень структури та функцій матки, що дозволяє зробити висновок, що надмірне вживання наркотичних речовин має безпосередній негативний вплив на органи репродуктивної системи.

Ключові слова: *матка, структура, опіюїди, експеримент, репродуктивне здоров'я.*

МИКРО- И УЛЬТРАСТРУКТУРНАЯ ОРГАНИЗАЦИЯ СТЕНКИ МАТКИ БЕЛОЙ ЛАБОРАТОРНОЙ КРЫСЫ В УСЛОВИЯХ 4-НЕДЕЛЬНОГО ДЕЙСТВИЯ НАЛБУФИНА

Иванкиев Я.Т.

Мировое общество столкнулось с проблемой, которая представляет угрозу для всего населения планеты - репродуктивное здоровье. Это мультифакторальная проблема, требующая комплексного подхода и действенных решений. Одним из важных факторов, который очень сложно контролировать и который сам по себе является проблемой, а его распространенность без преувеличения можно назвать эпидемией, является наркомания. Решение этих проблем обусловило цель нашей работы - установить, какие изменения происходят на микро- и ультраструктурных уровнях при воздействии опиоида на матку белой лабораторной крысы. Для гистологического исследования применили метод окрашивания гематоксилин-еозином, для исследования на клеточном уровне использовали метод электронной микроскопии. После 4 недель введения налбуфина белым лабораторным крысам на гистологических срезах наблюдали значительные изменения во всех слоях матки. Сосуды миометрия были расширены, переполнены эритроцитами, иногда содержали нейтрофилы и лимфоциты, перивазально отмечали появление макрофагов, в цитоплазме которых локализовался пигмент золотисто-бурого цвета. Также в миометрии наблюдали развитие вакуольной дистрофии. В эпителии слизистой оболочки рогов матки были некротические изменения и вакуольная дистрофия, а эпителиоциты, в которых выявлены некротические изменения, десквамировались в просвет матки. Внешняя поверхность периметрия была неровной вследствие некротических изменений однослойного плоского эпителия. В эктоцервиксе наблюдали гиперплазию многослойного плоского эпителия, в участках которого обнаружили хаотическое нагромождение низкодифференцированных эпителиальных клеток. Методом электронной микроскопии было установлено, что значительное количество гладких миоцитов теряло характерную отростчатую форму, их ядра были деформированы и находились в стадии апоптоза, каріопікноза и даже каріорексиса. Нуклеоплазма практически не содержала ядрышек, а гетерохроматин располагался по периферии ядра. Просветленная цитоплазма выполнена миофиламентами, которые хаотично расположены в клетке. Митохондрии приобретали различную форму и размеры, преимущественно с разрушенными кристами и участками просветления. О нарушении кровообращения свидетельствовали набухшие соединительнотканые прослойки между миоцитами. Описанные в эксперименте повреждения на всех уровнях свидетельствуют о деструктивном влиянии налбуфина, что вызывает необратимые изменения, которые приводят к значительным нарушениям структуры и функций матки, что позволяет сделать вывод, что чрезмерное употребление наркотических веществ имеет непосредственное негативное влияние на органы репродуктивной системы.

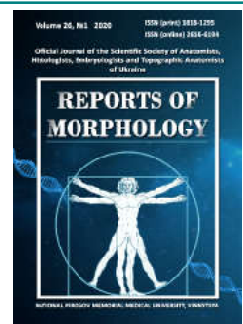
Ключевые слова: *матка, структура, опиоиды, эксперимент, репродуктивное здоровье.*



REPORTS OF MORPHOLOGY

Official Journal of the Scientific Society of Anatomists,
Histologists, Embryologists and Topographic Anatomists
of Ukraine

journal homepage: <https://morphology-journal.com>



Correlations of linear sizes of molars with cephalometric indicators of practically healthy men of the northern region of Ukraine

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ARTICLE INFO

Received: 18 December, 2019

Accepted: 22 January, 2020

UDC: 611.314:616.714.1-071.3:79-055.1(477)

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The question of the relationship between the metric characteristics of cranial structures and odontometric parameters, and the possibility of building models based on them, which can later find their practical application in dental practice, remain a pressing problem of modern medical science. The purpose of the study is to establish the features of the relationship between the linear dimensions of molars with the cephalometric parameters of the brain and facial skull of practically healthy men in the northern region of Ukraine. 32 practically healthy residents of the northern region of Ukraine (from Kyiv, Zhytomyr, Sumy and Chernihiv regions) underwent computed tomography followed by odontometry of molars and cephalometry. The correlations between odontometric and cephalometric parameters were assessed using Spearman's nonparametric statistics in the licensed package "Statistica 6.1". The peculiarities of the correlations of the studied characteristics of molars with the indicators of the cerebral skull are established - multiple, only direct reliable ($r = 0.35-0.57$) and unreliable ($r = 0.30-0.35$) average correlation force (18.7% on the upper jaw, of which the relative majority with vestibular-lingual and mesio-distal dimensions and 24.1% on the lower jaw, of which the relative majority with the height of the teeth, their crowns and the length of the tooth roots); as well as with the indicators of the facial skull - mostly direct reliable ($r = 0.35-0.51$) and unreliable medium strength ($r = 0.30-0.37$) correlations, in most cases of a single nature (6.0% on the upper jaw and 6.6% on the lower jaw, almost uniformly with the height of the teeth, their crowns, root length, vestibular-lingual and mesio-distal dimensions). The results of correlation analysis of craniofacial structures are necessary for the correct construction of mathematical models, which can later find their practical application in dental practice and forensic medicine.

Keywords: correlations, cephalometry, odontometry, administrative-territorial regions of Ukraine.

Introduction

Throughout its existence, mankind has sought to understand the basic principles of building the world and the phenomena observed in it. And naturally, the question of human anatomy and physiology and the search for an understanding of the laws of its structure and related functions, have occupied and occupy one of the leading places in world scientific research. With the beginning of the digital age and the creation of the artificial intelligence system, with the improvement of statistical analysis tools, mankind has the opportunity to calculate and analyze large data sets. And this state of affairs has forced us to reconsider and rethink things that lie on the surface - the relationship of various functionally connected anatomical components. Morphologists, like no other today, can provide new

information on understanding the basic principles of normal anatomy, the relationship between the shape and function of the various structural components of the human body. And in dentistry, as never before, the issues of modeling and reproduction of the structures of the dental apparatus remain acute. With powerful computational and statistical tools, specialists in many specialties related to the work with the craniofacial complex return to the question of studying the anatomical norm. The biggest number of questions arises about dental structures. Their anatomical diversity and complex morphofunctional connections with craniofacial structures provide a favorable basis for such studies to a greater extent in the fields of anthropology, dentistry and forensic medicine [3, 6, 9, 10]. It should be

noted that a large number of modern researchers in the study of the main odontological normative indicators indicate the need to consider ethnicity and gender [12, 15, 17, 22].

The main function of the dental apparatus is to grind food and prepare it for further digestion. This function is performed by the masticatory group of teeth, and that is why the molars were given the status of a large occlusion key. No wonder a large number of modern scientific papers are devoted to the study of the relationship of the masticatory group of teeth with other cranial structures, which also indicate the importance of considering the ethnic and sexual specifications of man [5, 13, 20, 21].

The question of the relationship between the metric characteristics of cranial structures and odontometric parameters, and the possibility of building models based on them, which can later find their practical application in dental practice, has been raised by scientists more than once [4, 7, 8, 10], because such models can be used by physicians not only for an individual approach to each patient but also for screening mass examinations [11] in order to predict the occurrence of a pathology, and thus create risk groups that will require special dental supervision in the future.

That is why *the purpose* of our study is to establish the features of the relationship between the linear dimensions of molars with the cephalometric parameters of the brain and facial skull of practically healthy men in the northern region of Ukraine.

Materials and methods

For the study, 32 residents of the northern region of Ukraine from Kyiv, Zhytomyr, Sumy and Chernihiv regions were selected, with favorable, moderately favorable and satisfactory ecological living conditions. Computed tomography was performed using a Veraviewepocs-3D dental cone tomography scanner (Morita, Japan). Committee on Bioethics of National Pirogov Memorial Medical University, Vinnytsya established (Minutes №19 from 08.11.2012, Minutes №5 from 23.05.2019) that the conducted research does not contradict the basic bioethical norms of the Council of Europe Convention on Human Rights and Biomedicine (1977), the Declaration of Helsinki, and also meet ethical and moral and legal requirements according to the order of the Ministry of Health of Ukraine №281 from 01.11.2000.

Odontometric study of the model of bone structures of the tooth-jaw complex in three projections was performed in the software shell i-Dixel One Volume Viewer (Ver.1.5.0, J Morita Mfg. Cor.). Measurements of the first and second molars of the right and left sides of the upper and lower jaws were performed: height of the tooth and crown of the tooth, length of the palatal medial and distal roots, vestibular-lingual and mesio-distal dimensions of the crown and neck of the tooth [18]. For convenience and compactness of the record, digital notation of teeth was used: the first digit indicates the quadrant number, and the

second the ordinal number of the tooth, counting from the center line. Thus: 16 - upper right first molars; 17 - upper right second molars; 26 - upper left first molars; 27 - upper left second molars; 36 - lower left first molars; 37 - lower left second molars; 46 - lower right first molars; 47 - lower right second molars.

The cephalometric study involved measuring the parameters of the cerebral and facial parts of the head with a large Martin compass and a soft centimeter tape. Cephalometric measurements were performed in accordance with generally accepted recommendations and anatomical guidelines and points [1].

The shape of the head was determined by the ratio of the largest width of the head to the length of the head, and in accordance with the obtained value of the indicator made the distribution of craniotypes: up to 75.9 - dolichocephaly; from 76.0 to 80.9 - mesocephaly; from 81.0 to 85.4 - brachycephaly; 85.5 and more - hyperbrachycephaly [23].

The type of face was calculated using the Garson index, according to which the morphological length of the face was divided by the largest width of the face, and according to the obtained value of the indicator made the distribution of face types: up to 78.9 - very wide face, 79.0-83.9 - wide face; 84.0-87.9 - average face; 88.0-92.9 - narrow face; 93.0 and more - a very narrow face [16].

The correlations between odontometric and cephalometric parameters were assessed using Spearman's nonparametric statistics in the licensed package "Statistica 6.1".

Results

The results of the correlation analysis between the sizes of molars of the upper and lower jaws with cephalometric indicators of the cerebral and facial skull of practically healthy men of the northern administrative-territorial region of Ukraine are presented in tables 1-6.

Discussion

The question of the relationship between the metric characteristics of cranial structures and odontometric parameters and the possibility of building models based on them, which can later find their practical application in dental practice, is being actively studied by scientists from different countries [4, 7, 8, 10]. Such models can be used by physicians not only for an individual approach to each patient but also for screening mass examinations to predict the occurrence of a particular pathology, and thus create risk groups that will require special dental supervision in the future.

Recently, many studies have focused on the importance of ethnic and gender issues of cephalometric and odontometric indicators [5, 12, 13, 15, 17, 19-21], the results of which have a positive effect on improving dental health. Understanding the correlations of craniofacial structures allows the construction of mathematical models that can later find their practical application in dental practice [4, 7,

Table 1. Correlations of the sizes of molars of an upper jaw with cephalometric indicators of a brain skull of men of the northern region of Ukraine (n = 10-32).

Sizes of molars	Cephalometric indicators						
	DUG_GOP	DUGS_GOP	DUG_AUAU	G_OP	FMT_FMT	EY_EY	KRANIO
17HZ	0.36	0.07	0.29	0.25	0.16	0.39	0.17
17HKZ	0.18	0.03	0.37	0.24	0.09	<u>0.30</u>	0.12
17HRZ1	0.23	0.16	0.19	0.10	0.18	<u>0.34</u>	0.16
17HRZ2	0.14	0.06	0.00	0.16	0.13	-0.04	-0.19
17HRZ3	0.13	-0.02	0.03	-0.02	0.05	0.08	0.14
17VO_K	0.14	0.03	0.29	-0.10	0.21	0.41	0.43
17VO_S	0.13	0.10	0.26	-0.09	0.28	0.47	0.45
17MD_K	0.06	0.05	0.13	0.13	0.25	0.20	0.03
17MD_S	0.19	0.00	0.16	0.27	0.35	0.26	-0.02
16HZ	0.02	-0.04	0.20	0.00	-0.15	-0.03	0.05
16HKZ	-0.02	0.23	0.17	0.16	-0.21	-0.03	-0.16
16HRZ1	0.06	-0.21	0.10	-0.14	0.09	0.01	0.14
16HRZ2	0.07	0.10	0.28	-0.11	0.16	<u>0.31</u>	0.36
16HRZ3	0.07	-0.18	0.13	-0.10	-0.03	-0.05	0.13
16VO_S	0.36	0.27	0.47	0.22	0.37	0.39	0.13
16VO_K	0.29	0.29	<u>0.33</u>	0.10	0.40	0.26	0.07
16MD_S	0.48	0.25	<u>0.30</u>	0.39	0.51	0.41	0.02
16MD_K	0.00	-0.11	0.26	-0.11	0.02	0.23	<u>0.32</u>
26HZ	0.03	-0.12	0.16	0.03	-0.02	-0.14	0.00
26HKZ	0.16	0.21	0.20	<u>0.34</u>	-0.04	0.00	-0.24
26HRZ1	0.00	-0.16	0.02	-0.03	-0.06	0.10	0.20
26HRZ2	0.04	-0.05	-0.06	-0.12	<u>0.32</u>	0.08	0.13
26HRZ3	-0.09	-0.20	0.12	-0.29	-0.04	-0.18	0.12
26VO_K	0.06	0.09	0.23	-0.16	0.37	0.19	0.28
26VO_S	0.25	0.23	0.40	0.04	<u>0.34</u>	0.29	0.17
26MD_K	0.07	-0.06	<u>0.33</u>	0.09	-0.01	0.12	0.09
26MD_S	0.38	<u>0.32</u>	0.44	<u>0.30</u>	0.43	0.46	0.12
27HZ	<u>0.32</u>	0.04	0.28	0.09	0.29	0.54	0.39
27HKZ	0.21	0.13	0.44	0.29	0.03	0.22	-0.04
27HRZ1	0.10	0.10	0.14	0.04	0.29	0.15	0.06
27HRZ2	0.10	0.01	0.02	0.12	0.10	0.00	-0.08
27HRZ3	0.06	-0.07	0.04	-0.11	0.10	0.01	0.11
27VO_K	0.07	-0.09	0.20	-0.13	0.21	0.27	0.35
27VO_S	0.03	-0.03	0.17	-0.17	0.29	<u>0.33</u>	0.43
27MD_K	0.10	0.06	0.12	0.17	<u>0.31</u>	0.14	-0.07
27MD_S	0.28	0.07	0.19	<u>0.31</u>	0.38	<u>0.32</u>	-0.02

Notes: here and in the following tables, bold and red highlighted - reliable medium-strength direct correlations; sand color and highlight - unreliable medium-strength direct correlations; HZ - tooth height; HKZ - height of the tooth crown; HRZ1 - length of the palatine root of the upper molars; HRZ2 - length of the dorsal proximal root of the upper molars; HRZ3 - length of the parietal distal root of the upper molars; VO_K - vestibular-lingual size of the tooth crown; VO_S - vestibular-lingual size of the neck of the tooth; MD_K - mesio-distal size of the tooth crown; MD_S - mesio-distal size of the tooth neck; DUG_GOP - the largest head circumference; DUGS_GOP - sagittal arch; DUG_AUAU - transverse arc; G_OP - the largest length of the head; FMT_FMT - the smallest width of the head (frontal diameter); EU_EU - the largest width of the head (occipital diameter); KRANIO - cranial index.

Correlations of linear sizes of molars with cephalometric indicators of practically healthy men of the northern...

Table 2. Correlations of the sizes of molars of a lower jaw with cephalometric indicators of a brain skull of men of the northern region of Ukraine (n = 10-32).

Sizes of molars	Cephalometric indicators						
	DUG_GOP	DUGS_GOP	DUG_AUAU	G_OP	EY_EY	FMT_FMT	KRANIO
47HZ	0.51	0.23	0.50	0.28	0.29	0.26	-0.04
47HKZ	0.25	0.11	0.35	0.18	0.16	0.09	-0.06
47HRZ4	0.43	0.20	0.41	0.23	0.49	0.38	0.19
47HRZ5	0.25	0.01	0.21	0.11	0.10	0.27	-0.03
47VO_K	0.15	0.21	0.24	0.09	0.20	0.16	0.08
47VO_S	-0.02	0.20	0.17	-0.05	0.26	0.19	0.30
47MD_K	0.19	0.04	0.51	0.12	0.31	0.18	0.17
47MD_S	0.23	0.08	0.36	0.07	0.40	0.49	0.24
46HZ	0.32	0.35	0.32	0.37	0.28	0.29	-0.06
46HKZ	0.43	0.39	0.46	0.32	0.40	0.30	0.07
46HRZ4	0.13	0.02	0.00	0.28	-0.06	0.00	-0.27
46HRZ5	0.29	0.23	0.18	0.34	0.26	0.38	-0.04
46VO_K	-0.12	0.01	0.25	0.11	0.02	-0.05	-0.05
46VO_S	-0.16	0.03	0.06	-0.02	0.10	0.10	0.15
46MD_K	0.10	0.01	0.21	0.27	0.09	0.15	-0.11
46MD_S	0.29	0.23	0.39	0.41	0.27	0.29	-0.13
36HZ	0.23	0.24	0.11	0.26	0.06	0.16	-0.16
36HKZ	0.31	0.30	0.36	0.25	0.23	0.01	0.02
36HRZ4	0.08	0.08	-0.08	0.14	-0.12	0.13	-0.25
36HRZ5	0.14	0.20	0.03	0.18	0.11	0.49	-0.05
36VO_K	-0.12	0.01	0.20	0.14	-0.07	0.05	-0.14
36VO_S	-0.08	0.10	0.14	0.02	0.15	0.20	0.16
36MD_K	0.06	0.09	0.29	0.32	0.07	0.15	-0.18
36MD_S	0.35	0.26	0.38	0.43	0.19	0.39	-0.21
37HZ	0.49	0.18	0.35	0.34	0.32	0.24	-0.02
37HKZ	0.29	0.16	0.36	0.27	0.23	0.12	-0.05
37HRZ4	0.38	0.05	0.17	0.18	0.33	0.32	0.12
37HRZ5	0.27	-0.02	0.13	0.18	0.18	0.30	0.04
37VO_K	-0.05	0.11	0.20	-0.03	0.09	0.12	0.12
37VO_S	-0.14	0.01	0.05	-0.19	0.15	0.16	0.34
37MD_K	0.31	0.13	0.53	0.25	0.33	0.21	0.09
37MD_S	0.42	0.12	0.48	0.19	0.57	0.48	0.32

Notes: here and in the following tables, HRZ4 - the length of the near root of the lower molars; HRZ5 - the length of the distal root of the lower molars.

Table 3. Correlations of the sizes of molars of an upper jaw with cephalometric indicators of a face skull of men of the northern region of Ukraine (n = 10-32).

Sizes of molars	Cephalometric indicators								
	ZY_ZY	ZM_ZM	TR_GN	TR_N	N_GN	N_PRN	N_SN	GO_GO	N_STO
17HZ	0.08	0.12	0.22	0.14	0.05	0.32	0.34	0.18	0.20
17HKZ	0.15	-0.20	-0.01	0.27	-0.24	0.30	0.37	0.18	0.28
17HRZ1	0.22	0.14	0.03	0.05	-0.14	0.24	0.20	0.05	0.00

Table 3. (continuation)

Sizes of molars	Cephalometric indicators								
	ZY_ZY	ZM_ZM	TR_GN	TR_N	N_GN	N_PRN	N_SN	GO_GO	N_STO
17HRZ2	-0.14	0.18	0.21	-0.07	0.24	0.07	0.10	0.15	-0.09
17HRZ3	0.15	<u>0.37</u>	0.07	-0.01	0.21	0.27	0.17	0.19	0.13
17VO_K	0.05	0.03	0.01	-0.07	-0.06	0.07	0.08	0.19	-0.08
17VO_S	0.10	-0.02	0.01	-0.04	-0.06	0.00	0.00	0.14	-0.15
17MD_K	0.20	-0.16	-0.05	-0.02	-0.15	0.08	0.10	0.25	-0.12
17MD_S	0.17	-0.01	-0.10	0.01	-0.10	0.16	0.24	0.08	-0.14
16HZ	0.01	-0.02	-0.04	-0.10	-0.10	0.22	0.25	0.16	0.15
16HKZ	0.11	<u>-0.30</u>	-0.10	-0.05	-0.17	0.15	0.22	0.10	0.29
16HRZ1	-0.05	0.21	-0.02	-0.11	-0.09	0.10	0.08	-0.07	-0.06
16HRZ2	0.11	0.04	-0.27	-0.17	-0.18	-0.02	-0.04	0.17	0.05
16HRZ3	-0.05	0.27	0.22	-0.01	0.06	0.18	0.12	0.11	0.06
16VO_S	0.19	-0.08	0.04	0.05	-0.05	0.14	0.19	0.17	-0.11
16VO_K	0.08	-0.10	0.20	0.12	-0.04	-0.02	0.02	<u>0.30</u>	-0.06
16MD_S	0.18	0.41	0.19	0.08	0.41	-0.15	-0.03	0.02	-0.26
16MD_K	-0.01	0.11	0.02	-0.03	-0.04	-0.08	-0.09	-0.06	0.23
26HZ	0.05	0.06	0.00	-0.11	0.09	0.27	0.26	0.20	<u>0.35</u>
26HKZ	0.12	-0.16	-0.02	0.00	0.01	0.16	0.21	0.15	0.35
26HRZ1	-0.05	0.15	-0.11	0.08	-0.15	0.24	0.19	-0.05	0.11
26HRZ2	-0.04	0.37	-0.10	-0.18	0.06	-0.04	-0.09	0.26	-0.20
26HRZ3	0.00	0.20	0.18	-0.12	0.13	0.06	0.04	0.17	0.19
26VO_K	0.09	-0.08	0.22	0.13	-0.08	0.08	0.07	<u>0.34</u>	-0.03
26VO_S	0.14	-0.06	0.17	0.19	-0.02	0.06	0.06	<u>0.30</u>	0.03
26MD_K	-0.04	0.13	-0.02	-0.09	-0.02	-0.02	0.00	-0.05	0.20
26MD_S	0.27	0.24	0.16	0.11	<u>0.33</u>	-0.17	-0.07	0.10	-0.21
27HZ	0.13	<u>0.30</u>	0.13	-0.02	0.10	0.00	-0.02	0.06	0.06
27HKZ	0.10	-0.24	-0.06	0.07	-0.25	0.16	0.20	0.02	0.27
27HRZ1	0.24	0.21	0.00	-0.07	-0.12	0.21	0.15	0.12	-0.04
27HRZ2	-0.03	0.22	0.14	-0.19	<u>0.30</u>	-0.04	-0.08	0.05	0.03
27HRZ3	0.04	0.44	0.08	-0.11	0.12	0.06	0.04	0.11	0.04
27VO_K	-0.10	0.11	0.09	-0.08	-0.06	-0.07	-0.07	0.08	0.00
27VO_S	-0.03	0.09	0.15	0.01	-0.02	-0.07	-0.07	0.09	-0.02
27MD_K	0.11	-0.11	0.05	0.04	-0.03	0.01	0.02	0.22	-0.09
27MD_S	0.23	0.04	-0.02	-0.03	0.05	0.20	0.24	0.05	-0.17

Notes: here and in the following tables, inaccurate mean correlations of inverse correlations are highlighted by underlining and green color; ZY_ZY - face width (distance between zygomatic points); ZM_ZM - average width of the face; TR_GN - physiological length of the face; TR_N - forehead height; N_GN - morphological length of the face; N_PRN - length of the nose; N_SN - nose height; GO_GO - width of the lower jaw (width between the corners of the lower jaw); N_STO - height of the upper part of the face.

Table 4. Correlations of the sizes of molars of a lower jaw with cephalometric indicators of a face skull of men of the northern region of Ukraine (n = 10-32).

Sizes of molars	Cephalometric indicators								
	ZY_ZY	ZM_ZM	TR_GN	TR_N	N_GN	N_PRN	N_SN	GO_GO	N_STO
47HZ	0.15	0.10	0.20	0.04	0.09	0.13	0.14	0.12	0.07
47HKZ	-0.03	-0.01	-0.08	-0.07	-0.10	0.04	0.10	-0.10	-0.07

Correlations of linear sizes of molars with cephalometric indicators of practically healthy men of the northern...

Table 4. (continuation)

Sizes of molars	Cephalometric indicators								
	ZY_ZY	ZM_ZM	TR_GN	TR_N	N_GN	N_PRN	N_SN	GO_GO	N_STO
47HRZ4	0.18	0.10	0.15	0.13	0.12	0.05	0.03	0.13	-0.01
47HRZ5	0.14	0.01	0.16	0.00	0.23	0.07	0.02	0.27	0.00
47VO_K	0.04	-0.16	0.15	-0.06	-0.02	0.04	0.00	0.26	-0.01
47VO_S	0.08	-0.16	-0.01	0.06	-0.09	0.09	0.06	0.22	-0.04
47MD_K	-0.04	-0.01	0.03	0.13	-0.13	0.09	0.10	0.08	0.17
47MD_S	0.11	0.05	-0.11	0.05	-0.04	0.03	0.02	0.18	-0.24
46HZ	<u>0.34</u>	0.19	0.15	<u>0.31</u>	0.03	0.16	0.16	<u>0.30</u>	-0.07
46HKZ	0.38	0.07	0.26	0.43	0.08	0.29	0.35	0.36	0.25
46HRZ4	-0.02	0.27	-0.11	0.05	-0.18	0.03	0.04	-0.14	-0.05
46HRZ5	0.18	0.27	0.18	<u>0.31</u>	0.00	-0.06	-0.01	0.20	0.00
46VO_K	0.03	-0.40	0.07	0.10	-0.20	0.22	0.20	<u>0.31</u>	0.16
46VO_S	0.05	-0.21	-0.08	0.13	-0.29	0.15	0.15	0.25	0.03
46MD_K	-0.14	0.03	0.01	0.09	-0.04	0.06	0.12	0.11	0.08
46MD_S	0.21	-0.01	0.02	0.08	-0.15	0.20	0.23	-0.10	-0.03
36HZ	0.18	0.21	0.24	<u>0.35</u>	0.09	0.06	0.11	0.20	0.09
36HKZ	0.29	-0.08	0.24	0.37	0.06	0.26	<u>0.31</u>	0.15	0.44
36HRZ4	-0.03	0.35	-0.03	0.00	-0.06	-0.13	-0.11	-0.04	-0.16
36HRZ5	0.24	0.28	0.26	0.35	-0.03	-0.02	0.06	0.22	0.01
36VO_K	0.01	-0.28	0.18	0.21	-0.11	0.17	0.14	<u>0.31</u>	0.15
36VO_S	0.11	-0.13	-0.07	0.07	-0.24	0.03	-0.01	<u>0.31</u>	-0.06
36MD_K	-0.10	-0.10	-0.01	0.06	-0.07	0.05	0.08	0.10	-0.07
36MD_S	0.11	0.13	0.23	0.13	0.09	0.05	0.06	0.07	-0.07
37HZ	0.12	0.16	0.17	0.12	0.07	0.17	0.19	0.04	0.19
37HKZ	0.08	0.00	0.01	0.11	-0.11	0.16	0.23	-0.11	0.07
37HRZ4	0.02	0.25	0.08	-0.01	0.11	-0.03	-0.02	-0.05	0.05
37HRZ5	0.12	0.20	0.13	-0.06	0.26	0.00	0.00	0.14	-0.05
37VO_K	0.07	-0.27	0.14	0.03	-0.11	0.09	0.07	<u>0.34</u>	0.14
37VO_S	0.02	-0.08	-0.10	-0.05	-0.10	-0.06	-0.11	<u>0.31</u>	-0.06
37MD_K	-0.03	0.06	0.13	0.17	-0.02	0.15	0.14	0.03	0.08
37MD_S	0.09	0.13	0.00	0.06	0.06	0.08	0.11	0.05	-0.18

Note: here and in the following tables, bold and blue highlighted significant medium-strength inverse correlations.

Table 5. Correlations of the sizes of molars of an upper jaw with cephalometric indicators of a face skull of men of the northern region of Ukraine (n = 10-32).

Sizes of molars	Cephalometric indicators								
	SN_PRN	AL_AL	CHI_CHI	EK_EK	MF_MF	N_I	PGO_GN	IGO_GN	IN_GARS
17HZ	-0.01	0.04	-0.09	<u>0.32</u>	0.17	-0.03	0.20	0.25	-0.08
17HKZ	0.06	-0.20	-0.14	0.29	0.02	-0.12	0.16	0.27	-0.24
17HRZ1	0.17	0.28	0.19	0.28	0.07	-0.04	0.28	<u>0.32</u>	-0.31
17HRZ2	-0.12	-0.02	0.00	-0.02	0.15	-0.06	-0.10	-0.19	0.12
17HRZ3	-0.08	-0.07	0.14	-0.06	0.19	-0.04	0.13	0.12	-0.03
17VO_K	-0.31	0.11	0.01	0.36	0.10	-0.01	-0.03	0.07	-0.21

Table 5. (continuation)

Sizes of molars	Cephalometric indicators								
	SN_PRN	AL_AL	CHI_CHI	EK_EK	MF_MF	N_I	PGO_GN	IGO_GN	IN_GARS
17VO_S	-0.30	0.14	0.01	0.33	0.15	-0.07	0.00	0.02	0.18
17MD_K	-0.11	-0.16	-0.12	0.35	-0.11	0.04	0.02	0.17	-0.30
17MD_S	-0.14	-0.02	-0.19	0.25	-0.05	-0.10	0.03	0.20	-0.28
16HZ	-0.02	-0.04	0.07	0.24	0.10	0.09	-0.04	0.03	-0.04
16HKZ	0.03	-0.15	-0.17	0.19	-0.05	-0.17	0.14	0.10	-0.07
16HRZ1	0.12	-0.01	0.36	0.19	0.06	0.02	-0.13	-0.05	0.00
16HRZ2	-0.11	-0.02	0.00	0.21	-0.09	0.09	0.10	0.09	-0.23
16HRZ3	-0.03	-0.08	0.15	0.08	0.18	0.20	-0.10	0.08	0.10
16VO_S	-0.25	-0.32	-0.41	0.21	-0.06	-0.01	0.01	0.22	-0.15
16VO_K	-0.06	-0.10	-0.19	0.16	-0.11	0.17	0.00	0.09	-0.16
16MD_S	-0.06	-0.14	-0.28	0.18	0.21	0.15	0.09	0.19	-0.06
16MD_K	0.20	-0.22	0.02	0.17	0.03	0.05	-0.06	0.05	-0.03
26HZ	0.05	-0.32	-0.14	0.12	0.01	0.29	-0.05	0.02	0.18
26HKZ	0.03	-0.21	-0.21	0.22	-0.03	0.03	0.20	0.18	0.04
26HRZ1	0.02	-0.15	0.07	-0.01	0.08	-0.10	0.07	0.13	-0.08
26HRZ2	-0.06	-0.02	-0.04	-0.05	-0.24	0.14	-0.05	0.06	-0.09
26HRZ3	0.18	-0.07	0.21	0.04	0.16	0.16	-0.21	-0.13	0.18
26VO_K	-0.09	-0.14	-0.12	0.17	-0.10	0.08	-0.16	-0.01	-0.20
26VO_S	0.01	-0.27	-0.33	-0.04	-0.05	-0.01	-0.05	0.09	-0.15
26MD_K	0.09	-0.31	-0.07	0.32	0.02	0.17	-0.02	0.16	0.15
26MD_S	-0.03	-0.10	-0.15	0.16	0.30	0.02	0.06	0.11	-0.19
27HZ	0.01	0.16	0.21	0.35	0.25	0.06	0.13	0.16	-0.24
27HKZ	0.12	-0.29	-0.22	0.22	0.00	-0.14	0.14	0.25	-0.13
27HRZ1	0.09	0.10	0.20	0.27	-0.01	0.05	0.13	0.21	-0.25
27HRZ2	-0.07	-0.05	0.15	0.01	0.24	0.09	-0.06	-0.22	0.08
27HRZ3	-0.05	0.08	0.34	0.06	0.21	-0.01	-0.05	-0.13	-0.09
27VO_K	-0.23	0.17	0.14	0.37	0.13	0.17	-0.15	-0.13	-0.14
27VO_S	-0.20	0.15	0.13	0.33	0.13	0.13	-0.15	-0.17	-0.21
27MD_K	0.00	-0.25	-0.21	0.15	-0.12	0.05	-0.03	0.10	-0.19
27MD_S	-0.11	-0.05	-0.25	0.16	-0.01	-0.09	0.08	0.26	-0.22

Notes: here and in the following tables, SN_PRN -the depth of the nose; AL_AL - width of the base of the nose (distance between alar points); CHI_CHI - width of the oral slit; EK_EK - extraocular width (biorbital width); MF_MF - interorbital width (anterior interorbital width); N_I - the distance between the nasion and the intercanine point; RGO_GN - body length of the lower jaw on the right; LGO_GN - body length of the lower jaw on the left; IN_GARS - Garson's morphological index.

Table 6. Correlations of the sizes of molars of a lower jaw with cephalometric indicators of a face skull of men of the northern region of Ukraine (n = 10-32).

Sizes of molars	Cephalometric indicators								
	SN_PRN	AL_AL	CHI_CHI	EK_EK	MF_MF	N_I	PGO_GN	IGO_GN	IN_GARS
47HZ	0.24	-0.02	0.07	0.14	0.19	0.07	0.01	0.19	-0.06
47HKZ	0.12	-0.18	-0.16	0.24	0.05	-0.22	-0.05	0.06	-0.08
47HRZ4	-0.06	0.25	0.23	0.16	0.27	0.01	0.14	0.22	-0.17
47HRZ5	0.26	-0.15	0.00	-0.04	-0.01	0.28	-0.17	0.10	0.10
47VO_K	-0.33	0.16	0.01	0.17	0.08	0.10	0.08	0.12	-0.10

Table 6. (continuation)

Sizes of molars	Cephalometric indicators								
	SN_PRN	AL_AL	CHI_CHI	EK_EK	MF_MF	N_I	PGO_GN	IGO_GN	IN_GARS
47VO_S	-0.34	0.03	-0.23	-0.03	0.03	-0.01	0.08	0.04	-0.17
47MD_K	-0.20	-0.18	0.03	0.35	0.13	-0.08	-0.10	0.07	-0.09
47MD_S	-0.26	-0.04	-0.07	0.11	0.03	-0.17	-0.04	0.08	-0.24
46HZ	0.15	-0.23	-0.18	0.05	0.08	0.01	0.23	0.51	-0.29
46HKZ	0.21	-0.20	-0.17	0.25	0.07	-0.01	0.24	0.51	-0.19
46HRZ4	0.13	0.04	0.09	-0.02	0.07	0.03	0.06	0.27	-0.07
46HRZ5	0.16	-0.09	-0.12	0.11	-0.04	0.29	0.26	0.44	-0.21
46VO_K	-0.14	-0.27	-0.11	0.26	-0.01	-0.04	-0.16	-0.02	-0.08
46VO_S	-0.26	-0.08	-0.13	0.12	-0.12	0.10	-0.06	-0.02	-0.25
46MD_K	-0.24	-0.19	-0.16	0.25	0.04	0.01	-0.19	0.05	0.13
46MD_S	-0.15	-0.29	-0.16	0.23	0.16	-0.09	-0.08	0.14	-0.35
36HZ	0.44	-0.15	-0.14	-0.01	0.01	0.13	0.15	0.31	-0.05
36HKZ	0.35	-0.21	-0.19	0.13	0.12	-0.01	0.23	0.31	-0.07
36HRZ4	0.17	0.01	0.10	-0.12	-0.02	0.07	-0.05	0.14	-0.03
36HRZ5	0.18	-0.24	-0.18	0.08	-0.10	0.20	0.13	0.25	-0.27
36VO_K	-0.10	-0.28	-0.10	0.18	0.03	0.03	-0.18	-0.04	-0.03
36VO_S	-0.33	-0.16	-0.20	0.09	-0.09	0.09	-0.01	0.07	-0.27
36MD_K	-0.38	-0.28	-0.23	0.23	0.08	-0.12	-0.18	0.06	0.04
36MD_S	-0.15	-0.25	-0.17	0.11	0.30	0.04	-0.14	0.02	-0.17
37HZ	0.24	0.01	-0.04	0.12	0.18	0.08	0.09	0.21	-0.10
37HKZ	0.27	-0.20	-0.20	0.24	0.05	-0.16	0.05	0.16	-0.16
37HRZ4	-0.04	0.28	0.21	0.17	0.16	0.12	0.07	0.14	-0.04
37HRZ5	0.19	-0.19	-0.14	0.08	0.05	0.24	-0.11	0.13	0.08
37VO_K	-0.28	0.06	0.04	0.18	-0.01	0.13	0.00	0.00	-0.13
37VO_S	-0.43	0.15	0.01	0.00	-0.01	0.09	0.02	-0.05	-0.17
37MD_K	-0.28	-0.09	0.08	0.38	0.23	-0.06	-0.01	0.21	-0.03
37MD_S	-0.30	-0.08	-0.13	0.30	0.16	-0.14	-0.02	0.17	-0.16

8, 10] and in forensic medicine [2] because such models can be used by doctors to create an individual diagnostic approach to each patient.

In the analysis of reliable and average strength of unreliable correlations of CT sizes of molars with cephalometric indicators and indices of practically healthy men from the northern region of Ukraine, the multiple nature of direct reliable ($r = 0.35-0.57$) and average strength of unreliable ($r = 0.30-0.35$) correlations was established only with indicators of a brain skull.

Our quantitative analysis of reliable and average strength of unreliable correlations of CT sizes of molars with cephalometric indicators and indices of practically healthy men of the northern region of Ukraine revealed the following distribution of correlations:

between the upper molars and indicators of a brain skull 47 correlations from 252 possible (18.7%), from which,

11.9% of direct reliable average force and 6.7% of direct unreliable average force, among which - with the first teeth 26 correlations from 126 possible (12.7% of direct reliable medium strength and 7.9% of direct unreliable medium strength); with second teeth 21 correlations from 126 possible (11.1% of direct reliable average forces and 5.6% of direct unreliable average forces); with the height of the teeth, their crowns and the length of the roots 13 correlations out of 140 possible (5.0% of direct reliable medium strength and 4.3% of direct unreliable medium strength); with vestibular-lingual and mesio-distal dimensions 34 correlations out of 112 possible (20.5% of direct reliable average forces and 9.8% of direct unreliable average forces);

between the lower molars and indicators of a brain skull 54 correlations from 224 possible (24.1%), from which, 15.2% of direct reliable average force and 8.9% of direct

unreliable average force, among which - with the first teeth 23 correlations from 112 possible (12.5% of direct reliable medium strength and 8.0% of direct unreliable medium strength); with second teeth 31 correlations from 112 possible (17.9% of direct reliable average forces and 9.8% of direct unreliable average forces); with the height of the teeth, their crowns and the length of the roots 32 correlations out of 112 possible (20.0% of direct reliable medium strength and 11.6% of direct unreliable medium strength); with vestibular-lingual and mesio-distal dimensions 22 correlations out of 112 possible (13.4% of direct reliable average forces and 6.2% of direct unreliable average forces);

between the upper molars and indicators of the facial skull 39 correlations out of 648 possible (6.0%), of which, 1.7% of direct reliable medium force, 2.8% of direct unreliable medium force, 0.2% of reverse reliable medium force and 1.4% of inverse unreliable medium force, among which - with the first teeth 18 correlations out of 324 possible (1.5% of direct reliable of medium strength, 2.2% of direct unreliable of medium strength, 0.3% of inverse reliable of medium strength and 1.5% of inverse unreliable of medium strength); with second teeth 21 correlations from 324 possible (1.9% of direct reliable average forces, 3.4% of direct unreliable average forces and 1.2% of inverse unreliable average forces); with the height of the teeth, their crowns and the length of the roots, 19 correlations out of 360 possible (1.7% of direct reliable medium strength, 2.8% of direct unreliable medium strength and 0.8% of inverse unreliable medium strength); with vestibular-lingual and mesio-distal dimensions 20 correlations out of 288 possible (1.7% of direct reliable medium forces, 2.8% of direct unreliable medium forces, 0.3% of reverse reliable medium forces and 2.1% of inverse unreliable medium forces);

between lower molars and indicators of a facial skull 38 correlations from 576 possible (6.6%), from which, 2.6% of direct reliable average force, 2.6% of direct unreliable average force, 0.5% of return reliable average force and 0.9% of return unreliable average force, among which - with the first teeth 29 correlations out of 288 possible (4.5%

of direct reliable medium strength, 4.2% of direct unreliable medium strength, 0.7% of inverse reliable medium strength and 0.7% of inverse unreliable medium strength); with second teeth 9 correlations out of 288 possible (0.7% of direct reliable medium strength, 1.0% of direct unreliable medium strength, 0.3% of inverse reliable medium strength and 1.0% of inverse unreliable medium strength); with the height of the teeth, their crowns and the length of the roots 21 correlations out of 288 possible (4.5% of direct reliable medium strength and 2.8% of direct unreliable medium strength); with vestibular-lingual and mesio-distal dimensions 17 correlations out of 288 possible (0.7% of direct reliable medium strength, 2.4% of direct unreliable medium force, 1.0% of inverse reliable medium force and 1.7% of inverse unreliable medium force).

Our results of qualitative and quantitative analysis of correlations differ from the results obtained in a similar sample of men in the northern region of Ukraine by V.O. Orlovskiy [14] for premolars.

The conducted correlation studies demonstrate the population specificity of the features of the dental system, which vary significantly depending on ethnicity and climatic and geographical conditions of human habitation.

Conclusions

Peculiarities of correlations of linear sizes of molars with cephalometric indicators of brain and facial skull of practically healthy men of the northern region of Ukraine are established. With indicators of the brain skull - multiple, only direct reliable ($r = 0.35-0.57$) and unreliable ($r = 0.30-0.35$) of medium strength correlation (18.7% in the upper jaw, of which the relative majority with vestibular-lingual and mesio-distal size and 24.1% on the lower jaw, of which the relative majority with the height of the teeth, their crowns and the length of the roots of the teeth); with facial skull indices - mostly direct reliable ($r = 0.35-0.51$) and unreliable medium strength ($r = 0.30-0.37$) correlations, in most cases of a single nature (6.0% on the upper jaw and 6.6% on the lower jaw, almost evenly with the height of the teeth, their crowns, the length of the roots, vestibular-lingual and mesio-distal dimensions).

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КОРЕЛЯЦІЇ ЛІНІЙНИХ РОЗМІРІВ ВЕЛИКИХ КУТНІХ ЗУБІВ ІЗ КЕФАЛОМЕТРИЧНИМИ ПОКАЗНИКАМИ ПРАКТИЧНО ЗДОРОВИХ ЧОЛОВІКІВ ПІВНІЧНОГО РЕГІОНУ УКРАЇНИ

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Питання взаємозв'язку метричних характеристик черепних структур і одонтометричних показників, та можливість побудови на їх основі моделей, що в подальшому можуть знайти своє практичне застосування в стоматологічній практиці, залишаються актуальною проблемою сучасної медичної науки. Мета дослідження - встановити особливості зв'язків лінійних розмірів великих кутніх зубів з кефалометричними показниками мозкового та лицевого черепа практично здорових чоловіків північного регіону України. У 32 практично здорових мешканців північного регіону України (з Київської, Житомирської, Сумської та Чернігівської областей) проведено комп'ютерну томографію з наступною одонтометриєю великих кутніх зубів та кефалометрією. Оцінку кореляцій між одонтометричними і кефалометричними показниками проводили з використанням непараметричної статистики Спірмена у ліцензійному пакеті "Statistica 6.1". Встановлені особливості зв'язків досліджених характеристик великих кутніх зубів із показниками мозкового черепа - множинні, лише прямі достовірні ($r = 0,35-0,57$) та недостовірні ($r = 0,30-0,35$) середньої сили кореляції (18,7% на верхній щелепі, з яких відносна більшість із присінково-язиковими і мезіо-дистальними розмірами та 24,1% на нижній щелепі, з яких відносна більшість із висотою зубів, їх коронок і довжиною коренів зубів); а також із показниками лицевого черепа - переважно прямі достовірні ($r = 0,35-0,51$) та недостовірні середньої сили ($r = 0,30-0,37$) зв'язки, у більшості випадків поодинокого характеру (6,0% на верхній щелепі та 6,6% на нижній щелепі, майже рівномірно з висотою зубів, їх коронок, довжиною коренів, присінково-язиковими та мезіо-дистальними розмірами). Результати кореляційного аналізу краніофациальних структур необхідні для коректної побудови математичних моделей, які в подальшому можуть знайти своє практичне застосування в стоматологічній практиці та в судовій медицині. **Ключові слова:** кореляції, кефалометрія, одонтометрія, адміністративно-територіальні регіони України.

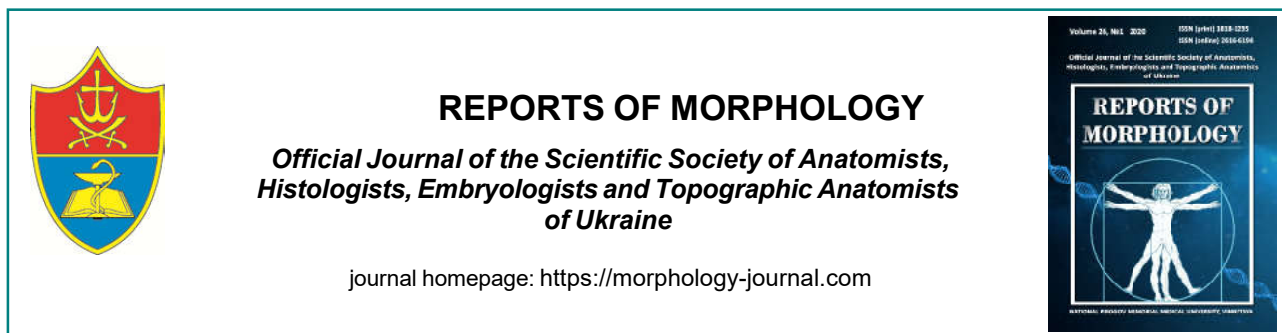
КОРЕЛЯЦИИ ЛИНЕЙНЫХ РАЗМЕРОВ БОЛЬШИХ КОРЕННЫХ ЗУБОВ С КЕФАЛОМЕТРИЧЕСКИМИ ПОКАЗАТЕЛЯМИ ПРАКТИЧЕСКИ ЗДОРОВЫХ МУЖЧИН СЕВЕРНОГО РЕГИОНА УКРАИНЫ

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Вопрос взаимосвязи метрических характеристик черепных структур и одонтометрических показателей и возможность построения на их основе моделей, которые в дальнейшем могут найти свое практическое применение в стоматологической практике, остаются актуальной проблемой современной медицинской науки. Цель исследования - установить особенности связей линейных размеров больших коренных зубов с кефалометрическими показателями мозгового и лицевого черепа практически здоровых мужчин северного региона Украины. Для 32 практически здоровых жителей северного региона Украины (жители Киевской, Житомирской, Сумской и Черниговской областей) проведена компьютерная томография с последующей одонтометрией больших коренных зубов и кефалометрия. Оценку корреляций между одонтометрическими и кефалометрическими показателями проводили с использованием непараметрической статистики Спирмена в лицензионном пакете "Statistica 6.1". Установлены особенности связей исследованных характеристик больших коренных зубов с показателями мозгового черепа - множественные, только прямые достоверные ($r = 0,35-0,57$) и недостоверные ($r = 0,30-0,35$) средней силы корреляции (18,7% на верхней челюсти, из которых относительное большинство с вестибуло-

оральными и мезио-дистальными размерами и 24,1% на нижней челюсти, из которых относительно большинство с высотой зубов, их коронок и длиной корней зубов); а так же с показателями лицевого черепа - преимущественно прямые достоверные ($r = 0,35-0,51$) и недостоверные средней силы ($r = 0,30-0,37$) связи, в большинстве случаев одиночного характера (6,0% на верхней челюсти и 6,6% на нижней челюсти, почти равномерно с высотой зубов, их коронок, длиной корней, преддверно-языковыми и мезио-дистальными размерами). Результаты корреляционного анализа краниофациальных структур необходимы для корректного построения математических моделей, которые в дальнейшем могут найти свое практическое применение в стоматологической практике и в судебной медицине.

Ключевые слова: корреляции, кефалометрия, одонтометрия, административно-территориальные регионы Украины.



Morphological changes in the conditions of adrenaline myocardial dystrophy against the background of the introduction of the compound PC-66 and amiodarone to rats

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ARTICLE INFO

Received: 18 December, 2019

Accepted: 22 January, 2020

UDC: 616.123:616-005.4:547.856.1

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Adrenaline damage to the myocardium is an important element in the pathogenesis of myocardial infarction in humans. Despite the use of modern methods of treatment of myocardial infarction, the issue of cardioprotection of reperfusion myocardial damage remains open. Promising in this direction is the use of quinazolone derivatives, which have already shown cardioprotective properties in other models of myocardial infarction. The aim of the study was to establish morphological changes in the conditions of adrenaline myocardiodystrophy (AMD) against the background of the introduction of the compound PC-66 and amiodarone in rats. The study was performed on 100 nonlinear rats of both sexes weighing 165-220 g, divided into four groups of 25 animals each: 1 - intact rats; 2 - rats with a model of adrenaline myocardial infarction without treatment (control); 3 - rats with AMD treated with amiodarone (10 mg/kg, intraperitoneally); 4 - rats with AMD treated with compound PC-66 (10 mg/kg, intraperitoneally). It was found that control rats under conditions of cardiotoxic dose of adrenaline in the left ventricular myocardium for up to 8 days of the experiment does not fully restore the myocardial structure, dystrophic and necrobiotic changes were found in both cardiomyocytes and walls of vessels of a blood microcirculatory channel of a myocardium. Course intraperitoneal administration to rats of the compound PC-66 in the conditions of adrenaline myocardial infarction as well as amiodarone, contributes to the attenuation of signs of dystrophic and destructive processes. The degree of protective effect on the myocardium under conditions of cardiotoxic dose of adrenaline compound PC-66 was not lower to the reference drug - amiodarone. Thus, it is morphologically confirmed that in adrenaline myocardial infarction the compound PC-66, similar to the action of amiodarone, has a cardioprotective effect.

Keywords: cardioprotection, PC-66, amiodarone, myocardium, morphology.

Introduction

Adrenaline myocardial damage is an important element in the pathogenesis of myocardial infarction in humans, which can be both an inducer of the pathological process and part of cascading myocardial damage [12, 18]. It has been established [1, 10] that myocardial infarction in humans causes significant endothelial injury, as well as a parallel increase in the concentration of circulating catecholamines and, in particular, adrenaline. It was also found [3] that sympatho-adrenal activation is a standard response of the body to myocardial infarction, but it can turn from a protective reaction to non-adaptive, which, in turn, can contribute to myocardial damage with a direct negative impact on the endothelium. There is no doubt that circulating catecholamines and endothelial damage are

interrelated and lead to increased mortality after myocardial infarction [9]. Despite the use of modern methods of treatment, myocardial infarction remains an open issue of cardioprotection of reperfusion myocardial damage [2].

Cardioprotection in myocardial infarction is a very significant factor influencing the consequences of therapy and survival of patients despite the use of thrombolysis [7]. Insufficient efficiency and the presence of side (negative) reactions in modern cardioprotective agents encourage the search for new molecules with this effect, promising to create on their basis more effective and safe drugs [9]. The search for new drugs is carried out around the world and includes both the study of the protective properties of long-known substances [8] and the study of new synthesized

substances with potential protective activity [5, 15]. According to many researchers [16, 22], the second way is more promising in scientific and practical terms.

In our opinion, the use of quinazalone derivatives, which have already shown cardioprotective properties [6] in other models of myocardial infarction, is promising in this direction.

That is why in order to establish the characteristics of the cardioprotective activity of the compound PC-66 we chose an experimental model of myocardial ischemia - adrenaline myocardiodystrophy (AMD) [14], which will reveal the cardioprotective effect of this compound. For comparison, we used amiodarone, which is currently considered by many researchers [11, 23] as a reference drug with cardioprotective properties against the background of myocardial infarction. It is also important to note that we studied the morphological changes that are the most objective signs of myocardial damage and its recovery against the background of treatment [13, 15].

Purpose of study: to establish morphological changes in the conditions of adrenaline myocardial infarction on the background of the introduction of the compound PC-66 and amiodarone in rats.

Materials and methods

AMD was modeled according to the standard method [15] by a single intramuscular (intravenous) injection of 0.18% solution of adrenaline tartrate (PJSC Pharmaceutical Company "Darnytsia", Kyiv) at a dose of 1 mg/kg body weight. The study was performed on 75 nonlinear rats of both sexes weighing 165-220 g, divided into four groups of 25 animals each: 1 - intact rats; 2 - rats with AMD model without treatment (control); 3 - rats with AMD receiving amiodarone (10 mg/kg, intraperitoneally (i/p)); 4 - rats with AMD, receiving compound PC-66 (10 mg/kg, i/p). The test substances were administered to groups of animals daily for 7 days: the first injection - for 30 minutes before AMD modeling.

Committee on Bioethics of National Pirogov Memorial Medical University, Vinnitsya (Minutes №7 from 21.09.2018) found that the experiment was conducted considering the recommendations of the European Commission for medical and biological research using animals, medical recommendations of the State Pharmacological Center of the Ministry of Health of Ukraine, as well as "Rules for clinical safety assessment pharmacological agents (GLP)".

To assess the morphological changes in the myocardium of experimental animals under experimental ischemia using PC-66 and reference drugs, pieces of cardiac muscle were fixed in 10% neutral formalin solution. Micropreparations were prepared according to standard methods, histological sections 5-7 μm thick were stained with hematoxylin and eosin, picrofuxin according to Van Gieson, a combination of PAS reaction with alcian blue [21].

Microscopy and photographing of histological

specimens were performed using a light microscope OLIMPUS BX-41 at magnifications of 40, 100, 200, 400 and 1000 times.

Results

Microscopic examination revealed that in control rats under conditions of cardiotoxic dose of adrenaline in the left ventricular myocardium on the second day of the experiment there is damage to the walls of blood vessels of the circulatory microcirculatory system, which lead to cardiac hemodynamics and reversible and irreversible structural changes. Under the conditions of action of a cardiotoxic dose of adrenaline in a myocardium of a left ventricle of rats in the specified term of experiment of a gleam of arterioles were full-blooded and contained parietal thrombi. In the walls of arterioles endothelial cells in a state of edema and destructively altered, do not form a continuous layer. In venules the gleams are expanded, sharply full-blooded. Endotheliocytes in their walls are also dystrophically and necrobiotically altered. Such changes increase the permeability of the walls of the vessels of the blood microcirculatory tract in the myocardium of the left ventricles of rats with the development of perivascular edema, hemorrhage and histiolympocytic infiltration (Fig. 1).

On the 8th day of the experiment under the action of a cardiotoxic dose of adrenaline, morphological disorders in the myocardium of rats were more pronounced than in the previous period of the study. During this period, dystrophic, hypertrophic and necrobiotic processes that developed in the myocardium were unbalanced and disproportionate. We found the predominance of dystrophic changes in cardiomyocytes. Histological examination revealed parenchymal dystrophy with pyknosis of the nuclei in cardiomyocytes.

Fibroblast proliferation is present around the muscle fibers, indicating connective tissue growth. Arterioles in the myocardium showed signs of spasm and histiolympocytic infiltration of the walls. At the same time, hypertrophied cardiomyocytes were almost absent (Fig. 2).

By the 8th day of the experiment there is no complete restoration of the structure of the myocardium of experimental rats, dystrophic and necrobiotic changes were detected in both cardiomyocytes and vascular walls of the blood microcirculatory tract of the myocardium.

Against the background of amiodarone, areas of the myocardium with signs of cardiomyocyte alteration were detected less frequently than in control rats. In most cardiomyocytes, the transverse striation is preserved, in contrast to rats, which were administered adrenaline without correction (Fig. 3). Foci of cardiomyocyte necrosis usually contained one cell and were not detected in all fields of vision.

The lumens of the blood capillaries are dilated, moderately full-blooded, but the endothelial lining of the capillaries is intact. The basement membrane in the walls

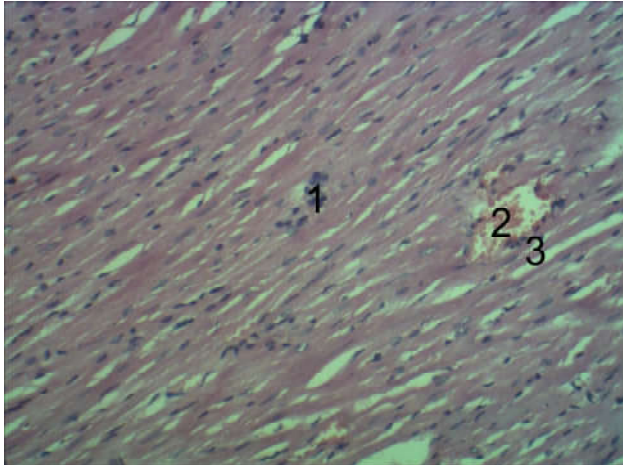


Fig. 1. A fragment of the myocardium of rats which was administered the compound PC-66 to correct the action of adrenaline. 2 day of observation. 1 - focal necrosis of cardiomyocytes; 2 - dilated lumens of the venules; 3 - stasis and diapedesis of leukocytes through the walls of venules. Hematoxylin-eosin. x100.

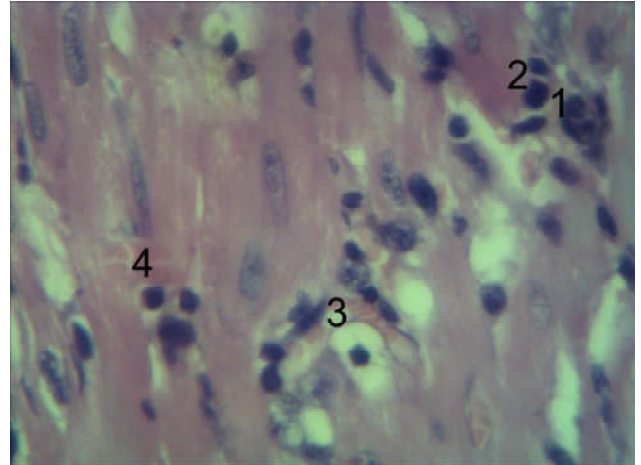


Fig. 2. Fragment of the myocardium of the left ventricle of rats on the background of the action of adrenaline for 8 days (control). 1 - focal necrosis of cardiomyocytes; 2 - histiolympocytic infiltration; 3 - dilated full-blooded lumens of blood capillaries; 4 - full-blooded lumens of venules. Hematoxylin-eosin. x400.

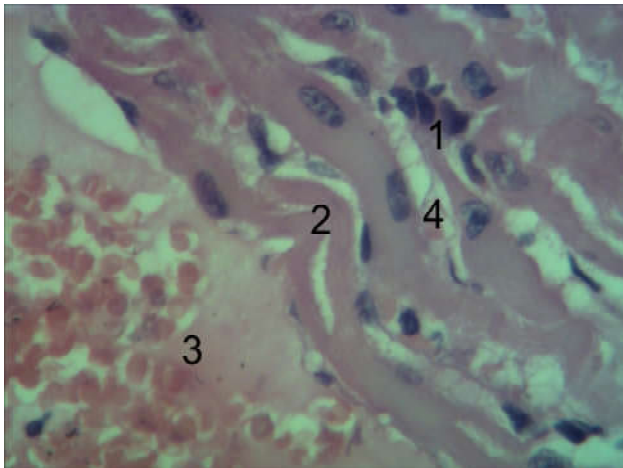


Fig. 3. A fragment of the myocardium of the left ventricle of a rat which was administered amiodarone to correct the action of adrenaline. 2 day of observation. 1 - cardiomyocyte necrosis; 2 - shortened cardiomyocytes; 3 - dilated and full-blooded lumens of the venules; 4 - dilated lumens of blood capillaries. Hematoxylin-eosin. x400.

of blood capillaries is homogeneous in thickness and color. At the same time, no diapedesis hemorrhages were detected. The interstitium around the capillaries is not loose, without signs of edema and contained single lymphocytes.

On day 8 of the experiment, rats treated with Cordarone were less likely to show signs of dystrophic and alterative changes in the left ventricular myocardium, both in cardiomyocytes and in the vessel walls of the blood microcirculatory tract, compared with control rats of the same research period (Fig. 4). Thus, in most of the cardiomyocytes of rats, which were administered Cordarone on the background of the action of adrenaline, there is a transverse striation, and the sarcoplasm was stained moderately basophilic. The endothelial lining in the walls of arterioles

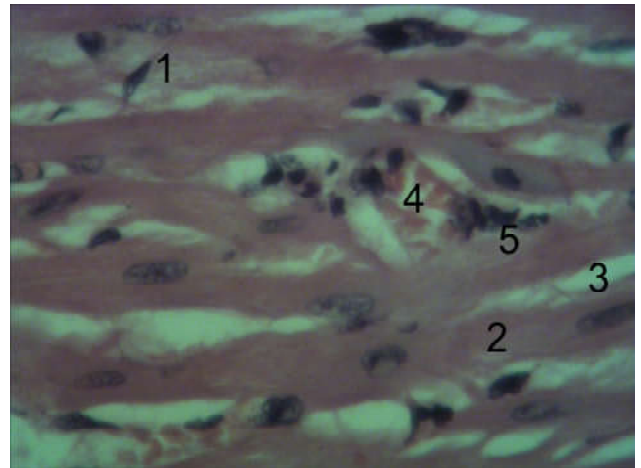


Fig. 4. A fragment of the myocardium of rats which was administered amiodarone to correct the action of adrenaline. 8 days of observation. 1 - dystrophically altered cardiomyocytes; 2 - muscle fibers; 3 - blood capillaries; 4 - venules; 5 - stasis and diapedesis of leukocytes through the walls of venules. Hematoxylin-eosin. x400.

and venules is continuous. Thrombi in arterioles and venules were found less frequently in contrast to rats given adrenaline without correction. The lumens of the venules and blood capillaries are dilated and moderately full-blooded compared to those in intact rats.

When using the compound PC-66 to correct the effect of adrenaline on the myocardium of rats at all times of the study, pathological changes in its structure are less pronounced than in rats that were administered adrenaline without correction (Fig. 5).

In most cardiomyocytes, the transverse striation was preserved. The foci of cardiomyocytes, in the sarcoplasm of which there is no transverse striation, as well as areas of shortened cardiomyocytes, are smaller than in rats, which were administered adrenaline without correction. Foci of

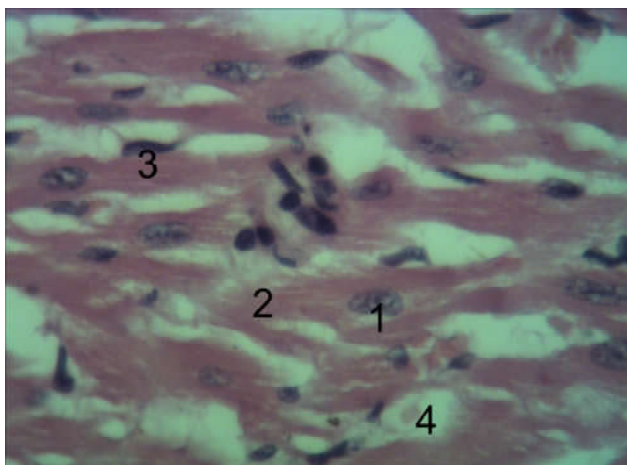


Fig. 5. A fragment of the myocardium of rats which was administered the compound PC-66 to correct the action of adrenaline. 2 day of observation. 1 - nuclei of cardiomyocytes; 2 - sarcoplasm of cardiomyocytes; 3 - fibroblasts; 4 - dilated lumens of capillaries. Hematoxylin-eosin. x400.

cardiomyocyte necrosis usually contained one cell and were not detected in all fields of view. Hypertrophied cardiomyocytes are located around the foci of necrotic cardiomyocytes, but their number was higher than in rats treated with Cordarone to correct the action of adrenaline. Areas of the myocardium with signs of cytoplasmic dystrophy and cardiomyocyte alteration were found less frequently than in rats treated with uncorrected adrenaline.

On day 8 of the study, rats treated with PC-66 for adrenaline showed signs of dystrophic and necrobiotic changes in the left ventricular myocardium, both in cardiomyocytes and in the vascular walls of the circulatory microcirculatory system, similar to those in rats. Corrections of the cardiotoxic effect of adrenaline were similar to administered Cordarone, and less pronounced than in rats administered adrenaline without correction in the same period of the study.

Left ventricular myocardial cardiomyocytes had the same diameter and shape. In the sarcoplasm of most of the cardiomyocytes of rats, which on the background of the action of adrenaline was administered the compound PC-66, there is a characteristic transverse striation. The nuclei in cardiomyocytes are located in the center, oval, chromatin in them is clarified in the center and condensed on the periphery (Fig. 6).

The endothelial lining in the walls of arterioles and venules is continuous. Thrombi in arterioles and venules were not detected in all fields of view, in contrast to rats, which were administered adrenaline without correction. The lumens of the venules and blood capillaries are dilated and moderately full-blooded compared to those in intact rats.

Discussion

Thus, the results of the study showed that the course of intraperitoneal administration to rats of the compound

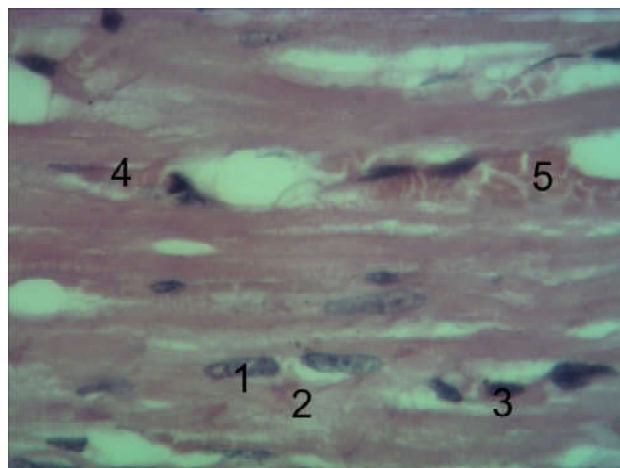


Fig. 6. A fragment of the myocardium of rats which was administered the compound PC-66 to correct the action of adrenaline. 8 days of observation. 1 - nuclei of cardiomyocytes; 2 - sarcoplasm of cardiomyocytes; 3 - proliferation of fibroblasts, 4 - dilated lumens of capillaries; 5 - dilated lumens of the venules. Hematoxylin-eosin. x400.

PC-66 at a dose of 10 mg/kg in conditions of adrenaline myocardiodystrophy as well as amiodarone (10 mg/kg i/p), helps to reduce the symptoms of degenerative and destructive processes [21] in damaged heart muscle, which may be a sign of the presence of cardioprotective action in the studied quinazoline derivative under given experimental conditions, and similar in other studies of cardioprotective properties [2, 6]. The degree of protective effect on the myocardium under conditions of cardiotoxic dose of adrenaline compound PC-66 was not inferior to the reference drug - amiodarone, which is a recognized cardioprotector [11, 23] in myocardial infarction.

The obtained results also indicate a significant damaging effect of adrenaline, which is realized on both the 2nd and 8th day of the study, which indicates a long-term negative effect of this compound [12, 18]. The injuries were not corrected without the use of cardioprotection, which increases the risk of further mortality in clinical practice [10].

The use of PC-66, as well as the comparison drug helped to reduce the degree and prevalence of pathological changes in the myocardium caused by experimental ischemia. Myocardial remodeling that occurs after an episode of ischemic injury has one very important aspect - the reconstruction of the connective tissue framework [19]. This develops enzymatic cleavage of connective tissue fibers (mainly collagen) and the synthesis of an intermediate substance, according to the new conditions of mechanical loads on the organ [4]. The greatest role in this process is assigned to enzymes of the metalloprotease group [20]. By the end of the experiment in animals treated with PC-66, changes in the myocardium were minimal, the histological structure of the heart muscle was close to that in the intact group. There were no signs of inflammation and severe circulatory disorders. Note that in comparison

with the intact myocardium there is a slight increase in the width of the stromal spaces and the diameter of cardiomyocytes, which indicates [17] the preservation of intercellular and intracellular edema, but these pathomorphological changes in the interstitium and cardiomyocytes are not alterative.

The use of PC-66 and amiodarone caused similar morphological changes in the myocardium, which indicate increased regeneration and reduced damage of adrenaline [15, 21]. The obtained changes indicate a direct cardioprotective effect of amiodarone and PC-66 on the background of AMD set at the morphological level according to modern recommendations [3].

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Conclusions

1. The administration to rats of the compound PC-66 at a dose of 10 mg/kg in conditions of adrenaline myocardial infarction as well as amiodarone (10 mg/kg i/p), helps to reduce the symptoms of degenerative and destructive processes in the damaged heart muscle, which can be a sign of the presence of cardioprotective action in the investigated quinazoline derivative under given experimental conditions.

2 According to the degree of protective effect on the myocardium in the conditions of cardiotoxic dose of adrenaline, the compound PC-66 was not lower to the reference drug.

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МОРФОЛОГІЧНІ ЗМІНИ В УМОВАХ АДРЕНАЛІНОВОЇ МІОКАРДІОДИСТРОФІЇ НА ФОНІ ВВЕДЕННЯ СПОЛУКИ ПК-66 ТА АМІОДАРОНУ У ЩУРІВ

Джигалюк О.В., Лисенко Д.А., Смолко Д.Г., Кириченко І.М., Прокопенко С.В.

Адреналінове ушкодження міокарда є важливим елементом патогенезу розвитку інфаркту міокарда у людини. Незважаючи на застосування сучасних методик лікування інфаркту міокарда залишається відкритим питання кардіопротекції реперфузійного ушкодження міокарда. Перспективним у цьому напрямі є використання похідних хіназолону, що вже виявили кардіопротективні властивості на інших моделях інфаркту міокарда. Мета роботи - встановити морфологічні зміни в умовах адреналінової міокардіодистрофії (АМД) на фоні введення сполуки ПК-66 та аміодарону у щурів. Дослідження проведено на 100 нелінійних щурах обох статей масою тіла 165-220 г, розбитих на чотири групи по 25 тварин у кожній: 1 - інтактні щури; 2 - щури з моделлю адреналінової міокардіодистрофії без лікування (контроль); 3 - щури з АМД, ліковані аміодароном (10 мг/кг, внутрішньоочеревинно); 4 - щури з АМД, ліковані сполукою ПК-66 (10 мг/кг, внутрішньоочеревинно). Встановлено, що у контрольних щурів в умовах дії кардіотоксичної дози адреналіну в міокарді лівого шлуночка в термін до 8 доби експерименту не відбувається повного відновлення структури міокарда, дистрофічні та некробіотичні зміни виявляли як в кардіоміоцитах, так і в стінках судин кровоносного мікроциркуляторного русла міокарда. Курсове внутрішньоочеревинне введення щурам сполуки ПК-66 в умовах адреналінової міокардіодистрофії так само, як і аміодарону, сприяє послабленню ознак дистрофічних та деструктивних процесів. При цьому за ступенем захисного ефекту на міокард в умовах дії кардіотоксичної дози адреналіну сполука ПК-66 не поступалась референс-препарату - аміодарону. Таким чином, морфологічно підтверджено, що при адреналіновій міокардіодистрофії сполука ПК-66 аналогічно дії аміодарону проявляє кардіопротекторний ефект.

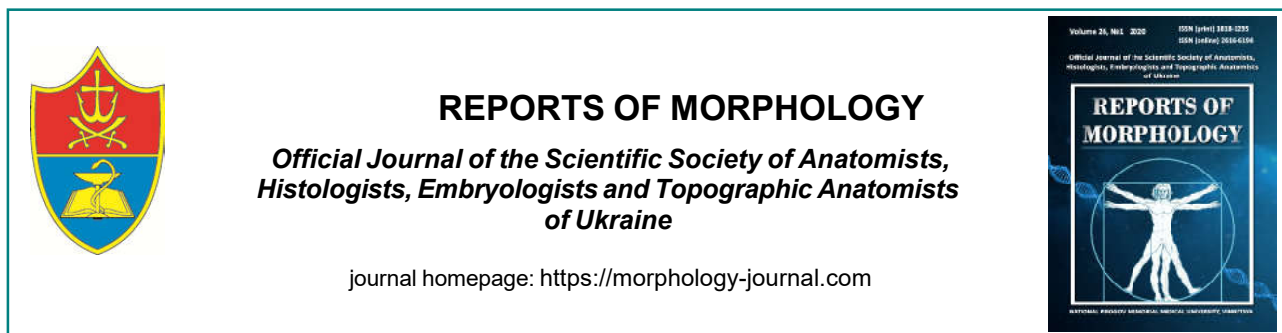
Ключові слова: кардіопротекція, ПК-66, аміодарон, міокард, морфологія.

МОРФОЛОГИЧЕСКИЕ ИЗМЕНЕНИЯ В УСЛОВИЯХ АДРЕНАЛИНОВОЙ МИОКАРДИОДИСТРОФИИ НА ФОНЕ ВВЕДЕНИЯ СОЕДИНЕНИЯ ПК-66 И АМИОДАРОНА У КРЫС

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Адреналиновое повреждение миокарда является важным элементом патогенеза развития инфаркта миокарда у человека. Несмотря на применение современных методов лечения инфаркта миокарда остается открытым вопросом кардиопротекция реперфузионного повреждения миокарда. Перспективным в этом направлении является использование производных хиназолон, которые уже проявили кардиопротекторные свойства на других моделях инфаркта миокарда. Цель работы - установить морфологические изменения в условиях адреналиновой миокардиодистрофии (АМД) на фоне введения соединения ПК-66 и амiodарона у крыс. Исследование проведено на 100 неллинейных крысах обоего пола массой тела 165-220 г, разбитых на четыре группы по 25 животных в каждой: 1 - интактные крысы; 2 - крысы с моделью адреналиновой миокардиодистрофии без лечения (контроль); 3 - крысы с АМД, леченные амiodароном (10 мг/кг, внутривбрюшинно); 4 - крысы с АМД, леченные соединением ПК-66 (10 мг/кг, внутривбрюшинно). Установлено, что у контрольных крыс в условиях действия кардиотоксической дозы адреналина в миокарде левого желудочка в срок до 8 суток эксперимента не происходит полного восстановления структуры миокарда, дистрофические и некробіотические изменения выявляли как в кардиомиоцитах, так и в стенках сосудов кровоносного микроциркуляторного русла миокарда. Курсовое внутривбрюшинное введение крысам соединения ПК-66 в условиях адреналиновой миокардиодистрофии так же, как и амiodарона, способствует ослаблению признаков дистрофических и деструктивных процессов. При этом по степени защитного эффекта на миокард в условиях действия кардиотоксической дозы адреналина соединение ПК-66 не уступало референс-препарату - амiodарону. Таким образом, морфологически подтверждено, что при адреналиновой миокардиодистрофии соединение ПК-66 аналогично действию амiodарона проявляет кардиопротекторный эффект.

Ключевые слова: кардиопротекция, ПК-66, амiodарон, миокард, морфология.



Contradictory views on the acquired and congenital etiology of pilonidal disease

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ARTICLE INFO

Received: 23 December, 2019

Accepted: 30 January, 2020

UDC: 611.711.8..616-053-089

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Pilonidal disease is a pathology that was first described more than 100 years ago. However, it still remains the subject of discussion, because there is still no clear unambiguous definition of this pathology, nor its well-known etiology. Despite the large number of developed and substantiated theories, there are still two opposing views on the cause of pilonidal disease. Some scientists are supporters of the "congenital" theory, others - the theory of acquired origin. However, this does not clarify the ultimate goal of these studies: to develop optimal treatment tactics. The purpose of the work is to clarify the data on the etiology of pilonidal disease in children. The study is based on the results of treatment analysis of 37 children diagnosed with "pilonidal disease" who were hospitalized in the Department of Emergency Surgery of Vinnytsia Regional Children's Clinical Hospital, of which boys - 26, girls - 11. The mean age of patients was 16.4 ± 0.4 years. Histological sections of tissue samples were stained with hematoxylin and eosin. Microscopy and creation of a photo archive of histological specimens were performed using a light microscope OLIMPUS BX 41 at a magnification of 100 and 200, in the software environment "Quick PHOTO MICRO 2.3". The study found that there are significant differences in the histological structure of pilonidal cysts in children and adults. In pediatric patients, mesenchymal tissue was found, which is not typical for this group of patients. It was also found that the cavity of the pilonidal cyst in children is covered with a multilayered squamous non-keratinizing epithelium, and there is almost no granulation tissue. In our opinion, pilonidal disease is a polyetiological disease, the main cause of which is the congenital features of the organism, which are realized due to socio-economic and environmental factors.

Keywords: pilonidal disease, children, etiology, morphology.

Introduction

Pilonidal disease (PD), despite more than a century of history as a pathology described by Anderson A. in 1847, still has a large number of "white" spots. These include many things, from a clear definition of the pathology and ending with the rehabilitation of patients after surgery. One such dilemma is the question of the etiology of this disease. Most researchers in the post-Soviet space believe that pilonidal disease is purely congenital and manifests itself after the birth of a child [7, 9, 15, 17]. As for most European and American researchers, they prefer the acquired genesis of the disease, which is realized through the influence of environmental and social factors. But is such a clear division justified enough?

In favor of the congenital genesis of the development of pilonidal disease testifies the fact that some researchers in its development note a hereditary predisposition in 10.4-

38.0% of cases [1, 13, 16]. In addition, Dool D. in 2009, determined that PD with a frequency of up to 12%, is observed in the first line of kinship [6]. In addition, the most common are young and working age - 15-30 years patients, which is close to the idea of congenital genesis of this pathology [7].

Another interesting assumption was made in 1931 by Stone H.B., who presented pilonidal disease as an analogy of uropygial glands. These glands are secondary sexual characteristics of birds, and in humans - the process of ectodermal layer of the outer ear and breast [1].

This theory was supported by Kallet H.I. in 1936, putting forward the data of his observations. They stated that the manifestation of the disease occurs directly during puberty, ie, during the development of secondary gonads under the influence of pituitary hormones [2].

The congenital theory of pilonidal disease has been described by many scientists, but the main and most important role is given by Bascom J. (1980), who formulated and described the follicular-retention theory of disease development and trichogenic-pump mechanism of secondary fistula [2, 10]. The essence of the theory is that the hair found in the cavity of the pilonidal cyst is the result of periodic occurrence of negative pressure in it in response to relaxation and tension of the gluteal muscles [5, 16]. This theory was most actively supported and developed by Karydakos G.E., who in 1992 published a work based on the analysis of the course of the disease and the treatment of 6000 patients with pilonidal disease [8].

However, it should be noted that all researchers from both "camps" see an important role in the constitutional features of the body, such as: the depth of the intergluteal fold and the condition of the skin in it, the structure of hair and hair distribution, shape and size of the pelvis, obesity etc. These factors should be considered as features of the constitution of each individual, which remain stable throughout life. This confirms that pilonidal disease should be considered as a multifactorial pathology, which is realized under the influence of various causes. However, the constitutional type of structure of the organism is an innate feature and is provided by genetic potential. Also, in completely healthy children (including newborns) during the examination there are often funnel-shaped and fistula-like formations in the intergluteal region, which are visually similar to the primary fistula courses (Fig. 1). But, although the constitution of the organism is stable throughout life, it is realized under the influence of environmental factors. These include physical factors (physical activity), as well as socio-economic factors that play the greatest role in adolescence (nature of work and study, diet, living conditions, diseases) [12]. Therefore, to consider pilonidal disease purely as a congenital or acquired pathology is not correct.

However, the question of what the main mechanism



Fig. 1. Patient H., age 3 years. Funnel-shaped retraction in the area of the intergluteal fold, detected during a preventive examination.

leads to the development of pilonidal disease - congenital or acquired - remains open.

Purpose of study: to clarify the data on the etiology of pilonidal disease in children.

Materials and methods

One of the theories of the development of PD pathology is based on the fact that the epithelium, which is found in the pilonidal cyst, is the final variant of the mechanism of formation of the ectodermal layer. Taking it as a basis, we performed a histological study of fragments of skin and subcutaneous fat containing pathological substrate (pilonidal cyst). These tissue arrays were removed intraoperatively. After the examination, an assumption was made about the congenital origin of the pathology due to a violation of cell determination. Such changes are most pronounced at the stage of tissue development from the material of embryonic rudiments due to tissue determination in the sacrococcygeal region.

The study is based on the results of the analysis of the treatment of 37 children diagnosed with "pilonidal disease" who were in the pediatric surgery clinic of National Pirogov Memorial Medical University, Vinnytsya from 2010 to 2017. The average age of patients was 16.4 ± 0.4 , the gender distribution was as follows: there were 26 boys and 11 girls.

In order to compare the morphological structure of the pilonidal cyst in adults, 17 samples of removed tissues were studied according to the archives of the Vinnytsia Regional Pathology Bureau. Sections of intraoperatively removed tissue samples for the study were stained with hematoxylin and eosin. Microscopy and creation of a photo archive of histological specimens were performed using a light microscope OLIMPUS BX 41 at magnification x100 and x200, in the software environment "Quick PHOTO MICRO 2.3".

Results

After histological examination of the samples we found that in tissue samples taken from the areas around the epithelial coccygeal passages in children, signs of mild chronic inflammation were detected and a large number of skin appendages were detected: deformed hair follicles with many hair shafts and sweat glands of the apocrine type which were not associated with the skin and were located deep in the formed fibrous tissue. These changes were observed in 15 children (41.7%). However, it is interesting that in addition to the "typical" findings, it was found that all the above structural elements were located between the immature mesenchymal tissue (Fig. 2). Similar changes were not detected in control samples of pilonidal cysts from adult.

Regarding the internal structure of the pilonidal cyst, in children in 21 cases (58.3%) it was noted that its cavity is covered with a multilayered squamous non-corneal epithelium. In contrast to these findings, in 12 adult patients

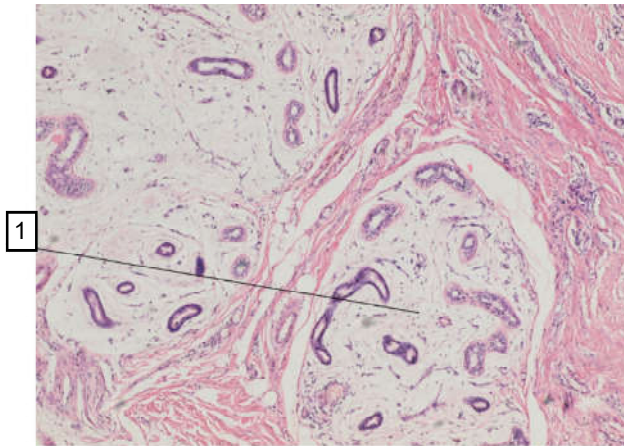


Fig. 2. Incorrectly developed skin appendages in the area of epithelial-coccygeal passages in 15-year-old girls. 1 - a large number of skin appendages (sweat glands of the apocrine type), located among the swollen immature mesenchymal tissue, with signs of minor chronic nonspecific inflammation. The skin appendages are located deep in the shaped fibrous tissue and are not connected to the skin. Hematoxylin-eosin, x100.

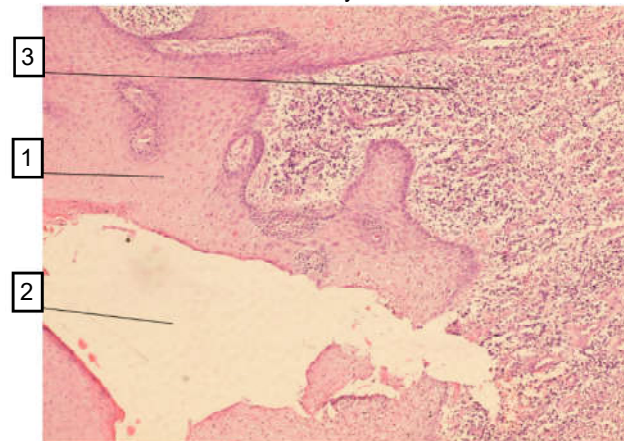


Fig. 3. Purulent-productive nonspecific inflammation in the surrounding tissues around the coccygeal cyst lined with multilayered squamous non-keratinizing epithelium. 1 - multilayered squamous non-keratinizing epithelium; 2 - the cavity of the coccygeal cyst; 3 - young granulation tissue with a pronounced leukocyte shaft with a large number of small newly formed vessels. Hematoxylin-eosin, x100.

(75.0%) on histological specimens revealed a complete absence of epithelial lining. Instead, signs of severe nonspecific inflammation and the presence of hemorrhages into the cyst wall were detected (Fig. 3).

These changes can be explained by a longer course of pilonidal disease in adults with more relapses with inflammation and the formation of pilonidal abscess. The result may be the creation of conditions for the complete destruction of the epithelial lining of the inner wall of the pilonidal cyst with its complete desquamation and replacement by granulation tissue.

Also, in the study of epithelial coccygeal cysts in adults in 15 patients (93.7%) their walls were lined with granulation tissue. The lumens of the latter contained fragments and

whole hair shafts, exfoliated cells of the epidermis and keratinized masses. The integumentary layer of multilayered squamous epithelium around the outer openings of the fistulous passages was sharply thickened. In contrast to adult patients, similar changes were found in only 11 children (30.5%). However, it should be noted that these patients were 17-18 years old and had frequent recurrences of the disease. It is also noteworthy that the hair shafts found did not show obvious signs of lysis (only signs of initial destruction were noted) and were associated with hair follicles. Such changes do not indicate in favor of their transdermal penetration into the cavity of the pilonidal cyst.

Discussion

At macroscopic study of a site of a pilonidal cyst it is possible to define primary fistulous courses, secondary fistulous courses and actually a pilonidal cyst with its cavity (in the presence of purulent contents in it).

Primary fistulas are mandatory components of pilonidal disease and are found in all patients, regardless of its clinical manifestations. They have a typical localization at the bottom of the intergluteal fold along the midline, often in its deepest part [5]. Histological examination of the latter revealed a typical described structure, which is presented in the form of small epithelial cup-shaped depressions. The latter have a blind end in the thickness of the dermis or subcutaneous fat and end with strands formed of connective tissue, which have the direction of the lashes to the thickness of fat and sacrococcygeal fascia (Tsema E.V.) [18]. However, in children there is a much smaller thickness of the "epithelial cups".

Secondary fistulous passages are elements that occur during the long course of pilonidal disease, accompanied by frequent periods of suppuration and spontaneous opening of the abscess. The purulent cavity due to the activity of the inflammatory process in the area of the sciatic fold increases in size. With the formation of significant pressure in it, spontaneous opening of the abscess can occur both through the primary fistulous course and through the formation of a "new" course (as a consequence of its spontaneous opening). Secondary fistulas are more often located lateral to the midline and intergluteal folds. This is due to the fact that in the latter the thickness of the dermis is slightly larger than in the areas of the medial surfaces of the buttocks, and the abscess is "harder" to open spontaneously in this area [14, 20].

As for the pilonidal cavity itself, our data coincide with other histological studies in that in most adult patients the inner wall of the pilonidal cyst has no epithelial lining and is represented by granulation tissue and immunopathological cells, which is a sign of chronic inflammation of the body. Researchers note that contents of the pilonidal cavity in adults is epithelial fragments and hair shafts of varying degrees of destruction. However, most studies did not consider the age of the patients and the

study groups most often consisted of adults. No adult study found immature mesenchymal tissue in the wall of the pilonidal cyst, which was found in pediatric patients. Also, in more than half of the histological preparations obtained after treatment of children, the lining of the cavity of the pilonidal cyst was found in the form of multilayered squamous non-keratinizing epithelium [4, 10, 11, 17, 18, 19].

In the future, it is rational to study the morphological structure of pilonidal cysts in patients of pediatric age and increase the sample. This will allow to more clearly establish the cause of this pathology and will allow to develop a standardized and well-founded method of treatment.

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Conclusions

1. Pilonidal disease should be considered as a polyetiological disease, which has its realization due to a number of congenital factors and individual characteristics of the organism, which, in turn, are embodied due to external and socio-economic factors.

2. Pilonidal disease, in our opinion, is a congenital pathology that occurs due to the combined work of environmental factors that can affect the severity of congenital features.

3. In favor of the congenital etiology of pilonidal disease testifies the presence in the pilonidal cyst in children of immature mesenchymal tissue, which in the norm is not characteristic of this age group.

СУПЕРЕЧЛИВІСТЬ ПОГЛЯДІВ НА НАБУТУ ТА ВРОДЖЕНУ ЕТІОЛОГІЮ ПІЛОНІДАЛЬНОЇ ХВОРОБИ Коноплицький В.С., Шавлюк Р.В., Шавлюк В.М.

Пілонідальна хвороба - патологія, яка вперше була описана понад 100 років тому. Однак, вона дотепер залишається предметом дискусій, тому що досі немає ні чіткого однозначного визначення даної патології, ні достеменно відомої її етіології. Незважаючи на велику кількість розроблених та аргументованих теорій досі існує два протилежних погляди на причину виникнення пілонідальної хвороби. Одні науковці є прихильниками "вродженої" теорії, інші - теорії набутого походження. Однак, це не вносить ясності у остаточну мету цих досліджень: вироблення оптимальної тактики лікування. Мета роботи - уточнення даних щодо етіології пілонідальної хвороби у дітей. Дослідження базується на результатах

аналізу лікування 37 дітей з діагнозом "пілонідальна хвороба", що знаходились на стаціонарному лікуванні у відділенні невідкладної хірургії Вінницької обласної дитячої клінічної лікарні, з яких хлопчики - 26, дівчатка - 11. Середній вік пацієнтів становив $16,4 \pm 0,4$ роки. Гістологічні зрізи зразків тканин забарвлювали гематоксилином та еозином. Мікроскопію та створення фотоархіву гістологічних препаратів проводили за допомогою світлового мікроскопа OLIMPUS BX 41 при збільшенні 100 та 200, у програмному середовищі "Quick PHOTO MICRO 2.3". У дослідженні виявлено, що відмічаються значні відмінності у гістологічній будові пілонідальних кіст дітей та дорослих. У пацієнтів дитячого віку знайдена мезенхімоподібна тканина, яка є нехарактерною для даного контингенту хворих. Також виявлено, що порожнина пілонідальної кісти у дітей вкрита багатошаровим плоским нероговіючим епітелієм, та у ній майже не відмічається наявність грануляційної тканини. На нашу думку, пілонідальна хвороба є поліетіологічним захворюванням, основною причиною якого є вроджені особливості організму, що мають реалізацію за рахунок соціально-економічних та факторів зовнішнього середовища.

Ключові слова: пілонідальна хвороба, діти, етіологія, морфологія.

ПРОТИВОРЕЧИВОСТЬ ВЗГЛЯДОВ НА ПРИОБРЕТЕННУЮ И ВРОЖДЕННУЮ ЭТИОЛОГИЮ ПИЛОНИДАЛЬНОЙ БОЛЕЗНИ

Коноплицкий В.С., Шавлюк Р.В., Шавлюк В.М.

Пилонидальная болезнь - патология, которая впервые была описана более 100 лет назад. Однако, она до сих пор остается предметом дискуссий, ведь до сих пор нет четкого однозначного определения данной патологии, а также точно неизвестна ее этиология. Несмотря на большое количество разработанных и аргументированных теорий до сих пор существует два противоположных взгляда на причину возникновения пилонидальной болезни. Одни ученые являются сторонниками "врожденной" теории, другие - теории приобретенного происхождения. Однако, это не вносит ясность в окончательную цель этих исследований: разработка оптимальной тактики лечения. Цель работы - уточнение данных об этиологии пилонидальной болезни у детей. Исследование базируется на результатах анализа лечения 37 детей с диагнозом "пилонидальная болезнь", которые находились на стационарном лечении в отделении неотложной хирургии Винницкой областной детской клинической больницы, из которых мальчиков было 26, а девочек - 11. Средний возраст пациентов составил $16,4 \pm 0,4$ года. Гистологические срезы образцов тканей окрашивали гематоксилином и еозином. Микроскопию и создание фотоархива гистологических препаратов проводили с помощью светового микроскопа OLIMPUS BX 41 при увеличении 100 и 200, в программной среде "Quick PHOTO MICRO 2.3". В исследовании выявлено, что отмечаются значительные различия в гистологической строении пилонидальных кист у детей и у взрослых. У пациентов детского возраста найдена мезенхимоподобная ткань, которая нехарактерна для данного контингента больных. Также выявлено, что полость пилонидальной кисты у детей покрыта многослойным плоским неороговевающим эпителием и в ней практически нет грануляционной ткани. По нашему мнению, пилонидальная болезнь является полиэтиологическим заболеванием, основной причиной которого являются врожденные особенности организма, имеющих реализацию за счет социально-экономических и факторов внешней среды.

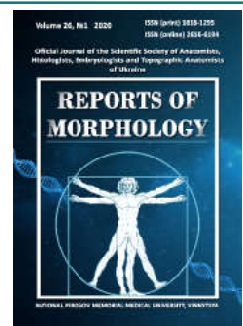
Ключевые слова: пилонидальная болезнь, дети, этиология, морфология.



REPORTS OF MORPHOLOGY

Official Journal of the Scientific Society of Anatomists,
Histologists, Embryologists and Topographic Anatomists
of Ukraine

journal homepage: <https://morphology-journal.com>



Electron microscopic changes of lymph nodes during correction of sodium glutamate action by melatonin

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ARTICLE INFO

Received: 26 December, 2019

Accepted: 3 February, 2020

UDC: 611.018.53.428:611.08:616-056.257-092.9

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The effect of monosodium glutamate on lymphoid organs remains insufficiently studied. Also, no less relevant is the issue of correction of changes caused by the action of monosodium glutamate. The aim of the study was to study the electron microscopic changes in the parenchyma of the lymph nodes of rats under the action of monosodium glutamate for six weeks and during correction with melatonin. The experimental study was performed on 66 white male and female rats of reproductive age. The structure of mesenteric lymph nodes of white rats under the conditions of physiological norm at the electron microscopic level was studied in 10 intact animals. Experimental animals were divided into 4 groups, each with 10 animals. The control was 16 white rats, which instead of a high-calorie diet (HCD) received a standard diet of vivarium. HCD was achieved by adding to the diet of monosodium glutamate at a dose of 0.07 g/kg body weight of rats. The dose of melatonin was 10 mg/kg body weight of rats, administered orally daily at the same time in the afternoon. The electron microscopic structure of the mesenteric lymph nodes of male and female rats of reproductive age of the intact and control groups corresponds to the species norm. The study showed that monosodium glutamate causes changes in the parenchyma of the lymph nodes as in alimentary obesity. After six weeks of HCD, the number of apoptotically altered lymphocytes increases. That part of lymphocytes, which has no signs of karyorrhexis or karyolysis, has a karyolemma with deep intussusception, the cytoplasm is enlightened, the tubules of the granular endoplasmic reticulum in cells with signs of edema, dilated, mitochondrial ridges swollen, damaged. There are profound destructive changes in the cellular composition of the organ and violations at the level of all parts of the vascular bed. After six weeks of melatonin correction, the number of macrophages and plasma cells decreased, in some lymphocytes the nucleolus is not clearly expressed, the karyolemma is uneven, the cytoplasm is enlightened, the number of osmophilic (fatty) inclusions decreases both in the intercellular space and in the cytoplasm of the cell. Therefore, the introduction of melatonin led to a significant restoration of the structural organization, and hence the function of this organ.

Keywords: sodium glutamate, melatonin, correction, nucleus, cytoplasm, ribosomes.

Introduction

Today, more than 2,500 additives are deliberately added to foods to preserve their properties and extend their shelf life. One of the most widely used additives both in Ukraine and around the world is monosodium glutamate [12, 19]. It increases appetite and enhances the taste of foods, which leads to an increase in the amount of food consumed per day, causing a high-calorie diet as in this experiment. Excess energy in the body leads to metabolic disorders, overweight and, as a result, obesity [3]. Despite its widespread use in the food industry, some questions about its effects on the body remain unanswered [20].

The literature describes studies performed on animals using this additive. Sodium glutamate is known to be neurotoxic, able to provoke degeneration of neuronal populations, and its effects on the body are accompanied by the development of pathological conditions such as stroke, epilepsy, schizophrenia, anxiety, depression, Parkinson's disease, Alzheimer's disease, Huntington's disease and Lou Gehrig's disease [19].

Metabolic characteristics of sodium glutamate are the development of insulin resistance, diabetes mellitus, low levels of high-density lipoprotein in the blood, high levels

of triglycerides, signs of inflammation and general oxidative stress [6, 8, 13]. It is known that hyperinsulinemia and metabolic disorders are directly related to reduced life expectancy, which is regarded not only as a medical but also a social problem.

However, the effect of monosodium glutamate on lymphoid organs remains insufficiently studied. It is known that the organs of the immune system are the rod that provides homeostasis, the body's resistance to foreign agents. Lymph nodes belong to the secondary immune organs, where antigen-dependent proliferation and differentiation of T and B lymphocytes occurs.

Also no less relevant is the issue of correction of changes caused by the action of monosodium glutamate. The drug chosen for correction is a synthetic analogue of melatonin (N-acetyl-5-methoxytryptamine) - a hormone of the pineal gland, an important regulator of sleep and circadian rhythms, which is synthesized by pinealocytes of the pineal gland under the control of the suprachiasmatic nucleus of the hypothalamus [7, 10, 11, 15]. Recently, the number of studies on the possible effects of this substance is growing [1, 14, 17, 18]. The neuroimmunomodulatory effect of melatonin on the immune system is supported by the presence of specific melatonin receptors in the immune system, as well as immunocompetent cells. These receptors are located both in the plasma membrane and in the cell nucleus. The antioxidant properties of melatonin and its effect on neutrophil infiltration have been studied in numerous experimental models in animals [4].

The purpose of the study: to study the electron microscopic changes in the parenchyma of the lymph nodes of rats in the correction of the action of monosodium glutamate by melatonin.

Materials and methods

This experimental study was performed on 66 white male and female rats of reproductive age (2.5-6.5 months) weighing 120-250 g.

The structure of mesenteric lymph nodes of white rats under the physiological norm at the electron microscopic level was studied in 10 intact animals. The experimental animals were divided into 4 groups: the first group (10 animals), which were fed a high-calorie diet (HCD) for six weeks by adding monosodium glutamate; the second group (10 animals), which were fed HCD for six weeks, then transferred to the standard diet of vivarium and melatonin was administered for two weeks; the third group (10 animals) and the fourth group (10 animals) were the same as the previous one, but melatonin was used for four and six weeks, respectively. There were 5 male rats and 5 female rats in each group. HCD was achieved by adding to the diet of monosodium glutamate at a dose of 0.07 g/kg body weight of rats. The dose of melatonin was 10 mg/kg body weight of rats, administered orally daily at the same time in the afternoon.

The control was 16 white rats, which instead of HCD

received a standard diet of vivarium.

All experimental animals were kept in the vivarium of Lviv National Medical University named after Danylo Halytsky. The research was conducted in accordance with the provisions of the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (Strasbourg, 1986), Council of Europe Directives 86/609/EEC (1986), Law of Ukraine № 3447 - IV "On the Protection of Animals from Cruel behavior", general ethical principles of animal experiments, approved by the First National Congress of Ukraine on Bioethics (2001).

Before collecting the material, the animals were anesthetized with anesthesia with diethyl ether. Fixation of pieces of lymph nodes was performed with a 1.5 % solution of osmium tetroxide in 0.2 M sodium cacodylate solution at pH 7.2 for 2-2.5 hours in the cold. Dehydration in increasing concentrations of ethyl alcohol (50°, 70°, 90° and absolute) for 30 minutes each and propylene oxide for 10 minutes. The material was poured into a mixture of epoxy resins and polymerized for 24 h in a thermostat at 60°C. Sections were made on an ultramicrotome UMTF-6M with a diamond knife (DIATOM) and double contrast was performed according to Reynolds and uranyl acetate. Submicroscopic examinations of the organ were performed using an electron transmission microscope TEM-100. The test material was documented using a SONY-H9 digital camera.

Results

The electron microscopic structure of the mesenteric lymph nodes of male and female rats of reproductive age of the intact and control groups corresponds to the species norm. Externally, the organ is surrounded by a connective tissue capsule, from which the cortical and medulla parts begin, which penetrate the parenchyma of the node. On the periphery is the cortical substance, which consists of primary and secondary lymphoid nodules, cortical intermediate lymphatic sinuses. Under the capsule there is the marginal sinus, which extends into the cortical intermediate lymphatic sinuses. Central and closer to the gate of the node there is the medulla, which is built of medulla cords and medulla intermediate lymphatic sinuses. In the area of transition of the cortical substance to the medulla there is the paracortical zone, which belongs to the T-dependent zone. The lymphoid tissue of the node is represented by small, medium and large lymphocytes. The skeleton of the organ is formed by reticular cells and tissue. Among lymphocytes are plasma cells and macrophages. The walls of the intermediate sinuses are lined with reticuloendotheliocytes, or shore cells. Small lymphocytes have a typical structure, their size is 6-7 µm, a relatively large nucleus is surrounded by a thin strip of cytoplasm. Medium lymphocytes have a rounded nucleus, which contains both heterochromatin and euchromatin, their size is 7-9 µm, organelles are located in the cytoplasm. Large lymphocytes (lymphoblasts) also have a typical structure, the nucleus contains mainly euchromatin, so it is lighter

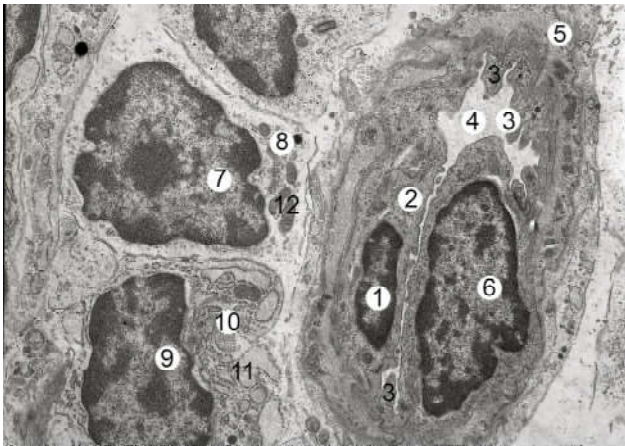


Fig. 1. Electron microscopic organization of the paracortical zone of the mesenteric lymph node of a white male rat of the intact group. 1 - endothelial cell nucleus; 2 - cytoplasm of endothelial cells; 3 - luminal surface of the cytoplasmic membrane forms single microvilli; 4 - lumen of the venule; 5 - basement membrane; 6 - the nucleus of the lymphocyte, which is preparing to migrate through the venule wall; 7 - lymphocyte nucleus; 8 - cytoplasm of lymphocytes; 9 - plasma cell nucleus; 10 - plasma cell cytoplasm; 11 - granular endoplasmic reticulum; 12 - mitochondria. Electronic microphotography. x6000.



Fig. 2. Electron microscopic organization of the medulla cord of the lymph node of a white female rat after six weeks of HCD. 1 - plasma cell nucleus; 2 - cytoplasm of the plasma cell, which contains an expanded granular endoplasmic reticulum and osmophilic (fat) inclusions (3); 4 - swollen endothelial cell nucleus; 5 - cytoplasm of endothelial cells; 6 - hemocapillary lumen; 7 - area of destructuring. Electronic microphotography. x6000.

than other lymphocytes, their size is about 10 μm , karyolemma is smooth, light cytoplasm filled with organelles. Plasmocytes have a nucleus with a specifically located heterochromatin, which resembles a "wheel spoke". The eccentrically located nucleus separates the cytoplasm. The parenchyma of the lymph node contains vessels of the hemomicrocirculatory tract. The arteries that enter the cortical trabeculae divide into hemocapillaries, which merge into the capillary venules, most of which are located in the paracortical area (Fig. 1). The latter, in turn, merge into the veins and exit through the gate of the node.

Submicroscopically, after six weeks of HCD, the number of apoptotically altered lymphocytes increases. The part of lymphocytes that does not show signs of karyorrhexis or karyolysis has a karyolemma with deep intussusception, the cytoplasm is enlightened, organelles have signs of damage. The number of macrophages and plasma cells increases in the parenchyma of the node. Their cytoplasm contains numerous primary and secondary lysosomes, including fragments of destroyed lymphocytes and osmophilic (fat) inclusions (Fig. 2), which are signs of alimentary obesity. The tubules of the granular endoplasmic reticulum in cells with signs of edema are dilated. Mitochondrial ridges are swollen, damaged, with an enlightened matrix. The nuclei of reticuloendotheliocytes are enlarged and deformed, their processes are thickened and swollen. Vessels of a hemomicrocirculatory channel also undergo changes at the level of all links. The wall of arteries and arterioles is sclerosed, thickened, the lumen is filled with shaped elements of blood. Hemocapillaries have a thickened basement membrane, endothelial cell nuclei are deformed and enlarged, and the luminal surface of its cytolemma forms numerous intussusceptions and depressions (Fig. 2). Through defects in a wall of blood capillaries are observed. Venules and veins with dilated full-blooded lumen.

Electron microscopically in the second group of experimental animals, all detected changes are similar to the previous group. A significant proportion of the cellular composition of the parenchyma of the lymph node is occupied by apoptotically altered lymphocytes, macrophages and plasma cells (Fig. 3). The intercellular space is expanded, there are signs of perivascular edema, a large number of osmophilic (fatty) inclusions are in the intercellular space and in the cytoplasm of macrophages and plasma cells. All lymphatic sinuses are dilated, a large number of collagen fibers and microfibrils in the parenchyma of the node compared with the intact group of animals.

In the third group of experimental animals, electron microscopically in the parenchyma of the lymph nodes revealed that the proportion of destructive changes decreased slightly compared to previous experimental groups. The karyolemma of lymphocyte nuclei has uneven contours, with numerous depressions and protrusions, their cytoplasm is somewhat enlightened (Fig. 4). The number of macrophages and plasma cells remains high. Reticuloendotheliocytes have thickened processes. Arteries and arterioles with a thickened wall, full-blooded. Veins and venules with dilated, deformed lumen. The lumen of hemocapillaries is narrowed, the basement membrane is thickened, swollen.

In the fourth group of experimental animals, ie after six weeks of correction of the action of HCD by melatonin, electron microscopically in the parenchyma of the lymph nodes revealed that among the unaltered lymphocytes there are destructively altered cells. Marginal, cortical and

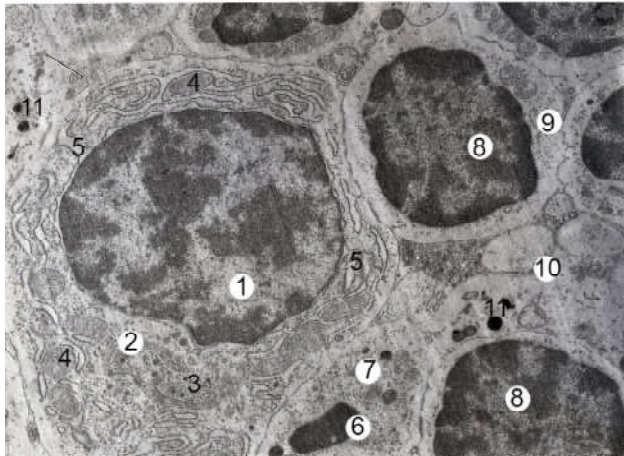


Fig. 3. Electron microscopic organization of the cortical substance of the mesenteric lymph node of a white male rat after six weeks of HCD, followed by two weeks of melatonin. 1 - plasma cell nucleus; 2 - plasma cell cytoplasm; 3 - primary lysosomes; 4 - swollen mitochondria; 5 - expanded granular endoplasmic reticulum; 6 - karyolysis of the nucleus of apoptically altered lymphocyte; 7 - cytoplasm of apoptically altered lymphocyte; 8 - nucleus with an uneven contour of the karyolemma of a small lymphocyte; 9 - cytoplasm of a small lymphocyte; 10 - vacuole-like structures in the intercellular space; 11 - osmophilic (fatty) inclusions. Electronic microphotography. x6000.



Fig. 4. Electron microscopic organization of the germinal center of the secondary lymphoid nodule of the mesenteric lymph node of a white female rat after six weeks of HCD, followed by four weeks of melatonin. 1 - karyopyknosis of the lymphocyte nucleus; 2 - karyolysis of the lymphocyte nucleus; 3 - cytoplasm of the middle B-lymphocyte; 4 - the nucleus of the middle B-lymphocyte. Electronic microphotography. x6000.

medulla intermediate lymphatic sinuses are somewhat dilated. The number of macrophages and plasma cells, compared with the previous group of animals, decreased. In some lymphocytes the nucleolus is not clearly expressed, the karyolemma is not equal, the cytoplasm is enlightened (Fig. 5). The number of osmophilic (fat) inclusions decreased both in the intercellular space and in the cytoplasm of cells, which indicates the regression of signs of alimentary obesity.

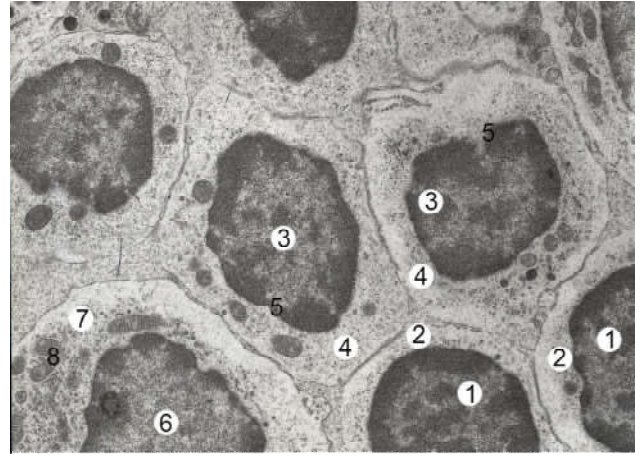


Fig. 5. Electron microscopic organization of the zona marginalis of the lymph node of a white male rat after six weeks of HCD, followed by six weeks of melatonin. 1 - the nucleus of a small B-lymphocyte; 2 - cytoplasm of a small B-lymphocyte; 3 - the nucleus of the middle B-lymphocyte; 4 - cytoplasm of the middle B-lymphocyte; 5 - depths and protrusions of the karyolemma; 6 - lymphoblast nucleus; 7 - cytoplasm of the lymphoblast; 8 - mitochondria. Electronic microphotography. x6000.

Discussion

The literature describes a study with the introduction of rat glutamate sodium at a dose of 30 mg/kg body weight for 30 days, noted the production in animals of excessive amounts of low and medium molecular weight and decreased excretory capacity of the kidneys. Low and medium molecular weight substances include creatinine, urea, oligosaccharides, lactic acid, bilirubin, amino acids, cholesterol, lipid peroxidation products and other compounds [12].

The study was performed on pregnant rats, which were divided into three groups - control, a group of animals that received monosodium glutamate with food, and a group that received a high-calorie diet due to the caloric content of food consumed. It was concluded that pregnant rats who consumed monosodium glutamate had a significant increase in body mass index, which the authors associated with the development of leptin resistance. Moreover, obesity in pregnant rats caused by monosodium glutamate had a greater effect on offspring metabolism and body weight than obesity induced by a high-calorie diet [2].

In an experimental study, administration of sodium glutamate to female rats at doses of 2 and 4 mg/kg body weight caused obesity in newborns. The authors studied metabolic changes at the ages of 4, 8, 12, 16 and 20 months. At a young age (four months), the level of Li index, triglycerides, total cholesterol, TNF- α and transaminases increased. While adiponectin levels decreased, glucose tolerance and insulin sensitivity were markedly altered. However, from 16 months of age, the level of Li and TNF- α index decreased significantly, and adiponectin increased, glucose and insulin homeostasis was restored. Obesity has been shown to be a major contributing factor to

premature metabolic changes in rats, however, in older age, all changes are offset [9].

A study in newborn rats treated subcutaneously from day 2 to day 12 of life with monosodium glutamate at a dose of 4 mg/kg/day was described. The correction was performed from 30 days of life with quercetin at a dose of 75 mg/kg/day. It is concluded that quercetin successfully improves metabolic changes caused by exposure to sodium glutamate. In addition, quercetin normalized glucose levels and minimized toxic effects associated with monosodium glutamate on liver and kidney function. These effects are associated with the antioxidant properties of quercetin [16].

The results of a study conducted on eight-week-old rats on a high-calorie diet and melatonin correction for ten weeks at a dose of 1 mg/kg/day showed that melatonin supplementation reduced serum triglycerides, total cholesterol, low lipoprotein protein and weight gain by reducing the level of lipogenesis and increasing the lipolytic capacity of adipocytes. Thus, the authors concluded that

melatonin can be considered a potential therapeutic agent for reducing metabolic and inflammatory disorders caused by obesity [5].

The novelty of the results described by us is the use of electron microscopic research methods, which gave new data at the ultrastructural level on the structure of lymph nodes under the action of monosodium glutamate and its correction by melatonin.

Conclusions

1. Electron microscopic examination showed that monosodium glutamate causes changes in the parenchyma of the lymph nodes as in alimentary obesity. After six weeks of HCD in the parenchyma of the lymph nodes there are profound destructive changes in the cellular composition of the organ, violations at the level of all parts of the vascular bed.

2. The introduction of melatonin leads to a significant restoration of the structural organization and, consequently, the function of this organ.

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ЕЛЕКТРОННО-МІКРОСКОПІЧНІ ЗМІНИ ЛІМФАТИЧНИХ ВУЗЛІВ ПРИ КОРЕКЦІЇ ДІЇ ГЛУТАМАТУ НАТРІЮ МЕЛАТОНІНОМ

Гарпак Т.В.

Недостатньо вивченим залишається питання впливу глутамату натрію на лімфоїдні органи. Також не менш актуальним є питання корекції змін, викликаних дією глутамату натрію. Мета дослідження - вивчити електронно-мікроскопічні зміни паренхіми лімфатичних вузлів щурів за умови дії глутамату натрію впродовж шести тижнів та при корекції мелатоніном. Експериментальне дослідження проведено на 66 білих щурах самцях і самках репродуктивного віку. На 10 інтактних тваринах на електронно-мікроскопічному рівні вивчили будову брижових лімфатичних вузлів білих щурів за умов фізіологічної норми. Експериментальні тварини були поділені на 4 групи, в кожній по 10 тварин. Контролем слугували 16 білих щурів, котрі замість висококалорійної дієти (ВКД) отримували стандартний харчовий раціон віварію. ВКД досягали, додаючи в їжу глутамат натрію в дозі 0,07 г/кг маси тіла щура. Доза мелатоніну становила 10 мг/кг маси тіла щура, її вводили перорально щодня в один і той же час у другій половині дня. Електронно-мікроскопічна будова брижових лімфатичних вузлів щурів самців та самок репродуктивного віку інтактної та контрольної груп відповідає видовій нормі. Дослідження показало, що глутамат натрію викликає зміни в паренхімі лімфатичних вузлів аналогічно змінам, що відбуваються при аліментарному ожирінні. Через 6 тижнів ВКД зростає кількість апоптично змінених лімфоцитів. Та частина лімфоцитів, яка немає ознак каріорексису або каріолісису, має каріолему з глибокими інвазіями, цитоплазма просвітлена, каналці гранулярної ендоплазматичної сітки в клітинах з ознаками набряку, розширені, мітохондріальні гребені набрякли, пошкоджені, з просвітленим матриксом. Спостерігаються глибокі деструктивні зміни клітинного складу органу та порушення на рівні всіх ланок судинного русла. Через 6 тижнів корекції мелатоніном кількість макрофагів та плазмоцитів зменшилася, в деяких лімфоцитах нечітко виражене ядрце, каріолема не рівна, цитоплазма просвітлена, кількість осміофільних (жирових) включень зменшилася як в міжклітинному просторі, так і в цитоплазмі клітин. Отже, введення мелатоніну призводить до значного відновлення структурної організації, а, отже, і функції даного органу.

Ключові слова: глутамат натрію, мелатонін, корекція, ядро, цитоплазма, рибосоми.

ЕЛЕКТРОННО-МИКРОСКОПИЧЕСКИЕ ИЗМЕНЕНИЯ ЛИМФАТИЧЕСКИХ УЗЛОВ ПРИ КОРРЕКЦИИ ДЕЙСТВИЯ ГЛУТАМАТА НАТРИЯ МЕЛАТОНИНОМ

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Недостаточно изученным остается вопрос влияния глутамата натрия на лимфоидные органы. Также не менее актуальным является вопрос коррекции изменений, вызванных действием глутамата натрия. Цель исследования - изучить электронно-микроскопические изменения паренхимы лимфатических узлов крыс в условиях действия глутамата натрия в течение шести недель и при коррекции мелатонином. Экспериментальное исследование проведено на 66 белых крысах самцах и самках репродуктивного возраста. На 10 интактных животных на электронно-микроскопическом уровне изучили строение брыжеечных лимфатических узлов белых крыс в условиях физиологической нормы. Экспериментальные животные были разделены на 4 группы, в каждой по 10 животных. Контролем служили 16 белых крыс, которые вместо высококалорийной диеты (ВКД) получали стандартный пищевой рацион вивария. ВКД достигали, добавляя в пищу глутамат натрия в дозе 0,07 г/кг массы тела крысы. Доза мелатонина составляла 10 мг/кг массы тела крысы, ее вводили перорально ежедневно в одно и то же время во второй половине дня. Электронно-микроскопическое строение брыжеечных лимфатических узлов крыс самцов и самок репродуктивного возраста интактной и контрольной групп соответствует видовой норме. Исследование показало, что глутамат натрия вызывает изменения в паренхиме лимфатических узлов аналогично изменениям, которые наступают при алиментарном ожирении. Через 6 недель ВКД растет количество апоптически измененных лимфоцитов. Та часть лимфоцитов, в которой нет признаков карiorексиса или кариолизиса, имеет кариолемму с глубокими инвазиями, просветленную цитоплазму, каналцы гранулярной эндоплазматической сети в клетках с признаками отека, расширенные, митохондриальные гребни набухшие, поврежденные, с просветленным матриксом. Наблюдаются глубокие деструктивные изменения клеточного состава органа и нарушения на уровне всех звеньев сосудистого русла. Через 6 недель коррекции мелатонином количество макрофагов и плазмоцитов уменьшилось, в некоторых лимфоцитах нечетко выраженное ядрышко, кариолемма неровная, цитоплазма просветленная, количество осміофильных (жировых) включений уменьшилось как в межклеточном пространстве, так и в цитоплазме клеток. Следовательно, введение мелатонина привело к значительному восстановлению структурной организации, а, следовательно, и функции данного органа.

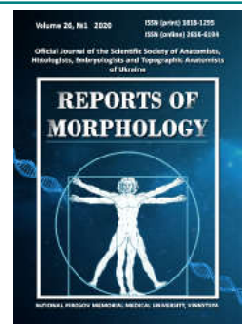
Ключевые слова: глутамат натрия, мелатонин, коррекция, ядро, цитоплазма, рибосоми.



REPORTS OF MORPHOLOGY

Official Journal of the Scientific Society of Anatomists,
Histologists, Embryologists and Topographic Anatomists
of Ukraine

journal homepage: <https://morphology-journal.com>



Correlations of time indicators of thigh rheogram with anthropometric dimensions in volleyball players of different somatotypes

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ARTICLE INFO

Received: 27 December, 2019

Accepted: 5 February, 2020

UDC: 572.087:612.13:796.071

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The constitutional features of the organism are an essential lever of sports performance, because they affect the general and special physical performance, aerobic productivity and efficiency of energy supply systems, in particular the indicators of central and peripheral hemodynamics. The aim of the study was to establish the features of the relationships between the temporal parameters of the rheovasogram of the thigh and anthropometric indices in highly qualified young women volleyball players, who belong to different constitutional types. An anthropo-somatotypological study of 113 high-level volleyball players of youth age (from 16 to 20 years old) was conducted. Anthropometric research was carried out by the method of V.V. Bunak (1941), somatotypological - by the calculated modification of the method of Heath-Carter (1990). According to the results of somatotyping, it was found that 29 volleyball players belonged to the mesomorphic type of constitution, to the ectomorphic type - 26 volleyball players, to the ecto-mesomorphic type - 27 volleyball players, to the middle intermediate type - 26 volleyball players, to endo-mesomorphic type - only 5 people. Rheovasographic parameters of the thigh were determined using tetrapolar rheocardiography on a computer diagnostic complex. Estimation of temporal rheovasographic parameters was performed according to the method of Ronkin and Ivanov [1997]. The analysis of the obtained results was performed in the licensed program "Statistica 5.5" using Spearman's correlation analysis. We found that in volleyball players of mesomorphs with indicators of external body structure, the temporal parameters of the thigh rheovasogram had few reliable mostly medium strength, direct correlations, except for the time of the ascending part of the rheogram and slow blood supply. In volleyball players of ectomorphic somatotype, the established relationships indicate that with increasing diameters of the pelvis and girth of the forearm, crus, thighs, there will be an elongation of the time parameters of the rheovasogram of the thigh. Volleyball players with an ecto-mesomorphic somatotype of the body showed a fairly large number of reliable inverse correlations, the thickness of the skin and fat folds is inversely proportional to the most time parameters of the thigh rheovasogram, except for the time of slow blood supply. Volleyball players of the intermediate somatotype, compared with other observation groups, found the most numerous relationships between anthropometric size and time indicators of the rheovasogram.

Keywords: correlation, temporal indicators of thigh rheovasogram, anthropometry, somatotype, volleyball players.

Introduction

Constitutional features of the organism, which are severely affected by genetic factors, in turn, are a significant lever of sports performance [8, 15, 23, 26]. Somatometric and somatotypological characteristics affect the efficiency of energy supply systems, development of physical qualities, general and special physical performance and

aerobic performance, intensity and duration of recovery processes, the nature of adaptation processes, resistance to various exogenous factors [6, 16]. A factor that does not cause objections to athletic performance is the functional state of the athlete's cardiovascular system [1, 9, 18, 22]. Many scientific studies have proven the importance of

indicators of central and peripheral hemodynamics for increasing the level of fitness of athletes and the formation of a high level of adaptive potential to intense physical activity in different directions [4, 10]. In turn, morpho-functional indicators of the cardiovascular system are under strict control of the constitutional features of the organism. Scientists have established relationships between indicators of external body structure and hemodynamic parameters [21, 24, 25]. In recent years, the work is devoted to establishing such relationships and interdependencies in athletes of different sports [7, 11, 12, 26].

The aim of our work is to establish the features of the relationships between the temporal parameters of the rheovasogram of the thigh and anthropometric indices in highly qualified young women volleyball players, who belong to different constitutional types.

Materials and methods

On the basis of the research center of National Pirogov Memorial Medical University, Vinnytsya conducted a study of 113 high-level young women volleyball players (from 16 to 20 years). Sports experience in all cases was more than 3 years.

Anthropometry was performed by the method of V.V. Bunak [2], somatotypological study - by the calculated modification of the method of Heath-Carter [3]. After somatotyping, it was found that 29 volleyball players belonged to the mesomorphic type of constitution, to the ectomorphic type - 26 volleyball players, to the ecto-mesomorphic type - 27 volleyball players, to the middle intermediate type - 26 volleyball players, to the endo-mesomorphic type - only 5 people, so we did not perform correlation analysis for it. Rheovasographic parameters of the thigh were determined using tetrapolar rheocardiography on a computer diagnostic complex. Evaluation of temporal rheovasographic parameters was performed according to the method of Ronkin and Ivanov [17].

The analysis of the obtained results was performed in the licensed program "Statistica 5.5" using Spearman's correlation analysis.

Results

After correlating the temporal rheovasographic parameters determined on the thigh with the dimensions that characterize the physique of the body, in the group of volleyball players with mesomorphic type of constitution, we found not numerous, mostly medium-strength direct connections (Table 1). In particular, the duration of the rheographic wave had significant correlations only with the girth of the neck and the thickness of the skin and fat folds on the crus. The time of ascending thigh rheovasogram part significantly correlated with the width of the distal epiphyses of the thigh and crus, with the circumferential dimensions of the shoulder in the unstressed state, forearms in the upper and lower parts, thighs, neck, crus in

the upper and lower parts, with transverse lower thoracic diameter and intertrochanteric distance. We determined that the time of the descending part of the thigh rheovasogram had reliable connections only with the thickness of the skin and fat folds on the abdomen, crus and under the shoulder blade. The time of rapid blood supply is statistically significantly correlated with chest girth on exhalation and at rest, with sagittal mid-thoracic and acromial diameters, with the thickness of the folds on the forearm. It was found that the time of slow blood supply of the rheovasogram of the thigh in mesomorphic somatotype volleyball players had significant correlations with body length, height of the suprathoracic, pubic and acromial points, width of the distal epiphyses of the thigh and crus, circumferential size of the shoulder in relaxed state, forearms at the bottom, thighs, neck, hands and feet, the size of the outer conjugate (see Table 1).

In ectomorphic somatotype volleyball players, the duration of the rheographic wave on the thigh was significantly correlated with body weight, acetabular point height, forearm and crus circumferences in the upper parts, and external conjugate (Table 2). In this group of athletes, the time of the ascending thigh rheovasogram had statistically significant relationships with thigh girth, intercrystal and interspinous distances, thickness of skin and fat folds on the back of the shoulder, chest, abdomen, side and crus. The time of the descending part of the rheovasogram had significant correlations with the girths of the forearms and crus in the upper parts and the sagittal mid-thoracic diameter. The time of rapid blood supply of the rheovasogram of the thigh in ectomorph volleyball players had significant correlations with the girth of the foot, intercrystal and interspinous distances. The time of slow blood supply to the rheovasogram was significantly correlated with the external conjugate and the thickness of the folds on the abdomen and crus.

In the group of volleyball players with ecto-mesomorphic somatotype (Table 3), significant correlations were found between the duration of the rheographic wave on the thigh and the girth of the crus, the transverse mid-chest diameter and the thickness of the skin and fat folds on the abdomen. The time of the ascending thigh rheovasogram had statistically significant correlations with the width of the distal epiphyses of the shoulder and thigh, the girth of the thighs, crus in the upper and lower parts, the thickness of the skin and fat folds on the abdomen and sides. The time of the descending part of the rheovasogram was significantly correlated only with the thickness of the folds on the abdomen. There are statistically significant relationships between the time of rapid blood supply of thigh vessels and weight, length, body surface area, acromial point height, width of the distal epiphyses of the shoulder and thigh, shoulder girth in a tense state, thighs, crus in the upper and lower parts, thighs, chest, the thickness of the folds on the chest, abdomen, sides. Rheovasographic index time of slow blood supply was

Table 1. Values of correlation coefficients (r) of time indicators of rheovasogram of a thigh with anthropometric sizes at mesomorphs young women volleyball players.

Anthropometric indicators	Rheovasographic indicators				
	C	A	B	A1	A2
body weight (kg)	0.05	0.37	-0.04	0.26	0.32
body length (cm)	-0.02	0.24	-0.05	-0.12	0.44
body surface area (m ²)	0.05	0.35	-0.03	0.18	0.35
height of the suprathoracic point (cm)	-0.02	0.33	-0.09	-0.05	0.49
pubic point height (cm)	-0.07	0.26	-0.12	-0.17	0.49
height of the acromial point (cm)	-0.03	0.35	-0.11	-0.03	0.50
finger point height (cm)	-0.11	0.18	-0.14	-0.09	0.38
acetabulum point height (cm)	-0.03	0.00	0.03	-0.35	0.26
the width of the distal epiphysis of the shoulder (cm)	0.10	0.19	0.17	-0.17	0.33
the width of the epiphysis forearm (cm)	-0.02	0.18	0.02	-0.17	0.27
the width of the distal epiphysis of the thigh (cm)	0.17	0.46	-0.01	-0.03	0.65
the width of the distal epiphysis of the crus (cm)	0.26	0.41	0.12	-0.02	0.51
shoulder girth in a tense state (cm)	-0.01	0.21	-0.12	0.17	0.24
shoulder girth in a relaxed state (cm)	0.02	0.41	-0.18	0.29	0.40
forearm girth at the top (cm)	0.04	0.40	-0.12	0.30	0.38
forearm girth at the bottom (cm)	0.18	0.47	0.04	0.02	0.60
thigh girth (cm)	0.17	0.51	0.01	0.27	0.48
crus girth at the top (cm)	0.07	0.41	0.00	0.20	0.28
crus girth at the bottom (cm)	0.01	0.40	-0.09	0.16	0.34
neck circumference (cm)	0.41	0.40	0.29	-0.09	0.61
waist circumference (cm)	-0.11	0.08	-0.09	0.08	0.08
thighs girth (cm)	-0.15	0.17	-0.16	0.27	0.07
hand girth (cm)	0.25	0.36	0.13	0.05	0.42
foot girth (cm)	0.10	0.23	0.13	-0.32	0.41
chest girth on inhalation (cm)	0.09	0.31	-0.08	0.38	0.28
chest girth on exhalation (cm)	0.12	0.29	-0.05	0.40	0.25
chest girth at rest (cm)	0.02	0.32	-0.14	0.49	0.20
transverse mid-thoracic diameter (cm)	0.02	0.34	-0.02	0.38	0.24
transverse lower thoracic diameter (cm)	-0.04	0.44	-0.17	0.29	0.39
sagittal mid-thoracic diameter (cm)	0.03	0.36	-0.16	0.65	0.06
acromial diameter (cm)	-0.07	-0.31	0.09	-0.41	-0.06
intercristal distance (cm)	-0.19	0.25	-0.25	0.18	0.23
interspinous distance (cm)	-0.26	0.24	-0.36	0.30	0.23
intertrochanteric distance (cm)	0.02	0.43	-0.02	0.38	0.27
external conjugate (cm)	-0.04	0.38	-0.10	0.22	0.42
the thickness of the folds on the back of the shoulder (mm)	0.07	-0.12	0.19	-0.27	-0.01
the thickness of the folds on the front surface of the shoulder (mm)	0.14	-0.25	0.29	-0.29	-0.14
the thickness of the folds on the forearm (mm)	0.11	-0.27	0.31	-0.46	-0.10
the thickness of the folds under the shoulder blade (mm)	0.32	-0.08	0.42	-0.15	-0.10
the thickness of the folds on the chest (mm)	0.02	-0.22	0.38	-0.27	-0.17

Correlations of time indicators of thigh rheogram with anthropometric dimensions in volleyball players...

Table 1. (continuation)

Anthropometric indicators	Rheovasographic indicators				
	C	A	B	A1	A2
the thickness of the folds on the abdomen (mm)	0.34	-0.31	0.44	-0.23	-0.30
the thickness of the folds on the side (mm)	0.23	0.16	0.17	0.01	0.19
the thickness of the folds on the thigh (mm)	0.28	-0.11	0.28	-0.32	0.04
the thickness of the folds on the crus (mm)	0.46	-0.16	0.49	-0.37	-0.01

Notes: here and in the future the corresponding direct and inverse correlations of average force and strong are allocated by corresponding colors; C - duration of the rheographic wave (s); A - time of the ascending part of the thigh rheovasogram (s); B - time of the descending part of the rheovasogram (s); A1 - time of rapid blood supply of the rheovasogram (s); A2 - time of slow blood supply of the rheovasogram (s).

Table 2. Values of correlation coefficients (r) of time indices of rheovasogram of a thigh with anthropometric sizes at ectomorphs young women volleyball players.

Anthropometric indicators	Rheovasographic indicators				
	C	A	B	A1	A2
body weight (kg)	0.45	0.31	0.34	0.18	0.13
body length (cm)	0.28	0.17	0.25	0.11	0.09
body surface area (m ²)	0.39	0.28	0.30	0.15	0.14
height of the suprathoracic point (cm)	0.24	0.14	0.20	0.19	0.06
pubic point height (cm)	0.29	0.33	0.23	0.19	0.18
height of the acromial point (cm)	0.09	0.15	0.05	0.10	0.09
finger point height (cm)	0.01	0.23	-0.06	0.20	0.17
acetabulum point height (cm)	0.42	0.33	0.36	0.19	0.20
the width of the distal epiphysis of the shoulder (cm)	0.31	-0.07	0.34	0.06	-0.13
the width of the epiphysis forearm (cm)	0.23	0.17	0.17	0.12	0.10
the width of the distal epiphysis of the thigh (cm)	0.18	-0.26	0.26	-0.15	-0.20
the width of the distal epiphysis of the crus (cm)	0.37	0.03	0.33	-0.09	0.09
shoulder girth in a tense state (cm)	0.24	0.28	0.14	0.16	0.10
shoulder girth in a relaxed state (cm)	0.32	0.22	0.24	0.06	0.11
forearm girth at the top (cm)	0.48	0.28	0.40	-0.05	0.18
forearm girth at the bottom (cm)	0.10	0.13	0.07	0.08	0.00
thigh girth (cm)	0.37	0.37	0.28	0.07	0.26
crus girth at the top (cm)	0.59	0.27	0.45	0.01	0.12
crus girth at the bottom (cm)	0.16	0.08	0.12	-0.26	0.14
neck circumference (cm)	0.35	0.23	0.29	-0.09	0.20
waist circumference (cm)	0.30	0.32	0.21	0.06	0.28
thighs girth (cm)	0.21	0.49	0.08	0.38	0.21
hand girth (cm)	0.23	0.08	0.14	0.04	-0.05
foot girth (cm)	0.01	-0.30	0.08	-0.48	-0.11
chest girth on inhalation (cm)	0.25	0.23	0.20	-0.01	0.11
chest girth on exhalation (cm)	0.27	0.17	0.22	-0.01	0.12
chest girth at rest (cm)	0.26	0.23	0.19	0.02	0.10
transverse mid-thoracic diameter (cm)	0.15	0.09	0.06	0.14	-0.12
transverse lower thoracic diameter (cm)	-0.08	0.02	-0.09	-0.34	0.24
sagittal mid-thoracic diameter (cm)	0.39	-0.01	0.40	0.28	-0.25
acromial diameter (cm)	0.20	0.10	0.19	0.26	-0.13

Table 2. (continuation)

Anthropometric indicators	Rheovasographic indicators				
	C	A	B	A1	A2
intercrystal distance (cm)	0.22	0.43	0.09	0.43	0.12
interspinous distance (cm)	0.05	0.45	-0.07	0.45	0.14
intertrochanteric distance (cm)	0.24	0.35	0.14	0.30	0.10
external conjugate (cm)	0.42	0.30	0.27	-0.07	0.42
the thickness of the folds on the back of the shoulder (mm)	-0.16	-0.39	-0.03	-0.12	-0.22
the thickness of the folds on the front surface of the shoulder (mm)	0.28	-0.11	0.24	-0.03	-0.09
the thickness of the folds on the forearm (mm)	0.31	-0.23	0.37	-0.13	-0.19
the thickness of the folds under the shoulder blade (mm)	0.15	-0.36	0.21	-0.11	-0.31
the thickness of the folds on the chest (mm)	0.04	-0.40	0.17	-0.20	-0.34
the thickness of the folds on the abdomen (mm)	0.00	-0.49	0.12	-0.10	-0.48
the thickness of the folds on the side (mm)	-0.01	-0.48	0.13	-0.27	-0.28
the thickness of the folds on the thigh (mm)	0.08	-0.29	0.20	-0.25	-0.11
the thickness of the folds on the crus (mm)	0.12	-0.47	0.26	-0.09	-0.43

Table 3. Values of correlation coefficients (r) of time indices of rheovasogram of a thigh with anthropometric sizes at ecto-mesomorphs young women volleyball players.

Anthropometric indicators	Rheovasographic indicators				
	C	A	B	A1	A2
body weight (kg)	0.23	0.35	0.19	0.47	-0.07
body length (cm)	0.17	0.28	0.15	0.41	-0.10
body surface area (m ²)	0.19	0.32	0.16	0.43	-0.09
height of the suprathoracic point (cm)	0.07	0.24	0.05	0.36	-0.10
pubic point height (cm)	0.12	0.14	0.12	0.25	-0.11
height of the acromial point (cm)	0.13	0.29	0.10	0.41	-0.07
finger point height (cm)	0.13	0.12	0.13	0.28	-0.17
acetabulum point height (cm)	0.14	0.23	0.12	0.32	-0.05
the width of the distal epiphysis of the shoulder (cm)	-0.14	-0.37	-0.10	-0.54	-0.04
the width of the epiphysis forearm (cm)	0.22	-0.33	0.31	-0.08	-0.40
the width of the distal epiphysis of the thigh (cm)	-0.20	-0.39	-0.11	-0.38	-0.31
the width of the distal epiphysis of the crus (cm)	0.19	0.03	0.21	0.07	-0.08
shoulder girth in a tense state (cm)	-0.01	0.18	-0.03	0.43	-0.20
shoulder girth in a relaxed state (cm)	-0.07	0.02	-0.06	0.22	-0.27
forearm girth at the top (cm)	0.00	-0.09	0.03	0.35	-0.44
forearm girth at the bottom (cm)	-0.02	-0.32	0.04	-0.05	-0.40
thigh girth (cm)	0.22	0.26	0.20	0.36	-0.11
crus girth at the top (cm)	0.16	0.46	0.09	0.56	0.02
crus girth at the bottom (cm)	0.40	0.44	0.31	0.44	0.12
neck circumference (cm)	0.20	-0.29	0.30	-0.02	-0.48
waist circumference (cm)	0.12	0.14	0.12	0.21	-0.10
thighs girth (cm)	0.22	0.37	0.17	0.37	0.04
hand girth (cm)	0.07	-0.18	0.10	0.03	-0.28
foot girth (cm)	0.21	-0.07	0.24	-0.14	-0.10

Correlations of time indicators of thigh rheogram with anthropometric dimensions in volleyball players...

Table 3. (continuation)

Anthropometric indicators	Rheovasographic indicators				
	C	A	B	A1	A2
chest girth on inhalation (cm)	0.13	0.31	0.10	0.50	-0.13
chest girth on exhalation (cm)	0.07	0.25	0.04	0.41	-0.11
chest girth at rest (cm)	0.06	0.25	0.04	0.41	-0.15
transverse mid-thoracic diameter (cm)	0.37	0.17	0.35	0.17	0.00
transverse lower thoracic diameter (cm)	0.09	-0.16	0.13	-0.25	-0.16
sagittal mid-thoracic diameter (cm)	0.29	0.13	0.28	0.18	-0.18
acromial diameter (cm)	0.28	-0.02	0.31	0.11	-0.21
intercrystal distance (cm)	0.35	0.24	0.31	0.28	-0.03
interspinous distance (cm)	0.07	0.31	0.02	0.30	0.04
intertrochanteric distance (cm)	0.36	0.24	0.34	0.34	-0.07
external conjugate (cm)	0.12	0.05	0.11	0.22	-0.27
the thickness of the folds on the back of the shoulder (mm)	-0.10	-0.28	-0.09	-0.07	-0.16
the thickness of the folds on the front surface of the shoulder (mm)	-0.10	-0.01	-0.11	-0.07	0.14
the thickness of the folds on the forearm (mm)	0.02	-0.18	0.06	-0.21	0.03
the thickness of the folds under the shoulder blade (mm)	-0.08	-0.02	-0.10	0.20	-0.12
the thickness of the folds on the chest (mm)	-0.36	-0.34	-0.31	-0.37	-0.03
the thickness of the folds on the abdomen (mm)	-0.46	-0.42	-0.38	-0.60	-0.01
the thickness of the folds on the side (mm)	-0.27	-0.54	-0.17	-0.54	-0.19
the thickness of the folds on the thigh (mm)	-0.17	-0.23	-0.12	-0.08	-0.26
the thickness of the folds on the crus (mm)	-0.07	-0.30	0.00	-0.14	-0.29

Table 4. Values of correlation coefficients (r) of temporal indices of rheovasogram of a thigh with anthropometric sizes at young women volleyball players with average intermediate somatotype.

Anthropometric indicators	Rheovasographic indicators				
	C	A	B	A1	A2
body weight (kg)	0.46	-0.20	0.45	0.20	-0.28
body length (cm)	0.32	-0.07	0.27	0.33	-0.17
body surface area (m ²)	0.40	-0.19	0.39	0.25	-0.28
height of the suprathoracic point (cm)	0.38	0.06	0.28	0.46	-0.06
pubic point height (cm)	0.30	-0.15	0.27	0.17	-0.17
height of the acromial point (cm)	0.42	0.01	0.32	0.37	-0.08
finger point height (cm)	0.14	-0.22	0.11	0.17	-0.27
acetabulum point height (cm)	0.44	0.20	0.33	0.49	0.11
the width of the distal epiphysis of the shoulder (cm)	0.40	0.31	0.31	0.39	0.21
the width of the epiphysis forearm (cm)	0.16	-0.17	0.10	0.05	-0.17
the width of the distal epiphysis of the thigh (cm)	0.12	0.08	0.05	0.07	0.15
the width of the distal epiphysis of the crus (cm)	0.06	0.08	-0.05	0.20	0.07
shoulder girth in a tense state (cm)	0.31	-0.32	0.37	-0.05	-0.38
shoulder girth in a relaxed state (cm)	0.35	-0.35	0.41	-0.07	-0.39
forearm girth at the top (cm)	0.35	-0.33	0.37	-0.09	-0.35
forearm girth at the bottom (cm)	-0.10	-0.36	-0.11	-0.08	-0.35
thigh girth (cm)	0.38	-0.38	0.46	0.02	-0.44

Table 4. (continuation)

Anthropometric indicators	Rheovasographic indicators				
	C	A	B	A1	A2
crus girth at the top (cm)	0.21	-0.49	0.30	-0.19	-0.52
crus girth at the bottom (cm)	0.35	-0.40	0.42	0.01	-0.44
neck circumference (cm)	-0.02	-0.27	0.00	0.01	-0.19
waist circumference (cm)	0.43	-0.20	0.44	0.12	-0.21
thighs girth (cm)	0.25	-0.42	0.34	-0.11	-0.47
hand girth (cm)	0.20	-0.35	0.25	-0.02	-0.40
foot girth (cm)	0.25	-0.35	0.31	-0.03	-0.33
chest girth on inhalation (cm)	0.62	0.12	0.55	0.24	0.06
chest girth on exhalation (cm)	0.51	-0.01	0.48	0.11	-0.06
chest girth at rest (cm)	0.65	0.11	0.59	0.17	0.05
transverse mid-thoracic diameter (cm)	0.30	-0.12	0.25	0.33	-0.18
transverse lower thoracic diameter (cm)	0.27	0.20	0.15	0.57	0.12
sagittal mid-thoracic diameter (cm)	0.52	-0.12	0.53	-0.13	-0.06
acromial diameter (cm)	0.35	-0.27	0.42	-0.15	-0.23
intercristal distance (cm)	0.05	0.04	0.02	0.42	-0.07
interspinous distance (cm)	0.16	0.13	0.08	0.60	-0.01
intertrochanteric distance (cm)	0.29	-0.27	0.34	0.20	-0.33
external conjugate (cm)	0.33	-0.20	0.37	0.23	-0.32
the thickness of the folds on the back of the shoulder (mm)	-0.11	0.41	-0.16	-0.01	0.45
the thickness of the folds on the front surface of the shoulder (mm)	-0.13	-0.45	0.02	-0.54	-0.39
the thickness of the folds on the forearm (mm)	-0.22	-0.48	-0.05	-0.50	-0.45
the thickness of the folds under the shoulder blade (mm)	-0.11	0.00	-0.13	-0.24	0.09
the thickness of the folds on the chest (mm)	-0.15	-0.63	0.03	-0.71	-0.48
the thickness of the folds on the abdomen (mm)	-0.01	0.48	-0.17	0.03	0.60
the thickness of the folds on the side (mm)	0.17	0.51	-0.04	0.32	0.58
the thickness of the folds on the thigh (mm)	-0.02	0.50	-0.13	-0.04	0.54
the thickness of the folds on the crus (mm)	-0.29	0.05	-0.33	-0.52	0.20

significantly correlated with the following anthropometric dimensions: the width of the distal epiphysis of the forearm, neck and forearm girth in the upper and lower parts.

We found that in volleyball players of the middle intermediate somatotype, the duration of the rheographic wave on the thigh had significant connections with body weight, acetabular point height, waist circumference and all chest sizes, sagittal mid-thoracic diameter (Table 4).

The time of the ascending part of the rheovasogram of the thigh had significant correlations with the girth of the crus and thighs, the thickness of the skin and fat folds on the shoulders, forearms, chest, abdomen, thighs and sides. The time of the descending part of the rheovasogram significantly correlated with body weight, thigh girth, waist girth, chest at inhalation, exhalation and at rest, acromial and sagittal mid-thoracic diameters. The time of rapid blood supply to the femoral vessels had statistically significant

correlations with the height of the suprathoracic and acetabular points, transverse lower thoracic diameter, intercristal distance of the pelvis, the thickness of the folds on the front surface of the shoulder, forearm, chest, crus. The time of slow blood supply was significantly correlated with the girth of the thigh, crus in the upper and lower parts, thighs, the thickness of the folds on the back of the shoulder, forearm, chest, abdomen, sides and thighs (see Table 4).

Discussion

A number of works have been devoted to the study of the relationships of individual indicators of the cardiovascular system with anthropo-somatotypological parameters in volleyball players. In particular, correlations were found between the indicators of central hemodynamics and constitutional body parameters in groups of highly qualified male volleyball players [7] and females [20, 27]. It

was found that the parameters of peripheral hemodynamics in athletes of this sport were associated with certain parameters of external body structure [11], but in comparison with wrestlers and athletes in volleyball players on the thigh was found the lowest number of rheovasographic parameters that significantly correlated with the parameters of external body structure [12].

Scientists have proved that the representatives of individual somatotypes differ not only in the external structure of the body [19], but also in the morpho-functional features of the cardiovascular system [5, 24, 26]. Therefore, the constitutional approach in determining the features of the correlations between the indicators of the external structure of the body and hemodynamic parameters has a clear practical direction [21, 25]. Our study shows that highly skilled volleyball players belonging to different constitutional groups differ in the strength and number of reliable relationships between temporal rheovasographic parameters of the thigh and anthropometric body size. Thus, in mesomorphic volleyball players it was found that the duration of the rheographic wave had the lowest number of reliable correlations, only 4.5% of all possible. The time of the ascending part of the femoral rheovasogram significantly correlated with 25.0% of the anthropometric dimensions we determined. It is noteworthy that all correlations are straight, medium strength. Features of the established connections testify that at increase in width of distal epiphyses of a thigh and a crus and circumferential sizes of a body and diameters of a trunk at volleyball players of mesomorphic somatotype the speed of regional blood-groove will slow down, because of a tone of resistance vessels (arterioles and capillaries) [17]. The time of the descending part of the rheovasogram of the thigh, which depends on the heart rate, was significantly correlated only with the thickness of 3 skin and fat folds (6.8% of all body sizes). The time of rapid blood supply was significantly correlated with only 11.4% of anthropometric sizes, with correlations of medium strength with chest girths, strong straight with mid-thoracic diameter, inverse width shoulder width and thickness of folds on the forearm. The volleyball players of mesomorphic somatotype had the largest number of reliable (29.5%) and strong correlations (6.8% of them were strong) of time of slow blood supply of the thigh rheovasogram, which depends on the tone of small and medium diameter arteries [17]. Therefore, with increasing the longitudinal size of the body, the width of the distal epiphyses of the thigh and crus and the circumferential size of the neck and limb segments will increase the time of slow blood supply.

In the general group of male volleyball players, as in our study for mesomorphic somatotype young women volleyball players, of all time parameters of the thigh rheovasogram, the most numerous correlations were found for the time of the ascending part of the rheogram and slow blood supply, which were interrelated with longitudinal and circumferential dimensions limbs and width of the distal

epiphyses of the extremities [12]. In mesomorphic volleyball players, the time of the ascending part of the rheogram and the time of slow blood supply of thigh vessels had the greatest number of reliable correlations [14].

We found that in ectomorph volleyball players the number of significant correlations and their strength ($r=0.38-0.48$) were smaller compared to mesomorphic somatotype athletes. In particular, the duration of the rheographic wave on the thigh was correlated with 11.4% of anthropometric indicators, the time of the ascending part of the rheovasogram - with 18.2%, the time of the descending part - with 6.8%, the time of rapid blood supply - with 6.8%, the time of slow blood supply - with 6.8% of external body size. The established relationships indicate that in volleyball players of ectomorphic somatotype with increasing diameters of the pelvis and girth of the forearm, crus, thighs, there will be an elongation of the time parameters of the rheovasogram of the thigh. In practically healthy girls of Podillia, who did not play sports and belonged to the ectomorphic somatotype, the highest number of significant inverse correlations was found between temporal rheovasographic parameters on the thigh and transverse body size [21], which, in our opinion, is evidence that they as the body diameters increase, the time values will be smaller.

In volleyball players with ecto-mesomorphic body type, a large number of reliable inverse correlations were found between the time indicators of peripheral hemodynamics and anthropometric body size. It is noteworthy that the thickness of the skin and fat folds is inversely proportional to most of the time parameters of the thigh rheovasogram, except for the time of slow blood supply. The duration of the rheographic wave significantly correlated with 6.8% of anthropometric indicators, the time of the ascending part of the rheovasogram - with 15.9%, the time of the descending part - with 2.3%, the time of rapid blood filling - with 38.6% (direct correlations predominate), the time of slow blood filling - with 9.1% of external size body (all correlations are inverse). Thus, in volleyball players with this body type, the most numerous and strongest connection with anthropometric body size was the time of rapid blood supply, which depends on the tone of the vascular wall of large arteries and is determined by the contractile function of the myocardium [17]. Analysis of the identified reliable relationships suggests that with increasing total body size, acromial point height, circumferential size of the shoulder, thigh, crus, thighs, chest and reducing subcutaneous fat and the width of the distal epiphysis of the thigh in volleyball players with ecto-mesomorphic somatotype will increase the time of rapid blood supply. It has previously been found [13] that in adolescent male volleyball players of the ecto-mesomorphic somatotype will increase the elasticity of the wall of the thigh arteries with increasing body weight, especially its muscle and fat components, and this, in turn, will lead to higher time of rapid blood supply.

In highly qualified young women volleyball players of

medium intermediate somatotype, compared with athletes of other constitutional types, the duration of the rheographic wave correlated with the largest number of body sizes (15.9%), all correlations are straight, medium strength ($r=0.43-0.52$) and strong ($r=0.62-0.65$). It is noteworthy that with increasing body weight, leg length, waist circumference and chest, anterior-posterior mid-thoracic size will increase the duration of the rheographic wave. The time of the ascending part of the thigh rheovasogram in volleyball players of this somatotype correlated with 18.2% of body size, interesting is the different nature of the relationship between this time rheovasographic index and subcutaneous fat. Thus, with increasing the size of the folds on the thigh, side, abdomen and decrease - on the chest, forearms, shoulders and thighs and crus will increase the tone of small diameter, and hence the time of the ascending part of the rheovasogram [13, 17]. The time of the descending part of the rheovasogram had straight medium correlation with 18.2% of anthropometric dimensions, mainly with the circumferential dimensions and width of the shoulders and pelvis. The time of rapid blood supply also had significant correlations with 18.2% of body size, with the thickness of the folds the correlations were inverse, with longitudinal and transverse dimensions - straight. Among the temporal parameters of the rheovasogram in volleyball players with an average intermediate somatotype, the time of slow blood filling had

the most numerous correlations (22.7%).

The established features of the relationship between the temporal parameters of peripheral hemodynamics and anthropometric body size in young women volleyball players of different somatotypes will allow to predict morpho-functional changes of the thigh vessels in accordance with changes in body components.

Conclusions

1. It was found that in mesomorphic young women volleyball players the most numerous correlations with anthropometric dimensions were found for the time of the ascending part of the rheogram and slow blood filling; in ectomorphs - only for the time of the ascending part of the rheovasogram; in ecto-mesomorphs - for the time of rapid blood supply; in volleyball players of medium intermediate somatotype - for the time of slow blood supply.

2. Of the anthropometric body sizes, the most numerous and strongest correlations with the temporal indices of the thigh rheogram in young women volleyball players of different constitutional types had longitudinal body sizes (only direct correlations), width of the distal epiphysis of the thigh and crus (mostly direct correlations), circumferential dimensions of limb segments and chest (mostly direct correlations) and the thickness of skin and fat folds (mostly inverse correlations).

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КОРЕЛЯЦІЇ ЧАСОВИХ ПОКАЗНИКІВ РЕОГРАМИ СТЕГНА З АНТРОПОМЕТРИЧНИМИ РОЗМІРАМИ У ВОЛЕЙБОЛІСТОК РІЗНИХ СОМАТОТИПІВ

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Конституціональні особливості організму є суттєвим важелем спортивної результативності, тому що впливають на загальну та спеціальну фізичну працездатність, аеробну продуктивність і показники ефективності роботи систем енергозабезпечення, зокрема, на показники центральної та периферичної гемодинаміки. Мета роботи - встановити особливості зв'язків між часовими параметрами реовазограми стегна та антропометричними показниками у висококваліфікованих волейболісток юнацького віку, які належать до різних конституціональних типів. Проведено антропоматотипологічне дослідження 113 волейболісток високого рівня спортивної майстерності юнацького віку (від 16 до 20 років). Антропометричне дослідження проводили за методом В.В. Бунака (1941), соматотипологічне - за розрахунковою модифікацією методу Heath-Carter (1990). За результатами соматотипування встановили, що 29 волейболісток належали до мезоморфного типу конституції, до ектоморфного - 26 волейболісток, до екто-мезоморфів - 27 волейболісток, до середнього проміжного типу - 26 волейболісток, до ендо-мезоморфів - лише 5 осіб. Реовазографічні параметри стегна визначали за допомогою тетраполярної реокардіографії на комп'ютерному діагностичному комплексі. Оцінку часових реовазографічних параметрів проведено за методикою Ронкіна та Іванова [1997]. Аналіз отриманих результатів проведений у ліцензійній програмі "Statistica 5.5" із використанням кореляційного аналізу за Спірменом. Нами встановлено, що у волейболісток-мезоморфів із показниками зовнішньої будови тіла часові параметри реовазограми стегна мали нечисельні достовірні переважно середньої сили, прямі кореляції, за винятком часу висхідної частини реограми та повільного кровонаповнення. У волейболісток ектоморфного соматотипу встановлені взаємозв'язки свідчать про те, що при збільшенні діаметрів таза та обхватних розмірів передпліччя, голіпки, стегон буде спостерігатися подовження часових параметрів реовазограми стегна. У волейболісток з екто-мезоморфним соматотипом виявлено достатньо велику кількість достовірних зворотних кореляцій, товщина шкірно-жирових складок обернено пропорційно взаємопов'язана з більшістю часових параметрів реовазограми стегна, за винятком часу повільного кровонаповнення. У волейболісток середнього проміжного соматотипу, порівняно з іншими групами спостереження, виявлені найчисельніші зв'язки між антропометричними розмірами та часовими показниками реовазограми.

Ключові слова: кореляція, часові показники реовазограми стегна, антропометрія, соматотип, волейболістки.

КОРЕЛЯЦІЇ ЧАСОВИХ ПОКАЗНИКІВ РЕОГРАМИ СТЕГНА З АНТРОПОМЕТРИЧНИМИ РОЗМІРАМИ У ВОЛЕЙБОЛІСТОК РІЗНИХ СОМАТОТИПІВ

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Конституціональні особливості організму є суттєвим важелем спортивної результативності, тому що впливають на загальну та спеціальну фізичну працездатність, аеробну продуктивність і показники ефективності роботи систем енергозабезпечення, зокрема, на показники центральної та периферичної гемодинаміки. Мета роботи - встановити особливості зв'язків між часовими параметрами реовазограми стегна та антропометричними показниками у висококваліфікованих волейболісток юнацького віку, які належать до різних конституціональних типів. Проведено антропоматотипологічне дослідження 113 волейболісток високого рівня спортивного мастерства юнацького віку (від 16 до 20 років). Антропометричне дослідження проводили за методом В.В. Бунака (1941), соматотипологічне - за розрахунковою модифікацією методу Heath-Carter (1990). За результатами соматотипування встановили, що 29 волейболісток належали до мезоморфного типу конституції, до ектоморфного - 26 волейболісток, до екто-мезоморфів - 27 волейболісток, до середнього проміжного типу - 26 волейболісток, до ендо-мезоморфів - лише 5 осіб. Реовазографічні параметри стегна визначали за допомогою тетраполярної реокардіографії на комп'ютерному діагностичному комплексі. Оцінку часових реовазографічних параметрів проведено за методикою Ронкіна та Іванова [1997]. Аналіз отриманих результатів проведений у ліцензійній програмі "Statistica 5.5" із використанням кореляційного аналізу за Спірменом. Нами встановлено, що у волейболісток-мезоморфів із показниками зовнішньої будови тіла часові параметри реовазограми стегна мали нечисельні достовірні переважно середньої сили, прямі кореляції, за винятком часу висхідної частини реограми та повільного кровонаповнення. У волейболісток ектоморфного соматотипу встановлені взаємозв'язки свідчать про те, що при збільшенні діаметрів таза та обхватних розмірів передпліччя, голіпки, стегон буде спостерігатися подовження часових параметрів реовазограми стегна. У волейболісток з екто-мезоморфним соматотипом виявлено достатньо велику кількість достовірних зворотних кореляцій, товщина шкірно-жирових складок обернено пропорційно взаємопов'язана з більшістю часових параметрів реовазограми стегна, за винятком часу повільного кровонаповнення. У волейболісток середнього проміжного соматотипу, порівняно з іншими групами спостереження, виявлені найчисельніші зв'язки між антропометричними розмірами та часовими показниками реовазограми.

проводили по методу В.В. Бунака (1941), соматотипологическое - по расчетной модификации метода Heath-Carter (1990). По результатам соматотипирования установили, что 29 волейболисток принадлежали к мезоморфному типу конституции, к эктоморфному - 26 волейболисток, к экто-мезоморфному - 27 волейболисток, к среднему промежуточному типу - 26 волейболисток, к эндо-мезоморфному - всего 5. Реовазографические параметры бедра определяли с помощью тетраполярной реокардиографии на компьютерном диагностическом комплексе. Оценку интервальных реовазографических параметров провели по методике Ронкина и Иванова [1997]. Анализ полученных результатов проведен в лицензионной программе "Statistica 5.5" с использованием корреляционного анализа по Спирмену. Нами установлено, что у волейболисток мезоморфов с показателями внешнего строения тела интервальные параметры реовазограммы бедра имели немногочисленные достоверные преимущественно средней силы, прямые корреляции, за исключением времени восходящей части реограммы и медленного кровенаполнения. У волейболисток эктоморфного соматотипа установленные взаимосвязи свидетельствуют о том, что при увеличении диаметров таза и обхватных размеров предплечья, голени, бедер будет наблюдаться удлинение временных параметров реовазограммы бедра. У волейболисток с экто-мезоморфным соматотипом обнаружено достаточно большое количество достоверных обратных корреляций, толщина кожно-жировых складок обратно пропорционально взаимосвязана с большинством временных параметров реовазограммы бедра, за исключением времени медленного кровенаполнения. У волейболисток среднего промежуточного соматотипа, по сравнению с другими группами наблюдения, обнаружены самые многочисленные связи между антропометрическими размерами и временными показателями реовазограммы.

Ключевые слова: корреляция, временные показатели реовазограммы бедра, антропометрия, соматотип, волейболистки.

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The introduction reflects the state of research and the relevance of the problem according to the world scientific literature (at least 15 references to English articles in international journals over the past 5 years). At the end of the entry, the purpose of the article is formulated (contains no more than 2-3 sentences, in which the problem or hypothesis is addressed, which is solved by the author).

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5-10 sentences that summarize the work done (in the form of paragraphs or solid text).

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Responsible editor - Gunas Igor Valeryovich (phone number: + 38-067-121-00-05; e-mail: gunas.red@gmail.com).

Signed for print 28.02.2020

Format 60x84/8. Printing offset. Order № 0097. Circulation 100.

Vinnitsya. Printing house "Tvory", Keleckaya St., 51a

PO Box 8825, 600-Richchya Str., 21, Vinnitsya, 21007

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