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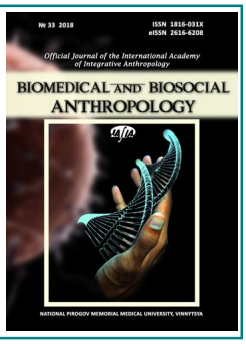

Determination of individual cephalometric characteristics of the occlusal plane in Ukrainian young men and young women with orthognatic bite

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To date, there are no clear recommendations on the use of a particular indicator, cephalometric method, normative basis for the inhabitants of Ukraine when assessing the cephalometric characteristics of the occlusal plane. The purpose of the study - by studying cephalometric indices and conducting direct stepwise regression analysis - develop in young men and women of Ukraine with orthognathic bite mathematical models of individual characteristics of the position of the occlusal plane. In 38 young men (aged 17-21 years) and 55 young women (aged from 16 to 20 years) with occlusion close to orthognathic bite and balanced faces, lateral teleroentgenograms were obtained using the Veraviewepocs 3D device, Morita (Japan). Cephalometric analysis was performed using OnyxCeph³™ software. Cephalometric points and measurements were performed according to the recommendations of W. B. Downs, J. McNamara, R. A. Holdway, P. F. Schmuth, A. M. Schwarz, C. C. Steiner and C. H. Tweed. In the licensed statistical package "Statistica 6.0", using regression analysis, the following teleroentgenographic characteristics of the position of the occlusal plane were simulated: the angle YGOCLPl, the angle POR_DOP, the angle POR_OCP, and the SN_OSP angle. It was established that in both young men and women, all four possible models with a determination coefficient from 0.808 to 0.998 in young men and from 0.832 to 0.974 in young women were constructed. In the analysis of models of teleroentgenographic characteristics of the position of the occlusal plane, depending on the peculiarities of the metric characteristics of the craniofacial complex, it was found that in young men the most frequent regression equations include - the Wits indicator (21.1% for all four equations), the angle AB_NPOG (15.8%) and the distance PN_POG (10.5%). In young women, most often the regression equations include - Wits indicator (17.4% - also to all 4 equations); angle AB_NPOG, distance AFH, angle MM and angle SN_GoGn (by 8.7%). So, using the method of stepwise regression, among Ukrainians of juvenile age, based on the features of teleroentgenographic indicators, reliable models of individual cephalometric characteristics of the occlusal plane were created.

Keywords: *occlusal plane, cephalometry, regression analysis, young men and women, orthognathic bite.*

Introduction

The issue of dentitions occlusion in scientific and practical literature have a lot of attention. The existence of different philosophies, techniques, often lack of common definitions - constantly encourages scientists and practitioners to conduct new research in this field. With the development of science, there is more and more issues related to the functioning of the tooth-jaw system and its impact on other organs and systems.

One of the main functions of the teeth and jaws is chewing function, which is implemented when closing the dental rows of the upper and lower jaws. The closure occurs in certain occlusion contact points, the totality of which forms the actual occlusion plane. Depending on the shape and nature of the closure, different contact groups are formed

and, accordingly, distinguish functional and static occlusion planes, which are usually depicted for technical reasons as straight lines on sagittal and frontal projections. And since the parameters of the occlusion planes are closely related to the characteristics of the teeth, anatomy and the functioning of the temporomandibular joints, the nature of the growth of craniofacial structures and muscle function, it is precisely because of the change in occlusion that we have the possibility of indirect influence on the above structures. A well-known gnathologist, one of the founders of the doctrine of the "chewing organ" Rudolf Slavicek notes: "The functions of the chewing organ are completely different and are closely connected to the somatic and mental functions of the brain. Of course, there is adaptability and compensatory capacity. However, the chewing organ and the psyche are closely interconnected "[30].

Very acute question arises about the creation of artificial occlusion surface in the treatment of complete adentia. So, in the manufacture of complete dentures, it is suggested to use the found dependencies of the location of the occlusion plane in relation to different anatomical planes. As a result of the use of completely non-invasive methods with the use of optical three-dimensional scanning systems and the creation of a three-dimensional object with facial and dental structures, the averaged relation of the occlusion plane and the Camper's plane passing through the tragus and subnasale, and having a 4.9° inclination in the sagittal plane, was invented [25]. However, research of Quran F. A. M. A., Hazza'a A. and Nahass N. A. [24] argues that the use of a plane that passes through the upper edge of the tragus and the lower edge of the nose wing is more correct for determining the occlusion plane.

The position of the closure planes is investigated in relation to the HIP-plane (Hamulus-Incisive-Papilla), which is quite convenient for clinical use. It is recommended to use the mean values of the angle of inclination of the occlusion plane that passes through the incisal edge of the central incisors and the mesiobuccal cusp of the upper first molar - 2.61±0.81° and mesiobuccal cusp of the upper second molar - 7.72±1.60° [14], although works by Jayachandran S., Ramachandran C. R. and Varghese R. [20] point to the parallelism of the planes. V. A. Khvatov [21] indicates exactly the orthopedic plane passing through the distobuccal cusp of second molar and the incisal edge of the central incisor of the mandible parallel to the Camper's horizontal. The author recommends such a plane when installing models in articulator, X-ray analysis, as well as in the analysis of motion recordings.

Determination of the occlusion plane pays great attention not only by maxillofacial surgeons and orthopedists, but also orthodontists. Jack Dale, in a document presented at the Charles H. Tweed Foundation Meeting in 1992, called the occlusion plane "working table of orthodontics" [22]. Understanding the importance of proper control of the occlusion plane is fundamental to the success of clinical treatment.

Since the occlusion surface is rather complicated, it is usually presented as a straight line which combines certain light-weight currents in the sagittal plane to simplify the understanding of skeletal and occlusion ratios on lateral teleroentgenographic images. W. B. Downs [12] used the ADP constructive point (anterior Downs point) the front point of the occlusion plane by Downs - center of the line connecting the incisal edges of the upper jaw and lower jaw central incisors and PDP (posterior Downs point) - the back point of the occlusion plane by Downs - the middle of the line, which connects mesiobuccal cusp of the upper first molar of the upper and lower jaw. C. C. Stainer [31] defined the occlusion plane by passing it through the points apOcP (anterior point of the occlusal plane, the ADP analog, the anterior point of the occlusion plane by Downs) and ppOcP (posterior point of the occlusal plane), the back point of the occlusion plane by Steiner - is located in the place of the most rear contact of the first molars.

Also, the position of the tooth row in the facial skeleton can be characterized by a line passing through the incisal edges of central incisors and distal lobes of second molars, separately for the upper or lower jaw [21, 33].

Fushima K. et al. [15] proposes to consider two occlusion planes - the anterior and posterior. The anterior occlusion plane is a line extending from the incisal edge of the central incisor of the upper jaw to the cusp of the upper second premolar. Posterior occlusion plane - a line extending from the lobe of the upper second premolar and the medial point of the occlusal surface of the upper second molar. This approach allows flexible approach to the diagnosis of tooth-jaw abnormalities and often puts the main goal of treatment - the normalization of the position of occlusion planes.

Three-dimensional studies by Coro J. C. et al. [5] of 111 people of different sex and age not only confirmed the dependence of the location of the rear occlusion plane in relation to the Frankfurt area in different facial types but also found tight correlations between the inclination of the posterior occlusion plane and the height of the branch and length of the body of the mandible. In addition to the morphological characteristics, closely related to the posterior occlusion plane, the presence and nature of lateral deviations of the mandible were revealed.

Choi Y. J. and co-authors [4] note that, in their studies of a group of treated patients with such a complex treatment plan and the stability of the results of dental implant pathology as the front open the bite, depending on the cephalometric configuration of the occlusion plane, and in particular the nature of the occlusion of premolars, there were different results of treatment.

It should also be noted that ignoring the degree of inclination of the occlusion surface can significantly affect the validity of such key diagnostic teleroentgenographic indicators as ANB angle and WITS indicator [6].

Analysis of the spatial location of the occlusion plane does not have any value in the treatment of functional disorders. So, research by Sato M. et al. [27] demonstrate

the close correlations of characteristics of chewing movements and muscle work with spatial position of occlusion plane, which allows professionals to work not only within the anatomical standards but also influence the complex functional connection elements craniofacial complex.

To assess the cephalometric characteristics of the occlusion plane in determining the orthodontic diagnosis, teaching aids suggest to use norms [11, 13, 16] that have been developed for different ethnic populations of other countries. And for today there are no clear recommendations on the use of a particular indicator, one or another cephalometric method, as well as what normative bases, which country or ethnic group should be used for Ukrainian citizens.

The *purpose* of the study - by studying cephalometric indices and conducting direct stepwise regression analysis to develop in young men and women of Ukraine with orthognathic bite mathematical models of individual characteristics of the position of the occlusion plane.

Materials and methods

With the use of Veraviewepocs 3D device, Morita (Japan) in 38 young men (17 to 21 years of age) and 55 young women (aged from 16 to 20 years) with occlusion close to the orthognathic and balanced face have received side teleroentgenograms. Cephalometric analysis was performed using OnyxCeph³™ software. Cephalometric points and measurements were performed according to the recommendations of A. M. Schwarz, J. McNamara, W. B. Downs, R. A. Holdway, P. F. Schmuth, C. C. Steiner and C. H. Tweed [12, 19, 23, 28, 29, 31, 32]. The analysis of teleroentgenograms and the results of their researches for Ukrainian young men and women is described in detail and set out in a number of previous articles [7-10, 17, 18].

In accordance with the above-mentioned procedures, we simulated the following teleroentgenographic characteristics of the position of occlusion planes (Fig. 1): **YGOCLPI** - the angle of inclination of the occlusion plane to the palatine plane is formed by the lines Is1L-DPOcl and ANS-PNS (°); **POR_DOP** - angle of inclination of the occlusion plane by Downs to the Frankfurt area, formed by the lines Po-Or and ADP-PDP (°); **POR_OCP** - angle of inclination of the occlusion plane by Steiner to the Frankfurt plane, formed by the lines of apOcP-ppOcP and Po-Or (°); **SN_OCP** - the angle of inclination of the shutter plane by Steiner to the front of the skull, formed by the lines apOcP-ppOcP and S-N (°).

The statistical processing of the obtained results was carried out in the license package "Statistica 6.0" using a direct stepwise regression analysis.

Results

As a result of modeling teleroentgenographic characteristics of the occlusion plane in young men and women with orthognathic bite and balanced face,

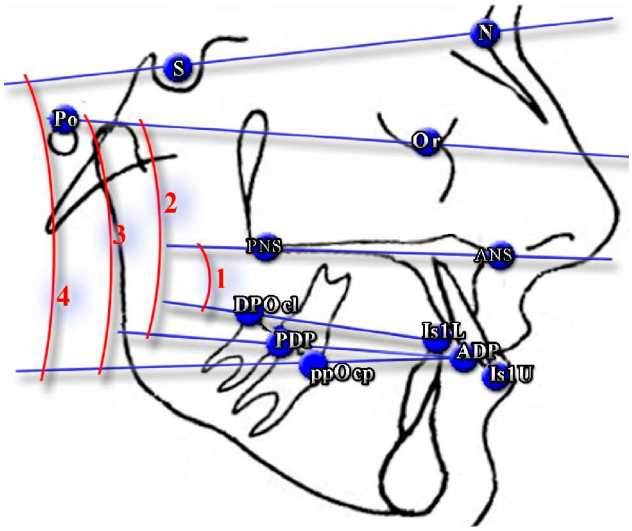

Fig. 1. Teleroentgenographic characteristics of the position of occlusion planes. 1 - YGOCLPI, 2 - POR_DOP, 3 - POR_OCP, 4 - SN_OCP.

depending on the metric parameters of the skull, we constructed the following linear equations.

For young men:

YGOCLPL = -33.59 - 0.224 x N_SP_SP - 0.981 x WITS + 0.465 x T + 0.109 x GL_SN_S + 0.439 x MM - 0.167 x GL_SNPOG (R^2=0.808; $F_{(6.29)}$=20.35; p<0.001; Error of estimate=1.858),

POR_DOP = 10,84 - 0.483 x PN_POG - 1.396 x WITS - 0.778 x AB_NPOG - 0.217 x AFH + 0.132 x B (R^2=0.953; $F_{(5.30)}$=122.4; p<0.001; Error of estimate=1.050),

POR_OCP = 8.421 - 0.457 x PN_POG - 1.170 x WITS - 0.782 x AB_NPOG -0.106 x R_ASC (R^2=0.988; $F_{(4.31)}$=627.6; p<0.001; Error of estimate=0.518),

SN_OCP = 77.24 - 0.801 x SND - 1.439 x WITS - 0.916 x AB_NPOG - 0.105 x S_L (R^2=0.980; $F_{(4.31)}$=375.2; p<0.001; Error of estimate=0.745).

For young women:

YGOCLPL = -34.59 + 0.453 x B - 0.551 x FMA - 0.369 x P_OR_N + 0.149 x N_POG_ - 1.311 x WITS + 0.749 x MM (R^2=0.832; $F_{(6.44)}$=36.37; p<0.001; Error of estimate=1.769),

POR_DOP = -54.08 - 0.483 x PN_POG + 0.292 x SN_GOGN + 0.858 x F - 0.532 x SNA - 0.201 x AFH + 0.342 x MM - 0.555 x WITS (R^2=0.849; $F_{(7.43)}$=34.52; p<0.001; Error of estimate=1.954),

POR_OCP = -39.83 + 0.891 x POR_GNS + 0.112 x ML_NSL - 0.169 x AFH - 0.638 x AB_NPOG - 0.915 x WITS (R^2=0.929; $F_{(5.45)}$=117.2; p<0.001; Error of estimate=1.227),

SN_OCP = 85.33 + 0.073 x SN_GOGN - 0.993 x SND + 0.060 x PN_A - 1.424 x WITS - 0.841 x AB_NPOG (R^2=0.974; $F_{(5.45)}$=335.6; p<0.001; Error of estimate=0.659).

In the constructed models: R^2 - coefficient of determination; $F_{(!.!!)}$=!!.!! - critical $_{(!.!!)}$ and got (!!.!!) value of Fisher's criterion; St. Error of estimate - standard error of the standardized regression coefficient; AB_NPOG - angle formed by lines A-B and N-Pog (defines the position of the plane AB in relation to the N-pog); AFH (distance AFH or front height of the face) - distance from the point Me to the line ANS-PNS; B (basal angle) - formed by lines ANS-PNS (palatine plane SpP) and Im-Me (mandibular plane MPS by Schwarz) (indicates the angle between the upper and lower jaws); F (face angle or angle F) - formed by lines Se-N and N-A (determines the location of the anterior contour of the upper jaw in the jet plane to the base of the skull); FMA (angle FMA, also meets the designation POr_MeGo) - formed by lines tGo-Me (mandibular plane Mp) and Po-Or (Frankfurt plane Fp); GL_SN_S (index Gl'_Sn_Sn_Gn' or facial vertical index) - distance ratio of Gl'-Sn and Sn-Gn' (defines vertical relationships in the face profile); GL_SNPOG (angle Gl'SnPog' or indicator of convexity of the soft tissue profile) - formed by lines Gl'-Sn and Sn-Pog'; ML_NSL (angle ML_NSL, or angle SN_GoMe) - is formed by lines tGo-Me and S-N (angle of inclination of the mandibular plane to the base of the skull); MM (maxillo-mandibular angle) - is formed by lines A-B and ANS-PNS (defines the angle below which the upper jaw is located in relation to the lower jaw in the sagittal plane); N_POG_ (angle N'Hold_Pog'_Hline) - angle between lines Ls-Pog' (H line, Holdway line) and N'Hold-Pog'; N_SP_SP (coefficient N_Sp'_Sp'_Me) - distance ratio N-Sp' and Sp'-Me (the ratio of the upper and lower height of the face); P_OR_N (soft tissue angle, or angle P_Or_N'Hold_Pog') - formed by lines Po-Or and N'Hold-Pog'; PN_A (distance PN_A) - distance from the point A to the point PNm (perpendicular line from the point N to the line Po-Or); PN_POG (distance PN_Pog) - distance from the point Pog to the nose perpendicular PN (perpendicular line from the point N to the line Po-Or); POR_GNS (angle POr_GnS or У-axis) - angle formed by lines Po-Or and S-Gn (angle of inclination У-axis relative to the Frankfurt horizontal); R_ASC (length of the branch of the mandible) - distance from the constructive point R.asc to a constructive point tGoS; S_L (distance S_L or the front length of the skull base by Steiner) - from the point S to a constructive point L, which is formed at the intersection of the perpendicular carried out from the point Pog to the line Se-N; SN_GOGN (angle SN_GoGn) - is formed by lines Go-Gn and S-N (angle of inclination (MpSt) mandibular plane by Stainer, to the base of the skull); SNA (angle SNA) - is formed by lines S-N and N-A (indicates the anterior-posterior position of the upper jaw to the base of the skull); SND (angle SND) - formed by lines S-N and N-D (indicates the anterior-posterior location of the symphysis (D - the center of the symphysis ossification) of the lower jaw to the base of the skull); T (profile angle T) - is formed by lines Sn-Pog' and Pn (nasal perpendicular, perpendicular to the line from the point N' to the line Se-N); WITS (indicator Wits) - distance between constructive points AOclP and BOclP - projections of the corresponding points A and B on the line apOcP-ppOcP (OcPSt, closing plane by Steiner), indicates a linear interjaw ratio in the anterior-posterior direction (if the projection of point A lies ahead of the projection of point B then the indicator takes a positive value; if the projection of point A lies behind the projection of point B then the indicator takes a negative value).

Discussion

In addition to the existence of different views on the definition of occlusion plane, discussions and scientific research are constantly under way to find regularities and correct landmarks to determine its spatial position.

Thus, Camara C. A. and Martins R.P. [2] suggested the use of a Functional Aesthetic Occlusal Plane (FAOP), which passes through the point of closure of the lips and the midpoint of the contact between the molars of the upper and lower jaws as a benchmark. It is noted that the maximum functional and aesthetic result is observed at the tangent location of the edge of the lower central incisors to this plane and the location of the incision edge of the maxillary central incisors is 2-4 mm below the latter.

S. Braun et al. [1] when investigating 260 people found geometric dependencies, in the form of regression polynomials, the distance from the center of the mandibular fossa to the functional occlusion plane and the angle of the latter with respect to the anterior part of the base of the skull, the S-N line.

Investigation by Čelar A. et al. [3] revealed a different nature of the location of occlusion planes, depending on different skeletal types and classes of dental anomalies by Engle. They retrospectively investigated teleroentgenograms of 230 people for the presence of bisectorial, reverse and backplane correlations with the Frankfurt (P-Or) and basal (S-Na) planes. Studies have shown stronger and more stable correlations with the basal plane compared to the Frankfurt, possibly due to the frequent difficulties in the localization of the orbital point and the porion. So in the group with skeletal second class, the anterior and posterior occlusion planes had a steeper (larger) angle of inclination compared with a more horizontal position in people with skeletal third grade. When divided into groups by the nature of the occlusion of the first molar by Engle, the front occlusion plane did not have statistically significant differences in relation to both planes, but at the same time the posterior occlusion plane significantly differed. The group with the first class correlation of molars had the most horizontally located occlusion plane.

Sahoo S. et al. [26] conducted a rather deep analysis of the literature from 1963 to 2013 relating to the determination of the occlusion plane, it is concluded that there are few real long-term studies and reliable data that could

recommend a single reliable orientation for determining the occlusion plane in various clinical cases.

In young men and women with orthognathic bite we developed reliable models of individual teleroentgenographic characteristics of the position of the occlusion plane, depending on the peculiarities of the metric characteristics of the craniofacial complex. It was established that in both young men and women, all four possible models with a determination coefficient of 0.808 to 0.998 in young men and from 0.832 to 0.974 in young women were constructed.

In the analysis of the models, it was found that in young men most often the regression equations include the Wits index, which indicates the linear interjaw relation in the anterior-posterior direction (21.1% to all four equations), the angle AB_NPOG (15.8%), and the distance PN_POG (10.5%) In young women, most often the regression equations include - the Wits indicator (17.4% - to all 4 equations); angle AB_NPOG, distance AFH (or forward facial height), maxillo-mandibular angle MM and angle SN_GoGn (by 8.7%). It should be noted that among the metric characteristics of the craniofacial complex to the models of teleroentgenographic characteristics of the position of the occlusion plane only in young men include the index Gl'_Sn_Sn_Gn ', the angle Gl'SnPog', the coefficient N_Sp'_Sp'_Me, the length of the branch of the mandible R_ASC, the distance S_L and the profile angle T, and only for young women - the angle or angle F, the angle FMA, the angle ML_NSL, the angle N'Hold_Pog'_Hline, the angle P_Or_N'Hold_Pog', the distance PN_A, the angle POr_GnS, the angle SN_GoGn and the angle SNA.

Consequently, taking into account the importance of determining the teleroentgenographic parameters of the spatial position of the occlusion plane and the diversity of the proposed methods, as well as the absence of the possibility of identifying individual normative diagnostic values, there is a scientific and clinical interest in conducting research on these issues. And the use of modern mathematical techniques allows us to develop tools for the determination of individual normative values of the position of occlusion planes, taking into account their ethnic, sexual, age and anatomical features of man.

Conclusions

In young men and women with orthognathic bite, all four possible models of individual teleroentgenographic characteristics of the position of the occlusion plane are constructed, in accordance with the determination coefficients from 0.808 to 0.998 and from 0.832 to 0.974. In young men models most often included - Wits indicator (21.1%), the angle AB_NPOG (15.8%) and the distance PN_POG (10.5%), while in young women - the Wits indicator (17.4%), the angle AB_NPOG, the distance AFH, the angle MM and angle SN_GoGn (by 8.7%).

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ВИЗНАЧЕННЯ ІНДИВІДУАЛЬНИХ ТЕЛЕРЕНТГЕНОГРАФІЧНИХ ХАРАКТЕРИСТИК ПОЛОЖЕННЯ ЗМИКАЛЬНОЇ ПЛОЩИНИ У УКРАЇНСЬКИХ ЮНАКІВ І ДІВЧАТ ІЗ ОРТОГНАТИЧНИМ ПРИКУСОМ

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На сьогоднішній день немає чітких рекомендацій щодо застосування того чи іншого показника, цефалометричного методу, нормативної бази для мешканців України при оцінці цефалометричних характеристик змикальної площини. Мета дослідження - шляхом вивчення цефалометричних показників і проведення прямого покрокового регресійного аналізу розробити у юнаків і дівчат України з ортогнатичним прикусом математичні моделі індивідуальних характеристик положення змикальної площини. У 38 юнаків (віком від 17 до 21 року) та 55 дівчат (віком від 16 до 20 років) з оклюзією наближеною до ортогнатичного прикусу та збалансованими обличчями були отримані бокові телерентгенограми за допомогою пристрою Veraviewepocs 3D, Morita (Японія). Цефалометричний аналіз проводили за допомогою програмного забезпечення OnyxCeph³™. Цефалометричні точки та вимірювання проводили згідно рекомендацій W. B. Downs, J. McNamara, R. A. Holdway, P. F. Schmuth, A. M. Schwarz, C. C. Steiner та C. H. Tweed. В ліцензійному статистичному пакеті "Statistica 6.0", з використанням регресійного аналізу, проведено моделювання наступних телерентгенографічних характеристик положення змикальної площини: кута YGOCLPI, кута POR_DOP, кута POR_OCP та кута SN_OCP. Встановлено, що як в юнаків, так і у дівчат побудовані усі 4 можливих моделі з коефіцієнтом детермінації від 0,808 до 0,998 в юнаків і від 0,832 до 0,974 у дівчат. При аналізі моделей телерентгенографічних характеристик положення змикальної площини в залежності від особливостей метричних характеристик краніофаціального комплексу встановлено, що в юнаків найбільш часто до регресійних рівнянь входять - показник Wits (21,1% - до усіх 4 рівнянь), кут AB_NPOG (15,8%) та відстань PN_POG (10,5%). У дівчат найбільш часто до регресійних рівнянь входять - показник Wits (17,4% - також до усіх 4 рівнянь); кут AB_NPOG, відстань AFH, кут MM та кут SN_GoGn (по 8,7%). Таким чином, за допомогою методу покрокової регресії з включенням, у українців юнацького віку, на основі особливостей телерентгенографічних показників розроблені достовірні моделі індивідуальних телерентгенографічних характеристик положення змикальної площини.

Ключові слова: *змикальна площина, цефалометрія, регресійний аналіз, юнаки, дівчата, ортогнатичний прикус.*

ОПРЕДЕЛЕНИЕ ИНДИВИДУАЛЬНЫХ ТЕЛЕРЕНТГЕНОГРАФИЧЕСКИХ ХАРАКТЕРИСТИК ПОЛОЖЕНИЯ ОККЛЮЗИОННОЙ ПЛОСКОСТИ У УКРАИНСКИХ ЮНОШЕЙ И ДЕВУШЕК С ОРТОГНАТИЧЕСКИМ ПРИКУСОМ

Дмитриев Н. А., Гунас И. В., Дзевульская И. В., Жулкевич И. В.

На сегодняшний день нет четких рекомендаций по применению того или иного показателя, цефалометрического метода, нормативной базы для жителей Украины при оценке цефалометрических характеристик замыкательной плоскости. Цель

исследования - путем изучения цефалометрических показателей и проведения прямого пошагового регрессионного анализа разработать у юношей и девушек Украины с ортогнатическим прикусом математические модели индивидуальных характеристик положения замыкательной плоскости. У 38 юношей (в возрасте от 17 до 21 года) и 55 девушек (в возрасте от 16 до 20 лет) с окклюзией приближенной к ортогнатическому прикусу и сбалансированными лицами были получены боковые телерентгенограммы с помощью устройства Veraviewepocs 3D, Морита (Япония). Цефалометрический анализ проводили с помощью программы OnyxCeph³™. Цефалометрические точки и измерения проводили согласно рекомендациям W. B. Downs, J. McNamara, R. A. Holdway, P. F. Schmuth, A. M. Schwarz, C. C. Steiner и C. H. Tweed. В лицензионном статистическом пакете "Statistica 6.0", с использованием регрессионного анализа, проведено моделирование следующих телерентгенографических характеристик положения замыкательной плоскости: угла YGOCLPI, угла POR_DOP, угла POR_OCP и угла SN_OCP. Установлено, что как у юношей, так и у девушек построены все 4 возможных модели с коэффициентом детерминации от 0,808 до 0,998 у юношей и от 0,832 до 0,974 у девушек. При анализе моделей телерентгенографических характеристик положения замыкательной плоскости в зависимости от особенностей метрических характеристик краниофациального комплекса установлено, что у юношей наиболее часто к регрессионным уравнениям входят - показатель Wits (21,1% - к всем 4 уравнениям), угол AB_NPOG (15,8%) и расстояние PN_POG (10,5%). У девушек наиболее часто к регрессионным уравнениям входят - показатель Wits (17,4% - также ко всем 4 уравнениям); угол AB_NPOG, расстояние AFH, угол MM и угол SN_GoGn (по 8,7%). Таким образом, с помощью метода пошаговой регрессии с включениями, для украинцев юношеского возраста, на основе особенностей телерентгенографических показателей, разработаны достоверные модели индивидуальных телерентгенографических характеристик положения окклюзионной плоскости.

Ключевые слова: *окклюзионная плоскость, цефалометрия, регрессионный анализ, юноши, девушки, ортогнатический прикус.*

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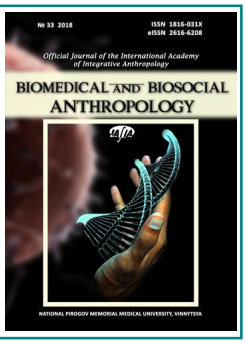

Effect of TXNRD2 rs35934224, FOXC1 rs2745599 and rs984253 genetic polymorphisms combinations on the development of primary open-angle glaucoma and their degree of association with the disease

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*Primary open-angle glaucoma (POAG) is a complex disease caused by numerous genetic and environmental factors, as well as their interaction. In recent studies, the effect of genetic polymorphisms combinations and non-equilibrium linkage of allele genes related to the development of POAG has been proved. The aim of the study was to determine the effect of TXNRD2 rs35934224, FOXC1 rs2745599 and rs984253 genetic polymorphisms combinations on the development of primary open-angle glaucoma and their degree of association with the disease. The study included 93 patients (185 eyes) with POAG stage I-IV and 89 volunteers (178 eyes) control subjects without any types of glaucoma. The patients were divided into four groups according to the degree of perimetric changes (Nesterov A. P., 2008). All patients performed visometry, computer perimetry, tonometry, biomicroscopy, ophthalmoscopy, gonioscopy, keratopahymetry, optical coherent tomography of the optic nerve. Analysis of the TXNRD2 rs35934224, FOXC1 rs2745599 and rs984253 genetic polymorphism with POAG was performed in real time using a polymerase chain reaction (PCR) in Gene Amp® PCR System 7500 (Applied Biosystems, USA) automatic amplifier. In the first stage of the study, the genomic DNA from whole venous blood was isolated using the standard reagents PureLink® Genomic DNA Kit for purification of genomic DNA, manufactured by INVITROGEN (USA). The analysis of polymorphism was carried out using unified test systems of TaqMan Mutation Detection Assays Life-Technology (USA). It was determined that the association with POAG had the genotype C/T*A/A*T/A as by comparing control with all patients, and by stratification - with the 1st, 2nd and 3rd groups of patients. The obtained results showed the evidentiary effect of this genotype combinations on the appearance of POAG, and on its progression by the stages of perimetric changes. The risk of the occurrence of POAG in carriers of genotypes C/T*A/A*T/A was increased by 2.8 times (p<0.001). In this combination, the two polymorphisms had heterozygous genotypes (rs35934224 - C/T, rs984253 - T/A), and the genotype rs2745599 - a mutant homozygote A/A. A combination of genotypes C/C*G/A*T/A was also important for the progression of the disease till stage II, which increased the risk of development of the POAG stage II by 2.9 times (p<0.01) compared to control. The risk of occurrence of the POAG in general and development of stage IV increased the presence of combinations of three minor genotypes T/T*A/A*A/A, which was encountered only in patients with POAG (in stage II - f = 0.025, in the third stage - f = 0.036, and in IV - f = 0.071). In our opinion, it confirmed the proposed working hypothesis of the study and showed that the more genotype combinations have the mutant alleles, the stronger this genotype affects the development of POAG.*

Keywords: *primary open-angle glaucoma, chromosome, genotype, polymorphism, TXNRD2 gene, FOXC1 gene, allele, heterozygote.*

Introduction

Primary open-angle glaucoma (POAG) is a complex disease caused by the combined effects of many genetic and environmental risk factors, each of which do not act alone to cause glaucoma. Recent advances in molecular

genetics have shown that POAG can be caused by numerous gene mutations in various chromosomal loci. A study performed by Cong G. et al. estimated that inherited and familial POAG cases may account for approximately 72% of all POAG cases [6, 7, 8, 22, 27].

Another gene for testing as the genetic marker of the primary open-angle glaucoma (POAG) has become the developmental gene: forkhead box C1 (FOXC1) [1, 28]. This gene plays an important role in the normal morphogenesis of the anterior segment of the eye and is involved in the regulation of intraocular pressure and the function of the trabecular mesh [21]. The FOXC1 gene (previously FKHL7) is one of the six known genes of glaucoma [28]. Although FOXC1 expression has not been studied in adults yet, it is possible that prolonging the expression of an abnormal gene product (from age-related, sub-clinical mutations) throughout life, or altering the expression level of FOXC1 may affect the normal function of the trabecular mesh, thereby leading to an increased risk for the development of POAG through difficulty in drainage and increased intraocular pressure [26].

Another gene that has attracted our attention is the TXNRD2 gene encoding the mitochondrial protein, thioredoxin reductase 2, which is required for mitochondrial redox homeostasis. Thioredoxin 2 reduces the damaging effect of active forms of oxygen, which are formed as a result of oxidative phosphorylation [4]. And the decrease in the number of active forms of oxygen by activating the expression of the TXNRD2 gene prevents mitochondrial dysfunction and apoptosis of ganglion cells in POAG [1, 2].

In recent proceedings devoted to genetic research in the POAG [1, 21], the effects of combinations of polymorphic genotypes and non-equilibrium linkage of allele genes related to the development of POAG were considered. This approach is a very promising area of research, since a particular patient has a certain common genotype consisting of the specific polymorphic genotypes combinations.

That is why, in our opinion, when conducting studies of several polymorphic genes it is advisable to consider the association of genotype combinations with the development of the disease.

The *aim* of the study was to determine the effect of TXNRD2 rs35934224, FOXC1 rs2745599 and rs984253 genetic polymorphisms combinations on the development of primary open-angle glaucoma and their degree of association with the disease.

Materials and methods

The research was performed at the Department of Eye Diseases of the National Pirogov Memorial Medical University and the department of ophthalmology of Vinnitsa Regional Clinical Hospital Named After N. I. Pirogov. The examination of patients and the diagnosis of POAG was carried out in accordance with the classification of A. P. Nesterov perimetric changes in the stages of glaucoma [17].

The study included 93 patients (185 eyes) with POAG stage I-IV and 89 volunteers (178 eyes) control subjects without any types of glaucoma. The patients were divided into four groups according to the degree of perimetric changes [17]. All patients performed visometry, computer perimetry, tonometry, biomicroscopy, ophthalmoscopy, gonioscopy, keratopahymetry, optical coherent tomography of the optic nerve.

All stages of molecular genetic research were carried out at the Research Institute of Experimental and Clinical Medicine of the O. O. Bogomolets National Medical University (chief - m.d., professor Natrus L.V.). Analysis of the TXNRD2 rs35934224, FOXC1 rs2745599 and rs984253 genetic polymorphism with POAG was performed in real time using a polymerase chain reaction (PCR) in Gene Amp® PCR System 7500 (Applied Biosystems, USA) automatic amplifier. In the first stage of the study, the genomic DNA from whole venous blood was isolated using the standard reagents PureLink® Genomic DNA Kit for purification of genomic DNA, manufactured by INVITROGEN (USA). The analysis of polymorphism was carried out using unified test systems of TaqMan Mutation Detection Assays Life-Technology (USA). For statistical analysis of the results, MedStat and MedCalc v.15.1 (MedCalc Software bvba) were used. Association of genotypes and alleles with the disease were determined by the odds ratio (OR); The limits of 95% of the credible interval (CI) were calculated by the method of J. Neyman. The differences were statistically significant at $p<0.05$. To test the probability of differences between groups, χ^2 was used and Fischer's exact criterion was used.

Results

The association with the disease has been confirmed only for genotype combinations C/C*A/A*T/A. It was shown that this genotype was found in the control group with a frequency of f = 0.101, and with POAG - with frequency f = 0.238, that is, 2.4 times more often ($p<0.001$).

The genotype combinations C/C*A/A*T/A increased the chances of development of the POAG compared to the control by 2.8 times (OR = 2.775; 95% CI = 1.532-5.021). Also, the genotype combinations of T/T*A/A*A/A increased the risk of development POAG ($p<0.05$), since such genotype wasn't detected in the control group. It should be noted that this genotype is a combination of all three mutant homozygotes. This fact confirmed the negative effect of the mutant alleles of all three polymorphisms on the occurrence of POAG.

According to the Table 1, four genotype combinations C/C*A/A*T/T, C/C*G/A*T/T, C/C*G/G*T/T and C/T*G/A*T/T showed a strong protective effect on POAG and substantially reduced the chances of development POAG.

The maximum power of connection was determined to genotype combinations C/C*G/G*T/T, which reduced the chances of development POAG by 7.7 times (OR = 0.132; 95% CI = 0.044-0.338). The genotype combinations C/T*G/A*T/T reduced the chances by 6.7 times (OR = 0.157; 95% CI = 0.035-0.697) and the genotype combinations C/C*A/A*T/T and C/C*G/A*T/T - 3.8 times for both cases (OR = 0.263; 95% CI = 0.101-0.685).

Table 1. Influence of genotype combinations on the development of POAG and their degree of association with the disease.

Genotypes	POAG	Control	χ^2	P	OR	95% CI
*C/C*A/A*T/A*	0.242	0.103	11.03	<0.001	2.775	1.532-5.021
*C/C*A/A*T/T*	0.033	0.111	7.552	<0.01	0.263	0.101-0.685
*C/C*G/A*T/T*	0.033	0.111	7.552	<0.01	0.263	0.101-0.685
*C/C*G/G*T/T*	0.024	0.152	16.93	<0.001	0.132	0.044-0.383
*C/T*G/A*T/T*	0.015	0.073	6.392	<0.05	0.157	0.035-0.697
*T/T*A/A*A/A*	0.031	0.001	4.044	<0.05	max	N/A-max

Notes: χ^2 - Pearson's χ-square criterion; p - statistical significance; OR - odds ratio; 95% CI - 95% credible interval for OR.

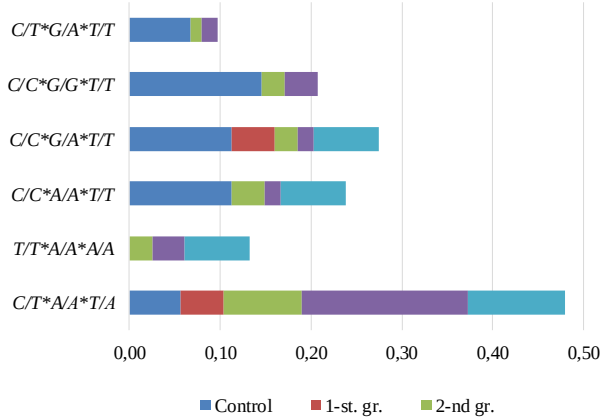

Fig. 1. Distribution of frequencies of genotype combinations in the control group and in patients with POAG when stratified in groups. The diagram shows genotype combinations for which the statistical significance of the differences at level p <0.05 in the groups of comparisons was found, as well as the associative relation with the disease (OR> 0) according to the tables 1 and 2.

Table 2. Influence of genotype combinations on the development of POAG and the degree of their association with disease in groups of patients.

Genotypes	Group	Control	χ^2	P	OR	95% CI
	1st group					
*C/C*A/A*T/A*	0.488	0.103	18.86	<0.001	8.086	3.025-21.65
	2nd group					
*C/C*A/A*T/A*	0.224	0.103	5.852	<0.05	2.541	1.244-5.197
*C/C*G/A*T/A*	0.201	0.086	6.564	<0.01	2.885	1.336-6.243
*C/C*G/A*T/T*	0.025	0.111	4.434	<0.05	0.203	0.052-0.886
*C/C*G/G*T/T*	0.027	0.152	7.295	<0.01	0.154	0.033-0.642
	3rd group					
*C/T*A/A*T/A*	0.181	0.065	6.933	<0.01	3.735	1.464-9.524
*C/C*G/G*T/T*	0.042	0.152	3.884	<0.05	0.223	0.051-0.965
	4th group					
*T/T*A/A*A/A*	0.075	0.001	6.483	<0.05	max	N/A-max

Notes: χ^2 - Pearson's χ-square criterion; p - statistical significance; OR - odds ratio; 95% CI - 95% credible interval for OR

In this regard, at the next stage, the character of the distribution (Fig. 1) and the connection (Table 2) of the genotype combinations with POAG in stratification by groups was determined.

Among the risk genotypes, association with the disease has been confirmed only for genotype combinations C/C*A/A*T/A. It was shown above that this genotype was found in the control group with a frequency f = 0.101, and in POAG - with frequency f = 0.238, that is, 2.4 times more often (p<0.001).

Henceforward, the nature of the connection between the genotype combinations with the disease when stratified by groups was calculated (Table 2).

In the 1st group, as in all patients with POAG, the association with the disease was determined only for genotype combinations C/C*A/A*T/A (χ^2 = 18.86; p<0.001), which in 8, 1 times increased the chances of development POAG (OR = 8,086; 95% CI = 3,025-21,65).

In the 2nd group, the genotype combinations C/C*A/A*T/A (χ^2 = 5.852, p<0.05) increased the chances of development POAG by 2.5 times (OR = 2.541; 95% CI = 1.244-5.197) as well as the genotype combinations C/C*G/A*T/A (χ^2 = 6.564; p<0.01), which increased the chances by 2.9 times (OR = 2.885; 95% CI = 1.336-6.243).

Two other genotype combinations, which in the 2nd group had a statistically significant association with POAG, reduced the chances of its development: C/C*G/G*T/T (χ^2 = 7.295; p<0.01) in 6,7 times (OR = 0.154; 95% CI = 0.033-0.642) and C/C*G/A*T/T (χ^2 = 4.434; p<0.05) - 5.0 times (OR = 0.203; 95% CI = 0.052-0.886).

In the 3rd group, reasonable differences were found for the risk genotype combinations C/T*A/A*T/A (χ^2 = 6.933; p<0.01), which increased the chances of development POAG by 3.7 times (OR= 3.735; 95% CI = 1.464-9.524) and for the protective genotype combinations C/C*G/G*T/T (χ^2 = 3.884; p<0.05), which reduced the chances of development POAG by 4,5 times (OR = 0,223; 95% CI = 0.051-0.965).

In the 4th group, the potentiating action of the combination of three mutant genotypes T/T*A/A*A/A (χ^2 = 6.483; p<0.05) was shown, which increased the chances of development POAG.

Discussion

Although increased intraocular pressure (IOP) is a key risk factor for primary open-angle glaucoma, the fact that about one third of European-born patients with glaucoma have a normal intraocular pressure (normotensive glaucoma) suggests that other factors may also affect the propensity to degeneration of optic nerve [9, 20]

There are increasing evidences of mitochondrial dysfunction in the susceptibility of the optic nerve to glaucoma [1, 5, 12, 14, 19, 23]. The retinal ganglion cell axons don't have a myelin sheath, so that sufficient amount of adenosine triphosphate (ATP) to maintain the potency of action in the absence of myelin is provided by a sufficient number of mitochondria. The optic nerve is a site that is particularly

susceptible to mitochondrial dysfunction [3, 13].

Genetic studies have shown that nuclear genes encoding mitochondrial proteins may contribute to the risk of COPD [10]. Recently, a large association of genomic studies revealed a significant association of POAG with single nucleotide polymorphism (SNPs) in the genomic region of TXNRD2, a nuclear-coded mitochondrial protein [1].

In previous studies, we determined the association of the *rs35934224* polymorphism of the *TXNRD2* gene with primary open-angle glaucoma. It was found that the polymorphism *rs35934224* had differences in the distribution of genotypes and alleles between patients with POAG and control group. Moreover, the shift of alleles and genotypes toward minor causes increased severity of the pathological process. But the stratification of the perimeter changes in the POAG showed that the association with the disease was significant at stages III and IV. Moreover, the chances of development of the III stage of POAG were significantly higher in comparison with the I stage in carriers of *C/T* and *T/T* genotypes and allele *T*. In the same plan, the protective effect of the ancestral genotype C/C was also strengthened [15].

FOXC1 is a gene that regulates the development of the anterior segment of the eye and is known to play a role in several autosomal dominant eye defects associated with increased risk of glaucoma, including the Axenfeld-Rieger anomaly, iris hypoplasia and Rieger syndrome [16, 18].

Foxc1 is expressed in the embryonic trabecular meshwork (TM) [25], the continuation of the expression of an abnormal gene product (from age-related, sub-clinical mutations) throughout life, or altered expression levels of FOXC1 may affect the normal function of the trabecular meshwork, thereby leading to an increased risk of glaucoma due to increased intraocular pressure This concept is confirmed by the fact that glaucoma associated with mutations in the genes of glaucoma development may occur at any time from birth to adulthood, and in some cases more than 70 years [24]. Moreover, in some patients with glaucoma due to FOXC1 mutations, the anomalies of the anterior segment can be very thin and easily passed through a clinical examination [11, 24], which is more consistent with POAG.

The connection of the polymorphism of the FOXC1 gene to the development of POAG has been studied in individual studies. Thus, in a study by British scientists [21] four polymorphisms were studied: rs2235715, rs2569889, rs2235716 and rs984253. In this case, all these polymorphisms do not cling to the coding region of the gene, and only the latter is located in the non-coding intron of the FOXC1 gene (16 13 294). We conducted a study of the association of polymorphisms rs984253 and rs2745599 of the FOXC1 gene with POAG. In which it was discovered that the distribution of genotypes and alleles had a relationship with POAG, but polymorphism *rs984253* had no relation to its progression in the stages of the pathological process. While the polymorphism *rs2745599* of the FOXC1 gene was related to the formation of the POAG of the most severe (IV) degree, and the risk of rapid progression of the disease was greater in the carriers of the minor allele A.

In this study, we determined the effects of the combinations of genotypes of polymorphisms on the development of POAG and the degree of their association with the disease. We found that the association with the disease had the genotype *C/T*A/A*T/A* as a comparison of control with all patients, and with stratification - from the 1st, 2nd and 3rd groups of patients. In our opinion, this convincingly indicated the evidentiary effect of this combination of genotypes and on the occurrence of POAG, and on its progression in the stages of perimetric changes. The risk of occurrence of POAGs in carriers of *C/T*A/A*T/A* genotypes was increased by 2.8 times ($p<0.001$). Interestingly, in this combination, the two polymorphisms had heterozygous genotypes (*rs35934224 - C/T, rs984253 - T/A*), and the genotype rs2745599 was a mutant homozygote *A/A*.

A combination of *C/C*G/A*T/A* genotypes was also important for the progression of the disease to stage II, which increased the risk of developing the II stage of POAG by 2.9 times ($p<0.01$) compared to control.

The risk of both general POAG and stage IV development increased the presence of combinations of three minor *T/T*A/A*A/A* genotypes that were found only in patients with POAG (at stage II f = 0.025, in stage III - f = 0.036 , and for IV- f = 0.071). In our opinion, this testified in favor of the proposed working hypothesis of the study and confirmed that the more combined the genotypes of the mutant alleles, the stronger this genotype affects the development of POAG.

Conclusions

1. The association with the disease had the genotype *C/T*A/A*T/A* as a comparison of control with all patients, and with stratification - with the 1st, 2nd and 3rd groups of patients. The risk of the occurrence of POAG in carriers of *C/T*A/A*T/A* genotypes was increased by 2.8 times (OR = 2.775; 95% CI = 1.532-5.021). Also, the combination of minor *T/T*A/A*A/A* genotypes made a significant increase in the risk of development of POAG ($p<0.05$), since no such genotype was detected in the control group.

2. For the progression of the disease to the II stage, the combination of *C/C*G/A*T/A* genotypes was also important, which increased the risk of development of the II stage of POAG in 2.9 times ($p<0.01$) as compared with the control.

3. The probable protective effect on the POAG was determined to combine the genotypes C/C*G/G*T/T, which reduced the chances of development of the POAG by 7.7 times (OR = 0.132; 95% CI = 0.044-0.383). The combination of genotypes C/T*G/A*T/T reduced the chances by 6.7 times (OR = 0.157; 95% CI = 0.035-0.697) and the combination of genotypes C/C*A/A*T/T and C/C*G/A*T/T - 3.8 times for both cases (OR = 0.263; 95% CI = 0.101-0.685).

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ВПЛИВ СПОЛУЧЕНЬ ГЕНОТИПІВ ПОЛІМОРФІЗМІВ RS35934224 ГЕНА TXNRD2, RS2745599 І RS984253 ГЕНА FOXC1 НА РОЗВИТОК ПЕРВИННОЇ ВІДКРИТОКУТОВОЇ ГЛАУКОМИ І СТУПІНЬ ЇХ АСОЦІАЦІЇ З ЗАХВОРЮВАННЯМ

Малачкова Н. В., Веретельник С. П., Слободян П. П.

Первинна відкритокутова глаукома (ПВКГ) - це складне захворювання, викликане численними генетичними й екологічними факторами, а також їх взаємодією. У останніх наукових дослідженнях було доведено вплив сполучень поліморфних генотипів та нерівноважне зчеплення алелей генів, що мають відношення до розвитку ПВКГ. Мета дослідження - визначення впливу

*сполучень генотипів поліморфізмів rs35934224 гена TXNRD2, rs2745599 і rs984253 гена FOXC1 на розвиток ПВКГ і ступінь їх асоціації з захворюванням. Проведено дослідження 93 хворих (185 очей) з ПВКГ I-IV стадій та 89 добровольців (178 очей), у яких не було встановлено будь-якої глаукоми, що склали контрольну групу. Хворих було розподілено на 4 групи відповідно до ступеня периметричних змін (Nesterov A. P., 2008). Всім хворим виконано візометрію, комп'ютерну периметрію, тонометрію, біомікроскопію, офтальмоскопію, гоніоскопію, кератопахіметрію, оптичну когерентну томографію зорового нерва. Аналіз поліморфізмів rs35934224 гена TXNRD2, rs2745599 і rs984253 гена FOXC1 проведено методом полімеразної ланцюгової реакції у реальному часі в автоматичному ампліфікаторі Gene Amp® PCR System 7500 (Applied Biosystems, США). На першому етапі дослідження проводили виділення геномної ДНК з цільної венозної крові з використанням стандартних реактивів PureLink® Genomic DNA Kit For purification of genomic DNA, виробник INVITROGEN (США). Аналіз поліморфізму здійснено з використанням уніфікованих тест-систем TaqMan Mutation Detection Assays Life-Technology (США). Встановлено, що асоціацію з ПВКГ мав генотип C/T*A/A*T/A як при порівнянні контролю зі всіма хворими, так і при стратифікації - з 1-ю, 2-ю і 3-ю групами хворих. Отримані результати свідчать про доказовий вплив цього сполучення генотипів і на виникнення ПВКГ, і на її прогресування за стадіями периметричних змін. Ризик виникнення ПВКГ у носіїв сполучення генотипів C/T*A/A*T/A збільшено у 2,8 рази (p<0,001). У цьому сполученні два поліморфізми мали гетерозиготні генотипи (rs35934224 - C/T, rs984253 - T/A), а генотип rs2745599 - мутантну гомозиготу A/A. Для прогресування захворювання до II стадії мало значення також сполучення генотипів C/C*G/A*T/A, яке збільшує ризик розвитку II стадії ПВКГ у 2,9 рази (p<0,01) у порівнянні з контролем. Ризик як загалом ПВКГ, так і розвитку IV стадії підвищувала наявність сполучень трьох мінорних генотипів T/T*A/A*A/A, яке зустрічалося тільки у хворих на ПВКГ (при II стадії f=0,025, при III стадії - f=0,036, а при IV - f=0,071). На наш погляд, це свідчило на користь висунутої робочої гіпотези дослідження та підтвердило, що чим більше у сполученні генотипів мутантних алелей, тим сильніше такий генотип впливає на розвиток ПВКГ.*

Ключові слова: *первинна відкритокутова глаукома, хромосома, генотип, поліморфізм, ген TXNRD2, ген FOXC1, алель, гетерозигота.*

ВЛИЯНИЕ СОЕДИНЕНИЙ ГЕНОТИПОВ ПОЛИМОРФИЗМОВ RS35934224 ГЕНА TXNRD2, RS2745599 И RS984253 ГЕНА FOXC1 НА РАЗВИТИЕ ПЕРВИЧНОЙ ОТКРЫТОУГОЛЬНОЙ ГЛАУКОМЫ И СТЕПЕНЬ ИХ АССОЦИАЦИИ С ЗАБОЛЕВАНИЕМ

Малачкова Н. В., Веретельник С. П., Слободян П. П.

*Первичная открытоугольная глаукома (ПОУГ) - это сложное заболевание, вызванное многочисленными генетическими и экологическими факторами, а также их взаимодействием. В последних научных исследованиях было доказано влияние соединений полиморфных генотипов и неравновесное сцепление аллелей генов, имеющих отношение к развитию ПОУГ. Цель исследования - определение влияния соединений генотипов полиморфизмов rs35934224 гена TXNRD2, rs2745599 и rs984253 гена FOXC1 на развитие ПОУГ и степень их ассоциации с заболеванием. Проведено исследование 93 больных (185 глаз) с ПОУГ I-IV стадий и 89 добровольцев (178 глаз), у которых не было установлено какой-либо глаукомы, составивших контрольную группу. Больные были разделены на 4 группы согласно степени периметрических изменений (Nesterov A. P., 2008). Всем больным выполнена визометрия, компьютерная периметрая, тонометрия, биомикроскопия, офтальмоскопия, гониоскопия, кератопахиметрия, оптическая когерентная томография зрительного нерва. Анализ полиморфизмов rs35934224 гена TXNRD2, rs2745599 и rs984253 гена FOXC1 проведено методом полимеразной цепной реакции в реальном времени в автоматическом амплификаторе Gene Amp® PCR System 7500 (Applied Biosystems, США). На первом этапе исследования проводили выделение геномной ДНК из цельной венозной крови с использованием стандартных реактивов PureLink® Genomic DNA Kit For purification of genomic DNA, производитель INVITROGEN (США). Анализ полиморфизма осуществлено с использованием унифицированных тест-систем TaqMan Mutation Detection Assays Life-Technology (США). Установлено, что ассоциации с ПОУГ имел генотип C/T*A/A*T/A как при сравнении контроля со всеми больными, так и при стратификации - с 1-й, 2-й и 3-й группами больных. Полученные результаты свидетельствуют о доказательном влияние этого соединения генотипов и на возникновение ПОУГ, и на ее прогрессирование по стадиям периметрических изменений. Риск возникновения ПОУГ у носителей соединений генотипов C/T*A/A*T/A увеличено в 2,8 раза (p <0,001). В этом сочетании два полиморфизма имели гетерозиготные генотипы (rs35934224 - C / T, rs984253 - T/A), а генотип rs2745599 - мутантную гомозиготу A/A. Для прогрессирования заболевания до II стадии имело значение также соединение генотипов C/C*G/A*T/A, которое увеличивает риск развития II стадии ПОУГ в 2,9 раз (p <0,01) по сравнению с контролем. Риск как в целом ПОУГ, так и развития IV стадии повышало наличие соединение трех минорных генотипов T/T*A/A*A/A, которое встречалось только у больных ПОУГ (при II стадии f = 0,025, при III стадии - f = 0,036 , а при IV - f = 0,071). На наш взгляд, это свидетельствовало в пользу выдвинутой рабочей гипотезы исследования и подтвердило, что чем больше в соединении генотипов мутантных аллелей, тем сильнее такой генотип влияет на развитие ПОУГ.*

Ключевые слова: *первичная открытоугольная глаукома, хромосома, генотип, полиморфизм, ген TXNRD2, ген FOXC1, аллель, гетерозигота.*

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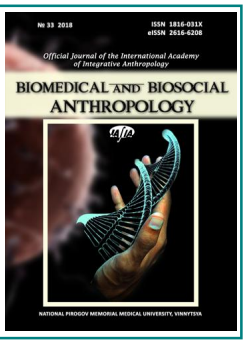

Peculiarities of organometric parameters of the hard palate in the second and third trimester of the intrauterine development and newborns

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Finding anatomical variability of organs, structures and their parts at all the stages of human development is rather topical. Determination of organometric parameters of the hard palate in fetuses and newborns is an essential part for perinatal diagnostics and understanding real parameters of the norm and pathology. Purpose of the study is to find organometric parameters of the palatine maxillary process and horizontal lamina of the palatine bone during fetal and early neonatal periods of human ontogenesis. By means of adequate anatomical methods of examination the study was conducted on 53 specimens of dead fetuses from 4 to 10 months of fetal development (from 165.0 mm to 500.0 mm of the parietal-calcaneal length (PCL)) and 9 specimens of dead neonates. The length of the palatine maxillary process during the perinatal period was found to be characterized by the two periods of accelerated development (5-7 and 8-10 months), and the period of relatively slow development (7-8 months). Its width was found to be characterized by the two period of accelerated development (5-7 and 9-10 months), and relatively slow development (7-8 months). The length of the horizontal lamina of the palatine bone is characterized by the period of accelerated development from 8 to 10 months, and the period of relatively slow development from 7 to 8 months. Meanwhile 5-8 and 9-10 months were the periods of accelerated development for its width, and 8-9 months - the period of relatively slow development for it. During fetal and early neonatal periods of human ontogenesis the value of all the paired correlation coefficients between organometric parameters of the palatine maxillary process (hard palate) and horizontal lamina of the palatine bone are positive and rather close to 1 (>0.84), which is indicative of a close positive correlation between all the organometric parameters. Very strong relation is found between the length of the hard palate and its width in the right and left (r=0.92), between the length of the hard palate and palatine bone (r=0.97), between the length of the palatine bone and the width of the hard palate in the right (r=0.91) and in the left (r=0.90). Therefore, by means of adequate anatomical methods of examination new scientifically substantiated data are obtained concerning organometric characteristics of anatomical structures of the hard palate at all the stages of perinatal period.

Keywords: *palatine maxillary process, horizontal lamina of the palatine bone, morphometry, fetal and early neonatal period of human ontogenesis.*

Introduction

Finding anatomical variability of organs, structures and their parts at all the stages of human development is rather topical [2]. Defects of the dentoalveolar system rank one of the main places among pathology of the maxillary-facial region, and according to the data of certain authors their occurrence is from 70 to 80% [1, 3, 4, 16]. One of the common congenital developmental defects of the maxillary-facial region is cleft of the lip and hard palate named "harelip" and "cleft palate". Severity of congenital facial defects is manifested not only by external deformation and functional impairments but negative effect on the child's psychic development as well [5, 8, 15].

The conducted investigation substantially supplies existing data concerning establishment of the structure and topography of the hard palate during the fetal and early neonatal periods of human ontogenesis, which is an

essential constituent while making perinatal diagnostics and understanding of real data of the norm and pathology [6, 7, 9, 20]. The obtained scientifically substantiated data concerning organometric characteristics of anatomical structures of the hard palate during all the stages of perinatal period determine the morphological basis and are important for finding the criteria of the hard palate morphogenesis and its correspondence with the terms of pregnancy [10, 17].

Nowadays organometric parameters of the hard palate in fetuses and newborns followed by the determination of its forms and types are not sufficiently studied [13].

Purpose of the study is to find organometric parameters of the palatine maxillary process and horizontal lamina of the palatine bone during fetal and early neonatal periods of human ontogenesis.

Materials and methods

The study was conducted on 53 specimens of dead fetuses from 4 to 10 months of fetal development (from 165.0 mm to 500.0 mm of the parietal-calcaneal length (PCL)) and 9 specimens of dead neonates of both sexes died of the causes not associated with diseases of the digestive tract, without external signs of anatomical defects, and without visible macroscopic departure from the normal cranial structure. Adequate anatomical methods were applied during investigation: macropreparation, making topographic-anatomical sections, morphometry, and statistical analysis. The study is conducted according to the main requirements of the Helsinki Declaration of the World Medical Association as a statement of ethical principles for medical research involving human subjects (1964-2000) and the Order of the Ministry of Health of Ukraine № 690, dated 23.09.2009. It is a fragment of a comprehensive planned initiation scientific-research work of M.H. Turkevych Department of Human Anatomy, and Department of Anatomy, Topographic Anatomy and Operative Surgery, the Higher State Educational Establishment of Ukraine "Bukovinian State Medical University": "Peculiarities of morphogenesis and topography if the organs and systems during prenatal and postnatal periods of ontogenesis " (state registration № 0115U002769).

Both fresh and fixed dead bodies of fetuses and newborns were used for macropreparation. PCL of the fetus was measured before the beginning of the study. Anatomical peculiarities of the processes of the upper jaws and horizontal laminas of the hyoid were investigated after these structures were prepared. After that by means of a tape measure, sliding compasses and dial caliper, the main parameters of the hard palate were measured including: the length of the palatine maxillary process, the width of the palatine maxillary process in the left and right (the most distant points between the middle palatine suture and middle edge of the dental cells), length and width (in the left and right) of the horizontal lamina of the palatine bone.

The obtained findings were statistically processed by means of the licensed program RStudio. The null hypothesis was checked concerning the fact that the samples were taken from one distribution, or from distributions with similar medians:

H_0: {every group has similar distribution}

H_1: {every group does not have similar distribution}

Student test, non-parametric Kruskal-Wallis test (answers the question if there is any difference between group distributions, but does not indicate what groups differ), Connowre-Iman test to compare stochastic domination and obtain the results between different paired comparison after Kruskal-Wallis test for stochastic domination among k groups were applied in the study. While making the analysis of selective correlation coefficient (r) the connection strength was assessed according to Cheddok scale: with r = 0 - no connection; with r = from 0.1 to 0.3 - mild connection; 0.3-0.5 - moderate connection; 0.5-0.7 - visible connection; 0.7-0.9 - high power connection, 0.9-1 - very high power connection. Statistically valuable were values with $p<0.05$.

Results

During the second trimester of the intrauterine development the length of the palatine maxillary process increases from 6.761±0.172 mm to 13.73±0.81 mm, the width from the left - from 3.414±0.113 mm to 7.321±0.253 mm, the width from the right - from 3.613±0.121 mm to 7.671±0.233 mm, the length of the horizontal lamina of the palatine bone - from 2.834±0.081 mm to 4.532±0.133 mm, the width - from 5.972±0.111 mm to 11.59±0.34 mm. During the third trimester of the intrauterine development and newborns these organometric parameters increase in the following way: the length of the palatine maxillary process increases from 11.86±0.27 mm to 24.71±0.33 mm, its width in the left - from 8.083±0.311 mm to 10.41±0.16 mm, in the right - from 8.181±0.361 mm to 10.72±0.16 mm, the length of the horizontal lamina of the palatine bone - from 4.621±0.111 mm to 8.684±0.111 mm, the width - from 14.42±0.95 mm to 16.04±0.19 mm (Fig. 1-5).

The correlation between all the organometric parameters of the palatine maxillary process (hard palate)

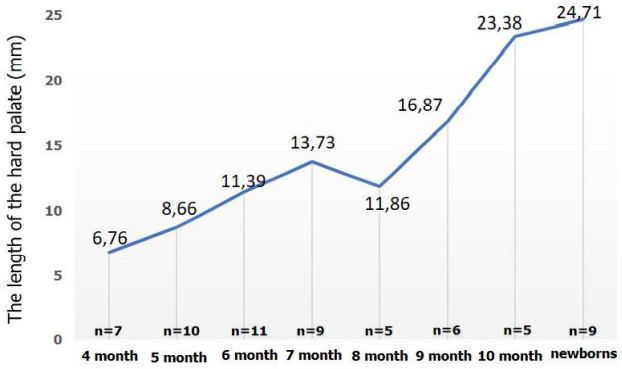

Fig. 1. Diagram of mean values of the length of the palatine maxillary process (hard palate) during the second and third trimesters of the intrauterine development.

Fig. 2. Diagram of mean values of the length of the palatine maxillary process (hard palate) in the left during the second and third trimesters of the intrauterine development.

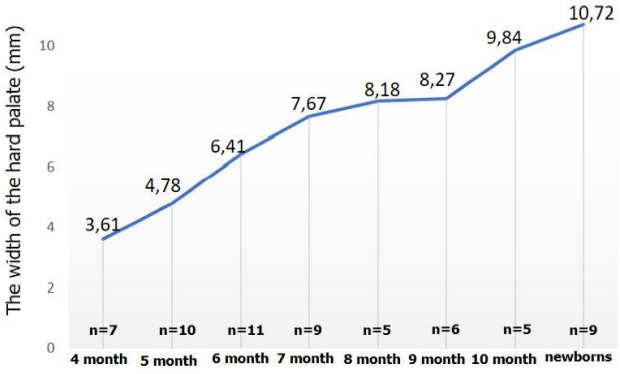

Fig. 3. Diagram of mean values of the length of the palatine maxillary process (hard palate) in the right during the second and third trimesters of the intrauterine development.

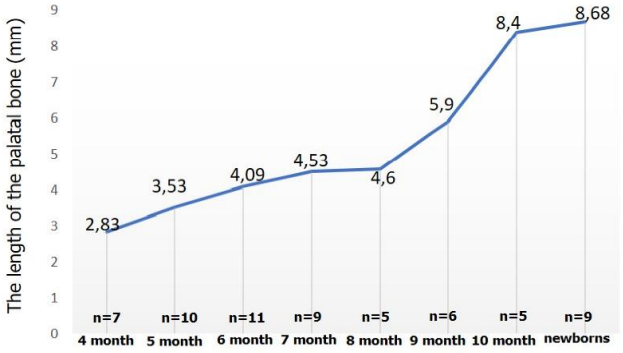

Fig. 4. Diagram of mean values of the horizontal lamina length of the palatine bone during the second and third trimesters of the intrauterine development.

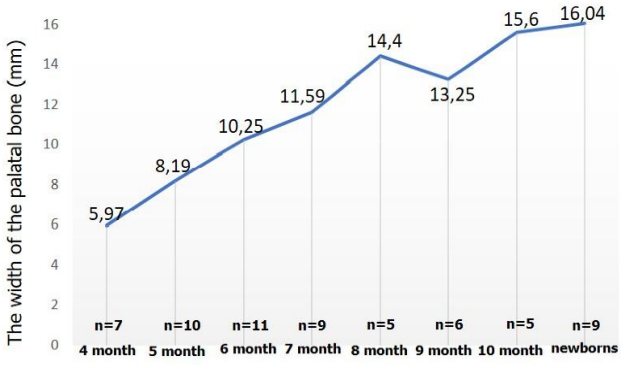

Fig. 5. Diagram of mean values of the horizontal lamina width of the palatine bone during the second and third trimesters of the intrauterine development.

and horizontal lamina of the palatine bone during the perinatal period determined that the values of all the paired correlation coefficients are positive and rather close to 1 (>0.84), which is indicative of a close positive correlation between all the organometric parameters.

Discussion

In the result of organometric measurements of the palatine maxillary process (hard palate) and horizontal lamina of the palatine bone during fetal and early neonatal periods of human ontogenesis it can be suggested that these structures are characterized by the periods of accelerated and relatively slow development. Certain data concerning organometric parameters of the hard palate are presented in the works by Guzik N. M. [11], Sane V. D. et al. [14], Tessler A. Y. et al. [19]. The length of the palatine maxillary process during the perinatal period was found to be characterized by the two periods of accelerated development (5-7 and 8-10 months), and the period of relatively slow development (7-8 months). Its width was found to be characterized by the two period of accelerated development (5-7 and 9-10 months), and relatively slow development (7-8 months). The length of the horizontal lamina of the hyoid is characterized by the period of accelerated development from 8 to 10 months, and the period of relatively slow development from 7 to 8 months. Meanwhile 5-8 and 9-10 months were the periods of accelerated development for its width, and 8-9 months - the period of relatively slow development for it.

Thus, for all the possible parameters of the hard palate in the second and third trimesters of the intrauterine development the periods of accelerated development were found in the middle and end of the fetal period of human ontogenesis. Practically in all the cases 7-8 months is the period of relatively slow development for these parameters.

In our opinion, a close positive correlation between all the organometric parameters of the palatine maxillary process (hard palate) and horizontal lamina of the palatine bone during the perinatal period is indicative of a considerable degree of integration and substantial synergism of accelerated and relatively slow periods of development of the examined structures [12, 18].

On the basis of the obtained parameters it was found that for the length of the palatine maxillary process (hard palate) during perinatal period the difference between medians of sampling is statistically significant ($p<0.001$). Connowre-Iman test resulted in finding the fact that the median difference in all the possible pairs of age groups for the length of the hard palate is statistically significant, except the pairs "6 months - 8 months", "7 months - 8 months", "7 months - 9 months", "10 months - newborns", that enables to suggest that intensive growth of the hard palate is from

the 4th to 7th month. Later the parameter of the hard palate becomes statistically significant in 8-month fetuses compared with the 9-month ones (p<0.01) and 9-month fetuses in comparison with 10-month fetuses (p<0.01).

Conducted Kruskal-Wallis test gave the following results for the width of the palatine maxillary process (hard palate): since p<0.05, the difference between group medians is statistically significant. Connowre-Iman test determined that median difference for all the possible pairs of age groups is statistically significant, except the pairs "7 months - 8 months", "7 months - 9 months", "8 months - 9 months", "10 months - newborns". On the basis of the obtained data it can be suggested that the periods of the most intensive growth of the hard palate width occurs from the 4th to the 7th month, and the period of relatively slow development - from the 7th to the 9th month. Considerable differences between the mean values of the hard palate width in the left and right were not found among any age groups (p>0.05). Similar conclusions are obtained for the medians (hard palate width) by age groups (p>0.05).

The difference between the medians of sampling the length of the palatine bone by the age groups is statistically significant (p<0.001). The median difference for all the possible pairs of age groups is statistically significant except the pairs "7 months - 8 months", "8 months - 9 months", "10 months - newborns". The larger parameter of the palatine bone length I n the 9-month fetuses compared with the 10-month fetuses is statistically significant (p<0.01).

Under conditions of the analysis of the palatine bone width according to age groups the difference between medians of sampling is statistically significant (p<0.001), except the pairs "8 months -10 months", "7 months - 9 months", "8 months - 9 months", "8 months - newborns", "10 months - newborns". The parameter of the palatine bone width increases to the 8th month. Considerable difference between the mean values of the palatine bone width from the 8th to the 9th month was not found (p=0,059), statistically significant is the parameter of the 9-month fetuses compared with the 10-month fetuses (p<0,05). Considerable difference between the mean values of 10-month fetuses and newborns was not found (p>0,05).

Very strong relation is found between the length of the hard palate and its width in the right and left (r=0.92), between the length of the hard palate and hyoid (r=0.97), between the length of the hyoid and the width of the hard palate in the right (r=0.91) and in the left (r=0.90).

Conclusions

1. The length of the palatine maxillary process during the perinatal period was found to be characterized by the two periods of accelerated development (5-7 and 8-10 months), and the period of relatively slow development (7-8 months). Its width was found to be characterized by the two period of accelerated development (5-7 and 9-10 months), and relatively slow development (7-8 months). The length of the horizontal lamina of the hyoid is characterized by the period of accelerated development from 8 to 10 months, and the period of relatively slow development from 7 to 8 months. Meanwhile 5-8 and 9-10 months were the periods of accelerated development for its width, and 8-9 months - the period of relatively slow development for it.

2. During fetal and early neonatal periods of human ontogenesis the value of all the paired correlation coefficients between organometric parameters of the palatine maxillary process (hard palate) and horizontal lamina of the hyoid are positive and rather close to 1 (>0.84), which is indicative of a close positive correlation between all the organometric parameters.

3. In the second and third trimester of the intrauterine development very strong connection is found between the length of the hard palate and its width in the right and left (r=0.92), between the length of the hard palate and palatine bone (r=0.97), between the length of the palatine bone and the width of the hard palate in the right (r=0.91) and in the left (r=0.90).

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ОСОБЛИВОСТІ ОРГАНОМЕТРИЧНИХ ПАРАМЕТРІВ ТВЕРДОГО ПІДНЕБІННЯ У ДРУГОМУ І ТРЕТЬОМУ ТРИМЕСТРАХ ВНУТРІШНЬОУТРОБНОГО РОЗВИТКУ ТА У НОВОНАРОДЖЕНИХ

Проданчук А. І., Слободян О. М., Корчинська Н. С.

Встановлення анатомічної мінливості органів, структур та їх частин на всіх етапах розвитку людини є вельми актуальним. Встановлення органометричних параметрів твердого піднебіння у плодів та новонароджених є необхідною складовою під час проведення перинатальної діагностики та розуміння фактичних даних норми і патології. Мета дослідження - встановити органометричні параметри піднебінного відростка верхньої щелепи і горизонтальної пластинки піднебінної кістки впродовж плодового і раннього неонатального періодів онтогенезу людини. За допомогою адекватних анатомічних методів дослідження виконано на 53 препаратах трупів плодів від 4-х до 10 місяців розвитку (від 165,0 мм до 500,0 мм тім'яно-п'яткової довжини (ТПД)) та на 9-ти препаратах трупів новонароджених. Встановлено, що для довжини піднебінного відростка верхньої щелепи впродовж перинатального періоду притаманні два періоди прискореного розвитку (5-7 і 8-10 місяці) і період відносно сповільненого розвитку (7-8 місяці); для його ширини - 5-7 і 9-10 місяці є періодами прискореного розвитку, 7-8 місяці - період відносно сповільненого розвитку. Для довжини горизонтальної пластинки піднебінного кістки є характерним період прискореного розвитку (8-10 місяці) і період відносного сповільненого розвитку (7-8 місяці); для її ширини 5-8 і 9-10 місяці - періоди прискореного розвитку, 8-9 місяці - відносно сповільненого розвитку. Упродовж плодового і раннього неонатального періодів онтогенезу значення усіх парних коефіцієнтів кореляції між органометричними параметрами піднебінного відростка верхньої щелепи (тверде піднебіння) і горизонтальної пластинки піднебінної кістки є позитивними і досить близькими до 1 (>0,84), що свідчить про тісний позитивний кореляційний зв'язок між усіма органометричними параметрами. Спостерігається зв'язок дуже високої сили між довжиною твердого піднебіння та його шириною справа та зліва (r=0,92), між довжинами твердого піднебіння і піднебінної кістки (r=0,97), між довжиною піднебінної кістки і шириною твердого піднебіння справа (r=0,91) та зліва (r=0,90). Зв'язок дуже високої сили між довжиною твердого піднебіння та його шириною справа та зліва (r=0,92), між довжинами твердого піднебіння і піднебінної кістки (r=0,97), між довжиною піднебінної кістки і шириною твердого піднебіння справа (r=0,91) та зліва (r=0,90). Таким чином, за допомогою адекватних анатомічних методів дослідження одержані нові науково обґрунтовані дані щодо органометричної характеристики анатомічних структур твердого піднебіння на всіх етапах перинатального періоду.

Ключові слова: *піднебінний відросток верхньої щелепи, горизонтальна пластинка піднебінної кістки, морфометрія, плодовий та ранній неонатальний періоди онтогенезу людини.*

ОСОБЕННОСТИ ОРГАНОМЕТРИЧЕСКИХ ПАРАМЕТРОВ ТВЕРДОГО НЕБА ВО ВТОРОМ И ТРЕТЬЕМ ТРИМЕСТРАХ ВНУТРИУТРОБНОГО РАЗВИТИЯ И У НОВОРОЖДЕННЫХ

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Установление анатомической изменчивости органов, структур и их частей на всех этапах развития человека является весьма актуальным. Установление органометрических параметров твердого неба у плодов и новорожденных является необходимой составляющей при проведении перинатальной диагностики и понимания фактических данных нормы и патологии. Цель исследования - установить органометрические параметры небного отростка верхней челюсти и горизонтальной пластинки небной кости в течение плодового и раннего неонатального периодов онтогенеза человека. С

помощью адекватных анатомических методов исследования выполнены на 53 препаратах трупов плодов от 4-х до 10 месяцев развития (от 165,0 мм до 500,0 мм теменно-пяточной длины (ТПД)) и на 9-ти препаратах трупов новорожденных. Установлено, что для длины небного отростка верхней челюсти в течение перинатального периода присущи два периода ускоренного развития (5-7 и 8-10 месяцы) и период относительно замедленного развития (7-8 месяца); для его ширины 5-7 и 9-10 месяцы являются периодами ускоренного развития, 7-8 месяцы - период относительно замедленного развития. Для длины горизонтальной пластинки небной кости характерно период ускоренного развития (8-10 месяцы) и период относительного замедленного развития (7-8 месяцы); для ее ширины 5-8 и 9-10 месяцы - периоды ускоренного развития, 8-9 месяцы - относительно замедленного развития. В течение плодового и раннего неонатального периодов онтогенеза значение всех парных коэффициентов корреляции между органометрическими параметрами небного отростка верхней челюсти (твердое небо) и горизонтальной пластинки небной кости являются положительными и достаточно близкими к 1 (>0,84), что свидетельствует о тесной положительной корреляционной связи между всеми органометрическими параметрами. Наблюдается связь очень высокой силы между длиной твердого неба и его шириной справа и слева (r=0,92), между длинами твердого неба и небной кости (r=0,97), между длиной небной кости и шириной твердого неба справа (r=0,91) и слева (r=0,90). Связь очень высокой силы между длиной твердого неба и его шириной справа и слева (r=0,92), между длинами твердого неба и небной кости (r=0,97), между длиной небной кости и шириной твердого неба справа (r=0,91) и слева (r=0,90). Таким образом, с помощью адекватных анатомических методов исследования получены новые научно обоснованные данные по органометрической характеристике анатомических структур твердого неба на всех этапах перинатального периода.

Ключевые слова: *небный отросток верхней челюсти, горизонтальная пластинка небной кости, морфометрия, плодовый и ранний неонатальный периоды онтогенеза человека.*

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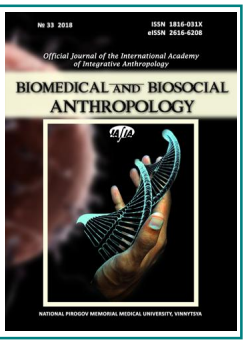

Sleep disturbances and related occupational diseases in Ukrainian firefighters

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Sleep deprivation is one of the main professionally determined factors for firefighters which can decrease their executive functioning and contribute to an array of health problems in them, including cardiovascular disease, diabetes, and depression mood disorders. The aim of this research is to gather preliminary data regarding the health of Ukrainian, with a focus on sleep quality indicators. Sleep-deprived participants in our research study were identified using such questionnaires as PSQI, ISI, ESS, SSS, FSS, and BQSA. Statistical processing of the data was carried out with the aid of Fisher's exact test, a statistical tool which is widely used in medical researches when the expected numbers are small. The obtained results confirm the presence of certain regularities. First, typical for the firefighting profession sleep disorders were detected among workers of operatively rescue service of Kropyvnitskiy city: including daytime fatigue, low sleep quality, insomnia, apnea, restless leg syndrome, low alertness, daytime sleepiness. Secondly, individuals suffering from sleep deprivation are at a higher risk for developing certain cardiovascular and metabolic diseases, depressive disorders, including increased impulsivity and overall lack of executive functioning. Thirdly, the importance of early detection and treatment for sleep disorders as a protective measure against the development of the aforementioned diseases has been stressed in our study. Sleep hygiene education should be provided to Ukrainian firefighters. It could influence them to make better choices related to their sleep, which would subsequently impact other areas of their health and wellbeing. Annual research studies concerning firefighters' sleep quality should be conducted in Ukraine on a regular basis with the aim to accumulate relevant statistics on the topic under consideration.

Keywords: *sleep disorders, executive functioning, occupational health, occupational disease, protective (preventive) medicine.*

Introduction

The future belongs to preventive medicine (Mykola Pyrogov)

At the time of scientific and technological progress, high level of stressfulness in human society and harmful effects of external environmental factors, the issue of health, and sleep as its essential component, is getting more and more significant regarding all fields of human activity and, first of all, those workers whose job is related to health risks, psychological tension, sleep deprivation and at the same time is of great importance for the entire community [6].

The relevance of this scientific research is stipulated by an urgent need for Ukrainian firefighters to change their attitudes to the quality of their sleep (sleep hygiene), taking into consideration the fact that their executive functioning is inseparable from shift work, unfavorable conditions and extreme situations. That means that they must attend to their occupational health, fitness and all aspects of occupational longevity. They should sustain the appropriate level of all functional systems of their body, developing in themselves a positive predisposition towards their jobs, good morale, value judgment, self-discipline and patriotism.

Sleep medicine has been developing intensively throughout a few decades, but the keen interest in health issues with a focus on sleep has increased immensely these days which is witnessed by the latest experimental researches in this field led by Esra Tasali [23], Mathew

Walker [28], Joelle Adrian [2], Volodymyr Koval'zon [19], Mykhailo Poluektov [20], scientists from M.D. Strazhesko Institute of Cardiology [21]. Experts state [18, 25] that low-quality, insufficient sleep, disturbed by shift work or any other external factor, aggravates daytime sleepiness and leads to a variety of changes in every neural and endocrine function of the human body including the increased level of stress hormones, cognitive and metabolic disorders, low level of immunity and risk factors for cancer and cardiovascular disease. The excessive light stimulation, and active behaviours at night are becoming most popular causes for circadian rhythm disorders and their further distabilisation (cognitive distortions).

The *aim* of this research is to gather preliminary data regarding the health of Ukrainian, with a focus on sleep quality indicators.

Materials and methods

The research study included firefighters of fire department units of the State Emergency Service of Ukraine in Kirovohrad oblast', which are located in the city of Kropyvnytskiy. Participants were professional firefighters regardless of their age, education and years of employment. While on duty, all of them work overnight shifts and respond to a wide range of incidents, including fires, explosions, terrorist events, mass-casualty incidents, motor vehicle accidents, ice/water rescues, and natural disasters. All subjects had to complete six questionnaires including the Pittsburg Sleep Quality Index (PSQI), the Insomnia Severity Index (ISI), the Epworth Sleepiness Scale (ESS), the Stanford Sleepiness Scale (SSS), the Fatigue Severity Scale (FSS) and the Berlin Questionnaire for Sleep Apnea (BQSA).

Rescuers took part in the survey research on a voluntary basis on condition of anonymity (their names were given by the authority under special codes). To make our testing convenient (it took 40-45 minutes), we offered tests in paper format either in Ukrainian or Russian, at the choice of each participant. 130 firefighters agreed to take part in the experiment and 124 of them gave full answers concerning their anthropometric measures and sleep hygiene. This array of information constitutes the basis for making conclusions and working out recommendations. Statistical processing of data was carried out with the aid of Fisher's exact test.

Results

Results from the conducted survey research show some interesting patterns.

The data we obtained concerning sleep deprivation in Ukrainian firefighters, correlate with similar values in representatives of rescue services from other countries. The statistics show that 37.2 percent of French [24, 27] and 59 percent of American firefighters are dissatisfied with the quality of their sleep [4, 5, 11, 12]. Among the firefighters from the Seoul Metropolitan Area (South Korea) 78.8 percent of firefighters have sleep problems [17]. In China 70 percent of

Table 1. Demographic characteristics of participants.

Indexes	Row total	Age categories		
		≤ 30 years	31-40 years	> 40 years
The number of participants	124	54	47	23
The mean age of participants (years)	32,80	25,83	35,74	43,13
The average BMI range (body mass index, kg/m^2)	26,09	25,33	26,85	26,32
Have characteristics of obesity, BMI > 30	13	3	9	1
Have high blood pressure	13	2	4	7
Heavy smokers	37	15	18	4
Diabetics	0	0	0	0
Consume alcohol in large quantities	0	0	0	0

Table 2. The detected sleep disturbances in firefighters of Kropyvnytskiy city (the years 2018).

Sleep disturbances	Survey Questionnaires	Total scores
Low sleep quality	PSQI	Satisfied by the main sleep- 76,81% Non-satisfied by the main sleep- 24,19%
Insomnia	ISI	Not found - 95,16% Is found - 04,84%
Daytime sleepiness	ESS	Non-significant, does not influence job performance - 92,74% Significant, may influence job performance - 07,26%
Alertness, executive functioning at daytime	SSS	High level - 86,71% Low level - 14,29%
Daytime fatigue	FSS	Non-significant, does not influence job performance - 68,55% Significant, may influence job performance - 31,45%
Apnea (OSAS)	BQSA	Not found - 89,00% Symptoms are found - 11,00%
Restless Leg Syndrome (RLS)	PSQI	Not found - 95,80% Is found - 04,20%

firefighters complain about low quality of their main sleep [13]. For Iranian and British rescue workers this rate is 69.9 and 61 percent.

According to age categories we classify the obtained experimental data as it is shown in table 3.

On the basis of the above, it may be concluded that in younger firefighters of our city stand out the parameters of an excessively high rate of daytime fatigue and decreased physical activity; middle aged firefighters have two high rate variables - dissatisfaction with their sleep and daytime sleepiness and older rescuers have such critically high quantitative variables as decreased alertness in the daytime and apnea. These data explain firefighters' predisposition to certain occupational illnesses and we have to prove this hypothesis with the aid of an appropriate method of

Table 3. The distribution of sleep deprivation variables in firefighters of Kropyvnytskiy city (the year 2018).

Parameters	Row total	Age categories		
		Younger (n=54)	Middle-aged (n=47)	Older (n=23)
Dissatisfied with sleep quality (%)	24,19	10,49	10,48	03,23
Insomnia (%)	04,84	01,61	01,61	01,61
Daytime sleepiness (%)	07,26	01,61	04,03	01,61
Decreased alertness (efficiency) (%)	14,29	03,57	04,76	05,95
Daytime fatigue, physical immobility (%)	31,45	12,10	10,48	08,87
OSAS (%)	11,10	02,20	03,58	05,23
RLS(%)	04,20	01,70	02,50	0

Table 4. The contingency table for different age categories of subjects according to the results of the PSQI, FSS, SSS questionnaires.

In the younger age group of firefighters:			
Indexes	Have daytime fatigue (FSS)	Have no daytime fatigue (FSS)	Row Total
Dissatisfied with their sleep (PSQI)	11 (A)	2 (B)	13
Satisfied with the quality of their sleep (PSQI)	4 (C)	37 (D)	41
Column Total	15	39	54
In middle-aged firefighters:			
	Smokers	Non-smokers	Row Total
Dissatisfied with their sleep (PSQI)	11 (A)	2 (B)	13
Satisfied with the quality of their sleep (PSQI)	7 (C)	27 (D)	34
Column Total	18	29	47
In the older age group of firefighters:			
	Have daytime fatigue (FSS)	Have no daytime fatigue (FSS)	Row Total
Low level of efficiency (SSS)	5 (A)	0 (B)	5
High level of efficiency (SSS)	6 (C)	12 (D)	18
Column Total	11	12	23

mathematical statistics - Fisher's exact test. The needed data are placed in contingency tables as it is shown in table 4.

We do hand calculations of Fisher's exact test according to the formula:

$$P = [(A+B)! \times (C+D)! \times (A+C)! \times (B+D)!] / [A! \times B! \times C! \times D! \times N!],$$

where N is an overall number of subjects; the symbol ! indicates the factorial operator (the product of a number and a sequence of numbers each of which is less than its predecessor on 1). The calculation results show that the indicator of Fisher's exact test (P) for the younger age group of firefighters constitutes 0.0000009 and this numeric value does not exceed the critical level of statistical significance for medical researches 0.05 and that proves the correlation between the results obtained from the two questionnaires - PSQI and FSS.

Fisher's exact test (P) for middle-aged firefighters equals 0.0001 and that proves the statistical relationship between the two risk factors for occupational illnesses in members of this profession. These risk factors include dissatisfaction with their sleep (according to the PSQI questionnaire) and smoking - a habit that promotes the development of atherosclerosis and cardiovascular disease and is considered to be the leading preventable cause of death in the world.

We used the aforementioned formula for computing Fisher's exact test (P) for the older age group of firefighters and we got the value 0.014, which does not exceed the critical level of statistical significance for medical researches 0.05. In such a way we prove the relationship between the results of the FSS and SSS tests.

Discussion

Consistent, long-term sleep disturbances are tightly connected with an array of clinical disorders, which constitute a group of occupational illnesses and which with a high level of probability can develop in members of all professions related to shift work and fulfilling duties under unfavorable and extreme conditions. First of all, it regards public safety workers, who, by their vocation, must be the first to respond to various calamities in the human society and to save lives. Sleep disturbances, as one of the main risk factors in firefighting, can contribute to the development of cardiovascular disease in firefighters, as well as diabetes and depressive mood disorders.

According to the data given by The World Health Organization [29], International Association of FireFighters [13], European Fire Academy [7], Federation Nationale des Sapeurs-Pompiers de France [8]) the following groups of occupational diseases are known in the firefighting profession:

- group I - artery hypertensive heart disease which is one of the most widely-spread cardiovascular diseases, as well as myocardial infarction (heart attack), stroke, heart failure and a number of similar illnesses. 20-30% of adults throughout the world suffer from artery hypertensive heart disease. Experts from the World Health Organization (WHO) single out an array of risk factors which contribute to the development of this disease. They are as follows: - age - gender - lack of exercise - smoking - alcohol abuse, excessive coffee consumption, energy drinks, as well as overweight and heredity. As usual, the active stage of artery hypertensive heart disease is provoked by overstrenuous psychic activity of a worker influenced by various psychoemotional factors[11, 18]. Highly effective in this respect are sport activities and exercise, which eliminate stress and increase muscle tone of the human body. The development of the symptoms of artery hypertensive heart disease is being provoked by such external factors as - climatic condition; - imbalanced diet (for

instance, eating too much salt, vitamin deficiency) - low quality of drinking water; - various noises and electromagnetic fields, radiation - non-favorable conditions in the work layout including problems in communication with colleagues; - unfavorable microclimate of a dwelling; - inefficient pastime. In order to prevent the development of this disease, experts say, in your working layout and at home you should control your blood pressure, systematically have medical examinations and monitor your electrocardiogram (ECG) results. One must have an individual overall exercise plan developed by a personal trainer;

- group II - diabetes. This is a metabolic disease, which results from the decreased level of insulin secretion and insulin resistance. Treating diabetes early with the aid of a diet, sugar decreasing medicines and workout routine can help prevent serious complications. Diabetes is caused by a number of genetic and individual lifestyle factors. The vast majority of patients who received this diagnosis are overweighed. Obesity by itself is a risk factor for diabetes.

- group III - depression, a serious mental health condition, the key emotional characteristics of which are a depressed mood, sadness, worthlessness and lack of interest in most normal activities. The associated symptoms include frequent headaches, fatigue, sleeping much more or much less, eating much more or much less than usual, lacking energy, suicidal thinking. Depression is caused by a combination of genetic, biological, environmental, and psychological factors. In some cases depressive mood disorders are a normal reaction to certain life circumstances and extreme situations. In our times depression is one of the most common mental disorders. Every tenth inhabitant of the planet Earth (over the age 40) experiences it. Those over 65 are three times more likely to become severely depressed. The depressive mood disorder can occur as a result of dramatic experience, for instance, passing of a relative or parent, a loss of status and loss of employment opportunities. This is a reactive depression, and it develops as a response to an external event or circumstance. A great many people who battle with early symptoms of this mental illness can recover from their condition in a half-year period through cognitive behavioral therapy, exercise training (physical activity is a very effective cure for any depression symptoms and reactive discouragement), strengthening of social communication, avoidance of conflicts in interpersonal relationships, increasing of body temperature which contributes to energy metabolism in the human body. Music therapy, art-therapy, dance therapy, aroma therapy, and work therapy can become a protective measure against depressive mood disorders and can help to maintain a high quality of life;

- group IV in this list of occupational illnesses can be constituted in the nearest future by certain kinds of cancer diseases which are currently the subject of intense research in several countries and scientists-immunologists who lead these experimental researches have just been awarded the Nobel Prize in the field of physiology and medicine (the year 2018) [3]. Now this group of diseases is not taken into consideration in our study.

Based on the findings of the current study, we analyze the quantitative variables of firefighters' predisposition to sleep related occupational illnesses. According to the results of FSS (daytime fatigue, physical inactivity), PSQI (restless leg syndrome, dissatisfaction about sleep quality), ISI (insomnia) in members of the younger age group we figure out that 20-30 year-old firefighters tend to developing depressive mood symptoms in them (group III of occupational diseases) which may be caused by a negative impact of excessive mobile telephone usage, especially in the evening, after 19.00 (these data are deserving of further investigation).

While analyzing the results of such tests as PSQI (sleep quality); ESS (daytime sleepiness); |FSS (daytime fatigue, physical inactivity); ISI (insomnia); BQSA (high blood pressure, hyperlipidemia, apnea) we monitor the predisposition of middle-aged firefighters to groups I and II of occupational illnesses - cardiovascular disease, arterial hypertension, diabetes. Special attention should be paid to further investigation of the problem of obesity and normalizing of BMI in this age category.

According to the results of the BQSA questionnaire (apnea, high blood pressure, hyperlipidemia) and the SSS questionnaire (alertness rate) we conclude that members of the older age category of firefighters are prone to group I of occupational illnesses, namely - cardiovascular disease, sudden cardiac arrest and getting into accidents and dangerous situations. These findings justify further exploration into the ways in which sleep disorders and cardiovascular disease relate to one another in rescue workers. And many of the firefighters who participated in this study identified a need to improve their sleep.

Based on the current researches in the field of sleep medicine [1, 10, 12, 17, 23, 26, 27, 28] scientists state that sleep deprivation, as one of the main occupational factors in firefighting, can contribute to the development of cardiovascular disease in rescue workers, as well as certain cancer diseases, diabetes and depressive mood disorders [28]. International organizations and unions of professional firefighters [2, 13, 16, 29] show that more often than civilians, firefighters are exposed to cardiovascular disease, diabetes, obesity, depressive mood disorders and suicidal attempts. Sleep deprivation and night shift work is associated with decreased alertness, vague thinking, depression [4, 12]. The obstructive sleep apnea can cause overweight, hypertension, diabetes and heart attacks. If this disease is not treated, it six times more often than in general population leads to getting into accidents and dangerous situations [11, 22, 23]. Early detection and treatment of sleep disorders using medicinal and non-medicinal methods is important in order to prevent the development of dangerous health deviations. Sleep has to become a priority in systemic researches in firefighting in order to learn its impact on all aspects of physical and mental health of firefighters of the State Emergency Service of Ukraine.

The data obtained in this study, when compared with similar variables concerning rescue services of other countries, can constitute a basis for further accumulation of the array of statistical information in relation to sleep disturbances in full-time firefighters and prevent certain occupational illnesses in members of this profession.

Conclusions

In the course of the survey research carried out among firefighters of Kropyvnytskiy city, we detected an array of typical for the firefighting profession sleep disturbances which are caused by a number of negative occupational factors, among which we single out the necessity to work on night shifts and a high level of stressfulness of the duties they fulfill. Sleep disorders are tightly connected with the development in rescuers such occupational diseases as cardiovascular disease (arterial hypertension, heart attacks), diabetes and depressive disorders, which can be distributed in the following way: - younger firefighters are inclined to the development of depression and various depressive mood disorders in them; - middle-aged firefighters are more likely to develop in them cardiovascular disease and diabetes due to a high BMI rate; - older rescuers have an inclination to heart attacks and getting into accidents and dangerous situations. A number of protective (preventive) measures should be worked out in order to minimize the negative impact of occupational factors leading to the development of certain occupational illnesses in professional firefighters. Sleep education and sleep hygiene should become firefighters' priorities on their jobs.

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ПОРУШЕННЯ СНУ Й ПОВ'ЯЗАНІ З НИМИ ПРОФЕСІЙНІ ЗАХВОРЮВАННЯ В УКРАЇНСЬКИХ ПОЖЕЖНИХ-РЯТУВАЛЬНИКІВ

Сухолєнцев О. М., Крайсвітній О. І., Ковальчук В. Б., Черній В. П., Ковальчук Н.Д.

Порушення сну являють собою один із основних професійно обумовлених факторів для пожежних-рятувальників, який знижує їхню працездатність і сприяє розвитку таких відхилень у стані здоров'я, як серцево-судинні захворювання, діабет, депресивні стани. Метою цього дослідження є збір попередніх даних стосовно професійного здоров'я українських пожежних з акцентом на показники якості сну. Для виявлення порушень сну ми скористалися наступними опитувальниками: Пітсбурзький показник якості сну (PSQI), Показник тяжкості інсомнії (ISI), Епвортська шкала сонливості (ESS), Шкала втомлюваності (FSS), Стенфордська шкала сонливості (SSS), Берлінський опитувальник (BQSA). Статистичне опрацювання даних здійснювалось за допомогою точного критерія Фішера, статистичного методу, який широко застосовується в медичних дослідженнях для малих вибірок. Отримані результати підтверджують наявність певних закономірностей. По-перше, типові для пожежної галузі порушення сну було виявлено серед працівників оперативно-рятувальної служби міста Кропивницького: денна втомлюваність, низька якість сну, інсомнія, апное, СНН (синдром неспокійних ніг), денна сонливість та низький рівень пильності. По-друге, особи, що страждають від вище зазначених порушень сну, мають вищий рівень ризику виникнення серцево-судинних, метаболічних захворювань, депресивних розладів. Також нами визначено, що зазначені порушення сну стали причиною підвищеної імпульсивності і зниженого рівня працездатності. По-третє, у нашому дослідженні підкреслюється значущість завчасного виявлення і корекції порушень сну як профілактичного заходу щодо розвитку зазначених вище захворювань. Роз'яснювальна робота стосовно гігієни сну має проводитися серед українських пожежних задля того, щоб вони могли покращити свій сон, що безсумнівно виявиться в усіх аспектах їхнього професійного здоров'я і добробуту. Щорічні дослідження якості сну мають проводитися регулярно з метою відстежити динаміку статистичних показників з цієї теми.

Ключові слова: *порушення сну, працездатність, професійне здоров'я, професійне захворювання, профілактична (превентивна) медицина.*

НАРУШЕНИЯ СНА И СВЯЗАННЫЕ С НИМИ ПРОФЕССИОНАЛЬНЫЕ ЗАБОЛЕВАНИЯ У УКРАИНСКИХ ПОЖАРНЫХ-СПАСАТЕЛЕЙ

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Нарушения сна представляют собой один из основных профессионально-обусловленных факторов для пожарных-спасателей, который снижает их работоспособность и способствует развитию таких отклонений в состоянии здоровья, как сердечно-сосудистые заболевания, диабет и депрессивные состояния. Целью настоящего исследования является сбор предварительных данных относительно профессионального здоровья украинских пожарных с акцентом на показатели качества сна. Для выявления нарушений сна нами использовались опросники: Питтсбургский показатель качества сна (PSQI), Показатель тяжести инсомнии (ISI), Эпвортская шкала сонливости (ESS), Стенфордская шкала сонливости (SSS), Шкала утомляемости (FSS), Берлинский опросник (BQSA). Статистическая обработка данных осуществлялась при помощи точного критерия Фишера, статистического метода, который повсеместно применяется в медицинских исследованиях с малыми выборками. Полученные результаты подтверждают наличие определенных закономерностей. Во-первых, типичные для пожарной отрасли нарушения сна были выявлены среди работников оперативно-спасательной службы города Кропивницкого: дневная утомляемость, низкое качество сна, инсомния, апноэ, СБН (синдром беспокойных ног), дневная сонливость и низкий уровень бдительности. Во-вторых, лица, страдающие от вышеуказанных нарушений сна, имеют более высокий уровень риска возникновения сердечно-сосудистых, метаболических заболеваний, и депрессивных расстройств. Также, нами определено, что вышеуказанные нарушения сна стали причиной повышения импульсивности и снижения уровня работоспособности. В-третьих, в нашем исследовании подчеркивается значимость раннего выявления и коррекции нарушений сна как профилактической меры против развития вышеуказанных заболеваний. Разъяснительная работа относительно гигиены сна должна проводиться среди украинских пожарных с тем, чтобы они могли улучшить свой сон, что, несомненно, скажется на всех аспектах их профессионального здоровья и благосостояния. Ежегодные исследования качества сна должны проводиться регулярно с целью отследить динамику статистических показателей по интересующей нас теме.

Ключевые слова: *нарушения сна, работоспособность, профессиональное здоровье, профессиональное заболевание, профилактическая (превентивная) медицина.*

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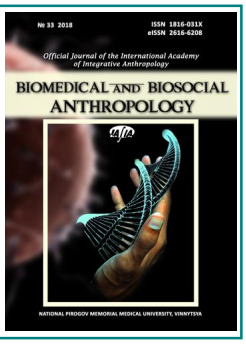

Galectin-3 - a modern biomarker for the diagnosis of left ventricular hypertrophy and chronic heart failure and control of treatment of patients with hypertension

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The development of new methods for the prevention and treatment of chronic heart failure and its control is an urgent medical and social problem. In this regard, using of new biological markers of the disease may be useful for early diagnosis of the disease, predict a clinical course, monitor the effects of pharmacotherapy (personalized medicine) and play an important role in stratifying the patient's risk. In 2013, according to the recommendation of the American Heart Association, a galectin-3 was introduced into the pool of such biomarkers for prevention and treatment of chronic heart failure. Objective: to improve prediction of the course and effectiveness of the therapy for hypertension and chronic heart failure as the hypertension complication in men 40-60 years old by applying the level of galectin-3 as a biomarker. There were observed the men 40-60 years old with hypertension and chronic heart failure for the concentration of galectin-3. Also, there were observed subjects without cardiovascular pathology (n=79), the men with hypertonic disease with myocardial hypertension (n=62) and the men with chronic heart failure II-III functional class of NYHA (n=50) for the indicators of central and systemic hemodynamics. The level of galectin-3 was determined by immunoassay analysis on the equipment "Stat Fact 300". Structural and functional parameters of myocardium were assessed by an ultrasound method using the equipment "RADMIR ULTIMARA". Data statistical analysis was performed on a personal computer using standard statistical package "Statistica 10.0". All data is presented in the form of average (M) and standard deviation (± σ). It has been established that the concentration of galectin-3 significantly decreases against the background of treatment. The level of galectin-3 in the patients with the II stage of hypertonic disease with good treatment effect was close to normal values compared to those with moderate treatment effect. In terms of patients with hypertension III stage, the level of galectin-3 also decreased, indicating the possibility of therapy monitoring using this biomarker. The mathematical model of the galectin-3 influencing factors also has been determined in patients with hypertension. The boundary level of the galectin-3 has been calculated, it is counted 46,51 pg/ml. It might be assumed a moderate effect of the treatment of hypertensive patients and chronic heart failure in males.

Keywords: *hypertonic disease, left ventricular hypertrophy, chronic heart failure, galectin-3.*

Introduction

Despite significant progress in the perception, diagnosis and treatment of hypertension, blood pressure monitoring is inadequate in at least half of hypertensive patients [27]. Accordingly, the risks of coronary heart disease, myocardial infarction, cerebral stroke, chronic heart failure (CHF), atrial fibrillation, renal failure and other complications remain uncontrolled. The prevalence of hypertension (HD) in the world is projected to rise to 1.5 billion people by 2025, leading to 7.6 million premature deaths (about 13.5% of the total), 54% of strokes and 47% of events caused by ischemic heart disease [21].

With an increase in the systolic blood pressure of 20 mmHg, and diastolic - at 10 mmHg the risk of developing cardiovascular disease is doubled [4]. However, today about

9% of patients with arterial hypertension do not know about their high blood pressure [25].

At rates of growth of morbidity CHF ranks first among all cardiovascular pathology. According to national registries of European countries, the prevalence of this syndrome is 1-9%, its frequency increases with age and after age 65 reaches 10-28%. Probability of death in CHF for a year from the moment of the first clinical symptoms is 10-15% - among all patients, and for 5 years - 50%. In severe cardiac decompensation, each second dies for a year. Over the past decade, mortality from this pathology has increased 2-fold. In developed countries, the main causes of CHF are HD and ischemic heart disease [15, 16]. That is why the success in timely diagnosis, prevention and treatment of HD and CHF in its background, is inextricably linked with the results of studying the mechanisms of their occurrence and progression [20].

The key component of the development of CHF in HD is left ventricular hypertrophy and concomitant recent myocardial fibrosis, which compromises the function of the heart. Fibrosis initially manifests diastolic dysfunction, with progression of the disease, systolic dysfunction occurs [28].

As a biomarker, a state of connective tissue and, in particular, myocardial fibrosis, has been proposed for galectin-3, which belongs to the family of galectin proteins [5]. It was found that the concentration of galectin-3 in the blood is maximal at the peak of myocardial fibrosis and inflammation that arises as a result of heart failure [2, 14]. It is believed that galectin-3 reflects central processes mediating nonadaptive cardiac remodeling [7]. Several studies have shown that galectin-3 markers of increased mortality and left ventricular remodeling in patients with and without CHF of different etiology [3, 26, 30]. According to Kubanek M. et al. [17] galectin-3 plays an important role in the initial stages of heart failure formation and is an important predictor of left ventricular hypertrophy. One of the certain limitations in estimating the prognostic value of galectin-3 is the dependence on sexual and age-related differences, as well as on the size of renal glomerular filtration [19].

Objective: to improve prediction of the course and effectiveness of therapy for hypertension and chronic heart failure, which is its complication in men 40-60 years by applying the level of galectin-3 as a biomarker.

Materials and methods

The study was performed according to the standards of proper clinical practice and the principles of the Helsinki Declaration. A written informed consent was received before enrollment of participants in the study.

The following males - residents of Podillya region were studied: 79 men aged 40-60, average age 57.06 ± 0.50 years, with no signs of cardiovascular disease, 62 men, average age 49.19 ± 0.66 years, with stage II hypertensive disease and 50 men, average age 50.14 ± 0.99 years, with HD complicated by CHF. During enrollment of males in the groups of patients with stage II HD and HD complicated by CHF, the following factors were considered: verified diagnosis of HD (with obligatory exclusion of symptomatic hypertension), the presence of LVH, confirmed by clinical and instrumental examinations. Exclusion criteria were symptomatic arterial hypertension, impaired renal function and liver, coronary heart disease developed prior to HD, endocrine, hematological, neoplastic and autoimmune disorders, complications of HD - myocardial infarction, acute cerebrovascular accident. In study patients with HD, the diagnosis of concomitant coronary artery disease was excluded after assessment of pre-test probability of the disease on the basis of simple clinical indicators - complaints, anamnesis of the disease, detailed data analysis of outpatient cards of patients, results of ECG at rest and ultrasound examination of the heart at rest [10].

All the males were inpatients at Vinnytsia Regional Specialized Clinical Hospital of Radiation Protection of Ministry of Health of Ukraine and Military Medical Clinical Center of Central Region of Air Forces of Ukraine, and were also observed on outpatient basis from December 2013 to July 2014.

Plasma galectin-3 concentration of study patients was determined by enzyme-linked immunoassay using standard set of reagents produced by Bender MedSystems GmbH (Austria), and "Stat Fact 330" apparatus. Detection of galectin-3 level is indicated in attestation certificate of the laboratory. Reference value of plasma galectin-3 concentration - 0.0 - 2.28 ng/ml, average level - 0.54 ng/ml.

Blood sampling was done in fasting state from cubital vein in the amount of 2ml whole blood at 8 a.m. Then 0.5 ml of plasma was separated, time between sampling of whole blood and plasma separation was less than 30 min. The separated plasma was frozen at -25°C.

Electrocardiogram registration was done according to conventional method using 12 standard leads. Blood pressure was measured according to recommendations of WHO experts. Evaluation of parameters of systemic and intracardiac hemodynamics was performed using echocardiography on echogram "RADMIR ULTIMARA" (Kharkiv, Ukraine). Left ventricular muscle mass index (LVMMI) was calculated using Penn Convention formula. LVMMI $\geq$ 115g/m^2 was considered the criterion of LVH for males according to clinical recommendations of the European Society of Hypertension (ESH) and the European Society of Cardiology (ESC) to treatment of arterial hypertension (2013, 2016) [9, 22].

Moderate hypertrophy of the left ventricle was established at the value of the index of left ventricular myocardial mass to 170 g/m^2, expressed above 170 g/m^2. The calculation of the relative thickness of the walls of the left ventricle by the formula [(2 x end-systolic thickness of the left wall of the left ventricle) / end diastolic size of the left ventricle], makes it possible to distinguish between the increase in left ventricular mass on concentric (relative thickness of the walls of the left ventricle $\geq$ 0.42) and eccentric (relative thickness walls of the left ventricle $\leq$ 0.42), and also allows for the concentric

remodeling of the left ventricle (normal mass of the left ventricular myocardium with an increase in the relative thickness of the walls of the left ventricle ≥ 0.42) [23]. In the pulsed Doppler regime, the transdermal flow parameters were studied: the maximum speed of rapid early diastolic filling (E) and the maximum rate (A) of left ventricular filling during left systole (cm/s), their ratio (E/A). Diastolic function of the left ventricle was evaluated in accordance with the current recommendations [12]. The state of the systolic function of the left ventricle myocardium was estimated by the indicator of the ejection fraction. The systolic function was considered to be preserved when the fraction rate exceeded 40%. In determining the boundary level of the galectin-3 in blood plasma, the formula proposed by Antonomov M.Yu. and others.[1, 29]:

X = [(M1 + 2 m1) + (M2 - 2 m2)] / 2,

where X is the boundary level of the galectin-3; M1 - the average value of level of the galectin-3 in the group with the absence of the sign (conditionally healthy); m1 - the standard deviation M1; M2 - the average value of the level of galectin-3 in the group with the presence of a sign (conditionally ill); m2 - M2 the standard deviation.

All patients were prescribed baseline therapy in accordance with the recommendations of the Ukrainian Association of Cardiologists (2014) regarding the prevention and treatment of arterial hypertension, the unified clinical protocol for medical treatment for arterial hypertension, approved by the Order of the Ministry of Health of Ukraine dated May 24, 2012 No. 384 and clinical guidelines for arterial hypertension of the European Society of Hypertension (ESH) and the European Society of Cardiology (ESC) 2013. The research was conducted with the stabilization of patients. Subsequently, a dynamic observation of patients prescribed antihypertensive (in the case of CHF and, if necessary, symptomatic) therapy for 6 months.

To evaluate the treatment efficacy, clinical criteria were developed for which the changes in the concentration of the biomarker of galectin-3 were considered. In the first stage, 2 graduations of patients were selected: the first - persons with a good effect of treatment in which the target blood pressure level ≤ 140/90 mm Hg was reached and a decrease of 1 functional class for NYHA in the presence of CHF. The second (moderate effect) patients whose arterial pressure decreased by 10% and more but the target pressure was not achieved and the decrease in CHF patients in the functional class I and more.

Statistical analysis included calculation of primary statistics, detection of differences between groups by statistical characteristics, determining the relationship between variables using parametric (Pearson correlation) and nonparametric (Spearman correlation) analysis. For quantitative indicators, the primary statistical processing included the calculation of the arithmetic mean (M), the standard deviation (m), the mean-square deviation (σ). The differences between the samples, distributed according to the law of normal distribution, were evaluated for Student's t-criterion (t) for unrelated measurements. Using a regression analysis, a mathematical model of the effect on the galectin-3 studied factors in patients with HD was determined. R2 is a determination coefficient whose value is from 0 to 1 and the closer the value to 1 is the stronger the connection. F - Fischer's criterion is a parametric criterion and is used to compare the variances of the two variation series. The regression equation has the following form: $Y = a + b \cdot X$, where y - is a dependent variable, x - is an independent variable, a - is a free member, and b - is a regression coefficient.

Mathematical processing was performed on a personal computer using standard statistical package "Statistica 10.0".

For initial preparation of tables and intermediate calculations Microsoft Excel package was used.

Results

The use of biological markers that reflect different aspects of the pathogenesis of CHF should be considered as a priority area in identifying patients at high risk of adverse clinical states, as well as for biomarker-controlled therapy and monitoring the feasibility of the therapy.

It was interesting to determine what affects the level of galectin-3. Using a method of stepwise multiple regression with the inclusion of predictors, the analysis developed a mathematical model for the effect on the concentration of galectin-3 in plasma blood factors in patients with HD II. In the uncomplicated course of the disease, the equation has the form:

$y_1 = 2.486 + 0.100 \cdot x_3 + 0.077 \cdot x_1 + 0.080 \cdot x_6 + 0.060 \cdot x_{12}$ (R^2=78.19%, p < 0.05, F=2.47),

where, y_1 - level of galectin-3 (index of dependent variable); x_1 - emission fraction in %; x_3 - shock volume, ml; x_6 - systolic blood pressure, mmHg; x_{12} - diastolic arterial pressure, mm Hg.

And also the model of influence on the concentration of galectin-3 studying factors in patients with HD that complicated the CHF of men:

$y_2 = 4.250 + 0.080 \cdot x_1 + 0.008 \cdot x_2 - 0.090 \cdot x_3 + 0.080 \cdot x_4 + 0.113 \cdot x_6 + 0.100 \cdot x_7 + 0.104 \cdot x_8 + 0.200 \cdot x_9 + 0.277 \cdot x_{10} - 0.230 \cdot x_{11}$ (R^2=82.14%, p < 0.05, F=14.47), where, y_2 - level of galectin-3 (index of dependent variable); x_1 - emission fraction in %; x_2 - is a very low density lipoprotein cholesterol, mmol/l; x_3 - shock volume, ml; x_4 - heart rate, bpm; x_6 - systolic blood pressure, mmHg.; x_7 - age, years; x_8 - is a functional class; x_9 - index of left ventricular myocardial mass g/m^2; x_{10} - thickness of interventricular septum, mm; x_{11} - total cholesterol, mmol/l.

Table 1 shows levels of galectin-3 before and after 6 months of treatment.

According to the findings, a higher level of galectin-3 was observed in patients with HD complicated by CHF compared to patients with uncomplicated HD. At the same time, the concentration of galectin-3 significantly decreases against the background of treatment. The level of blood in the galectin-3 in patients with HD II stage was close to

Table 1. Levels of galectin-3 before and after 6 months of treatment in patients with HD (M±σ).

Groups	Plasma level of galectin-3 before treatment (ng/ml)	Plasma level of galectin-3 after treatment (ng/ml)	p
Persons without cardiovascular pathology (n=79)	7.034±0.122 (1)		
Patients with HD of stage II (n=62)	21.31 ± 0.22 (2)	16,77 ± 0.38 (4)	p_{4-2}<0.05
Patients with HD of stage III (n=50)	46.65 ± 2.18 (3)	24.99 ± 0.93 (5)	p_{5-3}<0.05
P	p_{2-1}<0,001 p_{3-2}<0.001 p_{3-1}<0.001	p_{5-4}<0.001	

Notes: (1), (2), (3), (4), (5) - relevant groups; p - the indicator of the corresponding reliable values.

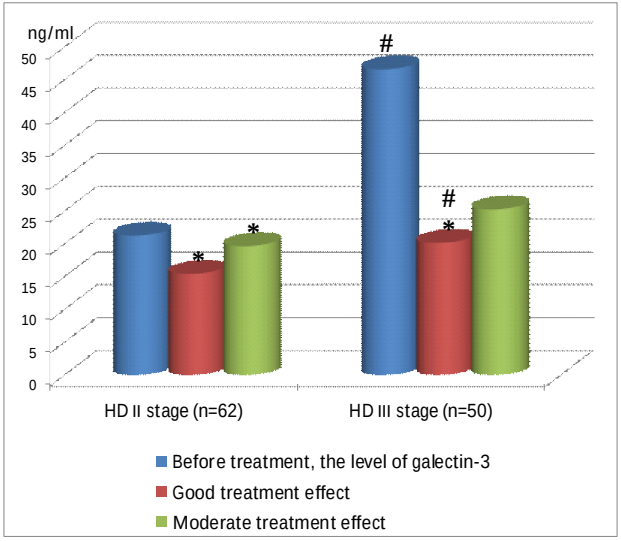

Fig. 1. Levels of galectin-3 in blood plasma after treatment in men with HD II and III stages, depending on the effectiveness of treatment, ng/ml.

Notes: # - the difference between the indices is reliable when comparing the levels of galectin-3 in individuals with HD of stage II, * - the difference between the indices is reliable when compared within a group.

normal values, and in patients with HD III stage slightly exceeded it.

Depending on the effectiveness of the therapy, levels of galectin-3 are shown in Figure 1.

The above data became the basis for calculating the boundary level of galectin-3, which could contribute to the prediction of treatment efficacy: the level of galectin-3 ? 46.51 pg / ml (sensitivity 94.0%, specificity - 84.2%, error-fiction - 60.7%, false-negative response - 6.0%, false-positive response - 15.8%) suggests a moderate effect on treatment in male patients of patients with HD and CHF.

Determination of the boundary level of galectin-3 in a patient before treatment will allow to select those who start therapy can not immediately give a good effect and it is better for them to apply more aggressive therapy.

Discussion

According to the data received by De Boer R. A. et al. [6] galectin-3 showed the highest degree of correlation with the severity of diastolic dysfunction (high E/Ea) compared to other echocardiographic parameters. In the course of clinical trials, it has been found that expression of galectin-3 increases in patients with a lower left ventricular ejection fraction, regardless of the etiology of heart failure. Also in research by De Boer R. A. and et al. [8] it was found that the concentration of galectin-3 is a phenotypic trait that reflects the intensity of cardial and vascular remodeling processes and may help to detect disturbances in the contractile and relaxation capacity of the myocardium, such as the left ventricular ejection fraction or peak systolic, early and late diastolic velocity.

In our opinion, the etiological factor imposes an imprint on the expressiveness of the fibrotic processes in the myocardium. In particular, as shown in Table 1 in patients with HD of stage II, that is, in the presence of left ventricular hypertrophy. Even without signs of CHF above and functional class, the level of galectin-3 was higher than that of people without cardiovascular disease of the same age. Thus, galectin-3 can mark and present a left ventricular hypertrophy caused by HD.

At the same time, in relation to the dynamics of the level of galectin-3 in plasma, which were obtained in a small number of studies on the background of ongoing therapy, are contradictory. Thus, the ability of galectin-3 to predict the efficacy of CHF pharmacotherapy was studied in a study of Cardiac Resynchronization in Heart Failure (CARE-HF) to study the level of galectin-3 in plasma when performing re-synchronization therapy, and included 250 people who had resynchronized therapy, however, no significant changes in the level of galectin-3 were found [11].

In the Deventer-Alkmaar heart failure study (DEAL-HF), 232 patients with NYHA functional class III-IV CHF were included, correlation between the dynamics of the level of galectin-3 in plasma during 12 months of follow-up (3 and 12 months), dynamics left diastolic volume of the left ventricle and left ventricular remodeling parameters were not noted. However, this again did not take into account again the etiology of CHF [18]. The controversial data from the Framingham study were surveyed of 3353 individuals (59 years of age, 53% women), an association between the level of galectin-3 and left ventricular mass was found [13].

V. Y. Tsuleiko et al. [24] showed that the level of galectin-3 in patients with CHF in 6 months. against the background of treatment showed a decrease of 1.5 times in patients with adequately selected therapy and amounted to 29.94 ng/ml, while patients who did not receive targeted doses of drugs, on the contrary, increased to 34.74 ng/ml.

Thus, the level of galectin-3 in blood plasma, according to several researchers, marks not only CHF as such, but also can reflect the effectiveness of treatment. According to the results of the study, the level of plasma in the blood of galectin-3 can be applied to predict the treatment of patients with HD and CHF.

Conclusions

1. The level of galectin-3 in blood plasma may indicate the presence of left ventricular hypertrophy in patients with HD that can be used to diagnose such myocardial remodeling in the absence of echocardiography.

2. The biomarker galectin-3 can be used to effectively predict the efficacy of treatment both in asymptomatic HD and in the development of CHF in its background.

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ГАЛЕКТИН-3 - СУЧАСНИЙ БІОМАРКЕР ДІАГНОСТИКИ ГІПЕРТРОФІЇ ЛІВОГО ШЛУНОЧКА ТА ХРОНІЧНОЇ СЕРЦЕВОЇ НЕДОСТАТНОСТІ І КОНТРОЛЮ ЛІКУВАННЯ ХВОРИХ НА ГІПЕРТОНІЧНУ ХВОРОБУ

Ружанська В.О., Сивак В.Г., Поліщук Т.В., Жебель В.М.

Розробка нових методів профілактики та лікування хронічної серцевої недостатності та контролю його ефективності являє собою актуальну медико-соціальну проблему. В цьому відношенні великий інтерес представляє застосування нових біологічних маркерів даного захворювання, котрі можуть бути корисними для ранньої діагностики захворювання, прогнозу щодо його клінічного перебігу, моніторування наслідків фармакотерапії (персоніфікована медицина) та відігравати важливу роль у стратифікації ризику пацієнта. За рекомендацією Американської асоціації серця з профілактики та лікування хронічної серцевої недостатності, 2013 рік в пул таких біомаркерів введено галектин-3. Мета роботи: покращити прогнозування перебігу та ефективності терапії гіпертонічної хвороби та хронічної серцевої недостатності яка є її ускладненням у чоловіків 40-60 років шляхом визначення рівня галектину-3 в якості біомаркера. У зазначеного контингенту обстежених вивчали концентрацію галектину-3, показники центральної та системної гемодинаміки в осіб без серцево-судинної патології (n=79), чоловіків хворих на гіпертонічну хворобу з гіпертрофією міокарда (n=62) та з хронічною серцевою недостатністю II-III функціонального класу по NYHA (n=50). Рівень галектину-3 визначався за допомогою імуноферментного аналізу на апараті "Stat Fact 300". Структурно-функціональні показники міокарда оцінювали за допомогою ультразвукового дослідження на апараті "RADMIR ULTIMARA". Отримані дані обробляли математично на персональному комп'ютері з використанням стандартного статистичного пакету "Statistica 10.0". Усі дані представлені у вигляді середнього значення (M) та стандартного відхилення (±σ). Встановлено, що концентрація галектину-3 достовірно знижується на фоні проведеного лікування. Рівень в крові галектину-3 у хворих на гіпертонічну хворобу II стадії при доброму ефекті лікування наблизився до нормальних величин порівняно з особами з помірним ефектом від лікування, а у пацієнтів з гіпертонічною хворобою III стадії відповідно теж став меншим, що свідчить про можливість моніторингу терапії з використанням даного біомаркера. Також визначено математичну модель впливу на галектин-3 досліджуваних факторів у хворих на гіпертонічну хворобу. Розраховано межовий рівень галектину-3 - 46,51 пг/мл, що дозволяє передбачити помірний ефект від лікування у осіб чоловічої статі, хворих на гіпертонічну хворобу та хронічну серцеву недостатність.

Ключові слова: *гіпертонічна хвороба, гіпертрофія лівого шлуночка, хронічна серцева недостатність, галектин-3.*

ГАЛЕКТИН-3 - СОВРЕМЕННЫЙ БИОМАРКЕР ДИАГНОСТИКИ ГИПЕРТРОФИИ ЛЕВОГО ЖЕЛУДОЧКА И ХРОНИЧЕСКОЙ СЕРДЕЧНОЙ НЕДОСТАТОЧНОСТИ И КОНТРОЛЯ ЛЕЧЕНИЯ БОЛЬНЫХ С ГИПЕРТОНИЧЕСКОЙ БОЛЕЗНЬЮ

Ружанская В.А., Сивак В.Г., Полищук Т.В, Жебель В.Н.

Разработка новых методов профилактики и лечения хронической сердечной недостаточности, а также контроля его эффективности представляет собой актуальную медико-социальную проблему. В этом отношении большой интерес представляет применение новых биологических маркеров данного заболевания, которые могут быть полезными для ранней диагностики заболевания, прогноза относительно его клинического течения, мониторинга последствий фармакотерапии (персонифицированная медицина) и играть важную роль в стратификации риска пациента. Согласно рекомендации Американской ассоциации сердца по профилактике и лечению хронической сердечной недостаточности 2013 год, в пул таких биомаркеров введено галектин-3. Цель работы: улучшить прогнозирование течения и эффективности терапии гипертонической болезни и хронической сердечной недостаточности, которая является ее осложнением у мужчин 40-60 лет путем определения уровня галектина-3 в качестве биомаркера. У данного контингента обследованных изучали концентрацию галектина-3, показатели центральной и системной гемодинамики у лиц без сердечно-сосудистой патологии (n=79), мужчин больных гипертонической болезнью с гипертрофией миокарда (n=62) и с хронической сердечной недостаточностью II-III функционального класса по NYHA (n=50). Уровень галектина-3 определялся с помощью иммуноферментного анализа на аппарате "Stat Fact 300". Структурно-функциональные показатели миокарда оценивали с помощью ультразвукового исследования на аппарате "RADMIR ULTIMARA". Полученные данные обрабатывали математически на персональном компьютере с использованием стандартного статистического пакета "Statistica 10.0". Все данные представлены в виде среднего значения (M) и стандартного отклонения (±σ). Установлено, что концентрация галектина-3 достоверно снижается на фоне проводимого лечения. Уровень галектина-3 в плазме крови у больных гипертонической болезнью II стадии при хорошем эффекте лечения приблизился к нормальным величинам по сравнению с лицами с умеренным эффектом от лечения, а у пациентов с гипертонической болезнью III стадии соответственно тоже стал меньше, что свидетельствует о возможности мониторинга терапии с использованием данного биомаркера. Также определена математическая модель влияния на галектин-3 изучаемых факторов у больных гипертонической болезнью. Рассчитан предельный уровень галектина-3 - 46,51 пг/мл, что позволяет предположить умеренный эффект от лечения у лиц мужского пола больных гипертонической болезнью и хронической сердечной недостаточностью.

Ключевые слова: *гипертоническая болезнь, гипертрофия левого желудочка, хроническая сердечная недостаточность, галектин-3.*

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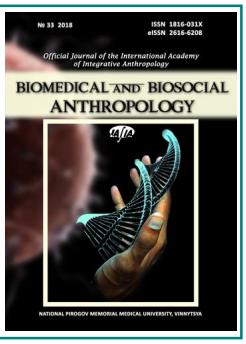

Age-related features of tongue arteries remodeling in the experimental animals

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The structural and functional features of the tongue attract the attention of researchers who are often interested in the peculiarities of the structural organization of its arterial bed, which plays an important role in blood supply and morphogenesis of the organ in various injuries. The aim of the research was to study the age-specific features of remodeling of tongue arteries in the experimental animals. The materials of the study were the arterial vessels of the tongue of 30 laboratory albino male rats, which were under normal vivarium conditions. The test animals were divided into two groups. The 1st group consisted of 15 intact, practically healthy animals at the age of 8 months, the 2nd -15 intact rats at the age of 24 months. The euthanasia of experimental animals was carried out by bloodletting under conditions of thiopental-sodium anesthesia. The pieces were cut from the middle part of the tongue and fixed in a 10% neutral solution of formalin. The indicated pieces of tongue were carried out through the ethyl alcohol of increasing concentration and placed in paraffin blocks. After deparaffinization microtome sections 5-7 microns thick were stained with hematoxylin-eosin, by van Gizon, Mallory, Weigert, and toluidine blue. The morphometry of the arteries of the middle (external diameter 51-125 microns) and small calibers (outer diameter - 26-50 microns) of the tongue was carried out. The morphometry of the arteries of the tongue was determined by their external and internal diameters, the thickness of the mediums and adventitia, the height of the endothelial cells, their nuclei, the nuclear-cytoplasmic relations in the endothelial cells, the Kernogan index, and the relative volume of the damaged endothelial cells. Quantitative indicators were processed statistically. The analysis of the obtained morphometric parameters revealed that with the age the arteries of the small caliber have changed more. The outer diameter of arteries of small caliber tongue of the 24-month-old albino rats has increased only for 1.2% and the clearance has decreased by 4.4%. An increase in the outer diameter of the examined vessels and a decrease in their lumen led to a change in the Kernogan index, which with a statistically significant difference ($p<0.01$) has decreased by 11.8%. The thickness of the mediums of these tongue arteries of the 24-month-old albino rats, has increased by 7.5% and the thickness of the adventitia by 6.2%. During the research in the experimental conditions, the height of the endothelial cells of the examined vessels has decreased by 2.4%, and the diameter of their nuclei - by 3.3%. There was no significant difference between the nuclear-cytoplasmic ratio in the endothelial cells of the studied vessels in the tongue of 8-month and 24-month-old white rats, which indicated a stability of structural cellular homeostasis. The relative amount of damaged endothelial cells in the studied experimental conditions in the arteries of the middle caliber has increased by 17.3%, and of the minor caliber - by 23.7%, which is explained by their age apoptosis. The obtained results testify that with the age there is a structural reorganization (remodeling) of predominantly arteries of the small caliber of the tongue, which is characterized by thickening of their walls, narrowing of the lumen, increasing of the thickness of the mediums and adventitia. The age-related decrease of the Kernogan index of the examined vessels indicates a decrease in their physiological capacity and deterioration of the blood supply of the organ. The morphometric parameters of endothelial cells and their nuclei are altered with the age, maintaining structural cellular homeostasis. The relative amount of damaged endothelial cells in the examined vessels is also increased with

the age. Proven, the degree of age-related structural rearrangement of the arterial bed of the tongue depends on the caliber of the vessels.
Keywords: *age features, rats, tongue, arteries, remodeling, morphometry.*

Introduction

The structural and functional features of the tongue attract the attention of researchers these days. The tongue belongs to the initial part of the gastrointestinal tract and throughout its life carries a multifaceted function. The tongue is always drawn into the pathological process with various diseases of the digestive system. It is known that the morphofunctional features of the specified organ and their changes in pathological conditions depend on the morphology of the vascular bed [1, 4, 13, 19, 20].

In recent years, researchers are increasingly interested in the peculiarities of the structural organizations of the tongue, its vascular bed and their changes in various pathological conditions [1, 3, 5, 7, 10]. The arterial bed of organs plays an important role in blood supply and their morphogenesis with various injuries [5, 8, 16, 18]. At the same time, the quantitative morphological study of the features of the age-related remodeling of the arterial bed of the tongue is not complete, which determines the relevance of this research.

The literature does not cover the issues of microcirculatory disorders in patients with desquamative and atrophic changes back of the tongue, the relationship between the frequency of occurrence and the state of oral hygiene and immune disorders is not described. In this regard, dentists are faced with the problem of choosing effective ways of this pathology treatment. The foregoing determines the relevance of the detailed study of histological and ultrastructural changes and vascular disorders by developing using common clinical methods and with the creation new experimental models [13].

The *aim* of the research - to study the age-specific features of remodeling of tongue arteries in experimental animals.

Materials and methods

The materials of the study were the arterial vessels of the tongue of 30 laboratory albino male rats, which were under normal vivarium conditions. The test animals were divided into two groups. The 1st group consisted of 15 intact, practically healthy animals at the age of 8 months, the 2nd - 15 intact rats at the age of 24 months.

The euthanasia of experimental animals was carried out by bloodletting under conditions of thiopental-sodium anesthesia. The pieces were cut from the middle part of the tongue and fixed in a 10% neutral solution of formalin. The indicated pieces of tongue were carried out through the ethyl alcohol of increasing concentration and placed in paraffin blocks. After deparaffinization microtome sections 5-7 microns thick were stained with hematoxylin-eosin, by Van Gieson, Mallory, Weigert, and toluidine blue [9, 14].

The morphometry of the arteries of medium (outer diameter 51-125 microns) and small calibers (outer diameter - 26-50 microns) of the tongue was performed [4, 15, 17]. The experiments and euthanasia of experimental animals were conducted in compliance with the "General Ethical Principles of Animal Experiments" adopted by the First National Congress on Bioethics (Kyiv, 2001) and in accordance with the "European Convention for the Protection of Vertebrate Animals Used for Research and Other Scientific Purposes" [12].

At the morphometry of the arteries of the tongue, their external (DE) and internal (DI) diameters, medial thickness (TM) and thickness of the adventium (TA), height of endothelial cells (HE), their nuclei (DN), nuclear-cytoplasmic relations in endothelial cells, Kernogan index (IK), the relative volume of damaged endothelial cells (VODE) were estimated [2, 11]. The morphometry of small-caliber arteries of the tongue was performed using a light microscope Olimpus BX-2 with a digital video camera and a software package "Video test 5.0" and "Video size 50". Morphological quantitative indicators were processed statistically. The processing of the received quantitative parameters was carried out in the department of systemic statistical research of the secondary educational institution "Ternopil State Medical University named after I. Y. Horbachevsky of the Ministry of Health of Ukraine" in the software package "Statistica". The difference between the comparative values was determined by the Mann-Whitney and Student criteria [6].

Results

The quantitative morphological indices obtained as a result of the study are presented in Table 1.

The comprehensive analysis of the obtained morphometric parameters of the arteries of the tongue revealed that some of them in the older-aged group of the experimental animals were significantly changed. Thus, the outer diameter of the arteries of the middle caliber has increased by 0.7%, the thickness of the mediums - by 4.1% ($p<0.05$), the thickness of the adventitia - by 8.3% ($p<0.01$), the relative amount of damaged endothelial cells by 17.3% ($p<0.01$), and their lumen has decreased by 2.4% ($p<0.05$), Kernogan index - by 6.3% ($p<0.01$).

The degree of remodeling of the small-caliber arteries of the tongue of 24-month-old albino rats, was more pronounced in comparison with the previous vessels. Thus, the outer diameter of the arteries of the small caliber of the tongue has increased from 41.10±0.54 μm to 41.60±0.51 μm, that is, only 1.2%. The internal diameter of the investigated vessels has decreased from 15.80±0.12 microns to 15.10±0.12 microns, that is, by 4.4%. The given quantitative morphological indicators of internal diameters of small caliber arteries of young and old animals statistically

Table 1. Morphometric characteristics of the arteries of the tongue of albino rats (M±m).

Indicator	observation group	
	1st	2nd
Arteries of medium caliber		
DE, microns	84.50±0.60	85.10±0.70
DI, microns	46.30±0.36	45.20±0.32*
TM, microns	19.50±0.21	20.30±0.24*
TA, microns	12.28±0.15	13.30±0.18**
IK, %	30.10±0.40	28.20±0.30**
HE, microns	6.420±0.120	6.300±0.120
DN, microns	2.450±0.020	2.400±0.020
NAC	0.146±0.003	0.145±0.004
VODE, %	1.960±0.050	2.300±0.060**
Arteries of small caliber		
DE, microns	41.10±0.54	41.60±0.51
DI, microns	15.80±0.12	15.10±0.12**
TM, microns	13.30±0.12	14.30±0.12**
TA, microns	5.650±0.050	6.000±0.060**
IK, %	14.80±0.18	13.10±0.12***
HE, microns	6.350±0.040	6.200±0.050*
DN, microns	2.420±0.020	2.340±0.020*
NAC	0.145±0.003	0.142±0.002
VODE, %	2.150±0.020	2.660±0.030***

Notes: * - p <0,05; ** - p <0.01 compared to group 1.

significantly (p<0.01) differ. An increase in the outer diameter of the studied vessels and a decrease in their lumen led to a change in the Kernogan index, which at the same time with a statistically significant difference (p<0.01) has decreased from 14.80±0.18 % to 13.10±0.12 %, that is by 11.5%. The growth of the thickness of the mediums of the indicated arteries of the tongue of the 24-month-old albino rats, with 13.30±0.12 μm to 14.30±0.12 μm was observed. The given morphometric parameters statistically significantly differed (p<0.01) and the last quantitative morphological index exceeded the previous by 7.5%. The thickness of the adventitia of the arteries of the given tongue caliber in the 8-month white rats was equal to 5.650±0.050 μm, and in animals of the older age group - 6.000±0.060 μm. A statistically significant (p<0.01) difference was found between the given morphometric parameters. At the same time, the last quantitative morphological indicator exceeded the previous one by 6.2%.

The experimental conditions also altered the height of the endothelial cells of the examined vessels. Thus, in the 1st group of observation, the specified morphometric parameter was 6.350±0.040 μm, and in the 2nd - 6.200±0.050 μm. The last quantitative morphological index was statistically significantly (p<0.05) lower, comparing with the previous one by 2.4%. The diameters of the nuclei of the studied cells also with a statistically significant difference (p<0.05) have decreased from 2.420±0.020 microns to 2.340±0.020 μm, that is, by 3.3%.

It should be noted that the significant difference between the nuclear-cytoplasmic ratio in the endothelial cells of the examined vessels in the tongue of 8-month and 24-month-old white rats was not observed. The specified morphometric parameter was respectively 0.145±0.040 and 0.142±0.020.

The relative amount of damaged endothelial cells in the studied experimental conditions has changed. Thus, in the 1st group of observations, the specified morphometric parameter equaled 2.150±0.020 %, and in the 2nd group with a statistically significant difference (p<0.001) has increased by 23.7% and reached 2.660±0.030 %.

Discussion

It is known that vascular endothelial cells play an important role in regulating vascular tone, homeostasis, inflammation, and also integrate reflex, humoral mechanisms and local processes. Endothelial cells synthesize biologically active substances that directly affect smooth myocytes of the arteries, causing vasodilation (nitric oxide, prostacyclin), or vasoconstriction (prostaglandin H2, endothelin). Under normal physiological conditions, these factors are in a state of dynamic balance. With an increase in the number of damaged endothelial cells, this balance is disturbed in the direction of vasoconstrictor factors. The leading role in the regulation of vascular tone plays nitrogen oxide (NO). Endothelial cell damage results in endothelial dysfunction, blockade of NO synthase, reducing of NO synthesis, activation of its degradation processes, and is accompanied by spasm, narrowing of the arterial lumen that supports and exacerbates hypoxia, which is complicated by edema, dystrophy and necrobiosis of cells and tissues [16, 18].

The conducted research and the obtained results testify that with the age there is a structural reorganization (remodeling) of predominantly arteries of the small caliber of the tongue, which is characterized by thickening of their walls, narrowing of the lumen, increasing of the thickness of the mediums and adventitia. The main reason for this is that they are in greater functional tension by regulating blood circulation [16]. The age-related decrease of the Kernogan index of the examined vessels indicates a decrease in their physiological capacity and deterioration of the blood supply of the organ. The morphometric parameters of endothelial cells and their nuclei are altered with the age, maintaining structural cellular homeostasis. The relative amount of damaged endothelial cells in the examined vessels is also increased with the age. The revealed evidence showed that despite the uneven spatial characteristics of the endothelial cells of small caliber arteries of the tongue and their nuclei in the mature albino rats and experimental animals of the elderly group, the structural cellular homeostasis in the studied cells was not violated [2, 18].

Despite structural changes, the arteries perform their

function, which is confirmed by the stability of cellular structural homeostasis and the absence of pathological changes in the studied organ. At the same time, some researchers suggest that age-related arterial remodeling reduces the adaptive reserves and compensatory capabilities of organs that are more likely can be damaged by the effects of negative endogenous and exogenous factors [5, 14, 19], which requires further in-depth research.

Conclusions

Age features of remodeling of the arteries of the tongue are characterized by thickening of the wall, narrowing of their lumen, decreasing of the Kernogan index, decreased blood vessel capacity, increased apoptosis and deterioration of blood supply to the organ. The degree of age-related structural rearrangement of the arterial bed of the tongue depends on the caliber of the vessels.

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ВІКОВІ ОСОБЛИВОСТІ РЕМОДЕЛЮВАННЯ АРТЕРІЙ ЯЗИКА В ЕКСПЕРИМЕНТАЛЬНИХ ТВАРИН

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Структурно-функціональні особливості язика до сьогоднішнього дня привертають увагу дослідників, які часто цікавляться особливостями структурної організації його артеріального русла, що відіграє важливу роль у кровопостачанні та морфогенезі органа при різних пошкодженнях. Мета дослідження - вивчити вікові особливості ремоделювання артерій язика в експериментальних тварин. Матеріалом дослідження були артеріальні судини язика 30 лабораторних білих щурів-самців, що знаходилися у звичайних умовах віварію. Дослідні тварини були розділені на 2-і групи. 1-а група нараховувала 15 інтактних практично здорових тварин віком 8 міс., 2-а - 15 інтактних щурів віком 24 міс. Евтаназія дослідних тварин здійснювалася кровопусканням в умовах тіопентал-натрієвого наркозу. З середньої частини язика вилучали шматочки, які фіксували у 10% нейтральному розчині формаліну. Вказані шматочки язика проводили через етилові спирти зростаючої концентрації і поміщали у парафінові блоки. Мікротомні зрізи товщиною 5-7 мкм після проведення депарафінізації фарбували гематоксилін-еозином, за Ван Гізоном, Маллорі, Вейгертом, толуїдиновим синім. Проводили морфометрію артерій язика середнього (зовнішній діаметр 51-125 мкм) та дрібного калібрів (зовнішній діаметр - 26-50 мкм). При морфометрії артерій язика визначали їх зовнішній та внутрішній діаметри, товщину медії і адвентиції, висоту ендотеліоцитів, їх ядер, ядерно-цитоплазматичні відношення в ендотеліоцитах, індекс Керногана, відносний об'єм пошкоджених ендотеліоцитів. Кількісні

показники обробляли статистично. В результаті аналізу отриманих морфометричних параметрів виявлено, що з віком більш виражено змінювалися артерії дрібного калібру. У 24-місячних білих щурів зовнішній діаметр артерій язика дрібного калібру зріс всього на 1,2%, а просвіт зменшився на 4,4%. Збільшення зовнішнього діаметра досліджуваних судин і зменшення їх просвіту призводило до зміни індексу Керногана, який при цьому статистично значуще ($p<0,01$) зменшився на 11,8%. У 24-місячних білих щурів виявлено зростання товщини медії вказаних артерій язика на 7,5%, а товщини адвентиції - на 6,2%. В експериментальних умовах висота ендотеліоцитів досліджуваних судин зменшилася на 2,4, а діаметр їх ядер - на 3,3%. Суттєвої різниці між ядерно-цитоплазматичним відношенням у ендотеліоцитах досліджуваних судин язика 8-місячних та 24-місячних білих щурів не виявлено, що свідчило про стабільність структурного клітинного гомеостазу. Відносний об'єм пошкоджених ендотеліоцитів в досліджуваних експериментальних умовах у артеріях середнього калібру зріс на 17,3%, а дрібного - на 23,7%, що пояснюється їх віковим апоптозом. Отримані результати свідчать, що з віком виникає структурна перебудова (ремоделювання) переважно артерій язика дрібного калібру, яка характеризується потовщенням їх стінки, звуженням просвіту, зростанням товщини медії та адвентиції. Вікове зменшення індексу Керногана досліджуваних судин свідчить про зниження їх фізіологічної пропускної здатності та погіршення кровопостачання органа. З віком змінюються морфометричні параметри ендотеліоцитів та їх ядер при збереженні структурного клітинного гомеостазу. З віком збільшується також відносний об'єм пошкоджених ендотеліоцитів досліджуваних судин. Доведено, що ступінь вікової структурної перебудови артеріального русла язика залежить від діаметра судин.
Ключові слова: *вікові особливості, щури, язик, артерії, ремоделювання, морфометрія.*

ВОЗРАСТНЫЕ ОСОБЕННОСТИ РЕМОДЕЛИРОВАНИЯ АРТЕРИЙ ЯЗЫКА У ЭКСПЕРИМЕНТАЛЬНЫХ ЖИВОТНЫХ

Гнатюк М. С., Боднарчук И. В., Татарчук Л.В., Гасюк П. А.

Структурно-функциональные особенности языка до сегодняшнего дня привлекают внимание исследователей, которые часто интересуются особенностями структурной организации его артериального русла, что играет важную роль в кровоснабжении и морфогенезе органа при различных повреждениях. Цель исследования - изучить возрастные особенности ремоделирования артерий языка у экспериментальных животных. Материалом исследования были артериальные сосуды языка 30 лабораторных белых крыс-самцов, находившихся в обычных условиях вивария. Экспериментальные животные были разделены на две группы. Первая группа насчитывала 15 интактных практически здоровых животных возрастом 8 мес., вторая - 15 интактных крыс в возрасте 24 мес. Эвтаназия экспериментальных животных осуществлялась кровопусканием в условиях тиопентал-натриевого наркоза. Со средней части языка вырезали кусочки, которые фиксировали в 10% нейтральном растворе формалина. Указанные кусочки языка проводили через этиловые спирты возрастающей концентрации и помещали в парафиновые блоки. Микротомные срезы толщиной 5-7 мкм после проведения депарафинизации окрашивали гематоксилин-эозином, по Ван Гизону, Маллори, Вейгерту, толуидиновым синим. Проводили морфометрию артерий языка среднего (наружный диаметр 51-125 мкм) и мелкого калибров (внешний диаметр - 26-50 мкм). При морфометрии артерий языка определяли их внешний и внутренний диаметры, толщину медии и адвентиции, высоту эндотелиоцитов, их ядер, ядерно-цитоплазматические отношения в эндотелиоцитах, индекс Керногана, относительный объем поврежденных эндотелиоцитов. Количественные показатели обрабатывали статистически. В результате анализа полученных морфометрических параметров выявлено, что с возрастом более выражено менялись артерии мелкого калибра. У 24-месячных белых крыс внешний диаметр артерий языка мелкого калибра вырос всего на 1,2%, а просвет уменьшился на 4,4%. Увеличение наружного диаметра исследуемых сосудов и уменьшение их просвета приводило к изменению индекса Керногана, который при этом статистически значимо ($p<0,01$) уменьшился на 11,8%. У 24-месячных белых крыс обнаружено рост толщины медии указанных артерий языка на 7,5%, а толщины адвентиции - на 6,2%. В исследуемых экспериментальных условиях высота эндотелиоцитов исследуемых сосудов уменьшилась на 2,4%, а диаметр их ядер - на 3,3%. Существенной разницы между ядерно-цитоплазматическим отношением в эндотелиоцитах исследуемых сосудов языка 8-месячных и 24-месячных белых крыс не обнаружено, что свидетельствовало о стабильности структурного клеточного гомеостаза. Относительный объем поврежденных эндотелиоцитов в исследуемых экспериментальных условиях в артериях среднего калибра вырос на 17,3%, а мелкого - на 23,7%, что объясняется их возрастным апоптозом. Полученные результаты свидетельствуют, что с возрастом возникает структурная перестройка (ремоделирование) преимущественно артерий языка мелкого калибра, которая характеризуется утолщением их стенки, сужением просвета, ростом толщины медиа и адвентиции. Возрастное уменьшение индекса Керногана исследуемых сосудов свидетельствует о снижении их физиологической пропускной способности и ухудшении кровоснабжения органа. С возрастом изменяются морфометрические параметры эндотелиоцитов и их ядер при сохранении структурного клеточного гомеостаза. С возрастом увеличивается также относительный объем поврежденных эндотелиоцитов исследуемых сосудов. Доказано, что степень возрастной структурной перестройки артериального русла языка зависит от диаметра сосудов.
Ключевые слова: *возрастные особенности, крысы, язык, артерии, ремоделирования, морфометрия.*

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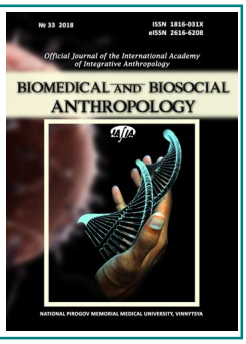

Features of indicators of crus rheogram in practically healthy teenagers of different somatotypes

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Norms for assessing the functional state of the peripheral vascular system are developed, as a rule, without regard to age, gender and somatotype. The purpose of the study is to establish features of the indicators of crus rheogram in practically healthy girls and boys of different somatotypes, residents of the Podillia region of Ukraine. Rheographic indicators of the cohort of 108 practically healthy girls aged from 12 to 15 years old and 103 boys aged from 13 to 16 years and 103, urban residents of the Podillia region of Ukraine, were determined using a cardiology computer diagnostic complex. Anthropometric survey was conducted in accordance with the scheme of V. V. Bunak (1941). To evaluate the somatotype of adolescents, the mathematical scheme of J. Carter and B. Heath (1990) was used. The statistical processing of the obtained results was carried out in the license package "Statistica 5.5" using nonparametric methods for evaluating the obtained results. As a result of the research, it was found that most of the amplitudes and some of the derived indicators of the crus rheogram in girls of the mesomorphic somatotype are significantly lower or tend to be smaller than those of other somatotypes, while the time of the rising part of the rheogram and the time of slow blood filling are significantly higher than at representatives of an ectomorphic somatotype. In boys of mesomorphic somatotype, the basic impedance and amplitude of the systolic wave and the average speed of fast and slow blood flow of the rheogram are significantly lower or tend to be lower than those of other somatotypes, while the time of the ascending part and fast blood flow of rheograms and the diastolic index are significantly greater than in the representatives of the ecto-mesomorphic somatotype. It has also been found that almost half of the amplitude and derivative indices are significantly higher in girls than in boys of corresponding somatotypes, and most of the time - on the contrary, in boys, than in girls of corresponding somatotypes. Thus, indicators of crus rheogram in practically healthy girls and boys of different somatotypes, inhabitants of the Podillia region of Ukraine have pronounced differences mainly between the representatives of mesomorphic and ectomorphic somatotypes. Established pronounced manifestations of sexual dimorphism of indicators of crus rheogram between adolescents of corresponding somatotypes.

Keywords: *indicators of crus rheogram, somatotype, practically healthy girls and boys, sexual differences.*

Introduction

Despite the considerable efforts of world medicine, the problem of successful treatment of lower limb vessels is still far from being solved. Thus, the successes of modern angiology led to an increase in the life expectancy of patients, which in turn led to an increase in the number of late complications of this pathology [6, 10]. First of all, they create a threat to early disability, worsen the quality of life and reduce its duration [14, 17, 26, 27].

To date, it has been established that vascular diseases of the lower extremities develop more often in patients who became ill both in childhood and in adolescence [1, 8]. This indicates the need to develop effective methods of prevention and treatment of vascular complications already in the early stages of the disease [11, 23, 28]. That is why, specialists who solve these tasks, should focus on the establishment of age standards and effective prediction of the occurrence of these disorders in children and adolescents [13, 18].

To evaluate the state of peripheral circulation, it is best to use the rheographic method. Its important advantage is the ability to evaluate the total blood flow to the tissues, for example, due to developed collaterals. In addition, blood circulation of several vascular areas, including symmetrical ones, is also simultaneously investigated, which makes it possible to easily detect circulatory disorders. This method significantly helps to correctly diagnose and, especially, for the current assessment of changes in blood circulation, including during functional tests [32].

Despite all the benefits of the method, the issue of hyperdiagnosis of vascular disease of the lower extremities in persons of different sex, age and somatotype by the results of the rheographic study remains relevant. Incorrect interpretation of the rheogram leads to hyperdiagnosis of serious illnesses and, consequently, to iatrogenesis and unreasonable limitation of physical activity and incorrect decision of expert questions. Most of the experimental and clinical studies performed on the diagnosis and treatment of lesions of the lower extremities from the side of the vascular bed relate mainly to the adult organism [4, 22, 24, 29]. A norm for assessing the functional state of the peripheral vascular system of adolescents were developed, as a rule, without somatotype and gender [9, 24, 25].

The *purpose* of the study is to establish features of the indicators of crus rheogram in practically healthy girls and boys of different somatotypes, residents of the Podillia region of Ukraine.

Materials and methods

After the preliminary questioning and instrumental and clinical-laboratory examinations on the basis of the research center of National Pirogov Memorial Medical University, Vinnytsya were selected 103 practically healthy boys aged 13 to 16 years old and 108 girls aged 12 to 15 years old, urban residents of the Podillia region of Ukraine.

Rheographic indicators of crus were determined using a cardiological computer diagnostic complex [35], which provides simultaneous recording of the electrocardiogram, phonocardiography, the main and differential tetrapolar rheogram and the measurement of blood pressure. For registration, tape rheovasographic electrodes TE.293.063-01 were used, of OJSC "NII REMA" production type "tape measure", which were superimposed on the edges of the investigated sections of the limbs. The study was conducted in a horizontal position of the patient after a 10-15 minute rest on the attic in a room with an air temperature of 20-22 °C. Before the registration, the electrodes and the investigated areas in the places of electrode overlay were treated with an alcohol, and then a physiological solution to reduce the resistance of the electrode-skin contact. Before each measurement, the device performed an automatic calibration with the quality control of the electrode overlay. The measuring current - 1.8 mA, the current frequency - 80 kHz. For the analysis 15 s rheogram records were used with subsequent program averaging of all periods of oscillation. As a result of processing rheograms, the characteristic points on the curve were automatically determined, the main indicators were determined, the conclusion about the condition of the circulatory system of the investigated area was formed.

Anthropometric survey was conducted in accordance with the scheme of V. V. Bunak [5]. To evaluate the somatotype of adolescents, the mathematical scheme of J. Carter and B. Heath [7] was used.

Statistical processing of the obtained results was carried out in the license package "Statistica 5.5" using non-parametric methods for evaluating the obtained results.

Results

Among the amplitude indicators of crus rheogram in girls of different somatotypes, the following changes are typical: relatively ($p < 0.05$-0.01) lower values of the amplitude of the systolic wave of the rheogram and rapid blood flow of the rheograms in mesomorphs than in ectomorphs and ecto-mesomorphs; relatively ($p < 0.05$) lover value of the amplitude of the diastolic wave of rheograms in mesomorphs than in ectomorphs; expressed tendency ($p = 0.057$) to the lower values of the basic impedance in the mesomorphs compared to the ectomorphs (Table 1). The following changes in the amplitude indices of the crus rheogram attract attention in boys: the values of the basal impedance in mesomorphs are significantly lower than in ectomorphs ($p < 0.01$), and in the ecto-mesomorphs the tendency ($p = 0.070$) to greater values than in the mesomorphs; relatively ($p < 0.05$) lower values of the amplitude of the systolic wave of the rheogram in mesomorphs than in ectomorphs (see Table 1).

When comparing the amplitude indicators of the crus rheogram between girls and boys of the corresponding somatotypes, the values of the following indices established significantly higher: basic impedance ($p < 0.001$) in girls of different somatotypes; amplitudes of incisure of rheograms ($p < 0.05$) in girls mesomorphs and ectomorphs; the amplitude of fast blood flow of rheograms ($p < 0.05$) in boys mesomorphs (see Table 1).

Among the time indicators of the crus rheogram in girls of different somatotypes, the following changes are typical: significantly higher ($p < 0.05$) values of the time of the ascending part of the rheogram and the time of slow blood flow of the rheograms in mesomorphs than those of the ectomorphic somatotype (see Table 1). Boys have the following changes in the time indicators of the crus rheogram: the higher values of the time of the rising part of the rheogram and the time of fast blood flow to the rheograms in the mesomorphs are significantly higher ($p < 0.05$-0.01) than in the ecto-mesomorphs and the tendency towards higher values ($p = 0.069$) of the time of the rising part than of ectomorphs (see Table 1).

When comparing time indicators of crus rheogram between girls and boys, of corresponding somatotypes established significantly higher, or the tendency towards

higher values of the following parameters: cardiac cycle duration (p<0.01-0.001) and time of the downward part of the rheogram in boys of different somatotypes; time of the rising part of the rheogram (p <0.05-0.01) in boys mesomorphs and ectomorphs; time of fast blood-filling rheograms in boys ectomorphs (p <0.05) and mesomorphs (p = 0.056) (see Table 1).

Among the derivative indicators of crus rheogram in girls of different somatotypes the following changes are typical: significantly (p <0.01-0.001) lower values of the average speed of fast and slow blood flow of rheograms in girls of mesomorphs than in girls of other somatotypes (see Table 1). In boys attract attention the following changes in the derivatives of the crus rheogram: significantly (p <0.05) greater diastolic index values in mesomorphs than in ecto-mesomorphs; relatively (p <0.05) lower values of mean speeds of fast rheogram in boys mesomorphs than in ectomorphs and a slight tendency (p = 0.076) to lower values in comparison with ecto-mesomorphs; relatively (p <0.05-0.01) lover values of mean velocity of slow blood filling of the crus in the mesomorphs are lower than those of other somatotypes (see Table 1).

Comparison of the derived indicators of crus rheogram between girls and boys of the corresponding somatotypes has established significantly higher values of the following indicators: the dicrotic index (p <0.05-0.01) in girls mesomorphs and ectomorphs; the index of tone of all arteries (p <0.05-0.01) in girls mesomorphs and ecto-mesomorphs; indicator of the tone of the arteries of middle and small diameter (p <0.05-0.001) in girls of different somatotypes (see Table 1).

Table 1. Changes in rheogram crus performance of adolescents of different somatotypes.

Indicators	Girls			Boys		
	mes	ec	ec/mes	mes	ec	ec/mes
G_Z (Ohm)	¯	-		q¯	p	-
G_H1 (Ohm)	q	p	p	q	p	
G_H2 (Ohm)						
G_H3 (Ohm)	q	p				
G_H4 (Ohm)	q	p	p			
G_C (s)						
G_A (s)	p	q		p-	¯	q
G_B (s)						
G_A1 (s)				p		q
G_A2 (s)	p	q				
G_H2H1 (%)						
G_H3H1 (%)				p		q
G_H4A1 (Ohm/s)	q	p	p	q¯	p	-
G_H1H4A2 (Ohm/s)	q	p	p	q¯	p	p
G_AC (%)						
G_A1C (%)						
G_A2C (%)						
G_A1A2 (%)						

Notes: mes - mesomorphic somatotype; ec - ectomorphic somatotype; ec/mes - ecto-mesomorphic, or meso-ectomorphic somatotype; - or ¯ - the value of the relevant indicators within the respective groups of boys or girls have a slight tendency to higher or lower values; **-** or ¯ - the value of the relevant indicators within the respective groups of boys or girls tends to higher or lower values; p r or q s - significant differences between the respective indicators in the groups of boys or girls; - significant differences in the performance of the respective somatotypes between boys or girls (higher rates are noted); - trends in the differences between boys or girls in the corresponding somatotypes (higher rates are noted); G_ - rheographic indicators of crus; _Z - basic impedance; _H1 - amplitude of the systolic wave; _H2 - incisure amplitude; _H3 - amplitude of the diastolic wave; _H4 - the amplitude of rapid blood flow; _C - duration of the heart cycle; _A - time of the ascending part; _B - time of the downward part; _A1 - time of fast blood filling; _A2 - time of slow blood flow; _H2H1 - dicrotic index; _H3H1 - diastolic index; _H4A1 - average speed of rapid blood flow; _H1H4A2 - the average speed of slow blood flow; _AC - index of tone of all arteries; _A1C - index of tone of arteries of large diameter; _A2C - index of tone of arteries of medium and shallow diameter; _A1A2 - ratio of arteries tones.

Discussion

Adolescence is the period of the most intense reorganization of the body. From how the genetically determined program of human development is implemented at this stage, its future health depends in many respects. Incorrect interpretation of normative rheographic data in adolescence is noted by the authors of many well-known manuals [20, 34]. For a long time, more attention was paid to young people in connection with the prize to the armed forces, therefore, the norms developed during the examination of young men, were used for young women, without taking into account the age peculiarities of development and the formation of their cardiovascular system [2, 12].

The authors of the research devoted to the development of functional criteria for assessing the circulation of lower extremities in adolescents emphasize that the range of rules for this age group is very broad [30, 33]. At the same time, in the literature less attention is paid to the causes of these changes. The assumptions about the mechanisms underlying the morpho-functional changes of the vessels of the lower extremities are stated. It is an intensive growth of vessels, activation of the hypothalamic-pituitary-adrenal gland system and associated vegetative changes, electrolyte imbalance, and also features of the stature [21, 31].

Adolescents of the same calendar age cannot be considered as a homogeneous group. They may be at different stages of puberty development and therefore have a different degree of morphofunctional maturity. Accumulate data on the dependence of morphofunctional parameters on the rate of puberty development; from biological, not from a calendar age. The interconnection of hemodynamic parameters with the types of constitution, biological age and hormonal phenotype of young women and young men [3,

15] is traced. The rheographic diagnostic algorithms used up till now do not take into account these features.

In connection with the foregoing it seems urgent to consider the features of hemodynamics of the vessels of the lower extremities in persons of adolescence age, evaluating the results depending on the type of body and gender.

In analyzing the features of the rheograms of crus in practically healthy teens of different somatotypes, we established the following changes:

- somatotypological features of girls crus rheograms: 1) in most cases, the amplitude indices in mesomorphs are significantly lower, or tend to be less than those of ecto- and ecto-mesomorphs (with the exception of the incisure amplitude); 2) the time of the ascending part of the rheogram and the time of slow blood filling in mesomorphs are significantly greater than that of ectomorphs; 3) the average speed of fast and slow blood filling in mesomorphs is significantly less than that of ecto- and ecto-mesomorphs;

- somatotypological features of crus rheograms in boys: 1) the basic impedance and amplitude of the systolic wave in mesomorphs are significantly lower, or tend to be less than those of ecto- and ecto-mesomorphs; 2) the time of the ascending part and the rapid blood flow to rheograms in mesomorphs are significantly greater than that of ecto-mesomorphs; 3) the average speed of fast and slow blood flow to rheograms in mesomorphs is significantly lower or tend to be lower than that of ecto and ecto-mesomorphs, and the diastolic index in mesomorphs is significantly greater than that of ecto-mesomorphs;

- gender-somatotypological peculiarities of the crus rheograms: 1) in girls of all somatotypes, the basic impedance is significantly greater than that of boys and attracts the attention of significantly higher values of the incisure amplitude in girls mesomorphs and ectomorphs, as well as the amplitude of rapid blood flow in boys mesomorphs; 2) significantly higher, or have tendency towards higher values of all time indicators in boys of mesomorphic and ectomorphic somatotypes, as well as the duration of the heart cycle and the time of the downward part of the rheogram in boys ecto-mesomorphs; 3) significantly higher, or have tendency towards higher values of the dicrotic index in girls of mesomorphic and ectomorphic somatotypes, the index of tone of all arteries in young women mesomorphs and ecto-mesomorphs, as well as the index of tone of arteries of middle and small diameter in girls of all somatotypes.

I. M. Kyrychenko [16] and V. M. Moroz et al. [19] proved that the magnitude of the indicators of central hemodynamics and all the indicators obtained with the tetrapolar rheocardiography method, both in boys and girls, most often differed in adolescents with mesomorphic somatotype, which coincides with the results we obtained.

Bogachyuk O. P. and Shevchenko V. M. [4], as in our studies, proved that in girls the maximum differences between the parameters of rheoencephalography are most often established in persons with mesomorphic somatotype, but in boys of different somatotypes, the true differences between the parameters of rheoencephalography are not installed at all.

In the body of adolescents morphofunctional and neuroendocrine changes occur, which are reflected in the activity of all organs, including the state of the vascular system of the lower extremities. Therefore, a comprehensive rheographic study of the features of peripheral hemodynamics in individuals of a certain age, sexual and constitutional group will help to identify group-specific markers that reflect the pre-nosological stages of the formation of angiopathies. This will allow for the development of recommendations for their detection, correction and prevention.

Conclusions

1. Most of the amplitudes and some of the derivative indicators of crus rheogram in girls of the mesomorphic somatotype are significantly lower or tend to be smaller than those of other somatotypes, while the time of the rising part of the rheogram and the time of slow blood filling are significantly greater than those of the ectomorphic somatotype.

2. The basic impedance and amplitude of systolic wave and the average speed of fast and slow blood flow of rheograms in boys of mesomorphic somatotype are significantly lower or tend to be lower than those of other somatotypes, while the time of the ascending part and fast blood flow of rheograms and diastolic index are significantly higher than in representatives of the ecto-mesomorphic somatotype.

3. Established pronouncements of sexual dimorphism indicators of crus rheogram among adolescents of corresponding somatotypes: almost half of the amplitude and derivative indices are significantly higher in girls of different somatotypes, and most of the time - in boys of different somatotypes.

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ОСОБЛИВОСТІ ПОКАЗНИКІВ РЕОГРАМИ ГОМІЛКИ У ПРАКТИЧНО ЗДОРОВИХ ПІДЛІТКІВ РІЗНИХ СОМАТОТИПІВ

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Нормативи для оцінки функціонального стану периферичної судинної системи розробляються, як правило, без урахування віку, статі та соматотипу. Мета дослідження - встановити особливості показників реограми гомілки у практично здорових дівчаток і хлопчиків різних соматотипів, мешканців Подільського регіону України. Реографічні параметри гомілки 108 практично здорових дівчаток віком від 12 до 15 років і 103 хлопчиків віком від 13 до 16 років, міських мешканців Подільського регіону України, визначені за допомогою кардіологічного комп'ютерного діагностичного комплексу. Антропометричне обстеження проведено згідно схеми В. В. Бунака (1941). Для оцінки соматотипу підлітків використовувалась математична схема J. Carter і B. Heath (1990). Статистична обробка отриманих результатів проведена в ліцензійному пакеті "Statistica 5.5" з використанням непараметричних методів оцінки отриманих результатів. В результаті проведених досліджень встановлено, що більшість амплітудних і частина похідних показників реограми гомілки у дівчаток мезоморфного соматотипу достовірно менші, або мають тенденцію до менших значень, ніж у представниць інших соматотипів, а час висхідної частини реограми та час повільного кровонаповнення - достовірно більші, ніж у представниць ектоморфного соматотипу. У хлопчиків мезоморфного соматотипу базовий імпеданс і амплітуда систолічної хвилі та середня швидкість швидкого і повільного кровонаповнення реограми достовірно менші, або мають тенденцію до менших значень, ніж у представників інших соматотипів, а час висхідної частини і швидкого кровонаповнення реограми та діастолічний індекс - достовірно більші, ніж у представників екто-мезоморфного соматотипу. Також встановлено, що майже половина амплітудних і похідних показників достовірно більша у дівчаток, ніж у хлопчиків відповідних соматотипів, а більшість часових - навпаки, у хлопчиків, ніж у дівчаток відповідних соматотипів. Таким чином, показники реограми гомілки у практично здорових дівчаток і хлопчиків різних соматотипів, мешканців Подільського регіону України мають виражені розбіжності переважно між представниками мезоморфного та ектоморфного соматотипів. Встановлені виражені прояви статевого диморфізму за показниками реограми гомілки між підлітками відповідних соматотипів.

Ключові слова: *показники реограми гомілки, соматотип, практично здорові дівчатка та хлопчики, статеві розбіжності.*

ОСОБЕННОСТИ ПОКАЗАТЕЛЕЙ РЕОГРАММЫ ГОЛЕНИ У ПРАКТИЧЕСКИ ЗДОРОВЫХ ПОДРОСТКОВ РАЗНЫХ СОМАТОТИПОВ

Хмель Л. Л., Гненная В. О., Серебренникова О. А., Смолко Н. Н.

Нормативы для оценки функционального состояния периферической сосудистой системы разрабатываются, как правило, без учета возраста, пола и соматотипа. Цель исследования - установить особенности показателей реограммы голени у практически здоровых девочек и мальчиков разных соматотипов, жителей Подольского региона Украины. Реографические параметры голени 108 практически здоровых девочек в возрасте от 12 до 15 лет и 103 мальчиков в возрасте от 13 до 16 лет, городских жителей Подольского региона Украины, определены с помощью кардиологического компьютерного диагностического комплекса. Антропометрическое обследование проведено согласно схеме В. В. Бунака (1941). Для оценки соматотипа подростков использовалась математическая схема J. Carter и B. Heath (1990). Статистическая обработка полученных результатов проведена в лицензионном пакете "Statistica 5.5" с использованием непараметрических методов оценки полученных результатов. В результате проведенных исследований установлено, что большинство амплитудных и часть производных показателей реограммы голени у девочек мезоморфного соматотипа достоверно меньше, или имеют тенденцию к меньшим значениям, чем у представительниц других соматотипов, а время восходящей части реограммы и время медленного кровенаполнения - достоверно больше, чем у представительниц эктоморфного соматотипа. У мальчиков мезоморфного соматотипа базовый импеданс и амплитуда систолической волны, средняя скорость быстрого и медленного кровенаполнения реограммы достоверно меньше, или имеют тенденцию к меньшим значениям, чем у представителей других соматотипов, а время восходящей части и быстрого кровенаполнения реограммы и диастолический индекс - достоверно больше, чем у представителей экто-мезоморфного соматотипа. Также установлено, что почти половина амплитудных и производных показателей достоверно больше у девочек, чем у мальчиков соответствующих соматотипов, а большинство временных - наоборот, у мальчиков, чем у девочек соответствующих соматотипов. Таким образом, показатели реограммы голени у практически здоровых девочек и мальчиков разных соматотипов, жителей Подольского региона Украины имеют выраженные различия в основном между представителями мезоморфного и эктоморфного соматотипов. Установлены выраженные проявления полового диморфизма по показателям реограммы голени между подростками соответствующих соматотипов.

Ключевые слова: *показатели реограммы голени, соматотип, практически здоровые девочки и мальчики, половые различия.*

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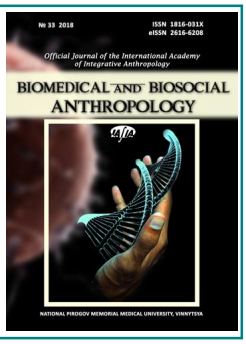

Peculiarities of the chest's size in female volleyball players of different constitutional types

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During qualified sport selection special attention should be paid to those features and abilities that have a great influence on the effectiveness, and those, that are mainly under the influence of genetic factor. Such morphogenetic markers of sports selection include, firstly, the constitutional features of athletes, in particular the shape of the chest. The purpose of work is to determine the differences between the anthropometric dimensions of the chest between female volleyball players of high level of athletic skill and non-sportsmen, who belonged to different constitutional types. On the base of the Scientific-Research Center of the Vinnytsya National Pirogov Memorial Medical University an anthropo-somatotypological investigation of 113 female volleyball players of high level athletic skill (from 16 to 20 years old) was done. The control group included 204 practically healthy young women, who were not engaged in sports of the corresponding age. Anthropometric research was performed according to the V. V. Bunak (1941) method, somatotypological study was based on the estimated modification of the Heath-Carter method (1990). In young women, who were not engaged in sports, more than in half of the cases were indicated constitutional types, which were characterized by good development of fatty body composition. Between female volleyball players were dominated individuals with mesomorphic somatotype (26.66%), ectomorphic somatotype (23.01%), ecto-mesomorphic somatotype (23.89%), and representatives of the intermediate somatotype (23.01%) were almost uniformly represented in the sample. The analysis of the results was carried out in the licensing program "Statistica 5.5" using nonparametric methods of estimating the parameters. We have found that the female volleyball players of the ectomorphic somatotype have the smallest anthropometric dimensions of the chest, as compared with athletes of other constitutional groups. In the mesomorphs female volleyball players all transverse and the most of overall sizes of the chest were the largest. Parameters of the athletes with the ecto-mesomorphic somatotype were slightly small to the size of the somatometric parameters of the mesomorphs, but they had the highest values of the anterior-posterior size of the chest. Female volleyball players with intermediate somatotype had larger values of the chest size than volleyball players with ectomorphic somatotype, although no significant difference was found when comparing them. It was found, that the most of the overall, transverse, and anterior-posterior dimensions of the chest in female volleyball players are statistically significantly higher than that of girls, who were not engaged in sports, and belonged to the same constitutional type as athletes. We have made a conclusion that belonging to one of the constitutional type does not provide similarity of morphometric parameters of the chest in persons with different levels of physical activity.

Keywords: *chest, anthropometry, somatotype, female volleyball players, juvenile age.*

Introduction

During a qualified sport selection, special attention should be paid to those features and abilities, that have a great influence on the effectiveness, and those, that are mainly under the influence of genetic factor [5, 8, 9, 10, 13, 21, 22, 25]. Among the morphogenetic factors that determine sports abilities, somatometric parameters play an important role

[14, 18, 19]. They have influence on the efficiency of energy supply systems, physical capacity, intensity of recovery, development of physical qualities and the nature of adaptation processes [24, 26]. These morphogenetic markers of sports selection, in the first place, include the constitutional features of athletes [7, 15]. Constitution is the complex of morphofunctional features of the organism, which is formed under the influence of the genotype and is modified by exogenous influences, among which the peculiarities of the particular sport activity are acquired [17]. Taking into account somatotypological affiliation of a person it is possible to indicate the time of puberty and aging, as well as to predict the influence of various environmental factors on the organism [1]. In various techniques of somatotyping, the following four features are taken into account, such as the development of the fat, bone and muscle components of body weight and human proportions, which, in particular, are determined by the shape of the chest. Anatomy of the human chest skeleton at various stages of ontogenesis (neonatal period, childhood, mature age) was of interest to many researchers [4, 11, 23]. In addition, in the literature there is evidence of differences in some parameters of the chest in individuals with a certain constitutional type. In most cases, these studies addressed to the children and persons of the youth age [6, 16]. L. V. Muzurova [12] was made morphometry of the body with the study of various parameters of the chest, such as the anterior-posterior, transverse size, anterior and posterior chest length in young men of 17-19 years of different types of constitution. But features of the chest in female athletes of high level of skills, which would belong to different constitutional types, are scarce.

The *purpose* of our work is to determine the differences between the anthropometric dimensions of the chest between female volleyball players of high level of athletic skill and non-sportsmen, who belonged to different constitutional types.

Materials and methods

On the base of the Scientific-Research Center of the Vinnytsya National Pirogov Memorial Medical University a comprehensive survey of 113 female volleyball players of high level athletic skill (from 16 to 20 years old) was done. Sports experience in all volleyball players is more than 3 years. The control group included 204 practically healthy young women, who were not engaged in sports of the corresponding age.

Anthropometric research was performed according to the V. V. Bunak [2] method, somatotypological study was based on the estimated modification of the Heath-Carter method [3]. After the somatotyping, it was found, that 29 female volleyball players and 36 non-sports young women belonged to the mesomorphic type of constitution. To ectomorphs were included 26 female volleyball players and 39 young women of the control group; to ecto-mesomorphs - 27 female volleyball players and 14 young women of the control group, to the middle intermediate type - 26 female volleyball players and 64 young women of the control group; to the endo-mesomorphs - 5 female volleyball players and 41 control young women, 10 control group young women belonged to the endomorphic somatotype. In the reason that the group of endo-mesomorphs among volleyball players was small, we did not study the constitutional features of the chest in this somatotype.

The analysis of the results was carried out in the licensing program "Statistica 5.5" using nonparametric methods of estimating the parameters. The reliability of the difference between the parameters was determined using the Man-Whitney U-criterion.

Results

After the somatotypological analysis of the overall dimensions of the chest (Table 1), it was found, that female volleyball players of the mesomorphic, ectomorphic, ecto-mesomorphic and intermediate types had a statistically significantly larger parameter of the chest girth during inspiration, than young women in the control group of the same somatotype (in all cases $p<0.001$). This anthropometric dimension is the largest in the female volleyball players of the mesomorphic somatotype, the smallest in athletes of ectomorphs. Significant differences were found when comparing female volleyball players with an ectomorphic type with athletes of mesomorphic and ecto-mesomorphic somatotypes (in both cases $p<0.01$).

The crossover size of the chest on expiration in mesomorphs female volleyball players is significantly lower, than in the control group ($p<0.001$). Athletes of the ectomorphic ($p<0.001$), ecto-mesomorphic ($p<0.001$) and intermediate ($p<0.01$) constitutional types have a larger girth of the chest on expiration, than girls of control groups. There are no established somatotypological differences in the level of this size of the chest when comparing groups of female volleyball players that belonged to different constitutional types (see Table 1).

The crossover size of the chest during rest at female volleyball players of different somatotypes is significantly higher, than that of control group young women (in all cases $p<0.001$). This size is the largest in the group of female volleyball players of mesomorphs. Parameters in the athletes of the ecto-mesomorphic and intermediate type are slightly smaller to the size of the chest girth at rest, and the ectomorphic female volleyball players have the smallest given size. Significant differences were found, when comparing volleyball players with an ectomorphic type with athletes of mesomorphic and ecto-mesomorphic somatotypes (in both cases $p<0.05$) (see Table 1).

It was found that the medium sternal diameter of the mesomorphic, ectomorphic, ecto-mesomorphic and intermediate somatotypes of female volleyball players is significantly higher ($p<0.01$-0.001), than that of young women of the same somatotype, who were not engaged in sports (respectively 26.60 ± 1.55 cm and 25.54 ± 2.96 cm in

Table 1. Features of the overall dimensions of the chest in female volleyball players of different somatotypes (M±σ, cm).

Parameters	Group	M±σ	p_1	p_2	p_3
Chest during inspiration	M_c	95.05±5.99		<0.01	>0.05
	$M_к$	86.46±7.14***			
	L_c	90.38±6.73	<0.01		<0.01
	$L_к$	82.67±5.12***			
	L-M_c	94.78±4.04	>0.05	<0.01	
	L-$M_к$	84.82±6.83***			
	S_c	92.73±6.10	>0.05	>0.05	>0.05
	$S_к$	86.42±4.99***			
Chest during expiration	M_c	85.94±6.34		>0.05	>0.05
	$M_к$	86.46±7.14***			
	L_c	83.09±6.05	>0.05		>0.05
	$L_к$	76.14±5.18***			
	L-M_c	86.00±4.67	>0.05	>0.05	
	L-$M_к$	77.34±5.86***			
	S_c	84.27±5.86	>0.05	>0.05	
	$S_к$	80.20±5.00**			
Chest during rest	M_c	89.94±6.29		<0.05	>0.05
	$M_к$	82.07±6.60***			
	L_c	85.94±6.60	<0.05		<0.05
	$L_к$	78.06±4.90***			
	L-M_c	89.33±4.40	>0.05	<0.05	
	L-$M_к$	80.37±6.14***			
	S_c	87.86±6.16	>0.05	>0.05	>0.05
	$S_к$	82.08±4.77***			

Notes: M_c - mesomorphs female volleyball players, $M_к$ - control group of mesomorphs somatotype, L_c - ectomorphic female volleyball players, $L_к$ - control group of ectomorphic somatotype, L-M_c - ecto-mesomorphic female volleyball players, L-$M_к$ - control group of ecto-mesomorphic somatotype, S_c - female volleyball players of the intermediate somatotype, $S_к$ - control group of female volleyball players of the intermediate somatotype; p_1 - the indicator of the statistical significance of the difference in anthropometric parameters between mesomorphs athletes and other groups of female volleyball players, p_2 - the indicator of the statistical significance of the difference in anthropometric parameters between ectomorphic female volleyball players and other groups of volleyball players, p_3 - the indicator of the statistical significance of the difference in anthropometric parameters between ecto-mesomorphic female volleyball players and other groups of athletes, * - the indicator of the significance of the difference in anthropometric parameters between individuals of the same somatotype in p<0.05, ** - the indicator of the significance of the difference in anthropometric parameters between individuals of the same somatotype in p<0.01, *** - the indicator of the significance of the difference in anthropometric parameters between individuals of the same somatotype in p<0.001.

mesomorphs, 25.38 ± 1.71 cm and 24.38 ± 2.95 cm in ectomorphs, 26.70 ± 1.37 cm and 24.32 ± 1.33 cm in ecto-mesomorphs, 23.85 ± 2.45 cm and 20.68 ± 1.50 cm in the representatives of the intermediate somatotype). In addition, it was found, that this size of the chest in female volleyball players of the ectomorphic somatotype is significantly larger, than that of athletes with mesomorphic (p<0.05) and ecto-mesomorphic (p<0.01) constitutional types.

Inferior sternal diameter in the female volleyball players of the mesomorphic, ectomorphic, ecto-mesomorphic and intermediate somatotypes is statistically significantly higher (p<0.001), than that of young men, who were not engaged in sports of the same somatotype (23.67 ± 2.31 cm respectively and 21.15 ± 3.38 cm in mesomorphs; 22.48 ± 1.40 cm and 20.14 ± 3.21 in ectomorphs, 23.87 ± 1.74 cm and 20.32 ± 1.55 cm in ecto-mesomorphs, 23.85 ± 2.45 cm and 20.68 ± 1.50 cm in the representatives of the intermediate somatotype). It was revealed, that in female volleyball players of the ectomorph somatotype the inferior sternal diameter has the smallest value in comparison with athletes of other constitutional types; statistically significant differences were observed between them and athletes of mesomorphic (p<0.05) and ecto-mesomorphic (p<0.01) types. In female volleyball players of the intermediate somatotype, the parameters of the inferior sternal diameter size are also greater than that of ectomorphs.

Anterior-posterior medium sternal size in female volleyball players of mesomorphic and ecto-mesomorphic somatotypes is statistically significantly higher (p<0.05), than in young women of the same somatotype who were not engaged sport (18.17 ± 2.02 cm, respectively, and 16.95 ± 1.20 cm in mesomorphs, 18.46 ± 3.20 cm and 16.82 ± 1.46 cm in ecto-mesomorphs). There were no significant differences between female volleyball players of the ectomorphic or intermediate somatotype and girls of the corresponding somatotypes, that were not engaged in sports (respectively 17.75 ± 3.59 cm and 16.72 ± 1.91 cm in ectomorphs, 16.90 ± 2.00 cm and 16.70 ± 1.28 cm in the representatives of the intermediate somatotype). The largest values of the anterior-posterior medium sternal size were found in athletes with an ecto-mesomorphic somatotype, but this group of athletes was the most heterogeneous in the value of this parameter, so there were no reliable differences when compared with the female volleyball players of other somatotypes.

There were no significant differences in the width of the shoulders between the female volleyball players of the mesomorphic, ectomorphic, ecto-mesomorphic or intermediate somatotypes and young women of the corresponding non-sports somatotypes (36.62 ± 2.16 cm, respectively, and 35.87 ± 2.66 cm in the mesomorphs, 35.69 ± 2.52 cm and 35.98 ± 2.32 cm in ectomorphs, 36.28 ± 2.00 cm and 35.75 ± 2.02 cm in ecto-mesomorphs, 36.44 ± 2.71 cm and 35.90 ± 2.77 cm in the representatives of the intermediate somatotype). Also, there are no significant differences in the comparison of athletes of different somatotypes.

Discussion

After somatotyping, we found, that female volleyball players belonged to the five constitutional types, while non-

sports girls belonged to six types of constitution. In young women, the control group is dominated by individuals with the intermediate somatotype (31.40%), with a high incidence of individuals with an endo-mesomorphic type (20.09%), and 4.90% - endomorphic type. Mesomorphic (17.64%) and ectomorphic (19.11%) types in this group occur almost with the same frequency, and the ecto-mesomorphic somatotype is found in 6.89% of cases. Thus, in young women, who were not engaged in sports, in more than half of the cases there are constitutional types, for which the good development of the fatty component of body composition is a characteristical feature. Female volleyball players are dominated by individuals with mesomorphic somatotype (26.66%), and ectomorphs (23.01%), ecto-mesomorphs (23.89%), and representatives of the intermediate somatotype (23.01%) in the sample are almost uniformly represented; an endo-mesomorphic somatotype was found in 4.42%. J. Lewandowska and others [7] proved, that adaptation to physical activity during the training process and taking into account the demands of sports selection in a particular sport, leads to a decrease in the varieties of somatotypes in comparison with the non-sports population. High-level athletes in different types of sport, which include volleyball, where stature is one of the most important factors affecting the outcome, are showed the greatest similarity to morphological characteristics and motor abilities. These qualities of athletes can be the basis for creating a somatic and physical "model" for this discipline.

The shape and size of the chest determine not only the somatotypological affiliation [16], but also have a significant role among other morphological indicators for predicting sports fitness. This is confirmed by Tkachuk M. G. and Sobolev A. A. [24], who discovered, that the overall parameters of the chest were significantly large for determining the fitness of the Sambs as length of their leg, the girth of arms and shoulders, correlation between the lengths of the leg and the length of the thigh, correlation between the length of the forearm and the shoulder length.

We found, that most of the overall, transverse and anterior-posterior dimensions of the chest in female volleyball players were statistically significantly higher, than that of young women, who were not engaged in sports, and belonged to the same constitutional type as athletes. An exception to this feature are only two anthropometric dimensions: the width of the shoulders, which does not have a significant difference between any of the comparison groups, and the girth of the chest during expiration in the volleyball players of the mesomorphic somatotype, which is significantly lower than in the control. We think that lower values of this size are the positive adaptation mechanism of changes. It is so, because only in mesomorphs, which are characterized by a predominant development of the muscular component of the somatotype, a decrease in the chest girth during expiration and an increase in this case the parameters during inspiration indicates a great excursion of the chest. In our previous studies [20], it was also found, that mesomorphs female volleyball players, that there were a significantly larger parameters of the length, body mass, body surface area and another body sizes, than in young women in the same somatotype, who were not engaged in sport. Thus, we can conclude, that belonging to one constitutional type, does not provide a similarity of morphometric parameters of the chest in persons with different levels of physical activity.

In addition, we found, that the female volleyball players of the ectomorphic somatotype have the smallest anthropometric dimensions of the chest, compared with athletes of other constitutional groups. In the mesomorphs female volleyball players all transverse, most overall sizes of the chest are the greatest. Parameters of the athletes with an ecto-mesomorphic somatotype are slightly small to the size of the somatometric parameters of the mesomorphs, but they have the largest values of the anterior-posterior size of the chest. Female volleyball players with intermediate somatotype have larger values of the size of the chest, than female volleyball players with an ectomorphic somatotype, although no significant difference in their comparison was found.

Using of the somatotypological method during analyzing of the external body parameters will allow more accurate prediction of changes in anthropometric parameters of volleyball players under the influence of training-competitive activities.

Conclusions

1. In female volleyball players of mesomorphic, ectomorphic, ecto-mesomorphic and intermediate somatotypes compared to young women, who are not engaged in sports of the same constitutional type, are indicated significantly larger somatometric parameters of the chest, except for shoulder width.

2. A large number of the anthropometric dimensions of the chest in female volleyball players of an ectomorphic somatotype are significantly less than female volleyball players of mesomorphic and ecto-mesomorphic types.

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ОСОБЛИВОСТІ РОЗМІРІВ ГРУДНОЇ КЛІТКИ У ВОЛЕЙБОЛІСТОК РІЗНИХ КОНСТИТУЦІОНАЛЬНИХ ТИПІВ

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При проведенні кваліфікованого спортивного відбору у окремий вид спорту особливу увагу необхідно приділяти тим рисам та здібностям, які однозначно впливають на результативність, і тим, які переважно знаходяться під впливом генетичних факторів. До таких морфогенетичних маркерів спортивного відбору, у першу чергу, належать конституціональні особливості спортсменів, зокрема форма грудної клітки. Мета роботи - встановити відмінності антропометричних розмірів грудної клітки між волейболістками високого рівня спортивної майстерності та неспортсменками, які належали до різних конституціональних типів. На базі науково-дослідного центру Вінницького національного медичного університету ім. М. І. Пирогова проведене антропо-соматотипологічне дослідження 113 волейболісток високого рівня спортивної майстерності юнацького віку (від 16 до 20 років). Контрольну групу склали 204 практично здорових дівчат того ж віку, які не займалися спортом. Антропометричне вимірювання проводили за методом В. В. Бунака (1941), соматотипологічне дослідження - за розрахунковою модифікацією метода Heath-Carter (1990). У дівчат, які не займалися спортом, більше ніж у половині випадків зустрічалися конституціональні типи, для яких характерним було добрий розвиток жирової складової статури тіла. У волейболісток переважали особи з мезоморфним соматотипом (26,66%), а ектоморфи (23,01%), екто-мезоморфи (23,89%) і представниці середнього проміжного соматотипу (23,01%) у вибірці були представлені майже рівномірно. Аналіз отриманих результатів проведено у ліцензійному пакеті "Statistica 5.5" з використанням непараметричних методів оцінки показників. Нами встановлено, що волейболістки ектоморфного соматотипу мають найменші антропометричні розміри грудної клітки, порівняно з спортсменками інших конституціональних груп. У волейболісток мезоморфів всі поперечні, більшість обхватних розмірів грудної клітки були найбільшими. Спортсменки з екто-мезоморфним соматотипом незначно поступалися за величиною соматометричних параметрів мезоморфам, але у них були найбільші середні значення передньо-заднього розміру грудної клітки. Волейболістки з середнім проміжним соматотипом мали більші

середні значення розмірів грудної клітки, ніж волейболістки з ектоморфним соматотипом, хоча достовірної різниці при їх порівнянні не виявлено. Виявлено, що більшість обхватних, поперечних і передньо-задніх розмірів грудної клітки у волейболісток статистично значуще більші, ніж у дівчат, які не займалися спортом і належали до того ж конституціонального типу, що і спортсменки. Можна зробити висновок, що належність до одного конституціонального типу не забезпечує подібність морфометричних параметрів грудної клітки в осіб з різним рівнем фізичного навантаження.
Ключові слова: *грудна клітка, антропометрія, соматотип, волейболістки, юнацький вік.*

ОСОБЕННОСТИ РАЗМЕРОВ ГРУДНОЙ КЛЕТКИ У ВОЛЕЙБОЛИСТОК РАЗЛИЧНЫХ КОНСТИТУЦИОНАЛЬНЫХ ТИПОВ

Сарафинюк Л. А., Пивторак В. И., Хавтур В. О., Федонюк Л. Я., Хапицкая О. П.

При проведении квалифицированного спортивного отбора в отдельный вид спорта особое внимание необходимо уделять тем характеристикам и возможностям, которые однозначно влияют на результативность, и тем, которые в основном находятся под влиянием генетических факторов. К таким морфогенетических маркерам спортивного отбора, в первую очередь, принадлежат конституциональные особенности спортсменов, в том числе форма грудной клетки. Цель работы - установить различия антропометрических размеров грудной клетки между волейболистками высокого уровня спортивного мастерства и неспортсменками, принадлежащими к разным конституциональным типам. На базе научно-исследовательского центра Винницкого национального медицинского университета им. Н. И. Пирогова проведено антропо-соматотипологическое исследование 113 волейболисток высокого уровня спортивного мастерства юношеского возраста (от 16 до 20 лет). Контрольную группу составили 204 практически здоровых девушек того же возраста, которые не занимались спортом. Антропометрические измерения проводили по методу В. В. Бунака (1941), соматотипологическое исследование - по расчетной модификации метода Heath-Carter (1990). У девушек, которые не занимались спортом, больше чем в половине случаев встречались конституциональные типы, для которых характерно хорошее развитие жировой составляющей телосложения. У волейболисток преобладали лица с мезоморфным соматотипом (26,66%), а эктоморфы (23,01%), экто-мезоморфы (23,89%) и представительницы среднего промежуточного соматотипа (23,01%) в выборке были представлены почти равномерно. Анализ полученных результатов проведен в лицензионном пакете "Statistica 5.5" с использованием непараметрических методов оценки показателей. Нами установлено, что волейболистки эктоморфного соматотипа имеют наименьшие антропометрические размеры грудной клетки по сравнению со спортсменками других конституциональных групп. У волейболисток мезоморфов все поперечные, большинство охватных размеров грудной клетки были наибольшими. Спортсменки с экто-мезоморфным соматотипом незначительно уступали по величине соматометрических параметров мезоморфам, но у них были наибольшие средние значения переднезаднего размера грудной клетки. Волейболистки со средним промежуточным соматотипом имели большие средние значения размеров грудной клетки, чем волейболистки с эктоморфным соматотипом, хотя достоверной разницы при их сравнении не обнаружено. Выявлено, что большинство охватных, поперечных и передне-задних размеров грудной клетки у волейболисток статистически значимо больше, чем у девушек, которые не занимались спортом и принадлежали к тому же конституциональному типу, что и спортсменки. Можно сделать вывод, что принадлежность к одному конституциональному типу не обеспечивает сходство морфометрических параметров грудной клетки у лиц с разным уровнем физической нагрузки.
Ключевые слова: *грудная клетка, антропометрия, соматотип, волейболистки, юношеский возраст.*

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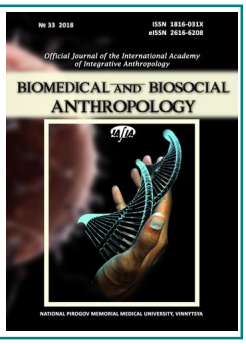

Age peculiarities of spirometric indices within the juvenile period of ontogenesis

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In the modern world, there are many causes (reducing the elasticity of the lungs, reducing bronchial tubes, reducing the strength of the respiratory muscles) that affect the parameters of external respiration. Knowledge of age, sexual and regional features of spirometric indicators helps to differentiate and detect the degree of disturbance of respiratory biomechanics and to choose effective treatments that are most appropriate for established violations. The purpose of the work is to establish the age-old peculiarities of the spirographic indexes of virtually healthy young men and women within the juvenile period of ontogenesis. We conducted a survey of 141 young women (from 16 to 20 years of age) and 154 young men (from 17 to 21 years) of adolescence. The spirographic study was conducted according to the generally accepted methodology of the American Association of Pulmonologists adopted in 1994 on the device Medgraphics Pulmonary Function System 1070 series. The analysis of the obtained results was carried out with the help of the license program "Statistica 5.5" using nonparametric methods of estimating indicators. The progressive age dynamics of the vital capacity, forced vital capacity, forced capacity of the lungs on the inhalation, volume exhalation velocity was detected in young women in 25% and 50% respectively of the forced vital capacity, the average expiration flow, the residual volume of exhalation and the forced inspiratory flow, respectively is 50% of exhalation from the forced vital capacity. In the last year (20 years) of the youthful period of ontogenesis in young women, the maximum arbitrary ventilation of the lungs is increased, the volume exhalation rate is 75%, and from 75% to 85% of exhalation from the forced vital capacity, the one-second volume of forced exhalation and maximal peak flow of exhalation. Within the juvenile period of ontogenesis in young men, the vital capacity of the lungs increases, the maximum arbitrary ventilation of the lungs and the maximum peak flow of exhalation. Only in the last year of the youthful period of ontogeny (21 years) in young men there is an increase in forced vital capacity, volume exhalation velocity, respectively, in 25% of the forced vital capacity, the residual volume of exhalation, one-second volume of forced exhalation was observed at the end.

Keywords: *spirometry, spirometric indices, young men, young women.*

Introduction

The widespread occurrence of bronchopulmonary diseases, their growth in recent decades makes it necessary for a wider introduction of methods for studying the respiratory system [6, 11, 12]. There are many factors in Ukraine and in other countries of the modern world (tobacco smoking, harmful working conditions, ecological situation, infectious diseases of the respiratory system, congenital anomalies of the lungs, etc.) that affect the reduction of the elasticity of the lungs, reduce the bronchial patency and strength of the respiratory muscles, which respectively affects the parameters of external respiration [4, 19].

Early detection of violations of respiratory biomechanics, dynamic observation of patients, the choice of treatment methods that best fit established violations, provide modern effective therapy. The widespread introduction of computerized devices, the rejection of the use of simple mechanical devices in recent years have both positive and negative sides. Sometimes there is the effect of a "black box" when the one who conducts a diagnostic study and evaluates its results does not fully understand their

diagnostic value. This situation arises in cases where the researcher does not take into account age, gender, constitution, bad habits, occupation of certain sports, lifestyle and other factors. This inevitably devaluates the study, leads to gross diagnostic and tactical errors, which are often observed in scientific and practical research [21].

Spirometry is the most common method of diagnosing the functional state of the lungs, as well as the detection of respiratory diseases [5, 8, 9]. Spirometry is a gold standard for the diagnosis of chronic obstructive pulmonary diseases [14], which worldwide have high prevalence, morbidity and mortality and create significant health problems [13].

Unlike laboratory tests that have fixed indicators of norm in young men and young women of a particular population, for spirometry, such indicators have been poorly studied [7]. Therefore, the establishment of standard parameters of spirography (volumetric, velocity and pulmonary ventilation) in healthy young men and young women within the juvenile period of ontogenesis is extremely important.

The *purpose* of the work is to establish the age-old peculiarities of the spirographic indexes of practically healthy young men and women within the juvenile period of ontogenesis.

Materials and methods

Together with the team of performers of the planned general-university scientific theme "Development of normative criteria of health of various age and sex groups", on the basis of the research center of the National Pirogov Memorial Medical University, Vinnytsya as a result of a comprehensive survey were selected adolescence, practically healthy young men and young women, urban population, who in the third generation live in the Podillia region of Ukraine.

The spirographic study was conducted according to the generally accepted methodology of the American Thoracic Society, adopted in 1994 [3] on the device Medgraphics Pulmonary Function System 1070 series.

A spirographic study of 141 young women was conducted, of which: 16 years old - 32; 17 years old - 29; 18 years old - 27; 19 years old - 25; 20 years old - 28 people; and 154 young men among them: 17-year-olds - 28; 18 years old - 37; 19 years old - 27; 20 years old - 32; 21-year-old 30 people.

The analysis of the obtained results was carried out with the help of the license program "Statistica 5.5" using nonparametric methods of estimating the indicators.

Results

It was established that the vital capacity of lungs in 16-year-old young women is 3.813 ± 0.687 L, at 17 years old - 3.980 ± 0.762 L, at 18 years old - 4.011 ± 0.536 L, at 19 years - 4.130 ± 0.628 L, in 20-year-olds - 4.305 ± 0.675 L. The value of this spirographic index is significantly higher in 20-year-old young women than in 16-year-olds ($p < 0.01$) and in 19-year-olds compared with 16-year-olds ($p < 0.05$) in the female population. The magnitude of the vital capacity is also significantly higher in 20-year-old young women compared to 17-year-olds ($p < 0.05$) young women.

The rate of forced vital capacity in 16-year-old young women is 3.541 ± 0.552 L, at 17 years old - 3.715 ± 0.619 L, at 18 years old - 3.723 ± 0.696 L, at 19 years old - 3.895 ± 0.674 L, at 20 years old - 4.005 ± 0.734 L. The value of this indicator of spirography is significantly higher in 20-year-old young women than in 16-year-olds ($p < 0.05$) and in 19-year-olds compared to 16-year-olds ($p < 0.05$) females.

Indicator of forced capacity of the lungs on the inspiration in 16-year-old young women is 2.636 ± 0.768 L, at 17 years old - 2.685 ± 0.672 L, at 18 years old - 2.761 ± 0.788 L, at 19 years old - 2.921 ± 0.633 L, in 20-year-old - 2.462 ± 0.663 L. The value of this spirographic index is significantly higher only in 19-year-old young women compared to 20-year-olds ($p < 0.05$) females.

The rate of maximum free ventilation in 16-year-old young women is 110.0 ± 21.6 L/min, at 17 years of age - 100.0 ± 19.9 L/min, at the age of 18 years - 105.9 ± 21.3 L/min, at the age of 19 years - 104.0 ± 28.3 L/min, at 20 years old - 121.8 ± 23.5 L/min. The value of this spirographic index is significantly higher in 20-year-old young women than in 16-year-olds ($p < 0.01$), 17-year-olds ($p < 0.001$), 18-year-olds ($p < 0.05$), and 19-year-olds ($p < 0.05$) females.

The indicator of volumetric exhalation velocity, correspondingly, in 25% of the forced vital capacity in 16-year-old young women is 5.947 ± 1.423 L/s, at 17 years of age - 5.775 ± 0.847 L/s, at 18 years of age - 5.348 ± 1.181 L/s, at 19 years - 6.285 ± 1.299 L/s, at 20 years old - 6.906 ± 1.544 L/s. The size of this spirographic index is statistically significantly higher in 20-year-old young women than in 16-year-olds ($p < 0.05$), 17-year-olds ($p < 0.01$), and 18-year-olds ($p < 0.001$) females. Also, the indicator of volume exhaust velocity, correspondingly, in 25% of the forced vital capacity is significantly higher in 19-year-old young women than in the 18-year-olds ($p < 0.05$).

The indicator of volume exhaust velocity, correspondingly, in 50% of the forced vital capacity in 16-year-old young women is 4.338 ± 1.053 L/s, at 17 years - 4.213 ± 0.956 L/s, at 18 years of age - 3.685 ± 0.986 L/s, at 19 years - 4.438 ± 1.332 L/s, at 20 years - 5.030 ± 1.344 L/s. The size of this spirographic index is statistically significantly higher in 20-year-old young women than in 16-year-olds ($p < 0.05$), 17-year-olds ($p < 0.01$), and 18-year-olds ($p < 0.001$) females. Also, the expiratory volume index of 50% of the forced vital capacity is significantly higher in 19-year-old young women than in 18-year-olds ($p < 0.05$) and is significantly higher in 16-year-olds compared to 18-year-old young women ($p < 0.05$).

Indicator of volume exhaust velocity, corresponding to 75% of the forced vital capacity in 16-year-old young women, is 2.372 ± 0.752 L/s, at 17 years of age - 2.203 ± 0.701 L/s, at 18 years old - 2.052 ± 0.724 L/s, at 19 years old - 2.355 ± 0.856 L/s, at 20 years old - 2.678 ± 0.704 L/s. The value of this spirographic index is statistically significantly higher in

20-year-old young women only compared to 17-year-olds (p <0.05) and 18-year-olds (p <0.01) females.

The indicator of volume exhalation rate from 75% to 85% of exhalation from forced vital capacity in 16-year-old young women is 1.948 ± 0.719 L/s, at 17 years of age - 1.675 ± 0.619 L/s, at 18 years of age - 1.684 ± 0.604 L/s, at 19 years - 1.870 ± 0.758 L/s, at 20 years - 2.107 ± 0.697 L/s. The value of this spirographic index is significantly higher in 20-year-old young women only compared to 17-year-olds (p <0.05) and 18-year-olds (p <0.05) females.

The average expiratory flow rate in 16-year-old young women is 3.784 ± 1.103 L/s, at 17 years old - 3.701 ± 0.982 l/s, at 18 years old - 3.349 ± 0.953 L/s, at 19 years old - 3.997 ± 1.173 L/s, at 20 years - 4.500 ± 1.161 L/s. The value of this spirographic index is significantly higher in 20-year-old young women than in 16-year-olds (p <0.05), 17-year-olds (p <0.01), and 18-year-olds (p <0.001) females. Also, the average outflow rate is significantly higher in 19-year-old young women than in the 18-year-olds (p <0.05).

The indicator of the maximum peak exhalation flow in 16-year-old young women is 6.581 ± 1.467 L/s, at 17 years old - 6.636 ± 1.072 L/s, at 18 years - 6.233 ± 1.688 L/s, at 19 years - 7.173 ± 1.661 L/s, at 20 years - 7.323 ± 1.918 L/s. The value of this spirographic index is significantly higher only in 20-year-old young women compared to 19-year-olds (p <0.05) females.

The rate of inhalation capacity in 16-year-old young women is 2.545 ± 0.437 L, at 17 years old - 2.727 ± 0.645 L, at 18 years old - 2.687 ± 0.549 L, at 19 years - 2.552 ± 0.403 L, at 20 years old - 2.627 ± 0.387 L. The true differences of this spirographic index within the juvenile period of ontogenesis in young women have not been established.

The rate of residual expiratory volume in 16-year-old young women is 1.267 ± 0.497 L, at 17 years old - 1.251 ± 0.291 L, at 18 years old - 1.325 ± 0.286 L, at 19 years - 1.578 ± 0.427 L, in the 20 years old - 1.676 ± 0.563 L. The size of this spirographic index is significantly higher in 20-year-old young women than in 16-year-olds (p <0.01), 17-year-olds (p <0.01), and 18-year-olds (p <0.01) females. Also, the residual expiratory rate is significantly higher in 19-year-old young women than in 17-year-olds (p <0.01) and 18-year-olds (p <0.05).

The rate of forced inhalation flow, which is 50% of exhalation from the forced vital capacity in 16-year-old young women, is 2.284 ± 0.573 L/s, at 17 years of age - 2.265 ± 0.856 L/s, at 18 years of age - 2.374 ± 1.000 L/s, at 19 years - 2.412 ± 0.812 L/s, at 20 years - 2.557 ± 0.869 L/s. The value of this spirographic index is significantly higher only in 19-year-old young women compared with 16-year-olds (p <0.05) females.

The rate of one-second volume of forced exhalation in 16-year-old young women is 3.159 ± 0.556 L, at 17 years old - 3.214 ± 0.510 L, at 18 years old - 3.204 ± 0.604 L, at 19 years - 3.432 ± 0.688 L, at 20 years - 3.551 ± 0.682 L. The value of this spirographic index is statistically significantly higher in 20-year-old young women than in 16-year-olds (p <0.05), 17-year-olds (p <0.05), and 18-year-olds (p <0.05) females.

The Tiffeneau-Pinelli index for 16-year-old young women is 89.24 ± 7.90%, at the age of 17 - 86.85 ± 7.14%, at 18-year-olds - 86.81 ± 7.68%, at 19-year-olds - 87.82 ± 7.46%, at the age of 20 - 87.68 ± 10.87%. The true differences of this spirographic index within the juvenile period of ontogenesis in young women have not been established.

It was established that the lifetime capacity of lungs in 17-year-old young men is 5.344 ± 0.701 L, in 18 years - 5.477 ± 0.805 L, at 19 years - 5.561 ± 0.712 L, at 20 years - 5.809 ± 0.916 L, in 21-year-olds - 6.101 ± 0.789 L. The value of this spirographic index is significantly higher in 21-year-old young men than in the 17-year-olds (p <0.001), 18-year-olds (p <0.01) and 19-year-old (p <0.05) year-olds than in the 17-year-olds (p <0.05) young men.

The indicator of forced vital capacity in 17-year-old young men is 5.116 ± 0.994 L, at 18-year-olds - 5.307 ± 1.130 L, in 19-year-olds - 5.200 ± 0.865 L, at 20-year-olds - 5.402 ± 1.119 L, at 21 years old - 6.047 ± 0.821 L. The value of this spirographic index is significantly higher in 21-year-old compared to 17-year-olds (p <0.001), 18-year-olds (p <0.01), 19-year-olds (p <0.001) and 20-year-olds (p <0.05) male.

Indicator of forced capacity of the lungs on the inspiration in 17-year-old young men is 3.608 ± 1.147 L, at 18 years old - 3.702 ± 1.124 L, at 19 years old - 3.704 ± 1.024 L, at 20 years old - 3.677 ± 1.134 L, in the 21-year-old - 3.714 ± 0.930 L. Significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

The rate of maximum random ventilation in 17-year-old young men is 153.3 ± 38.7 L/min, 18 years old - 181.5 ± 34.1 L/min, at 19 years - 176.5 ± 32.3 L/min, at 20 years - 189.9 ± 34.0 L/min, at 21 years - 200.0 ± 33.2 L/min. The value of this spirographic index is significantly higher in 21-year-old young men than in the 17-year-olds (p <0.001), 18-year-olds (p <0.05) and 19-year-olds (p <0.05) (p <0.001), at 19 years of age than in the 17-year-olds (p <0.05) and in 18-year-olds than in the 17-year-olds (p <0.01) young men.

The indicator of volumetric exhalation velocity, corresponding to 25% of the forced vital capacity in 17-year-old young men, is 7.985 ± 1.789 L/s, at 18 years old - 8.780 ± 2.012 L/s, at 19 years - 8.007 ± 2.417 L/s, at 20 years old - 8.647 ± 2.139 L/s, at 21 years old - 9.261 ± 1.832 L/s. The value of this spirographic index is statistically significantly higher only in 21-year-old young men compared with 17-year-olds (p <0.01) males.

The indicator of the volume exhaust velocity, correspondingly, in 50% of the forced vital capacity in 17-year-old young men is 5.654 ± 1.270 L/s, at 18 years of age - 6.242 ± 1.706 L/s, at 19 years - 5.156 ± 1.822 L/s, at 20 years of age - 5.746 ± 1.885 L/s, at 21 years of age - 5.963 ± 1.490 L/s. Significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

The indicator of volume exhaust velocity, corresponding

to 75% of the forced vital capacity in 17-year-old young men, is 2.963 ± 1.038 L/s, at 18 years old - 2.985 ± 1.031 L/s, at 19 years - 2.609 ± 1.120 L/s, at 20 years old - 2.954 ± 1.250 L/s, at 21 years old - 2.948 ± 0.990 L/s. The value of this spirographic index is statistically significantly higher only in 18-year-old young men compared with 19-year-olds ($p < 0.05$) males.

The indicator of the volume exhaust velocity from 75% to 85% of exhalation from the forced vital capacity in 17-year-old young men is 2.342 ± 0.902 L/s, at 18 years of age - 2.245 ± 0.871 L/s, at 19 years of age - 1.968 ± 0.927 L/s, at 20 years - 2.245 ± 1.093 L/s, at 21 years of age - 2.267 ± 0.948 L/s. Significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

The average expiratory flow rate for 17-year-old young men is 5.028 ± 1.235 L/s, at 18 years old - 5.486 ± 1.394 L/s, at 19 years - 4.692 ± 1.663 L/s, at 20 years - 5.133 ± 1.618 L/s, at 21 years of age - 5.254 ± 1.346 L/s. Statistically significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

The indicator of the maximum peak exhalation flow in 17-year-old young men is 9.676 ± 2.403 L/s, at the age of 18 years - 10.49 ± 2.29 L/s, at 19 years - 10.47 ± 2.09 L/s, at 20 years - 10.99 ± 2.26 L/s, at 21 years of age - 11.33 ± 2.27 L/s. The value of this spirographic index is significantly higher in 21-year-old young men than in the 17-year-olds ($p < 0.01$) and in 20-year-old young men compared with 17-year-olds ($p < 0.05$) males.

The rate of inhalation capacity in 17-year-old young men is 3.456 ± 0.644 L, at 18 years old - 3.490 ± 0.558 L, at 19 years old - 3.468 ± 0.477 L, at 20 years old - 3.711 ± 0.760 L, at 21 years old - 3.806 ± 0.751 L. Significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

The indicator of residual expiratory volume in 17-year-old young men is 1.926 ± 0.484 L, at 18 years old - 1.983 ± 0.680 L, at 19 years - 2.094 ± 0.680 L, at 20 years old - 2.098 ± 0.649 L, in the 21-year-old - 2.293 ± 0.548 L. The value of this spirographic index is statistically significantly higher in 21-year-old young men compared with 17-year-olds ($p < 0.01$) males.

The rate of forced flow of inspiration, which is 50% of exhalation from the forced vital capacity in 17-year-old young women, is 2.911 ± 1.466 L/s, at 18 years old - 2.935 ± 1.105 L/s, at 19 years - 2.871 ± 1.072 L/s, at 20 years - 2.991 ± 1.403 L/s, at 21 years - 3.182 ± 1.183 L/s. Statistically significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

The rate of one-second volume of forced exhalation in 17-year-old young women is 4.428 ± 0.844 L, at 18 years - 4.598 ± 0.975 L, at 19 years - 4.344 ± 0.841 L, at 20 years - 4.720 ± 0.885 L, at 21-year-olds - 5.076 ± 0.722 L. The value of this spirographic index is significantly higher in 21-year-old young men compared with 17-year-olds ($p < 0.01$), 18-year-olds ($p < 0.05$) and 19-year-olds ($p < 0.01$) males.

The Tiffeneau-Pinelli index of 17-year-old young men is 86.47 ± 6.32%, at 18-year-olds - 86.39 ± 5.20%, at 19-year-olds - 83.53 ± 8.39%, at age 20 - 85.22 ± 5.32%, at age 21 - 84.10 ± 6.93%. Significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

Discussion

The juvenile period of ontogenesis is marked by an uneven progressive increase in a number of morpho-functional indicators of the body [16]. Parameters of the respiratory system are not an exception to this regularity. The identified racial and population differences in the parameters of external respiration make relevant searches for normative indicators for the inhabitants of certain regions. But, unfortunately, data on the characteristics of external respiration indices in practically healthy persons within the youth period of ontogenesis does not exist at the representatives of the Podillia ethno-territorial region. Namely representatives of a separate population with a certain amplitude of acclimatization opportunities and inherited adaptation opportunities should take a prominent position in medical biology forecasting. To assess the health of an individual, it is necessary to have an idea of those indicators that can be considered normal for it as a representative of a specific ethno-social population, which is adapted to a certain complex of exogenous factors. This is especially relevant for the Ukrainian population, as the result of the demographic crisis of the twentieth century, environmental degradation, which is characteristic of many regions of the country, has created conditions that can affect the basic characteristics of the human population [2]. The results of scientific research by Tymchenko O. I. and others [22] suggest that the population of Ukraine is not adapted to the conditions of existence. Therefore, it once again emphasizes the urgent need to study the peculiarities of the morpho-functional parameters of the body, in particular the parameters of external respiration, in practically healthy persons of the Ukrainian ethnic group living on a separate territory of Ukraine - Podillia.

As a result of our study, it was found that most spirometric indicators in young women and young men have positive growth dynamics within the juvenile period of ontogenesis. Thus, the vital capacity of lungs in 16-year-old young women has the smallest value, at 20-year-olds - the largest. In young men of 17 years, the lifetime capacity of lungs is significantly lower than in young men of the 20 and 21 years. Thus, the progressive age-related increase of this indicator occurs in the second half of the youth period of ontogenesis: in the female population of 19-20 years, in young men from 20-21 years.

The rate of forced vital capacity is the volume of air that can escape from the lungs with forced exhalation after a maximum inhalation and in the normal range of 70-80% of

the lung capacity. We found that the progressive age-related increase in this indicator in young women was observed in the last 2 years of the youthful period of ontogenesis (from 19-20 years). In young men, an increase in forced vital capacity is observed at the end of the youthful period of ontogenesis, only from the age of 21.

The results obtained by us do not contradict the conclusions made by Alfrayh A. et al. [1] that the indicators of forced vital capacity increase with age in juvenile men and women.

We found that in young women the indicator of forced capacity of the lungs on the inspiration in the 16 and 17-year-old practically does not differ, in 18-year-old young women it is slightly larger, and in 19 years the greatest value of this indicator is observed. In males within the juvenile period, there are no significant differences in the ontogenesis in the size of this spirographic index.

In young men, there was a significant progressive increase in the rate of maximum random ventilation throughout the juvenile period of ontogeny, and in young women, this indicator is significantly increased only at the end of the juvenile period of ontogenesis (from 20 years).

The indicator of volume expiratory rate, correspondingly, in 25% of the forced vital capacity, has a progressive age increase in female subjects in the second half of the youth period of ontogenesis (from 19-20 years), and in males only at the end of this period of ontogenesis (at 21 year).

It is established that the indicator of volume exhalation velocity, correspondingly, in 50% of the forced vital capacity, has significantly higher values for young women at the end of the juvenile period of ontogenesis (from 19-20 years). Significant differences in young men of this spirographic index within the juvenile period of ontogenesis have not been established.

In young women, at the beginning of the youthful period of ontogeny, the progressive age dynamics of the volume expiratory rate indicator, respectively, in 75% of the forced vital capacity, is not observed, only in 20 years we observed a rapid increase of this indicator. It is established that this spirometric index has no progressive age dynamics in young men, it is significantly lower among young men in the middle of the youthful period of ontogenesis (19 years of age compared with 18-year-old young men).

It was established that the indicator of volume exhalation velocity from 75% to 85% of exhalation from forced vital capacity in the female population only in the last year of the youth period of ontogenesis has a rapid progressive age increase, in persons 16 - 19 years the value of this indicator did not differ significantly. Significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

Thus, the positive age dynamics of the volume velocity of exhalation on different segments of the bronchopulmonary segment is established, indicating the absence of peripheral obstruction in bronchi of different diameters. Research results of scientists [17] also indicate that the determination of the average expiration flow (FEF 25-75%) is a useful tool for clinical and epidemiological studies of pediatric bronchial asthma.

We have found that the average expiratory flow rate of young women in the last 2 years of the youth period is significantly higher than that of the female sex of younger age groups. Statistically significant differences of this spirographic index within the juvenile period of ontogeny in young men have not been established.

It was found that the maximum peak exhalation rate only in 20-year-old young women is significantly higher compared to 19-year-old female subjects. Progressive age increase of the index of maximum peak exhalation in young men is observed in the second half of the youthful period of ontogenesis (20-21 years).

Significant differences in the rate of inspiration within the juvenile period of ontogenesis in young men and young women have not been established.

The progressive age increasing in young women of the residual exhalation volume at the end of the youthful period of ontogenesis (in 19 and 20 years) was determined. In young men, this indicator is rapidly increasing at 21, and in previous years of this age interval only a gradual increase in the residual volume of exhalation is noted.

We have established a moderate increase with the age of the value of the indicator of forced inspiratory flow, which is 50% of the exhalation from the forced vital capacity, but the reliable difference is detected only when comparing its value in 19-year-old young women with 16-year-old. Statistically significant differences of this spirographic index within the juvenile period of ontogeny in young men are not defined.

It was established that the rate of one-second volume of forced exhalation in young women moderately increases in the period from 16 to 20 years, but only in the last year of the youthful period of ontogenesis, the value of this indicator was significantly more significant compared with the 16-year-olds, 17-year-olds and 18-years-old females. Progressive age-related increase in one-second volume of forced exhalation in young men is observed at the end of the youthful period of ontogenesis (21 years). Studying features of a one-second volume of forced exhalation Alfrayh A. et al. [1] found that this indicator increases from 6 to 18 years in males and females.

True differences in the Tiffeneau-Pinelli index within the juvenile period of ontogenesis in young women and young men are not established.

The age dynamics of spirometric indices scientists [5] explain by an increase in the strength of the respiratory muscles, in particular the forces of the intercostal muscles, as well as the increase in the elasticity of the lungs. These changes contribute to the improvement of functional parameters that are determined during spirometry. It has been proved that there is a direct relationship between the amount of forced exhalation volume for 1 second (FEV1), forced vital capacity of the lungs (FVC) and the mean expiratory flow (FEF 25-75%) with age, length and body weight [10]. In

addition, a higher body mass index had a positive effect on the value of forced exhalation volume for 1 second (FEV1) and forced vital capacity (FVC) in the direction of their increase [15, 18, 20]. Thus, anthropometric indices are strong determinants of lung function change.

Conclusions

1. In young women the progressive age dynamics of the following spirometric indicators is set: vital capacity, forced vital capacity, forced capacity of the lungs on the inspiration, volume of exhalation velocity, respectively, in 25% and 50% of the forced vital capacity, the average flow of exhalation, residual volume of exhalation and forced inflow, which is 50% of exhalation from the forced vital capacity. In the last year of the youthful period of ontogenesis in female subjects, the maximum arbitrary ventilation of lungs is increased, the expiratory volume is 75%, and from 75% to 85% of exhalation from the forced vital capacity, the one-second volume of forced exhalation and maximum peak flow exhale

2. In young men found that the vital capacity, the maximum arbitrary ventilation of the lungs and the maximum peak flow of exhalation increased within the juvenile period of ontogenesis. And increase in forced vital capacity, volumetric exhalation velocity, respectively, in 25% of the forced vital capacity, residual exhalation volume, one-second volume of forced exhalation was observed at the end of the youthful period of ontogenesis, only from 21 years.

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ВІКОВІ ОСОБЛИВОСТІ СПІРОМЕТРИЧНИХ ПОКАЗНИКІВ В МЕЖАХ ЮНАЦЬКОГО ПЕРІОДУ ОНТОГЕНЕЗУ

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У сучасному світі є багато причин (зменшення еластичності легень, зниження бронхіальної прохідності, зменшення сили дихальних м'язів), що впливають на показники зовнішнього дихання. Знання вікових, статевих та регіональних особливостей спірометричних показників допомагає розмежувати та виявити ступінь порушення біомеханіки дихання і вибрати ефективні засоби лікування, що найбільш відповідають встановленим порушенням. Мета роботи - встановити вікові особливості показників спірографії у практично здорових юнаків і дівчат у межах юнацького періоду онтогенезу. Нами було проведено обстеження 141 дівчини (з 16-ти до 20 років) та 154 юнаків (з 17-ти до 21 року). Спірографічне дослідження проводили за загальноприйнятою методикою Американської асоціації пульмонологів прийнятої у 1994 році на апараті Medgraphics Pulmonary Function System 1070 series. Аналіз отриманих результатів проведений за допомогою ліцензійної програми "Statistica 5.5" з використанням непараметричних методів оцінки показників. У дівчат виявлено прогресивну вікову динаміку життєвої ємності легень, форсованої життєвої ємності, форсованої ємності легень на вдиху, об'ємної швидкості видиху відповідно у 25% та 50% від форсованої життєвої ємності, середнього потоку видиху, залишкового об'єму видиху та форсованого потоку вдиху, що становить 50% видиху від форсованої життєвої ємності. У останній рік (20 років) юнацького періоду онтогенезу у дівчат збільшуються максимальна довільна вентиляція легень, показник об'ємної швидкості видиху відповідно у 75% та у від 75% до 85% видиху від форсованої життєвої ємності, односекундного об'єму форсованого видиху та максимального пікового потоку видиху. У межах юнацького періоду онтогенезу в юнаків збільшуються життєва ємність легень, максимальна довільна вентиляція легень і максимальний піковий потік видиху. Лише у останній рік юнацького періоду онтогенезу (21 рік) в юнаків спостерігається збільшення форсованої життєвої ємності, об'ємної швидкості видиху відповідно у 25% від форсованої життєвої ємності, залишкового об'єму видиху, односекундного об'єму форсованого видиху.

Ключові слова: *спірометрія, спірометричні показники, юнаки, дівчата.*

ВОЗРАСТНЫЕ ОСОБЕННОСТИ СПИРОМЕТРИЧЕСКИХ ПОКАЗАТЕЛЕЙ В ПРЕДЕЛАХ ЮНОШЕСКОГО ПЕРИОДА ОНТОГЕНЕЗА

Кириченко Ю. В.

В современном мире есть много причин (уменьшение эластичности легких, снижение бронхиальной проходимости, уменьшение силы дыхательных мышц), влияющих на показатели внешнего дыхания. Знание возрастных, половых и региональных особенностей спирометрических показателей помогает разграничить и выявить степень нарушения биомеханики дыхания и выбрать эффективные средства лечения, наиболее отвечающих установленным нарушением. Цель работы - установить возрастные особенности показателей спирографии у практически здоровых юношей и девушек в пределах юношеского периода онтогенеза. Нами было проведено обследование 141 девушек (с 16 до 20 лет) и 154 юношей (с 17-ти и до 21 года). Спирографическое исследования проводили по общепринятой методике Американской ассоциации пульмонологов принятой в 1994 году на аппарате Medgraphics Pulmonary Function System 1070 series. Анализ полученных результатов проведен с помощью лицензионной программы "Statistica 5.5" с использованием непараметрических методов оценки показателей. У девушек выявлено прогрессивную возрастную динамику жизненной емкости легких, форсированной жизненной емкости, форсированной емкости легких на вдохе, объемной скорости выдоха соответственно в 25% и 50% от форсированной жизненной емкости, среднего потока выдоха, остаточного объема выдоха и форсированного потока вдоха, что составляет 50% выдоха от форсированной жизненной емкости. В последний год (20 лет) юношеского периода онтогенеза у девушек увеличиваются максимальная произвольная вентиляция легких, показатель объемной скорости выдоха соответственно у 75% и у от 75% до 85% выдоха от форсированной жизненной емкости, односекундного объема форсированного выдоха и максимального пикового потока выдоха. В рамках юношеского периода онтогенеза у юношей увеличиваются жизненная емкость легких, максимальная произвольная вентиляция легких и максимальный пиковый поток выдоха. Лишь в последний год юношеского периода онтогенеза (21 год) у юношей наблюдается увеличение форсированной жизненной емкости, объемной скорости выдоха соответственно у 25% форсированной жизненной емкости, остаточного объема выдоха, односекундного объема форсированного выдоха.

Ключевые слова: *спирометрия, спирометрические показатели, юноши, девушки.*

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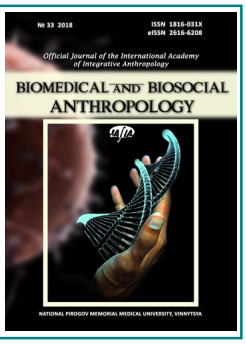

Correlation of indicators of cerebral blood circulation with anthropometric dimensions in practically healthy young men of ectomorphic somatotype

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In modern scientific literature, the vast majority of studies are devoted to the study of the features of cerebral circulation in representatives of different age-sex groups, but studies devoted to the constitutional features of cerebral hemodynamics in practically healthy population are practically absent. The purpose of the work is to establish correlation of indicators of cerebral blood circulation with anthropo-somatotypological parameters of the body in practically healthy young men of Podillia with ectomorphic somatotype. On the base of the research center of the National Pirogov Memorial Medical University, Vinnytsya conducted rheoencephalographic, anthropometric and somatotypological studies of 24 practically healthy urban young men from the Podillia region of Ukraine of ectomorphic somatotype. The correlation analysis was performed using Spearman nonparametric method in the licensed statistical package "Statistica 6.1". In practically healthy young men of the ectomorphic somatotype, the following multiple correlations of cerebral blood flow parameters with constitutional parameters of the body are established: direct reliable (r from 0.41 to 0.52) and unreliable mean power (r from 0.30 to 0.38) correlations of most amplitude indices with girth of the head and the largest length of the head, as well as the reverse, mostly unreliable (r from -0.30 to -0.40), and a reliable average power (r from -0.41 to -0.53) correlations with most of the total body size, half of the width distal epiphyses long tubular bones of the limbs (WDE), the majority of the circumference of the extremities, third indicators thickness of skin and fat folds (TSFF), performance component composition weight; direct, mostly unreliable, average strength (r from 0.33 to 0.38) correlations of the duration of the cardiac cycle and the time of the downward part of the rheogram with a half of the TSFF indices; direct, mostly unreliable, average strength (r from 0.30 to 0.37) correlations of the dicrotic index with a third of the indices of the TSFF and the endomorphic component of the somatotype, as well as the inverse of the reliable (r from -0.40 to -0.58) and unreliable mean force (r from -0.30 to -0.40) correlations of the average speed of fast and slow blood filling with all total, half of the longitudinal body sizes, half of the WDE indexes, the majority of circumferential body sizes, more than half the body diameters, most of the indicators of the TSFF, the endomorphic component of the somatotype and all the components of the body composition and the reverse, mostly reliable, average strength (r from -0.41 to -0.51) correlations of the index of tone of all arteries, the tone of the arteries of the large, as well as the middle and shallow diameters with more than half of the indices of the TSFF and the endomorphic component somatotype. In the analysis of correlations of rheoencephalogramms indicators with constitutional parameters of the body in practically healthy young men of the ectomorphic somatotype, the largest number, mostly inverse of reliable and unreliable mean strength correlations, was established for amplitude indices - with total body sizes (66.7% of the total number of these indicators), indicators of component body composition (60.0%), WDE (45.0%), circumferential dimensions of the body (34.7%), cephalometric indices (34.3%) and TSFF (33.3%). The largest number, mostly inverse, of reliable and unreliable average strength correlations, was found for the derived indicators - with TSFF (47.2% of the

total number of these indicators), somatotype components (29.2%), components of body mass (28.1%), total sizes body and WDE (25.0%); and, mostly direct, inaccurate average strength correlations, for time indicators was established - with cephalometric indices (28.6% of the total number of these indicators), TSFF (22.2%) and body diameters (14.3%).
Keywords: *correlations, rheoencephalography, anthropometry, ectomorphic somatotype, practically healthy young men.*

Introduction

Cerebrovascular diseases remain one of the most urgent medical and social problems. The incidence, disability and mortality of this pathology progressively increase with each subsequent decade. In connection with this, the nosologies associated with the lack of cerebral circulation have been isolated in an independent section of neuropathology - angio-neurology, and this problem is currently extremely important in medical and social significance [8, 15].

For now, vascular lesions of the brain have traditionally been regarded as the fate of persons of older age groups [12, 31]. It is now clear that this point of view is not true. In recent years, a broader circle of researchers has observed a sharp increase in cerebral vascular disorders in children and young people. A number of scholars [2, 9, 15] indicate that approximately 12% of acute cerebrovascular disorders occur in people aged 15-45, making up the most common cause of neurological problems in this age group.

The problems of timely diagnosis and treatment of cerebrovascular diseases at the early and pre-nosological stages of their formation, when the most effective treatment and preventive measures [15, 29], are extremely important. The lack of reference functional criteria for assessing cerebrovascular flow and the standards of individual parameters of the human body cause difficulties in the diagnosis and treatment of such patients.

The leading criteria for the state of cerebral vessels are functional parameters of the cerebral circulation, determined by means of rheoencephalography. The state of cerebral vessels reflects the combined variability of their morphofunctional parameters at different stages of ontogenesis [4, 21, 22, 24]. Moreover, a certain constitutional type is characterized not only by the features of its morphofunctional organization, but also by their reactivity [23, 24, 25].

From the clinical point of view, the consideration of covariances of rheoencephalographic parameters with anthropometric parameters of the patient has a significant role as predictors in the diagnosis of acute and chronic cerebrovascular disorders [2, 19]. The number of complex studies and the comparison of the results of this problem is quite limited [3, 6, 17, 18, 27], so it requires a special study, both from the anatomical and anthropological point of view, and from the clinical and diagnostic.

The *purpose* of the work is to establish correlations of indicators of cerebral blood circulation with anthropo-somatotypological parameters of the body of practically healthy young men of Podillia with ectomorphic somatotype.

Materials and methods

Rheoencephalographic, anthropometric and somatotypological studies of 143 practically healthy young men aged from 17 to 21 years, in the third generation residents of the Podillia region of Ukraine conducted on the basis of the research center of National Pirogov Memorial Medical University, Vinnytsya. The Bioethics Committee of the National Pirogov Memorial Medical University, Vinnytsya found that the research materials did not deny the basic bioethical norms of the Helsinki Declaration, the Council of Europe Convention on Human Rights and Biomedicine (1977), the relevant provisions of the WHO and the laws of Ukraine.

The rheoencephalography was performed using a computer diagnostic complex [33]. The anthropometric study, according to the scheme of Bunak V. V. [10], included the determination of total, longitudinal, circumferential body dimensions, body diameters (body size and pelvic size), width distal epiphyses of long tubular bones of the limbs (WDE) and thickness of skin-fatty folds (TSFF). Cephalometry included determination of head girth, sagittal arc, greatest length and width of the head, smallest head width, face and mandible width [1]. The components of the somatotype and the type of somatotype were determined according to the method of Carter J. and Heath B. [11], and the components of the body weight were measured by the method of Matiegka J. [20] and the American Institute of Nutrition (AIN) [28].

The analysis of correlations of cerebral blood flow with anthropometric and somatotypological parameters of young men of ectomorphic somatotype (n = 24) was performed using the nonparametric Spearman method in the licensed statistical package "Statistica 6.1".

Results

In the practically healthy young men of the ectomorphic somatotype, the following reliable and average strength false correlation of the parameters of cerebral circulation with constitutional parameters of the body are established:

basic impedance - a reliable strong reverse (r = -0.64) correlations with the intertrochanteric pelvic size; reliable mean reciprocal force (r from -0.41 to -0.53) correlations with forearm girth in the lower third, with transverse mid-sternal size, TSFF on the back of the shoulder, with bone mass by Matiegka, as well as an unreliable average force straight (r = 0.39) correlations with the smallest head width; unreliable mean reverse (r from -0.30 to -0.40) correlations with total body size, WDE of shoulder, with neck, waist and

brush girth, with TSFF on the forearm, under the shoulder blade, on the chest, with fat mass by Matiegka;

duration of the heart cycle - a reliable average power straight (r = 0.42) correlations with the TSFF on the tibia, as well as the unreliable mean force (r from 0.33 to 0.38) correlations with the TSFF on the abdomen, side, thigh;

the duration of the ascending part - a reliable average force straight (r = 0.43) correlations with the head girth; reliable mean reciprocal force (r = -0.42) correlations with the greatest head width, as well as unreliable mean force straight (r from 0.30 to 0.38) correlations with the width of the face, waist circumference, foot, chest on the inhalation, with transverse mid-sternal size, shoulder width, with intertrochanteric pelvic size;

the duration of the downstream part - the true average strength straight (r from 0.41 to 0.46) correlations with the TSFF under the shoulder blade, the thigh and the tibia, as well as the unreliable mean power straight (r = 0.37 in all cases) correlations with the TSFF on the abdomen, thigh, with the endomorphic component of the somatotype by Heath-Carter;

the duration of the fast blood flow phase - reliable average power straight (r = 0.43) correlations with a transverse mid-sternal dimension, as well as an unreliable mean reciprocal force (r -0.30 to -0.36) correlations with the smallest, largest width and sagittal arc of the head, with the girth of the thigh, the shin in the upper third, with the interspinous size of the pelvis;

the duration of the phase of slow blood filling - a reliable average force straight (r = 0.51 and r = 0.48) correlations with the head girth and the width of the face; reliable mean reverse force (r = -0.41) correlation with the forehead of the forearm, as well as the unreliable mean force straight (r = 0.30 and r = 0.31) correlations with the largest head width and abdominal TSFF;

the amplitude of the systolic wave - strong reverse (r = -0.65) correlations with the hip circumference; reliable mean force straight (r = 0.52) correlations with the greatest length of the head; reliable mean reciprocal force (r from -0.41 to -0.52) correlations with body weight, WDE of forehead, with shoulder girth in a tense and calm condition, interspinous size of the pelvis, with TSFF on the forearm, with muscle mass by Matiegka and for the AIN formula, as well as the unreliable mean power straight (r = 0.36 and r = 0.39) correlations with the head circumference and the width of the mandible; unreliable mean reciprocal force (r from -0.30 to -0.38) correlations with the area of the body surface, with the shoulder and leg WDE, with the girth of the shin in the upper third, with the neckline, chest on the exhalation and in a calm condition girth, with transverse mid- and lower-sternal dimensions, TSFF on the front and back surfaces of the shoulder, with the TSFF on the chest, on the side, with the endomorphic component of the somatotype by Heart Carter and the fat mass by Matiegka;

incisure amplitude - the true mean power straight (r = 0.43) correlations with the greatest length of the head; reliable mean reciprocal force (r from -0.45 to -0.52) correlations with the shoulder girth in a tense and calm condition, with a hip circumference, with a muscle mass by Matiegka and by the formula AIN, as well as an unreliable average force straight (r = 0.30) correlations with head circumference; unreliable mean reciprocal force (r from -0.30 to -0.39) correlations with body mass relation, with WDE of forearm, with upper leg girth, with transverse lower-sternal size, with mesomorphic component of the somatotype by Heath-Carter;

the amplitude of the diastolic wave - reliable average force straight (r = 0.46) correlations with the greatest length of the head; reliable mean reciprocal force (r from -0.43 to -0.53) correlations with shoulder girth in a tense and calm condition, with a hip circumference, with a muscle mass by Matiegka and the AIN formula, as well as an unreliable average force straight (r = 0.38) correlations with head circumference; unreliable mean reciprocal force (r from -0.30 to -0.37) correlations with the smallest head width, body weight, with the WDE of the forearm and the shin, with the upper leg girth over the upper third, with the transverse lower-thoracic size, with the TSFF on the back of the shoulder, on the forearm, chest, with mesomorphic component of the somatotype according to Heath-Carter;

the amplitude of the phase of rapid blood filling - a reliable strong reverse (r = -0.68) correlations with the circumference of the thigh; reliable mean force straight (r = 0.41) correlations with the greatest length of the head; reliable mean reciprocal force (r from -0.42 to -0.51) correlations with body weight, with WDE of the shin, with shoulder girth in a tense and calm condition, with an interspinous size of the pelvis, with muscle mass by Matiegka and according to the formula AIN, as well as the unreliable mean force straight (r = 0.31 and r = 0.39) correlations with the head circumference and the width of the mandible; unreliable mean reciprocal force (r from -0.30 to -0.37) correlations with the length and area of the body surface, with the WDE of the shoulder, with the shin girth of the upper third, with the neck, brush, chest girth in calm condition, with the TSFF on the back shoulder surface, on the forearm, side, with bone mass by Matiegka;

dicrotic index - a reliable average power straight (r = 0.41) correlations with the TSFF on the thigh; reliable mean reverse force (r = -0.44) correlations with the greatest head width, as well as unreliable mean force straight (r from 0.30 to 0.37) correlations with the TSFF on the side, the tibia, with the endomorphic component of the somatotype by the Heath-Carter;

diastolic index - only unreliable mean force straight (r from 0.30 to 0.37) correlations with the hips, TSFF on the thigh and shin;

the average speed of the phase of rapid blood filling - a reliable average force straight (r = 0.52) correlations with the largest length of the head; reliable average reciprocal force (r from -0.41 to -0.58) correlations with total body size, WDE shoulder, forearm, shin, with shoulder girth in a tense and

calm condition, with a girth of the thigh, neck, waist, chest on the exhalation and in a calm state, with transverse middle-thoracic size, TSFF on the back of the shoulder, on the forearm, on the chest, on the side, with the endomorphic component of the somatotype according to Heath-Carter, all the components of the mass by Matiegka and with muscle mass, determined by the formula AIN, as well as unreliable mean reciprocal force (r from -0.30 to -0.39) correlations with the height of the suprasternal, shoulder and finger points, with the forearm circumference in the lower third, with the girth of the brush, the chest on the inhalation, with the transverse lower limb size and the anterior-posterior size of the chest, with the interspinous and intertrochanteric dimensions of pelvic, with TSFF on the front of the shoulder, under the shoulder blade, on the abdomen, thigh, shin;

average speed of the phase of slow blood flow - a reliable average power straight (r = 0.44) correlations with the greatest length of the head; reverse credible medium strength (r from -0.40 to -0.58) correlations with weight and body surface area, circumference of the arm in tight and rest, circumference of the thigh, lower leg in the upper third, neck and chest at rest with cross medium-sternal, interspinous sizes of the pelvis, with TSFF on the forearm with muscle mass by Matiegka and the formula AIN and unreliable direct medium strength (r = 0.37 and r = 0.37) correlations with a width of mandible and an ectomorphic component of the somatotype of the Heath-Carter; return false medium strength (r from -0.31 to -0.40) correlations with the length of the body, with the height of the pubic, brachial points, with WDE of shoulder and leg, arm circumference of the lower third, circumference of the waist, wrist, chest on inspiration and expiration, with a transverse lower-sternal size and anterior-posterior size of the chest, with intertrochanteric size of pelvis, with TSFF on the front and back surfaces of the shoulder, chest, side, with endomorphic component of somatotype by Heath-Carter, with bone and fat masses by Matiegka;

rate the overall tone of the arteries - credible medium strength return (r from -0.41 to -0.51) correlations with TSFF under the shoulder blade, the abdomen, side, leg with endomorphic component somatotype by Heath-Carter and unreliable direct medium strength (r = 0.37) correlation with the width of the mandible; unreliable mean reciprocal force (r = -0.33 and r = -0.34) correlations with the WDE of the forearm, with the TSFF on the front of the shoulder;

indicator of large diameter arteries tone - reverse credible medium strength (r = -0.53 and r = -0.50) correlations with TSFF on the side, leg and unreliable direct medium strength (r = 0.34) correlations with the width of the lower jaw; unreliable mean reciprocal force (r from -0.31 to -0.39) correlations with the height of the trochanteric point, with the girth of the thigh, with the TSFF under the shoulder blade, on the abdomen, thigh, with the endomorphic component of the somatotype by Heath-Carter;

the indicator of the tone of the arteries of medium and small diameter - reliable average reciprocal force (r from -0.45 to -0.48) correlations with the TSFF under the shoulder blade, on the abdomen, side, tibia, with the endomorphic component of the somatotype according to Heath-Carter, and also the unreliable mean force direct (r = 0.36 and r = 0.35) correlations with the width of the mandible and face; unreliable mean reciprocal force (r from -0.30 to -0.40) correlations with the WDE of forearm, with the TSFF on the back of the shoulder, with a fat mass by Matiegka;

indicator of the ratio of tone of arteries of different diameters - reliable average power straight (r = 0.47) correlations with the WDE of the forearm; unreliable mean reciprocal force (r = -0.36 and r = -0.31) correlations with the width of the face and the shin circumference in the upper third.

Discussion

The system of cerebral circulation is characterized by relative independence from the general blood circulation. This is due to the presence of structural features of the structure of the vascular network, as well as regional mechanisms for maintaining cerebral circulation at an optimal level [5, 16, 30]. Against the background of increased interest in the study of the features of cerebral circulation in different age-sex contingents, very few studies devoted to the consideration of constitutional features of cerebral hemodynamics in practically healthy people [7].

Domestic and foreign researchers made an analysis of the correlations of rheoencephalographic indices with the data of general anthropometry and somatotype as the combined parameters of physical status and functional parameters of the vessels of the brain [3, 6, 17, 26, 27]. The most important in the search for morphogenetic condition of conditions and diseases of cerebral vessels from the scientific and practical point of view is the establishment of the relationship of rheoencephalographic indices with the ratio of individual components of the body [26, 27, 32]. It is known that the formation of components of the somatotype and the components of the body composition (in particular, the bone mass of the individual parts of the skeleton, skull) and the vessels of the head are determined by the same genetic mechanisms, but their conjugation and significance in neurological practice is not proved [32].

Thus, in analyzing the peculiarities of reliable correlations of the indicators of cerebral circulation with the constitutional parameters of the body of practically healthy young men of Podillia of the ectomorphic somatotype, we established the following *multiple correlations*: direct, reliable mean forces (r from 0.41 to 0.52) and unreliable average forces (r from 0.30 to 0.38) correlations of most amplitude indices (with the exception of the base impedance) with the *head girth* and the *greatest length of the head*, as well as the reversible, mostly unreliable, average forces (r from -0.30 to -0.40) and reliable the average strength (r from -0.41 to -0.53) correlations of most amplitude indices with the *majority of total body sizes* (with the exception of the incisure and diastolic wave amplitude), *half of the WDE indices, most limbs girth* (except for the base impedance), *one third of*

the indicators of the TSFF (with the exception of the incidence amplitude), t*he muscular component of the body mass using the methods of Matiegka and AIN* (with the exception of the base impedance) and *bone and fat components of the body mass using the Matiegka method* (only for the basic impedance); direct, mostly unreliable, average strength (r from 0.33 to 0.38), correlations of the duration of the cardiac cycle and the time of the downward part of the rheogram with *half of the TSFF indices and the endomorphic component of the somatotype* (only for the time of the downward part of the rheogram); direct, mostly unreliable, average forces (r from 0.30 to 0.37) correlations of the dicrotic index with a *third of the indices of the TSFF and the endomorphic component of the somatotype*, as well as the inverse of reliable average forces (r from -0.40 to -0.58) and unreliable mean force (r from -0.30 to -0.40) correlations of the average speed of fast and slow blood filling with all *total, half of the longitudinal body size, half of the WDE indexes, the majority of circumferential body sizes, more than half the body diameters, most of the indicators of the TSFF, the endomorphic component of somatotype* and all indicators of the body mass component composition and the inverse, mostly reliable, average strength (r from -0.41 to -0.51) correlations of the index of tone of all arteries, the tone of arteries of large diameter and the tone of arteries of medium and small diameter with *more than half of the TSFF indices and endomorphic component of the somatotype*. Attention is drawn to the lack of reliable and average force of false correlations: amplitudes indices with longitudinal dimensions of the body; time indices with total, longitudinal body dimensions and indicators of the component composition of body mass.

Quantitative analysis of correlations of cerebral circulatory parameters with constitutional body indicators in practically healthy young men from Podillia with ectomorphic somatotype showed the following distribution of correlations of *amplitude, time and derivative indices rheoencephalogramm*: 95 possible correlations of 285 (33.3%) with the amplitude parameters (of which 1.4 % of reliable direct average forces, 2.5% of the unreliable direct average forces, 1.1% of the true reverse strong, 10.2% of the true reciprocal average strength, 18.2% of the unreliable reciprocal average strength); 32 out of 285 possible (11.2%) with time indicators (of which, 2.8% of the reliable direct average forces, 4.9% of the unreliable direct average forces, 0.6% of the reliable reciprocal average forces, 2.8% of the unreliable reciprocal average forces); 115 correlations from 456 possible (25.2%) with derivatives indicators (of which, 0.9% are reliable direct average forces, 2.9% are false direct average forces, 10.7% are reliable reciprocal average forces, 10.7% unreliable reciprocal average forces).

Quantitative analysis of correlations of cerebral blood flow with constitutional parameters of the body of practically healthy young men of Podillia of the ectomorphic somatotype revealed the following distribution among the *anthropo-somatotypological parameters*: with amplitude indicators - *cephalometric indices* (12 - 34.3% of the total number of these indicators, of which 11.4% of reliable direct averages force, 20.0% of false direct middle forces, 2.9% of false reciprocal average forces); *total body sizes* (10 - 66.7% of the total number of these indicators, of which 13.3% of the true reciprocal average strength, 53.3% of unreliable reciprocal average strength); *WDE* (9 - 45.0% of the total number of indicators, of which 10.0% of the true reciprocal average strength, 35.0% of the unreliable reciprocal average strength); *body diameters* (8 - 22.9% of the total number of these indicators, of which 2.9% are reliable reverse strong, 8.6% reliable average reciprocal strength, 11.4% unreliable reciprocal average strength); *girth dimensions of the body* (26 - 34.7% of the total number of these indicators, of which 2.7% of the true reverse strong, 14.7% of the true reciprocal average force, 20.0% of the unreliable reciprocal average strength); *TSFF* (15 - 33.3% of the total number of these indicators, of which 4.4% of the true reciprocal average strength, 28.9% of the false reciprocal average strength); *components of the somatotype* (3 - 20.0% of the total number of indicators; all unreliable reciprocal average forces); *components of the body mass index* (12 - 60.0% of the total number of indicators, of which 45.0% of the true reciprocal average strength, 15.0% of unreliable reciprocal average strength). With time indicators - *cephalometric indices* (10 - 28.6% of the total number of these indicators, of which 8.6% of reliable direct average forces, 5.7% of unreliable direct average forces, 2.9% of reliable reciprocal average forces, 11.4% of unreliable reciprocal average forces); *WDE* (1 - 5.0% of the total number of indicators, all reliable reciprocal average strength); *body diameters* (5 - 14.3% of the total number of these indicators, of which 2.9% are reliable direct average forces, 8.6% of false direct average forces, 2.9% of false reciprocal average forces); *girth sizes of the body* (5 - 6.7% of the total number of these indicators, of which 4.0% of false direct average forces, 2.7% of false reverse average strength); *TSFF* (10 - 22.2% of the total number of these indicators, of which 8.9% are reliable direct average forces, 11.1% are false direct average forces, 2.2% are unreliable reciprocal average strength); *components of the somatotype* (1 - 6.7% of the total number of these indicators; all unreliable direct mean power). With derived indicators - *cephalometric indices* (10 - 20.8% of the total number of these indicators, of which 4.2% are reliable direct average forces, 12.5% are false direct middle forces, 2.1% are reliable reciprocal average forces, 2.1% are unreliable reciprocal average forces); *total body sizes* (6 - 25.0% of the total number of these indicators, of which 20.8% of the true reciprocal average force, 4.2% of the unreliable reciprocal average strength); *longitudinal body dimensions* (6 - 15.0% of the total number of indicators; all unreliable reciprocal average forces); *WDE* (8 - 25.0% of the total number of these indicators, of which 3.1% of the reliable direct average strength, 9.4% of the true reciprocal average strength, 12.5% of the unreliable reciprocal average strength); *body diameters* (10 - 17.9% of the total number of these indicators, of which 5.4% of the

true reciprocal average strength, 12.5% of false reverse average strength); *circumferential body dimensions* (25 - 20.8% of the total number of these indicators, of which 0.8% are false direct average forces, 10.8% of the true reciprocal average strength, 9.2% of false reverse average strength); *TSFF* (34 - 47.2% of the total number of these indicators, of which 1.4% are reliable direct average forces, 5.6% of unreliable direct average forces, 20.8% of the true reciprocal average strength, 19.4% of false reciprocal average forces); *components of the somatotype* (7 - 29.2% of the total number of these indicators, of which 8.4% are false direct average forces, 12.5% of the true reciprocal average strength, 8.4% of the unreliable reciprocal average strength); *components of the body weight* (9 - 28.1% of the total number of indicators, of which 18.8% of the true reciprocal average strength, 9.4% of the unreliable reciprocal average strength).

It should be noted that in the general group of practically healthy young men of Podillia, the highest number of reliable correlations has been established: among the amplitude indicators - mostly direct with amplitude of incisure; among the time indices - mainly direct with the duration of the ascending part, the phase of fast and slow blood flow of the rheograms, and mostly reversed with the duration of the downward part of the rheogram; among the derivatives - mostly reverse with the dicrotic index and the average speed of fast and slow blood flow of the rheograms and, mainly direct, with tone indices of all arteries and arteries of large, medium and shallow diameters [13].

In practically healthy young men of Podillia of mesomorphic somatotype among all groups of indicators of cerebral blood circulation, the greatest number of reliable correlations established with constitutional parameters of the body for time indices - mainly with total, longitudinal, circumflex body dimensions, indicators of body composition, WDE and cephalometric indices, respectively, for amplitude indices of rheograms - with body diameters, cephalometric indices, components of somatotype and components of component composition body weight; and for derivative indicators - with longitudinal, total, circumflex body dimensions and indicators of the component composition of body mass [14].

Thus, studies of correlations of rheoencephalographic parameters with body sizes complement existing perceptions about the peculiarities of the functional organization of hemodynamic processes in brain basins in practically healthy young men of the ectomorphic somatotype, which allow more accurately to differentiate the norm and pathology, as well as to improve the quality and effectiveness of the treatment of various vascular pathologies of the brain.

Conclusions

1. In the practically healthy young men of the ectomorphic somatotype, among the all groups of indicators of cerebral circulation, the largest number, mostly reverse valid and unreliable average strength, correlations with anthropomorphic somatotypological indicators was established for amplitude indices (33.3%) - with total body sizes (66.7% of the total number of these indicators), components of body mass (60.0%), WDE (45.0%), circumferential body size (34.7%), cephalometric indices (34.3%) and TSFF (33.3%).

2. The largest number, mostly inverse, of reliable and unreliable average strength correlations, was found for derivative indicators (25.2%) - with TSFF (47.2% of the total number of these indicators), somatotype components (29.2%), components of body mass index (28.1%), total body size and WDE (by 25.0%); and, mainly direct, inaccurate average strength correlations, for time indices (11.2%) was established - with cephalometric indices (28.6% of the total number of these indicators), TSFF (22.2%) and body diameters (14.3%).

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КОРЕЛЯЦІЇ ПОКАЗНИКІВ ЦЕРЕБРАЛЬНОГО КРОВООБІГУ З АНТРОПОМЕТРИЧНИМИ РОЗМІРАМИ ПРАКТИЧНО ЗДОРОВИХ ЮНАКІВ ЕКТОМОРФНОГО СОМАТОТИПУ

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В сучасній науковій літературі переважна більшість досліджень присвячена вивченню особливостей мозкового кровообігу у представників різних віково-статевих груп, а дослідження, присвячені конституціональним особливостям церебральної гемодинаміки у практично здорового населення практично відсутні. Мета роботи - встановити кореляції показників церебрального кровообігу з антропо-соматотипологічними параметрами тіла практично здорових юнаків Поділля ектоморфного соматотипу. На базі науково-дослідного центру Вінницького національного медичного університету ім. М. І. Пирогова проведені реоенцефалографічні, антропометричні та соматотипологічні дослідження 24 практично здорових міських юнаків Подільського регіону України ектоморфного соматотипу. Аналіз кореляцій проводили з використанням непараметричного методу Спірмена в ліцензійному статистичному пакеті "Statistica 6.1". У практично здорових юнаків ектоморфного соматотипу встановлені наступні множинні зв'язки показників церебрального кровообігу з конституціональними параметрами тіла: прямі достовірні (r від 0,41 до 0,52) і недостовірні середньої сили (r від 0,30 до 0,38) зв'язки більшості амплітудних показників з обхватом голови й найбільшою довжиною голови, а також зворотні, переважно недостовірні (r від -0,30 до -0,40), і достовірні середньої сили (r від -0,41 до -0,53) зв'язки з більшістю тотальних розмірів тіла, половиною показників ширини дистальних епіфізів довгих трубчастих кісток кінцівок (ШДЕ), більшістю обхватів кінцівок, третиною показників товщини шкірно-жирових складок (ТШЖС), показниками компонентного складу

маси тіла; прямі, переважно недостовірні, середньої сили (r від 0,33 до 0,38) зв'язки тривалості серцевого циклу й часу низхідної частини реограми з половиною показників ТШЖС; прямі, переважно недостовірні, середньої сили (r від 0,30 до 0,37) зв'язки дикротичного індексу з третиною показників ТШЖС і ендоморфним компонентом соматотипу, а також зворотні достовірні (r від -0,40 до -0,58) і недостовірні середньої сили (r від -0,30 до -0,40) зв'язки середньої швидкості швидкого й повільного кровонаповнення з усіма тотальними, половиною поздовжніх розмірів тіла, половиною показників ШДЕ, більшістю обхватних розмірів тіла, більш ніж половиною діаметрів тіла, більшістю показників ТШЖС, ендоморфним компонентом соматотипу й усіма показниками компонентного складу маси тіла та зворотні, переважно достовірні, середньої сили (r від -0,41 до -0,51) зв'язки показника тонусу всіх артерій, тонусу артерій великого, а також середнього та мілкого діаметра з більш ніж половиною показників ТШЖС й ендоморфним компонентом соматотипу. При аналізі кореляцій показників реоенцефалограми з конституціональними параметрами тіла у практично здорових юнаків ектоморфного соматотипу найбільшу кількість, переважно зворотних достовірних і недостовірних середньої сили, зв'язків встановлено для амплітудних показників - з тотальними розмірами тіла (66,7% від загальної кількості даних показників), показниками компонентного складу маси тіла (60,0%), ШДЕ (45,0%), обхватними розмірами тіла (34,7%), кефалометричними показниками (34,3%) та ТШЖС (33,3%). Найбільша кількість, переважно зворотних достовірних і недостовірних середньої сили зв'язків, для похідних показників встановлена - з ТШЖС (47,2% від загальної кількості даних показників), компонентами соматотипу (29,2%), показниками компонентного складу маси тіла (28,1%), тотальними розмірами тіла та ШДЕ (по 25,0%); а, переважно прямих недостовірних середньої сили зв'язків, для часових показників встановлена - з кефалометричними показниками (28,6% від загальної кількості даних показників), ТШЖС (22,2%) та діаметрами тіла (14,3%).
Ключові слова: *кореляції, реоенцефалографія, антропометрія, ектоморфний соматотип, практично здорові юнаки.*

КОРРЕЛЯЦИИ ПОКАЗАТЕЛЕЙ МОЗГОВОГО КРОВООБРАЩЕНИЯ С АНТРОПОМЕТРИЧЕСКИМИ РАЗМЕРАМИ ПРАКТИЧЕСКИ ЗДОРОВЫХ ЮНОШЕЙ ЭКТОМОРФНОГО СОМАТОТИПА

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В современной научной литературе подавляющее большинство исследований посвящено изучению особенностей мозгового кровообращения у представителей разных возрастно-половых групп, а исследования, посвященные конституциональным особенностям церебральной гемодинамики у практически здорового населения, практически отсутствуют. Цель работы - установить корреляции показателей мозгового кровообращения с антропо-соматотипологическими параметрами тела практически здоровых юношей Подолья эктоморфного соматотипа. На базе научно-исследовательского центра Винницкого национального медицинского университета им. Н. И. Пирогова проведены реоэнцефалографические, антропометрические и соматотипологические исследования 24 практически здоровых городских юношей Подольского региона Украины эктоморфного соматотипа. Анализ корреляций проводили с использованием непараметрического метода Спирмена в лицензионном статистическом пакете "Statistica 6.1". У практически здоровых юношей эктоморфного соматотипа установлены следующие множественные связи показателей мозгового кровообращения с конституциональными параметрами тела: прямые достоверные (r от 0,41 до 0,52) и недостоверные средней силы (r от 0,30 до 0,38) связи большинства амплитудных показателей с охватом головы и наибольшей длиной головы, а также обратные, преимущественно недостоверные (r от -0,30 до -0,40), и достоверные средней силы (r от -0,41 до -0,53) связи с большинством тотальных размеров тела, половиной показателей ширины дистальных эпифизов длинных трубчатых костей конечностей (ШДЭ), большинством обхватов конечностей, третью показателей толщины кожно-жировых складок (ТКЖС), показателями компонентного состава массы тела; прямые, преимущественно недостоверные, средней силы (r от 0,33 до 0,38) связи продолжительности сердечного цикла и времени нисходящей части реограммы с половиной показателей ТКЖС; прямые, преимущественно недостоверные, средней силы (r от 0,30 до 0,37) связи дикротического индекса с третью показателей ТКЖС и эндоморфным компонентом соматотипа, а также обратные достоверные (r от -0,40 до -0,58) и недостоверные средней силы (r от -0,30 до -0,40) связи средней скорости быстрого и медленного кровенаполнения со всеми тотальными, половиной продольных размеров тела, половиной показателей ШДЭ, большинством обхватных размеров тела, более чем половиной диаметров тела, большинством показателей ТКЖС, эндоморфным компонентом соматотипа и всеми показателями компонентного состава массы тела и обратные, преимущественно достоверные, средней силы (r от -0,41 до -0,51) связи показателя тонуса всех артерий, тонуса артерий крупного, а также среднего и мелкого диаметра с более чем половиной показателей ТКЖС и эндоморфным компонентом соматотипа. При анализе корреляций показателей реоэнцефалограммы с конституциональными параметрами тела у практически здоровых юношей эктоморфного соматотипа наибольшее количество, преимущественно обратных достоверных и недостоверных средней силы связей установлено для амплитудных показателей - с тотальными размерами тела (66,7% от общего количества данных показателей), показателями компонентного состава массы тела (60,0%), ШДЭ (45,0%), обхватными размерами тела (34,7%), кефалометрическими показателями (34,3%) и ТКЖС (33,3%). Наибольшее количество, преимущественно обратных достоверных и недостоверных средней силы связей, для производных показателей установлена - с ТКЖС (47,2% от общего количества данных показателей), компонентами соматотипа (29,2%), показателями компонентного состава массы тела (28,1%), тотальными размерами тела и ШДЭ (по 25,0%); а преимущественно прямых недостоверных средней силы связей, для временных показателей установлена - с кефалометрическими показателями (28,6% от общего количества данных показателей), ТКЖС (22,2%) и диаметрами тела (14,3%).
Ключевые слова: *корреляции, реоэнцефалография, антропометрия, эктоморфный соматотип, практически здоровые юноши.*

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For publication, scientific articles are accepted only in English only with translation on Ukrainian or Russian, which contain the following necessary elements: UDC code; title of the article (in English, Ukrainian and Russian); surname, name and patronymic of the authors (in English, Ukrainian and Russian); the official name of the organization (institution) (in English, Ukrainian and Russian); city, country (in English, Ukrainian and Russian); structured annotations (in English, Ukrainian and Russian); keywords (in English, Ukrainian and Russian); introduction; purpose; materials and methods of research; research results; discussion; conclusions; bibliographic references.

The title of the article briefly reflects its contents and contains no more than 15 words.

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Keywords: 4-6 words (or phrases).

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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).

"Materials and methods"

The section should allow other researchers to perform similar studies and check the results obtained by the author. If necessary, this section may be divided into subdivisions. Depending on the research objects, the ethical principles of the European Convention for the protection of vertebrate animals must be observed; Helsinki Declaration; informed consent of the surveyed, etc. (for more details, see "Public Ethics and its Conflict"). At the end of this section, a "statistical processing of results" section is required, which specifies the program and methods for processing the results obtained by the automobile.

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Requirements for writing this section are general, as well as for all international scientific publications. The data is presented clearly, in the form of short descriptions, and must be illustrated by color graphics (no more than 4) or drawings (no more than 8) and tables (no more than 4), the information is not duplicated.

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In the discussion, it is necessary to summarize and analyze the results, as possible, compare them with the data of other researchers. It is necessary to highlight the novelty and possible theoretical or practical significance of the results of the research. You should not repeat the information already listed in the "Introduction" section. At the end of the discussion, a separate paragraph should reflect the prospects for using the results obtained 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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