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CORRELATIONS OF THE UPPER RESPIRATORY TRACT CEPHALOMETRIC PARAMETERS IN UKRAINIAN YOUNG WOMEN WITH A VERY WIDE FACE TYPE

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Annotation. The relationship between craniofacial parameters and features of upper respiratory tract indicators is the subject of research for a wide range of scientists of various directions, which is connected with the multifaceted practical significance of the possible results obtained. One of the most important directions among these studies is the study of the normative indicators of the respiratory tract, depending on various variables, because understanding the values of the norm allows us to judge pathological changes in the future. The purpose of the study is to establish the peculiarities of correlations of cephalometric parameters of the upper respiratory tract in practically healthy Ukrainian young women with an orthognathic bite with a very wide face type. A cephalometric analysis of the upper respiratory tract, soft palate, hyoid bone, and tongue was performed on primary lateral teleroentgenograms of practically healthy young Ukrainian women with a very wide face type with an orthognathic bite. The evaluation of the correlations of these indicators was carried out in the "Statistica 6.0" license package using Spearman's non-parametric statistics. In young women with a very wide face type, the following multiple reliable and medium-strength unreliable correlations were established: direct strong (r from 0.64 to 0.76) and medium-strength (r from 0.33 to 0.57) correlations between almost all cephalometric characteristics of the upper respiratory tract itself ways; inverse moderate strength and strong (r from -0.30 to -0.60), as well as direct moderate strength and strong ($r=0.37$ and $r=0.90$) correlations between almost all indicators of the soft palate; direct strong ($r=0.74$) and medium strength ($r=0.51$) correlations between almost all tongue indicators; mostly direct, medium strength (r from 0.30 to 0.45) correlations between the value of the PM-UPW distance and most indicators of the soft palate; mainly strong (r from 0.33 to 0.72) correlations between the value of the PM-U distance and with all characteristics of the tongue, as well as the average strength, there are inverse ($r=-0.33$ and $r=-0.52$) correlations between the value of the NL/PM-U angle and most of the characteristics of the tongue; direct strong and medium strength (r from 0.46 to 0.67) correlations between the value of the AH-FH and AH-MP distances and most of the characteristics of the tongue. Thus, the most pronounced connections are established between the cephalometric characteristics of the upper respiratory tract itself, between the characteristics of the soft palate, between the characteristics of the tongue, as well as between the cephalometric characteristics of the hyoid bone and the tongue and between the characteristics of the soft palate and the tongue.

Keywords: cephalometry, upper respiratory tract, soft palate, hyoid bone, tongue, correlations, Ukrainian young women, face type, orthognathic bite.

Introductions

The upper respiratory tract is a complex structure that includes the nasal cavity, pharynx and larynx. Sometimes they also include paranasal sinuses. The upper respiratory tract is almost completely located in the main part of the human body, which probably determines their connection with craniofacial parameters. The key functions of this part of the respiratory tract are the delivery of air to the lower respiratory tract, its filtration, and heating. The speech-making function is also important.

Changes in the size of the upper respiratory tract of a person for hundreds of thousands of years occur under the influence of environmental factors, namely the features of the climatic conditions in which the population lives. A cool climate causes a sharp decrease in the length of the nasal bone, a decrease in the height of the nasal aperture, and a decrease in the median facial protrusion [10]. Even genetically related ethnic groups will have significant differences in the skeletal structure of the facial bones, which is proven by genetic studies. The data of the analysis showed that extreme temperatures have a greater influence

on the morphology of the specified structures of the face, and, accordingly, on the parameters of the upper respiratory tract [11].

Research data on the ethmoid bone of modern human populations from different parts of the planet indicate the existence of significant differences in its dimensional parameters, which depends on the temperature and humidity of the climate in which the population lives [16].

Pronounced manifestations of sexual dimorphism are characteristic of the cranial dimensions of the respiratory tract. A study of populations from different parts of the world showed significantly higher values of the studied parameters in all cases in men, which is related to body sizes of individuals of different sexes, energy needs and other factors [3].

The study of ontogenetic variations in the morphology of the human nasal cavity in individuals of different age groups (from less than 1 year to more than 20) showed the existence of specific growth periods that differ in men and women, with different growth peaks for different structures.

All this is also explained by different age and gender needs in oxygen consumption and climatic features [4]. That is, taking into account the above information, it is possible to judge the significant morphological variability of the parameters of the upper respiratory tract in different populations and the existence of a significant number of factors that additionally affect the features of the cranial part of the respiratory tract.

However, what is the value of information about the size of the upper respiratory tract? One of the important aspects of the practical application of the obtained information regarding the parameters of the respiratory tract is the effectiveness of the pharmacological use of inhalation drugs. Thus, it has been proven that the lateral deformation of the throat part of the respiratory tract affects the distribution of medicines [7].

At the same time, orthodontic interventions do not always cause changes in airway parameters. The study of orthodontic interventions by type of extraction showed that after their implementation there are no clinically significant changes in the studied parameters of all departments of the upper respiratory tract [18].

Sleep apnea is a serious challenge for society's health, the proportion of which increases over time. An increase in its prevalence was noted from 2008 to 2013, with registration in 37% of men and 50% of women, according to epidemiological data [12]. In elderly people, the incidence rate is even higher and is 90% in men and 78% in women. In general, various epidemiological studies show strikingly different data on the prevalence of sleep apnea - the share ranges from 9 to 38% in the general population [20].

An important factor is that in the etiology of sleep apnea, the factor of both external influence and anatomical factors that cause its occurrence is equally seriously considered [6]. Data from some studies show a strong relationship between craniofacial parameters and the size of the respiratory tract [24].

At the same time, a significant array of issues remains unsolved, in particular, within the Ukrainian population and requires detailed research.

The *purpose* of the study is to establish the peculiarities of correlations of cephalometric parameters of the upper respiratory tract in practically healthy young Ukrainian women with an orthognathic bite with a very wide face type.

Materials and methods

Primary lateral teleroentgenograms, obtained with the dental cone-beam tomograph Veraviewepocs 3D Morita (Japan) in the private dental clinic "Vinintermed", 76 Ukrainian young women (YW) (aged 16 to 20 years, among whom, according to Garson's morphological index [19], 25 had a very wide face type) with an orthognathic bite and the absence of pathology of the upper respiratory tract (effective radiation dose up to 0.001 mSv) were taken from the database of the research center and the pediatric dentistry department of the National Pirogov Memorial Medical

University, Vinnytsia.

Committee on Bioethics of National Pirogov Memorial Medical University, Vinnytsya (protocol № 8 From 30.09.2021) found that the studies do not contradict the basic bioethical standards of the Declaration of Helsinki, the Council of Europe Convention on Human Rights and Biomedicine (1977), the relevant WHO regulations and laws of Ukraine.

Cephalometric analysis of the upper respiratory tract was performed using the licensed medical software OnyxCeph^{3™}, version 3DPro (Image Instruments GmbH, Germany) and the diagnostic program "UniqCeph" (created at the National Pirogov Memorial Medical University, Vinnytsia). The following indicators were analyzed [14]:

characteristics of the upper respiratory tract itself: distance **PASmin** - translingual oropharyngeal space (mm); distance **PM-UPW** - nasopharyngeal space (mm); distance **U-MPW** - postpalatal oropharyngeal space (mm); distance **V-LPW** - lower oropharyngeal space (mm); area **UAA** - area of the upper respiratory area (mm²);

characteristics of the soft palate: angle **NL/PM-U** - angle of inclination of the soft palate (°); **PM-U** distance - length of the soft palate (mm); distance **SPT** - thickness of the soft palate (mm); **SPA** area - soft palate area (mm²);

characteristics of the hyoid bone: **AH-CV** distance - the position of the hyoid bone relative to the spine horizontally (mm); distance **AH-FH** - the position of the hyoid bone relative to the vertical Frankfurt plane (mm); distance **AH-MR** - the position of the hyoid bone relative to the mandibular plane vertically (mm);

tongue characteristics: **H-VT** distance - tongue height (mm); distance **VT** - tongue length (mm); section **TA** - tongue area (mm²).

The assessment of correlations between cephalometric indicators of the upper respiratory tract was carried out in the license package "Statistica 6.0" using non-parametric statistics of Spearman.

Results. Discussion

Table 1 presents the results of correlations between cephalometric indicators of the upper respiratory tract in practically healthy YW with an orthognathic bite, representatives with a very wide face type.

When analyzing the reliable and medium strength of unreliable *correlations between the cephalometric characteristics of the upper respiratory tract* in YW with a very wide face type, multiple direct strong ($r =$ from 0.64 to 0.76) and medium strength ($r =$ from 0.33 to 0.57) correlations were established between practically all cephalometric indicators. *Quantitative analysis* of reliable and medium-strength unreliable correlations between cephalometric characteristics of the upper respiratory tract itself revealed 9 direct correlations out of 10 possible (90.00%), of which 40.00% were strong and medium-strength reliable and 10.00% were unreliable.

When analyzing the reliable and medium-strength

unreliable correlations between the *cephalometric characteristics of the soft palate* in YW with a very wide face type, multiple inverse medium-strength and strong ($r=$ from -0.30 to -0.60) and direct medium-strength and strong ($r=$ 0.37 and $r=0.90$) correlations between almost all cephalometric indicators. *Quantitative analysis* of reliable and average strength of unreliable correlations between cephalometric characteristics of the soft palate revealed 5 correlations out of 6 possible (83.33 %), of which 16.67 % were inverse strong reliable and medium strength reliable and unreliable, as well as 16.67 % direct strong reliable and medium strength unreliable.

When analyzing the reliable and average strength of unreliable correlations between the *cephalometric characteristics of the hyoid bone* in YW with a very wide face type, only a reliable direct average strength ($r=0.56$) correlations between the value of the AH-MR distance and the AH-FH distance was established, which 3 possible connections is 33.33 %.

In the analysis of reliable and medium-strength unreliable correlations between the *cephalometric characteristics of the tongue* in YW with a very wide face type, multiple reliable direct strong ($r=0.74$) and medium-strength ($r=0.51$) correlations between the size of the TA area and the H-VT and VT distances were established. *Quantitative analysis* of reliable and medium-strength unreliable correlations between cephalometric characteristics of the tongue revealed 2 correlations out of 3 possible (66.67 %), of which 33.33 % were reliable direct strong and medium-strength correlations.

In the analysis of reliable and medium-strength unreliable correlations between the *cephalometric*

characteristics of the upper respiratory tract proper and the soft palate in YW with a very wide face type, multiple, mostly direct, medium-strength reliable ($r=0.42$ and $r=0.45$) and unreliable ($r=0.30$) correlations between the value of the PM-UPW distance and the PM-U, SPT and SPA section distances. *Quantitative analysis* of reliable and average strength of unreliable correlations between cephalometric characteristics of the proper upper respiratory tract and soft palate revealed 6 connections out of 20 possible (30.00 %), of which, 15.00 % direct average strength reliable, 10.00 % direct average strength unreliable and 5.00 % of the inverse of the average strength of the credible.

When analyzing the reliable and average strength of unreliable correlations between the *cephalometric characteristics of the upper respiratory tract proper and the hyoid bone* in YW with a very wide face type, no multiple relationships were established. *Quantitative analysis* of reliable and average strength of unreliable correlations between cephalometric characteristics of the proper upper respiratory tract and hyoid bone revealed 3 connections out of 15 possible (20.00 %), of which, 6.67 % of direct average strength of reliable and unreliable and inverse of average strength of reliable.

When analyzing the reliable and average strength of non-reliable correlations between the *cephalometric characteristics of the upper respiratory tract proper and the tongue* in YW with a very wide face type, no multiple relationships were established. *Quantitative analysis* of reliable and average strength of unreliable correlations between cephalometric characteristics of the upper respiratory tract proper and the tongue revealed 4 connections out of 15 possible (26.67 %), of which 20.00

Table 1. Correlations between cephalometric parameters of the upper respiratory tract in YW with a very wide face type (n=25).

Indicators	PASmin	PM-UPW	U-MPW	V-LPW	UAA	NL/PM-U	PM-U	SPT	SPA	AH-CV	AH-FH	AH-MP	H-VT	VT
PM-UPW	0.15													
U-MPW	0.72	0.43												
V-LPW	0.49	0.33	0.49											
UAA	0.72	0.57	0.76	0.64										
NL/PM-U	0.02	-0.48	-0.07	-0.24	-0.16									
PM-U	-0.01	0.45	-0.08	0.23	0.40	-0.60								
SPT	0.30	0.30	0.21	0.18	0.15	-0.30	0.09							
SPA	0.25	0.42	0.16	0.09	0.23	-0.47	0.37	0.90						
AH-CV	0.17	-0.01	0.33	0.59	0.26	0.02	-0.04	-0.13	-0.24					
AH-FH	-0.29	-0.24	-0.46	0.06	-0.02	0.22	0.30	-0.22	-0.13	0.16				
AH-MP	0.07	-0.10	-0.17	0.22	0.26	-0.14	0.53	-0.11	-0.01	0.03	0.56			
H-VT	-0.34	-0.03	-0.30	0.28	0.02	0.10	0.33	-0.12	-0.04	0.20	0.67	0.27		
VT	0.14	0.26	0.11	0.18	0.46	-0.52	0.72	0.11	0.36	0.09	0.23	0.65	0.02	
TA	-0.31	0.21	-0.18	0.26	0.23	-0.33	0.72	-0.09	0.15	0.18	0.59	0.46	0.74	0.51

Notes: yellow background - unreliable direct connections of medium strength; brown background - reliable direct connections of medium strength; red background - strong reliable direct connections; green background - unreliable feedback of medium strength; blue background - reliable feedback of medium strength; purple background - strong reliable feedback.

% of inverse average strength were unreliable and 6.67 % of direct average strength were reliable.

An analysis of the reliable and average strength of the non-reliable correlations between the *cephalometric characteristics of the soft palate and hyoid bone* in YW with a very wide facial type revealed no *multiple* correlations. *Quantitative analysis* of reliable and average strength of unreliable correlations between the cephalometric characteristics of the soft palate and hyoid bone revealed only 2 direct average strength of connections out of 12 possible (16.67 %), of which 8.33 % were reliable and unreliable.

When analyzing the reliable and average strength of unreliable correlations between the *cephalometric characteristics of the soft palate and tongue* in YW with a very wide face type, multiple direct, mostly strong reliable ($r=0.72$ in both cases) correlations were established between the value of the PM-U distance and all characteristics of the tongue, as well as average strength, there are inverse reliable ($r=-0.52$) and unreliable ($r=-0.33$) correlations between the value of the NL/PM-U angle and most of the characteristics of the tongue. *Quantitative analysis* of reliable and medium-strength unreliable correlations between cephalometric characteristics of the soft palate and tongue revealed 6 correlations out of 12 possible (50.00 %), of which 16.67 % were direct reliable strong and medium-strength unreliable, as well as 8.33 % inverse average strength of reliable and unreliable.

In the analysis of reliable and medium strength unreliable correlations between the *cephalometric characteristics of the hyoid bone and tongue* in YW with a very wide face type, multiple direct reliable strong ($r=0.65$ and $r=0.67$) and medium strength ($r=0.46$ and $r=0.59$) correlations were established. relationships between the AH-FH and AH-MP distances and most of the characteristics of the tongue. *Quantitative analysis* of reliable and medium-strength unreliable correlations between cephalometric characteristics of the hyoid bone and tongue revealed 4 connections out of 9 possible (44.44 %), of which 22.22 % were direct reliable strong and medium-strength.

Thus, in Ukrainian YW with a very wide face type, orthognathic bite and the absence of pathology of the upper respiratory tract, in the analysis of reliable and average strength of unreliable correlations, the most pronounced connections are established between the cephalometric characteristics of the upper respiratory tract itself, between the cephalometric characteristics of the soft palate, between the cephalometric characteristics of the tongue, between the cephalometric characteristics of the hyoid bone and the tongue, and between the cephalometric characteristics of the soft palate and the tongue.

A significant number of scientific publications have been devoted to the search for the relationship between craniofacial parameters in normal and pathological conditions and parameters of the respiratory tract, which confirm the data we obtained. J. Ansar with co-authors [1]

established that individuals with a hyperdivergent facial type have significantly smaller parameters of the nasopharynx ($p<0.001$) and oropharynx ($p<0.05$) than representatives of other types of facial growth. A decrease in pharyngeal airways was observed in individuals with large values of the craniocervical angle and a large inclination of the lower jaw. At the same time, the average values of the width of the upper respiratory tract did not differ significantly ($p>0.05$) between the hypodivergent and normodivergent groups and the hyperdivergent and normodivergent groups. The same data were obtained regarding the parameters of the lower respiratory tract [2]. Subjects with a hyperdivergent skeletal pattern, who belonged to skeletal classes I or II with malocclusion, showed a statistically significantly narrower upper pharyngeal area compared to normodivergent and hypodivergent faces [17].

Individuals with high facial skeletal angle have significantly ($p<0.01$) lower nasopharyngeal airway volume values compared to individuals with low and normal facial skeletal angle. At the same time, the volume of oropharyngeal airways is the highest in the group with a low angle [5].

Class I and III patients had significantly higher aerodynamic channel area values compared to class II. It was also noted that classes I and III had significantly higher values of air space volume in the upper, middle and lower pharyngeal areas compared to class II [23].

The authors of the study found that the volume of air space in different parts of the pharyngeal tract can vary depending on the type of skeletal structure of the face in teenagers. It was also found that an increase in the ANB angle can lead to a decrease in the volume of the air space in some parts of the pharyngeal tract [8].

E. Dalmau et al found that there are differences in anteroposterior airspace measurements depending on the level of the airway, but the magnitude of these differences depends on the skeletal pattern of each individual. The homogeneity between the middle and lower levels of the pathways gradually decreased from class I subjects to class III subjects [9].

Negative correlation was found between the width of the upper pharyngeal part and the ANB angle in the study of 114 patients data: the ANB angle decreased when the width of the upper pharyngeal part increased. The airways also showed a statistically significant negative correlation between the width of the lower pharyngeal part and the distance from the upper and lower lips to the E line. The upper pharyngeal part was affected by: an increase in the nasal tip angle, younger age, a decrease in the SNB angle; lower pharyngeal part was affected by an increase in the distance between the upper lip and the E line, as well as an increase in the thickness of the upper lip [15].

All three skeletal classes differed significantly in airway volume, minimum cross-sectional area, mean airspace area, and airway morphology ($p<0.05$). Statistically

significant differences were found in the volume of airways and the average area of the air space between patients with classes II and III ($p < 0.05$). The minimum cross-sectional area and airway morphology in class III patients were greater than in class I and II patients ($p < 0.05$) [21].

Subjects with a vertical skeletal pattern had significantly narrower upper airways than subjects with a horizontal skeletal pattern. The position of the posterior edge of the tongue was also significantly different in the vertical growth pattern group. In addition, in subjects with a brachyfacial facial structure, the hyoid bone was located further from the mandibular symphysis, which is reflected in large values of the distance between the hyoid and retrognathia (H-RGN) compared to dolichofacial and normal subjects [22].

A study with the participation of 105 people of both sexes showed that two horizontal linear measurements (depth of the air space of the hypopharyngeal tract, depth of the air space of the nasopharyngeal tract) and one spatial measurement (the space of the soft palate) differed significantly according to the classes of skeletal structure. Vertical and horizontal linear measurements in the three groups increased significantly in men compared to women [13].

Conclusions and prospects for further developments

1. In practically healthy Ukrainian YW with a very wide face type with an orthognathic bite, the following multiple correlations were established: mostly reliable, direct strong ($r =$ from 0.64 to 0.76) and medium strength ($r =$ from 0.43 to

0.57) correlations between most cephalometric characteristics of the upper respiratory tract itself; inverse strong reliable ($r = -0.60$) and medium strong reliable ($r = -0.47$) and unreliable ($r = -0.30$), as well as direct strong reliable ($r = 0.90$) and medium strong unreliable ($r = 0.37$) correlations between most cephalometric characteristics of the soft palate; direct reliable strong ($r = 0.74$) and medium strength ($r = 0.51$) correlations between most tongue characteristics.

2. In practically healthy Ukrainian YW with a very wide face type with an orthognathic bite, the following multiple correlations were established: mainly direct, medium-strength reliable ($r = 0.42$ and $r = 0.45$) and unreliable ($r = 0.30$) correlations between the value of the distance PM-UPW and most of the characteristics of the soft palate; direct, mostly strong reliable ($r = 0.72$ in both cases) correlations between the value of the PM-U distance and all characteristics of the tongue, as well as medium-strength inverse reliable ($r = -0.52$) and unreliable ($r = -0.33$) correlations between the value of the NL/PM-U angle and most of the characteristics of the tongue; direct reliable strong ($r = 0.65$ and $r = 0.67$) and medium strength ($r = 0.46$ and $r = 0.59$) correlations between the AH-FH and AH-MP distances and most of the tongue characteristics.

The results obtained by us from the correlation analysis of cephalometric indicators of the upper respiratory tract in Ukrainian YW with a very wide face type will allow us to correctly build individual normative models of these indicators in the future.

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ОСОБЛИВОСТІ КОРЕЛЯЦІЙ ЦЕФАЛОМЕТРИЧНИХ ПАРАМЕТРІВ ВЕРХНІХ ДИХАЛЬНИХ ШЛЯХІВ В УКРАЇНСЬКИХ ДІВЧАТ ІЗ ДУЖЕ ШИРОКИМ ТИПОМ ОБЛИЧЧЯ

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Анотація. Взаємозв'язок краніофациальних параметрів та особливостей показників верхніх дихальних шляхів є предметом досліджень для широкого спектру науковців різних напрямків, що пов'язано з багатогранною практичною значущістю можливих отриманих результатів. Одним з найбільш важливих напрямків серед даних досліджень є вивчення нормативних показників дихальних шляхів, залежно від різних змінних, адже розуміння значень норми дозволяє надалі судити про патологічні зміни. Мета дослідження - встановити особливості кореляцій цефалометричних параметрів верхніх дихальних шляхів у практично здорових українських дівчат із ортогнатичним прикусом із дуже широким типом обличчя. На первинних бокових телерентгенограмах практично здорових українських дівчат із дуже широким типом обличчя з ортогнатичним прикусом проведено цефалометричний аналіз верхніх дихальних шляхів, м'якого піднебіння, під'язикової кістки та язика. Оцінку кореляцій даних показників проведено в ліцензійному пакеті "Statistica 6.0" за допомогою непараметричної статистики Спірмена. У дівчат із дуже широким типом обличчя встановлені наступні множинні достовірні та середньої сили недостовірні кореляції: прямі сильні (r від 0.64 до 0.76) та середньої сили (r від 0.33 до 0.57) зв'язки між практично усіма цефалометричними характеристиками власне верхніх дихальних шляхів; зворотні середньої сили та сильні (r від -0.30 до -0.60), а також прямі середньої сили та сильні ($r=0.37$ і $r=0.90$) зв'язки між практично усіма показниками м'якого піднебіння; прямі сильний ($r=0.74$) та середньої сили ($r=0.51$) зв'язки між практично усіма показниками язика; переважно прямі, середньої сили (r від 0.30 до 0.45) зв'язки між величиною відстані $PM-UPW$ та більшістю показників м'якого піднебіння; переважно сильні (r від 0.33 до 0.72) зв'язки між величиною відстані $PM-U$ та усіма характеристиками язика, а також середньої сили зворотні ($r=-0.33$ і $r=-0.52$) зв'язки між величиною кута $NL/PM-U$ та більшістю характеристик язика; прямі сильні та середньої сили (r від 0.46 до 0.67) зв'язки між величиною відстаней $AN-FH$ і $AN-MP$ та більшістю характеристик язика. Таким чином, найбільш виражені зв'язки встановлені між цефалометричними характеристиками власне верхніх дихальних шляхів, між характеристиками м'якого піднебіння, між характеристиками язика, а також між цефалометричними характеристиками під'язикової кістки і язика та між характеристиками м'якого піднебіння і язика.

Ключові слова: цефалометрія, верхні дихальні шляхи, м'яке піднебіння, під'язикова кістка, язик, кореляції, українські дівчата, тип обличчя, ортогнатичний прикус.