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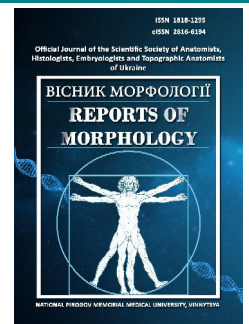
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## REPORTS OF MORPHOLOGY

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# Teleroentgenometric parameters of the soft palate in young men and young women with an orthognathic bite without and taking into account the type of face

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The study of the features of the upper respiratory tract and the relationship of their parameters with other anatomical formations and structures of the human body is one of the promising areas of modern science. Since numerous anatomical components are involved in the functioning of the respiratory tract, their detailed study should be carried out separately. One of these components that is of direct interest to science and practice is the soft palate. The purpose of the study is to establish the peculiarities of the teleroentgenometric parameters of the soft palate in Ukrainian young men and young women without pathology of the upper respiratory tract with an orthognathic bite without and taking into account the type of face. Determination of teleroentgenometric parameters of the soft palate was carried out in 72 young women and 46 young men with no pathology of the upper respiratory tract with an orthognathic bite (primary lateral teleroentgenograms were taken from the database of the research center and the Department of Pediatric Dentistry of the National Pirogov Memorial Medical University, Vinnytsya). For all young men and young women face type was determined using Garson's morphological index. The analysis of the obtained results was carried out in the statistical package "Statistica 6.0" using non-parametric estimation methods. As a result of the conducted research, pronounced gender differences were found (significantly greater, or a tendency to greater values in young men): the value of the PM-U distance in representatives without taking into account the type of face by 7.1 %, with very wide - by 9.2 %, with wide - by 8.4 % and with narrow - by 7.4 % face types; values of the SPT distance in representatives without taking into account the face type by 10.3 %, with very wide - by 16.4 % and with narrow - by 23.1 % face types; the values of the NL/PM-U angle in representatives without taking into account the face type by 7.6 % and by 11.5 % with wide face types; the size of the SPA area in representatives without taking into account the type of face by 17.2 %, with very wide - by 24.4 %, with wide - by 13.4 % and with narrow - by 32.2 % of face types. When analyzing the value of teloradiographic parameters of the soft palate in young men between different types of faces, it was established that significantly higher values or trends towards higher values in representatives with a narrow face of the SPT distance and SPA area than in young men with a very wide (respectively by 8.9 % and 13.0 %) and average (by 13.9 % and 22.2 %), respectively, face types, and in young men, regardless of face type, there is a tendency for greater values of the PM-U distance than in representatives with an average face (by 4.2 %). In young women with a narrow face, only a tendency to greater values of the NL/PM-U angle was established than in young women with a wide face (by 6.2 %). The results of the study are an integral element of determining the normative values of various parameters of the upper respiratory tract, which enables practicing doctors to more correctly distinguish the norm from pathology.

**Keywords:** teleroentgenography, cephalometry, soft palate, young men, young women, facial types, orthognathic bite.

### Introduction

The study of the upper respiratory tract is a complex and complex process, because this anatomical complex

includes a lot of structures of a different nature - both bony, cartilaginous and soft tissue. If we talk about the latter, the

soft palate has a special place among them.

The soft palate is a group of five muscles, and is an extension of the hard palate that hangs over the base of the tongue. In general, it occupies about a third of the roof of the oral cavity and has a unique for mammals (except some primates) process - the uvula. Intrauterine development of the palate includes the formation of the primary and secondary palate. If a small part of the hard palate is formed from the primary palate, then the majority of both the hard and soft palate is formed from the secondary. The rudiments of the secondary palate are formed at the 6th week of intrauterine development, and it is its developmental pathology that later leads to the formation of a cleft palate defect. Later in life, the soft palate takes part in the act of breathing and swallowing, where it plays one of the key roles. In addition, the function of voice production and speech production is important [13].

As an object of cephalometric research, the soft palate has been studied as an independent component for quite some time. This led to the formation of a classification of forms of the soft palate, which is still a subject of debate in the scientific world. One of the common ones is the classification that distinguishes 6 forms of the soft palate during cephalometric examination: leaf-shaped (the middle part is raised on both sides), rat-tail-shaped (inflated front part and free edge), pillow-shaped (short and thick), rectilinear, S-type, curved (the back part bends upwards from the front) [3, 7, 16].

The prevalence of such forms is quite heterogeneous in different populations. So, on the example of Indian, the first type is the most common and occurs in about half of the cases, the second and third types are less common, and all other types occur in less than 10 % of the population. At the same time, the presence of manifestations of sexual dimorphism regarding one or another type of palate is still debatable [3, 7]. However, these data raise an equally important question - can the features of the structure of the soft palate be interconnected with other structures of the respiratory tract or head, sex and other parameters?

Equally important is the fact that the size of the soft palate varies significantly in people with respiratory tract diseases. An increase in the length of PNS-U of the soft palate with a more severe course of obstructive sleep apnea [14]. In addition, certain forms of soft palate occur more often in people with this disease [5].

According to other studies, not only the parameters of the soft palate, but also other elements of the respiratory tract in the complex affect the severity of obstructive sleep apnea. Such a parameter is also a linear distance along a plane perpendicular to the plane of the hyoid bone of the lower jaw [4].

Thus, it becomes especially important to determine the normative indicators of the soft palate for individuals of a certain population, taking into account such parameters as gender and age. An equally important direction may be the search for the relationship between the parameters of

the soft palate and other craniofacial structures.

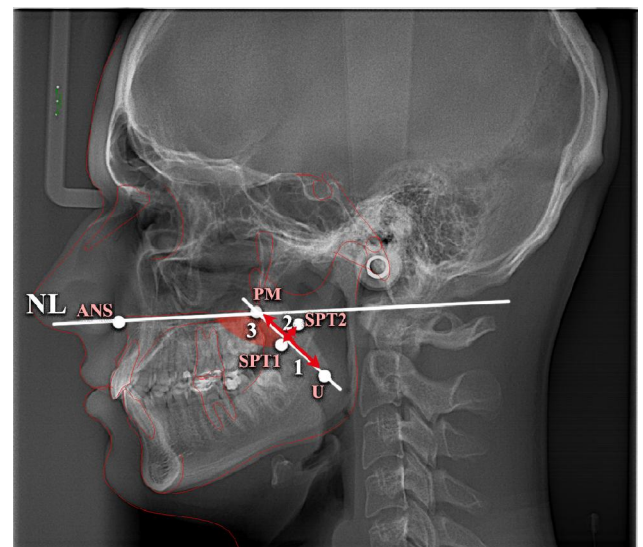
*The purpose of the study* is to establish the peculiarities of the teleroentgenometric parameters of the soft palate in Ukrainian young men and young women without pathology of the upper respiratory tract with an orthognathic bite without and taking into account the type of face.

### Materials and methods

Primary lateral radiographs of 46 Ukrainian young men (YM) (aged 17 to 21 years) and 72 Ukrainian young women (YW) (aged 16 to 20 years) with an orthognathic bite and the absence of upper respiratory tract pathology were taken from the database of the Scientific Research Center and Department of Pediatric Dentistry National Pirogov Memorial Medical University, Vinnytsya. All of them, after applying for dental care, underwent a teleroadiographic examination (effective radiation dose up to 0.001 mSv) using a dental cone-beam tomograph Veraviewepocs 3D Morita (Japan) on the basis of the private dental clinic "Vinintermed" (Vinnytsya). Cephalometric analysis was performed using the licensed medical software OnyxCeph<sup>TM</sup>, version 3DPro (Image Instruments GmbH, Germany) and the diagnostic program "UniqCeph" created at the National Pirogov Memorial Medical University, Vinnytsya.

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.

Using Garson's morphological index [17], the face type was determined in Ukrainian YM and YW: in YW - 25 with a very wide face, 25 with a wide face, 10 with an average face and 12 with a narrow face; in YM, 5 with very wide face, 22



**Fig. 1.** Linear parameters used in teleroentgenometric examination of the soft palate: 1 - distance PM-U, 2 - distance SPT, 3 - angle NL/PM-U, NL - nasal plane (passes through the ANS and PM points).

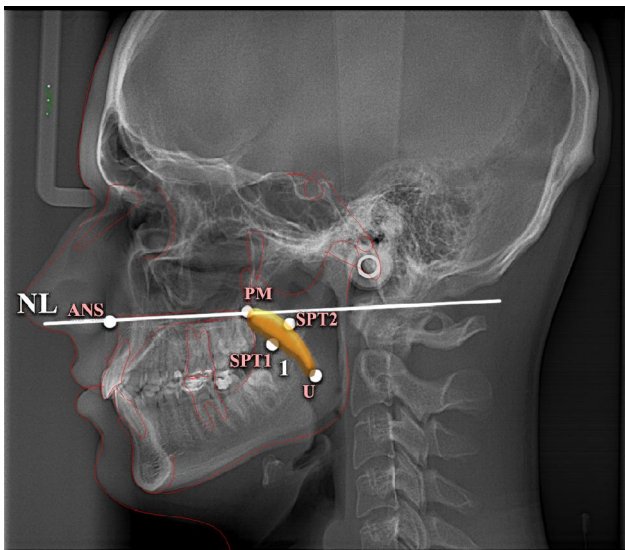


Fig. 2. The area of the soft palate (area SPA).

with wide face, 11 with medium face and 8 with narrow face.

The following telerontgenometric parameters of the soft palate were determined (Fig. 1, 2):

distance **PM-U** (also known as Soft palate length) - distance between points PM and U (mm);

distance **SPT** (also known as Maximum soft palate thickness) - the distance between the most distant points perpendicular to the line PM-U (mm);

angle **NL/PM-U** (also known as Soft palate inclination Angle) - the angle formed by the lines PM-U and NL (°);

area **SPA** (also known as Soft palate area) - outlined by a contour through points PM and U (mm<sup>2</sup>).

The analysis of the obtained results was carried out in the licensed statistical package "Statistica 6.0" using non-parametric estimation methods. Means and standard deviations were determined for each trait. The significance of the difference in values between independent quantitative values was determined using the Mann-Whitney U-test.

## Results

When comparing the value of the **PM-U** distance between Ukrainian YM and YW without pathology of the upper respiratory tract with an orthognathic bite without and taking into account the type of face, it was established (Fig. 3) that in YM without taking into account the type of face ( $31.45 \pm 3.43$  mm), with a very wide with a face ( $32.01 \pm 1.31$  mm), with a wide face ( $31.81 \pm 3.92$  mm) and with a narrow face ( $31.88 \pm 3.03$  mm), the value of this distance is significantly greater or tends to greater values than in YW without taking into account the type of face ( $29.23 \pm 2.84$  mm,  $p < 0.001$ ), with a very wide face ( $29.06 \pm 2.87$  mm,  $p < 0.05$ ), with a wide face ( $29.15 \pm 3.33$  mm,  $p < 0.01$ ) and a narrow face ( $29.53 \pm 2.29$  mm,  $p = 0.076$ ).

When comparing the value of the **PM-U** distance in Ukrainian YM or YW without pathology of the upper

respiratory tract with an orthognathic bite between different types of face, it was established (see Fig. 1) that only in YM without taking into account the type of face the value of this distance has a tendency ( $p = 0.062$ ) to greater values than in YM with an average face type ( $30.13 \pm 3.59$  mm).

When comparing the value of the **SPT** distance between Ukrainian YM and YW without pathology of the upper respiratory tract with an orthognathic bite without and taking into account the type of face, it was established (Fig. 4) that in YM without taking into account the type of face ( $7.340 \pm 1.460$  mm), with a very wide face ( $7.656 \pm 1.175$  mm) and with a narrow face ( $8.400 \pm 1.436$  mm), the value of this distance is significantly greater than in YW without taking into account the type of face ( $6.587 \pm 1.169$  mm,  $p < 0.01$ ), with a very wide face ( $6.397 \pm 1.142$  mm,  $p < 0.05$ ) and a

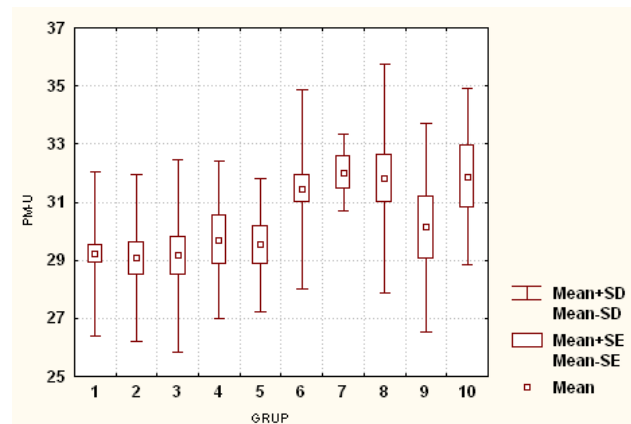


Fig. 3. The value of the **PM-U** distance (length of the soft palate) in YM and YW with orthognathic bite without and taking into account the type of face (mm). Notes: Here and in subsequent figures, 1 is YW excluding face type; 2 - YW with a very wide face type; 3 - YW with a wide face type; 4 - YW with an average face type; 5 - YW with a narrow face type; 6 - YM without taking into account the type of face; 7 - YM with a very wide face type; 8 - YM with a wide face type; 9 - YM with an average face type; 10 - YM with a narrow face type; Mean - sample mean;  $\pm$ SE - error of the mean;  $\pm$ SD - standard deviation.

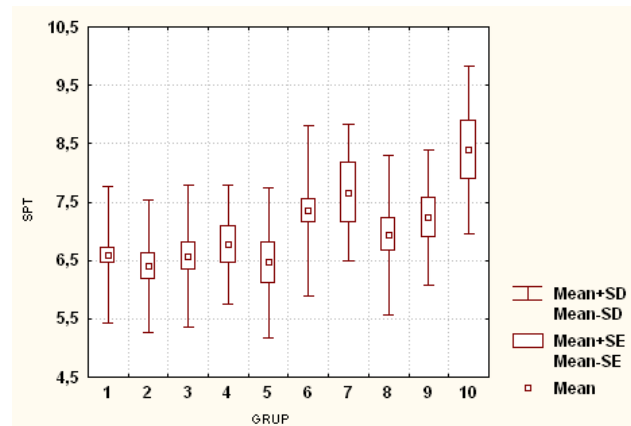
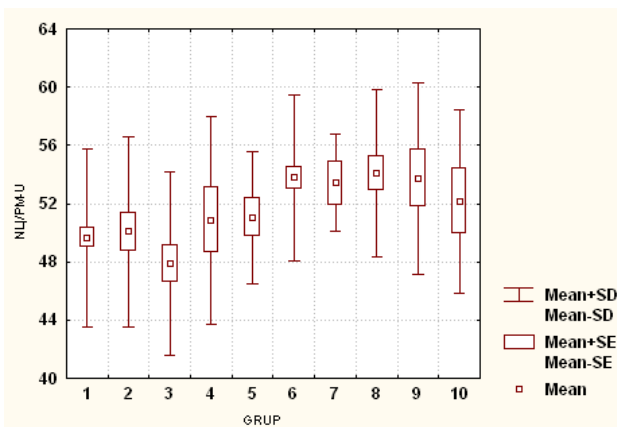
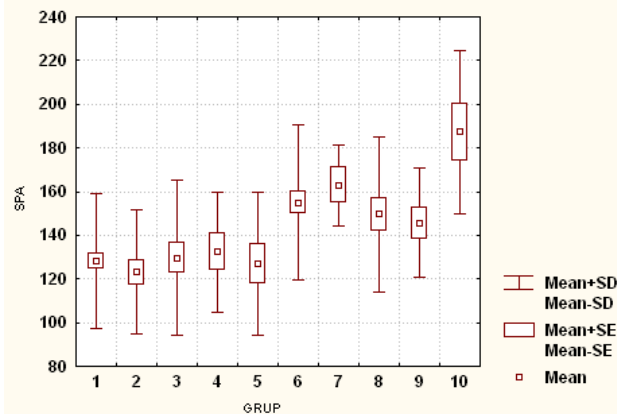


Fig. 4. The magnitude of the **SPT** (soft palate thickness) distance in YM and YW with orthognathic bite without and taking into account the type of face (mm).





**Fig. 5.** The value of the **NL/PM-U** angle (angle of inclination of the soft palate) in YM and YW with orthognathic bite without and taking into account the type of face (°).



**Fig. 6.** The size of the **SPA** area (area of the soft palate) in YM and YW with an orthognathic bite without and taking into account the type of face (mm²).

narrow face ( $6.458 \pm 1.275$  mm,  $p < 0.01$ ).

When comparing the value of the **SPT** distance in Ukrainian YM or YW without pathology of the upper respiratory tract with an orthognathic bite between different types of face, it was established (see Fig. 2) that only in YM with a narrow face type, the value of this distance is significantly ( $p < 0.05$ ) greater, than in YM with a very wide face type and has a slight tendency ( $p = 0.083$ ) to greater values than in YM with an average face type ( $7.235 \pm 1.152$  mm).

When comparing the value of the **NL/PM-U** angle between Ukrainian YM and YW without pathology of the upper respiratory tract with an orthognathic bite without and taking into account the type of face, it was established (Fig. 5) that in YM without taking into account the type of face ( $53.77 \pm 5.68$  °) and with a wide face ( $54.08 \pm 5.71$  °), the value of this angle is significantly greater than in YW regardless of face type ( $49.66 \pm 6.09$  °,  $p < 0.001$ ) and with a wide face ( $47.88 \pm 6.26$  °,  $p < 0.01$ ).

When comparing the value of the **NL/PM-U** angle in Ukrainian YM or YW without pathology of the upper

respiratory tract with an orthognathic bite between different types of face, it was established (see Fig. 3) that only in YW with a narrow face type ( $51.07 \pm 4.54$  °) the value of this angle has a tendency ( $p = 0.064$ ) to greater values than in YW with a wide face type ( $47.88 \pm 6.26$  °).

When comparing the size of the **SPA** area between Ukrainian YM and YW without pathology of the upper respiratory tract with an orthognathic bite without and taking into account the type of face, it was established (Fig. 6) that in YM without taking into account the type of face ( $155.0 \pm 35.5$  mm²), with a very wide face ( $162.8 \pm 18.7$  mm²), with a wide face ( $149.6 \pm 35.6$  mm²) and with a narrow face ( $187.2 \pm 37.2$  mm²), the value of this area is significantly greater or tends to greater values than in YW regardless of face type ( $128.3 \pm 30.7$  mm²,  $p < 0.001$ ), with a very wide face ( $123.0 \pm 28.4$  mm²,  $p < 0.01$ ), with a wide face ( $129.6 \pm 35.6$  mm²,  $p = 0.061$ ) and a narrow face ( $127.0 \pm 32.7$  mm²,  $p < 0.01$ ).

When comparing the size of the **SPA** area in Ukrainian YM or YW without pathology of the upper respiratory tract with an orthognathic bite between different types of face, it was established (see Fig. 4) that only in YM with a narrow face type, the size of this area is reliable ( $p < 0.05$  in both cases) is greater than in YM with very wide and medium ( $145.6 \pm 25.0$  mm²) facial types.

## Discussion

Thus, in Ukrainian YM and YW without pathology of the upper respiratory tract with an orthognathic bite without and taking into account the type of face, pronounced manifestations of sexual dimorphism (higher values in young men) of teleroentgenometric parameters of the soft palate were found: **PM-U** distance in YM without taking into account the type of face by 7.1 %, with a very wide face - by 9.2 %, with a wide face - by 8.4 % and with a narrow face - by 7.4 %; values of the **SPT** distance in YM without taking into account the type of face by 10.3 %, with a very wide face - by 16.4 % and with a narrow face - by 23.1 %; the values of the **NL/PM-U** angle in YM without taking into account the type of face by 7.6 % and with a wide face by 11.5 %; the size of the **SPA** area in YM without taking into account the type of face by 17.2 %, with a very wide face - by 24.4 %, with a wide face - by 13.4 % and with a narrow face - by 32.2 %.

When analyzing the teleroentgenometric parameters of the soft palate in Ukrainian YW or YM without pathology of the upper respiratory tract with an orthognathic bite between different facial types, in YM with a narrow facial type, significantly greater or tends to greater values of the **SPT** distance value were established than in YM with a very wide (by 8.9 %) and medium (by 13.9 %) face types and the size of the **SPA** area than in YM with very wide (by 13.0 %) and medium (by 22.2 %) face types, as well as in YM without taking into account the face type of the distance value **PM-U** tends to higher values than YM with an average face type (by 4.2 %); and in YWs with a narrow face type, a tendency to greater values of the **NL/PM-U** angle was established

than in YWs with a wide face type (by 6.2 %).

Works on the study of the relationship between the parameters of the soft palate and other structures of the human body are quite few in the scientific literature. Thus, Kulshrestha R. and co-authors [12] found significant differences for the value of the angle of inclination of the soft palate in groups with hypo- and hyperdivergent patterns of facial growth ( $p < 0.003$ ).

The first type of soft palate is significantly more common ( $p = 0.001$ ) in people with an average type of facial growth, and the second type in people with horizontal and vertical types of facial growth [21].

A statistically significant difference was found between all groups with different values of the Needs coefficient. The highest coefficient was observed with a curved type of soft palate (average value 0.9). The vertical growth type in all six types of soft palate demonstrated a higher Needs coefficient than the average and horizontal growth types [9]. Similar data were also obtained in another study [6].

If we talk about the pathology of the maxillofacial system and its relationship with the features of the soft palate, it has been established that in persons with a skeletal malocclusion of class I, a leaf-like form of the soft palate is most often found, and in class II - a rat's tail, in class III - leaf-like and curved forms in equal proportions [2].

In a study on another sample of patients, the following interdependencies were found: patients with a Class I malocclusion most often had a rat-tail type soft palate, Class II patients had a leaf-like soft palate, and Class III patients had a curved soft palate [18].

As for the study of the features of age or sexual dimorphism when studying the indicators of the soft palate, such work is more numerous. For the Iraqi population, adolescent females have been found to have higher soft palate thickness (SPT) values than adult females [1].

In a study of an Indian population, it was found that the velar length increased with age, and the length and width of the soft palate was greater in men than in women. However, a reliable correlation regarding the belonging of one or another type of soft palate to gender was not found [8].

In another study conducted by Indian scientists, the relationship between different types of soft palate in different age groups turned out to be insignificant. The highest values of the average length of the soft palate were found in men aged 46-55 years (and in all age groups higher values in men). In addition, a positive correlation was found between age and the type of soft palate [10].

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No correlations were found between the age of the person and the characteristics of the type of soft palate within the studied group, residents of the state of Vikarabad (India) [23].

For the Indian population, the average values of the total average anterior-posterior length of the soft palate were  $30.31 \pm 3.39$  mm, and the upper-lower one was  $10.72 \pm 1.71$  mm [15]. The presence of significant differences in most size indicators within the Indian population is confirmed by the results of other studies [19, 20]. However, the question of why the data of different studies show different results regarding the presence or absence of certain manifestations of sexual dimorphism in the investigated indicators still remains open. Probably, one of the explanations for this phenomenon can be the regional difference in the normative indicators of the Indian population, which is not taken into account by the authors of the mentioned studies.

In the American population, a statistically significant difference was noted for age in relation to the shape of the soft palate ( $p = 0.014$ ). At the same time, gender and race have no significant effect on its shape [11].

Nepalese researchers examined and analyzed 263 lateral teleroentgenograms of ethnic residents of Nepal. Statistical analysis of the obtained data did not reveal any manifestations of gender or age dimorphism regarding the features of the forms of the soft palate [22].

## Conclusions

1. Pronounced manifestations of sexual dimorphism of teleroentgenometric parameters of the soft palate were established in the Ukrainian youth population without pathology of the upper respiratory tract with an orthognathic bite - in most cases, higher values in young men without and taking into account the type of face (with the exception of the average face type).

2. Differences in teleroentgenometric parameters of the soft palate between young men and young women with different facial types are established mainly in young men - representatives with a narrow face have larger values of the **SPT** distance and the **SPA** area than in young men with very wide and medium facial types, as well as representatives regardless of face type have larger values of the **PM-U** distance than young men with an average face type; and young women with a narrow face type only have larger values of the **NL/PM-U** angle than young women with a wide face type.

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#### ТЕЛЕРЕНТОГНОМЕТРИЧНІ ПАРАМЕТРИ М'ЯКОГО ПІДНЕБІННЯ В ЮНАКІВ І ДІВЧАТ ІЗ ОРТОГНАТИЧНИМ ПРИКУСОМ БЕЗ ТА З УРАХУВАННЯМ ТИПУ ОБЛИЧЧЯ

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Дослідження особливостей верхніх дихальних шляхів та взаємозв'язку їх параметрів з іншими анатомічними утвореннями та структурами тіла людини є одним з перспективних напрямків сучасної науки. Так як у функціонуванні дихальних шляхів приймають участь численні анатомічні компоненти, слід проводити їх детальне дослідження окремо. Одним з таких компонентів, що безпосередньо представляє інтерес для науки та практики є м'яке піднебіння. Мета дослідження - встановити особливості телерентгенометричних параметрів м'якого піднебіння в українських юнаків і дівчат без патології верхніх дихальних шляхів із ортогнатичним прикусом без та з урахуванням типу обличчя. Визначення телерентгенометричних параметрів м'якого піднебіння проведено у 72 українських дівчат і 46 юнаків із відсутністю патології верхніх дихальних шляхів із ортогнатичним прикусом (первинні бокові телерентгенограми взяті з бази даних науково-дослідного центру та кафедри стоматології дитячого віку Вінницького національного медичного університету ім. М. І. Пирогова). Усім юнакам і дівчатам проведено визначення типу обличчя за допомогою морфологічного індексу Гарсона. Аналіз отриманих результатів проведений у статистичному пакеті "Statistica 6.0" з використанням непараметричних методів оцінки. В результаті проведених досліджень виявлені статеві розбіжності (достовірно більші, або тенденція до більших значень в юнаків): величини відстані РМ-У у представників без урахування типу обличчя на 7,1 %, з дуже широким - на 9,2 %, з широким - на 8,4 % і з вузьким - на 7,4 % типами обличчя; величини відстані SPT у

представників без урахування типу обличчя на 10,3 %, з дуже широким - на 16,4 % і з вузьким - на 23,1 % типами обличчя; величини кута  $NL/PM-U$  у представників без урахування типу обличчя на 7,6 % і з широким - на 11,5 % типами обличчя; величини ділянки  $SPA$  у представників без урахування типу обличчя на 17,2 %, з дуже широким - на 24,4 %, з широким - на 13,4 % і з вузьким - на 32,2 % типами обличчя. При аналізі величини телерентгенометричних параметрів м'якого піднебіння в юнаків між різними типами обличчя встановлено достовірно більші або тенденції до більших значень у представників із вузьким обличчям величини відстані  $SPT$  і ділянки  $SPA$ , ніж в юнаків із дуже широким (відповідно на 8,9 % і на 13,0 %) і середнім (відповідно на 13,9 % і на 22,2 %) типами обличчя, а в юнаків без урахування типу обличчя - тенденцію до більших значень величини відстані  $PM-U$ , ніж у представників із середнім обличчям (на 4,2 %). У дівчат із вузьким обличчям встановлено лише тенденцію до більших значень величини кута  $NL/PM-U$ , ніж у представниць із широким обличчям (на 6,2 %). Результати дослідження є складовим елементом визначення нормативних значень різних параметрів верхніх дихальних шляхів, що дає змогу практичним лікарям більш коректно відрізнати норму від патології.

**Ключові слова:** телерентгенографія, цефалометрія, м'яке піднебіння, юнаки, дівчата, типи обличчя, ортогнатичний прикус.

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