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TELEROENTGENOMETRIC PARAMETERS OF THE HYOID BONE AND TONGUE IN UKRAINIAN BOYS AND GIRLS WITH AN ORTHOGNATHIC BITE WITHOUT AND TAKING INTO ACCOUNT THE TYPE OF FACE

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In the course of the study, pronounced manifestations of sexual dimorphism (higher values in young men) of telerontgenometric parameters of the hyoid bone and tongue were established in the Ukrainian population of youth without pathology of the upper respiratory tract with an orthognathic bite, both in representatives without taking into account the type of face and, in most cases, in young men with different types of faces. Also, between young women and young men with different face types, reliable or trends of differences in the values of these parameters were established – young women with a narrow face have smaller values of the VT distance and the TA area than young women with very wide and wide face types; and young men with a narrow face have larger values of the AH-FH, AH-MP and H-VT distances than representatives with very wide and wide face types.

Key words: telerontgenography, cephalometry, hyoid bone, tongue, young men, young women, orthognathic bite, facial types.

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ОСОБЛИВОСТІ ТЕЛЕРЕНТГЕНОМЕТРИЧНИХ ПАРАМЕТРІВ ПІД'ЯЗИКОВОЇ КІСТКИ ТА ЯЗИКА В УКРАЇНСЬКИХ ЮНАКІВ І ДІВЧАТ ІЗ ОРТОГНАТИЧНИМ ПРИКУСОМ БЕЗ ТА З УРАХУВАННЯМ ТИПУ ОБЛИЧЧЯ

У ході дослідження в українського населення юнацького віку без патології верхніх дихальних шляхів із ортогнатичним прикусом встановлені виражені прояви статевого диморфізму (більші значення в юнаків) величини телерентгенометричних параметрів під'язикової кістки та язика як у представників без урахування типу обличчя, так і, у більшості випадків, в юнаків із різними типами обличчя. Також між дівчатами або юнаками з різними типами обличчя встановлені достовірні або тенденції відмінностей величини даних параметрів – у дівчат із вузьким обличчям менші значення величини відстані VT та ділянки TA, ніж у представниць із дуже широким і широким типами обличчя; а в юнаків із вузьким обличчям більші значення величини відстаней AH-FH, AH-MP і H-VT, ніж у представників із дуже широким і широким типами обличчя.

Ключові слова: телерентгенографія, цефалометрія, під'язикова кістка, язик, юнаки, дівчата, ортогнатичний прикус, типи обличчя.

The study is a fragment of the research project “Telerontgenographic characteristics of the upper respiratory tract in practically healthy young people”, state registration No. 0121U113152.

The study of the upper respiratory tract from the point of view of cephalometry is a complex task that requires taking into account anatomical formations and organs that, at first glance, are not directly identified with the concept of “respiratory tract”.

Among these, the tongue and hyoid bone complex should be considered. Both of them directly affect the physiological functioning of the respiratory tract and at the same time can affect the occurrence and development of their pathology. All this happens due to the direct interaction of the tongue and the

hyoid bone, which is connected to the floor of the mouth and the tongue, in particular, using muscles, and at the same time is connected to the larynx, epiglottis and pharynx [2].

By itself, the hyoid bone is not a stable anatomical formation – its anatomical structure variability is amazing. Thus, a study of the population of Anatolia (Turkey) shows that the classically described U-shaped form of the hyoid bone occurs only in 31.7 % of cases. In other cases, there are such morphological types as B-like (31.7 %), D-like (15.0 %), H-like (10.0 %), HK-like (6.7 %) and V-like (5.0 %). A review of literature data by the study's authors confirms that the classic form of bone is found in no more than 40 % of the population in most parts of the world [10].

In general, scientists are of the opinion that the peculiarities of the structure of the tongue, the upper respiratory tract and the formation of the hyoid bone in humans are an evolutionary element that arose as an adaptation to breastfeeding [2].

At the same time, it is a proven fact that the peculiarities of the location and size of both the tongue and the hyoid bone can cause pathological conditions, such as obstructive sleep apnea [6].

Thus, the study of normative teleroadiological indicators of both the tongue and the hyoid bone in a healthy population, taking into account age and other critically important parameters, is one of the first steps to overcoming further pathologies that can be provoked by abnormal sizes and positions of these structures [13].

The purpose of the study was to determine the peculiarities of teleroentgenometric parameters of the hyoid bone and tongue in Ukrainian young men and young women without pathology of the upper respiratory tract with an orthognathic bite and take into account the type of face.

Materials and methods. From the database of the National Pirogov Memorial Medical University, Vinnytsya, primary lateral teleroentgenograms (obtained after a teleroentgenographic examination using a dental cone-beam tomograph Veraviewepocs 3D Morita in the private dental clinic “Vinintermed”) of 72 Ukrainian young women (YW) (aged 16 to 20 years) and 46 Ukrainian young men (YM) (aged 17 to 21) with an orthognathic bite and the absence of upper respiratory tract pathology.

For cephalometric analysis, licensed medical software OnyxCeph³™, version 3DPro (Image Instruments GmbH, Germany) and a diagnostic program “UniqCeph” created at the National Pirogov Memorial Medical University, Vinnytsya were used.

Committee on Bioethics of National Pirogov Memorial Medical University, Vinnytsya (protocol No. 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.

Fig. 1 shows the lines used in the cephalometric study of the upper respiratory tract [12].

The following teleroentgenometric parameters of the hyoid bone (Fig. 2) and tongue (Fig. 3) were determined:

- distance **AH-CV** (also known as the Horizontal position of the hyoid) the distance between the point AH and cervical plane (CV) (mm);
- distance **AH-FH** (also known as the Vertical position of the hyoid concerning the Frankfort plane) – the distance between the point AH and the Frankfort plane (FH) (mm);
- distance **AH-MP** (also known as Vertical position of the hyoid with respect to the mandible) – the distance between the point AH and mandibular plane (MP) (mm);
- distance **H-VT** (also known as Height of the tongue) – the distance between the point H and the longitudinal axis (VT) (mm);
- distance **VT** (also known as Length of the tongue) – the distance between the point V and T (mm);
- area **TA** (also known as Tongue area) – outlined by a contour through points T-H-TB-V-Ge-T (mm²).

Garson's morphological index was used to determine face type. The following distribution by face types was established in Ukrainian girls and boys with an orthognathic bite: YW – with a very wide face – 25 YW and 5 YM; with a wide face – 25 YW and 22 YM; with an average face – 10 YW and 11 YM; with a narrow face – 12 YW and 8 YM.

The statistical analysis of the obtained results was carried out in the licensed statistical package “Statistica 6.0” using non-parametric estimation methods. The mean values for each trait under study and the standard square deviation were determined. The significance of the difference in values between independent quantitative values was determined using the Mann-Whitney U-test.

Results of the study and their discussion. When comparing the teleroentgenometric parameters of the hyoid bone and tongue between Ukrainian YM and YW with an orthognathic bite without and taking into account the type of face, we established the following reliable or trends of differences:

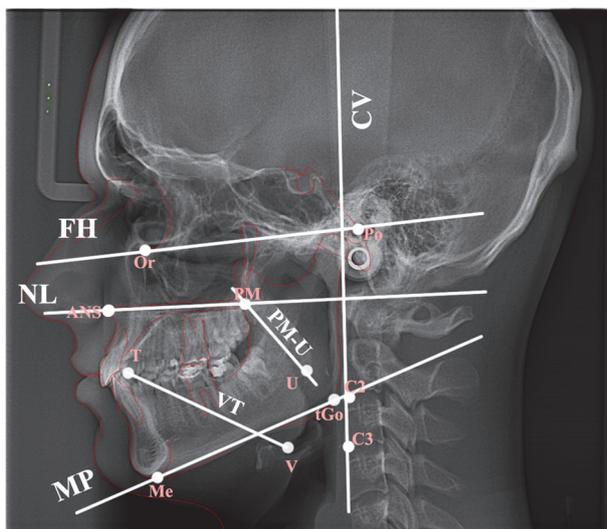


Fig. 1. Lines used in cephalometric examination of the upper respiratory tract. CV – cervical plane (passes through the points C2 and C3); FH – Frankfort plain (passes through the points Or and Po); MP – mandibular plane (passes through the points Me and tGo); NL – nasal plane (passes through the points ANS and PM); PM-U – longitudinal axis of the soft palate (passes through the points PM and U); VT – longitudinal axis of the tongue (passes through the points V and T).

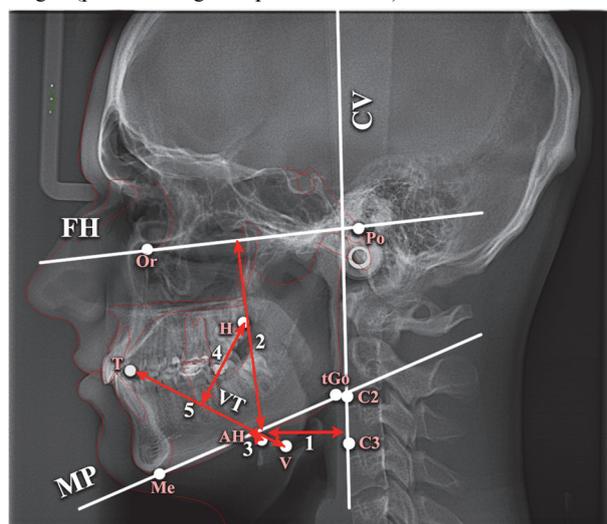


Fig. 2. Linear parameters used in teleröntgenometric examination of the hyoid bone and tongue: 1 – distance AH-CV, 2 – distance AH-FH, 3 – distance AH-MP, 4 – distance H-VT, 5 – distance VT.

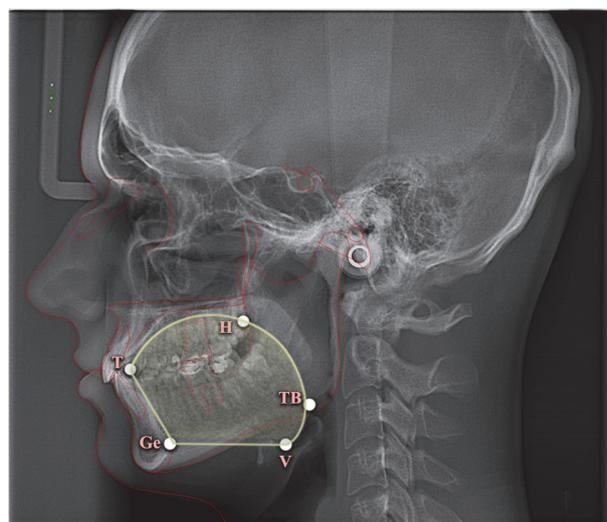


Fig. 3. Tongue area (area TA).

– the value of the distance AH-CV in YM without taking into account the type of face (35.81 ± 5.57 mm), with a very wide (37.84 ± 8.72 mm), wide (36.27 ± 6.13 mm), average (35.87 ± 3.19 mm) and narrow (34.70 ± 5.42 mm) face types is greater than that of YW regardless of face type (30.02 ± 3.69 mm, $p < 0.001$), with a very wide (31.07 ± 3.82 mm, $p < 0.05$), wide (29.93 ± 3.16 mm, $p < 0.001$), average (29.69 ± 3.71 mm, $p < 0.01$) and narrow (28.63 ± 4.62 mm, $p < 0.05$) face types;

– the value of the distance AH-FH in YM without taking into account the type of face (90.21 ± 5.95 mm), with a very wide (88.04 ± 6.21 mm), wide (90.11 ± 7.05 mm), average (90.09 ± 4.35 mm) and narrow (90.44 ± 5.50 mm) face types is greater than that of YW regardless of face type (77.64 ± 5.82 mm, $p < 0.001$), with a very wide (77.21 ± 7.51 mm, $p < 0.01$), wide (76.22 ± 4.44 mm, $p < 0.001$), average (78.41 ± 5.39 mm, $p < 0.001$) and narrow (80.81 ± 4.90 mm, $p < 0.01$) face types;

– the value of the AH-MP distance in YM without taking into account the type of face (15.51 ± 6.13 mm) and with a wide face type (16.53 ± 7.32 mm) greater than YW regardless of face type (11.54 ± 4.89 mm, $p < 0.001$) and with a wide face type (10.24 ± 5.48 mm, $p < 0.01$);

– the value of the distance H-VT in YM without taking into account the type of face (34.95 ± 4.40 mm), with a very wide (35.54 ± 2.92 mm), wide (34.72 ± 3.39 mm), average (33.91 ± 7.42 mm) and narrow (35.73 ± 2.59 mm) face types greater than YW regardless of face type (31.13 ± 3.04 mm, $p < 0.001$), with a very wide (30.56 ± 3.41 mm, $p < 0.01$), wide (30.91 ± 2.57 mm, $p < 0.001$), average (32.06 ± 3.58 mm, $p = 0.053$) and narrow (32.31 ± 2.36 mm, $p < 0.05$) face types;

– the value of the distance VT in YM without taking into account face types (73.37 ± 6.53 mm), with a very wide (76.86 ± 3.77 mm), wide (75.10 ± 7.48 mm) and average (72.42 ± 6.13 mm) face types greater than in YW regardless of face type (68.43 ± 4.60 mm, $p < 0.001$), with a very wide (66.88 ± 5.71 mm, $p < 0.01$), wide (68.62 ± 4.57 mm, $p < 0.01$) and average (67.36 ± 4.16 mm, $p < 0.05$) face types;

– the size of the area TA in YM without taking into account the type of face (2619 ± 237 mm²), with a very wide (2733 ± 244 mm²), wide (2629 ± 232 mm²), average (2630 ± 303 mm²) and narrow (2513 ± 191 mm²) face types greater than in YW regardless of face type (2253 ± 243 mm², $p < 0.001$), with a very wide (2252 ± 297 mm², $p < 0.01$), wide (2223 ± 195 mm², $p < 0.001$), average (2304 ± 313 mm², $p < 0.05$) and narrow (2297 ± 181 mm², $p < 0.05$) face types.

When comparing the teleroentgenometric parameters of the hyoid bone and tongue in Ukrainian YM or YW with an orthognathic bite between different facial types, the following reliable or trends of differences were established:

– in YM – the value of the AH-FH distance in representatives with a narrow face type (80.81 ± 4.90 mm) is greater than with a wide face type (76.22 ± 4.44 mm, $p < 0.05$); the value of the AH-MR distance in representatives with a narrow face type (13.60 ± 4.57 mm) is greater than with very wide (11.16 ± 4.31 mm, $p = 0.072$) and wide (10.24 ± 5.48 mm, $p < 0.05$) face types; the value of the H-VT distance in representatives with a narrow face type (32.31 ± 2.36 mm) is greater than with a very wide face type (30.56 ± 3.41 mm, $p = 0.080$);

– in YW – the value of the VT distance in women with a narrow face type (69.76 ± 3.54 mm) is smaller than with very wide (76.86 ± 3.77 mm, $p < 0.05$) and wide (75.10 ± 7.48 mm, $p = 0.095$) face types; the size of the TA area in women with a narrow face type (2513 ± 191 mm²) is smaller than with a very wide face type (2733 ± 244 mm², $p = 0.079$).

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 YM) of the AH-CV distance in representatives without taking into account the type of face were found by 16.2 %, with a very wide face – by 17.9 %, with a wide face – by 17.5 %, with an average face – by 17.2 % and with a narrow face – by 17.5 %; values of the AH-FH distance in representatives without taking into account the type of face by 13.9 %, with a very wide face – by 12.3 %, with a wide face – by 15.4 %, with an average face – by 13.0 % and with a narrow face – by 10.6 %; values of the AH-MR distance in representatives without taking into account the type of face by 25.6 % and by 38.1 % with a wide face; values of the H-VT distance in representatives without taking into account the type of face by 10.9 %, with a very wide face – by 14.0 %, with a wide face – by 11.0 %, with an average face – by 5.5 % and with a narrow face – by 9.6 %; values of the VT distance in representatives without taking into account the type of face by 6.7 %, with a very wide face – by 13.0 %, with a wide face – by 8.6 % and with an average face – by 7.0 %; the size of the TA area in representatives without taking into account the type of face by 14.0 %, with a very wide face – by 17.6 %, with a wide face – by 15.4 %, with an average face – by 12.4 % and with a narrow face – by 8.6 %.

When analyzing the value of teleradiographic parameters of the hyoid bone and tongue in Ukrainian YW or YM without pathology of the upper respiratory tract with an orthognathic bite between different facial types, YW with a narrow facial type found significantly smaller or trends towards smaller values of the VT distance than in YW with very wide (by 9.2 %) and wide (by 7.1 %) face types and the size of the TA area than in women with a very wide (by 8.0 %) face type; and in YM with a narrow type of face, significantly greater or trends to greater values of the AH-FH distance were established than in YM with a wide (by 5.7 %) face type, the value of the AH-MP distance than in representatives with a very wide (by 17.9 %) and wide (by 24.7 %) facial types and H-VT distance values than in representatives with a very wide (by 5.4 %) facial type.

The existence of numerous interrelationships between various parameters of the head and neck is a proven fact. For example, the ANB angle is a significant predictor of class I malocclusion. Patients with different occlusal pathologies have different mean values of the pharynx, tongue position, and hyoid bone [3].

At the same time, the interaction of a larger scale, such as with facial parameters, is a less studied phenomenon [9]. A large-scale review of literature sources carried out by a group of researchers led by De-La-Cruz M. J. [5] showed that despite the existence of a certain number of publications related to this topic, there is an unequivocal opinion about the interaction of such parameters as the position of the tongue, hyoid bone and parameters the face still doesn't exist.

In a study by Cheng J. H. and co-authors [4], they indicate that the hyoid bone has a significantly more anterior location in skeletal class III compared to class II.

Chinese scientists conducted research on 4 different age groups of Han children: 6–9 years, 10–12 years, 13–15 years, and 16–18 years. Significant sex differences in indicators of facial morphology, airway dimensions, and the position of the hyoid bone ($p < 0.05$) were found in groups 2, 3, and 4. In all groups, larger sizes were found in boys [8], which is consistent with our results.

Significant differences in the parameters of the width of the upper part of the oropharynx were found in individuals with different structures of the facial skeleton ($p = 0.0000$). Certain peculiarities were also found in the position of the back of the tongue in persons with vertical facial growth ($p = 0.0000$) and the hyoid bone in dolichofacials with a relatively normal face type ($p = 0.044$) [14].

If we talk about research on populations with pathology, the data obtained on populations of people suffering from obstructive sleep apnea are the worthiest of attention.

Thus, data from a survey of adolescents who received orthodontic care showed that the prevalence of obstructive sleep apnea in this population is 14.0 %. The facial profile (convex – OR 3.824), the angle of the lower jaw (steep – OR 79.75), and the shape of the upper arch (ovoid – OR 13.75) were most associated with this pathology [1].

Compared with healthy individuals, patients with obstructive sleep apnea have differences in such parameters as tongue area, upper airway length, maxillary and mandibular length, soft palate area, hyoid bone position, and anterior inferior facial height [11].

A study of healthy residents and patients with obstructive sleep apnea from Northern India revealed significantly greater values of mandibular-hyoid distance and soft palate length in representatives with pathology. An increase in the mandibular-hyoid distance was a prognostic sign of a more severe course of the disease [7].

When studying children with and without the pathology of obstructive sleep apnea, scientists found that in the former, the hyoid bone was located below, which in turn increased the area of the pharynx [15].

Conclusions

1. In young Ukrainians without pathology of the upper respiratory tract with an orthognathic bite, pronounced manifestations of sexual dimorphism of teleroentgenometric parameters of the hyoid bone and tongue were established (higher values in YM without taking into account the type of face and, in most cases, in representatives with different types of face).

2. Between YW or YM with different face types, differences in teleroentgenometric parameters of the hyoid bone and tongue have been established – in YW with a narrow face, the values of the VT distance and TA area are smaller than in YW with very wide and wide face types; and in YM with a narrow face, the values of AH-FH, AH-MP, and H-VT distances are larger than in YM with very wide and wide face types.

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