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# TELERADIOGRAPHIC PARAMETERS IN YOUNG MEN AND YOUNG WOMEN WITH ORTHOGNATHIC OCCLUSION, DETERMINED BY JARABAK METHOD

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Ukrainian young men and young women with orthognathic occlusion have pronounced sex differences for most of the basic teleradiographic characteristics of the skull and almost half of the indicators that can be used to change the parameters of the upper and lower jaws according to Jarabak method (young men have greater values of distances N-S, S-Ar, Ar-Go, Go_Me, N-Go, S-Gn, S-Go, N-Me and S-Go:N-Me ratio; and in young women – larger values of angles Sum and SN-GoGn). The established differences of teleradiographic indicators according to the Jarabak method with normative data for residents of European origin confirm (in young men have greater values of distances S-Ar, Ar-Go, Go_Me and S-Go, angles N-S-Ar, S-N-Pog, Mand1-GoMe and S-Go:N-Me ratio and smaller values of angles Ar-Go-Gn, Sum, N-S-Gn and distance N-Me; in young women have greater values of angles Max1-SN, Mand1-GoMe, distance Ar-Go and S-Go:N-Me ratio and smaller values of distances N-S, N-Me and angles Ar-Go-Gn, Sum) the need to determine regional standards for the correct use of this method in Ukraine.

**Keywords:** teleradiography, cephalometry according to Jarabak method, young men and young women with orthognathic occlusion.

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## ОСОБЛИВОСТІ ТЕЛЕРЕНГЕНОГРАФІЧНІХ ПОКАЗНИКІВ У ЮНАКІВ І ДІВЧАТ ІЗ ОРТОГНАТИЧНИМ ПРИКУСОМ, ЩО ВИЗНАЧАЮТЬСЯ ЗА МЕТОДОМ JARABAK

В українських юнаків і дівчат із ортогнатичним прикусом для більшості базових телерентгенографічних характеристик черепа та майже половини показників, яким за допомогою хірургії можливо змінювати параметри верхньої й нижньої щелеп за методом Jarabak встановлені виражені статеві відмінності (в юнаків більші значення відстаней N-S, S-Ar, Ar-Go, Go_Me, N-Go, S-Gn, S-Go, N-Me та співвідношення S-Go:N-Me; а у дівчат – більші значення кутів Sum і SN-GoGn). Встановлені відмінності телерентгенографічних показників за методом Jarabak з нормативними даними для мешканців європейського походження (в юнаків більші значення відстаней S-Ar, Ar-Go, Go_Me і S-Go, кутів N-S-Ar, S-N-Pog, Mand1-GoMe і співвідношення S-Go:N-Me та менші значення кутів Ar-Go-Gn, Sum, N-S-Gn і відстані N-Me; у дівчат більші значення кутів Max1-SN, Mand1-GoMe, відстані Ar-Go і співвідношення S-Go:N-Me та менші значення відстаней N-S, N-Me і кутів Ar-Go-Gn, Sum) підтверджують необхідність визначення регіональних нормативів для коректного використання даного методу в Україні.

**Ключові слова**: телерентгенографія, цефалометрія за методом Jarabak, юнаки та дівчата з ортогнатичним прикусом.

Teleradiographic method of research together with cephalometric analysis has become an indispensable method of planning orthodontic treatment for dentists around the world [4].

The use of different anatomical landmarks and the interpretation of the obtained data led to the emergence of different methods of cephalometric analysis of lateral teleradiograms. Thus, the methods of Steiner, Downs, Ricketts, Sassouni and Jarabak are known and widespread among dentists [3, 9, 13]. In

addition, they have found their practical application among forensic doctors, in particular in forensic dentistry [6].

However, with further research and implementation of these methods, it became clear that for adequate implementation of the methods of cephalometric analysis it is necessary to take into account primarily such a factor as ethnicity [3]. Thus, the study of normative teleradiographic indicators for the Ukrainian population is an urgent issue that needs to be addressed.

**The purpose** of the study was to establish teleradiographic indicators in Ukrainian young men and young women with orthognathic occlusion according to Jarabak method.

**Materials and methods.** The analysis of lateral teleradiograms (performed on a dental cone-beam tomograph Veraviewepocs 3D Morita) of 49 Ukrainian young men (aged 17 to 21 years) and 76 young women (aged 16 to 20 years) with a physiological bite as close as possible to orthognathic was done. The points required for cephalometric analysis were determined in accordance with the recommendations of Phulari B.S. [11] and Doroshenko S.I. and Kulginsky E.A. [2]. Cephalometric analysis was performed according to one of the modern modifications of the Jarabak method [8] – Roth-Jarabak, used in specialized medical diagnostic software OnyxCeph³™, version 3DPro, Image Instruments GmbH, Germany (software license No. URSQ-1799) (fig. 1 and 2).
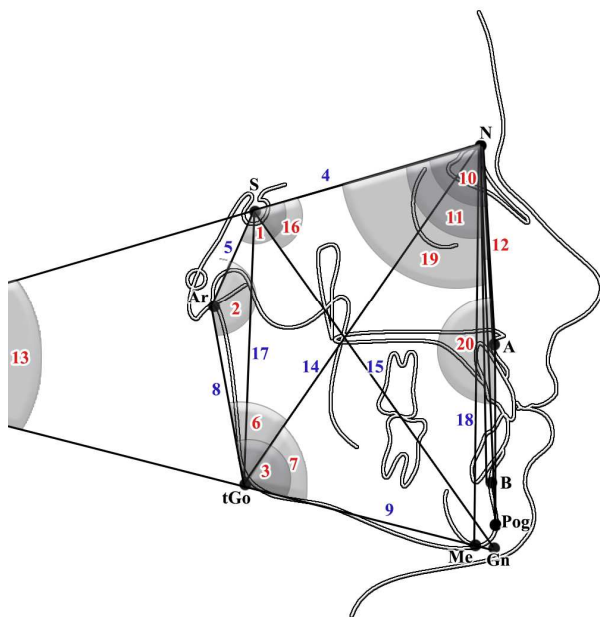


Fig. 1. The main cephalometric points and measurements according to the Roth-Jarabak method: 1 – angle N-S-Ar (°); 2 – angle S-Ar-Go (°); 3 – angle Ar-Go-Gn (°); 4 – distance N-S (mm); 5 – distance S-Ar (mm); 6 – angle N-Go-Ar (°); 7 – angle N-Go-Gn (°); 8 – distance Ar-Go (mm); 9 – distance Go_Me (mm); 10 – angle S-N-A (°); 11 – angle S-N-B (°); 12 – angle A-N-B (°); 13 – angle SN-GoGn (°); 14 – distance N-Go (mm); 15 – distance S-Gn (mm); 16 – angle N-S-Gn (°); 17 – distance S-Go (mm); 18 – distance N-Me (mm); 19 – angle S-N-Pog (°).
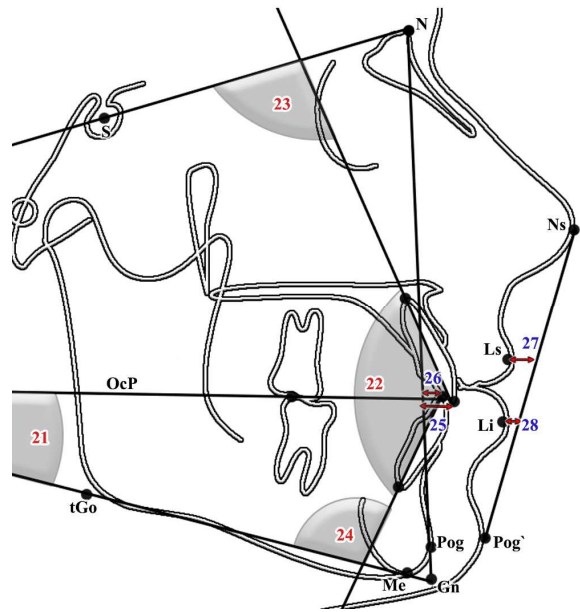
Fig. 2. The main cephalometric points and measurements according to the Roth-Jarabak method: 20 – angle N-A-Pog (°); 21 – angle OcP-GoGn (°); 22 – angle II (°); 23 – angle Max1-SN (°); 24 – angle Mand1-GoMe (°); 25 – distance 1up-NPog (mm); 26 – distance 1lo-NPog (mm); 27 – distance Ls-NsPog' (mm); 28 – distance Li-NsPog' (mm).

In addition, the Roth-Jarabak method was used to measure: Sum – the sum of the angles N-S-Ar, S-Ar-Go and Ar-Go-Gn, characterizes the direction of development (vertical when increasing and horizontal when decreasing) of the lower jaw (°); the ratio of Go_Me:N-S – the ratio of the distances Go_Me and N-S, allows you to estimate the degree of development of the lower jaw relative to the anterior base of the skull (%); the ratio of S-Ar:Ar-Go – the ratio of the distances S-Ar and Ar-Go, allows to assess the degree of development of the mandible ramus relative to its body (%); S-Go:N-Me ratio – the ratio of S-Go and N-Me distances, characterizes the ratio between the front and rear face heights (%). It should be noted that, unlike the original Jarabak analysis, the Roth-Jarabak analysis does not use a specific A-point which is placed 2 mm in front of the apex of the medium maxillary incisor, but uses the more common Downs A-point. For convenience of perception and further clinical use, as well as for structuring a large array of metric characteristics, we used the distribution of teleradiographic indicators on three groups proposed by Dmitriev M. O. [1].

Statistical processing of the obtained results was performed in the license package "Statistica 6.0" using non-parametric evaluation methods.

**Results of the study and their discussion.** Table 1 presents the results of comparison of teleradiographic indicators by the method of Jarabak, which belong to the first (metric characteristics of the skull, which usually do not change during surgical and orthodontic treatment) and the third (indicators that actually characterize the position of each individual tooth relative to each other, cranial structures and the profile of the soft tissues of the face) groups, between Ukrainian young men and young women with orthognathic occlusion, as well as with the value of these indicators obtained by Jarabak, namely:

– angle N-S-Ar – is formed by the lines N-S and S-Ar, characterizes the position of the temporomandibular joint;

– distance N-S – the distance from point N to point S, characterizes the length of the anterior base of the skull;

– distance S-Ar – the distance from point S to point Ar, characterizes the location of the temporomandibular joint relative to the Turkish saddle;

– distance Ar-Go – the distance from the point Ar to the point tGo, characterizes the length of the ramus of the mandible;

– angle OcP-GoGn – formed by the lines OcP and tGo-Me, characterizes the slope of the closing plane to the mandibular plane;

– angle II – is formed by the central axes of the upper and lower medial incisors, characterizes the angular ratio of the medial incisors of the upper and lower jaws;

– angle Max1-SN – formed by the central axis of the upper medial incisor and the line S-N, characterizes the inclination of the upper medial incisor to the anterior base of the skull;

– angle Mand1-GoMe – formed by the central axis of the lower medial incisor and the line tGo-Me, characterizes the inclination of the lower medial incisor to the mandibular plane;

– distance 1up-NPog – the distance from the cutting edge of the upper medial incisor to the line N-Pog, characterizing the anterior-posterior position of the upper medial incisor defined in millimeters;

– distance 1lo-NPog – the distance from the cutting edge of the lower medial incisor to the line N-Pog, characterizes the anterior-posterior position of the lower medial incisor defined in millimeters;

– distance Ls-NsPog' – the distance from the point Ls to the line Ns-Pog`, characterizes the position of the upper lip relative to the "Aesthetic line" – the line Ns-Pog`;

– distance Li-NsPog' – the distance from the point Li to the line Ns-Pog`, characterizes the position of the lower lip relative to the "Aesthetic line" – the line Ns-Pog`.

Table 1 presents the results of comparison of teleradiographic indicators by the method of Jarabak, which belong to the first (metric characteristics of the skull, which usually do not change during surgical and orthodontic treatment) and the third (indicators that actually characterize the position of each individual tooth relative to each other, cranial structures and the profile of the soft tissues of the face) groups.

Table 1

**Comparison of teleradiographic indicators by the Jarabak method, which belong to the first and third group, between Ukrainian young men and young women with orthognathic occlusion, as well as with the value of these indicators obtained Jarabak (M±σ)**

| Indices | Young men | Young women | p | By Jarabak | P$_{ym}$ | P$_{yw}$ |
|---|---|---|---|---|---|---|
| **The first group** | | | | | | |
| N-S-Ar (°) | 125.4±5.6 | 124.6±5.9 | 0.6436 | 123.0±5.0 | **0.0267** | 0.1167 |
| N-S (mm) | 70.45±2.89 | 66.64±4.98 | **0.0000** | 71.0±3.0 | 0.3553 | **0.0000** |
| S-Ar (mm) | 34.92±3.18 | 32.17±3.41 | **0.0000** | 32.0±3.0 | **0.0000** | 0.7747 |
| Ar-Go (mm) | 52.41±4.89 | 47.53±4.81 | **0.0000** | 44.0±5.0 | **0.0000** | **0.0001** |
| S-Ar:Ar-Go (%) | 67.27±8.65 | 67.99±7.76 | 0.6821 | 60.0 – 75.0 | | |
| **The third group** | | | | | | |
| OcP-GoGn (°) | 13.22±4.01 | 14.05±3.92 | 0.2135 | 14.0 | | |
| II (°) | 133.5±7.8 | 131.9±8.4 | 0.3574 | 135.0 | | |
| Max1-SN (°) | 103.6±6.7 | 104.4±6.2 | 0.3998 | 102.0±2.0 | 0.1092 | **0.0092** |
| Mand1-GoMe (°) | 96.92±7.32 | 95.20±6.84 | 0.1844 | 90.0±3.0 | **0.0000** | **0.0000** |
| 1up-NPog (mm) | 4.531±2.837 | 4.868±2.744 | 0.7906 | 5.0±2.0 | 0.3434 | 0.7703 |
| 1lo-NPog (mm) | 1.816±2.675 | 2.263±2.650 | 0.5240 | -2.0 – 2.0 | | |
| Ls-NsPog' (mm) | -4.776±2.257 | -5.263±2.430 | 0.3627 | -4.0 – -1.0 | | |
| Li-NsPog' (mm) | -3.143±2.208 | -3.171±2.665 | 0.8914 | 0 – 2.0 | | |

Notes: p – the reliability of the difference between the values of the respective indicators between Ukrainian young men and young women; p$_{ym}$ – the reliability of the difference between the values of the relevant indicators between Ukrainian young men with the values obtained for residents of European origin; p$_{yw}$ – the reliability of the difference between the values of the relevant indicators between Ukrainian young women with the values obtained for residents of European origin; in the column "By Jarabak" values of indicators M±σ or limits of their percentile scope are resulted.

Table 2 presents the results of comparison of teleradiographic indicators by the method of Jarabak, which belong to the second group (indicators that are most often necessary to focus on when performing orthodontic treatment of patients who are in the process of growth, as well as in people with a formed skeleton, which with orthognathic surgery can change the width, length, angles and position of the upper and lower jaws), between Ukrainian young men and young women with orthognathic occlusion, as well as with the value of these indicators obtained by Jarabak, namely:

– angle S-Ar-Go – is formed by the lines S-Ar and Ar-tGo, characterizes the position of the temporomandibular joint and the ramus of the mandible;

– angle Ar-Go-Gn – is formed by the lines Ar-tGo and tGo-Gn, characterizes the value of the angle of the mandible;

– angle N-Go-Ar – formed by lines N-tGo and tGo-Ar, characterizes the angle of inclination of the mandibular ramus to the line N-tGo;

– angle N-Go-Gn – formed by lines N-tGo and tGo-Gn, characterizes the angle of the mandible to the line N-tGo;

– distance Go_Me – the distance from the point tGo to the point Me, characterizes the length of the lower jaw;

– angle S-N-A – formed by lines S-N and N-A, characterizes the position of the upper jaw in the boom plane;

– angle S-N-B – formed by lines S-N and N-B, characterizes the position of the lower jaw in the sagittal plane;

– angle A-N-B – formed by lines A-N and N-B, characterizes the inter-jaw ratio in the sagittal plane;

– angle SN-GoGn – formed by lines S-N and tGo-Gn, characterizes the inclination of the body of the lower jaw to the anterior base of the skull;

– distance N-Go – the distance from point N to point tGo, characterizes the height of the bone base of the face, and the actual distance of the chin from point N in the vertical plane;

– distance S-Gn – the distance from point S to point Gn, characterizes the length of the face determined by the axis Y, and the actual distance of the chin from the Turkish saddle;

– angle N-S-Gn – formed by lines N-S and S-tGn, characterizes the direction of the axis of development of the mandible;

– distance S-Go – the distance from point S to point tGo, characterizes the posterior height of the face, and the actual distance of the angle of the mandible from the Turkish saddle, also determines the degree of development of the mandibular ramus mainly in the vertical plane;

– distance N-Me – the distance from point N to point Me, characterizes the anterior height of the face, and the actual distance of the lower point of the chin Me from point N;

– angle S-N-Pog – formed by the lines S-N and N-Pog, characterizes the position of the lower jaw, namely the chin in the sagittal plane;

– angle N-A-Pog – formed by N-A and A-Pog lines, characterizes the convexity of the facial bone profile.

Table 2 presents the results of comparison of teleradiographic indicators by the method of Jarabak, which belong to the second group.

When comparing the cephalometric parameters used in the Jarabak method, between Ukrainian young men and young women with orthognathic occlusion in young men found significantly larger (p<0.05-0.001) values of the distances N-S, S-Ar, Ar-Go (see Table 1), Go_Me, N-Go, S-Gn, S-Go, N-Me and the ratio of S-Go:N-Me (see Table 2); and in young women, the values of the Sum and SN-GoGn angles were significantly larger (p<0.05). No significant differences or trends in sex differences were found between the Jarabak teleradiography parameters belonging to the third group.

Thus, for most of the metric characteristics of the skull, which usually do not change during surgical and orthodontic treatment, and almost half of the indices that can be used to change the width, length, angles and positions of the upper and lower jaws with orthognathic surgery.

When comparing the cephalometric parameters obtained by us in Ukrainian young men and young women with orthognathic occlusion with the indicators used in the specialized medical diagnostic software OnyxCeph³™ (3DPro version, Image Instruments GmbH, Germany), which are offered as normative indicators for residents of European origin according to Jarabak method, the following differences were found:

– among the indicators of the first group – in young men significantly greater (p<0.05-0.001) values of the distances S-Ar and Ar-Go and the angle N-S-Ar;in young women significantly higher (p<0.001) value of the distance Ar-Go and significantly lower (p<0.001) the value of the distance N-S;

– among the indicators of the second group – in young men significantly greater, or the tendency to greater values (p<0.05-0.001, p=0.063) distances Go_Me and S-Go, the angle S-N-Pog and the ratio S-Go:N-Me, significantly smaller (p<0.05-0.001) the values of the angles Ar-Go-Gn, Sum, N-S-Gn and the distance N-Me; in young women, the values of the angles Ar-Go-Gn, Sum and the distance N-Me are significantly smaller (p<0.001) and the values of the ratio S-Go:N-Me are significantly larger (p<0.001);

– among the indicators of the third group – in young men significantly higher (p<0.001) the value of the angle Mand1-GoMe; in young women, the values of the angles Max1-SN and Mand1-GoMe were significantly higher (p<0.001).

Table 2

**Comparison of teleradiographic indicators by the Jarabak method, which belong to the second group, between Ukrainian young men and young women with orthognathic occlusion, as well as with the value of these indicators obtained Jarabak (M±σ).**

| Indices | Young men | Young women | p | By Jarabak | $P_{ym}$ | $P_{yw}$ |
|---|---|---|---|---|---|---|
| S-Ar-Go (°) | 142.0±6.5 | 144.0±7.0 | 0.1398 | 143.0±6.0 | 0.4282 | 0.4086 |
| Ar-Go-Gn (°) | 118.6±6.1 | 119.9±6.7 | 0.2387 | 130.0±7.0 | **0.0000** | **0.0000** |
| Sum (°) | 386.0±6.5 | 388.5±5.4 | **0.0312** | 396.0±5.0 | **0.0000** | **0.0000** |
| N-Go-Ar (°) | 50.20±3.47 | 49.96±4.09 | 0.9174 | 52.0 – 55.0 | | |
| N-Go-Gn (°) | 68.47±5.02 | 69.96±4.46 | 0.0947 | 70.0 – 75.0 | | |
| Go_Me (mm) | 73.61±5.13 | 69.34±5.97 | **0.0000** | 71.0±5.0 | **0.0119** | 0.1065 |
| Go_Me:N-S (%) | 104.3±6.1 | 104.2±5.9 | 0.8102 | 100 | | |
| S-N-A (°) | 82.86±3.33 | 82.22±3.99 | 0.3547 | 80.0 – 84.0 | | |
| S-N-B (°) | 80.63±3.38 | 80.37±3.44 | 0.4916 | 78.0 – 82.0 | | |
| A-N-B (°) | 2.306±1.906 | 1.776±2.114 | 0.2220 | 0 – 4.0 | | |
| SN-GoGn (°) | 25.96±6.45 | 28.51±5.41 | **0.0312** | 36.0 | | |
| N-Go (mm) | 119.6±5.7 | 111.6±8.8 | **0.0000** | - | | |
| S-Gn (mm) | 128.1±5.3 | 121.2±9.1 | **0.0000** | - | | |
| N-S-Gn (°) | 64.76±4.21 | 65.50±3.74 | 0.3886 | 66.5±3.0 | **0.0197** | 0.1157 |
| S-Go (mm) | 82.63±5.40 | 75.87±6.96 | **0.0000** | 74.5±6.0 | **0.0000** | 0.2563 |
| N-Me (mm) | 114.9±5.8 | 109.2±8.3 | **0.0000** | 118.0±7.0 | **0.0185** | **0.0000** |
| S-Go:N-Me (%) | 72.14±5.63 | 69.57±4.60 | **0.0147** | 64.0±2.0 | **0.0000** | **0.0000** |
| S-N-Pog (°) | 82.24±3.53 | 81.53±3.58 | 0.1860 | 81.0±3.0 | **0.0625** | 0.3884 |
| N-A-Pog (°) | 1.404±5.164 | 1.368±5.260 | 0.8734 | 175.0 | | |

Thus, among the indicators we were able to compare with the normative data for residents of European origin according to the method of Jarabak in Ukrainian young men with orthognathic occlusion most of the cephalometric parameters belonging to the first and second groups, and young women – half of the cephalometric parameters of all three groups of indicators according to Jarabak methods have significant differences, which confirms the need to determine not only age and sex, but also regional standards for the correct use of this method in Ukraine.

In general, the process of adaptation of teleradiographic parameters according to different author's methods of cephalometric analysis is one of the most promising and relevant areas in orthodontics. Given the high prevalence of occlusal diseases and the dental system in general, congenital anomalies and acquired injuries, knowledge of the norm for a certain group of people, namely the national, ethnic principle is extremely important [3].

Domestic researchers have already taken the first steps in identifying the features of cephalometric indicators for the population of Ukraine. Thus, Gunas I. V. and co-authors [7] conducted a cephalometric examination of adolescents, residents of the Podillia region of Ukraine by the method of McNamara. Statistical analysis of the obtained data revealed that almost half of the studied parameters differed from the normative indicators. In addition, the authors identified the features of sexual dimorphism in the studied indicators: boys had higher values of indicators that characterize the relationship between the upper and lower jaws, while girls had higher values of the base angle.

In another work, the team of authors [6] established the features of the position of the central incisors in accordance with the cephalometric indicators by the Steiner method for Ukrainian boys and girls. According to the results of the study, the ANB angle was crucial for determining the position of the examined teeth.

Foreign research to study the characteristics of indicators by the method of Jarabak has intensified in recent years. Alshahrani I. and others [5] found significant differences (p<0.05) in cephalometric parameters compared with control data for Saudi men and women. These differences relate to the anterior and posterior length of the skull base, anterior and posterior facial height, mandibular ramus height, and mandibular length.

Nepal residents had lower values of anterior skull base length, total and upper gonial angle (p<0.001), greater values of posterior skull base length, anterior facial height, mandibular ramus height, and saddle angle (p<0.001) compared to Jarabak data [12].

Statistically significant differences were also found for Pakistanis compared to the benchmarks. Significant differences were found when comparing the anterior length of the skull base, the height of the mandibular ramus, the length of the mandible and the posterior height of the face [10].

Achieving the goal of this study once again confirms the need to study the characteristics of cephalometric indicators taking into account the ethnicity of the person and is consistent with the results and the general trend observed in the works of other domestic and foreign groups of researchers.

## Conclusions

1. The following sex differences of cephalometric parameters by the Jarabak method have been established between Ukrainian young men and young women with orthognathic occlusion: young men have significantly higher values of distances NS, S-Ar, Ar-Go, Go_Me, N-Go, S-Gn, S-Go, N-Me and S-Go:N-Me ratio; and in young women – significantly higher values of the angles Sum and SN-GoGn.

2. The following differences in cephalometric parameters, proposed as normative indicators for residents of European origin according to the Jarabak method: Ukrainian young men have significantly larger, or the tendency to greater values of the distances S-Ar, Ar-Go, Go_Me and S-Go, angles N-S-Ar, S-N-Pog, Mand1-GoMe and the ratio S-Go:N-Me and significantly smaller the values of the angles Ar-Go-Gn, Sum, N-S-Gn and the distance N-Me; Ukrainian girls have significantly higher values of angles Max1-SN, Mand1-GoMe, distance Ar-Go and the ratio S-Go:N-Me and significantly smaller values of distance N-S, N-Me and angles Ar-Go-Gn, Sum.

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