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SIMULATION OF INDIVIDUAL TELERADIOGRAPHIC INDICATORS USING THE "CEPHALOMETRICS FOR ORTHOGNATHIC SURGERY" METHOD IN UKRAINIAN YOUNG WOMEN WITH A VERY BROAD FACE TYPE

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In the course of the study, in Ukrainian young women with an orthognathic bite and with a very wide face type, reliable regression models of teleroentgenometric indicators used in the "Cephalometrics for orthognathic surgery" method were built and analyzed (all indicators were divided into 3 groups according to the method of Dmitriev M. O.). With a coefficient of determination higher than 0.6, out of 33 possible, 5 reliable indicator models were built, which were included in the second and third groups, depending on the indicators of the first group (R^2= from 0.616 to 0.789), and out of 19 possible – 13 indicator models, which were included in the third group depending on the indicators of the first and second groups (R^2= from 0.612 to 0.991).

Key words: regression models, teleradiography, cephalometry, COGS method, young women, face types, orthognathic occlusion.

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МОДЕЛЮВАННЯ ІНДИВІДУАЛЬНИХ ТЕЛЕРЕНТГЕНОМЕТРИЧНИХ ПОКАЗНИКІВ ЗА МЕТОДОМ «ЦЕФАЛОМЕТРІЯ ДЛЯ ОРТОГНАТИЧНОЇ ХІРУРГІЇ» В УКРАЇНСЬКИХ ДІВЧАТ ІЗ ДУЖЕ ШИРОКИМ ТИПОМ ОБЛИЧЧЯ

У ході дослідження, в українських дівчат із ортогнатичним прикусом із дуже широким типом обличчя, побудовані та проведено аналіз достовірних регресійних моделей телерентгенометричних показників, що використовуються в методиці "Цефалометрія для ортогнатичної хірургії" (усі показники були розподілені на 3 групи за методикою Дмітрієва М. О.). Із коефіцієнтом детермінації вищим 0,6, із 33 можливих побудовані 5 достовірних моделей показників, що увійшли до другої та третьої груп в залежності від показників першої групи (R^2= від 0,616 до 0,789) та з 19 можливих – 13 моделей показників, що увійшли до третьої групи в залежності від показників першої та другої груп (R^2= від 0,612 до 0,991).

Ключові слова: регресійні моделі, телерентгенографія, цефалометрія, COGS-метод, дівчата, типи обличчя, ортогнатичний прикус.

The study is a fragment of the research project "Current trends and latest technologies in the diagnosis and treatment of odontopathology, diseases of periodontal tissues and oral mucosa", state registration No. 0118U005471.

Pathology of the maxillofacial system is a complex problem, the etiology of which can be both congenital and acquired. Factors affecting the formation of this system begin to act already in the antenatal period of development [10].

If we talk about the antenatal period, deformations of the maxillo-dental system can be caused by excessive sports, the use of tight clothes by the mother, anemia, gestosis in the anamnesis, premature birth. In the future, already in the postnatal period, the key factors are the preservation of the physiological balance in the masticatory muscles, which can be achieved due to the formation of proper sucking, swallowing, breathing and speech. An equally important factor is the presence of pathologies of accompanying organ systems, the presence of harmful habits, climate features, the quality of water used, and socio-economic factors [11]. Such a number of risk factors causes, accordingly, a high prevalence of pathology of the dental and jaw system. In India, the prevalence of dental anomalies is 25.8 %, in Brazil 56.9 %, in Australia 24.4 %. Among them, there are often pathologies of the size, shape and location of teeth, the presence of cysts [13].

In order to successfully plan the treatment of such a pathology, since the beginning of the 60s, the cephalometric method of research has become widely used among orthodontists, which currently has many modifications and can be performed on the basis of 2D and 3D technologies, calculated manually or by an artificial network, etc. [14]. Some studies indicate that, at the same time, cephalometric analysis is not so important for making key decisions. Thus, the data of Arabian researchers showed that the majority of decisions regarding treatment planning or tooth extraction, which were made by doctors before conducting a cephalometric analysis, did not change after it was performed [8].

It should be taken into account that the application of the cephalometric method requires certain experience and skills from the orthodontist. A study by Portuguese scientists showed that among less

experienced orthodontists the agreement was only 28 %, while among more experienced orthodontists it was 67 % [6].

However, as practice shows, these methods need to take into account many details, such as: the age of the examinees, sex, racial and ethnic, national and even regional affiliation, facial features, etc. [13].

Therefore, in order to successfully apply the current methodology to a certain population of people, it is necessary to conduct a preliminary study using the criteria described above.

The purpose of the study was to build and analyze regression models of indices according to the technique "Cephalometry for orthognathic surgery" in young women with an orthognathic bite and a very wide face type.

Materials and methods. 25 Ukrainian young women (YW) with a physiological bite (as close as possible to orthognathic) with a very wide face underwent a cephalometric study using the COGS method ("Cephalometrics for orthognathic surgery", 1979) (using a dental cone-beam tomograph Veraviewepocs 3D Morita). The primary teleradiograms were taken from the database of the Research Center and the Department of Pediatric Dentistry of the National Pirogov Memorial Medical University, Vinnytsya (all YW applied to the private dental clinic "Vinintermed" for a diagnostic examination and had previously undergone a dental examination). 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.

Face type was determined using Garson's morphological index [3].

For correct modeling and convenient subsequent clinical use of a large array of metric characteristics, we used the distribution of teleradiographic indicators into three groups [1, 2].

The first group includes the metric characteristics of the skull, which usually do not change during surgical and orthodontic treatment. Since the "Cephalometrics for orthognathic surgery" technique contains only 2 cranial indicators belonging to the first group (**Ar-Pt** – the distance from the Ar point to the Pt point determined along the HR-Line (mm); **Pt-N** – the distance from the Pt point to the N point determined along the Hr-Line (mm)), then for a more informative and comprehensive study we added the main and most common measurements of the basic cranial indicators proposed by other authors (Schwartz, Roth, Jarabak, Bjork, Steiner, Ricketts and Downs): **N-Se** – the distance from point Se to point N (mm); **N-S** – the distance from point N to point S (mm); **N-CC** – the distance from point N to point CC (mm); **S-E** – the distance from point S to constructive point E (mm); **S-Ar** – the distance from point S to point Ar (mm); **P-PTV** – the distance from the Po point to the perpendicular of the Pt-Line to the Frankfurt plane lowered from the Pt point (mm); **H** – the angle formed by lines Po-Or and Pn (°); **POr-NBa** – the angle formed by the Po-Or and Ba-N lines (°); **N-S-Ba** – the angle formed by S-N and S-Ba lines (°); **N-S-Ar** – the angle formed by lines N-S and S-Ar (°); **S-Ar'** – the distance from point S to projection point Ar' (mm); **N-S:S-Ar'** is the ratio of S-Ar' and N-S distances.

The second group includes indices of the maxillofacial system, which can be used to change the width, length, angles and position of the upper and lower jaws with the help of orthognathic surgery: **N-A-Pog** – the angle formed by the lines N-A and A-Pog (°); **N-A** – the distance between points N and A determined along the HR-Line (mm); **N-B** – the distance between points N and B determined along the HR-Line (mm); **N-Pog** – the distance between points N and Pog determined along the HR-Line (mm); **N-ANS** – the distance from point N to ANS (mm); **ANS-Me** – the distance from the ANS point to Me (mm); **PNS-N** – the distance from the PNS point to the HR-Line (mm); **MP-HP** – the angle formed by the mandibular plane tGo-Me and the HR-line (°); **ANS-PNS** – the distance from the ANS point to the PNS point parallel to the HR-Line horizontal line (mm); **Ar-Go** – the distance from point Ar to point tGo (mm); **Go-Pog** – the distance from the Pog point to the tGo point (mm); **B-Pog** – the distance from point Pog to point B, parallel to the mandibular plane, tGo-Me line (mm); **Ar-Go-Gn** – the angle formed by the lines Ar-tGo and tGo-Me (°); **A-B** – the distance between points A and B determined along the Occl line. Plane that passes through the points apOcP-ppOcP.

The third group includes indices 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: **1u-NF** – the position of the upper intermediate incisor relative to the palatal plane, determined by the length of the perpendicular to the ANS-PNS line drawn from the Is1u point (mm); **1l-MP** – the position of the lower central incisor relative to the mandibular plane, determined by the length of the perpendicular to the tGo-Me line lowered from the Is1L point (mm); **6u-NF** – the position of the first large canine relative to the palatal plane is determined by the length of the perpendicular to the ANS-PNS line drawn from point 6u

(mm); **6l-MP** – the position of the lower first large canine tooth relative to the mandibular plane, determined by the length of the perpendicular to the tGo-Me line lowered from point 6L (mm); **OP-HP** – the angle formed by the lines apOcP-ppOcP and HR-Line (°); **Max1-NF** – the angle formed by lines Ap1u-Is1u and ANS-PNS (°); **Mand1-MP** – the angle formed by Is1L-Ap1L and tGo-Gn lines (°); **Gl'-Sn-Pog'** – the angle formed by the lines Gl'-Sn and Sn-Pog' (°); **Gl'-Sn** – the distance from point Gl' to point Sn measured parallel to the horizontal HR-Line (mm); **Gl'-Pog'** – the distance from point Gl' to point Pog' measured parallel to the horizontal HR-Line (mm); **Sn-Gn'-C** – the angle formed by the Sn-Pog' and Me'-C(H) lines (°); **Cotg-Sn-Ls** – the angle formed by the Cotg-Sn and Sn-Ls lines (°); **Ls-(Sn-Pog')** – the distance from the Ls point to the Sn-Pog' line (mm); **Li-(Sn-Pog')** – the distance from the Li point to the Sn-Pog' line (mm); **Sm-(Li-Pog')** – the distance from Sm point to Li-Pog' line (mm); **Stms-I** – the distance from the Stms point to the Is1u point (mm); **Gl'-Sn/Sn-Me'** – vertical height ratio (%); **Sn-Gn'/C-Gn'** – lower vertical height-depth ratio (%); **Sn-Stms/Stmi-Me'** – the ratio of Sn-Stms and Stmi-Me' distances (%).

The "Statistica 6.0" license package uses the method of stepwise regression analysis to build models.

Results of the study and their discussion. As a result of the research conducted in young women with an orthognathic bite with a very wide face type, 5 reliable regression models of teleradiographic indices were built out of 33 possible according to the COGS method with a coefficient of determination greater than 0.6, which were included in the second and third groups depending on the indices of the first group:

– distance value *N-A*=70.36 - 0.681×N-CC - 0.269×N-S-Ar (R^2=0.665, $F_{(2.22)}$=21.83, p<0.001, Std.Error of estimate=2.101);

– distance value *N-Pog*=163.7 - 0.721×H - 0.428×N-S-Ar - 2.111×N-S + 1.499×N-Se (R^2=0.660, $F_{(4.20)}$=9.71, p<0.001, Std.Error of estimate=3.797);

– angle value *MP-HP*=-102.7 + 1.616×H - 1.203×Por-NBa (R^2=0.616, $F_{(2.22)}$=17.63, p<0.001, Std.Error of estimate=3.163);

– angle value *Gl'-Sn-Pog'*=59.69 + 1.792×Por-NBa - 2.947×N-CC + 1.906×Pt-N - 0.240×N-S-Ar (R^2=0.653, $F_{(4.20)}$=9.43, p<0.001, Std.Error of estimate=3.687);

– distance value *Gl'-Sn*=23.23 - 0.876×N-CC + 0.588×Por-NBa + 0.719×S-Ar + 0.379×P-PTV + 0.601×N-S:S-Ar' (R^2=0.789, $F_{(5.19)}$=14.19, p<0.001, Std.Error of estimate=1.937);

where, here and in the following equations, R^2 – coefficient of determination; $F_{(!)}$=! – the corresponding critical value of Fisher's test; p – confidence level; Std.Error of estimate – standard error of estimate.

Coefficients of determination of the regression equations of the *distances N-B, N-ANS, ANS-Me, PNS-N, ANS-PNS, Go-Pog, B-Pog, 1u-NF, 6u-NF, Gl'-Pog', Sm-(Li -Pog') and Stms-I, the values of the N-A-Pog, Ar-Go-Gn, OP-HP, Max1-NF, Mand1-MP and Sn-Gn'-C angles and the values of the Gl'-Sn/Sn-Me ratios ' and Sn-Stms/Stmi-Me'* in YW with a very wide face type are equal to 0.082 to 0.587 and therefore have no important practical significance. Models of *Ar-Go, A-B, 6l-MP, Ls-(Sn-Pog'), Li-(Sn-Pog'),* distances, *Cotg-Sn-Ls* angle, and *Sn-Gn'/C-Gn'* ratio are not built.

Thus, for Ukrainian YW with a very wide face, out of 33 possible, only 5 reliable models of teleroentgenometric indicators were built using the COGS method with a coefficient of determination greater than 0.6, which were included in the second and third groups depending on the indices of the first group (R^2= from 0.616 to 0.789). The built models most often include: the value of the N-CC distance (17.65 %) and the value of the Por-NBa (17.65 %), N-S-Ar (17.65 %) and H (11.76 %) angles.

Also, in young women with an orthognathic bite with a very wide face type, 13 reliable regression models of teleradiographic indices were built using the COGS method with a coefficient of determination greater than 0.6 out of 19 possible, which were included in the third group depending on the indices of the first and second groups:

– distance value *1u-NF*=12.67 + 0.456×ANS-Me + 0.269×Ar-Pt - 0.305×N-ANS - 0.177×N-A - 0.162×Ar-Go (R^2=0.842, $F_{(5.19)}$=20.24, p<0.001, Std.Error of estimate=0.987);

– distance value *1l-MP*=12.24 + 0.489×ANS-Me + 0.194×N-A-Pog + 0.275×N-ANS + 0.262×P-PTV - 0.066×Ar-Go-Gn (R^2=0.781, $F_{(5.19)}$=13.55, p<0.001, Std.Error of estimate=0.923);

– distance value *6u-NF*=6.254 + 0.157×ANS-Me + 0.147×N-S-Ba - 0.412×N-A-Pog + 0.437×A-B - 0.363×N-CC + 0.252×Por-NBa (R^2=0.808, $F_{(6.18)}$=12.63, p<0.001, Std.Error of estimate=0.727);

– distance value *6l-MP*=24.58 - 0.156×Ar-Go-Gn + 0.416×ANS-Me + 0.192×N-A-Pog + 0.219×N-ANS - 0.088×N-S-Ba (R^2=0.758, $F_{(5.19)}$=11.92, p<0.001, Std.Error of estimate=1.084);

– angle value *OP-HP*=0.299 + 0.813×N-Pog - 1.732×A-B + 0.752×N-A-Pog - 1.591×N-B (R^2=0.991, $F_{(4.20)}$=522.0, p<0.001, Std.Error of estimate=0.441);

– angle value *Max1-NF*=113.8 - 1.762×ANS-Me + 1.179×PNS-N - 0.325×N-A-Pog + 0.403×N-B + 0.333×N-S-Ba (R^2=0.711, $F_{(5.19)}$=9.37, p<0.001, Std.Error of estimate=3.544);

– angle value *Mand1-MP*=217.7 - 0.793×Ar-Go-Gn + 0.651×N-A-Pog + 1.297×A-B - 0.540×N-ANS (R^2=0.898, $F_{(4.20)}$=43.98, p<0.001, Std.Error of estimate=2.980);

– angle value *Gl'-Sn-Pog'*=8.389 + 0.897×N-A-Pog + 1.133×Por-NBa - 0.688×N-ANS - 0.445×Ar-Go + 0.552×PNS-N (R^2=0.744, $F_{(5.19)}$=11.05, p<0.001, Std.Error of estimate=3.250);

– distance value *Gl'-Sn*=-13.66 + 0.939×N-A + 0.413×Por-NBa + 0.281×S-Ar (R^2=0.865, $F_{(3.21)}$=44.92, p<0.001, Std.Error of estimate=1.472);

– distance value *Gl'-Pog'*=-35.35 + 1.022×N-Pog - 0.603×P-PTV + 0.300×Pt-N (R^2=0.896, $F_{(3.21)}$=60.48, p<0.001, Std.Error of estimate=1.990);

– ratio value *Gl'-Sn/Sn-Me'*=213.2 + 5.556×N-CC - 2.879×N-Se - 2.728×H + 1.833×N-A-Pog + 0.968×Ar-Pt (R^2=0.656, $F_{(5.19)}$=7.26, p<0.001, Std.Error of estimate=6.876);

– angle value *Sn-Gn'-C*=130.0 - 1.772×N-ANS + 2.566×Por-NBa + 1.478×S-Ar - 1.459×Go-Pog + 0.950×ANS-Me (R^2=0.612, $F_{(5.19)}$=6.00, p<0.01, Std.Error of estimate=6.689);

– distance value *Sm-(Li-Pog')*=20.69 - 0.561×B-Pog - 0.093×N-S - 0.190×H + 0.106×MP-HP (R^2=0.613, $F_{(4.20)}$=7.92, p<0.001, Std.Error of estimate=0.709).

Coefficients of determination of the regression equations of the *Ls-(Sn-Pog'), Li-(Sn-Pog') and Stms-I* distances and the *Sn-Gn'/H-Gn' and Sn-Stms/Stmi-Me'* ratios in YW with a very wide face type are from 0.157 to 0.546 and therefore have no important practical value. The *Cotg-Sn-Ls* angle model is not built at all.

Thus, in Ukrainian YW with a very wide face, out of 19 possible, 13 reliable models of teleroentgenometric indicators were built using the COGS method with a coefficient of determination greater than 0.6, which were included in the third group depending on the indicators of the first and second groups (R^2= from 0.612 to 0.991). The constructed models most often include the value of the angles N-A-Pog (13.56 %) and Por-NBa (6.78 %) and the value of the distances ANS-Me (10.17 %) and N-ANS (8.47 %).

In our other study, where the analysis of indicators among young men and YW with different types of faces was carried out using the same methodology, significant differences were found between YW for the indicators: with a very wide face type, the distances 1u-NF, 1l-MP, 6u-NF, angle OP-HP; for young men, no such trends or differences were found [12].

As for the works of foreign authors, they found numerous confirmations of sexual and ethnic dimorphism of orthodontic indicators according to the COGS method, which is fully consistent with our current and previous data.

When analyzing the data of the COGS teleroentgenometric indices of the residents of Saudi Arabia, men and women aged 20–24 years, regarding the horizontal distance from the tip of the nose to the incisal edge of the most prominent upper central incisor and chin, the length of the nose, the nasolabial angle, it was established that men have a greater vertical distance from the tip of the nose to the chin, and women have a greater vertical distance from the tip of the nose to the upper lip and larger nasolabial angles [4].

The conducted meta-analysis of 4 sources from scientometric databases confirmed the existence of differences in COGS indices of the method for the population of northern India. Compared to Europeans, the population of northern India revealed smaller values of the base of the skull, smaller values of the height of the face, but at the same time a greater inclination of the incisors of the lower jaw and a more protruding chin [7]. In another work, differences between normative data and data obtained during the survey of the population of the state of Chhattisgarh (India) were compared. Significant differences were also found, especially those related to the upper-mandibular ratio, dental parameters, and vertical parameters of hard tissues [15].

Compared to Europeans, southern Vietnamese have lower values of cranial fossa length, vertical facial height, maxillary and mandibular length, and facial convexity (p<0.01). In comparison, residents of northern Vietnam showed higher values of the angle of the lower jaw and the protrusion of the upper and lower incisors (p<0.05) [9].

As for the changes in teleroentgenometric parameters according to the COGS method after surgical intervention, the data of Bhagat S. K. with co-authors [5] showed that significant angular, horizontal and

vertical changes occur during anterior osteotomy of the upper jaw, namely: N-Pg distance, U1-NF, L1-Mp angles, labial angle, protrusion and upper–lower lip length.

Built, in YW with an orthognathic bite with a very wide type of face, regression models of teleroentgenometric indicators used in the technique "Cephalometrics for orthognathic surgery" will allow the development of a computer program that will make it possible to automatically calculate the necessary cephalometric indicators.

Conclusions

1. In YW with a very wide face, 5 reliable regression models of teleroentgenometric indicators with a coefficient of determination higher than 0.6 were built using the COGS method, which were included in the second and third groups depending on the indicators of the first group (R^2= from 0.616 to 0.789) and 13 models of indices which entered the third group depending on the indicators of the first and second groups (R^2= from 0.612 to 0.991).

2. Among the teleroentgenometric indices of the first group that were included in the models of indices of the second and third groups according to the COGS method, the value of the N-CC distance, the Por-NBa and N-S-Ar angles (17.65 % each) and the H angle (11.76 %) are most often included.

3. Among the teleroentgenometric indices of the first and second groups that were included in the models of indicators of the third group according to the COGS method, the value of the N-A-Pog angle (13.56 %), the distances ANS-Me (10.17 %) and N-ANS (8.47 %) and angle Por-NBa (6.78 %) are most often included.

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