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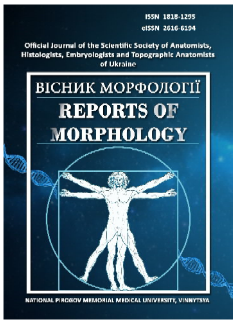

Modeling the parameters necessary for constructing the correct shape of the dental arch depending on the features of teleradiometric indicators using the Steiner or Tweed methods and computed tomography dimensions of teeth in Ukrainian young men and young women with physiological occlusion

Ryabov T. V., Shinkaruk-Dykovytska M. M., Pylypiuk O. Yu., Muntian O. V., Drachevska I. Yu., Rokunets I. L., Burdeina L. V.

National Pirogov Memorial Medical University, Vinnytsya, Ukraine

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CORRESPONDING AUTHOR

e-mail: dr.riabov1989@gmail.com
Ryabov T. V.

CONFLICT OF INTEREST

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Data are available upon reasonable request to corresponding author.

The study of the parameters of the dental arch, taking into account teleradiometric indicators and tooth sizes, is important for planning orthodontic treatment, which contributes to achieving stable and functionally optimal results. The Steiner and Tweed methods, widely used to assess craniofacial proportions, allow identifying key anthropometric features that affect the shape of the dental arch. The additional use of computed tomography measurements provides high accuracy in analyzing tooth sizes, which is especially important for individualizing orthodontic approaches. The aim of the work is to build and analyze regression models of parameters necessary for constructing the correct shape of the dental arch in Ukrainian young men and young women with physiological occlusion, depending on the features of teleradiometric indicators according to the Steiner or Tweed methods and computed tomography sizes of the teeth. On standardly obtained teleradiograms and created in the 3D Slicer v5.4.0 software on teleradiograms with points marked on 3D objects (41 Ukrainian young men and 68 young women with physiological occlusion from the data bank of the Department of Pediatric Dentistry and the Scientific and Research Center of the National Pirogov Memorial Medical University, Vinnytsya), measurements according to the Steiner S. S. and Tweed C. H. methods were carried out in the OnyxCeph³™ application, version 3DPro, from Image Instruments GmbH, Germany. On computer tomograms for morphometric study of teeth and dental arches we used software applications i-Dixel One Volume Viewer (Ver.1.5.0) J Morita Mfg. Cor, and Planmeca Romexis Viewer (ver. 3.8.3.R 15.12.14) Planmeca OY. Regression models were built using the licensed package "Statistica 6.0". It was found that in young men, taking into account the Steiner method, all 18 possible reliable models with a coefficient of determination greater than 0.6 were built (R^2= from 0.611 to 0.911, p<0.001), and taking into account the Tweed method, 17 models (R^2= from 0.638 to 0.872, p<0.001); and young women only 5 reliable models with a coefficient of determination greater than 0.6 when taking into account the Steiner method (R^2= from 0.613 to 0.782, p<0.001) and only 4 reliable models when taking into account the Tweed method (R^2= from 0.619 to 0.745, p<0.001). When analyzing the frequency of occurrence in the regression equations of computed tomography sizes of teeth and teleradiometric indicators according to the Steiner or Tweed methods, it was established: in young men, the width of the crown part of the tooth in the mesio-distal and vestibulo-oral planes, the length of the tooth in the mesio-distal and vestibulo-oral planes and teleradiometric indicators are most often included in the models; and in young women: when taking into account the indicators according to the Steiner method - the width of the crown part of the tooth in the mesio-distal and vestibulo-oral plane and teleradiometric indicators; when taking into account the indicators according to the Tweed method - the width of the crown part of the tooth in the mesio-distal and vestibulo-oral plane, the length of the tooth in the mesio-distal and vestibulo-oral planes, teleradiometric indicators and the length of the crown part of the tooth in the mesio-distal plane. When analyzing the frequency of occurrence in the regression equations of the corresponding teeth, it was found that in young men, the models that take into account the teleradiometric indicators according to the Steiner or Tweed methods most often include the upper and lower incisors, upper and lower premolars and upper canines; and in young women upper and lower incisors, upper and lower canines, lower premolars and upper first molars taking into account teleradiometric indicators according to the Steiner method, as well as upper and lower incisors and lower premolars taking into account teleradiometric indicators according to the Tweed method.*

Keywords: *dentistry, teleradiometry according to the Steiner and Tweed methods, computed tomography dimensions of teeth and dental arches, regression analysis, Ukrainian young men and young women, physiological occlusion.*

Introduction

Modeling of dental arch parameters based on teleradiometric indicators and computed tomography measurements is an important aspect of modern orthodontics. In particular, the study of the dependence of the shape of the dental arch on anatomical and functional characteristics contributes to the development of individualized approaches to treatment. In this context, the use of Steiner and Tweed methods for the analysis of teleradiograms and cone-beam computed tomography data provides high accuracy in assessing the position of the teeth and jaws in space. The prevalence of dentition and occlusion anomalies is a significant factor determining the need for in-depth study of dental arch parameters. For example, a study in Turkey found that the frequency of anomalies such as macrodentia and microdentia is 13.2 %, and supernumerary teeth occur in 1.8 % of the population [6]. At the same time, in the French population, the frequency of anomalies reaches 27 %, with hypodontia being the most common disorder [8]. In a systematic review by Khalaf K. et al. [16], hypodontia had an average frequency of 6.4 %, with variations depending on the region and ethnic group [16]. A study of the prevalence of anomalies such as supernumerary teeth indicated that their frequency varied from 0.1 % to 3.8 %, depending on the population and diagnostic methods. In particular, a systematic review by Ata-Ali F. et al. [7] highlighted that these anomalies often lead to changes in the shape of the dental arch, especially in the anterior region. The presence of supernumerary teeth is also correlated with an increased risk of crowding of the dentition, which complicates the modeling process. A study by Herrera-Atoche J. R. et al. [14] in a Mexican population found that 19.5 % of the subjects had at least one dental anomaly. The most common were hypodontia and macrodontia, which in turn affect the width and symmetry of the dental arch.

Of particular interest are the parameters of the dental arch in individuals with normal occlusion, as they are the standard for orthodontic treatment. A study by Paranhos et al. found that the shape of the dental arch is closely related to the type of face: dolichocephalic individuals more often have a narrowed arch shape, while brachycephalic individuals have a wider one [22]. This confirms the importance of taking into account individual anthropometric characteristics when modeling the arch.

Data from Goncalves-Filho A. J. et al. [12] indicate that the presence of anomalies, such as fused teeth or root displacement, significantly affects the shape of the arch. For example, 3.1 % of patients with dental anomalies had pronounced arch asymmetry. In addition, a study by Shilpa G. et al. [27] showed that the frequency of anomalies in the temporary bite can reach 18.3 %, and these disorders often affect the parameters of the permanent bite.

The dependence of the arch shape on teleradiometric indicators has been widely studied in clinical studies. According to the results of Saghiri M. A. et al. [23], the arch shape largely depends on the ratio of the anterior-posterior and transverse parameters of the jaws, and indicators such as ANB are key in determining the harmony of the arch. At the same time, Muhamad A. H. et al. [20] indicate the stability of the dental arch curve in patients with a normal bite, with an average width of 33.4±1.5 mm in the frontal region.

The issue of modeling the shape of the dental arch also includes the study of the relationship with the parameters of the crowns. According to Lagana G. et al. [17], an increase in the width of the incisors by 1 mm can cause a change in the arch parameters by 0.8-1.1 mm. A systematic review conducted by Lombardo G. et al. [18] found that the prevalence of various forms of arch anomalies ranges from 11.6 % in children to 39.1 % in adults.

Thus, the analysis of the characteristics of the dental arch parameters in individuals with physiological occlusion is an important task for the development of optimal diagnostic and treatment algorithms.

The purpose of the study is to construct and analyze regression models of parameters necessary for constructing the correct shape of the dental arch in Ukrainian young men and young women with physiological occlusion, depending on the characteristics of teleradiometric indicators according to the Steiner or Tweed methods and computed tomography dimensions of the teeth.

Materials and methods

Primary computed tomography scans of 41 Ukrainian young men (aged 17 to 21) and 68 Ukrainian young women (aged 16 to 20) with a physiological bite that was as close as possible to orthognathic were obtained from the data bank of the Department of Pediatric Dentistry and the Research Center of the National Pirogov Memorial Medical University, Vinnytsya. All teleradiography (using the Veraviewepocs 3D Morita dental cone-beam tomograph, Japan) and computed tomography (using the Planmeca ProMax 3D Mid dental cone-beam tomograph, Finland) studies were conducted on the basis of the principle of voluntary informed consent in the private dental clinic "Vinintermed" and in the "Planmeca 3D Maxillofacial Diagnostics Center". The Bioethics Committee of the National Pirogov Memorial Medical University, Vinnytsya (protocol No. 7 dated 8.11.2022) established that the conducted studies do not contradict the basic bioethical norms of the Declaration of Helsinki, the Council of Europe Convention on Human Rights and Biomedicine (1977), the relevant provisions of the WHO and the laws of Ukraine.

On standardly obtained teleradiograms and teleradiograms created in the 3D Slicer v5.4.0 software with points marked on 3D objects, measurements were performed using the method of Steiner S. S. [29] and Tweed C. H. [30] in the OnyxCeph³™ application, version 3DPro, from Image Instruments GmbH, Germany.

According to the Steiner method, the following angular and linear indicators were determined (Fig. 1, 2): **SNA_S angle** – characterizes the position of the anterior contour of the upper jaw in the sagittal plane (°); **SNB_S angle** – characterizes the position of the anterior contour of the chin, in the sagittal plane (°); **ANB_S angle** – characterizes the position of the lower jaw relative to the upper jaw in the sagittal plane (°); **SND angle** – characterizes the position of the center of the chin, in the sagittal plane (°); **SN-OcP angle** – characterizes the inclination of the occlusal plane relative to the anterior cranial base S-N (°); **SN-GoGn angle** – characterizes the inclination of the body of the lower jaw relative to the anterior cranial base S-N (°); **II angle (interincisor angle)** – characterizes the inclination of the upper and lower central incisors relative to each other (°); **Max1-NA angle** – characterizes the position of the upper central incisor to the N-A line (°); **angle Max1-SN** – characterizes the position of the central incisor to the anterior cranial base S-N (°); **angle Mand1-NB** – characterizes the position of the lower central incisor to the N-B line (°); **distance 1u-NA** – characterizes the position of the crown of the upper central incisor in the sagittal plane relative to the N-A line (mm); **distance 1l-NB** – characterizes the position of the crown of the lower central incisor in the sagittal plane relative to the N-B line (mm); **distance Pog-NB** – required to determine the Holdaway ratio (mm); **Holdaway Ratio** – the difference between the values of the 1l-NB and Pog-NB indicators, characterizes the position of the crown of the lower central incisor in the sagittal plane relative to the bone chin Pog (mm); **distance S-L** – characterizes the position of the anterior contour of the lower jaw (mm); **distance S-E** length of the posterior part of the base of the skull according to Steiner (mm).

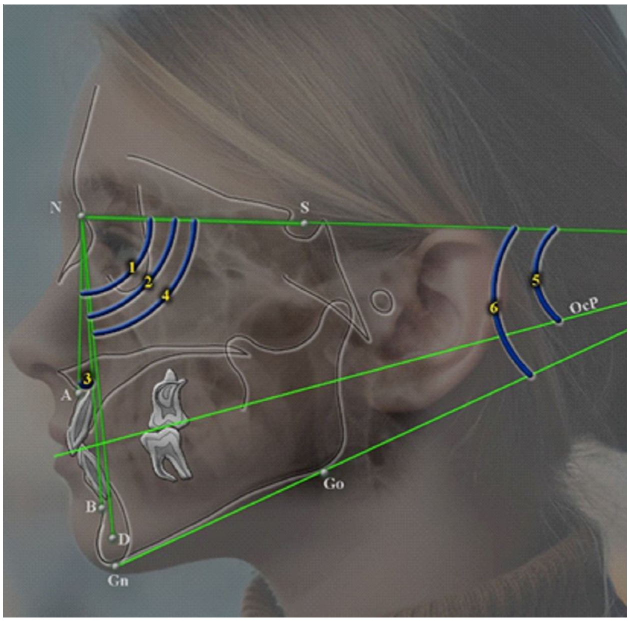

Fig. 1. Measurement according to the Steiner method. 1 – angle SNA_S, 2 – angle SNB_S, 3 – angle ANB_S, 4 – angle SND, 5 – angle SN-OcP, 6 – angle SN-GoGn.

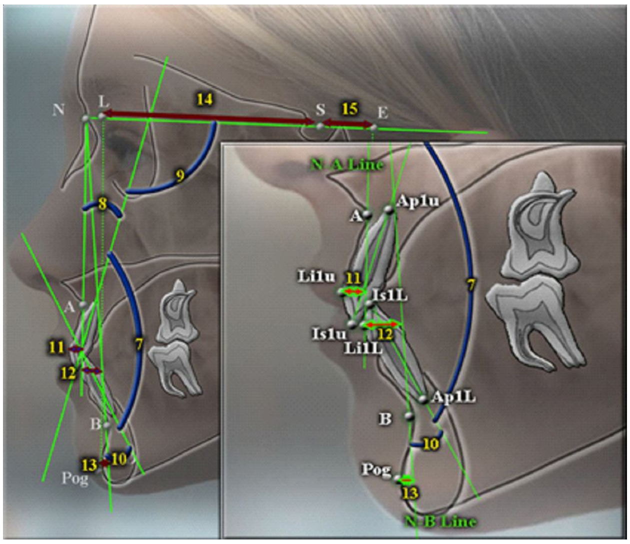

Fig. 2. Measurement according to the Steiner method. 7 – angle II, 8 – angle Max1-NA, 9 – angle Max1-SN, 10 – angle Mand1-NB, 11 – distance 1u-NA, 12 – distance 1l-NB, 13 – distance Pog-NB, 14 – distance S-L, 15 – distance S-E.

According to the Tweed method, the following angular and linear indicators were determined (Fig. 3-5): **IMPA angle** – the angle of the incisal plane of the lower jaw, formed by the central axis of the lower central incisor and the mandibular plane <u>MP</u> (°); **FMA angle** – the Frankfurt mandibular angle, formed by the mandibular plane and the Frankfurt plane <u>FP</u> (°); **FMIA angle** – the Frankfurt angle of the mandibular incisor, the central axis of the lower central incisor and the Frankfurt plane FP (°); **SNA_T angle** – formed by the lines S-N and N-A (indicates the anterior-posterior location of the upper jaw to the base of the skull) (°); **SNB_T angle** – formed by the lines S-N and N-B (indicates the anterior-posterior location of the lower jaw to the base of the skull) (°); **angle ANB_T** – formed by lines A-N and N-B (indicates the angular inter-jaw relationship in the anterior-posterior direction; considered positive if point A is in front of line NB; if lines NA and NB overlap, the angle is 0°; if point A is behind line NB, the angle is considered negative) (°); **angle POr_OcP** – formed by the occlusal plane OclP and the Frankfurt plane FP (°); **angle Z** – the angle between the soft tissue profile, which is determined by the mandibular-labial line and the Frankfurt plane FP (°); **Wits index** – the distance between the projections of the corresponding points A and B on the occlusal plane OclP, indicates the linear inter-jaw relationship in the anterior-posterior direction (if the projection of point A is in front of the projection of point B, then the index takes a positive value; if the projection of point A is behind the projection of point B, then the index takes a negative value) (mm); **AFH distance** – the anterior height of the face (distance from the lowest point on the symphysis of the lower jaw and the plane of the base of the upper jaw SpP) (mm); **PFH distance** – the posterior height of the face (distance from point Ar to point tGo) (mm); **Ls1u_Ls distance** – the thickness of the upper lip (distance from point Ls1u to point Ls) (mm); **Pog_Pog' distance** – the thickness of the soft tissues of the chin (distance from point Pog to point Pog') (mm); **AFH_PFH ratio** – the ratio between the values of AFH and PFH.

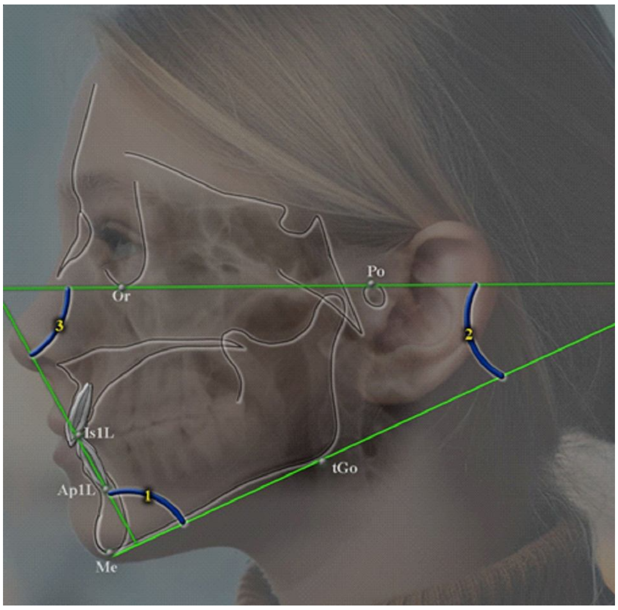

Fig. 3. Measurements according to the Tweed method. 1 – IMPA angle, 2 – FMA angle, 3 – FMIA angle.

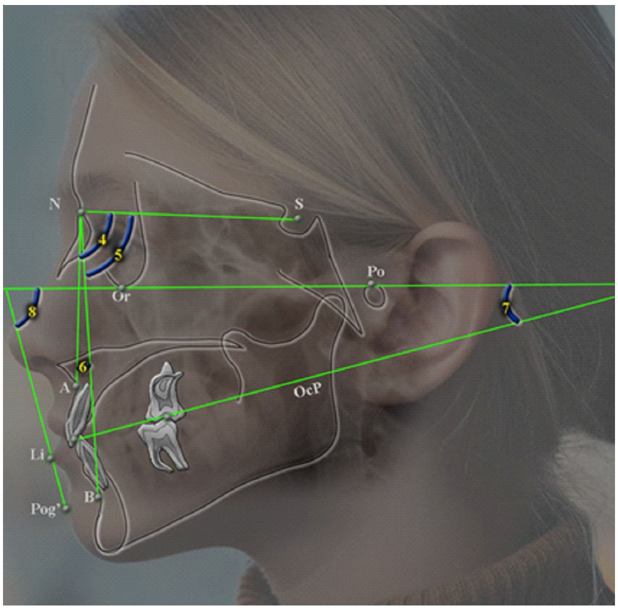

Fig. 4. Measurement according to the Tweed method. 4 – angle SNA_T, 5 – angle SNB_T, 6 – angle ANB_T, 7 – angle POr_OcP, 8 – angle Z.

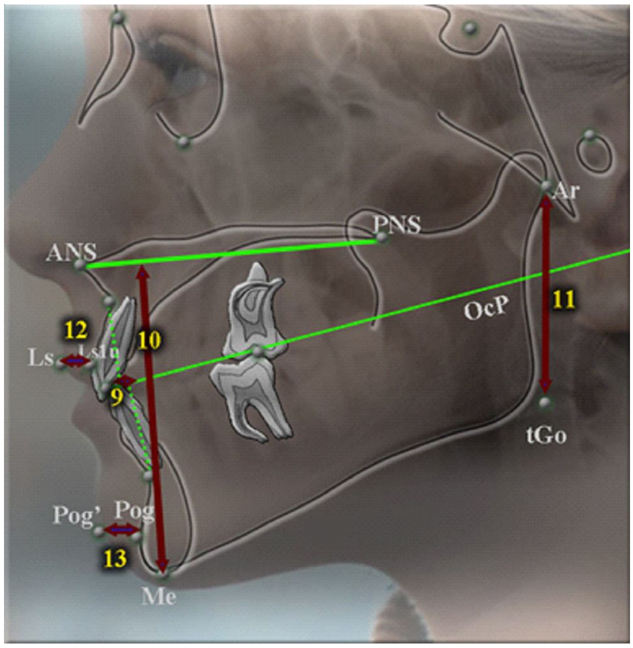

Fig. 5. Measurement according to the Tweed method. 9 – Wits index, 10 – AFH distance, 11 – PFH distance, 12 – Ls1u_Ls distance, 13 – Pog_Pog' distance.

To conduct a morphometric study of teeth and dental arches, we used the software applications i-Dixel One Volume Viewer (Ver.1.5.0) J Morita Mfg. Cor, and Planmeca Romexis Viewer (ver. 3.8.3.R 15.12.14) Planmeca OY.

For the frontal group of teeth, namely for the incisors and canines of the upper and lower jaws, the width of the coronal and cervical (width between the dentino-enamel boundaries) parts of the tooth and the length of the entire tooth in the coronal and sagittal planes (Fig. 6), as well as the length of the coronal and root parts relative to the cervical line in the corresponding planes (Fig. 7).

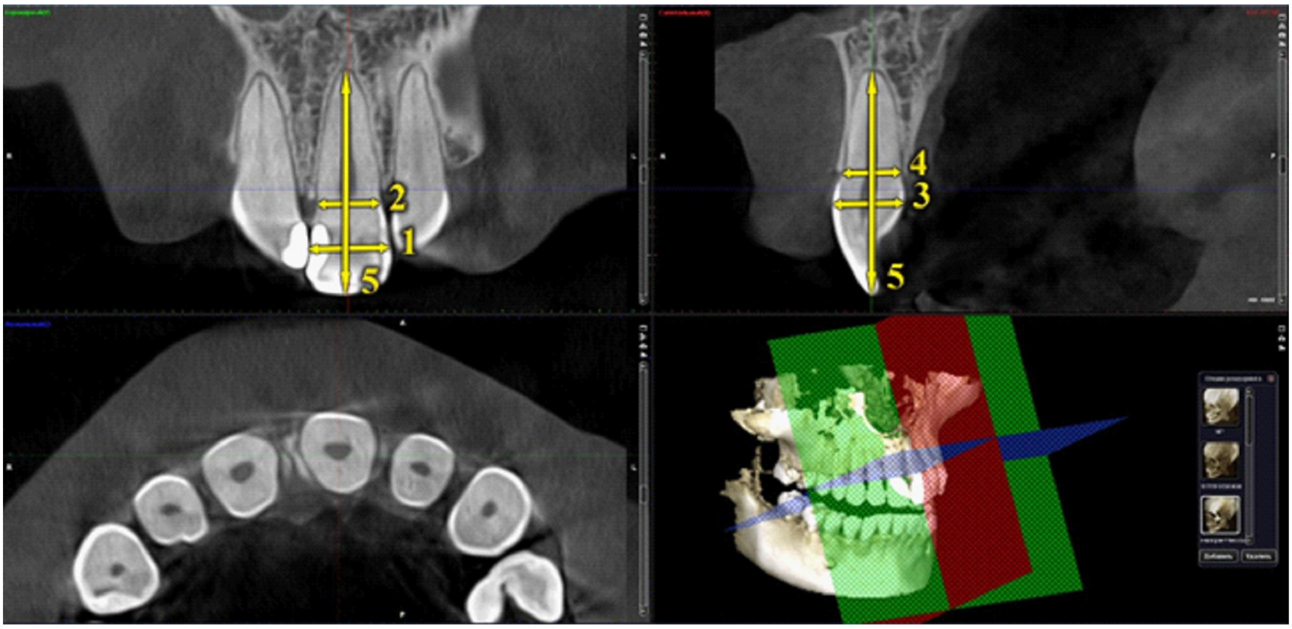

Fig. 6. Determination of metric characteristics of incisors and canines, upper and lower jaws (mm). 1 – width of the crown part of the tooth in the mesio-distal plane (MdK); 2 – width of the cervical part of the tooth in the mesio-distal plane (MdC); 3 – width of the crown part of the tooth in the vestibulo-oral plane (VoK); 4 – width of the cervical part of the tooth in the vestibulo-oral plane (VoC); 5 – length of the tooth (same) in the mesio-distal and vestibulo-oral planes (MdLD).

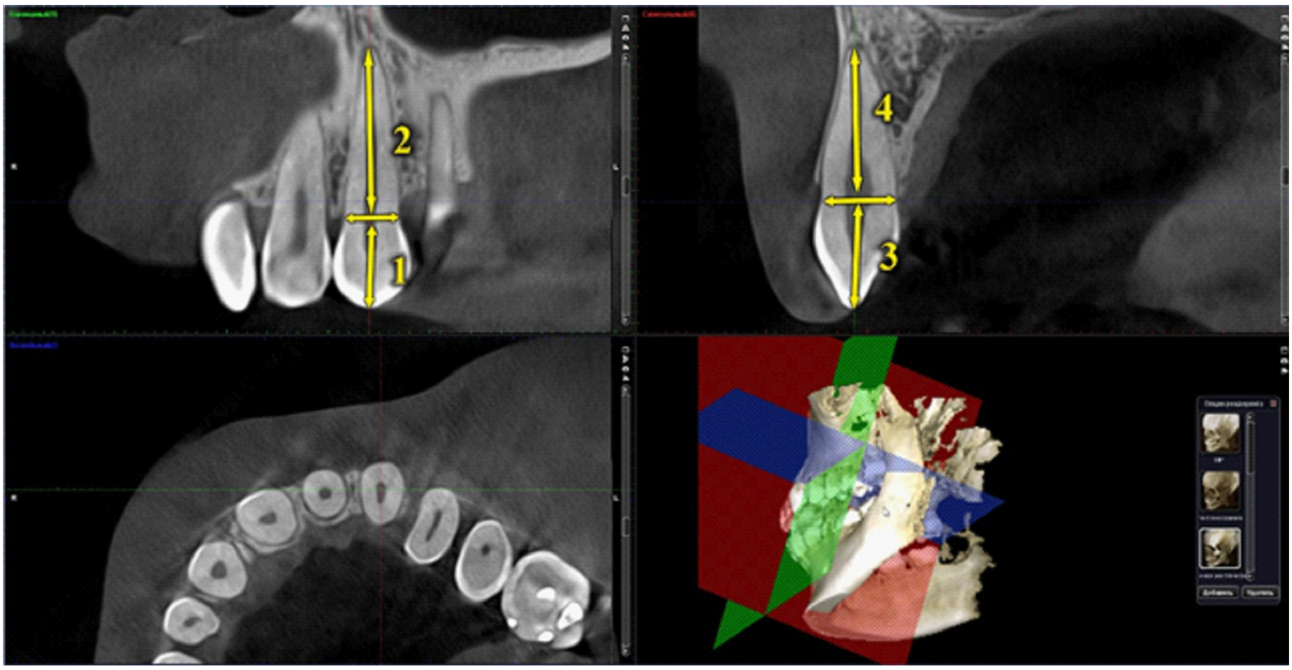

Fig. 7. Determination of metric characteristics of incisors and canines, upper and lower jaws (mm). 1 – length of the crown part of the tooth in the mesio-distal plane (MdLK); 2 – length of the root part of the tooth in the mesio-distal plane (MdLR); 3 – length of the crown part of the tooth in the vestibulo-oral plane (VoLK); 4 – length of the root part of the tooth in the vestibulo-oral plane (VoLR).

For the first and second premolars (Fig. 8) and the first molar (Fig. 9) of the upper and lower jaws, the width of the crown part in the mesio-distal and vestibulo-oral planes was determined. Additionally, for premolars, the length of the tooth was also determined, which was measured between the tops of the vestibular tubercle and the root. If the premolar has two roots, the top of the vestibular root was selected (see Fig. 8).

Since in previous studies conducted by Marchenko A. V. et al. [19], when comparing the computed tomography sizes

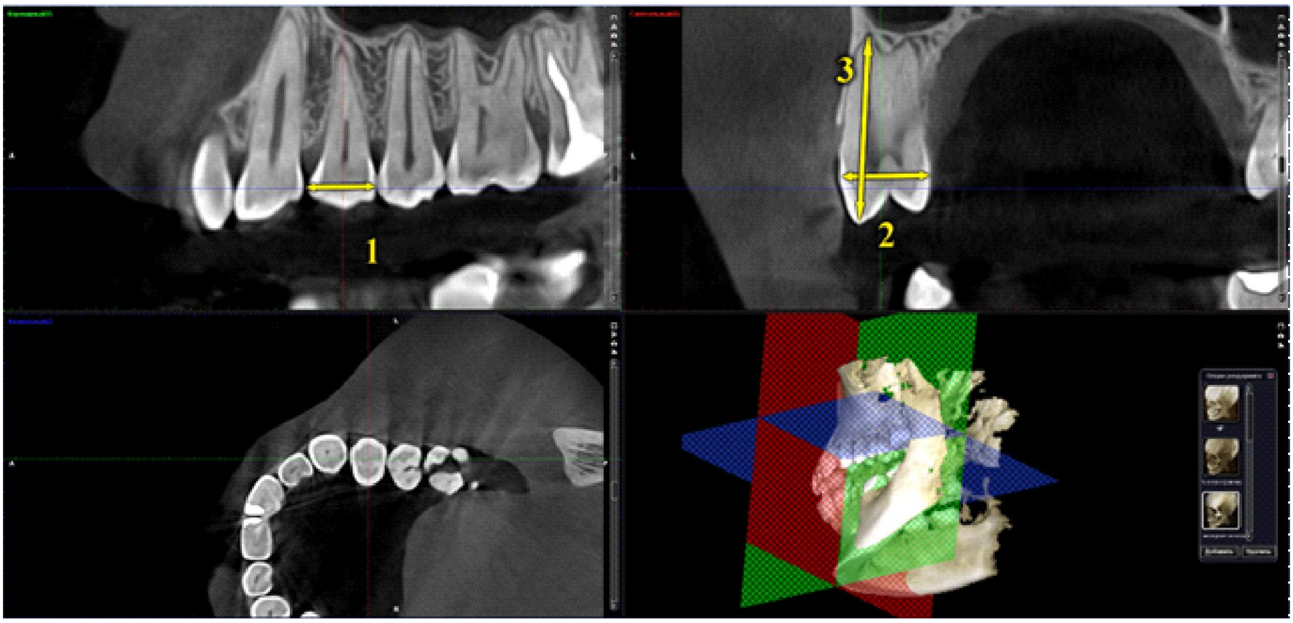

Fig. 8. Determination of metric characteristics of the premolars of the upper and lower jaws (mm). 1 – width of the crown part of the tooth in the mesio-distal plane (MdK); 2 – width of the crown part of the tooth in the vestibulo-oral plane (VoK); 3 – length of the tooth in the vestibulo-oral plane (MdLD).

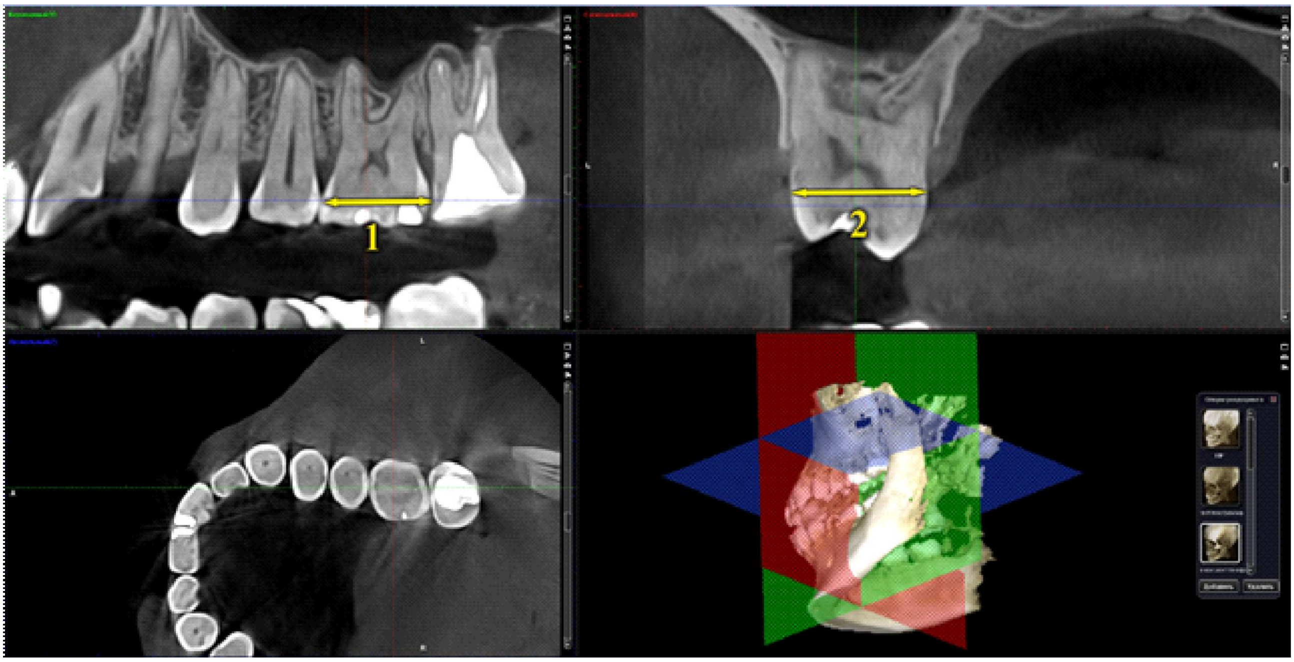

Fig. 9. Determination of metric characteristics of molars of the upper and lower jaws (mm). 1 – width of the crown part in the mesio-distal plane (MdK); 2 – width of the crown part in the vestibulo-oral plane (VoK).

of the same teeth on the right and left sides, no significant or trending differences were found, we used the average values of the corresponding teeth on the upper and lower jaws: 11 or 41 upper or lower central incisors, 12 or 42 upper or lower lateral incisors, 13 or 43 upper or lower canines, 14 or 44 upper or lower first premolars, 15 or 45 upper or lower second premolars, 16 or 46 upper or lower first molars.

To characterize the dental arches, we used indicators that in the transverse (axial) plane characterize the distance between the cusps of the crowns and the tops of the roots of the canines (Fig. 10) and the first molars (Fig. 11) of the upper and lower jaws, as well as the distance between the premolar and molar points according to Pon (Fig. 12); in the sagittal plane, the distance between the crowns of the central incisors and the lines connecting the canines, first premolars and molars of the upper jaw (see Fig. 12); in the vertical (coronal) plane, the distances that characterize the position of the canines, first premolars and molars relative to the hard palate (Fig. 13).

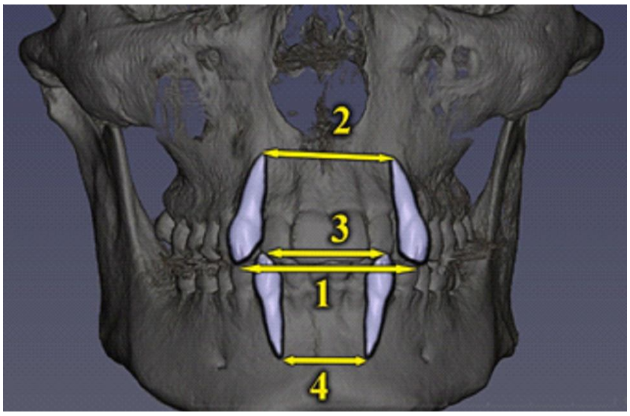

Fig. 10. Determination of the distance between the apical tubercles (1 – distance 13_23Bugr) and the root tips (2 – distance 13_23Apx) of the canines on the upper jaw and between the apical tubercles (3 – distance 33_43Bugr) and the root tips (4 – distance 33_43Apx) of the canines on the lower jaw (mm).

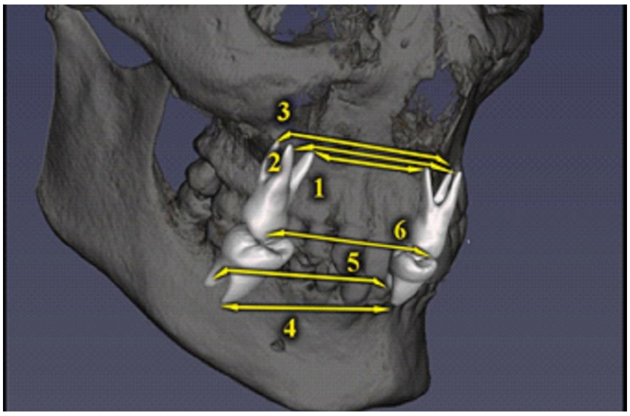

Fig. 11. Determination of the distances between the apices of the palatal (1 – distance mapex_6), medial vestibular (2 – distance napx_6) and distal vestibular roots (3 – distance dapx_6) and vestibular medial cusps (6 – distance VestBM) of the upper first molars and the distal (5 – distance dapx_46) and medial (4 – distance mapx_46) roots of the lower first molars (mm).

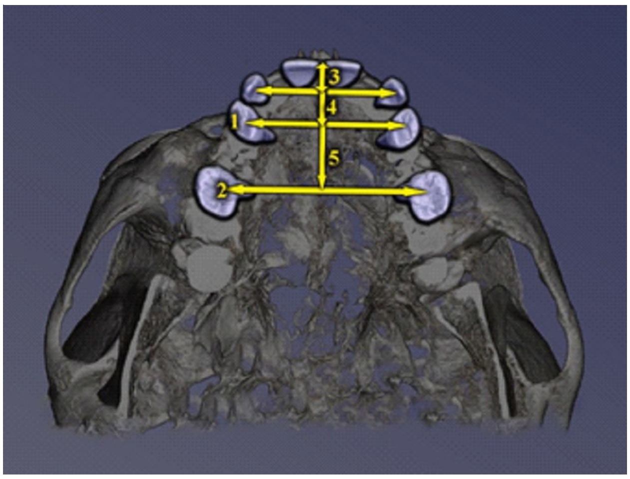

Fig. 12. Determination of the distances between the premolar (1 – distance PonPr) and molar (2 – distance PonM) points according to Pon, the distances between the crowns of the central incisors and the lines connecting the canines (3 – distance DL_C), the first premolars (4 – distance (DL_F) and molars (5 – distance DL_S) of the upper jaw (mm).

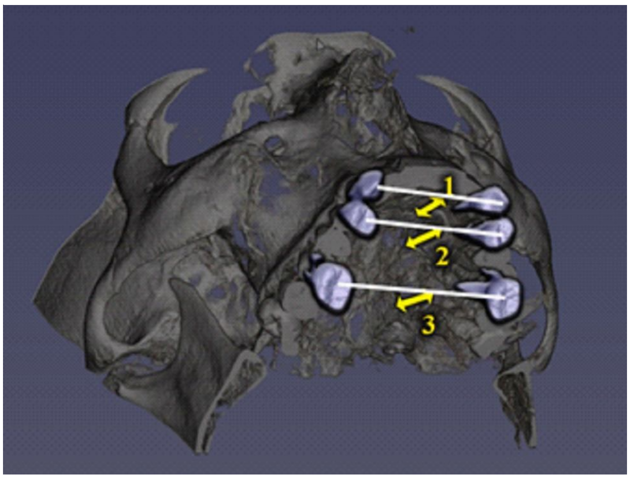

Fig. 13. Determination of distances characterizing the position of the intercanine (1– distance GL_1), premolar (2 – distance GL_2) and molar (3 – distance GL_3) lines relative to the hard palate (mm).

Using the stepwise regression analysis method in the licensed statistical package “Statistica 6.0”, the parameters necessary for constructing the correct shape of the dental arch were simulated depending on the features of teleradiometric indicators according to the Steiner or Tweed method and computed tomography dimensions of the teeth.

Results

In Ukrainian young men with physiological occlusion, reliable regression models (with the coefficient of determination of the regression polynomial $R^2>0.60$) of the sizes necessary for constructing the correct shape of the dental arch depending on the features of teleradiometric indicators according to the *Steiner method* and computed tomography sizes of the teeth have the form of the following linear equations:

distance DL_C (young men regardless of face type)= - 10.55 + 1.235×MdK11 + 1.273×VoK41 - 0.394×VoLK41 + 0.339×VoLK13 + 0.115×S-E ($R^2=0.880$, $F_{(5.35)}=23.94$, $p<0.001$, Std.Error of estimate=0.683);

distance GL_1 (young men regardless of face type)= 32.39 - 0.283×Max1-NA + 2.244×MdK11 - 2.047×MdK46 - 1.232×MdLR12 + 2.111×VoK41 + 0.494×VoLK12 - 0.080×II ($R^2=0.864$, $F_{(7.33)}=13.90$, $p<0.001$, Std.Error of estimate=1.343);

distance DL_F (young men regardless of face type)= -

9.925 + 1.390×MdK11 + 1.553×VoK45 - 0.304×VoLK42 - 1.001×VoK45 + 0.143×S-E + 1.637×MdK42 (R^2=0.911, $F_{(6.34)}$=27.63, p<0.001, Std.Error of estimate=0.689);

distance GL_2 (young men regardless of face type)= 10.86 - 0.251×Max1-NA + 1.224×MdLK12 - 1.193×MdLD45 + 2.141×VoK12 + 1.322×MdLK13 + 1.396×VoK14 - 2.004×MdK44 + 0.396×1I-NB (R^2=0.832, $F_{(8.32)}$=8.99, p<0.001, Std.Error of estimate=1.634);

distance PonPr (young men regardless of face type)= 5.701 + 1.366×MdK12 + 1.573×MdK15 - 0.478×MdLR12 + 2.217×MdK45 + 2.042×MdK41 - 0.319×MdLD14 (R^2=0.895, $F_{(6.34)}$=22.80, p<0.001, Std.Error of estimate=1.002);

distance DL_S (young men regardless of face type)= 0.843 + 1.493×MdK11 + 2.022×VoK15 + 0.979×VoK46 - 1.140×VoK45 + 0.163×S-E - 0.053×II + 0.197×MdLK43 (R^2=0.900, $F_{(7.33)}$=42.53, p<0.001, Std.Error of estimate=0.652);

distance GL_3 (young men regardless of face type)= 11.58 - 1.004×MdLD45 + 1.262×MdLD11 - 0.641×ANB_S - 0.567×MdLD41 + 3.090×MdK42 - 1.606×MdK16 + 1.343×VoK15 + 0.125×S-E (R^2=0.709, $F_{(8.32)}$=9.73, p<0.001, Std.Error of estimate=1.259);

distance PonM (young men regardless of face type)= 1.850 + 0.659×MdLD44 - 0.638×MdLD14 + 1.454×MdK15 + 2.664×MdK45 + 2.051×VoK43 + 2.196×MdK41 - 1.627×VoK42 (R^2=0.774, $F_{(7.33)}$=16.12, p<0.001, Std.Error of estimate=1.345);

distance 13_23Bugr (young men regardless of face type)= 7.992 + 2.502×MdK12 + 1.849×MdK13 - 0.487×VoLR12 - 0.913×VoK14 + 1.396×MdK41 + 1.171×MdC41 (R^2=0.764, $F_{(6.34)}$=18.34, p<0.001, Std.Error of estimate=1.058);

distance 13_23Apx (young men regardless of face type)= 42.43 + 1.853×MdC12 + 0.325×ANB_S - 1.672×VoK16 + 1.062×VoK45 - 1.600×VoC43 + 0.331×MdLK41 + 0.531×MdLD14 - 0.457×MdLD13 (R^2=0.611, $F_{(8.31)}$=6.08, p<0.001, Std.Error of estimate=1.600);

distance VestBM (young men regardless of face type)= 30.23 + 3.095×VoK15 + 1.197×MdLD44 - 0.595×MdLD42 - 0.819×MdLD45 + 0.805×MdLD11 - 1.273×MdK11 - 0.415×MdLR13 (R^2=0.786, $F_{(7.33)}$=17.28, p<0.001, Std.Error of estimate=1.348);

distance napx_6 (young men regardless of face type)= 31.79 + 3.799×MdC42 - 2.940×VoK16 + 3.934×MdK12 - 0.647×VoLR13 + 0.876×Pog-NB + 2.156×VoK13 - 1.387×MdK11 (R^2=0.731, $F_{(7.33)}$=12.80, p<0.001, Std.Error of estimate=1.824);

distance dapx_6 (young men regardless of face type)= -23.49 + 2.973×VoK15 + 3.030×MdK46 - 5.057×MdC13 + 1.121×VoLK13 + 2.296×MdK12 + 3.452×MdK15 + 2.377×VoC13 - 1.996×MdK16 (R^2=0.764, $F_{(8.32)}$=12.95, p<0.001, Std.Error of estimate=2.374);

distance mapex_6 (young men regardless of face type)= -18.54 + 3.609×MdK45 + 4.242×MdK15 + 2.438×MdK12 - 0.403×MdLR42 + 0.235×S-E + 3.481×MdC42 - 1.681×MdC13 (R^2=0.849, $F_{(7.33)}$=26.51, p<0.001, Std.Error of estimate=1.412);

distance 33_43Bugr (young men regardless of face type)= 1.121 + 1.479×MdK12 + 2.406×MdK42 - 0.343×MdLR11 + 0.380×MdLD43 - 0.227×VoLR13 (R^2=0.673, $F_{(5.35)}$=14.40, p<0.001, Std.Error of estimate=0.902);

distance 33_43Apx (young men regardless of face type)= 8.749 + 0.958×MdLD43 + 4.801×VoC12 - 3.475×VoK12 - 0.523×VoLR12 - 1.363×MdC11 + 3.167×VoK43 - 2.156×MdK15 - 1.760×VoC43 (R^2=0.709, $F_{(8.32)}$=9.74, p<0.001, Std.Error of estimate=1.400);

distance mapx_46 (young men regardless of face type)= 15.05 + 1.420×MdLK12 + 3.349×MdK45 + 2.606×VoK16 - 0.703×MdLD45 - 1.346×VoK46 + 1.219×MdC43 - 0.823×MdC11 (R^2=0.757, $F_{(7.32)}$=14.26, p<0.001, Std.Error of estimate=1.479);

distance dapx_46 (young men regardless of face type)= 17.74 + 5.132×MdK44 - 0.216×S-E + 0.429×VoLR13 - 2.885×VoK11 + 1.414×VoK16 - 0.172×Mand1-NB + 0.538×MdLR11 (R^2=0.689, $F_{(7.32)}$=10.14, p<0.001, Std.Error of estimate=1.746);

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

In Ukrainian *young women* with physiological occlusion, reliable regression models (with the coefficient of determination of the regression polynomial R^2>0.60) of the sizes necessary for constructing the correct shape of the dental arch depending on the features of teleradiometric indicators according to the *Steiner method* and computed tomography sizes of the teeth have the form of the following linear equations:

distance DL_F (young women regardless of face type)= 6.836 + 0.747×MdK11 - 0.070×II + 1.276×MdK13 + 0.999×VoC11 - 0.549×VoK45 - 0.266×MdLK43 + 0.669×MdK43 (R^2=0.708, $F_{(7.60)}$=20.74, p<0.001, Std.Error of estimate=0.788);

distance GL_2 (young women regardless of face type)= 19.95 - 0.157×Max1-SN + 1.847×MdK46 - 1.493×VoLK43 + 1.023×VoLK41 + 1.627×VoK43 - 1.453×MdK16 - 1.720×VoK41 + 1.360×MdK45 (R^2=0.613, $F_{(8.59)}$=11.69, p<0.001, Std.Error of estimate=1.589);

distance DL_S (young women regardless of face type)= -3.048 + 1.461×MdK11 + 0.224×Holdaway Ratio + 1.170×MdK16 + 1.039×VoK11 + 0.251×MdLD11 - 0.196×MdLD15 (R^2=0.782, $F_{(6.61)}$=36.57, p<0.001, Std.Error of estimate=0.803);

distance mapx_46 (young women regardless of face type)= 8.581 + 0.234×SND - 0.075×MdC43 - 0.298×Holdaway Ratio + 1.091×MdK16 + 0.744×MdLK13 + 1.624×MdK41 - 0.887×VoK44 + 1.333×MdC13 (R^2=0.634, $F_{(8.53)}$=11.47, p<0.001, Std.Error of estimate=1.783);

distance dapx_46 (young women regardless of face type)= 9.425 + 0.670×MdLD45 - 0.439×Holdaway Ratio + 1.857×VoC12 + 0.277×SNB_S + 1.930×MdC12 -

1.028×VoLK13 (R^2=0.668, $F_{(6.55)}$=18.45, p<0.001, Std.Error of estimate=1.958).

Since, in young women, regardless of the type of face, in the constructed reliable models of *distances DL_C, GL_1, PonPr, GL_3, PonM, 13_23Bugr, 13_23Apx, VestBM, napx_6, dapx_6, mapex_6, 33_43Bugr and 33_43Apx*, the coefficient of determination of the regression equations is from 0.313 to 0.513, these models do not have important practical significance in dental practice.

In Ukrainian *young men* with physiological occlusion, reliable regression models (with the coefficient of determination of the regression polynomial R^2>0.60) of the sizes necessary for constructing the correct shape of the dental arch depending on the features of teleradiometric indicators according to the *Tweed method* and computed tomography sizes of the teeth have the form of the following linear equations:

distance DL_C (young men regardless of face type)= -6.910 + 1.098×MdK11 + 0.899×VoK41 - 0.417×VoLK41 + 0.237×VoLK13 + 0.100×Wits + 0.522×MdC11 (R^2=0.778, $F_{(6.34)}$=19.86, p<0.001, Std.Error of estimate=0.686);

distance GL_1 (young men regardless of face type)= 22.80 + 0.760×ANB_T - 0.653×VoLR12 + 1.085×VoC11 + 0.081×AFH - 1.606×MdK46 + 0.802×MdLK13 - 0.662×VoLK41 (R^2=0.694, $F_{(7.33)}$=10.68, p<0.001, Std.Error of estimate=1.476);

distance DL_F (young men regardless of face type)= -2.091 + 1.499×MdK11 + 1.231×VoK15 - 0.337×VoLK42 - 0.678×VoK45 + 1.189×VoC42 - 0.209×MdLR42 (R^2=0.794, $F_{(6.34)}$=21.79, p<0.001, Std.Error of estimate=0.759);

distance GL_2 (young men regardless of face type)= -4.788 + 0.281×POr_OcP + 2.384×MdK13 + 0.077×AFH - 0.584×MdLD41 + 2.200×VoK12 + 0.518×MdLK43 - 0.460×MdLD45 (R^2=0.638, $F_{(7.33)}$=8.33, p<0.001, Std.Error of estimate=1.743);

distance PonPr (young men regardless of face type)= 5.701 + 1.366×MdK12 + 1.573×MdK15 - 0.478×MdLR12 + 2.217×MdK45 + 2.042×MdK41 - 0.319×MdLD14 (R^2=0.801, $F_{(6.34)}$=22.80, p<0.001, Std.Error of estimate=1.002);

distance DL_S (young men regardless of face type)= 4.940 + 1.930×MdK11 + 1.724×VoK15 + 0.892×VoK46 - 0.080×FMIA - 0.759×VoK45 - 0.275×MdLR12 (R^2=0.872, $F_{(6.34)}$=38.76, p<0.001, Std.Error of estimate=0.726);

distance GL_3 (young men regardless of face type)= 7.243 + 0.79×AFH - 0.950×MdLD45 + 0.889×MdLD11 - 1.764×MdK16 + 3.160×MdK42 + 1.324×MdK13 - 0.271×ANB_T (R^2=0.715, $F_{(7.33)}$=11.82, p<0.001, Std.Error of estimate=1.227);

distance PonM (young men regardless of face type)= 1.850 + 0.659×MdLD44 - 0.638×MdLD14 + 1.454×MdK15 + 2.664×MdK45 + 2.051×VoK43 + 2.196×MdK41 - 1.627×VoK42 (R^2=0.774, $F_{(7.33)}$=16.12, p<0.001, Std.Error of estimate=1.345);

distance 13_23Bugr (young men regardless of face type)= 10.89 + 2.614×MdK12 + 2.102×MdK13 - 0.525×VoLR12 - 0.640×VoK14 + 1.393×MdK41 + 2.124×MdC41 - 1.432×VoC41 - 0.213×Ls1u_Ls (R^2=0.834, $F_{(8.32)}$=20.06, p<0.001, Std.Error of estimate=0.915);

distance VestBM (young men regardless of face type)= 23.72 + 2.982×VoK15 + 1.085×MdLD44 - 0.706×MdLD42 - 0.842×MdLD45 + 0.748×MdLD11 + 0.099×FMIA - 1.186×MdK11 (R^2=0.788, $F_{(7.33)}$=17.51, p<0.001, Std.Error of estimate=1.342);

distance napx_6 (young men regardless of face type)= 22.50 + 3.035×MdC42 - 4.144×VoK16 + 3.511×MdK12 - 0.686×VoLR13 + 0.924×MdLD45 - 1.123×VoLR11 + 3.222×MdK44 + 0.182×FMIA (R^2=0.798, $F_{(8.32)}$=15.76, p<0.001, Std.Error of estimate=1.606);

distance dapx_6 (young men regardless of face type)= -21.88 + 3.371×VoK15 + 2.222×MdK46 - 4.227×MdC13 + 1.151×VoLK13 + 2.578×MdK12 + 2.762×MdK15 (R^2=0.696, $F_{(6.34)}$=13.00, p<0.001, Std.Error of estimate=2.612);

distance mapex_6 (young men regardless of face type)= -11.23 + 3.492×MdK45 + 3.284×MdK15 + 2.133×MdK12 + 2.357×MdC41 - 0.645×MdLR42 + 0.486×MdLD44 - 0.572×MdLK13 (R^2=0.830, $F_{(7.33)}$=23.02, p<0.001, Std.Error of estimate=1.504);

distance 33_43Bugr (young men regardless of face type)= -2.284 + 1.418×MdK12 + 2.494×MdK42 - 0.349×MdLR11 + 0.450×MdLD43 - 0.281×VoLR13 + 0.265×MdLR42 + 0.032×AFH_PFH - 0.271×MdLR12 (R^2=0.760, $F_{(8.32)}$=12.65, p<0.001, Std.Error of estimate=0.808);

distance 33_43Apx (young men regardless of face type)= 24.62 + 0.800×MdLD43 - 0.411×Ls1u_Ls + 4.792×VoK43 - 3.023×VoC43 - 1.899×VoK42 - 0.406×MdLD45 - 1.881×MdK15 (R^2=0.737, $F_{(7.33)}$=13.23, p<0.001, Std.Error of estimate=1.308);

distance mapx_46 (young men regardless of face type)= 12.65 + 1.576×MdLK12 + 2.357×MdK45 + 2.845×VoK16 - 0.648×MdLD45 - 2.008×VoK46 - 0.099×PFH + 3.114×MdK42 (R^2=0.788, $F_{(7.32)}$=16.98, p<0.001, Std.Error of estimate=1.383);

distance dapx_46 (young men regardless of face type)= 19.97 + 4.741×MdK44 - 0.217×IMPA - 3.955×VoK11 + 0.396×MdLD13 + 2.057×MdK45 + 0.192×SNA_T + 1.030×VoK16 (R^2=0.733, $F_{(7.32)}$=12.57, p<0.001, Std.Error of estimate=1.618).

Since, in young men, regardless of the type of face, in the constructed reliable model of the *distance 13_23Apx*, the coefficient of determination of the regression equation is 0.529, this model does not have important practical significance in dental practice.

In Ukrainian *young women* with a physiological bite, reliable regression models (with a coefficient of determination of the regression polynomial R^2 >0.60) of the sizes necessary for constructing the correct shape of the dental arch depending on the features of teleradiometric indicators according to the *Tweed method* and computed tomography sizes of the teeth have the form of the following linear equations:

distance DL_C (young men regardless of face type)= -

6.910 + 1.098×MdK11 + 0.899×VoK41 - 0.417×VoLK41 + 0.237×VoLK13 + 0.100×Wits + 0.522×MdC11 (R^2=0.778, $F_{(6.34)}$=19.86, p<0.001, Std.Error of estimate=0.686);

distance GL_1 (young men regardless of face type)= 22.80 + 0.760×ANB_T - 0.653×VoLR12 + 1.085×VoC11 + 0.081×AFH - 1.606×MdK46 + 0.802×MdLK13 - 0.662×VoLK41 (R^2=0.694, $F_{(7.33)}$=10.68, p<0.001, Std.Error of estimate=1.476);

distance DL_F (young men regardless of face type)= -2.091 + 1.499×MdK11 + 1.231×VoK15 - 0.337×VoLK42 - 0.678×VoK45 + 1.189×VoC42 - 0.209×MdLR42 (R^2=0.794, $F_{(6.34)}$=21.79, p<0.001, Std.Error of estimate=0.759);

distance GL_2 (young men regardless of face type)= -4.788 + 0.281×POr_OcP + 2.384×MdK13 + 0.077×AFH - 0.584×MdLD41 + 2.200×VoK12 + 0.518×MdLK43 - 0.460×MdLD45 (R^2=0.638, $F_{(7.33)}$=8.33, p<0.001, Std.Error of estimate=1.743);

distance PonPr (young men regardless of face type)= 5.701 + 1.366×MdK12 + 1.573×MdK15 - 0.478×MdLR12 + 2.217×MdK45 + 2.042×MdK41 - 0.319×MdLD14 (R^2=0.801, $F_{(6.34)}$=22.80, p<0.001, Std.Error of estimate=1.002);

distance DL_S (young men regardless of face type)= 4.940 + 1.930×MdK11 + 1.724×VoK15 + 0.892×VoK46 - 0.080×FMIA - 0.759×VoK45 - 0.275×MdLR12 (R^2=0.872, $F_{(6.34)}$=38.76, p<0.001, Std.Error of estimate=0.726);

distance GL_3 (young men regardless of face type)= 7.243 + 0.79×AFH - 0.950×MdLD45 + 0.889×MdLD11 - 1.764×MdK16 + 3.160×MdK42 + 1.324×MdK13 - 0.271×ANB_T (R^2=0.715, $F_{(7.33)}$=11.82, p<0.001, Std.Error of estimate=1.227);

distance PonM (young men regardless of face type)= 1.850 + 0.659×MdLD44 - 0.638×MdLD14 + 1.454×MdK15 + 2.664×MdK45 + 2.051×VoK43 + 2.196×MdK41 - 1.627×VoK42 (R^2=0.774, $F_{(7.33)}$=16.12, p<0.001, Std.Error of estimate=1.345);

distance 13_23Bugr (young men regardless of face type)= 10.89 + 2.614×MdK12 + 2.102×MdK13 - 0.525×VoLR12 - 0.640×VoK14 + 1.393×MdK41 + 2.124×MdC41 - 1.432×VoC41 - 0.213×Ls1u_Ls (R^2=0.834, $F_{(8.32)}$=20.06, p<0.001, Std.Error of estimate=0.915);

distance VestBM (young men regardless of face type)= 23.72 + 2.982×VoK15 + 1.085×MdLD44 - 0.706×MdLD42 - 0.842×MdLD45 + 0.748×MdLD11 + 0.099×FMIA - 1.186×MdK11 (R^2=0.788, $F_{(7.33)}$=17.51, p<0.001, Std.Error of estimate=1.342);

distance napx_6 (young men regardless of face type)= 22.50 + 3.035×MdC42 - 4.144×VoK16 + 3.511×MdK12 - 0.686×VoLR13 + 0.924×MdLD45 - 1.123×VoLR11 + 3.222×MdK44 + 0.182×FMIA (R^2=0.798, $F_{(8.32)}$=15.76, p<0.001, Std.Error of estimate=1.606);

distance dapx_6 (young men regardless of face type)= -21.88 + 3.371×VoK15 + 2.222×MdK46 - 4.227×MdC13 + 1.151×VoLK13 + 2.578×MdK12 + 2.762×MdK15 (R^2=0.696, $F_{(6.34)}$=13.00, p<0.001, Std.Error of estimate=2.612);

distance mapex_6 (young men regardless of face type)= -11.23 + 3.492×MdK45 + 3.284×MdK15 + 2.133×MdK12 + 2.357×MdC41 - 0.645×MdLR42 + 0.486×MdLD44 - 0.572×MdLK13 (R^2=0.830, $F_{(7.33)}$=23.02, p<0.001, Std.Error of estimate=1.504);

distance 33_43Bugr (young men regardless of face type)= -2.284 + 1.418×MdK12 + 2.494×MdK42 - 0.349×MdLR11 + 0.450×MdLD43 - 0.281×VoLR13 + 0.265×MdLR42 + 0.032×AFH_PFH - 0.271×MdLR12 (R^2=0.760, $F_{(8.32)}$=12.65, p<0.001, Std.Error of estimate=0.808);

distance 33_43Apx (young men regardless of face type)= 24.62 + 0.800×MdLD43 - 0.411×Ls1u_Ls + 4.792×VoK43 - 3.023×VoC43 - 1.899×VoK42 - 0.406×MdLD45 - 1.881×MdK15 (R^2=0.737, $F_{(7.33)}$=13.23, p<0.001, Std.Error of estimate=1.308);

distance mapx_46 (young men regardless of face type)= 12.65 + 1.576×MdLK12 + 2.357×MdK45 + 2.845×VoK16 - 0.648×MdLD45 - 2.008×VoK46 - 0.099×PFH + 3.114×MdK42 (R^2=0.788, $F_{(7.32)}$=16.98, p<0.001, Std.Error of estimate=1.383);

distance dapx_46 (young men regardless of face type)= 19.97 + 4.741×MdK44 - 0.217×IMPA - 3.955×VoK11 + 0.396×MdLD13 + 2.057×MdK45 + 0.192×SNA_T + 1.030×VoK16 (R^2=0.733, $F_{(7.32)}$=12.57, p<0.001, Std.Error of estimate=1.618).

Since, in young men, regardless of the type of face, in the constructed reliable model of the *distance 13_23Apx*, the coefficient of determination of the regression equation is 0.529, this model does not have important practical significance in dental practice.

In Ukrainian *young women* with a physiological bite, reliable regression models (with a coefficient of determination of the regression polynomial R^2 >0.60) of the sizes necessary for constructing the correct shape of the dental arch depending on the features of teleradiometric indicators according to the *Tweed method* and computed tomography sizes of the teeth have the form of the following linear equations:

distance DL_F (young women regardless of face type)= -13.55 + 1.153×MdK11 + 0.069×IMPA + 0.900×VoC11 + 1.054×MdK13 - 0.346×VoK45 + 0.178×MdLD41 (R^2=0.653, $F_{(6.61)}$=19.14, p<0.001, Std.Error of estimate=0.851);

distance DL_S (young women regardless of face type)= -4.420 + 1.388×MdK11 + 1.076×MdK45 + 0.492×MdLD41 + 0.072×IMPA - 0.331×MdLD44 + 0.618×MdK16 (R^2=0.745, $F_{(6.61)}$=29.66, p<0.001, Std.Error of estimate=0.870);

distance mapx_46 (young women regardless of face type)= 8.346 + 1.500×MdK16 - 0.070×MdC43 + 0.220×Z + 1.333×MdLK13 - 1.551×VoK44 + 1.758×VoK43 - 0.229×MdLK41 (R^2=0.619, $F_{(7.54)}$=12.52, p<0.001, Std.Error of estimate=1.802);

distance dapx_46 (young women regardless of face type)= 0.885 + 0.302×Z + 0.477×VoLR42 + 2.351×MdC12 + 0.940×MdLD45 - 0.618×MdLR42 - 0.336×MdLR41 + 0.706×MdLK12 (R^2=0.719, $F_{(7.54)}$=19.70, p<0.001, Std.Error of estimate=1.820).

Since, in young women, regardless of face type, in the constructed reliable models of *distances DL_C, GL_1, GL_2, PonPr, GL_3, PonM, 13_23Bugr, 13_23Apx, VestBM, napx_6, dapx_6, mapex_6, 33_43Bugr and 33_43Apx*, the value of the coefficient of determination of the regression equations is from 0.285 to 0.546, these models do not have important practical significance in dental practice.

Discussion

Thus, as a result of the regression analysis, *in young men* with physiological occlusion, all 18 possible reliable ($p<0.001$ in all cases) models of linear parameters of dental arches were constructed depending on the features of computed tomography sizes of teeth and teleradiometric indicators according to the *Steiner* method with a determination coefficient of more than 0.6 (R^2= from 0.611 to 0.911); as well as 17 reliable ($p<0.001$ in all cases) models depending on the features of computed tomography sizes of teeth and teleradiometric indicators according to the *Tweed* method with a determination coefficient of more than 0.6 (R^2= from 0.638 to 0.872).

As a result of the analysis of the frequency of occurrence in the regression equations of computed tomography tooth sizes and teleradiometric indicators according to the *Steiner* method or the *Tweed* method *in young men*, the following percentage of occurrence in the models of these indicators was established: taking into account teleradiometric indicators according to the *Steiner* method the width of the crown part of the tooth in the mesio-distal (27.64 %) and vestibulo-oral plane (19.51 %), the length of the tooth in the mesio-distal and vestibulo-oral planes (13.01 %), teleradiometric indicators according to the *Steiner* method (12.20 %), the width of the cervical part of the tooth in the mesio-distal (7.32 %) and vestibulo-oral plane (3.25 %), the length of the root part of the tooth in the mesio-distal (4.88 %) and vestibulo-oral plane (4.07 %) and the length of the crown part of the tooth in mesio-distal (4.07 %) and vestibulo-oral plane (4.07 %); taking into account teleradiometric indicators according to the *Tweed* method the width of the crown part of the tooth in the mesio-distal (29.06 %) and vestibulo-oral plane (16.24 %), the length of the tooth in the mesio-distal and vestibulo-oral planes (15.38 %), teleradiometric indicators according to the *Tweed* method (13.68 %), the length of the root part of the tooth in the mesio-distal (5.98 %) and vestibulo-oral plane (4.27 %), the length of the crown part of the tooth in the vestibulo-oral (4.27 %) and mesio-distal plane (3.42 %) and the width of the cervical part of the tooth in the mesio-distal (4.27 %) and vestibulo-oral plane (3.42 %).

As a result of the analysis of the frequency of occurrence in the regression equations of the corresponding teeth *in young men*, the following percentage of occurrence in the models of these indicators was established: taking into account teleradiometric indicators according to the *Steiner* method upper incisors (17.78 % of all independent variables, including 12.04 % central incisors and 15.74 % lateral incisors), lower incisors (15.74 % of all independent variables, including 8.33 % central incisors and 7.41 % lateral incisors), upper canines (12.04 %), lower canines (7.41 %), upper premolars (12.96 % of all independent variables, including 4.63 % first and 8.33 % second), lower premolars (14.81 % of all independent variables, including 3.70 % first and 11.11 % second), upper first molars (5.56 %), lower first molars (3.70 %); taking into account teleradiometric indicators according to the *Tweed* method upper incisors (23.76 % of all independent variables, including 10.89 % central incisors and 12.87 % lateral incisors), lower incisors (21.78 % of all independent variables, including 9.90 % central incisors and 11.88 % lateral incisors), upper canines (10.89 %), lower canines (5.94 %), upper premolars (11.88 % of all independent variables, including 2.97 % first and 8.91 % second), lower premolars (17.82 % of all independent variables, including 4.95 % first and 12.87 % second), upper first molars (3.96 %), lower first molars (3.96 %).

In *young women* with physiological occlusion, out of 18 possible, only 5 reliable ($p<0.001$ in all cases) models of linear parameters of dental arches were constructed depending on the features of computed tomography sizes of teeth and teleradiometric indicators according to the *Steiner* method with a coefficient of determination greater than 0.6 (R^2= from 0.613 to 0.782); and only 4 reliable ($p<0.001$ in all cases) models depending on the features of computed tomography sizes of teeth and teleradiometric indicators according to the *Tweed* method with a coefficient of determination greater than 0.6 (R^2= from 0.619 to 0.745).

As a result of the analysis of the frequency of occurrence in the regression equations of computed tomography tooth sizes and teleradiometric indicators according to the *Steiner* method or the *Tweed* method *in young women*, the following percentage of occurrence in the models of these indicators was established: taking into account teleradiometric indicators according to the *Steiner* method the width of the crown part of the tooth in the mesio-distal (28.57 %) and vestibulo-oral plane (14.28 %), teleradiometric indicators according to the *Steiner* method (20.00 %), tooth length in the mesio-distal and vestibulo-oral planes (8.57 %), the length of the crown part of the tooth in the vestibulo-oral (8.57 %) and mesio-distal plane (5.71 %) and the width of the cervical part of the tooth in the mesio-distal (8.57 %) and vestibulo-oral plane (5.71 %); taking into account the teleradiometric indicators according to the *Tweed* method - the width of the crown part of the tooth in the mesio-distal (23.08 %) and the vestibulo-oral plane (11.54 %), the length of the tooth in the mesio-distal and vestibulo-oral planes (15.38 %), teleradiometric indicators according to the *Tweed* method (15.38 %), the length of the crown part of the tooth in the mesio-distal plane (11.54 %), the width of the cervical part of the tooth in the mesio-distal (7.69 %) and the vestibulo-oral plane (3.85 %) and the length of the root part of the tooth in the mesio-distal (7.69 %) and the vestibulo-oral plane (3.85 %).

As a result of the analysis of the frequency of occurrence in the regression equations of the corresponding teeth in *young women*, the following percentage of occurrence in the models of these indicators was established: taking into account teleradiometric indicators according to the *Steiner* method upper incisors (24.99 % of all independent variables, including 17.85 % central incisors and 7.14 % lateral incisors), lower incisors (10.71 % of all independent variables, including all central incisors), upper canines (14.29 %), lower canines (17.85 %), upper premolars (3.57 % of all independent variables, including all second incisors), lower premolars (14.28 % of all independent variables, including 3.57 % first and 10.71 % second incisors), upper first molars (10.71 %), lower first molars (3.57 %); taking into account teleradiometric indicators according to the *Tweed* method upper incisors (22.73 % of all independent variables, including 13.64 % central incisors and 9.09 % lateral incisors), lower incisors (27.27% of all independent variables, including 18.18 % central incisors and 9.09 % lateral incisors), upper canines (9.09 %), lower canines (9.09 %), lower premolars (22.73 % of all independent variables, including 9.09 % first and 13.64 % second), upper first molars (9.09 %).

The study of dental arch parameters and their relationship with teleradiometric indicators using the Steiner and Tweed methods, as well as measurements using cone-beam computed tomography, is important for creating prognostic models in orthodontics. Taking into account the parameters of the shape, length and width of the arch in combination with anatomical features allows improving approaches to diagnosis and treatment planning. M. K. Alam et al. [1] emphasize the influence of gender and age on the dimensions of the dental arch. Their study showed that the width of the dental arch in women is usually smaller than in men, with a difference of up to 2.4 mm in the frontal region. These results are consistent with the studies of Daoud R. et al. [9], which demonstrated that the length of the arch in girls is also smaller than in boys, with an average difference of 3.1 mm ($p<0.05$). At the same time, the data of Shahid M. K. et al. [2] confirmed that the relationship between tooth sizes in groups with different widths, lengths and perimeters of the arch showed consistent patterns. They noted that the increase in the perimeter of the arch was directly correlated with the increase in the size of the crowns in the anterior region (correlation coefficient 0.73; $p<0.05$).

The width and inclination of the molars are key parameters for assessing the shape of the dental arch. F. Albalawi et al. [3] showed that the correlation between the width of the arch and the inclination of the molars reaches 0.62, indicating a significant interdependence of these characteristics. Their findings complement the data of Alghamdi M. and Tashkandi N. [4], who found that a larger angle of the mandibular plane is associated with a smaller perimeter of the arch ($p<0.01$).

I. G. A. W. Ardani et al. [5] drew attention to the relationship between tooth sizes and arch shape in patients with physiological occlusion. Their data show that the correct ratio of the crowns of the upper and lower teeth has a positive effect on the harmony of the arch shape (correlation coefficient 0.75).

E. Salam et al. [24] work confirms that the width of the arch and the intercanine distance have a direct effect on its length. In particular, they note that each increase in the intercanine distance by 1 mm contributes to an increase in the length of the arch by 1.2 mm ($p<0.05$). Similar data are provided by Elhiny O. A. et al. [11], who showed that the ratio of the size of the teeth and the perimeter of the arch is an important prognostic factor for assessing possible occlusion pathologies.

H. Omar et al. [21] studies complement the understanding of the influence of the shape and size of the dental arch. They noted that in patients with a proportional arch shape, the ratio of the anterior and posterior widths is significantly correlated with indicators of functional occlusal load (correlation coefficient 0.67).

Of particular note is the study by Dmitriev M. et al. [10], who developed models for assessing the location of central incisors using the Steiner method. Their findings showed that in girls, the anterior location of the incisors is more often associated with a decrease in intermolar width, while in boys these indicators are more stable.

The results of the study by Hasegawa Y. et al. [13], where the dimensions of the dental arch in modern Mongolians and Japanese were compared, are interesting. They found that in Japanese patients, the arches have a greater width, which is associated with a greater length of teeth ($p<0.01$). Such ethnic differences are important for the creation of regional orthodontic standards, in particular for the Ukrainian population.

Regarding the relationship between crown dimensions and arch parameters, Shahid F. et al. [25, 26] determined that the crown size in the anterior region affects the shape of the arch. They found that the difference in crown width can change the arch perimeter by up to 4 mm. These findings are consistent with the study by Kato M. and Arai K. [15], who emphasized the importance of matching the basal arch shape to the coronal parameters in patients with mandibular crowding.

Regarding three-dimensional analysis of the dental arch, Somvasoontra S. et al. [28] drew attention to the relationship between the shape of the anterior part of the arch, the thickness of the alveolar bone and the sagittal position of the roots of the central incisors. In particular, they found that the incorrect position of the roots of the central incisors can lead to functional and aesthetic disorders in the future.

Thus, a comprehensive approach to dental arch analysis, combining teleradiometric indicators and cone-beam computed tomography, is an effective tool in predicting and correcting the shape of the dental arch. The obtained data can be used to create individualized orthodontic schemes that take into account the anatomical features of Ukrainian boys and girls with physiological occlusion.

Conclusion

1. In Ukrainian young men and young women with physiological occlusion without taking into account the type of face, as a result of the regression analysis, reliable ($p<0.001$ in all cases) models of linear parameters of dental arches were constructed depending on the computed tomography sizes of the teeth and the features of teleradiometric indicators according to the Steiner or Tweed methods with a coefficient of determination greater than 0.6 (in young men all 18 possible when taking into account the Steiner method, R^2= from 0.611 to 0.911 and 17 when taking into account the Tweed method, R^2= from 0.638 to 0.872; in young women only 5, when taking into account the Steiner method, R^2= from 0.613 to 0.782 and only 4 when taking into account the Tweed method, R^2= from 0.619 to 0.745).

2. When analyzing the frequency of occurrence in regression equations of computed tomography tooth sizes and teleradiometric indicators according to the Steiner or Tweed methods in young men, the models most often include the width of the crown part of the tooth in the mesio-distal (27.64 % and 29.06 %, respectively) and vestibulo-oral plane (19.51 % and 16.24 %, respectively), the length of the tooth in the mesio-distal and vestibulo-oral planes (13.01 % and 15.38 %, respectively) and teleradiometric indicators (12.20 % and 13.68 %, respectively). In young women, when taking into account the indicators according to the Steiner method - the width of the crown part of the tooth in the mesio-distal (28.57 %) and vestibulo-oral plane (14.28 %) and teleradiometric indicators (20.00 %); and when taking into account the indicators according to the Tweed method the width of the crown part of the tooth in the mesio-distal (23.08 %) and vestibulo-oral plane (11.54 %), the length of the tooth in the mesio-distal and vestibulo-oral planes (15.38 %), teleradiometric indicators (15.38 %) and the length of the crown part of the tooth in the mesio-distal plane (11.54 %).

3. When analyzing the frequency of occurrence in regression equations of the corresponding teeth in young men, the models that take into account teleradiometric indicators according to the Steiner or Tweed methods most often include: upper incisors (17.78 % and 23.76 %), lower incisors (15.74 % and 21.78 %), lower premolars (14.81 % and 17.82 %), upper premolars (12.96 % and 11.88 %) and upper canines (12.04 % and 10.89 %). In young women: when taking into account teleradiometric indicators according to the Steiner method upper incisors (24.99 %), lower canines (17.85 %), upper canines and lower premolars (14.28 % each), lower incisors and upper first molars (10.71 % each), and when taking into account teleradiometric indicators according to the Tweed method lower incisors (27.27 %), upper incisors and lower premolars (22.73 % each).

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МОДЕЛЮВАННЯ ПАРАМЕТРІВ НЕОБХІДНИХ ДЛЯ ПОБУДОВИ КОРЕКТНОЇ ФОРМИ ЗУБНОЇ ДУГИ В ЗАЛЕЖНОСТІ ВІД ОСОБЛИВОСТЕЙ ТЕЛЕРЕНТГЕНОМЕТРИЧНИХ ПОКАЗНИКІВ ЗА МЕТОДАМИ STEINER АБО TWEED І КОМП`ЮТЕРНО-ТОМОГРАФІЧНИХ РОЗМІРІВ ЗУБІВ В УКРАЇНСЬКИХ ЮНАКІВ І ДІВЧАТ ІЗ ФІЗІОЛОГІЧНИМ ПРИКУСОМ

Рябов Т. В., Шінкарук-Диковицька М. М., Пилипюк О. Ю., Мунтян О. В., Драчевська І Ю., Рокунець І. Л., Бурдейна Л. В.

Вивчення параметрів зубної дуги з урахуванням телерентгенометричних показників і розмірів зубів є важливим для планування ортодонтичного лікування, що сприяє досягненню стабільних і функціонально оптимальних результатів. Методи Steiner і Tweed, широко застосовувані для оцінки черепно-лицьових пропорцій, дозволяють виявити ключові антропометричні особливості, які впливають на форму зубної дуги. Додаткове використання комп`ютерно-томографічних вимірів забезпечує високу точність аналізу розмірів зубів, що особливо актуально для індивідуалізації ортодонтичних підходів. Мета роботи – в українських юнаків і дівчат із фізіологічним прикусом побудувати та провести аналіз регресійних моделей параметрів необхідних для побудови коректної форми зубної дуги в залежності від особливостей телерентгенометричних показників за методами Steiner або Tweed і комп`ютерно-томографічних розмірів зубів. На отриманих стандартним шляхом телерентгенограмах і створених в програмному забезпеченні 3D Slicer v5.4.0 телерентгенограмах з маркованими на 3D об`єктах точками (41 українських юнаків і 68 дівчат із фізіологічним прикусом із банку даних кафедри стоматології дитячого віку та науково-дослідного центру Вінницького національного медичного університету ім. М. І. Пирогова), вимірювання за методами Steiner C. C. і Tweed C. H. проводилося в застосунку OnyxCeph³™, версії 3DPro, компанії Image Instruments GmbH, Німеччина. На комп`ютерних томограмах для проведення морфометричного дослідження зубів та зубних дуг нами використовувалися програмні застосунки i-Dixel One Volume Viewer (Ver.1.5.0) J Morita Mfg. Cor та Planmeca Romexis Viewer (ver. 3.8.3.R 15.12.14) Planmeca OY. Регресійні моделі побудовані за допомогою ліцензійного пакету «Statistica 6.0». Встановлено, що в юнаків при урахуванні методу Steiner побудовані усі 18 можливих достовірних моделей із коефіцієнтом *детермінації більшим 0,6 (R^2= від 0,611 до 0,911, p<0,001), а при урахуванні методу Tweed 17 моделей (R^2= від 0,638 до 0,872, p<0,001); а у дівчат лише 5 достовірних моделей із коефіцієнтом детермінації більшим 0,6 при урахуванні методу Steiner (R^2= від 0,613 до 0,782, p<0,001) і лише 4 достовірних моделі при урахуванні методу Tweed (R^2= від 0,619 до 0,745, p<0,001). При аналізі частоти входження до регресійних рівнянь комп`ютерно-томографічних розмірів зубів і телерентгенометричних показників за методами Steiner або Tweed встановлено: в юнаків найбільш часто до моделей входять ширина коронкової частини зуба у мезіо-дистальній і вестибуло-оральній площині, довжина зуба у мезіо-дистальній та вестибуло-оральній площинах і телерентгенометричні показники; а у дівчат: при урахуванні показників за методом Steiner ширина коронкової частини зуба у мезіо-дистальній і вестибуло-оральній площині та телерентгенометричні показники; при урахуванні показників за методом Tweed ширина коронкової частини зуба у мезіо-дистальній і вестибуло-оральній площині, довжина зуба у мезіо-дистальній та вестибуло-оральній площинах, телерентгенометричні показники та довжина коронкової частини зуба у мезіо-дистальній площині. При аналізі частоти входження до регресійних рівнянь відповідних зубів встановлено, що в юнаків до моделей, які враховують телерентгенометричні показники за методами Steiner або Tweed, найбільш часто входять верхні й нижні різці, верхні й нижні малі кутні зуби та верхні ікла; а у дівчат верхні й нижні різці, верхні й нижні ікла, нижні малі кутні зуби та верхні перші великі кутні зуби при урахуванні телерентгенометричних показників за методом Steiner, а також верхні й нижні різці та нижні малі кутні зуби при урахуванні телерентгенометричних показників за методом Tweed.*

***Ключові слова**: стоматологія, телерентгенометрія за методами Steiner і Tweed, комп`ютерно-томографічні розміри зубів і зубних дуг, регресійний аналіз, українськи юнаки та дівчата, фізіологічний прикус.*

Author's contribution

Ryabov T. V. – research, methodology and writing of the original draft, formal analysis, validation.
Shinkaruk-Dykovytska M. M. – conceptualization, supervision.
Pylypiuk O. Yu. – data visualization.
Muntian O. V. – review writing and editing.
Drachevska I. Yu. – review writing and editing.
Rokunets I. L. – software.
Burdeina L. V. – review writing and editing.