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Research Article

Development of a Computer Version of the Assessment of the Proportionality of the Face Parameters

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Abstract

A new analysis of the estimation of the proportionality of the face parameters relative to the Po-n reference line is proposed. A computer version has been developed that allows an automated calculation of the proportionality of the face parameters and presents the result of the analysis in the form of a tabular protocol, as well as a graph of the evaluation scale.

Keywords: *Photometric Analysis; Computer Version; Morphometric Parameters of the Face; Soft Tissue Analysis; Reference Line*

Relevance

The need to study the proportions of the face led orthodontists to analyze the photos taken in the fas and profile. The full name of the applied method for assessing the state of soft tissue structures of the face using Latin terminology will be designated as photo-cephalo-morphometry. Abbreviated - photometry of the face. During the initial examination, the protocol of the clinical examination of the dentoalveolar system is filled in. In relation to the face, in addition to personal perception, objective methods of assessment are used, based on the measurement of the image of the face on the film. Photometric analysis of the face is carried out before the start of orthodontic treatment in order to conduct a primary diagnosis, make a correct diagnosis and make a treatment plan, guided by the principle of harmony of beauty. Further, if necessary, the orthodontist evaluates the changes in facial proportions at the treatment stage and the final analysis of the state of the soft tissue structures of the maxillofacial complex.

The parts of the face are in certain proportions with each other. The identification of these proportions is part of the tasks of photometry. In order to expand the possibilities of diagnosis and evaluation of treatment results, it is proposed to conduct a multivariate analysis of soft tissue parameters relative to the Po-n reference line, which would allow us to judge not only the presence of dental anomalies, but also their reflection on the proportions of the face.

Modern work of orthodontists, in addition to clinical activities, is associated with the automation of the workflow. Employees of the Department of Orthodontics, following the current trends of information technology, are involved in the process of creating software in various areas of scientific, educational and medical activities. With the advent of digital technologies, it became necessary to develop a computer version of the assessment of the proportionality of the face parameters from photographs. Morphometric parameters are

measured from the photos of the face, the data obtained is analyzed, recorded and archived. The computer version will allow you to rationalize the working time of the orthodontist and save the data obtained [1-10].

Purpose of the Study

Development of an analysis of the proportionality of the proportions of the face, followed by the creation of its computer version.

Research Objectives

1. Determination of the indices of the linear and angular parameters of the face relative to the reference line Po-n.
2. Development of a computer version of the analysis of the revealed proportions of the soft tissues of the face.
3. Compare analog and digital methods of obtaining information about the proportions of the face.
4. To evaluate the soft tissues of the face of volunteers with normal occlusion using the developed morphometric computer version.

Materials and Methods

In the clinical part of the study, 30 volunteers with normal occlusion aged 17 - 25 years were selected, including 10 men and 20 women. After the examination, all patients underwent photometric diagnostics. After that, the angular and linear parameters of the face, as well as index indicators, were evaluated. For the correct position of the head, we used a photostat developed by us (Figure 1). As a reference line, we used the Po-n line.

Figure 1: *Photostat for centering the head when making photos.*

The development of the software module required several steps to implement it. After the first stage of creating a computer version of the analysis of the proportionality of the proportions of the face, the testing stage, the so-called commissioning works, followed. After identifying and eliminating the expressed violations, the use stage begins. However, the use stage implies not only the application of the software module for practical needs, but also continues to serve as a test model at the same time. Based on the test model, the software is further corrected in order to create several iterations of improved versions. The correction of the computer version was carried out in two directions: the identification and elimination of errors in the mathematical algorithm and the development of the program interface.

Results and Discussion

As a result of the study, morphometric points were determined in order to place them on the photos of the face in the fas (Table 1 and figure 2) and in the profile (Table 2 and figure 3).

Abbreviated Name	Decoding the Name	Description of the Location
Po(r)	Cutaneous point porion	The uppermost part of the tragus of the right ear
Po(l)	Cutaneous point porion	The uppermost part of the tragus of the left ear
p(r)	Pupillary point	The center of the right pupil
p(l)	Pupillary point	The center of the left pupil
n	Skin point (nasion)	The middle of the indentation of the nose along the pupillary line.
gl	Skin point glabella	A point located slightly above the midpoint of the medial ends of the superciliary arches.
sn	Cutaneous point subnasion	Tray point
st(r)	Cutaneous point stomion	The point of closing the lips on the right
st(l)	Cutaneous point stomion	The point of closing of the lips on the left
gn	Cutaneous point gnation	Is the lowest point of the chin protrusion

Table 1: *Morphometric points on photos of the face in the fas.*

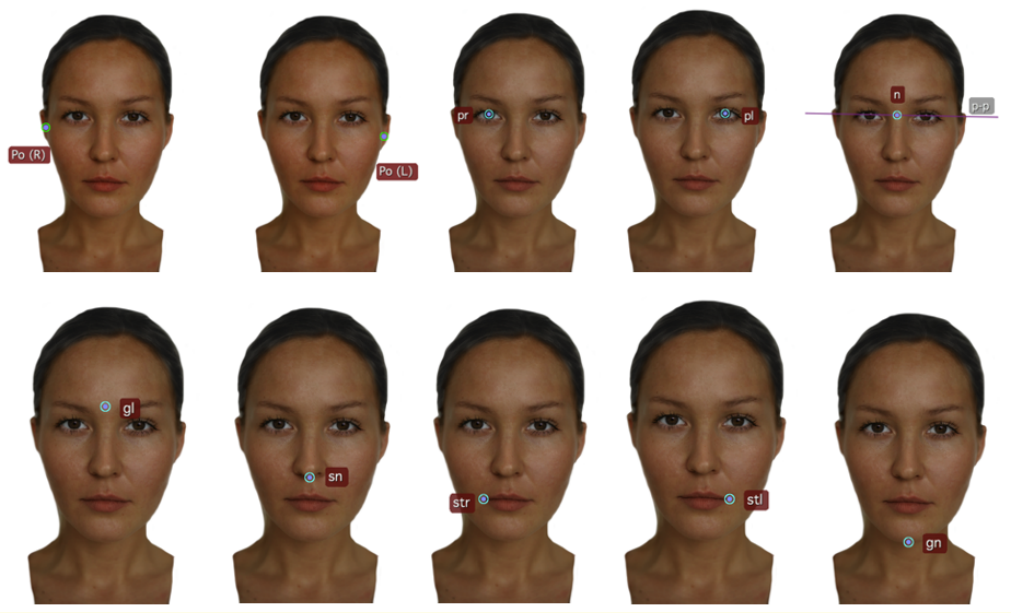

Figure 2: *Interface of the computer version. Morphometric points on photos of the face in the fas.*

Abbreviated Name	Cutaneous Point Nasion	Description of the Location
n	Cutaneous point porion	The deepest point in the area of the transition of the frontal part to the nose
Po	Cutaneous point orbitale	Is the most upper part of the tragus of the ear
or	Cutaneous point subnasion	The point of the lower edge of the orbit
sn	Cutaneous point stomion	The point of transition of the contour of the base of the nose to the vermillion of the upper lip
sto	Cutaneous point supramentale	The point of closing of the lips
sm	Cutaneous point pogonion	Is the deepest point of the chin-lip fold
pg	Cutaneous point nasion	The most prominent point on the anterior contour of the chin protrusion
ta		Is the point of transition of the chin to the base of the lower jaw
tp		The point of transition of the pharyngeal part to the neck

Table 2: *Morphometric points on photos of a person in profile.*

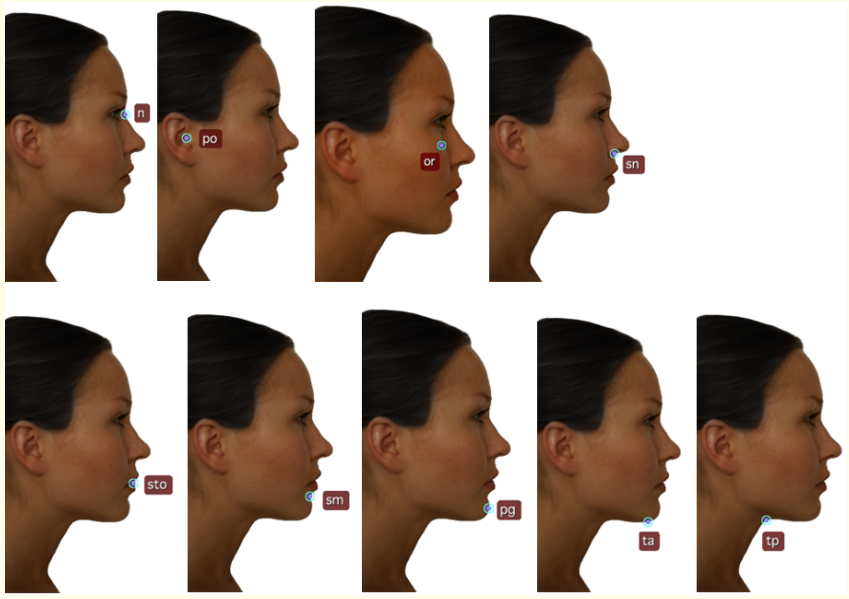

Figure 3: *Interface of the computer version. Morphometric points on photos of a person in profile.*

An index parameter was also derived that allows us to classify patients by the ratio of the width of the face to the reference line Po-n (Figure 4); index parameters were developed (Table 3 and figure 5), angular (Table 4 and figure 6) and linear (Table 5 and figure 7) morphometric parameters of the proportionality of the face in the face and in the profile (Table 6, figure 8, table 7, figure 9, table 8, figure 10, table 9, figure 11 respectively).

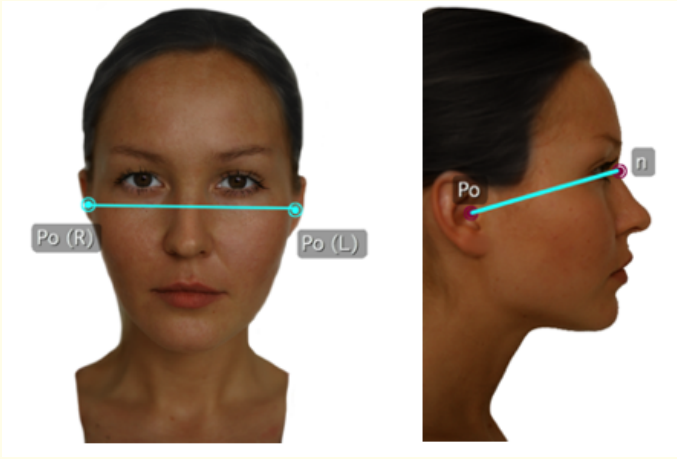

Figure 4: *Reference parameter Po (l)-Po(r)/Po-n.*

Parameter Designation	Parameter Description
n - gn/n - sn	The ratio of the front face height and the front upper face height
n - sn/sn - gn	The ratio of the front upper face height and the front lower face height
sn - sto/sto - gn	The ratio of the heights of the middle and lower third of the face

Table 3: *Index parameters of the proportionality of a person in the FAS.*

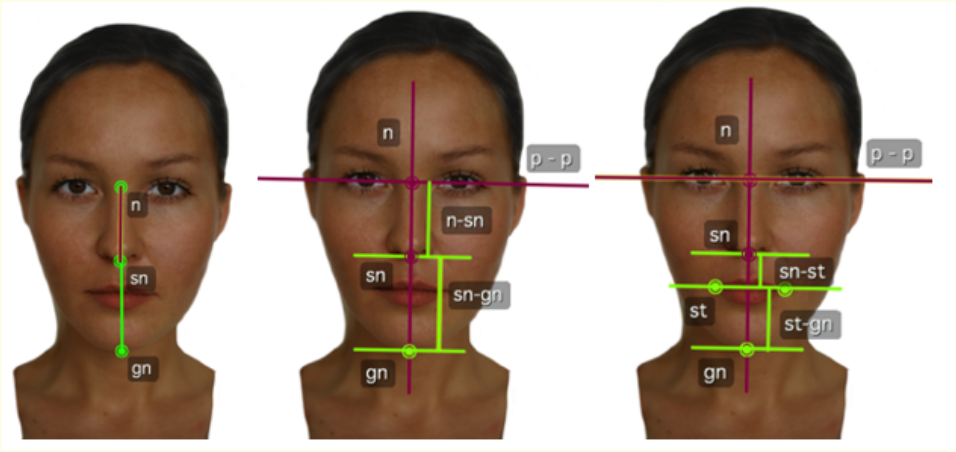

Figure 5: *Index parameters of the proportionality of the face in the fas.*

Parameter Designation	Parameter Description
st–st / n-sn	The angle of inclination of the line of the corners of the mouth in relation to the vertical line of the face
n–sn / gn	Angle, shows the degree of displacement of the chin from the vertical line of the face

Table 4: *Angular parameters of the proportionality of the face in the fas.*

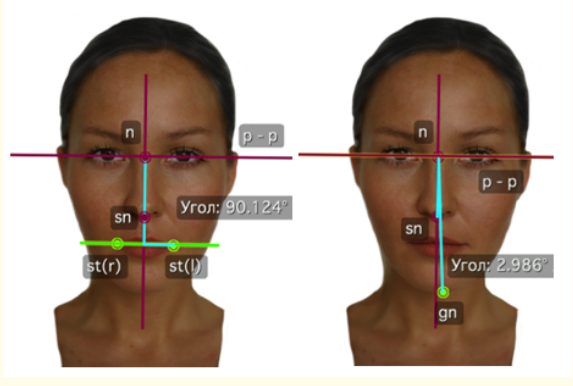

Figure 6: *Angular parameters of the proportionality of the face in the fas.*

Parameter Designation	Parameter Description
N - Gn	Length of the front face height
n - sn	Length of the front upper face height
sn - gn	Length of the front lower face height
sn - sto	Length of the anterior height of the middle third of the face

Table 5: *Linear parameters of the proportionality of the face in the fas.*

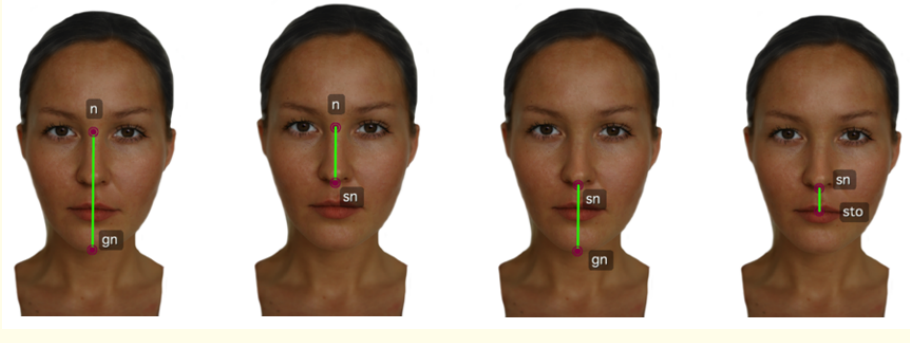

Figure 7: *Linear parameters of the proportionality of the face in the fas.*

Parameter Designation	Parameter Description
Po-n/Po-sn	Ratio of reference line distances to sagittal length Po-sn
Po-n/Po-sto	Ratio of reference line distances to sagittal length Po-sto
Po-n/Po-pg	Ratio of reference line distances to sagittal length Po-pg

Table 6: *Index parameters of the proportionality of the face in the profile.*

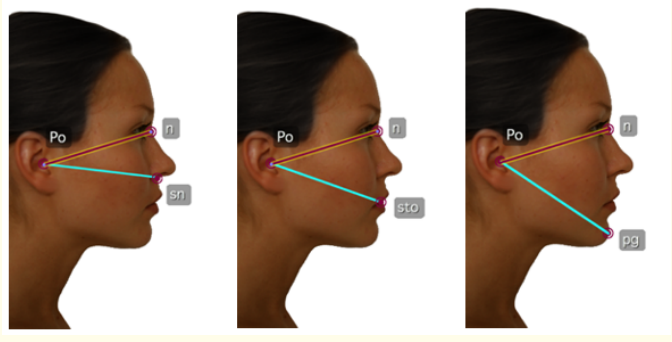

Figure 8: *Index parameters of the proportionality of the face in the profile.*

Parameter designation	Parameter description
n – sn- pg	The angle of the face profile
Po/n/sn	The angle that characterizes the position of the point sn in relation to the reference line
Po/n/sm	The angle that characterizes the position of the point sm in relation to the reference line
Po/n/pg	The angle that characterizes the position of the anterior point of the chin in relation to the reference line
ta-tp/sn-n	The angle of inclination of the tangent of the pharyngeal part drawn through the points ta-tp to the vertical line of the face

Table 7: *Angular parameters of the proportionality of the face in the profile.*

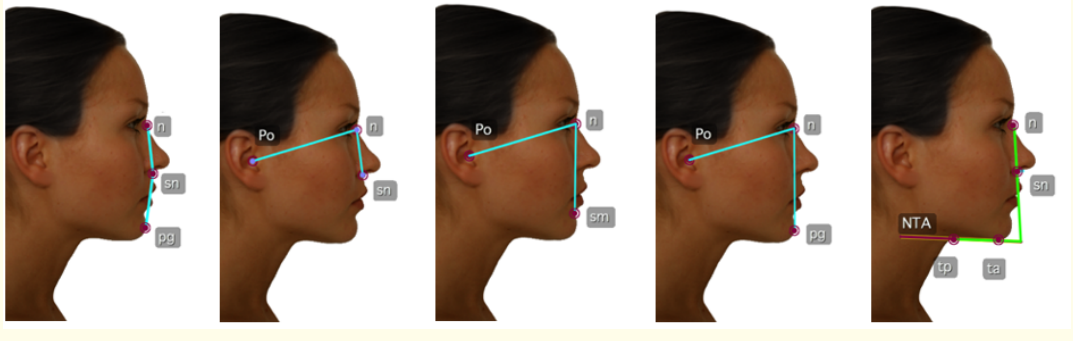

Figure 9: *Angular parameters of the proportionality of the face in profile.*

Parameter Designation	Parameter Description
Po-n	Reference line
Po-sn	Length vector line length Po-sn
Po-sto	Vector line length Po-sto
Po-sm	Vector line length Po-sm
Po-pg	Vector line length Po-pg

Table 8: *Linear parameters of the proportionality of the face in the profile from Po.*

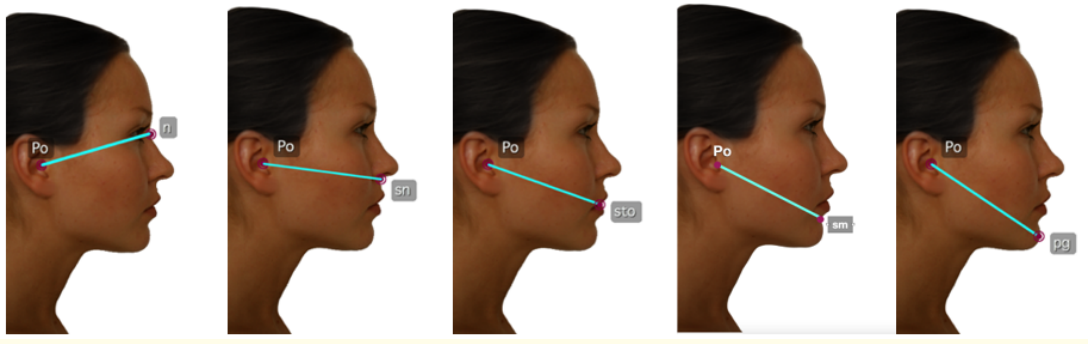

Figure 10: *Linear parameters of the proportionality of the face in the profile from Po.*
PL: Perpendicular to Po-n. L – (plotted point) - intersection of Po-or and PL. PLV-Perpendicular to po-or.

Parameter Designation	Parameter Description
PLV-sn	Distance from off-face PLV to sn
PLV-sto	Distance from off-face PLV to sto
PLV-pg	Distance from off-face PLV to pg

Table 9: *Linear parameters of the proportionality of the face in profile from PLV.*

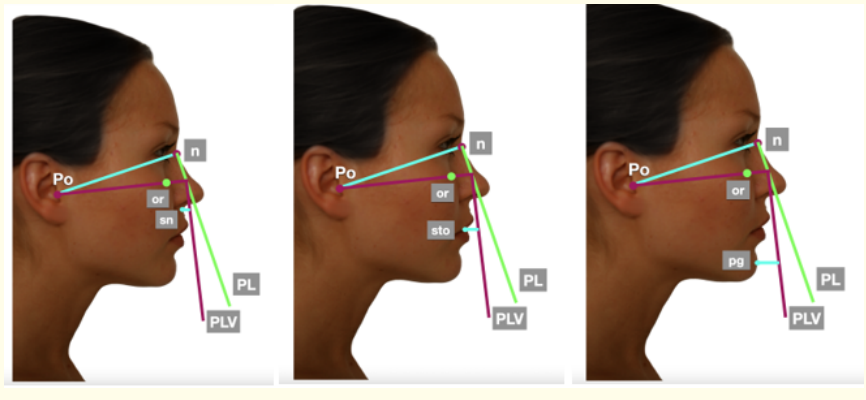

Figure 11: *Linear parameters of the proportionality of the face in profile from PLV.*

Parameters used for photometric analysis of the face

Po(l)-Po(r)/Po-n - the ratio of the width of the head to the reference line Po-n.

Created a graph of the evaluation scale within 100% on three planes: sagittal, transversal, vertical. The graph allows you to visually analyze the data obtained and determine the % deviation of the parameters in comparison with the norm (Figure 12).

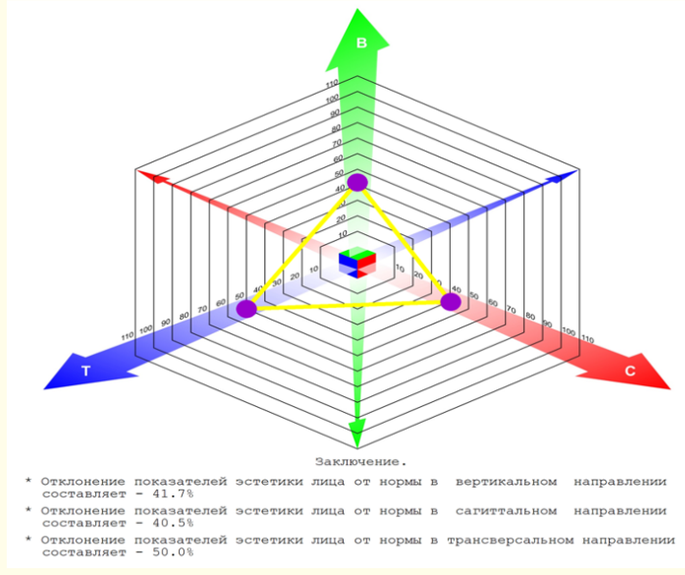

Figure 12: *The interface of the computer version. Graph of the is rating scale.*

We have developed a protocol that presents the parameters of the proportionality of the face in the form of absolute values (Figure 13). Indicators of morphometric parameters in individuals with normal occlusion are highlighted in yellow in the protocol.

Плоскость	Параметр	N	1	откл.%	P
T	Po(L)-Po(R)/Po-n	1.44±0.04	1.422	-	норма
	фас				
B	n–gn/n–sn	2.15±0.06	2.394	11.333	***
B	n–sn/sn–gn	0.75±0.02	0.717	4.352	*
B	sn-sto/sto-gn	0.46±0.01	0.617	34.167	***
T	/_ n-sn/st-st	91.3±2.7	91.089	-	норма
T	/_ sn-n-gn	0.1±0.01	1.137	>60.0	***
	профиль				
B	/_ n/sn/pg	176.8±5.3	171.267	3.130	*
C	/_ Po/n/sn	79.0±2.4	81.598	3.289	*
C	/_ Po/n/sm	70.5±2.1	73.465	4.206	*
C	/_ Po/n/pg	72.7±2.2	76.464	5.177	*
C	ta-tp/sn-n	89.4±2.7	85.527	4.332	*
C	Po-n/Po-sn	1.06±0.03	0.991	6.554	**
C	Po-n/Po-sto	1.03±0.03	0.960	6.778	**
C	Po-n/Po-pg	0.80±0.02	0.873	9.082	***
	Линейные параметры (фас)				
T	Po(L)-Po(R)	136.8±4.1	127.603	6.723	**
B	n–gn	126.2±3.8	109.806	12.991	***
B	n–sn	58.8±1.8	45.874	21.984	***
B	sn–gn	67.4±0.2	63.948	5.122	*
B	sn–sto	22.1±0.8	24.423	10.512	***
	Линейные параметры (профиль)				
C	Po–n	94.7±2.8	89.719	5.259	*
C	Po–sn	89.6±2.7	90.577	-	норма
C	Po–sto	92.0±2.8	93.440	-	норма
C	Po–pg	118.4±3.5	102.812	13.165	***
C	PLV–sn	-11.1±0.5	-2.211	>60.0	***
C	PLV–sto	-3.7±0.2	-6.080	>60.0	***
C	PLV–pg	-8.2±0.4	-10.493	27.966	***

Figure 13: *The interface of the computer version. Protocol of photometric examination of the face.*

Conclusion

1. The indices of linear and angular parameters of the soft tissues of the face are most informative and convenient for practical use when using the Po-n reference line.

2. A computer version of the analysis of the revealed proportions of the soft tissues of the face has been developed.

3. Digitalization of the developed method reduces time and material costs in comparison with the analog (manual) implementation. Working with the software module helps to streamline the working time of an orthodontist.

4. Determination of the values of proportionality of the facial proportions of volunteers with normal occlusion allows us to qualitatively improve the subsequent diagnosis.

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