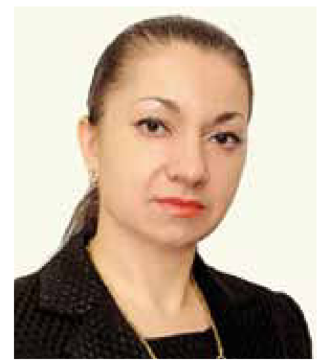
EFFICIENCY EVALUATION FOR INTEGRATED APPROACH TO CHOICE OF ORTHODONTIC AND PROSTHETIC TREATMENTS IN PATIENTS WITH REDUCED GNATHIC REGION

D.A. Domenyuk[1], E.G. Vedeshina, S.V. Dmitrienko[2],

[1] *Department of General Practice Dentistry and Pediatric Dentistry, Stavropol State Medical University, Stavropol, Russia*
[2] *Department of Dentistry, Pyatigorsk Medical-Pharmaceutical Institute (Branch of Volgograd State Medical University, Pyatigorsk, Russia*

domenyukda@mail.ru
s.v.dmitrienko@pmedpharm.ru

Dmitry Domenyuk, *Doctor of Medicine, Associate Professor*



Ernessa Vedeshina, *Candidate of Medical Science, Junior Lecturer*

Sergey Dmitrienko *Doctor of Medicine, Professor, Head of Department*

ABSTRACT — The results of morphometric, photostatic, teleradiographyc research together with an analysis of tomograms of temporo-mandibular joints as well as studies of the functional status in the dentofacial region stand proof that there is a reason for employing an integrated approach to treating patients with dentition defects in the lateral segments presenting cases of reduced gnathic region. The efficacy of orthodontic and prosthetic treatment can be seen from the outcomes obtained so far — normalization of the teeth position and dentition on the whole, restoration of the gnathic region's height, recovered chewing function and aesthetic features.

KEYWORDS — gnathic region, orthodontic treatment, prosthetic treatment, teleradiography, tomography, electromyography.

The recent years have witnessed a special emphasis placed on comprehensive treatment offered to adult patients suffering from reduced gnathic region; this is due to high prevalence and, therefore, a high need for specialized treatment [14]. Until recently, the orthodontic treatment for adults was not much common; however, according to W. Proffit (2012) nowadays adults account for around 15% out of the entire body of orthodontic patients, while there is also a growing respective trend among those over 40 [12].

In their scientific endeavor dentists are guided by individual variability in the dentofacial region. It stands a proven fact that one of the indicators for evaluating self-regulation in the dentofacial system is the morphometric parameters matching the size of the teeth to the dental arches. Therefore, prior to performing prosthodontic and orthodontic treatments on patients with dentition pathology it is advisable to employ biometric methods in order to determine and personalize the topographical features of anatomical structures in the dentofacial region [2,4,6,7].

A factor of paramount importance that has its impact on the position of the teeth in the row is the right match between the size of permanent teeth and the dental arches' parameters. Cases of discrepancy here may result in crowded teeth or interdental spacings. The issue of interdependence between the teeth size and the parameters of the dental arches, jaw bones, and the craniofacial complex as a whole has become of specific relevance lately due to the advances in orthodontic treatments for patients with dentition pathology [1,3,13].

The introduction of newer nonremovable orthodontic appliances has expanded significantly the treatment options when dealing with dentofacial anomalies. Such appliances can be effectively used to bring back to normal the shape and dimensions of dentition, to correct the growth and development of the apical bases in the jaws and jaw bones, to reach a stable myodynamic equilibrium, as well as for reasons of aesthetical and functional improvement in the dentofacial system [9,10,11].

Nevertheless, despite all the improved methods of diagnostics and a significant increase in the number of treatment strategies one cannot but admit that there are still numerous issues related to orthodontic and prosthodontic treatment of adult patients that remain unresolved and rather questionable [5,8].

There is still a need for investigation into functional disorders in the dentofacial region under this pathology. Experts also stick to different opinions when it comes to the option of integrated treatment for this group of patients – some propose surgical and prosthodontic intervention; others, however, believe that in order to ensure a comprehensive chewing function as well as to meet the patient's aesthetic requirements prosthetic repair should be preceded with an orthodontic treatment. There is no common understanding as to the methods and terms of orthodontic treatment for cases of different forms of reduced gnathic region, the construction of temporary and permanent prosthetic devices, as well as the manufacturing materials to be used. There are no clear recommendations for the comprehensive treatment of patients with various forms of reduced gnathic regions. In case these issues are resolved it could improve integrated (orthodontic and prosthodontic) treatment for this pathology.

Purpose – producing a rationale for an integrated approach to treating patients with dentition defects in the lateral segments and with reduced gnathic region.

Integrated orthodontic and prosthodontic (prosthetic) treatment was performed in 111 patients (46 men and 67 women) who developed dentoalveolar gnathic reduction due to the loss of their posterior teeth. The pathology in question was associated with abnormal occlusion in the sagittal, transversal and vertical directions and increased teeth abrasion, which was proven by the anamnesis data and the results of clinical and laboratory research.

The main objective of the comprehensive treatment here was to improve the position of the jaws, which was evaluated based on the results from photostatic, teleradiographyc examinations as well as an analysis of tomograms in the temporo-mandibular joints, and following the functional status of the dentofacial region.

The outcomes of the morphometric study revealed improved morphological parameters of the face upon completion of the comprehensive treatment (Table 1).

The outcomes showed that the parameters like zy-zy, gl-n, gn-me, and the height of the nasomaxillary complex (n-inc) virtually underwent no change. As a rule, changes in the gnathic region occurred between the points of inc-spm and inc-me, which increased the height of the gnathic part of the face also improving the morphometric face height.

The improved facial profile was noted not only through a visual-rank evaluation but also in a photostatic study. A lateral teleradiography showed no change in the position of the maxilla during the comprehensive treatment while it also was within the respective age norm; however, at the same time the mandibula moved in sagittal direction, which led to a change and, that is to say, normalization in the ANB angle. The gonial angle remained within the range of 119–123 degrees (just like prior to the treatment); the gnathic angle, however, (between the mandibular flat and the spinal flat) went up to 23–27 degrees thus increasing the height of the lower part of the face and normalizing the aesthetic profile (Fig. 1).

The study outcomes demonstrated that such comprehensive treatment resulted in changed key teleradiographyc parameters. Table 2 offers a view on the teleradiographyc data.

The outcomes show a significantly reduced ANB angle, and after the comprehensive treatment was completed its indicators went normal. The treatment resulted in normalization of the interincisal angle, which measured within 134–138 degrees.

The mandibular angle virtually suffered no change; yet at mandibular protrusion and restored occlusal relationships the gonial angle (between the mandibular flat and the spinal flat) was within the age norm (24–30 degrees).

Using an X-ray examination of the temporomandibular joints in most cases we identified, prior to the treatment, disturbed topographic relations of the joint's elements. The joint heads of the mandibula were displaced distally up; there was a widening of the joint space in the anterior part, and its narrowing in the posterosuperior part. One of the major stages of the orthodontic treatment for these patients was gradual dosed mesial movement of the lower jaw aiming at normalizing position (Fig. 2).

The main criterion for measuring the sagittal mandibular shift in each case was the position of the mandibular head in the glenoid cavity; we were seeking its position at the base of the articular tubercle, which we pursued through tomograms of the temporo-mandibular joints. In the cases where after a mesial shift the mandibular head was situated at the top of the articular tubercle or was found on the lower half of the rear slope of the tubercle we performed some correction of the orthodontic appliances in order to reduce the amplitude of the sagittal mandibular shift to permissible limits (Fig. 3).

Table 1. *Face measurements in patients*

Morphometric parameters	Facial dimensions (mm) in humans	
	Before treatment	After treatment
n-me (face height)	108.5 ± 3.13	112.96 ± 2.26
gl-me	118.88 ± 3.29	123.34 ± 2.34
n-inc (height of the nasomaxillary complex)	73.57 ± 2.52	74.45 ± 2.24
sn-inc (height of the dentoalveolar part of the maxilla)	18.39 ± 2.17	19.27 ± 1.62
n-sn	55.18 ± 3.39	55.18 ± 3.39
sn-gn	47.30 ± 2.06	51.76 ± 1.59
inc-me (height of the mandibula)	34.93 ± 2.32	38.51 ± 1.87
sn-spm (intergnathic height)	31.35 ± 3.45	37.41 ± 2.14
gn-me	6.02 ± 1.19	6.02 ± 1.19
Inc-spm (height of the dentoalveolar part of the mandibula)	12.96 ± 1.89	18.14 ± 1.27
gl-n	10.38 ± 2.62	10.38 ± 2.62
zy-zy	135.57 ± 6.79	135.57 ± 6.79

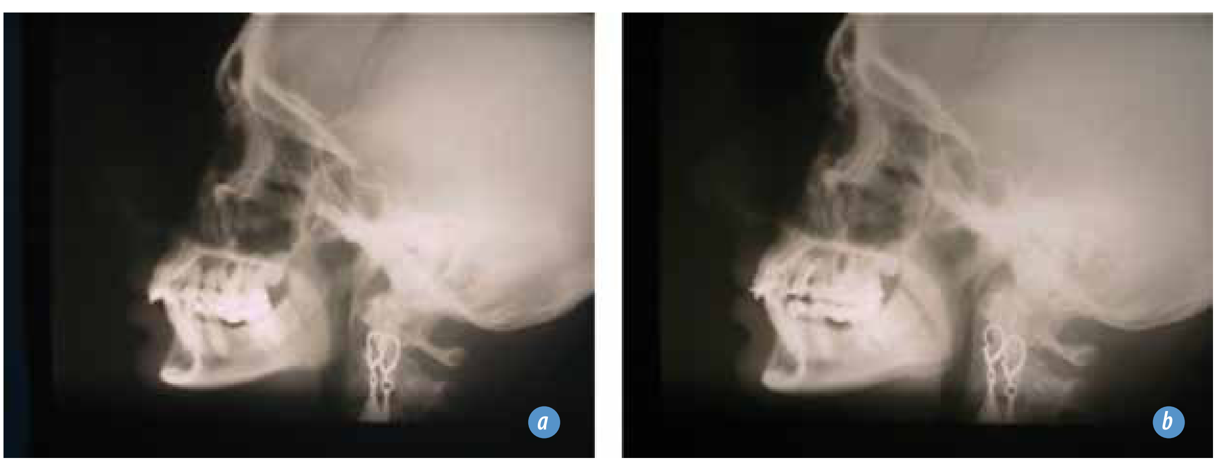


Fig. 1. *Lateral teleradiography, patient S., 44 yrs old, prior (a) and into the treatment (b)*

Table 3 contains the major tomography results.

Once the treatment was complete and there was an increase in the height of the gnathic part of the face (by 4.43 mm) there was also a forward shift of the mandibular head (D1) by 0.5 mm and a reduction in the distance of D2 by 0.2 mm, D3 by 0.1 mm, and widening of the joint space in the posterior part (D4) by 0.5 mm.

The efficacy of orthodontic treatment in the group under investigation was also identified based on the improved position of the teeth roots, which had a significant impact on the occlusal relationship between the dental arches of the upper and lower jaws. The number of occlusal contacts after the comprehensive treatment almost doubled.

Such comprehensive treatment led to improved shape and sizes of the dental arches as well as restored occlusal relationship (Fig. 4).

While studying the indicators of the patients' chewing efficiency we could conclude that the true indicators of the significant improvement in the chewing efficiency and reduced chewing time were due to the period of complete adjustment (4–6 months after only) to the temporary prostheses through the stages of orthodontic treatment, and were related to the normalization of the mandibular position. Until

Table 2. Major teleradiographyc parameters in patients

Major teleradiographyc parameters	Outcomes	
	Before treatment	After treatment
Facial angle ANSe	85.6 ± 1.1	85.1 ± 1.8
ANB	6.7 ± 0.9	1.9 ± 0.7
Gnathic angle	21.6 ± 2.4	26.8 ± 3.1
Gonial angle	120.6 ± 1.3	120.8 ± 1.5
Interincisal angle	152.6 ± 4.8	136.4 ± 3.2
Facial convexity angle (n-ss-spm), deg.	171.7 ± 4.35	168.9 ± 4.24
Height at skeletal points (sna' – me'), mm	66.76 ± 5.58	70.96 ± 4.68
Height at skin points (sn'-Kme'), mm	71.5 ± 6.8	75.4 ± 6.45
Position of mandibular angle, vertically (go-x), mm	67.7 ± 7.8	68.5 ± 7.3
Position of mandibular angle, sagittally (go-y), mm	1.76 ± 0.15	2.70 ± 0.33
Position of mandibular head, vertically (co-x), mm	9.7 ± 2.1	10.1 ± 2.1
Position of mandibular head, sagittally (co-y), mm	16.1 ± 3.4	16.2 ± 3.7

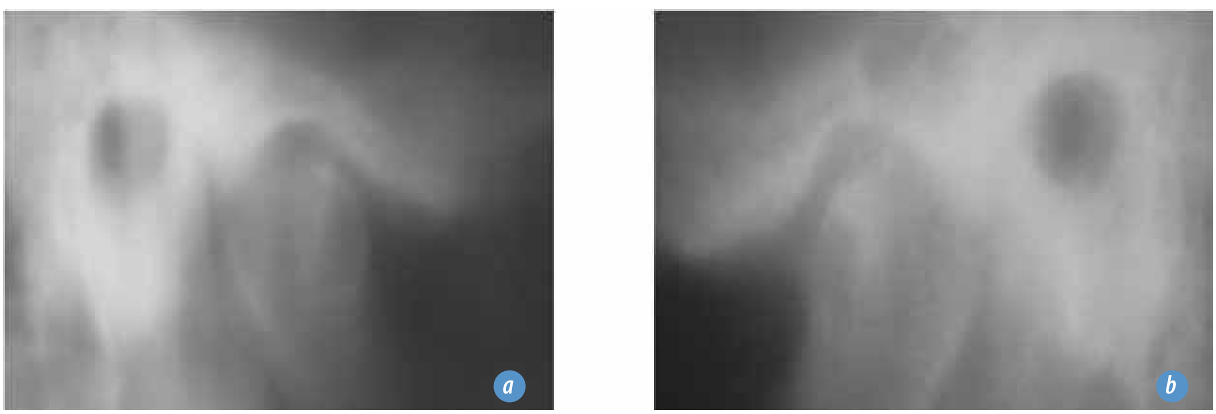


***Fig. 2.** Position of elements in temporo-mandibular joints; patient S., age – 44; right (a) and left (b) before treatment*

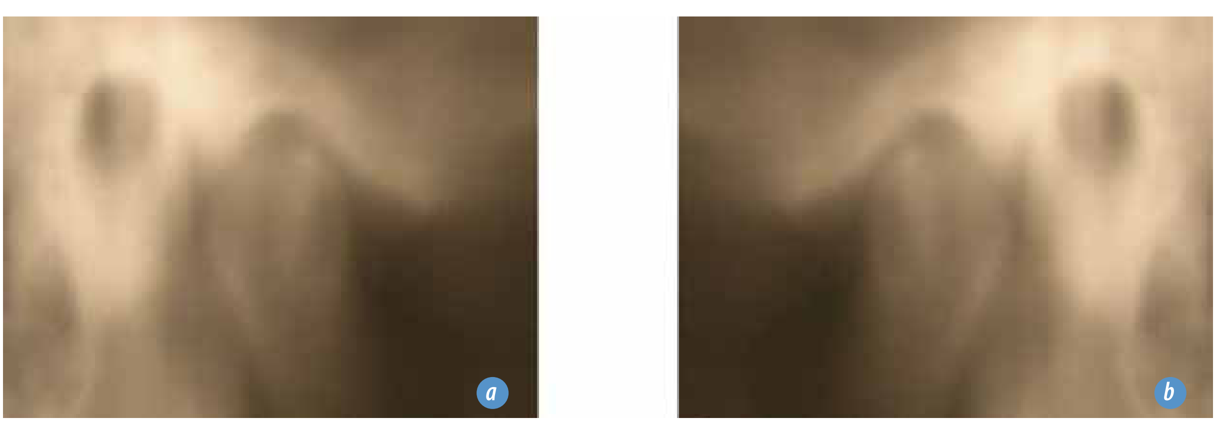


***Fig. 3.** Position of elements in temporo-mandibular joints; patient S., age –44; right (a) and left (b) after treatment*

Table 3. Major tomogram data for temporo-mandibular joints

Major tomogram data for temporo-mandibular joint (TMJ)	Outcomes	
	Before treatment	After treatment
Pm/Pr, deg.	123.9 ± 4.98	123.9 ± 4.98
A-B, mm	18.25 ± 1.5	18.25 ± 1.5
D1, mm	2.65 ± 0.7	2.15 ± 0.6
D2, mm	3.3 ± 0.7	3.1 ± 0.8
D3, mm	3.65 ± 0.9	3.55 ± 0.6
D4, mm	2.4 ± 0.7	2.9 ± 0.9
D, mm	9.9 ± 1.0	9.85 ± 1.0
a, deg.	47.9 ± 4.2	47.9 ± 4.2

Fig. 4. Patient, before (a), into (b) and after (c) treatment

that point the indicators were rather controversial and unreliable, which could be accounted for by the specificity of adult patients' dentofacial region adjustment to the new position of the mandible.

Table 4 offers a view on the results of studying the temporal muscles tone (g) in the patients of Group 1, Subgroup1.

The results suggest that the temporal muscles resting tone at the normalized height of the gnathic part of the face and the adjustment to the prosthetic appliances was significantly decreased both in males and females. The tension tone was significantly increased in both sexes. The temporal muscles tone indicators approached the thresholds obtained from people with physiological occlusion, which served proof of the comprehensive treatment efficiency.

To see the results of studying the masseter muscles tone (g), please refer to Table 5 below.

The study showed that after the comprehensive treatment and normalized height of the gnathic part of the face the masseter muscles tone approached the threshold indicators for the normal tone, which demonstrated the efficiency of the treatment. The tone of the masseter muscles in males was significantly higher than that of females.

The spontaneous activity in the resting phase in masseter muscles was identified in 38.4% ± 5.7% of the patients prior to the treatment and in 30.8% ± 7.4% of them after the treatment.

The functional activity of the masseter muscles when chewing and highest possible compression of the jaws was 49.2 ± 2.8% below the norm before the treatment while after the treatment this share was 63.4 ± 2.8%.

The functional activity of the temporal muscles when chewing and highest possible compression of the jaws was 65.2% ± 34.8% lower than the normal index before the treatment; after the treatment, however, this index was 71.8% ± 3.3%.

The quantitative factors could be described with an increase in the average time of one dynamic cycle (DC) of up to 0.85–0.90 sec. The temporal parameters of electromyograms (EMG) can be seen in Table 6.

The outcomes obtained from this study show that the bioelectric activity of the jaw muscles significantly increased in both sexes. The bioelectric activity phase (BEA) in the temporal muscle before the treatment in the males was 0.28 ± 0.04 sec., and after the treatment it was 0.35 ± 0.02 sec. The time of bioelectric rest (BER) in the temporal muscles in the males went up (0.25 ± 0.05 sec. to 0.41 ± 0.03 sec.), due to which the ratio of excitation and inhibition (K coefficient) went down from 1.12 ± 0.08 to 0.85 ± 0.05. There was a significant decrease in the number of the dynamic cycles

Table 4. *Temporal muscles tone*

	Temporal muscle tone indicator			
	Before treatment		After treatment	
	Males	Females	Males	Females
Resting tone (Rt)	65.9 ± 3.3	53.2 ± 2.6	54.3 ± 2.9	45.1 ± 2.2
Tension tone (Tt)	158.1 ± 4.2	133.9 ± 5.3	169.3 ± 3.8	152.2 ± 3.2

Table 5. *Tone of the masseter muscles*

Tone status	Masseter muscles tone indicators			
	Before treatment		After treatment	
	Males	Females	Males	Females
Resting tone (Rt)	63.6 ± 3.7	55.1 ± 2.9	53.9 ± 3.1	44.9 ± 2.5
Tension tone (Tt)	160.7 ± 4.8	140.5 ± 5.6	172.9 ± 4.1	157.5 ± 4.6

Table 6. *Temporal parameters of electromyograms (patients, 6 m after treatment)*

EMG parameters	Temporal indices for muscle EMG			
	Temporal muscle		Masseter muscle	
	Males	Females	Males	Females
BEA	0.35 ± 0.02	0.37 ± 0.07	0.38 ± 0.03	0.41 ± 0.03
BER	0.41 ± 0.03	0.42 ± 0.05	0.40 ± 0.02	0.39 ± 0.02
K	0.85 ± 0.05	0.88 ± 0.09	0.95 ± 0.09	1.05 ± 0.08
DC	0.79 ± 0.19	0.81 ± 0.06	0.75 ± 0.03	0.84 ± 0.03
DC No	18.1 ± 2.6	19.6 ± 1.12	18.2 ± 1.5	18.9 ± 1.5
FPM	14.1 ± 1.1	15.8 ± 1.1	13.9 ± 1.6	15.4 ± 1.6

(22.8 ± 1.11 to 18.1 ± 2.6) as well as in the time of the full period of mastication (FPM) – from 17.6 ± 1.9 to 14.1 ± 1.1 sec. A similar situation was observed in the females where the ratio of excitation and inhibition (K coefficient) went down from 1.33 ± 0.09 to 0.88 ± 0.09. A significant decrease was to be seen in the number of the dynamic cycles (23.4 ± 1.13 to 19.6 ± 1.12) and in the time of the full period of mastication (FPM) – from 18.7 ± 1.3 to 15.8 ± 1.1 sec.

There was also a change in the parameters of electromyograms in the masseter muscles (both the females and the males). The bioelectric activity phase (BEA) of the masseter muscle in the males was 0.33 ± 0.02 sec. prior to the treatment, while afterwards it was 0.38 ± 0.03 sec. The time of bioelectric rest (BER) in the masseter muscles in the males went up from 0.26 ± 0.03 sec. to 0.40 ± 0.02 sec., due to which the ratio of excitation and inhibition (K coefficient) reduced (1.27 ± 0.05 to 0.95 ± 0.09). There was a significant drop in the number of the dynamic cycles (21.7 ± 2.8 to 18.2 ± 1.5) as well as in the time of the full period of mastication (FPM) – from 16.9 ± 1.3 to 13.9 ± 1.6 sec. This was also the case with the female population where the ratio of excitation and inhibition (K coefficient) went down from 1.24 ± 0.09 to 0.84 ± 0.03. The number of the dynamic cycles reduced significantly as well as the time of the full period of mastication (FPM) — from 17.5 ± 1.7 to 15.4 ± 1.6 sec.

CONCLUSION

Comprehensive orthodontic and prosthetic treatment for patients with dentition defects in the lateral segments with a reduced gnathic region yields favorable results — normalization of the teeth position and dentition on the whole, restoration of the gnathic region's height, recovered chewing function and aesthetic characteristics.

REFERENCES

1. **Alexander R.G.** A Practical Approach to Arch Form. // Clinical Impressions. – 1992. – № 3. Vol. 2 – P. 34–38.
2. **Brader A.C.** Dental arch form related to intra-oral forces // American Journal of Orthodontics. – 1972. – № 61. – P. 541–561.
3. **Chuck G.C.** Ideal arch form. Angle Orthodontist. – 1932. – 116. – P. 1–12.
4. **Domenyuk, D.A.** Clinical anatomy of teeth and dentofacial segments / D.A. Domenyuk, E.G. Vedeshina, S.V. Dmitrienko. – Stavropol: Publishing House of Stavropol State Medical University, 2015. – 210 p.
5. **Domenyuk, D.A.** Evaluation of correlations between the electrolyte composition and local immunity indices of the mixed saliva in patients with anomalies in the dentofacial system (Part I) / D.A. Domenyuk // Institute of Stomatology. – 2014. – № 2 (63) – P. 66–68.
6. **Domenyuk, D.A.** Interrelation between sagittal and transversal sizes in form variations of maxillary dental arches / D.A. Domenyuk, S.V. Dmitrienko // Archiv euromedica, 2014. – Vol. 4. – № 2. – P. 10–13.
7. **Domenyuk, D.A.** Modern classification of dental arches / D.A. Domenyuk, S.V. Dmitrienko // Archiv euromedica, 2014. – Vol. 4. – № 2. – P. 14–16.
8. **Domenyuk, D.A.** Molecular genetic method in identifying the intensity of morphological and functional changes in patients with dentition pathology (Part I) / D.A. Domenyuk, B.N. Davydov, A.G. Karslieva // Institute of Stomatology. – 2014. – № 3 (64) – P. 78–80.
9. **Felton J.M., Sinclair P.M., Jones D.L., Alexander R.G.** Computerized Analysis of the Shape and Stability of Mandibular Arch form.// American Journal of Orthodontics. – 1987. – № 92. – P. 478–483.
10. **Hawley C.A.** Determination of the normal arch and its application to orthodontia // Dental Cosmos. – 1905. – № 47. – P. 541–552.
11. **McLaughlin, R., Bennett, J., Trevisi, H.** Systemized Orthodontic Treatment Mechanics. Translated from Eng. – Lvov: GalDent, 2005. – 324 p. – 950 fig.
12. Relationship between occlusal findings and orofacial myofunctional status in primary and mixed dentition. Prevalence of orofacial dysfunctions / F. Stahl, R. Gradowski, M.Gaebel, G. Kundt // J. Orofac. Orthop. – 2007. – № 68 (2). – P/ 74–90.
13. **Scott J.H.** The shape of dental arches // Journal of Dental Reseach. – 1957. – № 36. – P. 996–1003.
14. **Tugarin V.A., Persin L.S., Porokhin A.Yu.** Modern fixed-type orthodontic appliances Edgewise. – M., 1996. – 220 p.