http://dx.doi.org/10.35630/2199-885X/2020/10/4.42

MODIFICATION OF THE DENTAL ARCH SHAPE USING GRAPHIC REPRODUCTION METHOD AND ITS CLINICAL EFFECTIVENESS IN PATIENTS WITH OCCLUSION ANOMALIES

Received 29 September 2020; Received in revised form 21 October 2020; Accepted 27 October 2020

Oleg Ivanyuta[1], Ghamdan Al-Harazi[2], Dmitry Domenyuk[1], Sergey Dmitrienko[3], Stanislav Domenyuk[4], Sergey Ivanyuta[1], Dmitry Kuleshov[4]

[1] Department of General Practice and Pediatric Dentistry, Stavropol State Medical University, Stavropol, Russia;
[2] Department of Orthodontic, Pedodontic and Preventive Dentistry, Faculty of Dentistry, Sana'a University, Yemen;
[3] Department of Dentistry, Volgograd State Medical University Volgograd,
[4] North Caucasus Federal University, Stavropol, Russia

domenyukda@mail.ru

ABSTRACT — Based on the results of the dentoalveolar system morphometry performed in patients with permanent teeth physiological occlusion we have developed a method for studying the anterior dental arch. It follows the circle of geometry patterns as well as stable values in the medial-distal dimensions of the front teeth crowns. In view of the mesial-distal dimensions of 14 teeth and dental arch width between the second molars and individually built radius of the circle we modified the method of dental arches graphic reproduction. The first stage of the dental arch individual shape graphic reproduction implies designing a dental pentagon, whereas its base is the width of the dental arch between the second molars, and the median sagittal line determines the depth of the dental arch. The upper sides of the pentagon (incisor-canine diagonals) run from the central interincisal point to the canine point, while the lower sides (canine-molar diagonals) connect the canine points to the molar points. At the second stage of the dental arch individual shape graphic reproduction, a circle is outlined, whose radius is related directly to the width of the anterior dental arch, and has an inverse relationship with its depth. There is a proof offered for clinical feasibility of the method employed to predict the optimal individual shape of the dental arch through graphic reproduction in patients with class I Angel occlusion issues. The study showed that the effectiveness of therapeutic and diagnostic measures for patients with abnormal shape and size of dental arches. It can be achieved if the sequence of the graphic construction stages is strictly followed.

KEYWORDS — graphic reproduction of dental arches, individual shape of the dental arch, occlusion anomalies, odontometry, gnathic type of dental arch, dental type of dental arch.

INTRODUCTION

Solving the problems of modern orthodontics viewed as a complex dental discipline, is aimed not at correcting the teeth position, dentition and bite alone, yet also at creating conditions to ensure proper growth of the jaw bones, correcting the shape of the facial skull, improving the dental apparatus functions, and restoring the facial aesthetics [2, 6, 8, 12, 24, 28, 41, 46].

The traditional methods that allow in most cases achieving optimal outcomes in correcting dental anomalies and deformities at the early stages still maintain their clinical value. However, given the progress of medical technologies and knowledge, there have appeared a significant number of advanced methods and means of treatment, which allow carrying out high-level treatment, as well as taking preventive measures, working with patients who need orthodontic assistance [13, 21, 26, 32, 44, 47–51].

Optimal functioning of the dentoalveolar apparatus in case of an orthognathic bite, taken as a type of physiological bite, is achieved through the best aesthetic and morphological optimum, the highest indicators of the chewing function, favorable conditions for somatic swallowing, as well as a comprehensive tongue function. Well-developed signs of physiological occlusion, which are the result of the normal teeth position, the closing of the teeth-antagonist pairs (dental ridges), a well-shaped occlusal plane, with the coordination and control from the central nervous system, will ensure a balanced performance of the temporomandibular joint, the maxillofacial muscles, and the biomechanic features of the lower jaw movement [5, 16, 19, 29, 38, 40, 43].

One of the most urgent issues that orthodontists have to face currently, implies improving the diagnostics of dental anomalies, since this is important in terms of setting diagnoses, selecting the treatment tactics, and identifying the scope of the measures to be taken. No other dental discipline has the identification of an anomaly — and therefore the identification of the treatment aims — as significant as in orthodontics, so there is every reason for diagnostic research to be considered a key factor at the initial stages of orthodontic care [1, 4, 7, 14, 17, 23, 25, 39].

Specialists have proposed a large number of special examination methods (clinical, cephalometric, anthropometric, X-ray, functional), which, taken together, allow obtaining a fairly complete and objective picture of the dental system status, as well as assessing properly the morphofunctional changes that occur due to various types of anomalies in different age groups [3, 9–11, 15, 20, 22, 30, 33–36].

The construction of a dental arch employing a geometric and graphical method has stirred interest from researchers for many decades. The proposed graphic reproduction of the dental arch by Howley-Herber-Herbst method has already entered both academic and special literature, to turn into an attribute for diagnosing occlusion anomalies. Clinicians claim that the effectiveness of the dental arch graphical construction by the Howley-Herber-Herbst method has proven itself in cases where the width of the dental arches between the canines is twice the depth of the anterior dental arch [27, 31, 37, 42, 45].

There is special attention to be paid to the graphic construction of the dental arch, based on the circle geometry regularities. The arch radius is calculated based on the central angle value. The depth and the width of the anterior segment are to be calculated through the Huygens formula, where the length of the dental arch is taken as the sum of the width of the six front teeth crowns. This method allows calculating the dental arch latitudinal indicators in the canine area, the depth of the anterior segment in case of dental arches anomalies, taking into account odontometric values [18]. There has been a method developed for constructing an arch, where the circle diameter is viewed as a value equal to the difference between the width and the depth of the dental arch to the level of the canine location. This graphic design, however, applies to patients with permanent teeth physiological occlusion [52, 53].

Despite the numerous methods of dental arch graphic reproductions available nowadays, there is no data concerning the methods of constructing dental arches for occlusion anomalies, taking into account the individual features of the dental system, which is the rationale behind, and the purpose, of this study.

Aim of study:

to improve the dental arches graphic reproduction method in patients with occlusion anomalies taking into account individual specifics of the dental system.

MATERIALS AND METHODS

When dealing with patients featuring abnormal shape and size of the dental arches, measuring the linear parameters proves complicated due to the abnormal teeth location in the front and side parts. Modification of the dental arches graphic reproduction method is based on employing stable biometric indicators in the transversal direction along with an evaluation of the inter-canine transversal and the depth of the dental arch anterior part. The radius of the circle for the front teeth location was calculated following the formula below:

$$R = \frac{\left(\frac{W_{(c\text{-}c)}}{2}\right)^2 + \left(D_{(in\text{-}c')}\right)^2}{2 \cdot \left(D_{(in\text{-}c')}\right)}$$

where R is the circle radius; W(c-c) is the front arch width; D(in-c') is the anterior arch depth. The transversal measurements of the anterior part were performed using the Pont and Korkhaus methods, where the arch was divided into segments through the Pont points at the first premolars (Fig. 1).

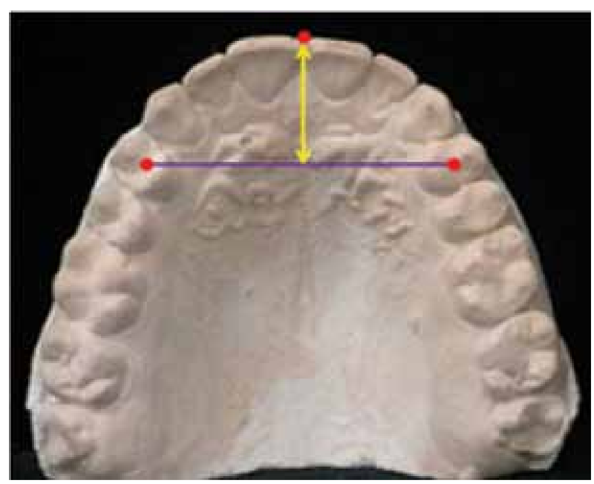


***Fig. 1.** Dental arch depth measurement*

The algorithm for constructing a graphic reproduction of the dental arch included the following calculation and diagnostic stages. First, a dental (incisor-canine-molar) pentagon was designed based on dental arches biometric indicators. On the dental arch, the location of the central incisal point was marked as *in* (*incisivus*); the canine points were marked with *c* (*caninus*), located on the canines tearing tubercles. The points located on the distal tubercles tops on the vestibular side of the permanent bite second molars were marked as *m* (*molares*). The canine and the molar points were connected with conventional lines that determined the transversal dimensions of the arches (inter-canine and intermolar distance). The middle of these lines was marked with *c'* and *m'*. From the *m'* point, a perpendicular was drawn, which ran through the *c'* and *in* points to divide the arch into symmetrical parts. In the sagittal direction, the depth of the dental arch anterior part was identified as the distance between the *in-c'* points. The depth of the complete dental arch corresponded to the *in-m'* (Fig. 2).

which, according to Bolton, falls within the normal value of the *anterior ratio* index (77.28%). The total value of the mesiodistal sizes for 12 teeth in the upper jaw was 97.56 mm; for the lower jaw — 89.06 mm; the overall ratio index (by Bolton) was 91.29%, which corresponds to the norm and indicates compliance with the odontometric indicators. The length of the maxillary dental arch was 117.06 mm, whereas the

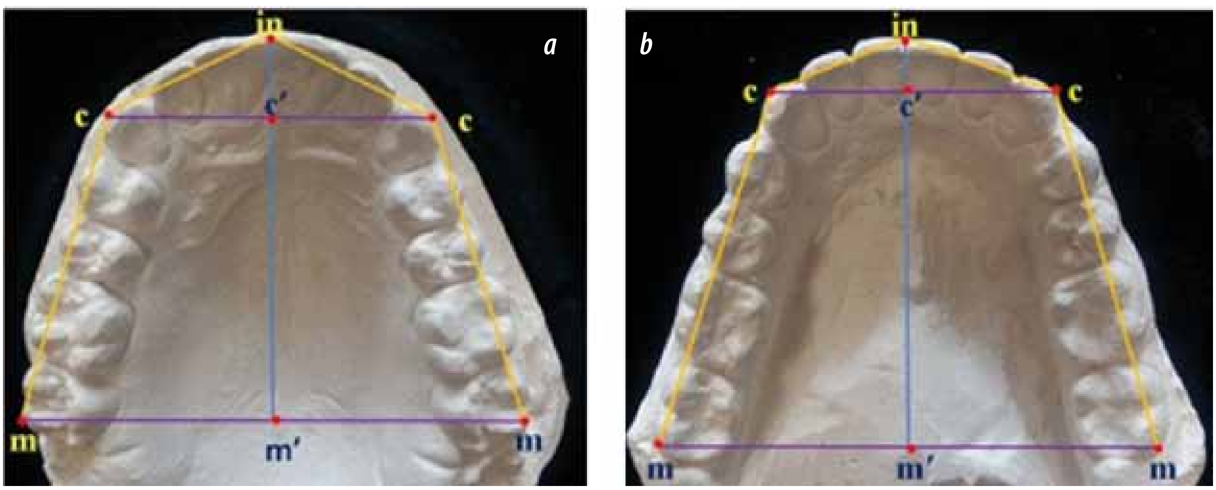
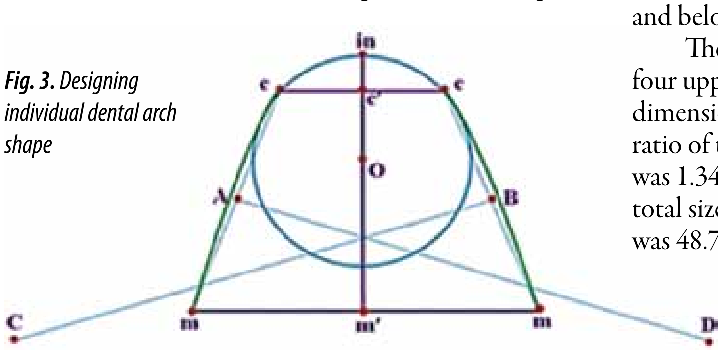


Fig. 2. *Reference points for designing a dental pentagon on the upper (a), lower (b) jaw*

At the second stage, the arch graphic reproduction was done. From the *in* point, the point *o* was drawn down along the vertical line, for a value equal to the calculated radius, and then a circle was outlined, which, in case of physiological occlusion, passes through the canine points. The middle of the side lines (*c-m*) was marked as the *A* and *B* points. Further, perpendicular lines were drawn from points *A* and *B*, with an intercrossing on the *in-m'* vertical at a value equal to the length of the dental arch (the sum of crowns width of 14 teeth). These lines were marked as *A-D* and *B-C*, respectively. From points *C* and *D*, the distance to the canine points (*c*) or to the molar points (*m*) of the opposite side was measured, while the specified value served as the dental arch lateral segment radius (Fig. 3).

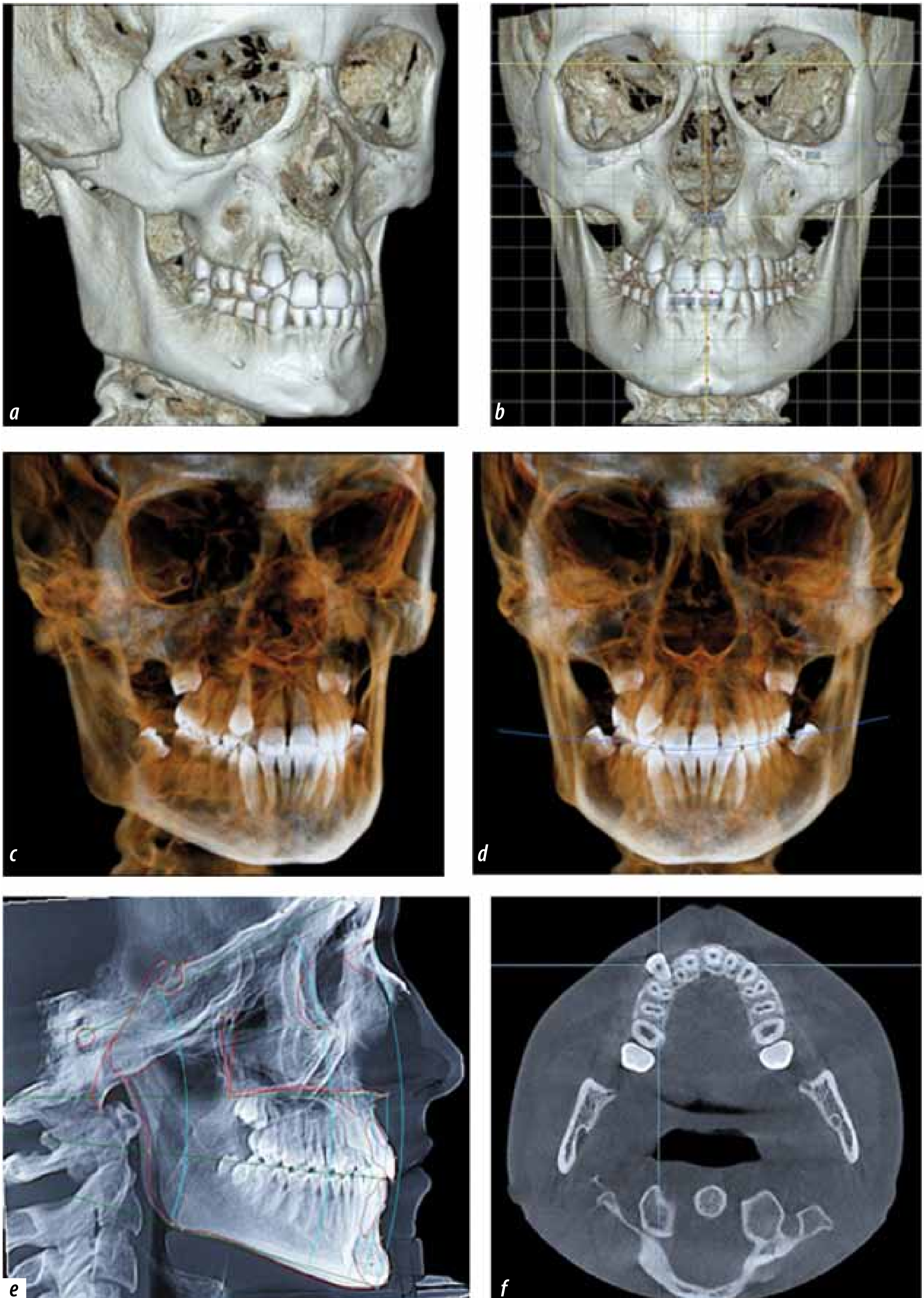
Fig. 3. *Designing individual dental arch shape*



The effectiveness of the method for constructing the dental arch individual shape can be illustrated with a clinical example. Patient K., 18 y.o., came to the clinic complaining about the front teeth wrong location. A visual examination showed relative symmetry of the face; the vertical proportions were within the age norm. In profile, the upper lip does not reach the Riccets E-line. When examining the oral cavity, the Angel class I occlusion anomaly was diagnosed; the first molars were in a neutral position on both sides; the upper canine on the right was beyond the dental arch (on the vestibular side), and occupied a supraposition due to a lack of space in the dentition (Fig. 4).

Measuring the teeth revealed that the upper teeth dimensions correspond to the antagonists parameters, and belong to normodontia (Table 1).

The sum of the mesial-distal dimensions of the four upper incisors was 32.56 mm, while the similar dimensions of the antagonist teeth were 24.2 mm. The ratio of the upper vs. lower teeth size (Tonn index) was 1.34, which pointed at their proportionality. The total size of incisors and canines on the maxillary arch was 48.76 mm; on the mandibular arch — 37.66 mm,


a
b
c
d
e
f

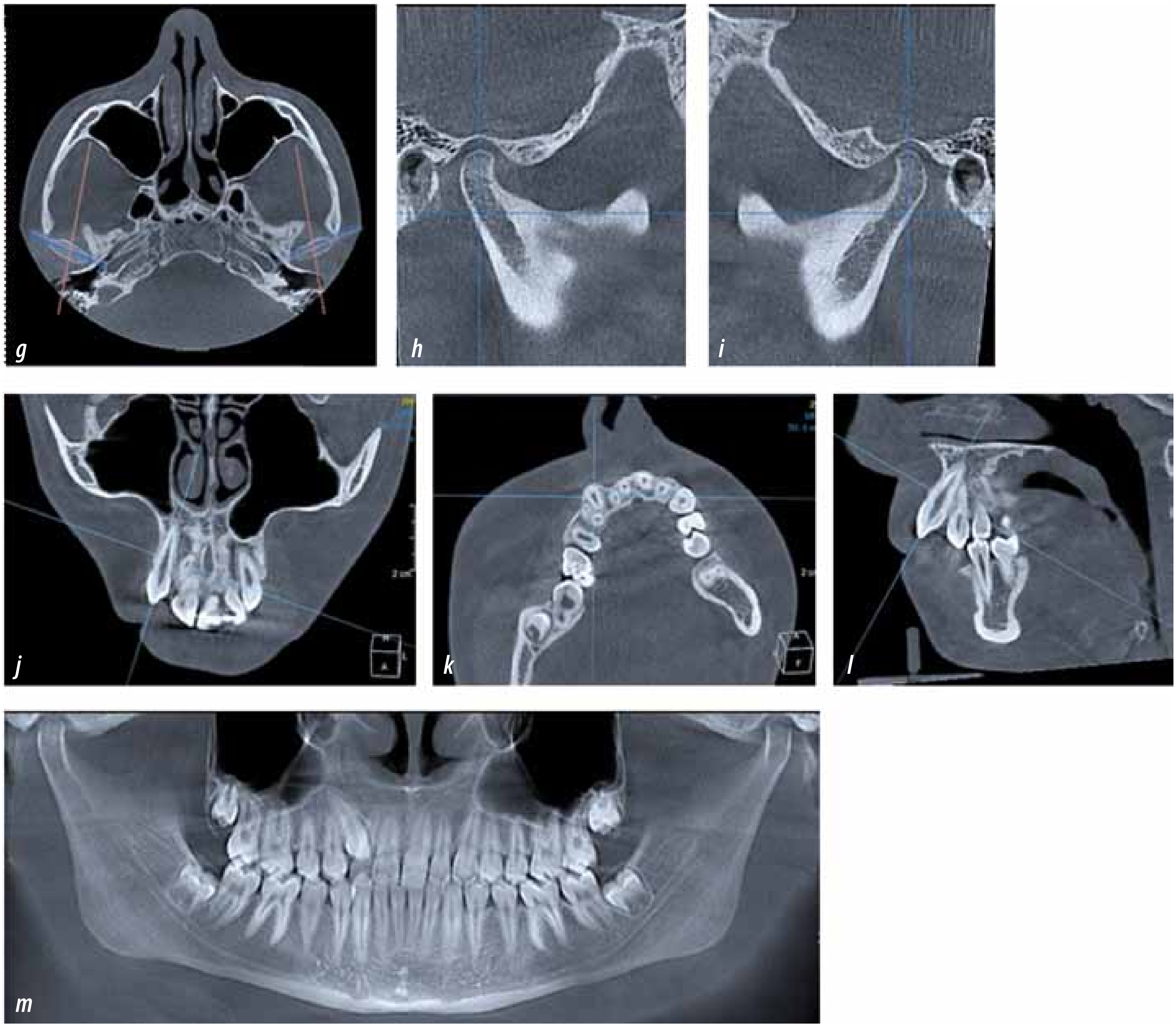


Fig. 4. *3D visualization in the "Bone" option and VR mode in the sagittal (a) and frontal (b) planes; 3D visualization in the "Teeth" option in the sagittal (c) and in the "Teeth 2" option in the frontal (d) planes; Decoding a teleroentgenogram using the Sassuoni method (e); Maxillary axial reformat (f); Temporomandibular joint in axial (g), sagittal right (h) and sagittal left (i) projections; Topography of the canine in the frontal (j), axial (k) and sagittal (l) planes; MIP image of panoramic construction of the jaw bones (m)*

Table 1. *Odontometry indicators, Patient K.*

Examined dentitions	Dimensions of teeth that have a certain position in the dentition						
	1	2	3	4	5	6	7
Upper jaw	9.04	7.24	8.1	7.4	6.72	10.28	9.75
Lower jaw	5.7	6.4	6.73	7.3	7.6	10.8	10.03

mandibular dental arch was 109.12 mm, this indicating a normodontia dental system.

Subject to the proposed algorithm, the width of the dental arches between the second molars (upper jaw — 58.6 mm, lower jaw — 53.21 mm) was measured. The value of the dental arch gnathic index (the length to width ratio) was as follows: on the upper jaw — 1.998 units, on the lower jaw — 2.051 units. The estimated parameters fall within the dolichognathic dental arch. A comparison of the gnathic and dental types allowed attributing the dental arches of both jaws to the protrusion type. In view of the types of arches and the proposed coefficients, the forecasted parameters of dental arches were calculated (Table 2).

***Table 2.** Forecasted parameters of dental arches (mm), Patient K.*

Examined parameters	Dimensional parameter on dental arch	
	Upper	Lower
Front segment arch length	40.66	30.93
Front segment arch diagonal	20.33	15.46
Front segment arch depth	10.16	6.49
Front segment arch width	35.21	28.07
Circle radius	20.33	18.41
Dental arch diagonal	55.22	50.52
Dental arch depth	46.80	42.94

The next stage implied the design of a dental diagnostic pentagon with a circle in order to evaluate the location of the front teeth as well as to compare the obtained graphic reproductions with the abnormal shape of the arch (Fig. 5).

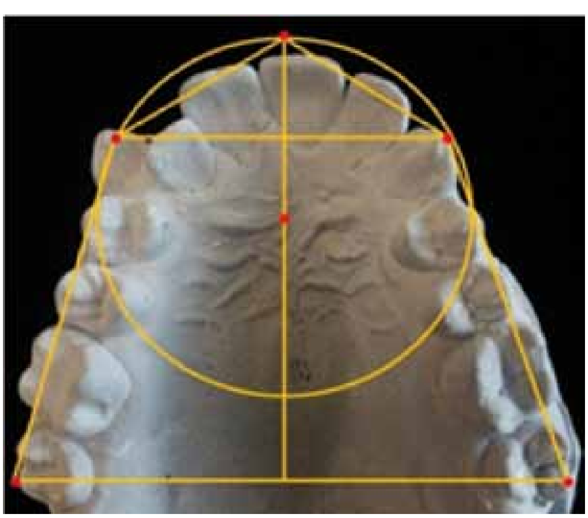


***Fig. 5.** Comparison of the upper jaw abnormal arch with the forecasted parameters*

The measuring of the parameters and comparing the abnormal arch with the graphic reproduction revealed a mismatch, which was most significant in the anterior segment. The diagonal of the anterior section on the right was 2.09 mm below the calculated values. The arch depth was shortened by 3.02 mm, while in the anterior part of the arch the mismatch was 3.11 mm. The inter-canine distance exceeded the calculated values by 1.84 mm, which was due to the vestibular position of the right canine. The diagonal of the right side of the arch was below the calculated values by 3.9 mm, and corresponded to the lack of space for the canine location, which determined the orthodontic treatment tactics using fixed equipment of mechanical effect. The sequence of changing the arches, braces installation on the lower jaw, and the retention period of treatment were performed following the Protocol for orthodontic patients. After the final stage of the treatment, the shape of the dental arches on both jaws matched the normal parameters and the calculated values as identified at the pathology diagnostics stage. The status of the occlusion, both in the lateral and anterior parts, matched the signs of physiological occlusion and the calculated type of dental arches (Fig. 6, 7).

Patient K's facial features basically revealed no change after the treatment of the dental arches abnormal shape. The smile features no buccal corridors, which makes the patient's face harmonious and aesthetic, as well as serves evidence to the treatment effectiveness (Fig. 8).

Given the above, employing the graphical research method at the stage of diagnostics and treatment working with patients featuring abnormal shape and size of dental arches, proves an effective tool, and is to be recommended for clinical orthodontics.

CONCLUSIONS

1. A comprehensive approach based on an objective analysis of the quantitative (morphometric) and qualitative (clinical, visual) features of the dental complex allows obtaining a complete image of the normal or pathological status in terms of the dentition and occlusion, as well as taking timely preventive or therapeutic measures in view of the clinical indications.

2. Setting a diagnosis in orthodontics clinical practice is based on scientific knowledge, taking into account the age-bound norm and the patient's dental system development patterns, as well as the body's potential for self-regulation, on the one hand, and on the other — on the ability to interpret clinical signs and morphological parameters. Based on the outcomes of clinical and morphological conclusions, indications for preventive or therapeutic measures are developed, with forecasts made concerning the effectiveness of

Fig. 6. *Occlusal relationship of dental arches after orthodontic treatment, Patient K*

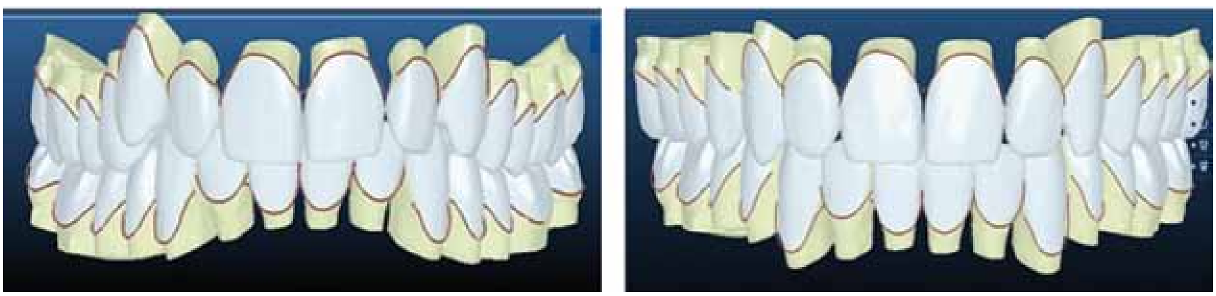


Fig. 7. *Virtual diagnostic Set–Up model in the ORAPIX 3Txer 2.5.0 file (Japan), patient K; prior to, and after the orthodontic treatment*

Fig. 8. *Facial signs, Patient K.; prior to, and after the orthodontic treatment*

treatment and the risk of developing the anomalies recurrence.

3. The effectiveness of therapeutic and diagnostic measures in patients with abnormal types of occlusal relationship has been proven through modifying the dental arches graphic reproduction method, taking into account individual dental features.

4. The first stage of graphic reproduction of the dental arch individual shape implies constructing a detailed pentagon whose base is the width of the dental

arch between the second molars, whereas the median sagittal line determines the dental arch depth. The upper sides of the pentagon (incisor-canine diagonals) run from the central inter-incisal point to the canine point, while the lower sides (canine-molar diagonals) connect the canine and the molar points. The second stage of graphic reproduction involves drawing a circle whose radius is to be calculated as the ratio of the sum of the square from half-width of the anterior part of the arch and the arch depth square to double-depth of the anterior part.

5. The study has proven clinical feasibility of the method to be employed for predicting the optimal individual dental arch shape through graphic reproduction in patients with Angel class I occlusion issues.

6. It has been illustrated that the effectiveness of therapeutic and diagnostic measures in patients with occlusion anomalies shall be achieved through following strictly to the sequence of dental arch graphic construction stages.

REFERENCES

1. **Avanisyan V., Al-Harazi G., Kondratyeva T., Harutyunyan Yu.** Morphology of facial skeleton in children with undifferentiated connective tissue dysplasia. Archiv EuroMedica. 2020. Vol. 10; 3: 130–141. https://dx.doi.org/10.35630/2199-885X/2020/10/3.32
2. **Bishara, S.E.** Textbook of Orthodontics. Mosby. – 2001. 592 p.
3. **Borodina V.V.** Biometry of permanent occlusion dental arches – comparison algorithm for real and design indicators. Archiv EuroMedica. 2018. Vol. 8. No 1. P. 25–26. DOI: 10.35630/2199-885X/2018/8/1/25
4. **Cevidanes L.** Comparison of two protocols for maxillary protraction: bone anchors versus face mask with rapid maxillary expansion. Angle Orthod. 2010;Vol. 80; 5: 799–806. DOI: 10.2319/111709-651.1
5. **Davydov B. N.** Applied significance of biometric diagnostics in planning dentistry treatment tactics. Medical alphabet.2020; (12):27–35. https://doi.org/10.33667/2078-5631-2020-12-27-35.
6. **Davydov B.N.** Anthropometric peculiarities of the maxillofacial region in children with congenital pathology in the period of the brew of the dairy teeth. Pediatric dentistry and prophylaxis. 2018; Vol. 17; 2 (65): 5–12. (In Russ.) DOI: 10.25636/PMP.3.2018.2.1.
7. **Davydov B.N. Kondratyeva T.A., Harutyunyan Yu.S.** Cephalometric features of connective tissue dysplasia manifestation in children and adolescents. Pediatric dentistry and dental profilaxis. 2020;20(3):174–183. (In Russ.) https://doi.org/10.33925/1683-3031-2020-20-3-174-183
8. **Davydov B.N.** Morphological peculiarities of facial skelet structure and clinical and diagnostic approaches to the treatment of dental anomalies in children in the period of early change. Pediatric dentistry and prophylaxis. 2019; Vol. 19; 1 (69): 26–38. (In Russ.) DOI: 10.33925/1683-3031-2019-19-69-26-38.
9. **Davydov B.N.** Modern possibilities of clinical-laboratory and x-ray research in pre-clinical diagnostics and prediction of the risk of development of periodontal in children with sugar diabetes of the first type. Part I. Periodontology, 2018; Vol. 23; 3–23(88): 4–11. DOI:10.25636/PMP.1.2018.3.1
10. **Davydov B.N.** Peculiarities of microcirculation in periodont tissues in children of key age groups sufficient type 1 diabetes. Part I. Periodontology, 2019; Vol. 24; 1–24(90): 4–10. DOI: 10.25636/PMP.1.2019.1.1
11. **Davydov B.N.** Peculiarities of microcirculation in periodont tissues in children of key age groups sufficient type 1 diabetes. Part II. Periodontology. 2019;24(2):108–119. (In Russ.) DOI:10.33925/1683-3759-2019-24-2-108-119
12. **Dean, J.A.** McDonald and Avery's dentistry for the child and adolescent, 10th edition. 2015. 6–700 p.
13. **Dmitrienko S.V.** Algorithm for determining the size of artificial teeth by the morphometric parameters of the face in people with full adentia. Dentistry. 2018; 97(6): 57–60. DOI – 10.17116/stomat20189706157
14. **Dmitrienko S.V.** Analytical approach within cephalometric studies assessment in people with various somatotypes. Archiv EuroMedica. 2019. Vol. 9; 3: 103–111. https://doi.org/10.35630/2199-885X/2019/9/3.29
15. **Dmitrienko S.V.** Enhancement of research method for spatial location of temporomandibular elements and maxillary and mandibular medial incisors. Archiv EuroMedica. 2019. Vol. 9. No 1. P. 38–44. https://doi.org/10.35630/2199-885X/2019/9/1/38
16. **Dmitrienko T.D.** Connection between clinical and radiological torque of medial incisor at physiological occlusion. Archiv EuroMedica. 2019. Vol. 9. № 1. P. 29–37. https://doi.org/10.35630/2199-885X/2019/9/1/29
17. **Dmitrienko S.** Modern x-ray diagnostics potential in studying morphological features of the temporal bone mandibular fossa. Archiv EuroMedica. 2020. Vol. 10. No 1. P. 116–125. https://doi.org/10.35630/2199-885X/2020/10/36
18. **Domenyuk D.A.** Algorithm for forecasting the shape and size of dent arches front part in case of their deformations and anomalies. Archiv EuroMedica. 2017. Vol.7. No 2. P. 105–110.
19. **Domenyuk D. A.** Anatomical and topographical features of temporomandibular joints in various types of mandibular arches. Medical News of North Caucasus. 2019; 14(2):363–367. DOI – http://dx.doi.org/10.14300/mnnc.2019.14089 (In Russ.)
20. **Domenyuk D.A.** Contemporary methodological approaches to diagnosing bone tissue disturbances in children with type 1 diabetes. Archiv EuroMedica, 2018; 8(2): 71–81. DOI:10.35630/2199-885x/2018/8/2/71

21. **Domenyuk D.A.** Changes of the morphological state of tissue of the paradontal complex in the dynamics of orthodontic transfer of teeth (experimental study). Periodontology, 2018; Vol. 23; 1–23(86): 69–78. DOI:10.25636/PMP.1.2018.1.15

22. **Domenyuk D.A.** Major telerenthengogram indicators in people with various growth types of facial area. Archiv EuroMedica. 2018. Vol. 8. No 1. P. 19–24. DOI: 10.35630/2199-885X/2018/8/1/19

23. **Domenyuk D.** Structural arrangement of the temporomandibular joint in view of the constitutional anatomy. Archiv EuroMedica. 2020. Vol. 10. No 1. P. 126–136. https://doi.org/10.35630/2199-885X/2020/10/37

24. **Fischev S.B., Puzdyryova M.N.** Morphological features of dentofacial area in peoples with dental arch issues combined with occlusion anomalies. Archiv EuroMedica. 2019. Vol. 9; 1: 162–163. https://doi.org/10.35630/2199-885X/2019/9/1/162

25. **Fomin I.V.** Effect of jaw growth type on dentofacial angle in analyzing lateral teleradiographic images. Archiv EuroMedica. 2019. Vol. 9; 1: 136–137. https://doi.org/10.35630/2199-885X/2019/9/2/136

26. **Gavrilova O.A.** Microbiological verification for the use of thermoplastics in prosthetic treatment of dentition issues in children. Archiv EuroMedica, 2018; 8(2): 88–90.

27. **Graber T. M.** Orthodontics. Principles and Practice; 4th ed. N. Y.: Elsevier, 2005. – 953 p.

28. **Gribel B.F.** From 2D to 3D: an algorithm to derive normal values for 3-dimensional computerizet assessment. Angle Orthod. 2011. Vol. 81; 3–10. DOI: 10.2319/032210-166.1

29. **Harutyunyan Yu.** Undifferentiated connective tissue dysplasia as a key factor in pathogenesis of maxillofacial disorders in children and adolescents. Archiv EuroMedica. 2020. Vol. 10; 2: 83–94. https://dx.doi.org/10.35630/2199-885X/2020/10/2.24

30. **Ivanyuta S.O.** Individual-typological variability of structures of the craniofacial area in people with various constitutions. Entomology and Applied Science Letters. 2020. Vol. 7; 1: 20–32.

31. **Keim R.G.** 2002 JCO Study of orthodontic diagnosis and treatment procedures. Part 1. Results and trends. J Clin Orthod. 2002. Vol. 36; 553–568. DOI: 10.2319/032210-166.1

32. **Kondratyeva T.** Methodological approaches to dental arch morphology studying. Archiv EuroMedica. 2020. Vol. 10; 2: 95–100. https://dx.doi.org/10.35630/2199-885X/2020/10/2.25

33. **Korobkeev A. A.** Variability of odontometric indices in the aspect of sexual dimorphism. Medical News of North Caucasus. 2019;14(1.1):103–107. DOI – https://doi.org/10.14300/mnnc.2019.14062 (In Russ.)

34. **Korobkeev A.A.** Types of facial heart depth in physiological occlusion. Medical news of North Caucasus. 2018. – Vol. 13. – No 4. – P. 627–630. (In Russ., English abstract). DOI – https://doi.org/10.14300/mnnc.2018.13122.

35. **Korobkeev A.A.** Anatomical features of the interdependence of the basic parameters of the dental arches of the upper and lower jaws of man. Medical news of North Caucasus. 2018. – Vol. 13. – № 1-1. – P. 66–69. (In Russ., English abstract). DOI – https://doi.org/10.14300/mnnc.2018.13019

36. **Korobkeev A. A.** Clinical and computer-tomographic diagnostics of the individual position of medial cutters in people with physiological occlusion. Medical News of North Caucasus. 2020;15(1):97–102. DOI – https://doi.org/10.14300/mnnc.2020.15023 (In Russ.)

37. **Kuroda T.** Diagnosis and management of oral dysfunction. World J. Orthod. 2000. Vol. 1; 125–133.

38. **Lepilin A.V., Shkarin V.V., Al-Harazi G.** A biometric approach to diagnosis and management of morphological changes in the dental structure. Archiv EuroMedica. 2020. Vol. 10; 3: 118–126. https://dx.doi.org/10.35630/2199-885X/2020/10/3.30

39. **Lepilin A.V., Fomin I.V.** Diagnostic value of cephalometric parameters at graphic reproduction of tooth dental arches in primary teeth occlusion. Archiv EuroMedica, 2018. Vol. 8. No 1. P. 37–38. DOI: 10.35630/2199-885X/2018/8/1/37

40. **Lepilin A.V.** Dependence of stress strain of dental hard tissues and periodontal on horizontal deformation degree. Archiv EuroMedica. 2019. Vol. 9; 1: 173–174. https://doi.org/10.35630/2199-885X/2019/9/1/173

41. **Mattar S. E.** Skeletal and occlusal characteristics in mouth-breathing pre-school children. J. Clin. Pediatr. Dent. 2004: Vol. 28, № 4: 315–318. DOI: 10.17796/jcpd.28.4.hg0k800564031787.

42. **McNamara J.A.** Orthodontic and Dentofacial Orthopedics. Needfarm Press. Inc., 1998. 555 p.

43. **Porfiriadis M.P.** Mathematic simulation for upper dental arch in primary teeth occlusion. Archiv EuroMedica, 2018. Vol. 8. No 1. P. 36–37.

44. **Nanda R. S.** Dentofacial growth in long-term retention and stability. Elsevier Inc. 2005. 383 p.

45. **Proffit W.R., Fields H.W.** Contemporary orthodontics. – St. Louis: C.V. Mosby, 2000. – 768 p.

46. **Ramirez-Yañez G.** Dimensional changes in dental arches after treatment with a prefabricated functional appliance. J. Clin. Pediatr. Dent. 2007. Vol. 31, No 4: 279–283.

47. **Samedov F. V., Ivanyuta I. V.** Dynamics of change in the integrated indicators of life quality and dental status of children with chronic somatic pathology at the stages of complex treatment. Medical alphabet. 2020;(23): 34–40. https://doi.org/10.33667/2078-5631-2020-23-34-40

48. **Shkarin V.V., Ivanov S.Yu.** Morphological specifics of craniofacial complex in people with varioustypes of facial skeleton growth in case of transversal occlusion anomalie. Archiv EuroMedica. 2019. Vol. 9; 2: 5–16. https://doi.org/10.35630/2199-885X/2019/9/2/5

49. **Shkarin V.V., Grinin V.M., Khalfin R.A.** Specific features of transversal and vertical parameters in lower molars crowns at various dental types of arches. Archiv EuroMedica. 2019. Vol. 9; 2: 174–181. https://doi.org/10.35630/2199-885X/2019/9/2/174

50. **Shkarin V.V., Grinin V.M., Khalfin R.A.** Specific features of grinder teeth rotation at physiological occlusion of various gnathic dental arches. Archiv EuroMedica. 2019. Vol. 9; 2: 168–173. https://doi.org/10.35630/2199-885X/2019/9/2/168

51. **Shkarin V.V., Davydov B.N.** Non-removable arch orthodontic appliances for treating children with congenital maxillofacial pathologies – efficiency evolution. Archiv EuroMedica, 2018. Vol. 8. № 1. P. 97–98. https://doi.org/10.35630/2199-885X/2018/8/1/97

52. **Shkarin V.V.** Mathematical and graphics simulation for individual shape of maxillary dental arch. Archiv EuroMedica, 2017. Vol. 7; № 1: 60–65.

53. **Shkarin V.V., Porfiriadis M.P.** Setting reference points for key teeth location in case of abnormal dental arch shape. Archiv EuroMedica, 2017. Vol.7; No 2: 111–117.