THE CONSTRUCTION PECULIARITIES OF ARTIFICIAL DENTAL ARCHES OF FULL REMOVABLE PROSTHESIS WITH USING OF TEETH MODELS AND ALVEOLAR ARCHES

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ABSTRACT — The aim of the study was to substantiate the method of setting artificial teeth according to the models corresponding to the gnathic and dental types of the face. This study included two main stages. First of all, the results of a study of patients in the comparison group were analyzed, which included 287 patients with physiological occlusion of permanent teeth. The main group included 27 elderly people with a complete absence of teeth. Considering the complexity of measuring the depth of the dental arch, we used mathematical calculations to determine it. The Huygens formula was used which showed the relationship between the height of the segment and the length of the arc and chord. Nine basic variants of comparison the dental models and alveolar arches were offered. To people with mezognathic microdontal types of dental arches the models of small arches with an inter-arches distance of 4 mm were recommended. In the dolichognathic microdontal type, the narrow arches are used with a distance between the central points of the patterns of 6 mm, and with dolichognathy and normodentism, the distance between them is 9 mm. The average size of the arches models with a distance of 4 mm between them is recommended for people with a brachygnathy and dental microdentism, with a 6 mm gap for mezognathic normodontal types, and 9 mm for dolichognathic macrodontal types of dental arches.

KEYWORDS — odontometry, the research methods of dental arches, craniometry, the defects of dentition.

INTRODUCTION

The issues of setting artificial teeth in making the removable prostheses for patients are devoted a sufficient importance in the specialized literature. The specialists pay a particular attention to the individual morphological features of the maxillofacial area in different age periods [3, 4]. The methods of selecting the artificial tooth sizes by diagonal facial dimensions are shown and dental and interdental indexes are established [2, 10, 12]. The sexual and racial features of dental arches in people with physiological occlusion have been established, which can be used for prosthetic and orthodontic treatment [20].

Nevertheless, the choice of the designed shape of the dental arch requires the detailed analysis. At present time, the relationship between the size of the face and the parameters of the dental arches has been convincingly proved, which is important in the orthopedic dentistry and orthodontics clinic when choosing methods of treatment [9]. The patterns of dental arches are proposed to determine the dimensions of metal arches depending on the gnathic type of the face. From the entire variety of dental arches sizes, three main patterns were defined. The metal arches of large sizes are recommended to be used in the treatment of people with mezognathic macrodontal, brachygnathic normo- and marodontal types of dental arches, the width of which is more than 62 mm in the place of second molars [6, 16, 17].

With the complete absence of teeth, the main guideline for setting artificial teeth is the alveolar arch. It should be noted that the dimensions of the alveolar arches have been studied by researchers in people with physiological occlusion and their correlation with the parameters of the dental arches has been shown [18]. An important factor in the setting of artificial teeth is an incline of teeth in the vestibular-lingual direction (torques or angles of inclination) [5, 7, 8]. Changes in the shape of dental arches are determined in people with anomalies of occlusion, which requires the additional methods of diagnosis and determination of the location of the key teeth [1, 11, 13, 15, 19]. The necessity and effectiveness of using X-ray methods of investigation in people with defects of dental arches is shown [14].

Thus, the analysis of the literature showed that each gnathic type of face corresponds to the same types of dental and alveolar arches. At the same time, the different values of torques of the medial incisors do not allow the combination of arched patterns in the construction of artificial dental arches. The additional researches are required to determine the distance between the central points of the dental and alveolar arches, depending on the facet type.

The aim

The substantiation of the technique of setting artificial teeth according to the patterns corresponding to gnathic and dental types of face.

Materials and research methods

This study included two main stages. First of all, the results of a study of patients in the comparison group were analyzed, which included 287 patients with physiological occlusion of permanent teeth. The main group included 27 elderly people with a complete absence of teeth.

All patients under morphometry of the face were measured two basic sizes: the width and the diagonal of the face. The width of the distal section was measured between the tragus points located at the top of the tragus of the auricle (t-t). The diagonal of the face was measured from the tragus point to the subnasal (low-nosed) point (t-sn).

Taking into account the received data, the type of face was determined. The diagonal dimensions of the face were the indicators of the dental type. The dimensions of diagonals from 122 to 130 mm on both sides of the face were characteristic of normodontic facial types and corresponded to the normodont type of the dental system. The change in the indicator to a smaller or larger side made it possible to classify a person's type as a micro- or a macro-type, respectively. The gnathic index of the face was determined by the gnathic index. At the same time, the arithmetic meaning was determined from the diagonals of the right and left sides, the percentage of which to the width of the distal part of the face with the obtained numerical values from 83 to 93 characterized the mezognathic type of face. The value of the gnathic index more than 93 was found with people of dolichongnathic type, and with a decrease in the index, the brachygnathic type of face was determined, which agrees with the literature data.

With physiological occlusion, facial types, as a rule, corresponded to the types of dental arches, which allowed us to distinguish three basic forms: narrow, medium and wide. Narrow dental arches predominated in people with mezognathic microdontal, and dolichognathic normo- and micro-dental types of dental arches. Wide dental arches were defined in people with mesognathic macrodont, brachygnathic normo- and macrocondal type of dental arches. With mezognathic normodontic, dolichognathic macrodontal and brachynagic microdontal types of dental arches, their shape approximated to the average size.

A study on gypsum models of the jaws was conducted in people's comparison group, in order to develop patterns of dental and alveolar arches. The odontometry was performed according to the generally accepted methods in odontology and dentistry. Vestibular-lingual and mesial-distal dimensions of tooth crowns were measured. The length of the dental arch was calculated as the sum of the width of the crowns of 14 teeth. The length of the anterior section of the dental arch was determined by the sum of 6 anterior teeth.

The sizes of dental and alveolar arches were estimated. Transverse parameters were measured between fangs and second molars. The diagonal measurements in the anterior part were estimated from the distance from the intercutter point to the point located on the tearing tubercle of the fang from the vestibular side near the occlusal contour of the crown (the junction of the dental arch of the anterior and lateral sections).

Studying the alveolar arches, the measuring points were placed from the lingual (palatine) surface in the interdental spaces. The linear parameters of the alveolar arches were measured in the same way as in the dental arches (Fig. 1).

Taking into consideration the complexity of measuring the depth of the dental arch, we used mathematical calculations to determine it. The Huygens formula was used, which shows the relationship between the height of the segment and the length of the arch and chord. As applied to the dental arch, the formula looked like this:

$$D_{1\text{-}3} = \sqrt{[(9 \cdot L^2)+(6 \cdot L \cdot W_{3\text{-}3})-(15 \cdot W_{3\text{-}3})]}/64,$$

where $D_{1\text{-}3}$ — the depth of the arch; L — the length of the arch (the sum of the teeth sizes); $W_{3\text{-}3}$ is the width of the arch in the fang area.

The obtained data served as the main reference for the construction of a circle for the location of the front teeth. In accordance with the law of circle geometry, its diameter determined the ratio of the length of the segment chord to the sinus of the central angle. In our case, the chord was the width of the dental arch in the fang area, and the value of the central angle corresponded to the double arctangent of the ratio of the arch depth to its width (circle diameter = $W_{3\text{-}3} / \sin \alpha$; here, $\alpha = 2 \cdot \text{arctg}\, D_{1\text{-}3}/W_{3\text{-}3}$).

The circumference was the basis for designing the individual shape of the arch (dental or alveolar). After the construction of the circle, the positions of the fangs were determined on both sides of the central point of the arch by a distance that is equal to the frontal-fang diagonal. On the continuation of the diameter of the circle, a value equal to the depth of the arch was plotted. From the showed point on both sides the segments were laid, in combination, corresponding to the width of the arch in the molars area. The locations of the fangs and molars were joined by straight lines, from the middle of which the perpendicular lines were constructed, the size of which was the sum of the width and the diagonal of the dental arch. From the obtained points, the points of the fangs and molars were connected by a divider (Fig. 2).

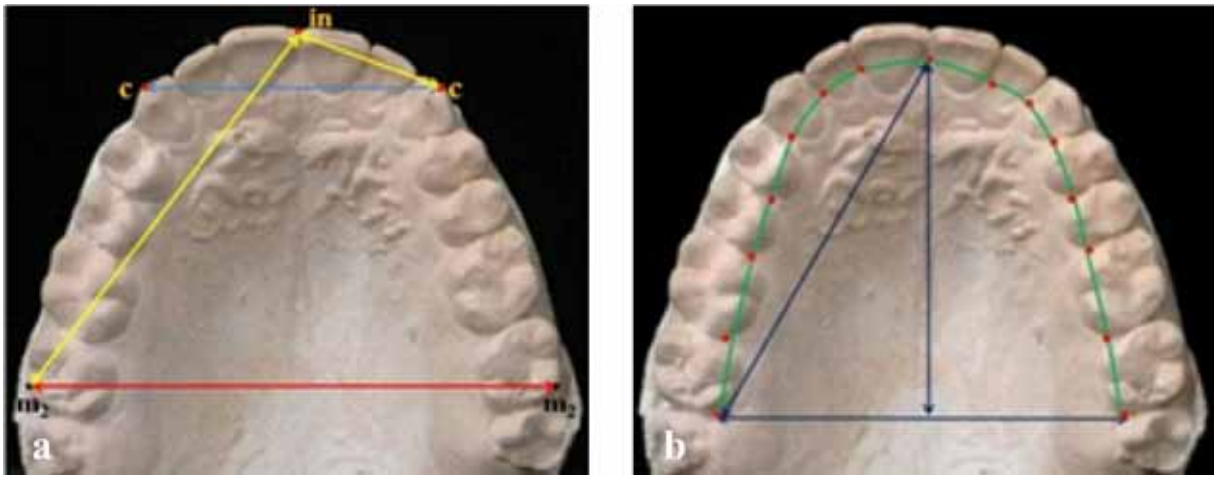

Fig.1. Linear parameters and measuring points for the biometrics of the dental arch (a) and the alveolar arch (b)

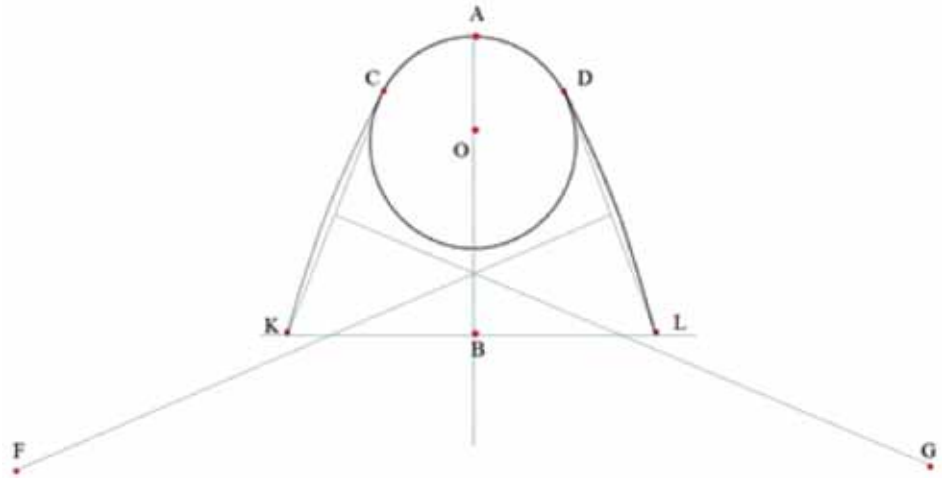

Fig.2. The individual dental arch, built by mathematical modeling

Using the method of cone-beam computed tomography the distance between the central points of the dental and alveolar arch was determined by the method. In this case, the perpendicular to the occlusal plane was lowered from the location of the alveolar arch in the region of the medial incisors and the distance from the intersection of these lines to the vestibular surface of the occlusal contour of the incisor was measured.

The statistical processing of data was carried out on a personal computer using a generally accepted software package.

RESULTS AND DISCUSSION

The results of the study of patients in the comparison group and the biometry of gypsum models of the jaws, taking into account the forms distinguished by us, are presented in Table 1.

Unreliable differences in the indexes were revealed by such an indicator as the depth of the alveolar arch, which is explained by the same reasons as in the analysis of dental arches.

The obtained sizes of dental and alveolar arches allowed us to make templates of three kinds, which we used to construct artificial dental arches.

For comparing the two templates the great importance has an inter-arch distance. The analysis of the measurements carried out on the images of the cone-beam computer tomogram showed three main variants, caused by the values of the angle of inclination (torques) of the cutters. The high values of torques were found in people with mezognathic macrodontal, dolichognathic normo- and macrodontal types of dental arches. In these cases, the distance between them was 9.0 ± 1.0 mm. The low values

Table 1. The main parameters of dental arches (in mm), taking into account their shape

The main parameters of alveolar arches	Sizes of alveolar arches (in mm) with the form:		
	narrow	medium	wide
The length of anterior alveolar arch	39,66 ± 0,32	41,41 ± 0,36	44,00 ± 0,41
The width of anterior alveolar arch	29,67 ± 0,24	32,16 ± 0,26	35,72 ± 0,32
The depth of anterior alveolar arch	13,17 ± 0,37	13,47 ± 0,39	14,00 ± 0,41
The radius of anterior alveolar arch	14,88 ± 0,21	16,81 ± 0,23	18,74 ± 0,25
The length of complete alveolar arch	102,62 ± 0,98	108,16 ± 1,01	110,98 ± 1,19
The width of complete alveolar arch	45,84 ± 0,41	47,44 ± 0,47	52,40 ± 0,52
The depth of complete alveolar arch	42,86 ± 0,37	43,79 ± 0,39	43,12 ± 0,42
The diagonal of complete alveolar arch	48,61 ± 0,29	49,82 ± 0,41	50,47 ± 0,35

of torques were found in people with mezognathic microdontal, brachignathic normo- and microdontal types of dental arches. The inter-arch distance was 6.0 ± 1.0 mm. The standard values of torques were with mezognathic normodont, dolichognathic microdontal and brachignathic macrodontal types of dental arches and the distance between them was 4.0 ± 1.0 mm.

The variants of the distance between the teeth with different inclinations of teeth are shown in Fig. 3.

The proposed models were recommended for setting artificial teeth in the articulator and used by the dentist during the testing of the laboratory stages of manufacturing the prosthetic construct (Fig. 5).

CONCLUSION

Thus, 9 basic variants of comparison of dental and alveolar arches models were offered. In people with mezognathic microdontal types of dental arches, the models of small arches with an inter-arch distance of 4 mm were recommended. In the dolichognathic microdontal type, narrow arches are used with a distance between the central points of the patterns of 6 mm, and with dolichognathic and normodontism, the distance between them is 9 mm. The average size of the arch models with a distance of 4 mm between them is recommended for people with brachygnathy and dental microdontism, with a 6 mm gap for mezognathic normodontal types, and 9 mm for dolichognathic macrodontal types of dental arches. Wide models of arches with short distances were used in the prosthetics of people with brachygnathic normodontal type of face. With brachygnathic macrodontal facial type, a distance of 6 mm is recommended, and for the mezognathic face type the distance is 9 mm.

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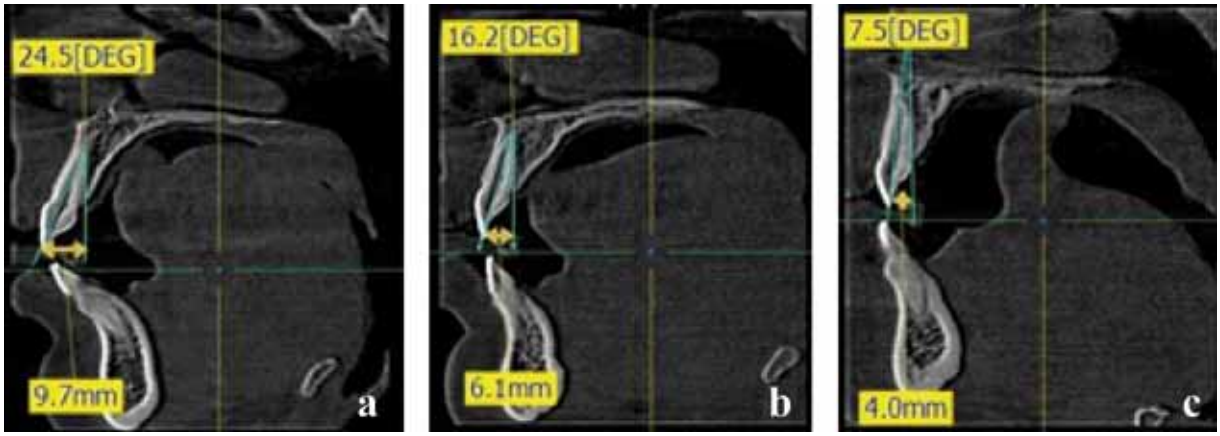

Fig. 3. Variants of distance between high (a), standard (b) and low (c) torques. Variants for comparing arches patterns are shown in Fig. 4

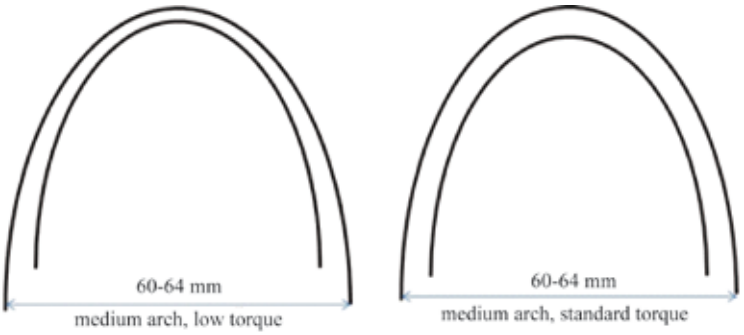

Fig. 4. Variants of the location of medium arch models at low (a) and standard (b) torques

Fig. 5. Variants of designing artificial dental arches according to the models of alveolar and dental arches taking into account gnathic and dental type of face

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