SETTING REFERENCE POINTS FOR KEY TEETH LOCATION IN CASES OF ABNORMAL DENTAL ARCH SHAPE

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ABSTRACT — The results of anthropometric, clinical studies and mathematical simulation were used to develop an algorithm for examining patients with anomalies in the shape and size of dental arches, which allows determining the position of the central (inter-canine) point. The algorithm is based on the measurement of the dental arch width between the second molars and the front-distal diagonal value, which is defined as the ratio of the half sum of 14 teeth to 1.04 coefficients. It has been proven that the canine teeth location is determined from the size of the front-canine diagonal calculated as the ratio of the dental arch diagonal to the ratio of the dental arch length and the sum of the width of the 6 anterior teeth crowns, employing the correction factor of 0.1.

KEYWORDS — anomalies of shape and size of dental arch, facial measurement methods, teeth size, key teeth.

INTRODUCTION

The integrity of the human body, as well as the interdependence of its organs and systems' form and functions, can be definitely seen when studying the interrelation (interdependence) of local and general somatic disorders arising in case of dentoalveolar anomalies [4, 7, 11, 19, 26, 29].

Russian and foreign experts have proven that dentoalveolar anomalies manifest themselves through abnormal development of teeth and jaws. The symptoms in such cases

include abnormal occlusion, which must be differentiated from various types falling within the normal range, and which do not involve functional and aesthetic disorders. There is no definite standard norm for the jaw system structure, but on the contrary, there are individual features of the shape, size and location of the teeth and jaws that fit within the limits and concept of the norm as long as they provide for an aesthetic optimum and proper function of the dental apparatus [2, 17, 24].

Anomalies of the occlusion whose distinctive features include incorrect position of the teeth, absence of multiple contacts between the dentition, changed shape of the alveolar process, disturbed size of the jaw bones and their spatial arrangement in the skull, are aggravating factors adding to the development of functional disorders pertaining not to maxillofacial area alone yet also to the macroorganism as a whole [6, 14, 25].

Planning the treatment of patients with dentoalveolar anomalies involving a thorough clinical and paraclinical examination, an individual approach in view of the respective set of anthropometric and X-ray cephalometric parameters, with deep knowledge of the terminology and contemporary classification of dentoalveolar anomalies, and specific features of dentoalveolar development, would allow shaping a well-balanced, functional and aesthetic occlusion [1, 3, 23, 35].

The anomalies of dental arch sizes and shapes are diverse and respective literature contains various classifications for them [5, 16, 20].

There are many research methods that allow not only detecting abnormalities and deformations, yet also identifying the treatment methods in orthodontic clinics [12, 30].

Note to be made that human dentoalveolar arches present a wide variety of shapes and sizes even within physiological occlusion, proof to this fact being numerous studies published in Russian and other languages [8, 18, 21, 33].

There are methods of estimation as well as the basic sizes shown for different varieties of the dental arch shape. Apart from linear dimensions, angular parameters are presented – namely the torque size and angulations, which is of particular importance when selecting braces [9, 27].

Special attention is paid by clinicians to the location of the central (or inter-incisal) point which changes its position in case of the dental arch asymmetry, protrusion or retraction of the incisors. The spot located between the medial incisors is used by clinicians to identify the depth of the dentoalveolar arches [13, 22, 34].

Identification of the depth of the dental arch anterior segment is an essential attribute when diagnosing occlusion disturbances [10, 31].

Evaluation of the transversal and sagittal dimensions is performed employing the Pont (Linder-Hart) methods, while clinical experts claim these methods to be faulty [15].

Special attention is to be paid to studies focusing on evaluation of the dental arches dimensions based on the relatively stable cranio-facial parameters [28, 32].

Nevertheless, while studying the available research outcomes, we failed to find data regarding how to determine the position of the central point and key teeth (namely canine teeth) in people with abnormal shape and size of the dental arches, which might guide the choice of methods for orthodontic treatment.

Aim of study

identification of the position for the central point and canines in case of abnormal shape and size of the dental arches.

MATERIALS AND METHODS

The study involved 57 patients with physiological occlusion of permanent teeth and 52 people with anomalies in the shape and size of dental arches.

The method for forecasting the references concerning the location of the key teeth at abnormal shape of the dental arches is based on examining patients with physiological occlusion.

The most stable parameter of the upper arch is the width between the second molars and the permanent teeth dimensions.

Teeth were measured in the mesial-distal plane at the widest point between the proximal surfaces (the tooth crowns width). The dental arch width was determined between the points located on the vestibular distal tubercles near the crowns' occlusal contour (Fig. 1).

The front-distal and canine diagonals were determined from the central point located between the medial incisors near the cutting edge, to the points located on the molars and canines, respectively (Fig. 2).

The depth of the dental arch was determined from the central intercellular point to the line connecting the antimeres, the canines and molars in particular (Fig. 3).

The statistical processing was performed directly from the common data matrix of ECXEL 7.0 (Microsoft, USA) also involving certain features offered by the STATGRAPH 5.1 (Microsoft, USA) software, ARCADA (Dialog-MGU, Russia), and implied detecting the median values, its mean root square deviation, and the non-sampling error. Further on, following the patterns commonly employed for medical and biological studies (sample numbers; type of distribution; non-parametric criteria; reliability of the difference of 95%, etc.) the significance of the sampling difference was evaluated subject to the Student's criterion (t) and the respective significance index (p).

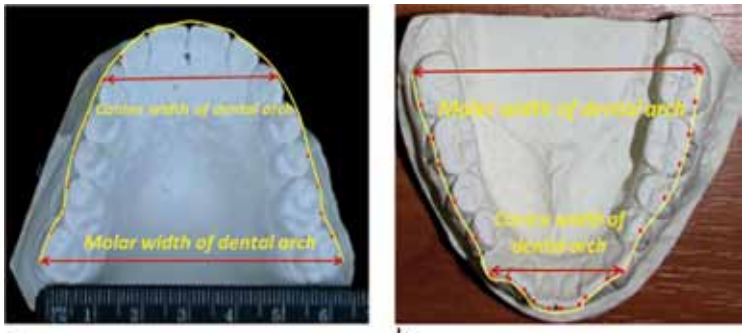

Fig. 1. *Photographs of plaster models of the upper (a) and lower (b) jaws with plotted reference lines for measuring the width of the dental arch*

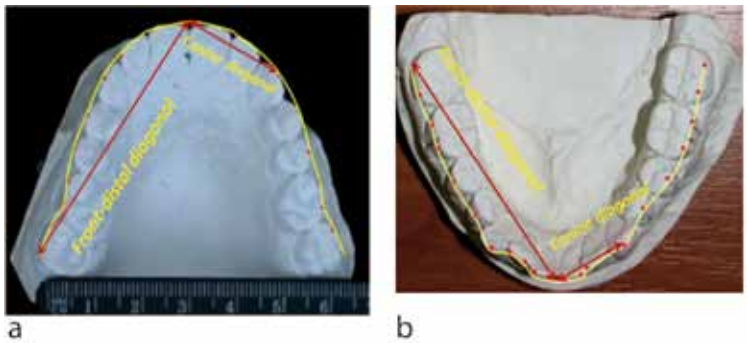

Fig. 2. *Photographs of gypsum models of the upper (a) and lower (b) jaws with marked reference lines for measuring the frontal-distal and canine diagonal of the dental arch*

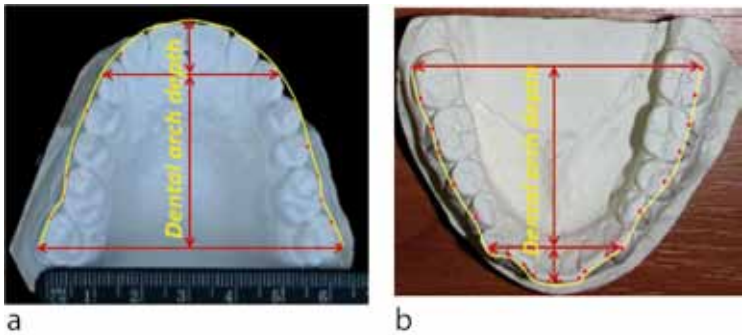

Fig. 2. *Photographs of plaster models of the upper (a) and lower (b) jaws with plotted reference lines for measuring the depth of the dental arch*

RESULTS AND DISCUSSION

The study carried out among people with physiological occlusion has shown that the sum of the upper jaw 14 teeth (the length of the upper dental arch) averaged 114.66±1.98 mm, which fell within normodontia. At the same time, the 6 anterior teeth accounted for 47.04±1.02 mm. The ratio of the dimensions of all teeth to the anterior teeth was 2.437±0.098 mm. The front-distal diagonal (FDD) was 55.125±0.39 mm on each side, which was 1.04 of the dimensions of the teeth making up the dental arch. The obtained value can be used as a factor in determining the dental arch diagonal through the teeth size.

The patients under examination had a front-canine diagonal (FCD) of 21.72±0.34 mm in the average. In this regard, the ratio of FDD to PCD for the group as a whole was 2.538±0.026, which was 0.1 mm above the ratio of all the teeth to the front teeth. This means that the obtained data can be used to identify the size of the front-canine diagonal in patients with abnormal dental arches. In this case, the formula below is recommended:

$$FCD = FDD / (\Sigma_{14\ teeth}/\Sigma_{6\ teeth} + 0.1)$$

The dental arch width between the molars was 59.7±1.45 mm, while at the canines it was 37.31±0.98 mm. The ratio between the measured dimensions in the transverse plane was 1.6, which can also be used as a reference to determine the forecasted width of the dental arch between the canines based on the size of the arch width at the molars in case of abnormal dimensions of the dental arches and abnormal arrangement of the canines or their retention.

The ratio of the dental arch length to its width was 0.96±0.03, which signified mesognathic dental arches in the majority of the patients examined.

The dental arch depth at the anterior part was 11.09 mm and corresponded to the calculations for the width of the anterior and front-canine diagonals, like a right-angled triangle leg.

The obtained data laid the basis for the algorithm employed to identify the position of the key teeth and the dental arch size evaluated in patients with abnormal occlusion.

The algorithm is based on identifying the central spot, which corresponds to the location of the inter-incisal point located in front or backwards, depending on the retrusive or protrusive position of the incisors in anomalies. To do this, a horizontal transverse line was drawn on translucent paper (tracing paper), which corresponded to the dental

arch width between the second molars. A perpendicular was built from the center of this line. Then, from the points bounding the first line, segments were cut equal to the FDD to the perpendicular, while the resulting intersection point corresponded to the location of the inter-incisal (central) spot (Fig. 4).

Note to be made that the FDD size was determined through the sum of the mesial-distal diameters of the teeth. The formula we recommend is here below:

$$FDD = \Sigma_{14\ teeth}/2/1.04$$

Second, the forecasted width of the dental arch between the canines was determined. To do this, the value of a relatively stable parameter, namely the dental arch width between the second molars, was divided by the index of 1.6.

Third, the size of the front-canine diagonal was calculated. When determining the potential size of the front-canine diagonal in patients with dental arch anomalies, the calculation followed the formula below:

$$FCD = FDD / (\Sigma_{14\ teeth}/\Sigma_{6\ teeth} + 0.3)$$

The forecasted depth of the dental arch was calculated as a right-angled triangle leg, where the hypotenuse was the front-canine diagonal, the second leg being half the width of the dental arch between the second molars:

$$\text{The depth of the anterior part} = \sqrt{FCD^2 - (\text{half inter–canine width})^2}$$

The marks on the tracing paper were applied to the cast model of the upper jaw to determine the position of the key teeth and to develop further plan of orthodontic treatment (Fig. 5).

The radius of the circle on which the six front teeth are to be located, was carried out through the generally accepted in geometry method employed to determine the diameter of the circle along the length and height of the sector bounded by the chord.

Besides, the circle diameter (D) was calculated by the ratio of the arch length (L) to the central angle (α):

$$D = \frac{L}{\alpha}$$

The central angle was shaped by the circle radii bounding the chord, and was calculated subject to the formula:

$$\alpha = 2 \cdot \text{arctg}\ \frac{2H}{X}$$

where H is the segment height and X is the chord length.

The length of the arch bounded by the chord was calculated as the product of the ratio of the chord length to the central angle ratio to its sine:

$$L = X \cdot \frac{\alpha}{\sin \alpha}$$

In calculation of the circle diameter when constructing the dental arch, the length of the chord (X) corresponded to the inter-incisal distance. The height of the segment (H) determined the depth of the dental arch anterior section and was calculated as a leg to a right-angled triangle shaped by the front-canine (canine) diagonal and half the width of the dental arch between the canines.

Given the above, identifying the basic references for the location of the key teeth, it is sufficient to measure the mesial-distal diameters of the 14 teeth that make up the dentition, and the width of the dental arch between the second molars. The appropriate ratios are used to identify the location of the inter-incisal (central) point and the canines' position.

CONCLUSIONS

1. In view of the outcomes of morphological, clinical studies, and mathematical modeling, an algorithm for examining patients with anomalies in the shape and size of dental arches has been developed, which allows identifying the position of the central (inter-incisal) point.

2. The algorithm is based on measurements of the dental arch width between the second molars and the front-distal diagonal, which is defined as the ratio of the half sum of 14 teeth to the ratio of 1.04.

3. It has been proven that the location of the canines is determined based on the size of the front-canine diagonal calculated as the ratio of the dental arch diagonal to the ratio of the dental arch length to the sum of the crowns width of the 6 anterior teeth, with a correction factor of 0.1 used.

4. The introduction of the algorithm (a sequence of morphometric measurements and mathematical calculations) would allow, with a high degree of certainty, detecting the position of the central point and the key teeth. Employing such reference points when working with patients revealing abnormal dental arch shape or size, might lead to a better reasoned choice of tactics and the manipulations to be performed, which would allow shortening the time spent on diagnostics and enhance the effectiveness of orthodontic treatment.

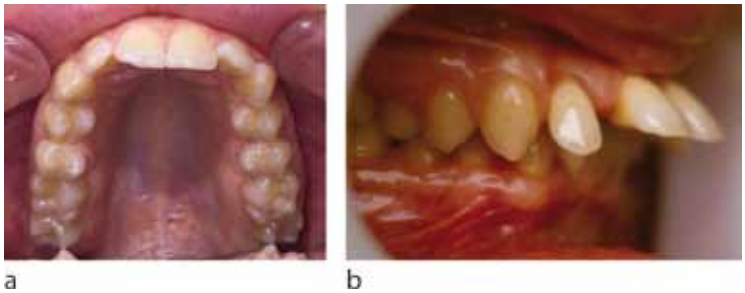

Fig. 4. Changed position of the central point at retrusion (a), protrusion (b) incisors

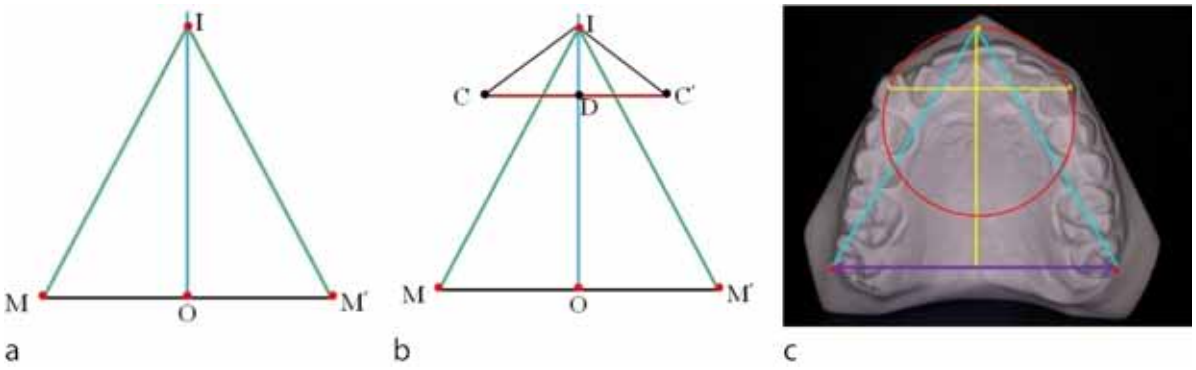

Fig. 5. Method for identifying the position of the central point (I) — a, the depth of the anterior part (ID), the positions of the canines along the FCD (IC and IC') — b and the evaluation on the upper jaw cast model (c)

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