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VARIANT ANATOMY OF TRANSITIONAL OCCLUSION DENTAL ARCH AT OPTIMAL OCCLUSAL RELATIONSHIPS

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ABSTRACT — Through the transitional bite period, the variability of the dental arch shape and size is due to the replacement of milk teeth with permanent ones, which feature different odontometric values. The aim of this study was to identify the main linear and angular parameters of dental arches, in view of the trusive position of the incisors with optimal functional occlusion. A stratified study was involved 76 children ages 8–12 years old, who were divided into three groups (protrusive, retrusive and mesotrusive dental arches). An analysis of cone-beam computed tomograms and plaster models of jaws was carried out, which was preceded by obtaining informed consents according to the Ethics Committee requirements. The study revealed certain features of the variant anatomy of transitional occlusion dental arch. The calculated factors allowed identifying the proportionality of the dental arch parameters to odontometric indicators. During that, the dental-diagonal factor (the ratio of the dental arch length to the incisor-molar diagonals) for the upper jaw was 1.06±0.01, for the lower arch being equal to 1.09±0.01, in all types of dental arches, which is a fact to be used in clinical orthography to predict the location of the dental arch incisor (central) point in case of shape anomalies, specifically in the anterior part. The angular parameters of the diagnostic dental pentagon will allow simulating the geometric and graphical construction of arches through the transitional occlusion period.

KEYWORDS — morphometry, odontometry, CBCT, plaster model biometry, physiological protrusion of teeth, transitional occlusion.

INTRODUCTION

Through the period of transitional occlusion, dental arches feature the greatest variability, while their parameters are dependent from numerous etiological factors due to replacement of milk teeth with permanent ones, pathologies of dental and periodontal hard tissues, and premature removal of milk teeth [2, 5, 13, 19, 37, 40].

This age period is under special attention from orthodontists, while the treatment of anomalies is typically aimed at the jaw bone growth, taking into account the cranial morphology [4, 6, 9, 12, 23, 36, 42].

Speaking of permanent teeth occlusion period, the main differences in the shape of the human dental arch with physiological occlusion are known to be due to the specifics of sagittal, diagonal and transversal sizes that determine the arcade and dental types of the teeth system, as well as due to peculiarities of the teeth physiological rotation at different variants of dental arches [10, 14, 20, 24, 27, 30, 38, 45].

The calculated index values of the gnathic (arcadian) type, as well as differences in odontometric indicators determining the dental arch length, are currently employed in clinical orthodontics and orthopedic dentistry when treating patients through the period of permanent teeth occlusion [11, 15, 21, 25, 44].

Research has revealed certain sex- and race-bound features of the milk and permanent teeth, dental arches, dental segments, which allows identifying respective treatment methods and prevention measures, as well as to regulate the orthodontic load during the replacement of abnormally positioned teeth [17, 22, 26, 29].

Special importance in clinical orthodontics is attached to biometric studies through the transitional occlusion period, where the dental arch parameters change after the eruption of the next group of the second-generation teeth [3, 16, 35].

Until now, the protocol methods employed to study transversal arch sizes are Pont's and Linder-Harth methods, which differ in index values, which, in turn, often determines the difficulties related to their clinical implementation associated with the dental system featuring either the brachygnathic or the dolichognathic type [1, 18, 41].

Through the transitional occlusion period, such studies can be held only after the incisors cut out on both jaws, whereas the dimensions of such jaws correlate, to a certain extent, with the dental arch and craniofacial parameters. At the same time, the eruption of the first premolars is viewed as a necessary condition for measuring the anterior part parameters [39]. Within this period of the maxillary system development, the mutual position of incisors can be used to measure the incisor angle of antagonists that determine the trusive type of the dental system. The X-ray methods of examination show that in case of the mesotrusive type, the incisor angle made up by the conditional median verticals of the medial upper incisors and their antagonists is an average of 120–140° degrees. A decrease in the angle is typical of physiological protrusion, provided the incisor overlap is optimal both vertically and horizontally. An increase in the angle is indicative of the retrusive position of the incisors in both jaws [7, 28]. As far as transversal dimensions of dental arches are concerned, most experts tend to believe that the most appropriate reference to be used when measuring them are points located not in the middle of the occlusal surface of the chewing teeth (as proposed by A. Pont (1909), G. Harth (1930), H. Linder (1931)) yet on the crown vestibular surface of the teeth located near the occlusal contour [34]. This can be accounted for by the fact that the shape of dental arches allows choose the size of metal dental arches of non-removable arch structures, which are widely used in clinical practice [8, 31–33, 43].

However, we found no data regarding the variants of biometric parameters and odontometric indicators in children through their transitional occlusion period, so the rational of this work as well as its aim can be explained by a brief review of respective literature that has been carried out.

Aim:

To identify the main dental arch parameters of the transitional occlusion in view of the variant anatomy of the intrusive position of the incisors with optimal functional occlusion.

MATERIALS AND METHODS

The study involved 76 children who were divided into three groups based on the trusion type, namely by the front teeth location, and the magnitude of the incisor angle of the antagonizing medial incisors, taking into account the recommendations offered by experts, where a value of 125–140° is typical of mesotrusion. An increase or a decrease in the angle points at the retrusive or protrusive types, respectively.

Group 1 included 32 children with incisors were located by the mesotrusive type; Group 2 were 26 patients with the protrusive type of incisor arrangement, and Group 3 included 18 children who featured the retrusive position of the incisors with an optimal amount of incisor overlap, both vertically and horizontally. The relationship of antagonists, in all pairs of jaw models, matched the signs of optimal functional occlusion, following the respective age characteristics (Fig. 1).

Odontometry implied only identifying the mesial-distal diameters of the teeth crowns and calculating the total length of the dental arch (DAL12 teeth) following the total sum component, while there was also the sum of the width of the 4 incisor crowns identified (CW4 incisors) of the upper and the lower jaw, which is a mandatory protocol measure in clinical orthodontics.

The transversal dimensions included an analysis of the dental arch width between the first permanent molars located on the 6th position in the dental arch (DAW6-6). The width of the anterior dental arch was measured between the contact points of the distal surfaces of the lateral incisors located the 2nd in the dental arch (IW2-2).

The size of the incisor-molar diagonal was measured from the interincisal point (the first position of the teeth in the arch) to the distal vestibular tubercle of the sixth tooth (IMD1-6). In the anterior part, the incisor diagonal (ID1-2) was measured from the interincisal point to the distal contact point of the permanent lateral incisor with a milk canine and, actually, was close to the sum total component of the incisor crowns width in the examined part of the dental arch.

The depth of the anterior (incisal) part of the arch (IDep1-2) was measured sagittally from the interincisal point to the conditional line connecting the distal surfaces of the lateral incisors.

The obtained linear dimensions allowed using geometrical methods to design diagnostic dental pentagons, where the base was the dental arch molar width, whereas the height corresponded to the dental arch depth. The anterior part of the pentagon was shaped by an isosceles incisor triangle, the sides of that corresponding to the dimensions of the incisor diagonals, its base being the width between the incisors, while the height of the triangle corresponded to the incisor depth. The sides of the pentagon connected the lateral incisor distal point with the distal vestibular odontomer of the six-year molar (Fig. 2).

The main angles of the pentagon (incisor, canine and molar) were measured with the calculation of the sum total component for all the trusive variants of dental arches.

The statistical processing of the obtained data was performed with Microsoft Excel 2013 software as well as the SPSS Statistics (Version 22) statistical software package. The critical level of a possible null statistical hypothesis was set at 0.05.

RESULTS AND DISCUSSION

Table 1 offers a look at the analysis of the data obtained through measuring the jaw cast models within the period of the transitional occlusion in view of the

Fig. 1. *Occlusion relationships through the transitional occlusion period (a, b) and identifying the incisor angle of antagonists on CBCT (c)*

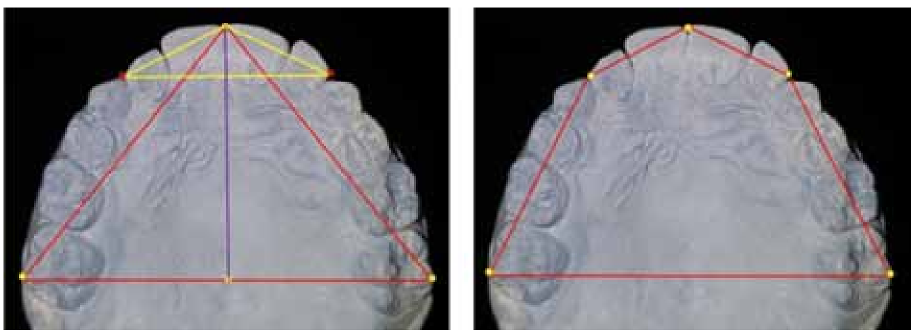

Fig. 2. *Designing diagnostic triangles (a) and the dental arch pentagon (b) on jaw cast model photos featuring transitional occlusion, to measure the angles*

dental arch trusion type, which served the basis for distributing the patients through the groups (Table 1).

Table 1. *Dental arch size in the three groups, (mm), (M±m) (p ≤ 0.05)*

Dental arch parameters	Dental arch size in studied groups					
	Group 1, on arch		Group 2, on arch		Group 3, on arch	
	upper	lower	upper	lower	upper	lower
DAL12 teeth	92.24±1.11	86.70±1.08	100.78±1.14	91.78±1.12	91.55±1.07	85.44±1.09
CW4 incisors	31.02±1.07	22.79±1.04	33.14±0.94	24.50±1.12	27.49±1.15	21.30±0.73
DAW6-6	57.97±1.54	52.28±1.61	60.91±1.49	55.11±1.55	54.13±1.39	48.68±1.42
IMD1-6	44.24±0.62	40.65±0.68	47.57±0.73	42.12±0.59	42.66±0.61	38.52±0.63
DAD1-6	33.42±0.81	31.01±0.73	36.54±0.84	33.93±0.66	31.56±0.59	29.61±0.68
ID1-2	15.51±0.58	11.39±0.47	16.57±0.44	12.25±0.53	14.62±0.56	11.03±0.32
IDep1-2	6.67±0.19	3.87±0.11	8.28±0.13	5.27±0.09	4.96±0.06	2.86±0.04
IW2-2	28.01±1.02	21.43±0.99	28.70±1.04	22.12±0.96	27.49±1.02	21.30±1.05

The patients within the groups revealed certain difference in odontometric indicators that determine the dental arch length (DAL12 teeth). The highest indicators of the parameter in question were to be observed in Group 2 with the protrusive type of dental systems — 100.78±1.14 mm on the upper jaw, and 91.78±1.12 mm — on the lower jaw, which lies within the opinion of experts pointing that with the protrusive type of arch is more commonly associated with the macrodont type of the dental system. A similar, and quite expected, situation was also seen in relation to such an indicator as the total width of the crowns of the 4 incisors in the upper jaw (CW4 incisors), which, upon analysis of the models within Group 2 was found to be at 33.14±0.94 mm, this being above the respective indicators in Groups 1 and 2 (31.02±1.07 mm and 27.49±1.15 mm, respectively).

The transversal parameters, both in the molar (DAW6-6) and in the anterior part (IW2-2) of the dental arches were similar with no significant difference identified between the studied indicators.

A reliable difference ($p<0.05$) was observed when analyzing the dental arch anterior part depth (ID1-2), which was due to the trusive type of arches and the teeth inclination value in the anterior-posterior direction.

The obtained absolute values for transversal, diagonal and sagittal dimensions allowed identifying the index values. The ratio of the dental arch length to the sum total component (IMD1-6) of the incisor-molar diagonals (dental-diagonal factor) in the examined children, for instance, was 1.06±0.01 for the upper jaw and 1.09± 0.01 for the lower arch, and the values now can be used in clinical practice to diagnosis of anomalies in the shape and size of dental arches, specifically in the sagittal and diagonal direction. Besides, the linear parameters of the dental arches allowed — as per each type of dental systems — building individual diagnostic dental pentagons and identifying the features of the major angles: incisor, canine and molar, which can be seen in Table 2.

Table 2. Dental pentagon angles in the groups examined within the study, (°), (M ±m) (p ≤ 0.05)

Major parameters	Dental pentagon angle					
	Group 1, on arch		Group 2, on arch		Group 3, on arch	
	upper	lower	upper	lower	upper	lower
Incisor	131.1±1.69	139.9±1.75	120.7±1.49	130.3±1.53	139.8±1.47	151.0±1.58
Canine	139.6±1.64	136.4±1.59	145.7±1.99	142.5±1.87	132.4±1.89	127.6±1.78
Molar	65.2±1.33	63.7±1.72	64.7±1.76	62.3±1.67	66.4±1.58	67.5±1.49
Sum total	539.6±2.98	540.2±2.85	540.7±2.77	539.7±1.95	540.6±2.09	540.0±2.14

The lowest values for the incisor angle, measured both on the upper and lower dental arch, were obtained while studying models with the protrusive type of incisors (Group 2), whereas the said values were the largest in physiological variants of the retrusive position (Group 3). During that, the canine angles on each side, on the contrary, had a larger value in case of arches falling within the protrusive type — 145.7±1.99° on the upper jaw, and 142.5±1.87° on the lower arch. The lowest value of the pentagon canine angle was detected through the models in Group 3 groups — 132.4±1.89° and 127.6±1.78° on the upper and on the lower jaw, respectively,

Notable is the approximate equality of the molar angles of the pentagon — the analysis of these revealed no significant difference (p<0.05). Given that, children going through the transitional occlusion period with optimal functional bite had the pentagon sum total value within an average of 540°.

CONCLUSIONS

1. The data obtained through clinical, radiological, and morphometric studies helped identify the specific features of the dental arch variant anatomy for the transitional occlusion.

2. The major linear parameters of dental arches within the transitional occlusion period were determined by the trusive types of dental arches as well as the vestibular-lingual inclination of the front teeth.

3. The proposed, explained and calculated index values, which take into account the transversal, the diagonal and the sagittal dimensions of the dental arches enabled to identify the proportion relationship between the odontometric indicators and the parameters of dental arches.

4. The dental-diagonal factor, taken as the ratio of the dental arch length to the incisor-molar diagonals, was 1.06±0.01 for the upper jaw and 1.09±0.01 for the lower jaw, regardless of the dental arch type. This knowledge can be used in clinical orthodontics to forecast the location of the incisor (central) point of the dental arch with shape anomalies, especially in the anterior part.

5. The angular parameters of the diagnostic dental pentagon might allow simulating the geo-metric and graphical construction of arches through the transitional occlusion period.

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