

## INTERRELATION BETWEEN SAGITTAL AND TRANSVERSAL SIZES IN FORM VARIATIONS OF MAXILLARY DENTAL ARCHES

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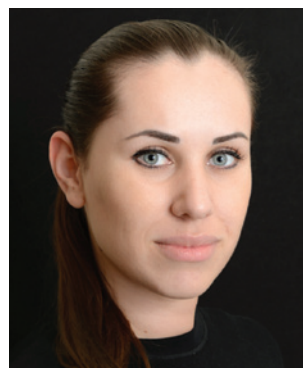
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### ABSTRACT

Interrelation between sagittal and transversal sizes in form variations of maxillary dental arches. Scientific studies and clinical observations confirm that human dental arch forms reveal a great variety. There has been an analysis conducted aiming at detecting the interrelation between sagittal and transversal sizes of maxillary dental arches in 287 patients (both sexes; in their early adulthood, aged 21–35) with physiological occlusion of permanent teeth. Three types of maxillary dental arches were proposed: vestibular dental arch, alveolar lingual (palatal) arch, and dentoalveolar arch. There has been an interrelation established between the sagittal (the depth of the arch) and transversal (the width of the arch) sizes of the maxillary dental arches, and to evaluate the dental arch form it has been recommended to determine the arch index (the ratio between its depth and width). With the dental arch index of  $0.74 \pm 0.03$  the arch form was defined as mesognathic; the dentoalveolar arch and alveolar arch index then was  $0.9 \pm 0.05$ . In case of a dental arch index below 0.7, the dentoalveolar arch and alveolar arch index being less than 0.85, the arch form was viewed as brachygnathic. The form was classified as dolichognathic in case the index went beyond 0.77 with the dentoalveolar arch and alveolar arch indices exceeding 0.95.

Numerous experts for more than a hundred years now have offered description of the shapes and the sizes of maxillary dental arches [1, 5, 6, 7, 8]. The first classification for dental arch forms proposed three main forms – narrowed, square and oval [2]. At the same time, research data and clinical observations suggest that maxillary dental arch forms in humans can be described with considerable diversity. Most researchers evaluated the biometrics of maxillary arches and detected their relation to the size of the teeth and the craniofacial complex [3, 4, 9].

In the literature available, we did not find any data on the relationship between the sagittal and the transversal sizes of maxillary dental arches in view of the variety of their shapes, namely mesognathic, dolichognathic, and brachygnathic, which has stood to be



the objective of the present study.

There has been an analysis conducted regarding the sagittal and transversal sizes in maxillary dental arches in 287 patients (both sexes; in their early adulthood) with physiological occlusion of permanent teeth.

Three types of maxillary dental arches have been proposed – the vestibular dental arch, the alveolar

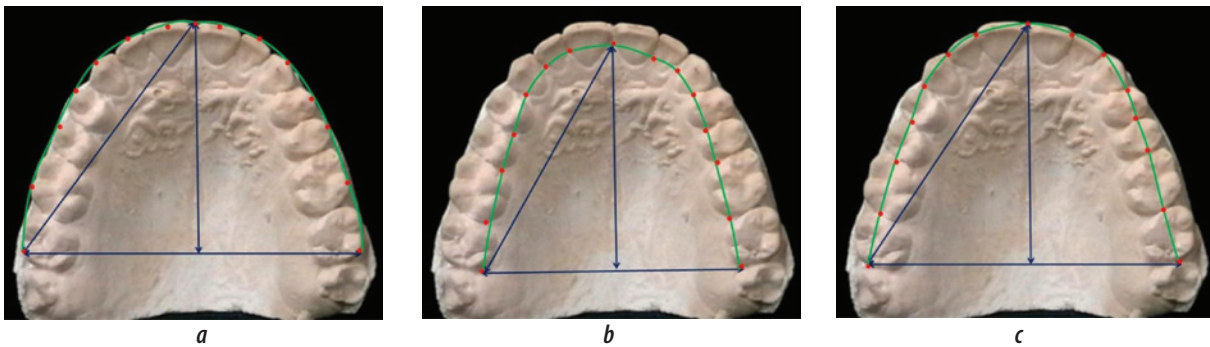


Fig. 1. Maxillary cast models with the contours of the dental arch (a), the alveolar arch (b), and the dentoalveolar arch (c).

lingual (palatal) arch, and the dentoalveolar arch. The cast models of the upper jaw were dotted in order to constructing and morphometric measurements in the maxillary dental arches. When studying the dental arch, the main points were set in the middle of the vestibular surface of the incisors, canines and premolars' occlusal contour (the most prominent part in the vestibular contour of the tooth crown' occlusal surface); the most protruding points on the vestibular contour' occlusal surface of the vestibular distal cusps were marked on the molars. The alveolar lingual (palatal) arch was formed through connecting the dots located at the lingual surface of the dental arch in the interdental spaces. When studying the dental arch the dots were set in the middle of the teeth crowns' distal surface in proximity of the occlusal contour (Fig. 1).

The key parameters for measuring the maxillary dental arches included the arch length, width, and depth as well as the frontal distal diagonal. The longitudinal length of the dentition was detected through the Nance method as a sum of the mesial distal diameters of the compounding teeth. The third molars were not included in the measurements due to being the most variable ones.

When measuring the dental arch and the dentoalveolar arch, the frontal vestibular point was arranged amidst the medial incisors. The width of the maxillary arches (dental arch, dentoalveolar arch, and alveolar arch) was measured between the second molars ( $W_d^{7-7}$ ,  $W_{da}^{7-7}$  and  $W_a^{7-7}$ ). The depth of the arch ( $D_d^{1-7}$ ,  $D_{da}^{1-7}$  и  $D_a^{1-7}$ ) was determined as a distance from the frontal vestibular point to the line connecting the corresponding points of the second molars along the projection of the median palatal suture.

The arch form was defined through the arch index (the ratio between its depth and width). The maxillary dental arch form was defined as mesognathic in the cases where the dental arch index was  $0.74 \pm 0.03$ ,

that of the dentoalveolar the alveolar arch –  $0.9 \pm 0.05$ , regardless of the teeth size (macrodontia, microdontia or normal teeth size). For the brachygnathic form the dental arch index was below 0.7, the indices of the dentoalveolar and the alveolar arches being less than 0.85. In the event the dental arch index went beyond 0.77, that in the dentoalveolar and the alveolar arches exceeding 0.95, the form was classified as dolichognathic.

To estimate the size of the teeth we used the mean module of the molar crowns (half-sum of the first and second molar crowns modules). The crown module was calculated employing the A.A. Zubov method, taken as half-sum of the vestibular lingual and the mesial distal diameters of the tooth crown. The mean module of the molar crowns residing in the range of 10.6 – 11 mm was viewed as normal teeth size. A reduced value was typical of microdontia, while the value's increase was indicative of macrodontia in the permanent molars.

The outcomes suggest that in case of physiological occlusion of permanent teeth there were nine major types of maxillary dental arches to be found. Individuals with the mesognathic, brachygnathic, and dolichognathic arch forms revealed variants of microdontia, normal teeth size, and macrodontia of the permanent molars. There also has been an investigation into the parameters of the dental, the alveolar, and the dentoalveolar arches in patients with the above-mentioned forms of maxillary dental arches.

The study has shown that, regardless of the form of the maxillary arches and the teeth size, the matching index for the teeth size in relation to the frontal distal diagonal (the ratio between the sum of the mesial distal diameters of the seven teeth on one side to the length of the frontal distal diagonal) was stable, and for the dental arches it was  $1.06 \pm 0.01$ , for the dentoalveolar arches –  $1.07 \pm 0.01$ , while for the alveolar arches it was  $1.14 \pm 0.01$ . This index is of high pragmatic value

and allows determining whether or not the size of teeth conforms to the size of the jaws, as well as it allows predicting a deficit or an excess of space in the jaw bones for permanent teeth. Mention to be made here that the dental arch length (which is the sum of the mesial distal diameters of 14 teeth) in case of normal teeth size in the permanent teeth averaged  $115.11 \pm 4.21$  mm. In case of macrodontia the dental arch length was over 120 mm with an average of  $124.14 \pm 4.37$  mm. For microdontia it was typical to have the dental arch length less than 110 mm with its value being  $105.34 \pm 4.64$  mm.

We have studied the main parameters in the dental, the alveolar and the dentoalveolar arches also evaluating the interrelation between the major points.

Table 1 contains the results obtained through a study of the dental arches.

The outcomes have shown that under macrodontia of permanent teeth virtually all the measurements in the dental arches were significantly higher than in case of microdontia. The major indicator for the teeth size was the frontal distal diagonal (FDDd1-7).

During that, the key indicator for the dental arch form was the dental arch index, and the ratio between the depth of the dental arch (Dd1-7) and the width between the second permanent molars in those with mesognathic dental arch was  $0.75 \pm 0.03$  for normal teeth size,  $0.74 \pm 0.03$  – for macrodontia, and  $0.73 \pm 0.03$  – under microdontia. Thus, the dental arch index in case of mesognathia averaged  $0.75 \pm 0.03$ , depended on the ratio of sagittal and transversal dimensions, and revealed absolutely no dependence on the actual sizes of the teeth. The dental arch index for dolichognathic form was, on average,  $0.81 \pm 0.02$ , while in case of brachygnathic form it averaged  $0.68 \pm 0.02$ . Note to be made here of the ratio of the dental arch depth ( $D_d^{1-7}$ ) to the depth of the anterior part of the arch ( $D_d^{1-3}$ ), which in case of mesognathia was  $4.81 \pm 0.03$ , for dolichognathia –  $3.73 \pm 0.03$ , while under brachygnathia it was  $4.97 \pm 0.04$ .

Table 2 contains the results of the study in relation to the alveolar arches measurements.

The results showed that the absolute values of the alveolar arches' parameters were significantly lower if compared to the dental ones. However, the comparative measures revealed the same proportional relationships. The ratio of the depth of the alveolar arch ( $D_a^{1-7}$ ) to the width between the second permanent molars ( $W_a^{7-7}$ ) in those with the mesognathic arch was  $0.93 \pm 0.02$  for the normal teeth size,  $0.9 \pm 0.03$  – for macrodontia, and  $0.89 \pm 0.03$  – in case of microdontia of the permanent teeth. The ratio of the depth of the alveolar arch ( $D_a^{1-7}$ ) to the depth of the anterior part of the arch ( $D_a^{1-3}$ ) under mesognathia was  $4.3 \pm 0.03$ , while

for dolichognathia it was  $3.6 \pm 0.04$ , and for brachygnathia –  $4.95 \pm 0.04$ , coinciding with the similar dental arch indices.

Table 3 offers the study results regarding the dentoalveolar arches.

The dentoalveolar arch index in people with mesognathic arch form was  $0.93 \pm 0.02$  for normal teeth size,  $0.92 \pm 0.03$  – for macrodontia, and  $0.91 \pm 0.03$  – for microdontia. Therefore, the dentoalveolar arch index under mesognathia averaged  $0.91 \pm 0.03$  and depended on the ratio of the sagittal and the transversal dimensions, while being virtually irrespective of the actual sizes of the teeth. The dentoalveolar arch index in case of the dolichognathic form was, on average,  $0.97 \pm 0.02$ , while for the brachygnathic form it was  $0.79 \pm 0.03$ . The fact that stands out here is the ratio of the depth of the dentoalveolar arch ( $D_d^{1-7}$ ) to the depth of the anterior part of the arch ( $D_d^{1-3}$ ), which under mesognathia was  $3.53 \pm 0.03$ , under dolichognathia –  $3.01 \pm 0.03$ , being equal to  $3.99 \pm 0.04$  for brachygnathia.

Hence, each of the maxillary arch forms has typical major parameters, which may prove useful when determining the size of the metal arcs implemented at various stages of orthodontic treatment.

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**Table 1.** The main parameters of the dental arches in case of their form variations

Forms of the dental arches	Main measurements in dental arches (mm)				
	$W_d^{7-7}$	$D_d^{1-7}$	$W_d^{3-3}$	$D_d^{1-3}$	$FDD_d^{1-7}$
Mesognathic, normal teeth size	57.48 ± 1.54	43.11 ± 0.93	36.08 ± 0.67	9.22 ± 0.36	52.12 ± 1.42
Mesognathic macrodontia	64.28 ± 1.61	47.45 ± 1.08	35.96 ± 1.14	10.85 ± 0.55	57.42 ± 1.63
Mesognathic microdontia	55.17 ± 1.39	40.16 ± 0.87	36.03 ± 0.78	7.46 ± 0.32	48.73 ± 1.38
Dolichognathic, normal teeth size	59.83 ± 1.69	47.45 ± 1.29	37.04 ± 0.92	11.32 ± 0.68	56.09 ± 1.54
Dolichognathic macrodontia	61.17 ± 1.82	50.78 ± 1.93	38.41 ± 1.16	15.03 ± 1.51	59.28 ± 1.97
Dolichognathic microdontia	55.07 ± 1.33	43.47 ± 1.12	36.67 ± 0.72	12.01 ± 1.24	51.08 ± 1.23
Brachygnathic, normal teeth size	61.98 ± 1.95	42.02 ± 1.09	35.81 ± 0.91	7.98 ± 0.41	51.98 ± 1.39
Brachygnathic macrodontia	66.32 ± 2.04	44.52 ± 1.25	35.04 ± 1.08	9.37 ± 0.74	56.06 ± 1.73
Brachygnathic microdontia	57.54 ± 1.43	38.68 ± 0.86	32.42 ± 0.59	7.92 ± 0.41	48.31 ± 1.29

**Table 2.** The main parameters of the alveolar arches in case of their form variations

Arch forms	Main measurements in alveolar arches (mm)				
	$W_a^{7-7}$	$D_a^{1-7}$	$W_a^{3-3}$	$D_a^{1-3}$	$FDD_a^{1-7}$
Mesognathic, normal teeth size	46.21 ± 2.03	43.12 ± 0.59	33.79 ± 1.34	9.56 ± 0.74	48.31 ± 0.86
Mesognathic macrodontia	54.03 ± 2.36	48.51 ± 1.24	32.47 ± 0.95	11.84 ± 1.22	52.96 ± 1.75
Mesognathic microdontia	44.52 ± 1.99	39.03 ± 0.82	31.21 ± 0.96	9.09 ± 0.57	44.82 ± 1.31
Dolichognathic, normal teeth size	49.02 ± 1.36	48.02 ± 1.12	31.03 ± 0.89	13.03 ± 1.14	52.04 ± 1.48
Dolichognathic macrodontia	50.48 ± 1.94	49.53 ± 1.67	36.01 ± 1.23	14.48 ± 1.54	55.11 ± 1.76
Dolichognathic microdontia	44.51 ± 1.13	43.04 ± 1.09	31.97 ± 0.91	12.04 ± 1.11	47.29 ± 1.42
Brachygnathic, normal teeth size	52.04 ± 1.19	40.47 ± 1.05	32.96 ± 1.45	9.48 ± 0.47	48.47 ± 1.35
Brachygnathic macrodontia	54.49 ± 1.88	44.95 ± 1.21	33.01 ± 1.15	9.51 ± 0.88	52.19 ± 1.65
Brachygnathic microdontia	46.52 ± 1.21	38.93 ± 0.81	32.38 ± 0.62	7.89 ± 0.38	44.72 ± 1.07

**Table 3.** The main parameters of the dentoalveolar arches in case of their form variations

Arch forms	Main measurements in dentoalveolar arches (mm)				
	$W_{da}^{7-7}$	$D_{da}^{1-7}$	$W_{da}^{3-3}$	$D_{da}^{1-3}$	$FDD_{da}^{1-7}$
Mesognathic, normal teeth size	49.51 ± 1.52	46.03 ± 1.13	38.48 ± 1.03	13.02 ± 0.78	51.71 ± 1.54
Mesognathic macrodontia	56.49 ± 1.82	50.98 ± 1.53	38.61 ± 1.44	14.39 ± 1.03	56.68 ± 1.69
Mesognathic microdontia	48.03 ± 1.55	43.31 ± 1.21	33.47 ± 1.07	12.41 ± 1.01	48.29 ± 1.13
Dolichognathic, normal teeth size	51.49 ± 1.92	50.02 ± 1.34	36.61 ± 1.12	17.04 ± 1.09	56.11 ± 1.66
Dolichognathic macrodontia	54.53 ± 1.73	53.96 ± 1.88	38.48 ± 1.12	18.02 ± 1.57	59.19 ± 2.08
Dolichognathic microdontia	48.51 ± 1.42	46.22 ± 1.23	36.19 ± 1.08	14.99 ± 1.22	51.03 ± 1.12
Brachygnathic, normal teeth size	55.04 ± 1.89	43.33 ± 1.17	37.51 ± 1.19	11.48 ± 1.04	52.01 ± 1.13
Brachygnathic macrodontia	58.68 ± 1.84	46.48 ± 1.29	38.49 ± 1.27	11.51 ± 1.05	55.29 ± 1.54
Brachygnathic microdontia	50.96 ± 1.31	41.52 ± 1.18	35.52 ± 1.15	10.02 ± 1.11	48.04 ± 1.32