

# Facial type measurements influence on transverse dimensions of normal occlusion arches

*Influência das medidas do tipo facial nas dimensões transversas das arcadas em oclusão normal*

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## Abstract

**Objective** – To correlate facial type measurements of Caucasian individuals with transverse dimensions of normal occlusion arches. **Methods** – Twenty-one pairs of dental models were selected according to the following inclusion criteria: presence of all permanent teeth from 1<sup>st</sup> molar to 1<sup>st</sup> molar; normal occlusion; no prosthetic crowns; no previous orthodontic treatment and 2 mm or less of crowding or spacings. The cephalometric measurements of lateral cephalometric X-ray of the same individuals were taken and tabulated. To evaluate the repetition of arch measurements, paired Student's t-test and Pearson's correlation coefficient were used. The relationship between the measurements was analysed by using the Pearson's correlation. **Results** – The repetition of the measurements showed high correlation and no systematic error. In the comparison between the measurements, a moderate negative correlation was observed between facial axis angle and the measurements Upper and Lower 6-6, whereas a positive correlation was observed between dentition height and the latter. **Conclusion** – It was observed a negative correlation between facial axis angle and upper and lower inter-molar distance as well as a positive correlation between dentition height and upper and lower inter-molar distance.

**Descriptors:** Face; Dental models; Dental arch

## Resumo

**Objetivo** – Correlacionar medidas do tipo facial, em indivíduos leucodermas, com dimensões transversas das arcadas em oclusão normal. **Métodos** – Vinte e um pares de modelos de gesso foram selecionados de acordo com os requisitos de inclusão: presença de todos os dentes permanentes de 1º molar a 1º molar; oclusão normal; sem coroas protéticas; nenhum tratamento ortodôntico prévio e apinhamentos ou espaçamentos menores ou iguais a 2 milímetros. As medidas cefalométricas das telerradiografias laterais destes mesmos indivíduos foram consultadas e tabuladas. Para a avaliação da repetibilidade das medidas das arcadas foram utilizados o teste t de Student pareado e o coeficiente de Pearson. O grau de associação entre as medidas foi analisado pelo coeficiente de correlação de Pearson. **Resultados** – A repetibilidade de medidas demonstrou alta correlação e ausência de erro sistemático. Na comparação entre as medidas houve correlação negativa moderada do ângulo do eixo facial com as medidas Sup 6-6 e Inf 6-6 e correlação positiva da altura da dentição com as medidas Sup 6-6 e Inf 6-6. **Conclusão** – Houve correlação negativa entre ângulo do eixo facial e as distâncias intermolares superiores e inferiores e, correlação positiva entre a altura da dentição e as distâncias intermolares superiores e inferiores.

**Descriptores:** Face; Modelos dentários; Arco dental

## Introduction

The earliest dental studies were already concerned about the harmful effects of malocclusion, such as the distortion of normal lines of the face. One of the objectives of orthodontics is to harmonise these lines with ideal facial features of beauty according to the individuality of each case. Therefore, it is important to keep in mind the contours of a perfect face as well as the normal dental occlusion as a model from which deviations can be observed<sup>1</sup>. Dental arches exhibiting perfect intercuspidation of the teeth and balanced function are fundamental for diagnosing occlusion and maintaining its stability. Functional changes cause physiological imbalance in the muscle pressure exerted on dental arches, often resulting in discrepancies like maxillary deficiency.

Cephalometric analyses and study models are crucial tools for diagnosis and planning of clinical cases in orthodontics and facial orthopedics. Adding this information to clinical aspects, the practitioner can better individualise their treatment planning. With regard to the type of face, there are individuals tending to have a vertical pattern with more elongated face, whereas others have a hori-

zontal trend with wider face. Among these groups, there are also individuals presenting an average face in which the vertical and horizontal proportions are in greater balance. The relationship between dental arch characteristics and facial type can help the practitioner to individualise the treatment, thus optimising the response to orthodontic therapy. For individualisation of the orthodontic treatment planning, the practitioner should know the characteristics of normality according to age, gender, ethnic group, and facial type. However, there has been little research on the facial relationship between vertical morphology and dental arches with normal occlusion<sup>2</sup>.

The objective of the present work was to correlate facial type measurements obtained from Ricketts cephalometric analysis<sup>3</sup> of Caucasian individuals to those from transverse dimensions on dental models with normal occlusion.

## Methods

Twenty-one pairs of orthodontic dental models from Brazilian Caucasian white students aged 12-17 years old, all presenting normal occlusion, were selected for study.

The cephalometric measurements of lateral teleradiographs of these individuals were obtained from the Prof. Kurt Faltin Jr's archive, with data being entered into an electronic spreadsheet (Microsoft<sup>TM</sup> Office Excel, version, 2007). The UNESP-Araraquara research ethics committee has previously approved the study (Protocol #30/09).

When the original dental models were made, irreversible hydrocolloid material (alginate) was used for the impressions of the dental models while wax bite record was obtained at centric occlusion. The resulting mouldings were filled with orthodontic plaster to produce the study models. The bases of the models were trimmed, according to Balters<sup>4</sup> (1969), following the Camper's plane as reference.

Transverse analysis of dental arches performed on the dental models was based on the landmarks of Pont's analysis, with landmarks modified by Korkhaus<sup>5</sup>. These landmarks are located at the pre-molar and molar regions, corresponding to the centre of mesio-distal sulcus of upper first pre-molars and to the central fossa of upper first molars, whereas the most anterior landmarks are buccally located at the contact point between lower first and second pre-molars and more posteriorly at the tip of the central buccal cusp of lower first molars. The distances between landmarks located on pre-molars and between those located on upper and lower molars were measured by means of digital calliper (DIGIMESS<sup>TM</sup>) and are the following:

- Upper 4-4: Distance between the centres of mesio-distal sulcus of upper first pre-molars;
- Upper 6-6: Distance between central fossae of upper first molars;
- Lower 4-4: Distance between the buccal faces of lower first pre-molars;
- Lower 6-6: Distance between the tips of the central buccal cusp of lower first molars.

These distances were correlated to the facial type measurements proposed in the Ricketts cephalometric analysis<sup>3</sup>, namely: facial axis angle (FAA), which is the posterior-lower angle measurement formed by the intersection of facial axis (pterygoid-gnathion) with basion-nasion plane; total facial height (TFH), which is the anterior-lower angle measurement formed by basion-nasion plane and mandible body, that is, Xi-PM (centre of the ascending ramus to mentonian process); and dentition height (DH), which is the anterior-lower angle measurement formed by Xi-ENA (centre of the ascending ramus to anterior nasal spine) and Xi-PM (centre of the ascending ramus to mentonian process). The measurements of these angles were only obtained and tabulated as they had already been traced for standardisation of the use of the sample.

For assessment of the repetition of transverse arch dimensions on dental models, which was performed by the same examiner, Student's paired t-test was used for verifying systematic error while Pearson's correlation coefficient for determining the degree of relationship between both measurements at a 1-week interval. It is important to point out that such assessment was carried out only for arch measurements.

The degree of correlation between the pairs of measurements was analysed by using the Pearson's correlation

coefficient. All statistical analyses were performed at 5% significance level.

## Results

Assessment of the repetition of transverse measurements has shown a correlation higher than 0.995. Student's t-test indicated no existence of systematic error from one measurement to another ( $p > 0.05$ ).

Higher correlation was observed in transverse arch measurements for pairs of plaster casts: Upper 4-4 and Lower 4-4 had correlation coefficient of 0.701, whereas Upper 6-6 and Lower 6-6 had 0.925. Among the variables obtained from cephalometric measurements, FAA was found to be negatively correlated to TFH and DH, thus showing correlation coefficients of -0.856 and -0.797, respectively. On the other hand, the correlation coefficient was positive (0.760) between TFH and DH.

Table 1 lists the Pearson's correlation coefficients between transverse measurements of the arches and cephalometric measurements which determine the facial type. The measurements showing statistically significant correlation were the following: facial axis angle (FAA), which had negative correlation with arch measurements (Upper 6-6 and Lower 6-6), and dentition height (DH), which had positive correlation with the latter. However, correlations were moderate despite being significant.

**Table 1. Pearson's correlation coefficient**

Models	Cephalometric measures		
	F.A.A.	T.F.H.	D.H.
Upper 4-4	-0.166 p=0.473	0.114 p=0.623	0.33 p=0.144
Upper 6-6	-0.576 p=0.006**	0.367 p=0.102	0.492 p=0.023*
Lower 4-4	-0.27 p=0.237	0.218 p=0.343	0.394 p=0.077
Lower 6-6	-0.531 p=0.013*	0.287 p=0.207	0.51 p=0.018*

(\*)  $0.01 < p \leq 0.05$  (\*\*)  $p \leq 0.01$

## Discussion

In the present study, only individuals with normal occlusion have been evaluated because they were less likely to have dental compensations compared to those cases of malocclusion, since some authors studying the dental arch width observed that malocclusions can be originated from upper posterior teeth<sup>6</sup>.

In order to standardise the sample, only Caucasian individuals were selected for study as there is ethnic influence on the measurements of skeleton<sup>7-8</sup>, teeth and soft tissue<sup>7</sup>.

The transverse arch measurements on dental models showed correlations between upper and lower inter-premolar dimensions as well as between upper and lower inter-molar dimensions. In the cases of normal occlusion, the transverse distances in upper arch are equivalent to those in lower arch at the pre-molar and molar regions, thus indicating a good transverse relationship with no cross-bite or atresia. With regard to the posterior-anterior

cephalometry, all dental measurements were found to be highly correlated between themselves<sup>9</sup>.

With regard to angular variables, the facial axis angle was negatively correlated with dentition height and total facial height. This occurred due to the fact that the facial axis angle was measured at the lower-posterior region of the intersection between facial axis and basion-nasion plane, meaning that the greater the angle the less the dentition and total facial heights. The contrary is also true.

The comparison of facial measurements with transverse arch dimensions showed that facial axis angles had a negative correlation in relation to upper and lower inter-molar distances. On the other hand, dentition height had a positive but moderate correlation. Despite the tendency of one measurement to follow another one's variation, one cannot state that a given variation in facial measurement will predict the variation in transverse arch measurement. These results can be related to the fact that molars tend to incline buccally as the mandibular width increases<sup>10</sup>. Because of the increase in vertical dimensions, the upper posterior teeth become buccally inclined and consequently there is a tendency of greater lingual inclination for decreased vertical dimensions<sup>11</sup>.

On the other hand, cephalometric posterior-anterior measurements showed that smaller skeletal and dental widths were found in vertical facial patterns,<sup>10</sup> whereas the maxillary-mandibular difference in molars was the same<sup>12</sup>.

A study reported that Caucasian individuals are more likely to have normal occlusion in the horizontal facial pattern as they presented greater inter-canine and inter-molar distances<sup>13</sup>, which is in opposition to our findings. In another study on cases of 9-mm crowding or spacing, it was observed that arch widths tend to decrease as facial pattern becomes more vertical. On the other hand, lower arch exhibited no narrowing of inter-molar width with the vertical increase of the face<sup>14</sup>, but controversy does exist<sup>15</sup>.

Rather than dividing the sample into three facial types, the present work has aimed at using angles of this facial pattern and correlating them to transverse measurements of the dental arches. Those cases of severe vertical patterns were not observed in the sample because they are probably seldom found in individuals with normal occlusion.

The morphological characteristics related to masticatory functions and facial types have been associated with thickness of mandibular cortical bone and buccal-lingual inclination of first and second molars. The masticatory muscle activity has influence on occlusion, form of dental arches and mandibular shape. Lower molars erupt lingually and then incline buccally due to tongue pressure and masticatory function, thus occupying a position of equilibrium between lingual and buccal pressures. When the lingual volume of long-face individuals is equal to that of short-face ones, their molars receive a high pressure despite the narrowed arch and verticalisation occurs as a result. The buccal cortical bone thickness is greater in short-face individuals than in long-face ones, and during the masticatory function teeth are supported by this massive bone structure, leading to a lingual inclination greater than that in individuals with average and vertical facial types<sup>16</sup>. Such evidence suggests that measurements of transverse mandibular dimensions

found in the present study are due to dental inclinations resulting from physiological muscle stress. Patients with oral habits or using oral breathing devices with muscle imbalance can have a decrease in the mandibular inter-canine distance as well as in both mandibular and maxillary inter-molar distances<sup>17</sup>.

Those results obtained called the orthodontist and facial orthopedics professional attention because it considers only normal relationships that happens in a very few cases even in early dentition stages<sup>18</sup>, because it depends on anatomical and functional characteristics working together to achieve and maintain the balance. Because the cases in the present study exhibited normal occlusion, it is likely that functional balance was present in all facial patterns. The correlations found between dental and facial measurements may be the result of physiological muscle stress.

## Conclusion

In the sample of the present study, it was observed a negative correlation between facial axis angle and inter-molar distances in upper and lower arches as well as a positive but moderate correlation between dentition height and inter-molar distances in both arches.

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