

## Relationship between maxillary and mandibular base lengths and dental crowding in patients with complete Class II malocclusions

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### ABSTRACT

**Objective:** To verify the relationship between maxillary and mandibular effective lengths and dental crowding in patients with Class II malocclusions.

**Materials and Methods:** The sample comprised 80 orthodontic patients with complete Class II malocclusions in the permanent dentition (47 male, 33 female) who were divided into two groups according to the amount of mandibular tooth-arch size discrepancy. The maxillary and mandibular effective lengths (Co-A and Co-Gn) and tooth-arch size discrepancies were measured on the initial cephalograms and dental casts, respectively. Intergroup comparisons of apical base lengths were performed with independent *t*-tests. Correlation between base length and dental crowding was examined by means of Pearson's correlation coefficient ( $P < .05$ ).

**Results:** Patients with Class II malocclusion and moderate to severe crowding had significantly smaller maxillary and mandibular effective lengths than subjects with the same malocclusion and slight mandibular crowding. A weak inverse correlation was also found between maxillary and mandibular effective lengths and the severity of dental crowding.

**Conclusion:** Decreased maxillary and mandibular effective lengths constitute an important factor associated with dental crowding in patients with complete Class II malocclusion. (*Angle Orthod.* 2011;81:217–221.)

**KEY WORDS:** Dental crowding; Class II malocclusion; Apical base length

### INTRODUCTION

Anterior crowding is one of the most common problems that motivate patients to seek orthodontic treatment. Dental crowding can be defined as a discrepancy between tooth size and arch size that results in malposition and/or rotation of teeth. Many factors have been evaluated and found to be related to anterior dental crowding,<sup>1–13</sup> including dental arch

width<sup>14–16</sup> and length,<sup>10,14,17–19</sup> mesiodistal tooth diameter,<sup>1,2,8,9,20,21</sup> and dental proportions.<sup>22–24</sup>

Additionally, some cephalometric features are associated with a greater amount of dental crowding. Sakuda et al.<sup>25</sup> found that patients with crowding in the permanent dentition had a smaller mandibular body length. Leighton and Hunter<sup>5</sup> observed a smaller mandibular body length in patients with severe crowding in the mixed and permanent dentition. Berg<sup>26</sup> compared a group of subjects with normal occlusion and a group of patients with dental crowding of at least 3.5 mm in the permanent dentition and found that the group with dental crowding showed a significantly smaller mandibular length compared to the sample with normal occlusion. None of these studies specified the type of malocclusion of the sample. Turkkahraman and Sayin<sup>27</sup> compared patients with and without anterior crowding who presented Class I facial pattern in the early mixed dentition. They observed that patients with incisor crowding showed a shorter maxillary and mandibular length.

In general, patients with Class II malocclusion have a smaller mandibular length than subjects with normal occlusion and Class I malocclusion.<sup>28–31</sup> However, the relationship between apical base length and anterior

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dental crowding in a sample with Class II malocclusions exclusively has not been investigated. Therefore, the objective of this study was to evaluate the relationship of maxillary and mandibular effective lengths to the amount of anterior dental crowding in patients with complete Class II malocclusion. The null hypothesis tested was that patients with complete Class II malocclusions and mandibular crowding  $\geq 3$  mm have similar apical base effective lengths as patients with the same malocclusion and mandibular crowding  $< 3$  mm.

## MATERIALS AND METHODS

The sample was retrospectively selected from the files of the Orthodontic Department at Bauru Dental School, University of São Paulo. The inclusion criteria were presence of a complete (full cusp) bilateral Class II malocclusion (molar relationship)<sup>32,33</sup> with no open-bite or crossbite; presence of all permanent teeth up to the first molars; absence of proximal decay or restoration; and absence of dental anomalies of number, size, form, and position. Eighty patients (47 male, 33 female) who satisfied the inclusion criteria were selected. The sample was divided into two groups according to severity of pretreatment mandibular anterior crowding. Group 1 consisted of 25 patients (15 male, 10 female) with a mean age of 12.81 years (SD = 1.74; range = 10.67–18.33 years) and crowding  $\geq 3$  mm. Group 2 had 55 patients (32 male, 23 female) with a mean age of 13.33 years (SD = 1.36; range = 11.08–18.25 years) and crowding  $< 3$  mm.

Measurements were performed on pretreatment dental casts and lateral headfilms. Mandibular and maxillary crowding were calculated as the difference between arch perimeter and the sum of tooth widths from the second premolar to the second premolar on the other side, in millimeters, and calculated by a single examiner. The arch perimeter was measured from the mesial aspect of the permanent first molar to its antimere with a brass wire.<sup>34</sup> In a well-aligned arch, arch perimeter was equal to the sum of the tooth widths. Negative values indicated crowding.<sup>35</sup>

Anatomic tracings and location of dentoskeletal landmarks were manually conducted by a single investigator and digitized (Numonics AccuGrid XNT, model A30TL.F, Numonics Corporation, Montgomeryville, PA). These data were then stored in a computer and analyzed with Dentofacial Planner 7.02 Plus (Dentofacial Software Inc, Toronto, Ontario, Canada). This software corrected the image magnification factors of the radiographic images that were between 8% and 12% and measured the cephalometric variables (Figure 1).

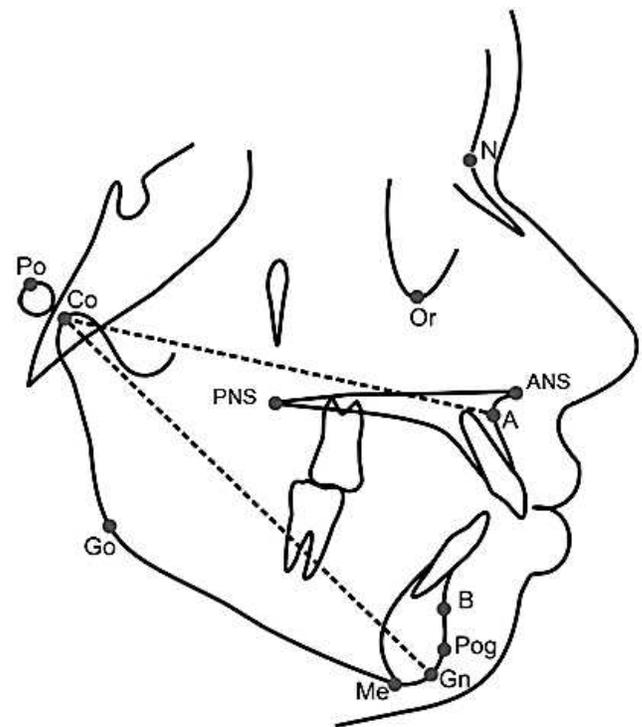


Figure 1. Cephalometric variables measured.

## Error Study

A month after the first measurements, 40 pairs of dental casts (20 of each group) were remeasured and 40 randomly selected radiographs were retraced and redigitized by the same examiner (O.M.) Casual errors were calculated according to Dahlberg's formula ( $Se^2 = \Sigma d^2/2n$ ) where  $Se^2$  is the error variance and  $d$  is the difference between two determinations of the same variable.<sup>36</sup> Systematic errors were evaluated with dependent  $t$ -tests<sup>36</sup> at a significance level of 5%.

## Statistical Analyses

Intergroup compatibility for initial age and sex distribution was evaluated with  $t$ -tests and  $\chi^2$  tests, respectively. The cephalometric variables were compared between the groups with  $t$ -tests. Correlation between maxillary and mandibular effective lengths and dental crowding severity was investigated with the Pearson correlation coefficient. Statistical analyses were performed with Statistica software (Statistica for Windows, version 6.0, Statsoft, Tulsa, OK) at  $P < .05$ .

## RESULTS

There were no systematic errors. The casual errors ranged from 0.26 mm (maxillary crowding) to 0.68 mm (Co-A), which are within the acceptable range in cephalometric studies.<sup>36–40</sup> The groups were compatible in terms of age and sex distribution (Table 1).

**Table 1.** Compatibility Between the Groups: Age and Sex (Proportion)

	Group 1 (n = 25) Mandibular Crowding ≥3mm		Group 2 (n = 55) Mandibular Crowding <3mm		t -test	P Value
	Mean	SD	Mean	SD		
Age	12.81	1.74	13.33	1.36	-.514	.1552
	N	%	n	%	χ <sup>2</sup>	P Value
Male	15	60	32	58	.23	.878
Female	10	40	23	42		

According to the selection criteria, there were significant intergroup differences in maxillary and mandibular crowding (Table 2). Maxillary and mandibular effective lengths were significantly smaller in group 1 (crowding ≥3 mm) than in group 2 (crowding <3 mm).

The hypothesis was rejected. There were significant weak to moderate inverse correlations between apical base effective lengths and maxillary and mandibular crowding and moderate to strong positive correlations between maxillary and mandibular crowding and between maxillary and mandibular effective lengths (Table 3).

**DISCUSSION**

**Sample Selection**

The groups under investigation included only patients with complete bilateral Class II molar relationship so that Class II malocclusions could be clearly characterized.<sup>32,33</sup>

Group selection according to the severity of mandibular dental crowding used 3-mm crowding as a limit for group assignment as previously described.<sup>10</sup> In this way, group 1 consisted of patients with moderate to severe crowding whereas group 2 had patients without crowding or with slight crowding. Only three patients in group 2 had spacing in the mandibular dental arch, with a maximum of 3 mm of positive discrepancy. Some previous studies used 4-mm crowding as the splitting limit; however, this criteria could have further reduced the number of patients in group 1.<sup>2,3,5</sup> Experimental groups with large numbers of individuals are difficult to find when the selection criteria are highly specific.<sup>41,42</sup>

**Table 3.** Correlations Between Apical Base Length and Dental Crowding (Pearson Correlations)

	R	P
Mandibular crowding × Co-A	-.367	.001
Mandibular crowding × Co-Gn	-.317	.004
Maxillary crowding × Co-A	-.531	<.001
Maxillary crowding × Co-Gn	-.339	.002
Maxillary crowding × mandibular crowding	.634	<.001
Co-A × Co-Gn	.696	<.001

Among patients with complete Class II malocclusion, it is interesting that the majority showed slight or absence of mandibular crowding (n = 55) but only 31.25% of the total sample showed moderate to severe crowding (n = 25). The mandibular incisor labial tipping observed as a natural compensation of Class II malocclusion may have helped decrease the amount of crowding.<sup>30,43</sup>

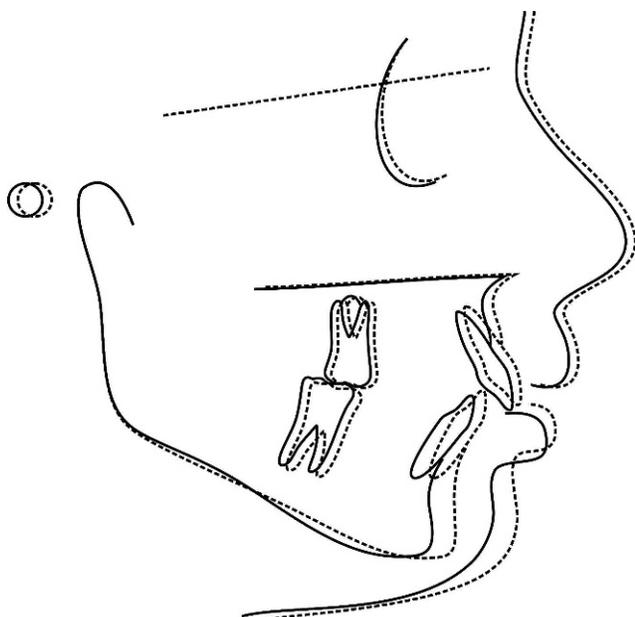
**Apical Base Effective Lengths**

The results showed that subjects with moderate to severe dental crowding had smaller maxillary and mandibular effective lengths compared with subjects without crowding or with slight dental crowding (Table 2; Figure 2). In addition, there was a significant weak to moderate inverse correlation between the amount of crowding and maxillary and mandibular effective lengths (Table 3). Based on the results of the present study, it can be speculated that midface and mandibular effective lengths (Co-A and Co-Gn) would correlate to a given range of mandibular dental crowding. These results are similar to the results of previous studies conducted on samples with unspecified malocclusions.<sup>25-27</sup> Therefore, effective lengths of the apical bases can be inversely associated to the amount of dental crowding independent of the type of malocclusion.

It is interesting to note that although the groups were selected according to mandibular crowding, maxillary crowding was also significantly greater in the severely crowded group. This seems reasonable because there was significant correlation between the maxillary and mandibular effective lengths and crowding. Therefore, it can be concluded that severely crowded subjects are more likely to present shorter effective apical base

**Table 2.** Intergroup Comparison Concerning the Amount of Crowding and Apical Base Lengths (t-tests)

	Group 1 (n = 25) Mandibular Crowding ≥3 mm		Group 2 (n = 55) Mandibular Crowding <3 mm		Difference	P Value
	Mean	SD	Mean	SD		
Mandibular Crowding (mm)	5.13	1.65	0.54	0.89	4.59	<.0001
Co-A (mm)	81.82	4.52	86.14	5.27	-4.32	.0006
Co-Gn (mm)	103.46	5.01	108.00	6.04	-4.54	.0016
Maxillary crowding (mm)	8.68	3.88	3.25	3.69	5.43	<.0001



**Figure 2.** Superimposition (sella-nasion line at sella) of mean cephalometric tracings for group 1 (continuous line) and group 2 (dotted line).

lengths and that the shorter the base lengths the greater the likelihood for crowding. This is especially applicable to subjects with complete Class II malocclusion, but it can be extrapolated to other types of malocclusions based on similar studies.<sup>5,25-27</sup>

### Clinical Implications

The current results suggest that besides tooth size and transverse arch dimensions, effective apical base length is also an important factor related to the amount of dental crowding, even in subjects with complete Class II malocclusion. Therefore, this has to be taken in consideration during treatment planning. If dental crowding is mostly due to the first two problems and ranges from slight to moderate, treatment protocols such as interproximal stripping and/or arch expansion are more appropriately indicated. However, when dental crowding ranges from moderate to severe and is not attributable to tooth size and transverse arch dimension problems, it is most likely resultant from deficient effective apical base lengths. Consequently, in these cases extractions would likely be the best treatment alternative.

### CONCLUSIONS

- Subjects with complete Class II malocclusion and moderate to severe mandibular crowding have significantly smaller effective apical base lengths than subjects with the same malocclusion and slight mandibular crowding.

- Although weak, there is a significant inverse correlation between maxillary and mandibular effective lengths and the severity of dental crowding.

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