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# Comparative tomographic study of the maxillary central incisor collum angle between Class I, Class II, division 1 and 2 patients

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## Abstract:

**INTRODUCTION:** It has been reported that Class II, division 2 maxillary central incisors frequently demonstrate increased collum angles, which indicates an excessive palatal “bend” of the crown. However, evidence supporting such observation is mostly derived from radiographic studies.

**OBJECTIVE:** The objective of this study was to evaluate and compare the collum angle of maxillary central incisors in Class I, Class II, division 1, and Class II, division 2 cases using cone-beam computed tomography.

**MATERIALS AND METHODS:** Forty-eight consecutive orthodontic cases (16 Class I, 16 Class II, division 1, and 16 Class II, division 2 malocclusion) with cone-beam computed tomography as part of their initial diagnostic records were evaluated. Cross-sections including maxillary right and left central incisors were used to calculate the angulation between the crown and root long axes (collum angle). Comparisons between groups were performed using analysis of variance for multiple and *post-hoc* Tukey for paired analyses.

**RESULTS:** Mean collum angle observed in Class II, division 2 cases was significantly larger ( $5.2 \pm 1.3^\circ$ ) than the ones obtained for Class I ( $1.1 \pm 4.2^\circ$ ) ( $P = 0.034$ ) or Class II, division 1 cases ( $0.1 \pm 0.7^\circ$ ) ( $P = 0.014$ ).

**CONCLUSIONS:** Our findings suggest that Class II, division 2 individuals demonstrate accentuated lingual inclination of the maxillary central incisor crown compared to the other types of malocclusion studied here. Such morphological feature indicates the need for better tooth movement planning, especially in regard to root palatal torquing of the maxillary central incisors.

## Keywords:

Angle Class II, cone-beam computed tomography incisor, overbite

## Introduction

The Class II, division 2 (Class II/2) malocclusion was originally characterized by Angle as having distal occlusion of the lower teeth in addition to specific features such as “slight narrowing of the maxillary arch, bunching of the maxillary incisors, with overlapping and lingual inclination.”<sup>[1]</sup> There appears to be no

consensus on the exact underlying skeletal features of this malocclusion type,<sup>[2-4]</sup> since no radiographic records were available at the time when Edward Angle proposed his classification system.<sup>[1]</sup> Therefore, the Class II/2 might be considered as a unique malocclusion for its dental aspects, i.e., deep overbite and maxillary incisors retroclination.

Concerning the maxillary central incisors of Class II/2 individuals, there have been reports

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regarding its morphological peculiar configuration. Among other documented characteristics, such as reduced labiolingual and mesiodistal dimensions,<sup>[2,5]</sup> it has been reported that Class II/2 maxillary central incisors, as opposed to other malocclusion types, frequently demonstrate a certain “misalignment” between its crown and root axes. According to several cephalometric studies, maxillary central incisors of Class II/2 individuals, in contrast to other malocclusion types, demonstrate reduced crown-root angles, which indicates an excessive palatal “bend” of the crown.<sup>[5-18]</sup>

The importance of the crown-root angle, as well as its complementary, the so-called collum angle (CA), has been especially considered regarding Class II/2 malocclusions. For instance, a large CA (or a small crown-root angle) has been suggested to be one of the possible reasons for the deep overbites generally observed in such patients.<sup>[6-8]</sup> CA should be also taken into consideration during Class II/2 malocclusions treatment planning due to the resultant proximity of the central incisors palatal root surfaces in relation to the bone palatal plate. According to several researchers’ justifiable concerns,<sup>[5,11,18]</sup> potential palatal torqueing of the central incisors roots of Class II/2 patients might possibly result in impinging of the root on palatal cortical bone and, as a consequence, root resorption of the involved teeth.<sup>[19,20]</sup>

However, the main criticism to evidences supporting Class II/2 central incisors morphology refers to the fact that they mostly derive from radiographic records, which might potentially prevent central incisors roots and apices to be accurately identified due to the superimposition of structures.<sup>[5]</sup> On the other hand, cone-beam computed tomography (CBCT) has been extensively utilized in orthodontics to visualize anatomic structures that are hard to identify in routine panoramic or lateral cephalometric radiographs.<sup>[21,22]</sup> Therefore, studies investigating CA in different malocclusions by means of CBCT examinations should be performed, as already suggested.<sup>[17]</sup>

To our knowledge, there is a single study that has been recently published,<sup>[18]</sup> which utilized CBCT in the comparative analysis of Class II/2 and Class I orthodontic patients. According to this study, the maxillary central incisors of Class II/2 exhibited significant larger crown-root angles,<sup>[18]</sup> which contradicts most previous findings, as observed in radiographic examinations. Considering this controversy and the existence of a limited number of studies utilizing CBCT,<sup>[18]</sup> it seems advisable to perform further researches on that topic.

Therefore, the objective of this study was to perform a comparative analysis between Class I, Class II/2, and

Class II, division 1 (Class II/1) patients in relation to the maxillary central incisors CA, according to CBCT records.

## Materials and Methods

This is a cross-sectional observational study conducted at the Department of Dentistry, in the University of Alberta (Canada). It has been previously approved by the University of Alberta Ethics in Research Board (protocol: Pro00056111).

Forty-eight orthodontic cases, which had CBCT as part of their initial diagnostic examinations, were consecutively collected from the Orthodontic Graduate Program records in University of Alberta. Examinations were performed from January, 2013 to December, 2015. CBCT images were acquired for orthodontic purposes where conventional cephalometric and panoramic radiographs did not provide sufficient information for proper diagnosis and treatment planning, e.g., impacted teeth, temporomandibular joint disorders, or evaluation of maxillary transverse dimension or growth.

The images were acquired by i-CAT CBCT scan (Imaging Sciences International, Hatfield, PA, USA). The CBCT machine was routinely calibrated and participants were provided with lead apron. CBCT protocol used in this study was a large field of view (16 cm width × 13 cm height), 120 kVp, 24 mAs, 20 s scan time, 0.3 mm voxel size, and 303 basis projections.

Records were selected if the right and left maxillary central incisors clearly demonstrated fully formed apices. Records of patients with history of facial trauma, craniofacial syndromes, as well as those depicting maxillary central incisors restorations or root external resorption were excluded. After collection, the included patients’ examinations were divided into three groups:

- Group I: 16 Class I patients’ records;
- Group II/1: 16 Class II/1 patients’ records; and
- Group II/2: 16 Class II/2 patients’ records.

One examiner (TEB), who had been previously calibrated, was responsible for performing measurements. Cross-sections including maxillary right/left central incisors were digitized using the 3D module of Dolphin imaging software (Dolphin Imaging Software version 11.7, CA, USA), and the CA of both teeth was calculated afterwards. The parameters used to identify crown and root long axes, as well as the CA measurement are described elsewhere<sup>[9]</sup> [Figure 1].

## Statistical analysis

Comparisons of CA between groups were performed using analysis of variance (ANOVA) for multiple

analysis and *post-hoc* Tukey for paired analyses. Reproducibility was measured according to intra-class coefficient (ICC) analysis.

Tests were performed with Statistical Package for the Social Sciences software (SPSS version 20, IL, USA), with level of significance set at 0.05.

### Results

Study groups mean age and sex distributions are depicted in Table 1. There were no significant differences regarding mean age ( $P < 0.001$ ) or gender distributions ( $P < 0.001$ ). ICC analysis demonstrated that CA measurement was sufficiently reliable (ICC: 0.897,  $P < 0.001$ ).

Comparisons between groups demonstrated that, on average, CA of maxillary central incisors of group II/2 are significantly larger than the ones obtained from both

I and II/1 groups [Table 2]. There were no significant differences between groups I and II/1 [Table 2].

### Discussion

According to CBCT assessment method, Class II/2 individuals presented maxillary central incisors palatally shifted crowns compared with Class I and Class II/1 cases. In general, our results are in accordance with the ones collected in the literature,<sup>[5,9-11,13,15-18]</sup> according to which maxillary central incisors of Class II/2 orthodontic patients present, in comparative terms, either larger CAs<sup>[9,10,15-17]</sup> or smaller crown-root angles,<sup>[17,23,24]</sup> when compared to most of the measurements obtained from other malocclusions. Because CA and crown-root angles are complementary, all of the referred studies including ours confirm that maxillary central incisors are morphologically peculiar.

Specifically, differences observed here were statistically relevant when Class II/2 cases were compared to both Class II/1 and Class I patients. The same findings were presented by most of the studies that individually compared Class II/2 patients to specific malocclusions, such as Class II/1<sup>[10,11,13,15-17]</sup> and Class I.<sup>[15,16,18]</sup> However, our results disagree with others<sup>[10,11]</sup> concerning the comparative analysis between Class II/2 and Class I patients. Even though mean differences between these groups seem to be relatively smaller, they still reached statistical significance according to our analysis. In the other hand, the referred studies<sup>[10,11]</sup> did not find any significant difference between both malocclusion types. Such divergence might be attributed to diverse assessment methods (radiographic) or sample discrepancies (ethnicity).

Several reasons have been considered to explain such palatal “bend” of maxillary central incisor crowns. Authors have indicated genetics or heritability as some of the involved factors.<sup>[2,5,24,25]</sup> Another study<sup>[12]</sup> demonstrated that the development of a deviant CA depends predominantly on local factors. According to this investigation, conducted in a non-Class II/2 sample, overjet, and inter-incisal angle are relevant predictors of the crown-to-root deflection.<sup>[12]</sup>

Others researchers have also hypothesized that the altered crown-root angulation might be a natural

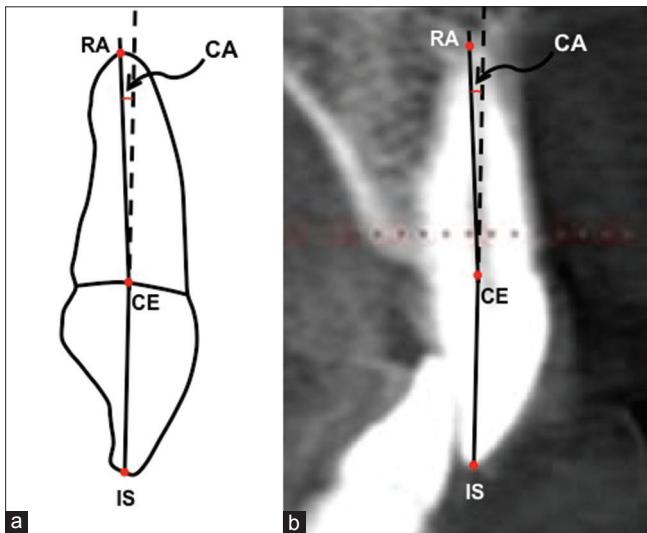


Figure 1: (a) Illustrative representation of the collum angle (CA); (b) Representation of the measurement of the CA; IS (superius point of the incisal edge); CE (mid-point of the cemento-enamel junction); RA (root apex)

Table 1: Study groups characterization according to number of components, sex and mean ages

Characteristics	Groups		
	I	II/1	II/2
n	16	16	16
Sex (male/female)	6/10	6/10	6/10
Age-years (mean±SD*)	18.25±0.56	16.91±0.62	16.95±0.72

\*SD: Standard-deviation

Table 2: Comparative analysis of collum angle between study groups

Variable	Groups			ANOVA P	Tukey Paired comparisons	
	I	II/1	II/2			P
CA-degrees (mean±SD*)	1.1±4.2	0.1±0.7	5.2±1.3	0.009	I vs. II/1	0.851
					I vs. II/2	0.034
					II/1 vs. II/2	0.014

\*SD: Standard-deviation

adaptation of Class II/2 maxillary central incisors as a result of their inherently reduced labio-lingual<sup>[8]</sup> or mesio-distal dimension,<sup>[6]</sup> or as a result of their improper position within the jaw.<sup>[11]</sup>

However, most of the studies suggest that the main role is most likely to be played by the lower lip position<sup>[9,16,17,23,26]</sup> or function.<sup>[7,9,10,27]</sup> Credible evidences on this assumption were provided by few researches.<sup>[27,28]</sup> One of these study<sup>[28]</sup> demonstrated that, although not statistically significant, Class II/2 patients present higher lower lip resting pressure compared to other malocclusion types. In this sample, the lower lip covered 5 mm of the maxillary central incisors in the children with Class II/2 malocclusions compared with 2 mm and 1.5 mm, respectively, in those with Class I and Class II/1 malocclusions. A similar study<sup>[27]</sup> also investigated differences in the level of the lower lip line between Class II/2 and Class I patients. Results showed that the former group presented a significantly higher lower lip line than the latter (5.1 mm versus 2.7 mm above the incisal edge of the maxillary central incisors).<sup>[27]</sup> In addition, according to proper sensors readings, in the Class II/2 group, resting lip pressure had a positive value on the incisal half of the maxillary central incisors but a negative value in the cervical zone.<sup>[27]</sup> Class I patients showed the opposite phenomena.<sup>[27]</sup>

Therefore, it seems safe to infer that, up to the present, the most consistent reason explaining maxillary incisors “bending” in Class II/2 patients is the localization of the lower lip line, which is apparently higher. It is suggested that potential bending of the tooth at the cervical part might take place due to the pressure from the lower lip exerted during the development and eruption of the incisors.<sup>[16]</sup> There have been reports that the relationship of the lower lip to the maxillary incisors is established between 9 and 13 years, which lends plausible physiological foundation to that theory.<sup>[29]</sup> However, because no longitudinal studies have been performed to substantiate this assumption, no causal relationship can be categorically validated, even though evidences indicate so.

Despite the fact that the search for its fundamental reason should continue, the morphologic “bending” of Class II/2 maxillary central incisors definitely brings relevant clinical repercussions that deserve close attention. Because the orthodontic treatment of Class II/2 patients generally requires root palatal torque of those teeth, the current concern lies on moving their roots into the lingual cortical plate,<sup>[5,9,11,17]</sup> which might potentially produce perforation<sup>[5,11,17]</sup> or increase the likelihood of root resorption.<sup>[19,20]</sup> Considering this potential hazard, it seems highly advisable to include, as a routine basis, either CA or crown-root angle evaluation

during treatment planning of Class II/2 cases, as already suggested by other authors;<sup>[5,9,11]</sup> and, whenever available, CBCT examinations should be obviously preferred.

As previously demonstrated,<sup>[24]</sup> third-order recommendations for maxillary central incisor inclination cannot be provided irrespective of its crown-to-root morphology. Lingual alveolar bone thickness seems to vary little according maxillary central incisors axial inclination.<sup>[30]</sup> Patients presenting lingually (Class II/2), normal (Class I) or labially inclined incisors (Class II/1 or Class III) seem to present similar alveolar bone therapeutic boundaries lingually. Therefore, surrounding alveolar bone limits also need to be taken into consideration during tooth torqueing planning.

CA mean values obtained within this study and in comparison with most of the other ones<sup>[5,9-11,13,15-18]</sup> were somewhat heterogeneous. Literature CA values ranged from, approximately, 1° to 10°, which is comparable to our CA variability. This might encourage clinicians to engage further efforts towards the planning of more judicious torque movements when managing Class II/2 cases.

This study has emphasized, according to accurate tomographic findings, the need for better tooth movement planning. However, larger studies might be performed to confirm or refute our relevant findings. Future researches must be also directed to investigate, by means of tomographic evaluations, not only maxillary central incisors CA but also its pretreatment position and its surrounding alveolar bone characteristics as potentially predictive factors for palatal cortical plate perforation and external root resorption. This would surely assign the proper clinical meaning to the topic that has been under discussion.

## Conclusions

Our findings suggest that Class II, division 2 individuals demonstrate accentuated palatal inclination of the maxillary incisor crown, as compared to Class I or Class II, division 1 cases.

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## Conflicts of interest

There are no conflicts of interest.

## References

1. Angle EH. Classification of malocclusion. Dent Cosmos 1899;41:248-64.
2. Peck S, Peck L, Kataja M. Class II Division 2 malocclusion: A heritable pattern of small teeth in well-developed jaws. Angle Orthod 1998;68:9-20.



3. Brezniak N, Arad A, Heller M, Dinbar A, Dinte A, Wasserstein A. Pathognomonic cephalometric characteristics of Angle Class II Division 2 malocclusion. *Angle Orthod* 2002;72:251-7.
4. Al-Khateeb EA, Al-Khateeb SN. Anteroposterior and vertical components of class II division 1 and division 2 malocclusion. *Angle Orthod* 2009;79:859-66.
5. McIntyre GT, Millett DT. Crown-root shape of the permanent maxillary central incisor. *Angle Orthod* 2003;73:710-5.
6. Backlund E. Overbite and the incisor angle. *Tr Eur Orthodont Soc* 1958;34:277-86.
7. Backlund E. Tooth form and overbite. *Tr Eur Orthodont Soc* 1960;36:97-104.
8. Carlsson R, Rönnerman A. Crown-root angles of upper central incisors. *Am J Orthod* 1973;64:147-54.
9. Delivanis HP, Kuftinec MM. Variation in morphology of the maxillary central incisors found in class II, division 2 malocclusions. *Am J Orthod* 1980;78:438-43.
10. Williams A, Woodhouse C. The crown to root angle of maxillary central incisors in different incisal classes. *Br J Orthod* 1983;10:159-61.
11. Bryant RM, Sadowsky PL, Hazelrig JB. Variability in three morphologic features of the permanent maxillary central incisor. *Am J Orthod* 1984;86:25-32.
12. Harris EF, Hassankiadeh S, Harris JT. Maxillary incisor crown-root relationships in different angle malocclusions. *Am J Orthod Dentofacial Orthop* 1993;103:48-53.
13. Korda RA, Nikolidakis DK, Xagoraris MD, Athanasiou AE, Papadopoulos MA. Crown/root relations and root morphological characteristics of permanent maxillary central incisors in Class II, division 1 and 2 malocclusions. *Hell Orthod Rev* 2000;3:89-96.
14. Gaballa S, El-Bialy, T. Predictors of maxillary incisor crown-root angulation (Collum angle). *Egypt Orthod Soc J* 2002;22:69-81.
15. Shen YW, Hsu JT, Wang YH, Huang HL, Fuh LJ. The Collum angle of the maxillary central incisors in patients with different types of malocclusion. *J Dent Sci* 2012;7:72-6.
16. Srinivasan B, Kailasam V, Chitharanjan A, Ramalingam A. Relationship between crown-root angulation (collum angle) of maxillary central incisors in Class II, division 2 malocclusion and lower lip line. *Orthodontics (Chic.)* 2013;14:e66-74.
17. Israr J, Bhutta N, Chatha MR. Comparison of collum angle of maxillary central incisors in Class II div 1 & 2 malocclusions. *Pak Oral Dent J* 2016;36:91-4.
18. Li M, Wang SW, Zhao YJ, Liu Y. [A cone-beam computed tomography study on crown-root morphology of maxillary anterior teeth in Class II, division 2 malocclusion]. *Beijing Da Xue Xue Bao* 2016;18;48:105-10.
19. Ten Hoeve A, Mulie RM. The effect of antero-postero incisor repositioning on the palatal cortex as studied with laminagraphy. *J Clin Orthod* 1976;10:804-22.
20. Horiuchi A, Hotokezaka H, Kobayashi K. Correlation between cortical plate proximity and apical root resorption. *Am J Orthod Dentofacial Orthop* 1998;114:311-8.
21. Hodges RJ, Atchison KA, White SC. Impact of cone-beam computed tomography on orthodontic diagnosis and treatment planning. *Am J Orthod Dentofacial Orthop* 2013;143:665-74.
22. Kapila SD, Nervina JM. CBCT in orthodontics: Assessment of treatment outcomes and indications for its use. *Dentomaxillofac Radiol* 2015;44:20140282.
23. Luffingham JK. The lower lip and the maxillary central incisor. *Eur J Orthod* 1982;4:263-8.
24. Knösel M, Jung K, Attin T, Engelke W, Kubein-Meesenburg D, Gripp-Rudolph L, *et al.* On the interaction between incisor crown-root morphology and third-order angulation. *Angle Orthod* 2009;79:454-61.
25. Logan WR. Deckbiss-a clinical evaluation. *Tr Eur Orthodont Soc* 1959;35:277-86.
26. Nicol WA. The lower lip and the upper incisor in Angle's Class II division 2 occlusion. *Trans Brit Soc Study Orthod* 1963;14:81-4.
27. Lapatki BG, Mager AS, Schulte-Moenting J, Jonas IE. The importance of the level of the lip line and resting lip pressure in Class II, Division 2 malocclusion. *J Dent Res* 2002;81:323-8.
28. Thüer U, Ingervall B. Pressure from the lips on the teeth and malocclusion. *Am J Orthod Dentofacial Orthop* 1986;90:234-42.
29. Vig PS, Cohen AM. Vertical growth of the lips: A serial cephalometric study. *Am J Orthod* 1979;75:405-15.
30. Tian YL, Liu F, Sun HJ, Lv P, Cao YM, Yu M, *et al.* Alveolar bone thickness around maxillary central incisors of different inclination assessed with cone-beam computed tomography. *Korean J Orthod* 2015;45:245-52.