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A Comparative Cephalometric Evaluation of Maxillary Central Incisor Crown Root Relationships in Various Malocclusions

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Author's contribution

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background and Objectives: An attractive smile is a pleasant effect of Orthodontic treatment which has got a lot of emotional benefits.The variation in tooth morphology of anteriors and its angulations and Inclinations play an important role in Smile Esthetics.The angulations of the root to the crown of a single rooted anterior teeth is known as Collum angle.The Collum angle of a single-rooted teeth is of particular interest to an Orthodontist because any variation in root angulations can cause unpredictable axial force application in movements such as intrusion and extrusion.The aim of the study is to compare the Collum angle,Labial crown root angle and Torque angle of class I with that of class II and class III.

Materials and Methods: Lateral cephalometric radiographs of 15 patients with age 20-30yrs, each for Class I,class II div 2,Class II div 1,Class III. patients were collected from the Department of Orthodontics, Azeezia College of dental science. Lateral cephalometric radiographs are scanned, digitized, and loaded into Nemoceph software for landmark identification and measurement.These measurements were compared to find the changes in CA,LCRA and torque angle of maxillary central incisors of patients with class I ,class II and class III dental malocclusion.

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Results and Discussion: CA, LCRA, Torque angle of Class II div 2 shows significant difference when comparing with other classes of malocclusion. Variations in the crown-root angle, or "collum angle" (CA), is an important factor in treatment planning because it helps to achieve greater predictability in root position, and to anticipate difficulties with intrusion, extrusion, tipping and torqueing mechanics.
Conclusions: CA, LCRA, Torque angle of Class II div 2 malocclusion showed significantly greater value, when comparing with other classes of malocclusion.

Keywords: Collum angle; labial crown root angle; torque angle; lateral cephalograms.

1. INTRODUCTION

Aesthetics is the most important factor which attracts both young and adult patients for orthodontic treatment. Orthodontic treatment helps to ensure the proper functioning of teeth and create healthy smiles. An a ttractive smile is a pleasant effect of orthodontic treatment which has got a lot of emotional benefits. Orthodontic treatment brings teeth, lips, and face into proportion which improves the self-confidence and self-esteem of the patient.

The anterior teeth have a great influence on personality because they are the only perceptible teeth in both smiling and talking. The variability in tooth morphology plays an important role in attaining good aesthetics. The variations can occur both in the angulations and inclinations of anterior teeth [1-3].

The angulation of the root to the crown specifically for a single-rooted anterior teeth is known as Collum Angle [4]. An Incisor, with a normal collum angle, plays an important role in the development of dentition and occlusion. The Collum angle of single-rooted teeth is of greater interest to an orthodontist because any change in root angulations can cause unpredictable axial force application in movements such as intrusion and extrusion. It may also lead the roots to violate labial/lingual cortical boundaries when being repositioned [4-7]. The Collum angle is the angle formed by joining the long axis of the crown and root using lateral cephalogram.

According to Bryant et al. [8] the crown-root angle can show the extent to which the root can be torqued palatally due to an increase in the proximity of the roots to the palatal cortical plate of the alveolar ridge. Harris et al. [9] conducted a study to find the variations in the tooth morphology and crown-root angulations. The Palatal bending of the crown of the maxillary central incisor is the most important feature of class II div 2 malocclusions.

The increased angulation between the long axis of the crown and root of the retroclined maxillary incisor can be assessed using a lateral cephalogram. Taylor [10] conducted a study on the variation in the morphology of the maxillary central incisor and conclude that morphological variation has got a strong influence from environmental, genetic, and physical factors. Collum angle also varies according to this. The retroclination of the maxillary incisor was strongly influenced by the sagittal relationship of jaws.

For identifying the collum angle, points are marked using cephalogram. Collum angle of maxillary incisor is defined by three points U1 central incisor tip (incisor superius), the intersection points of labial and palatal cementoenamel junctions, and root apex. Carlsson and Ronnerman [11] conducted a study to find the amount of abrasion in accordance with changing angulations and concluded that the angles examined differ widely from tooth to tooth therefore the incision superius tend to move facially as abrasion progresses. The desired torque has been defined as a tangent point at various levels on the clinical crown [12-14]. This study suggests new angular measurements of crown-root angulation and torque that are built by visible anatomic points, in the assumption of increasing their reliability and usefulness.

This study is to compare the variations in the crown-root angle or “collum angle"(CA), labial crown root angle (LCRA), and torque angle in class I, class II, and class III malocclusions. This helps to attain greater predictability in root positions and to expect difficulties with intrusion, extrusion, or torquing mechanics and their implementation to clinical practice.

2. MATERIALS AND METHODS

Patient with skeletal class I, class II, class III malocclusion between Age group 20 to 30 years with full complement of teeth were selected. Lateral cephalometric radiographs of acceptable

quality were used. Lateral cephalometric radiographs can be scanned ,digitized, and loaded into Nemoceph software for landmark identification and measurement .The study population consisted of subject with different class I, class II,class III malocclusion, without prior Orthodontic treatment of their teeth .This is a comparative study to measure the changes seen in CA,LCRA and torque angle of maxillary central incisors of patients with class I,class II,class III dental malocclusion .The class I is compared with class II,class III malocclusion .Ideal lateral cephalometric radiograph is used for identification and measurements.

The CA is traditionally measured according to three points on the most anterior maxillary central incisor: the undamaged incisal edge [incisor superius, or IS] (Rakosi 1982), the constructed bisection of the facial and lingual cementoenamel junctions (FCEJ and ICEJ, respectively), and the anatomic root apex [upper incisor apicale, or UIA] (Rakosi 1982). The CA is the supplement (180 degrees - x) of this angle. A straight tooth will have a CA of zero, a lingually inclined root will have a positive angle, and a labially inclined root will have a negative angle. The traditional CA measurement, used in this study, is illustrated in Figs. 2 and 3.

The labial crown root angle (LCRA) is constructed on a cephalometric radiograph with three points on the most anterior maxillary central incisor: IS, FCEJ, and UIA. The LCRA is the supplement (180 degrees – x) of this angle. It may be more clinically useful than the CA, because the plane defined by IS and FCEJ, more closely approximates the labial surface of the upper central incisor crown. The points of this measurement, however, depends on how it correlates with the CA, since the ultimate goal of the LCRA is to describe crown-to-root angulation. The labial crown-root angle is illustrated in Fig. 4.

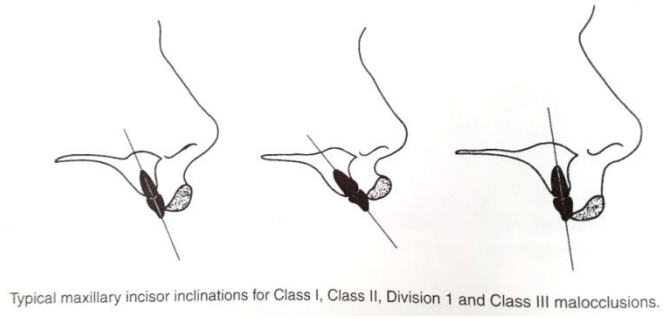


Fig. 1. Maxillary incisor inclinatons

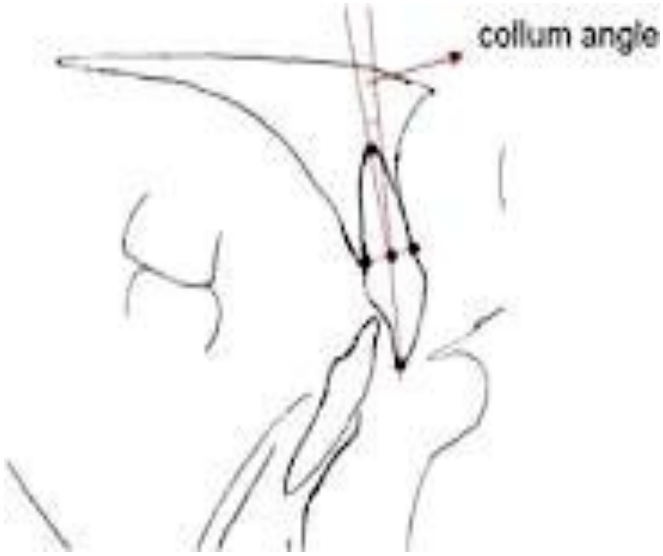


Fig. 2. The traditional CA measurement

Fig. 3. Labially inclined root

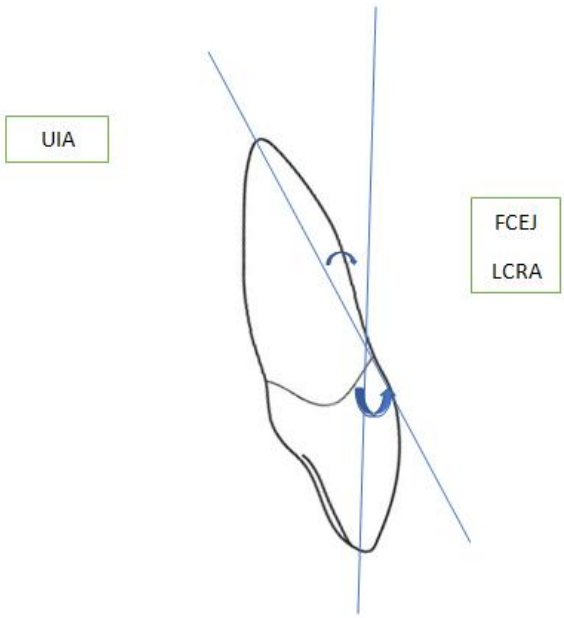


Fig. 4. Labial crown-root angle

Torque is defined in this study as an angle formed by two lines. The first line is formed by FCEJ and IS. This differs from previous definitions of torque that have utilized a tangent line on the labial surface of the crown. The second line is drawn perpendicular to the occlusal plane through IS, where the occlusal plane is identical to that originally defined by Downs: a line from the bisection of U6 occlusal and L 6 occlusal surfaces to the bisection of U1 incisal edge and L 1 incisal edge (Downs 1948). A positive torque angle indicates buccal crown inclination, and a negative torque angle indicates lingual crown inclination. The torque angle used in this investigation is illustrated in Fig. 5.

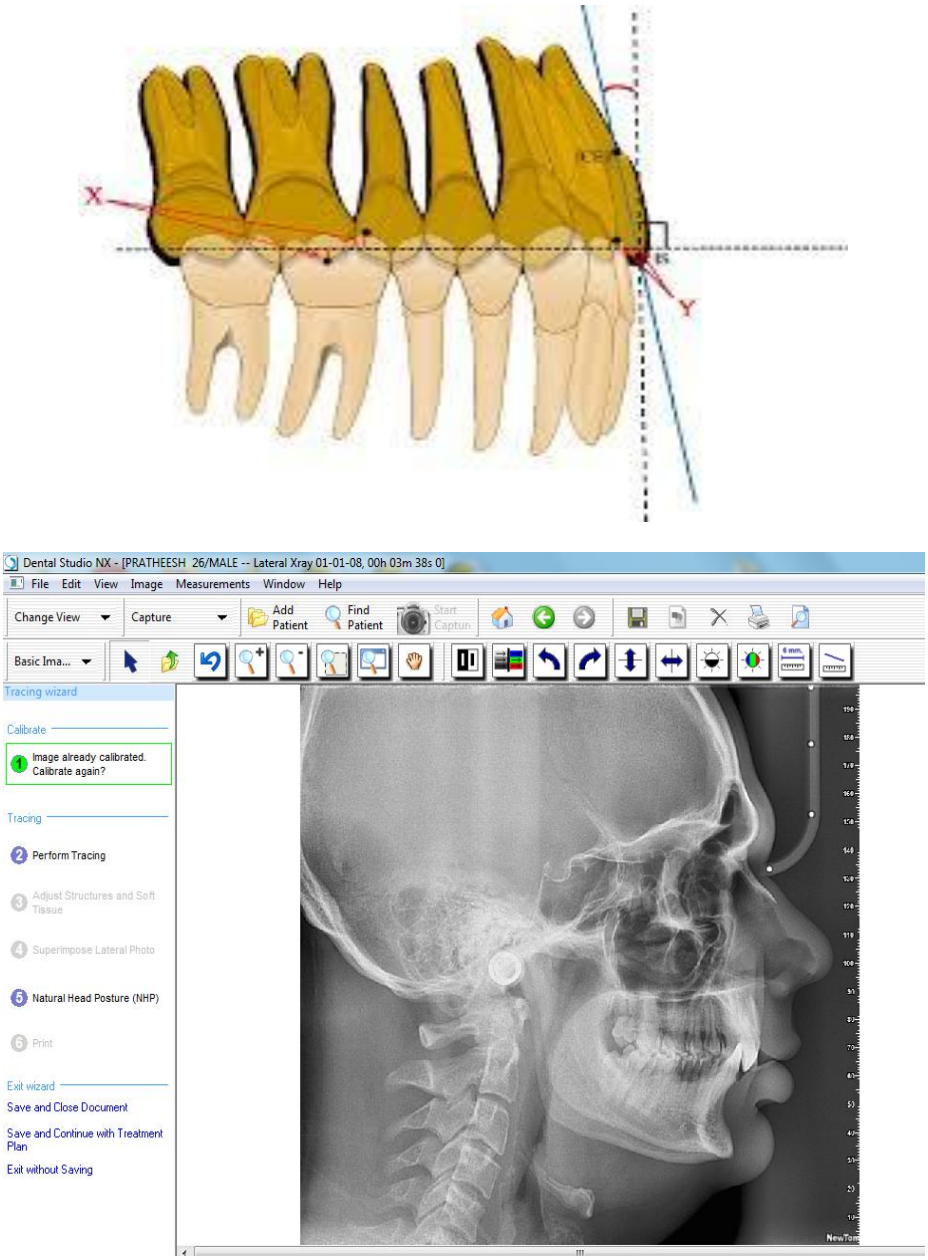


Fig. 5. The torque angle used in this investigation

2.1 Sample Size

Sample size is calculated as 51

Sample size is calculated using the formula

N per group = $(\sigma_1+\sigma_2)^2(Z_{1-}\alpha/_2+Z_{1-}\beta)^2$
α = 5%
σ_1 = standard deviation of second variable
1-β = 80%
Sample size selected for the study is 17 each group
Number of groups is 3 = 17 x 3 =51

2.2 Sampling Method

Lateral Cephalometric Radiograph of 51 patients between the age group of 20-30 years is selected and an informed consent is obtained for their use in the thesis.

2.3 Selection Criteria

2.3.1 Inclusion criteria

- Patient with skeletal class I, class II, class III malocclusion.

- Age 20 to 30 years.
- Lateral cephalometric radiographs of acceptable quality.
- Patients with full complement of teeth.
- No previous orthodontic treatment.

2.3.2 Exclusion criteria

- Visible periodontal disease, caries, excessive dental attrition.
- Any missing or supernumerary teeth visible on smiling.
- Patients with prosthodontic or restorative work
- on any teeth visible on smiling.
- History of trauma to the dentofacial region.

2.4 Data Collection

Informed consent was taken from the patients for radiographic examination and to use the material for analysis. Patients with class I, class II, class III malocclusion will be selected and included in the study.

2.5 Data Entry

Lateral cephalometric radiographs were scanned ,digitized,and loaded into Nemoceph software for landmark identification and measurement .The study population consisted of subject with different class I,class II,class III malocclusion,without prior Orthodontic treatment of their teeth .This is a comparative studty to measure the changes seen in CA,LCRA and torque angle of maxillary central incisors of patients with class I,class II,class III dental malocclusion .The class I is compared with class II,class III malocclusion .Ideal lateral cephalometric radiograph is used for identification and measurements.

3. RESULTS

The pre-treatment lateral cephalograms were used for evaluating collum angle, labial crown root angle and torque angle of class I, class II Division 1, class II Division 2 and class III malocclusion using nemoceph software. Results were tabulated on MS EXCEL and statistical evaluation was done. The statistical calculations were performed using the software SPSS for windows (statistical presentation system software, SPSS Inc.1999, New York) version 19.

Table 1. Total number of samples and percentage of values obtained

Malocclusions	N	Collum Angle	
		Mean	Sd
Class I	15	17.47	3.44
Class II a	15	17.13	4.24
Class II b	15	19.13	4.66
Class III	15	20.13	3.34
Total	60	18.47	4.05

Table 1 The total number of samples taken was 15 each in different Classes of malocclusions,and the mean value of Collum Angle obtained for Class II Div 2 is significantly greater than other classes of malocclusions.

Table 2. Comparison of collum angle in different classes of malocclusion

Malocclusions	N	Collum Angle		P
		Mean	Sd	
Class I	15	7.25	0.92	
Class II a	15	7.90	0.83	
Class II b	15	11.68	1.12	<0.001
Class III	15	7.96	0.76	

Table 3 shows comparison of collum angle in different classes of malocclusions with Tukeys multiple comparison test. The values obtained for class II div 2 shows significant difference.

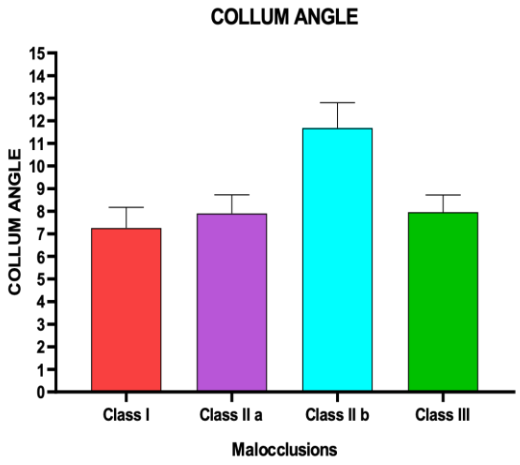


Fig. 6. Representing bar diagram showing collum angle in different classes of malocclusions, with collum angle plotted in X axis and vertical bar representing each classes of malocclusion

Table 3. Comparison of collum angle in different classes of malocclusions using tukeys multiple comparison test

Tukey's multiple comparisons test	Mean Diff.	Se	95% CI of diff.	Adjusted P Value
Class I vs. Class II a	-0.644	0.3346	-1.530 to 0.2421	0.230
Class I vs. Class II b	-4.425	0.3346	-5.311 to -3.539	<0.001
Class I vs. Class III	-0.7027	0.3346	-1.589 to 0.1834	0.166
Class II a vs. Class II b	-3.781	0.3346	-4.667 to -2.895	<0.001
Class II a vs. Class III	-0.05867	0.3346	-0.9448 to 0.8274	0.998
Class II b vs. Class III	3.723	0.3346	2.837 to 4.609	<0.001

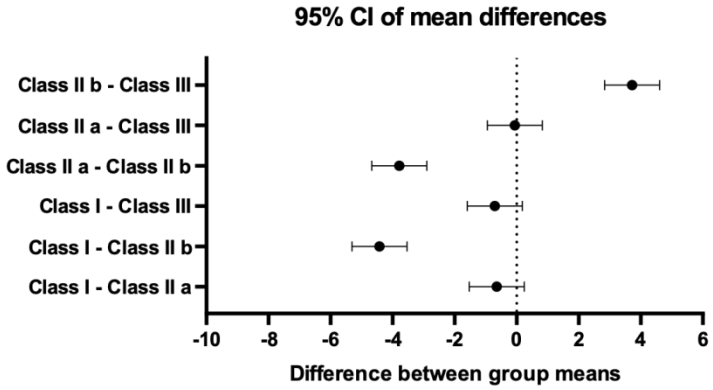


Fig. 7. Graph representing difference in different classes of malocclusion

Table 4. Comparison of labial crown root angle on different classes of malocclusion

Malocclusions	N	Labial crown root Angle (LCRA)		P
		Mean	sd	
Class I	15	28.00	1.89	
Class II a	15	28.99	1.90	
Class II b	15	38.69	2.08	<0.001
Class III	15	29.56	1.43	

Table 5. Comparison of labial crown root angle in different classes of malocclusion using tukeys multiple comparisons test

Tukey's multiple comparisons test	Mean Diff.	se	95% CI of diff.	Adjusted P Value
Class I vs. Class II a	-0.9887	0.672	-2.768 to 0.7908	0.462
Class I vs. Class II b	-10.7	0.672	-12.48 to -8.917	<0.001
Class I vs. Class III	-1.566	0.672	-3.345 to 0.2135	0.103
Class II a vs. Class II b	-9.708	0.672	-11.49 to -7.929	<0.001
Class II a vs. Class III	-0.5773	0.672	-2.357 to 1.202	0.826
Class II b vs. Class III	9.131	0.672	7.351 to 10.91	<0.001

Fig. – 7, graph representing 95% confidence interval of mean difference in different classes of malocclusions, with malocclusions plotted against x axis and mean values plotted against y axis.

Table 5, shows comparison of labial crown root angle in different classes of malocclusions with Tukeys multiple comparison test.Mean difference class II div 2 shows greater difference comparing with that of other classes of malocclusions.

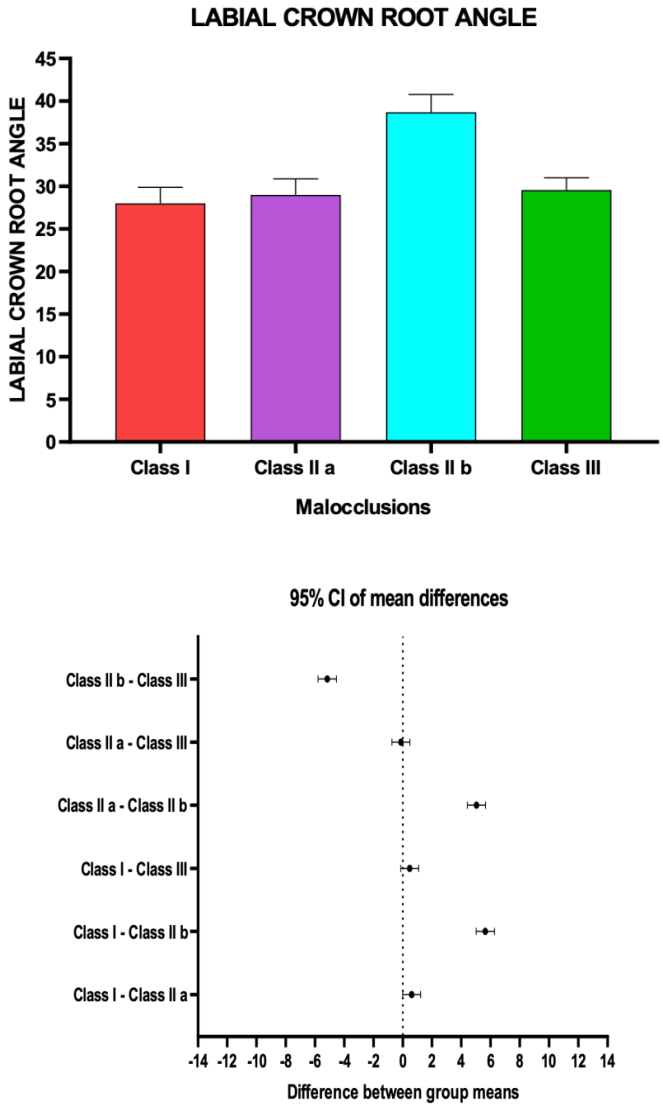


Fig. 8. Graph representing variation in crown root angle in different classes of malocclusion

Fig. 8, representing bar diagram showing labial crown root angle in different classes of malocclusions, with labial crown root angle in x-axis and vertical bar representing each classes of malocclusion.

Fig. 8, graph representing 95% confidence interval of mean difference in different classes of malocclusions, with malocclusions plotted against x axis and mean values plotted against y - axis.

Fig. 6. representing bar diagram showing torque angle in different classes of malocclusions, with torque angle in x-axis and vertical bar representing each classes of malocclusion.

Table 6. Comparison on torque angle on different classes of malocclusion

Malocclusions	N	Torque angle		P
		Mean	Sd	
Class I	15	7.660	0.484	
Class II a	15	7.055	0.473	
Class II b	15	2.015	0.974	<0.001
Class III	15	7.182	0.494	

Table 7 shows comparison of torque angle in different classes of malocclusions with Tukeys multiple comparison test. Mean difference of Class II div 2, is greater than other classes of malocclusion.

Fig. 9, representing bar diagram showing torque angle in different classes of malocclusions, with torque angle in x-axis and vertical bar representing each classes of malocclusion.

Graph 1 graph representing 95% confidence interval of mean difference in different Classes of malocclusions, with malocclusions plotted against x axis and mean values plotted against y axis.

Table 7. Comparison of torque angle in different classes of malocclusion using tukeys multiple comparisons test

Tukey's multiple comparisons test	Mean Diff.	se	95% CI of diff.	Adjusted P Value
Class I vs. Class II a	0.6047	-0.009476 to 1.219	0.2318	0.055
Class I vs. Class II b	5.645	5.020 to 6.270	0.2359	<0.001
Class I vs. Class III	0.478	-0.1361 to 1.092	0.2318	0.176
Class II a vs. Class II b	5.04	4.415 to 5.665	0.2359	<0.001
Class II a vs. Class III	-0.1267	-0.7408 to 0.4875	0.2318	0.947
Class II b vs. Class III	-5.167	-5.792 to -4.542	0.2359	<0.001

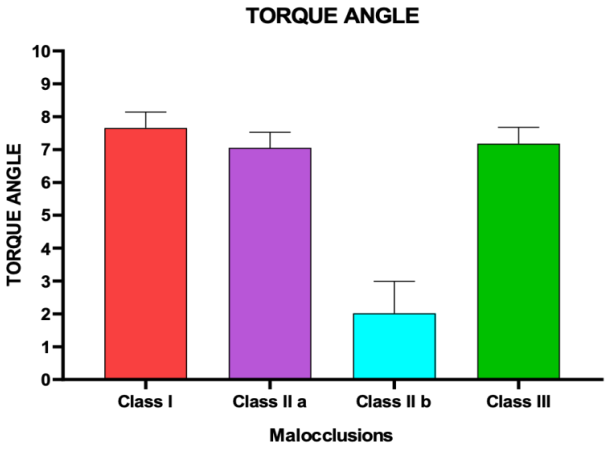
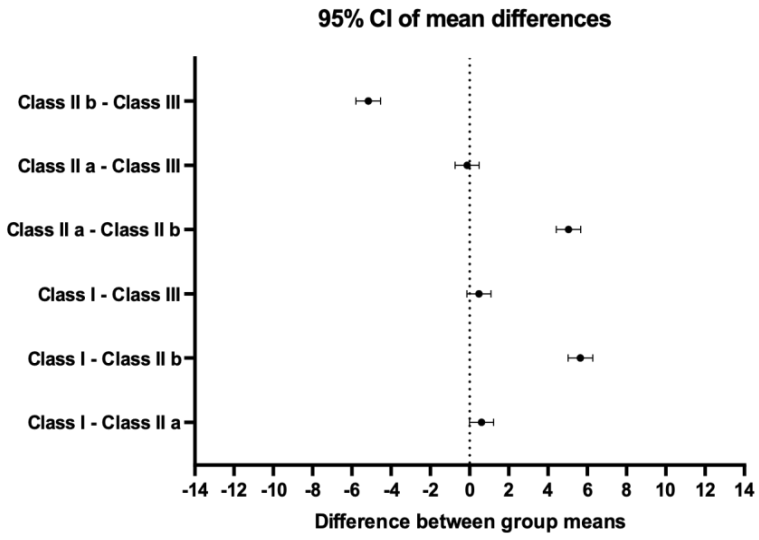


Fig. 9. Bar diagram representing difference in torque angle in different classes of malocclusion



Graph 1. Graph representing difference in torque angle in different classes of malocclusion

4. DISCUSSION

In this study, the collum angle, the labial crown root angle is compared with class I and class II div 1, class II div 2 malocclusion and class III. The mean value shows no significant difference regarding the collum angle, except for class II div 2. The mean values show significant difference in the Labial crown root angle in the case of class II div 2 patients. The studies of Delivanis and Kuftinec [15] appears to be more correlated with this study. He conducted a study on the change in crown root morphology of maxillary central incisor in class II div 2 malocclusion and concluded that the crowns of the maxillary central incisors tended to “bend” more lingually inpatients with class II Division 2, than in with other types of malocclusions. This tendency has also been studied by Backlund[53] and concluded that this bending was an important factor contributing to the development of class II Division 2 malocclusions. The significance of Delivanis and Kuftinec study was that, the crown-root angulation appearing in class II Division 2 malocclusions may complicate torque of the incisors and orthodontic intrusion, in more complicated cases, this may increase the danger of perforating the palatal cortical plate.

This study was conducted to find the difference in collum angle, labial crown root angle and torque angle in different classes of malocclusion. Collum angle of class I was compared with class II div 1, class II div 2, and class III malocclusion. The values shows that collum angle of class II div 2 shows significant difference when compared with that of class I, class II div I, and class III. While planning an intrusion mechanics, for such patient’s care should be taken to avoid the impingement in palatal cortical plate.

The labial crown root angle of class I was compared with class II div 2, class II div 1 and class III malocclusion. The labial crown root angle of class II div 2 shows significant difference when compared with that of class I, class II div 1 and class III malocclusions. Class III shows a greater variation when compared with that of class I and class II div 1 shows a greater value when compared with that of class I.

The torque angle of class I is compared with that of class II div I, class II div 2 and class III malocclusions. Class II div 2 shows significant change in the values when compared with other class of malocclusion. Class III, class II div 1 shows a lesser variation on comparison with class I malocclusion.

Collum angle has got a greater influence on both labial and lingual orthodontics. When there is an increase in collum angle, the stress-strain distribution also increased in both labial and lingual orthodontics. As there was a change in center of rotation cervically, the intrusion reduced when collum angle increased. This was stated by Sandesh [16] S Pai in his studies on the effect of labial and lingual retraction and intrusion force on maxillary central incisor with varying collum angles. They concluded that there is a strong correlation between Collum angle and intrusion mechanics both in labial and lingual orthodontics. Intrusion process was severely reduced with increased collum angle. This can be taken into consideration while giving Tads for intrusion mechanics.

5. CONCLUSION

The Collum angle, Labial crown root angle and Torque angle of Class II DIVISION 2 is significantly greater when comparing with other class of malocclusion.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

CONSENT

Informed consent was obtained from the subjects for the use of lateral cephalometric radiographs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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