"RELATIONSHIP BETWEEN COLLUM ANGLE OF MAXILLARY CENTRAL INCISOR AND MAXILLA, PRE- AND POST-TREATMENT IN CLASS II DIV 2 PATIENTS- A RETROSPECTIVE CEPHALOMETRIC STUDY"

By

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Dissertation

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IN

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(BRANCH – V)

Under the Guidance of

Dr K M KELUSKAR M.D.S., PhD

DEPARTMENT OF

ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

KLE VISHWANATH KATTI INSTITUTE OF DENTAL SCIENCES,

KAHER, BELAGAVI, KARNATAKA.

2019 – 2022

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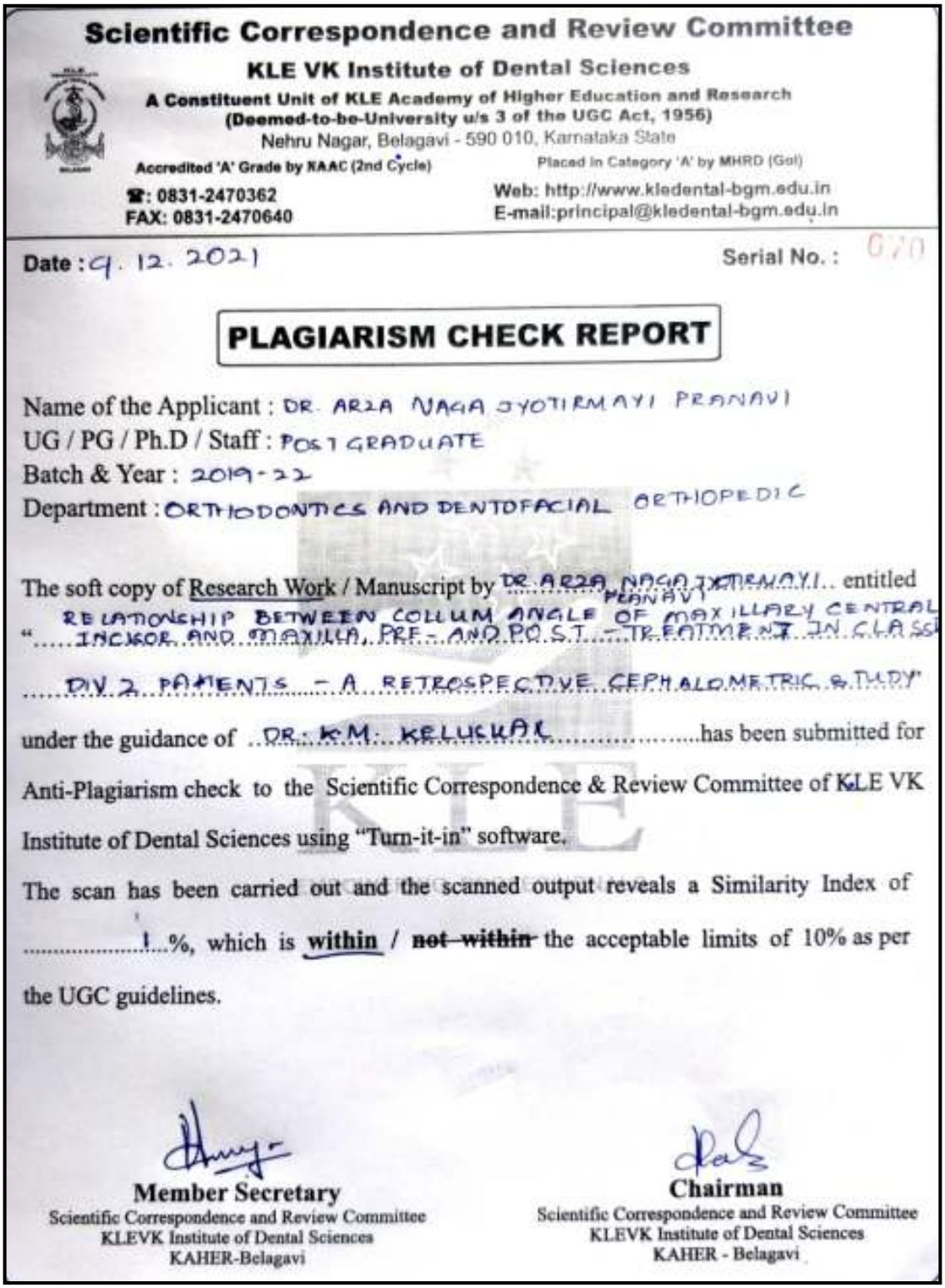

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thesis as an unassertive tribute to all their love, affection, dreams and strong principles, which they have instilled in me.

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Dr ARZA NAGA JYOTIRMAYI PRANAVI

LIST OF ABBREVIATIONS

Class II/1	-	Class II division 1 malocclusion
Class II/2	-	Class II division 2 malocclusion
SNA	-	Sella-nasion–point A
SNB	-	Sella-nasion–point B
ANB	-	Point A- nasion- point B
Co-Gn	-	Condyle to Gnathion
Co- Pt A	-	Condyle to subnasale
Apex	-	Apex of the root of maxillary central incisor
ANS	-	Anterior nasal spine
PP	-	Palatal plane
CA	-	Crown Axis
RA	-	Root Axis
N-Pog	-	Nasion to Pogonion
N-Perp	-	Nasion perpendicular

ABSTRACT

Introduction: Crown-root angulation or collum angle is the angle between long axis of the crown and long axis of the root. It is more commonly observed in the maxillary incisors in Class II division 2 malocclusion. Along with the various dentoskeletal problems presented in a Class II/2 malocclusion, the retroclined maxillary incisors appear to be of concern as they are the most prominent teeth in the mouth. Orthodontic treatment is most often performed in such cases, wherein there is change in inclination of the maxillary incisors. The positional change after orthodontic treatment in maxillary central incisors with collum angle with the maxilla is not significantly understood. Thus, in this study we aim to:

1. Assess collum angle in pre- and post- treatment cephalograms in subjects presenting with Class I malocclusion.

2. Assess collum angle in pre- and post- treatment cephalograms in subjects presenting with Class II div 1 malocclusion.

3. Assess collum angle in pre- and post- treatment cephalograms in subjects presenting with Class II div 2 malocclusion.

4. Determine using cephalometric measures, the position of root of the maxillary central incisor in respect to the maxilla in each of the three groups.

5. Determine using cephalometric measures, the position of the crown of the maxillary central incisor in respect to the maxilla in each of the three groups.

Materials and methods: The study was a retrospective cephalometric study conducted on 114 patients with Class I, II/1, and II/2 malocclusions who underwent orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopaedics, KLE Academy of Higher Education and Research, (KAHER) KLE V.K Institute of Dental Sciences, Belagavi. Pre- and post-treatment lateral cephalogram of patients was traced manually, 15 parameters were measured and scrutinized using SPSS (Statistical Package for Social Sciences Cooperation, Chicago USA) version 25. Further, descriptive and inferential analysis was done to reach a final conclusion.

Results: The mean collum angle in group 1, 2 and 3 was recorded to be 6.23± 5.81, 1.97± 8.25 and 9.21± 7.27, respectively. (0.001) Group 2 showed mean decrease of 3.69mm in the distance between point A and apex of the root was seen post treatment. (0.000) Mean decrease of 3.41mm and increase of 1.46mm in the distance between ANS and apex of the root was seen post treatment in group 2 and 3, respectively. (0.000) Mean increase of 2.84mm and decrease of 1.82mm in the distance between tip of the incisor and ANS was seen post treatment in group 2 and 3, respectively. (0.000) Mean decrease of 13.1° and increase of 8.43° in the angle between palatal plane and crown axis was observed post treatment in group 2 and 3, respectively. (0.000) Mean decrease of 12.79° and increase of 6.36° in the angle between palatal plane and root axis was observed post treatment in group 2 and 3, respectively. (0.000) Mean decrease of 11.49° and increase of 7.05° in the angle between facial plane and crown axis was observed post treatment in group 2 and 3, respectively. (0.000) Mean decrease of 10.66° and increase of 4.93° in the angle between facial plane and root axis was observed post treatment in group 2 and 3, respectively. (0.000 and 0.001, respectively) Mean decrease of 10.97° and increase of 8.18° in the angle between N

Perpendicular plane and crown axis was observed post treatment in group 2 and 3, respectively. (0.000) Mean increase of 6.43° in the angle between N Perpendicular plane and root axis was observed in group 2 post treatment. (0.000)

Conclusion: The collum angle of maxillary central incisor is different in different types of malocclusion, and most often is seen in Class II/2. Orthodontic treatment changes the inclination of the tooth root and tooth crown in relation to the maxilla. In class II/2, the root moves closer to the maxillary labial cortical plate. Excessive proclination of maxillary central incisor may lead to dehiscence, fenestration or root exposure.

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INTRODUCTION

Class II Division 2 malocclusion, with its usually accompanying skeleton-dental features, is a condition in which the mandibular dental base is positioned in a distal relation to the cranium. It occurs in roughly 5% of all existing malocclusions.[1] According to previous studies, the malocclusion groups assessed showed deficient mandibular length than normal, whereas cranial and maxillary base lengths were observed to be normal. The occlusion associated with Class II div 2 is thought to be characterised by forwardly positioned maxillary buccal segments and a very slight prognathic or orthognathic antero-posterior basal bone relationship.[1]

Sella-nasion–point A (SNA), sella-nasion–point B (SNB), & ANB angles were recommended by Riedal to determine the denture base relationship in sagittal plane. The ANB angle is a sagittal skeletal discrepancy indication that has been the most often utilised measurement.[2]

In certain studies, the maxilla was shown to be more protrusive in Class II/1 patients, but the mandible was found to be normal in size & position. The maxilla was determined to be at a normal position with respect to the cranial base in other studies, wherein the mandible was retrusive. While others discovered that in Class II/1 patients, the Class II skeletal pattern is caused by both maxillary protrusion & mandibular retrusion. The maxillary sagittal position in Class II/2 malocclusion participants is alike to that of Class I or Class II/1 patients, according to the majority of research.[3]

In comparison to Class I and Class II/1 malocclusions, Class II/2 malocclusions have the following cephalometric characteristics:

1. The maxillary length & sagittal positions are similar.
2. Shorter length of the mandibular bone and a retruded sagittal position
3. The gonial angle is acute.
4. Obtuse interincisal angle.
5. The deep overbite is caused by excessive skeletal counterclockwise rotation of the mandible, rather than dentoalveolar overeruption.[4]

Vertically, a low mandibular plane angle is related by the two bony structures. High lip line is seen with this class of malocclusion. This may suggest that the maxillary alveolus shows hyperplastic growth in a downward & forward direction. Furthermore, most authors believe that in a normal scenario, the maxillary central incisors are retroclined, with lateral incisors that are proclined or overlap the central incisors. There is always a deep overbite, often known as deckbiss.. According to studies, the angle between maxillary and mandibular incisor is increased and a gliding contact develops, this leads to slight axial stress on the teeth, permitting them to overlap excessively in the vertical plane. Eruption of the same proceeds until masticatory axial forces or opposing soft tissue forces counteract the force of growth.[5]

Class II division 2 malocclusions are of three types:

- Type A, all four permanent incisors in the maxilla are tipped palatally, & the maxillary canines are well aligned in the dental arch.

- Type B, the maxillary central permanent incisors are palatally tipped, & the lateral incisors are labially tipped.

- Type C, all four permanent incisors in the maxilla are tipped palatally, & the canines are buccally located, outside the dental arch. [5]

High position of stomion is an essential feature of Class II division 2 malocclusions.

In Class II division 1 malocclusions, there is increase in labial inclination after emergence whereas, in Class II division 2 malocclusions, the maxillary central incisors incline more palatally as they erupt. Maxillary incisors most frequently show palatal displacement of crown with the apices moving labially in total complete overbite. Bone deposition at the anterior surface of alveolar process to maintain root coverage is insufficient and limited if the roots motion far outside their normal boundaries. Denudation of bone can be seen at the labial surface of roots.[5]

The anterior torque must be exact in order to create pleasing aesthetics, steady occlusion, normal overjet, and overbite. When compared to other types of skeletal malocclusion, the root of the maxillary central incisor can get close to the lingual cortical alveolar bone during treatment, which raises the danger of dehiscence or/& fenestration, root resorption, & torque limitation.[6]

The collum angle of maxillary central incisors may limit the degree to which the roots of these teeth can be torqued lingually when related to the lingual maxillary cortical plate. Wheeler claimed that the maxillary central incisors are also the most typical of the mould design of the teeth, implying that their morphology is less inconsistent than the other teeth in the oral cavity . The crown-root angulation, the

morphology of the labial surface of the crown, and the shape of the lingual surface of the crown are three significant aspects of their morphology.[7] In this study, we have studied the crown root angulation of the maxillary central incisor in Class II division 2 patients alongside Class I and Class II division 1 malocclusion patients.

Collum angle refers to the angle formed between the long axis of the crown and the long axis of the root. It is a key factor in orthodontic treatment which affects the root location of the tooth. This angle varies significantly for the same tooth in different people. During orthodontic treatment, because of improper torque if the root is moved into the cortex bone, it can result in root resorption. Added to this, it could impede the efficiency of intrusive and extrusive mechanics and affect the desired movement of the incisors. In Class II/2 patients, maxillary central incisors show an increased crown-root ratio, a decreased labiopalatal thickness, and axial bending. Thus, collum angle evaluation should be taken as a routine procedure for tooth torque control in orthodontic treatment planning for Class II/2 patients.[8] In Class II/ 2 malocclusions, the crown-root angle can make orthodontic intrusion and torque of the incisors more difficult, as well as raise the risk of palatal cortical plate perforation. [1,7,8].

Studies show that the collum angle seen with respect to Class II div 2 malocclusion is significantly higher than other types of malocclusions.[1,6,9] The morphology of the tooth, and position of the lower lip also play a significant role in development of collum angle.[9] Torque expression also varies considerably depending on the bracket position and presence of collum angle, which might also lead to dehiscence and fenestration.[8]

As a result, a study is needed to assess the collum angle of the maxillary central incisor with regard to the maxilla in Class II div 2 malocclusions before and after treatment, as well as a comparison of the collum angles of the maxillary central incisor and its relationship with maxilla in different types of malocclusions.

AIMS AND OBJECTIVES

AIM OF THE STUDY:

To investigate in Class II division 2 patients, the relationship between the collum angle of the maxillary central incisor and the maxillary bone before treatment and after treatment.

OBJECTIVES:

1. To assess collum angle in pre- and post- treatment cephalograms in patients presenting with Class I malocclusion.
2. To assess collum angle in pre- and post- treatment cephalograms in patients presenting with Class II/ 1 malocclusion.
3. To assess collum angle in pre- and post- treatment cephalograms in subjects presenting with Class II div 2 malocclusion.
4. To determine using cephalometric measures, the position of root of the maxillary central incisor in respect to the maxilla in each of the three groups.
5. To determine using cephalometric measures, the position of the crown of the maxillary central incisor in respect to the maxilla in each of the three groups.

REVIEW OF LITERATURE

1. **Xiao-ming Wang, Ling-zhi Ma, Jing Wang, and Hui Xue (2019),** to provide recommendations for adequate expression of torque in anterior teeth and minimize alveolar fenestration and dehiscence, employed CBCT to study the discrepancy of the tooth crown & root morphology of central incisors among varied forms of skeletal malocclusion. 108 CBCT images in total were assimilated (ranging from 18 to 30). They were also categorized into low, average, and high angles, with Class I consisting of 14 females & 10 males (24); Class II consisting of 13 females and 7 males (20); and Class III consisting of 13 females & 9 males (22), after which software was used to measure the collum angle, this is the angle generated by intersection of the long axis of both, the crown and that of the root. The maxillary incisor in patients with Class II malocclusion and the mandibular incisor in patients with Class III malocclusion both had significant crown-root angulation and, as a result, significant labial surface curvature, according to the researchers. Equivalent variation during bracket bonding can enhance the probability of alveolar bone fenestration and dehiscence by increasing torque expression inaccuracy.
2. **Wei-Dong Kong, Jun-Yu Ke, Xiang-Quan Hu, Wu Zhang, Shu-Shu Li and Yi Feng [6] (2016)** used CBCT to evaluate the effect of labial crown shapes and collum angle on maxillary anterior tooth torque. Utilization of 206 extracted maxillary anterior teeth in total was done to create scanning models using dental wax, which were then scanned and evaluated. They found that for the same kind of tooth at different lengths from the incisal edge, a tangent between the labial surface and the incisal edge to the long axis of the crown

(alpha angle) and the collum angle were statistically substantially different. They came to the conclusion that labial cron morphologies & collum angle for maxillary front teeth between people show significant variance, implying that tooth morphologies of these upper front teeth do have an influence in torque variations.

3. **Ft. M. Bryant, P. L. Sadowsky and J. B. Hazelrig, [7] (1984)** studied the variance in three anatomic aspects of the maxillary central incisor in a quantitative manner. Proximally viewed curvature on the lingual surface of the crown, the angle generated by a tangent drawn through the mid part of the labial surface of the crown & the crown's long axis from a proximal view, & the collum angle were all determined using two different sources: the first, radiographs of 98 extracted upper central incisors, & the second, a group of hundred cephalometric radiographs (included 25 of Angle Class I, Class II/1, Class II/2, and Class III malocclusions). Collum angle was the evaluated first, after which measurement of angle formed by crown's long axis & a tangent drawn to the center of the crown's labial surface was carried out. They found that the mean crown-root angle for Class II/2 malocclusions differed significantly from that for Class II/ 1 and Class III malocclusions, meanwhile the other two features did not significantly show variation among the 4 malocclusion groups for the third measurement. The parameters of a mathematical equation which described the curvature on the lingual surface of the crown were utilized for comparisons.
4. **Helen P. Delivanis and Mladen M. Kuftinec [10] (1980)** tested the postulation that deep overbite along with the supposed entrapment of the lower jaw, was partly due to presence of collum angle. A group of 33 patients with Class II/2

malocclusions and the control group of 33 patients were evaluated and it was established that the former group showed significantly increased collum angle than the latter group.

5. **Badrinath Srnivasan, Vignesh Kailasam, Arun Chitharanjan, Arthi Ramalingam [9] (2013)** studied the magnitude of the collum angle in Class II/2 patients its relationship to the lower lip, using a set of one hundred and twenty conventional Lateral Cephalograms and divided it into Class 1, II/1, II/2 of 40 in each group. They concluded that variation in the lower lip line is a probable etiologic factor in development of collum angle, increasing when the lower lip is placed at the middle third of the crown. Also, significantly increased collum angle was seen in class II/2 malocclusion than the other groups.
6. **Sandesh. Pai, Suchareeta. Panda, Vinaya. Pai, M. Anandu, E. Vishwanath, A. Suhas [8] (2017)** analyzed the effects of forces of intrusion, forces of retraction, & torque control on the central incisors of the maxilla with varying degrees of collum angle in labial and lingual orthodontic procedures using finite element analysis of 4 pairs of 3-dimensional finite element models (FEMs) for lingual and labial orthodontics. Each were representative of upper central incisor with periodontal ligament and alveolar bone, with 0[degrees], 5[degrees], 10[degrees], and 15[degrees] crown root angulation. They concluded that there was an increase in stress-strain distribution in LaO and LiO with increase in collum angle. With a cervical shift of the centre of rotation, the amount of intrusion decreased when collum angle increased. The values were more apparent in Lingual orthodontics.

7. **Naphtali Brezniak, Arnon Arad, Moshe Heller, Ariel Dinbar, Arieh Dinte, Atalia Wasserstein [4] (2002)** studied 50 patients clinically diagnosed with Class II/2 (experimental group), and compared them to 54 Class II/1 and 34 Class I patients (control groups). They described the skeletal as well as the dentoalveolar characteristics specific to Class II/2 malocclusion. They concluded that patients having Class II/2, along with having a pathognomonic dental appearance, have several skeletal, sagittal and vertical attributes that vary it from both Class I and Class II/1 malocclusions.
8. **Yen-Wen Shen, Jui-Ting Hsu, Yi-Hui Wang, Heng-Li Huang, Lih-Jyh Fuh [11] (2012)** performed a study in Taiwanese patients, evaluating collum angle of upper central incisor in different types of malocclusions. 124 patients were categorized into 4 groups based on the malocclusion. Collum angle for Class I, Class II/1, Class II/2 and Class III was observed to be 6.1°±5.2°, 5.3°±4.2°, 10.6°±4.4° and 5.6°± 5.1°, respectively. It was seen to be the greatest in Class II/2 malocclusion.
9. **Kazem S. Al-Nimri, Abdalla M. Hazza'a, Rami M. Al-Omari[2] (2009**) evaluated 30 lateral cephalograms of patients with Class II/2 malocclusion for the change in position of subspinale (point A) with proclination of upper incisors. They observed a 0.25 mm downward vertical displacement, which had no statistically significance (P - 0.154), and a backward horizontal displacement of 0.6 mm, which was statistically significant (P- 0.001). They have reasoned the cause of this change to be due to bone remodeling which was associated with proclination of the maxillary incisor and that the change in position of subspinale (point A) does not significantly affect the SNA.

MATERIALS AND METHODS

STUDY DESIGN: Retrospective study

SOURCE OF DATA: Patients who have undergone treatment in the Department of Orthodontics and Dentofacial Orthopaedics, KLE'S Academy of Higher Education and Research, KLE VK Institute of Dental Sciences, Belagavi-590010

INCLUSION CRITERIA:

- Class II div 2 incisor relationship with Class II or end- on molar relationship and ANB angle greater than 4 degrees
- Class II/1 incisor relationship with Class II or end- on molar relationship and ANB angle greater than 4 degrees
- Class I malocclusion with Angle's class I molar relationship and ANB angle greater than or equal to 0 and < than or equal to 4 degrees
- Patients with both convex and concave profile.

EXCLUSION CRITERIA:

- History of extracted or missing permanent molars.
- Maxillary incisors absent from birth.
- Presence of: Supernumerary teeth; developmental anomalies; dento-facial deformities or severe facial asymmetries.
- Patients presenting with Class III malocclusions.

PERMISSIONS TAKEN: Institutional ethical clearance.

SAMPLE SIZE ESTIMATION: Sample size for the study was estimated as 38 samples in each group with a total of 114 subjects, based on the formula

$$N = \frac{2\,(S)^2(Z\ 1\text{-}\alpha/2 + Z\ 1\text{-}\beta)^2}{d^2}$$

Where standard deviation

S1= 4.69

S2= 1.06

S3= 1.53

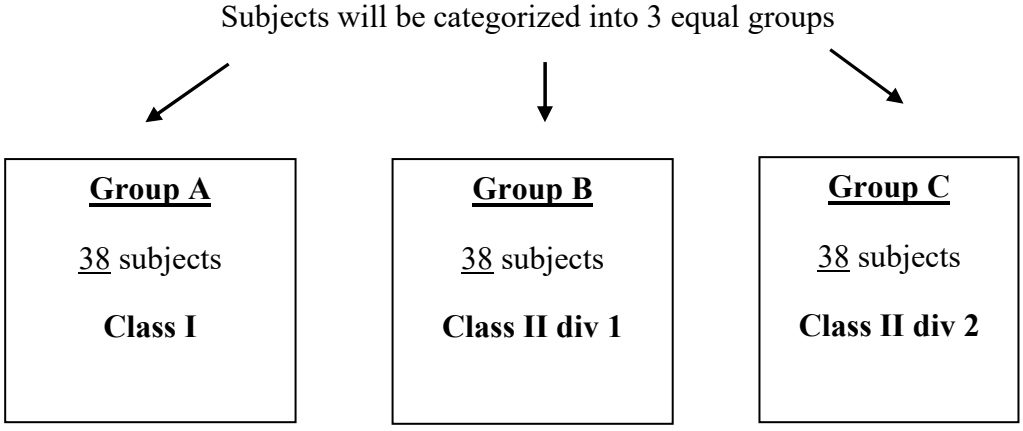
d=detectable mean difference= 5.80

Z α=1.96 at 5% α error

Z β=0.84 90% power

So, the calculated sample size is **38** per group, which makes the sample size **114** in total

METHODOLOGY:



Pre-treatment and Post- treatment lateral cephalograms and of the patients will be collected.

The following measurements were be made

1. On lateral cephalogram:

    a. Linear measurements:

    - **Co-Gn** (mm) - Distance between condylion and gnathion, effective length of mandible [12]
    - **Co-pt A** (mm) - Distance between condylion and gonion, effective length of maxilla[12]
    - **Pt A- root of the apex**- Distance between point A and radiographic root apex
    - **ANS- root of the apex**- Distance between ANS and radiographic root apex
    - **U1- ANS**- Distance between incisor superiorous/ tip of the upper incisor to ANS

[Root Apex- mid-point of the apical most part of radiographic root (if root resorption seen)]

    b. Angular measurements:

    - **SNA angle**- Angle between cranial base to sub-spinale (A-point)[13]
    - **SNB angle**- Angle between cranial base to supra-mentale (B-point)[13]
    - **ANB angle**- Difference between SNA and SNB[13]

- **CA- RA** – Angle between crown axis and root axis: Collum Angle[7]
- **PP- CA**- Angle between Palatal plane and Crown Axis
- **PP-RA**- Angle Between Palatal plane and Root Axis
- **NP- CA**- Angle between Nasion- Pogonion and crown axis
- **NP-RA**- Angle between Nasion- Pogonion and Root axis
- **N- Perp to CA**- Angle between Nasion- Perpendicular and crown axis
- **N- Perp to RA**- Angle between Nasion- Perpendicular and Root axis

To avoid errors during lateral cephalogram tracing, the crown of the upper central incisor will be linked to the cast and/or pictures of the subject.

↓

The interexaminer reliability will be assessed using intraclass correlation statistics, wherein, 30% of the sample size will be re-evaluated.

SELECTION OF SUBJECTS

Patients were be selected from among those who have undergone treatment in the Department of Orthodontics and Dento-facial Orthopaedics, KLE'S Academy of Higher Education and Research , KLE VK Institute of Dental Sciences, Belagavi-590010

INSTRUMENTS AND MATERIALS:

- Pre-treatment and post-treatment lateral cephalograms
- Patient casts/ Photographs
- Acetate matte sheets
- Lead pencil (0.35 mm)
- Scale

- Set-squares
- Protractor
- View box

CEPHALOMETRIC LANDMARKS [14]

- A point (Subspinale) : Most concave point of anterior maxilla
- B point (Supramentale) : Deep most point on mandibular symphysis
- Anterior Nasal Spine(ANS) : Anterior most point on maxillary bone
- Pogonion (Pg) : Most anterior point of mandibular symphysis
- Sella Tursica (S) : Midpoint of sella tursica
- Menton(M) : Lowest point on symphysis of the mandible
- Nasion (N) : Most anterior point on frontonasal suture
- Gnathion (Gn) : Point located perpendicular on symphysis of the mandible midway between pogonion and menton
- Gonion(G) : Most posterior and inferior point on angle of mandible
- U1 : Tip of maxillary central incisor

REFERENCE PLANES[14]

- Palatal plane (PP) (ANS-PNS): *This plane is formed by joining ANS to PNS and is used to assess the vertical tilt of maxilla*
- Facial plane (N-Pg): *This vertical plane is generated by connecting nasion to pogonion as represented in the Schudy analysis*

- Nasion Perpendicular (N Perp): *This vertical plane is generated by constructing a perpendicular line from Nasion to Frankfort horizontal plane*
- SN plane: *This plane portrays the anterior cranial base and is drawn by drawing a line from sella to nasion*
- Horizontal plane (HP): *A plane constructed 7° from the SN plane keeping Nasion as reference point*
- Crown axis: *line passing through U1 and center-point of the line drawn through the labial and palatal points on CEJ of the tooth.*
- Root axis: *line going through the root apex / center point of the apical most part of radiographic root (if root resorption seen).*
- *All linear parameters are measured parallelly to the Horizontal plane.*

STATISTICAL TEST:

Kruskal Wallis test was utilized to compare between the three groups like class I, II division 1 and II division 2. Wilcoxon signed rank test was utilized to differentiate between the pre and post op of class I, II division 1 and II division 2.

RESULTS

Table 1 –Comparison of Pre-treatment Linear and Angular parameters in group 1, 2

PARAMETER	CLASS I	CLASS II DIV 1	CLASS II DIV 2	p-value
CO-GN (linear)	103.95±7.91	95.87±4.390	102.41±6.916	.000*
CO-PT A (linear)	80.10± 6.09	79.21±4.618	83.08±5.980	.004*
PT A- APEX (linear)	4.79± 3.39	9.54±1.931	7.45±6.500	.000*
ANS- APEX (linear)	10.44± 4.27	14.51±2.235	11.44±2.789	.000*
U1- ANS (linear)	25.74± 3.51	23.31±1.894	26.44±2.963	.000*
SNA (angular)	82.40± 5.50	84.08±3.351	81.46±2.910	.004*
SNB	79.44± 4.18	78.33±3.351	76.49±3.516	.010*
ANB	4.92± 13.38	5.74±1.446	5.03±2.032	.000*
COLLUM ANGLE (CA-RA)	6.23± 5.81	1.97±8.251	9.21±7.270	.001*
PP-CA	116.08± 9.13	124.36±5.436	112.62±13.437	.000*
PP-RA	121.05± 8.64	126.38±7.195	120.69±11.098	.009*
NPOG-CA	29.59± 9.75	34.77±4.439	25.62±14.952	.004*
NPOG-RA	35.67± 8.64	36.79±8.355	33.74±11.733	.460
N PERP-CA	24.66± 9.13	30.92±5.936	20.92±15.325	.001*
N PERP-RA	30.71± 8.561	32.95±10.428	29.03±11.986	.361

p value <0.05* statistically significant

Table 2 – Comparison of Post-treatment Linear and Angular parameters in group 1, 2 and 3 using Kruskal Wallis test

PARAMETER	CLASS I	CLASS II DIV 1	CLASS II DIV 2	p- value
CO-GN (linear)	102.18±8.568	97.38±4.121	102.97±7.117	.001*
CO-PT A (linear)	78.38±7.191	78.59±4.102	81.54±5.712	.030*
PT A- APEX (linear)	6.10±1.829	5.85±1.899	6.55±1.895	.282
ANS- APEX (linear)	11.94±2.498	11.10±3.127	12.90±2.439	.020*
U1- ANS (linear)	26.15±3.259	26.15±2.134	24.62±3.675	.017*
SNA	81.41±9.673	82.90±2.693	80.38±2.759	.006*
SNB	79.38±4.405	79.49±3.203	77.56±3.210	.102
ANB	3.26±3.322	3.69±1.764	2.90±1.373	.086
COLLUM ANGLE (CA-RA)	6.23± 5.81	1.97±8.251	9.21±7.270	.001*
PP-CA	112.03±8.456	111.26±6.540	121.05±11.801	.000*
PP-RA	114.67±8.151	113.59±8.549	127.05±11.905	.000*
NPOG-CA	32.08±24.913	23.28±6.545	32.67±11.490	.000*
NPOG-RA	34.72±25.048	26.13±9.739	38.67±11.439	.000*
N PERP-CA	22.74±9.71	19.95±6.68	29.10±13.55	.004*
N PERP-RA	25.38±10.04	22.85±9.88	35.46±13.508	.000*

p value <0.05* statistically significant

TABLE 3: Intra group comparison of different linear parameters pre and post-intervention using Wilcoxon signed rank test

PARAMETER	CLASS I pre	CLASS I POST	MEAN DIFFERENCE	p-value
CO-GN (linear)	102.18±8.568	103.95±7.91	1.77	.082
CO-PT A (linear)	80.10± 6.09	78.58±7.191	-1.52	.056
PT A- APEX (linear)	4.79± 3.39	6.10±1.829	1.31	.129
ANS- APEX (linear)	10.44± 4.27	11.94±2.498	1.50	.066
U1- ANS (linear)	25.74± 3.51	26.15±3.259	0.41	.801
SNA (linear)	82.40± 5.50	81.41±9.673	-0.99	.628
SNB (linear)	79.44± 4.18	79.38±4.405	-0.06	.843
ANB (linear)	4.92± 13.38	3.26±3.322	-1.66	.929
COLLUM ANGLE (CA-RA)	6.23± 5.81	6.23± 5.81	0	.301
PP-CA	116.08± 9.13	112.03±8.456	-4.05	.033*
PP-RA	121.05± 8.64	118.26±8.151	-2.79	.000*
NPOG-CA	29.59± 9.75	32.08±24.913	2.49	.497
NPOG-RA	35.67± 8.64	38.31±25.048	2.64	.004*
N PERP-CA	24.66± 9.13	22.74±9.714	-1.92	.187
N PERP-RA	30.718.561	28.97±10.041	-1.74	.001*

p value <0.05* statistically significant

TABLE 4: Intra group comparison of different linear parameters pre and post-intervention using Wilcoxon signed rank test

PARAMETER	CLASS II DIV 1 pre	CLASS II DIV 1 POST	MEAN DIFFERENCE	p-value
CO-GN (linear)	95.87±4.390	97.38±4.121	1.51	.000*
CO-PT A (linear)	79.21±4.618	78.59±4.102	-0.62	.053
PT A- APEX (linear)	9.54±1.931	5.85±1.899	-3.69	.000*
ANS- APEX (linear)	14.51±2.235	11.10±3.127	-3.41	.000*
U1- ANS (linear)	23.31±1.894	26.15±2.134	2.84	.000*
SNA	84.08±3.351	82.90±2.693	-1.18	.000*
SNB	78.33±3.351	79.49±3.203	1.16	.000*
ANB	5.74±1.446	3.69±1.764	-2.05	.000*
COLLUM ANGLE (CA-RA)	1.97±8.251	1.97±8.251	0	.091
PP-CA	124.36±5.436	111.26±6.540	-13.1	.000*
PP-RA	126.38±7.195	113.23±8.549	-13.1	.000*
NPOG-CA	34.77±4.439	23.28±6.545	-11.49	.000*
NPOG-RA	36.79±8.355	25.25±9.739	-11.5	.000*
N PERP-CA	30.92±5.936	19.95±6.684	-10.97	.000*
N PERP-RA	32.95±10.428	21.92±9.888	-11.03	.000*

p value <0.05* statistically significant

TABLE 5: Intra group comparison of different linear parameters pre and post-intervention using Wilcoxon signed rank test

PARAMETER	CLASS II DIV 2 pre	CLASS II DIV 2 POST	MEAN DIFFERENCE	p-value
CO-GN (linear)	102.41±6.916	102.97±7.117	0.56	.000*
CO-PT A (linear)	83.08±5.980	81.04±5.712	-2.04	.043*
PT A- APEX (linear)	7.45±6.500	6.55±1.895	-0.9	.050
ANS- APEX (linear)	11.44±2.789	12.90±2.439	1.46	.000*
U1- ANS (linear)	26.44±2.963	24.62±3.675	-1.82	.000*
SNA	81.46±2.910	80.38±2.759	-1.08	.001*
SNB	76.49±3.516	77.56±3.210	1.07	.001*
ANB	5.03±2.032	2.90±1.373	-2.13	.000*
COLLUM ANGLE (CA-RA)	9.21±7.270	9.21±7.270	0	.306
PP-CA	112.62±13.437	121.05±11.801	8.43	.000*
PP-RA	120.69±11.098	130.26±11.905	9.57	.000*
NPOG-CA	25.62±14.952	32.67±11.490	7.05	.000*
NPOG-RA	33.74±11.733	41.88±11.439	8.14	.001*
N PERP-CA	20.92±15.325	29.10±13.555	8.18	.000*
N PERP-RA	29.03±11.986	38.31±13.508	9.28	.000*

p value <0.05* statistically significant

Table 6: Pairwise comparison of groups across Co-Gn parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
2-3	-31.205	7.666	0.000
2-1	-38.295	7.666	0.000
3-1	7.090	7.666	1.000

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 7: Pairwise comparison of groups across Co-A parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
2-1	3.179	7.666	1.000
2-3	-23.321	7.666	0.007
1-3	-20.141	7.666	0.026

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 8: Pairwise comparison of groups across PTA-Apex parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
1-3	-14.269	7.637	0.185
1-2	-52.615	7.637	0.000
3-2	38.346	7.637	0.000

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 9: Pairwise comparison of groups across ANS-Apex parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
1-3	-3.641	7.647	1.000
1-2	-38.013	7.647	0.000
3-2	34.372	7.647	0.000

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 10: Pairwise comparison of groups across U1-ANS parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
2-1	36.615	7.635	0.000
2-3	-37.385	7.635	0.000
1-3	-0.769	7.635	0.920

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 11: Pairwise comparison of groups across SNA parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
3-1	0.705	7.643	1.000
3-2	22.410	7.643	0.010
1-2	-21.705	7.643	0.014

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 12: Pairwise comparison of groups across SNB parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
3-2	13.282	7.647	0.247
3-1	23.103	7.647	0.008
2-1	9.821	7.647	0.597

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 13: Pairwise comparison of groups across ANB parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
1-3	-27.244	7.606	0.001
1-2	-37.949	7.606	0.000
3-2	10.705	7.606	0.478

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 14: Pairwise comparison of groups across CA-RA parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
2-1	15.423	7.622	0.129
2-3	-28.308	7.622	0.001
1-3	-12.885	7.622	0.273

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 15: Pairwise comparison of groups across PP-CA parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
3-1	6.974	7.674	1.000
3-2	35.218	7.674	0.000
1-2	-28.244	7.674	0.001

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 16: Pairwise comparison of groups across PP-RA parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
1-3	-1.590	7.677	1.000
1-2	-21.256	7.677	0.017
3-2	19.667	7.677	0.031

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 17: Pairwise comparison of groups across NPOG-CA parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
3-1	6.833	7.675	1.000
3-2	24.628	7.675	0.004
1-2	-17.795	7.675	0.061

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 18: Pairwise comparison of groups across NPERP-CA parameter (pre treatment)

Group 1- group 2	Test statistic	Std.error	P value
3-1	6.077	7.672	1.000
3-2	27.269	7.672	0.001
1-2	-21.192	7.672	0.017

1-Class I; 2- Class II Div 1; 3- Class II Div 2

Table 19: Pairwise comparisons post treatment (Co-Gn parameter)

Group 1-Group 2	Test statistic	Std.error	P value
2-1	19.218	7.657	0.036
2-3	-26.821	7.657	0.001
1-3	-7.603	7.657	0.962

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 20: Pairwise comparisons post treatment (Pt A- Apex parameter)

Group 1-Group 2	Test statistic	Std.error	P value
1-2	-1.833	7.666	0.000
1-3	-18.436	7.666	0.059
2-3	-16.603	7.666	0.000

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 21: Pairwise comparisons post treatment (ANS APEX parameter)

Group 1-Group 2	Test statistic	Std.error	P value
2-1	6.397	7.623	0.000
2-3	-20.795	7.623	0.000
1-3	-14.397	7.623	0.177

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 22: Pairwise comparisons post treatment (U1 ANS parameter)

Group 1-Group 2	Test statistic	Std.error	P value
3-1	18.372	7.645	0.049
3-2	19.474	7.645	0.033
1-2	-1.103	7.645	1.000

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 23: Pairwise comparisons post treatment (CA-RA parameter)

Group 1- group 2	Test statistic	Std.error	P value
2-1	15.423	7.622	0.129
2-3	-28.308	7.622	0.001
1-3	-12.885	7.622	0.273

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 24: Pairwise comparisons post treatment (PP-CA parameter)

Group 1-Group 2	Test statistic	Std.error	P value
2-1	3.679	7.674	1.000
2-3	-32.128	7.674	0.000
1-3	-28.449	7.674	0.001

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 25: Pairwise comparisons post treatment (PP-RA parameter)

Group 1-Group 2	Test statistic	Std.error	P value
2-1	5.372	7.676	1.000
2-3	-41.397	7.676	0.000
1-3	-36.026	7.676	0.000

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 26: Pairwise comparisons post treatment (NPOG-CA parameter)

Group 1-Group 2	Test statistic	Std.error	P value
2-1	16.218	7.676	0.104
2-3	-30.782	7.676	0.000
1-3	-14.564	7.676	0.173

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 27: Pairwise comparisons post treatment (NPOG-RA parameter)

Group 1-Group 2	Test statistic	Std.error	P value
2-1	13.051	7.676	0.267
2-3	-36.487	7.676	0.000
1-3	-23.436	7.676	0.007

1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 28: Pairwise comparisons post treatment (N PERP-CA parameter)

Group 1-Group 2	Test statistic	Std.error	P value
2-1	8.628	7.674	0.783
2-3	-25.256	7.674	0.003
1-3	-16.628	7.674	0.091

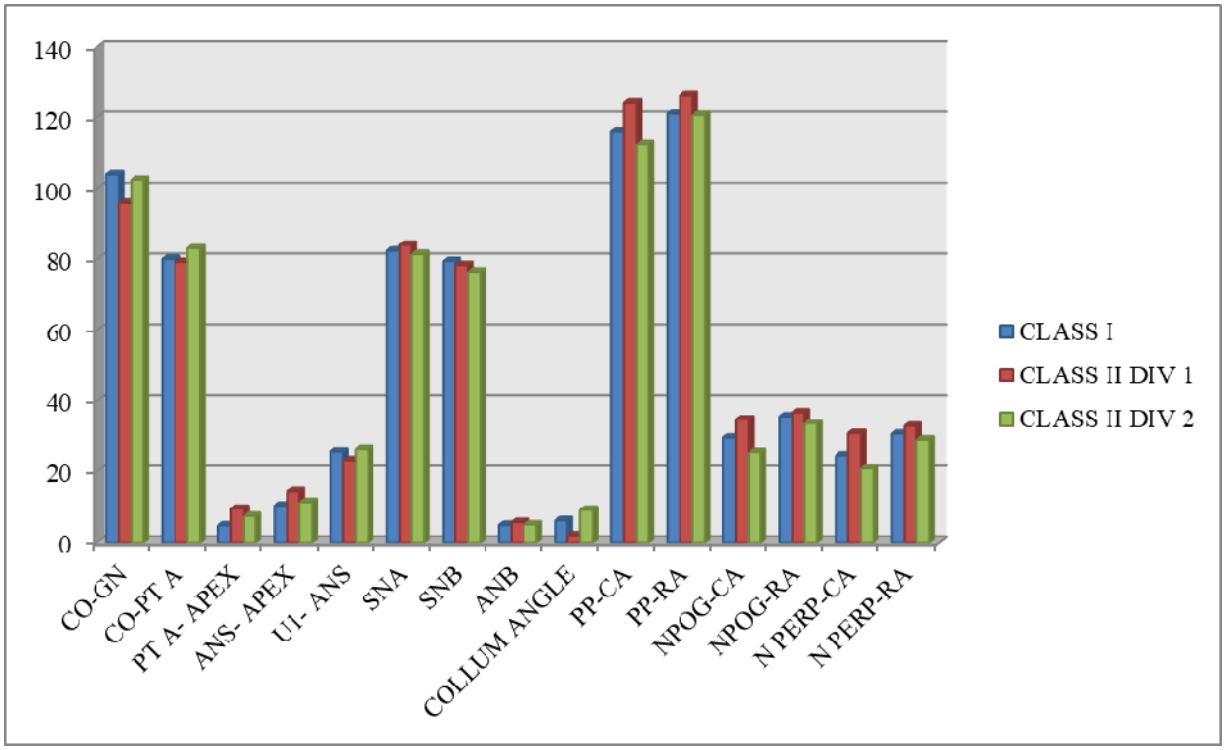
1-Class I; 2- Class II Div 1; 3-Class II Div 2

Table 29: Pairwise comparisons post treatment (N PERP-RA parameter)

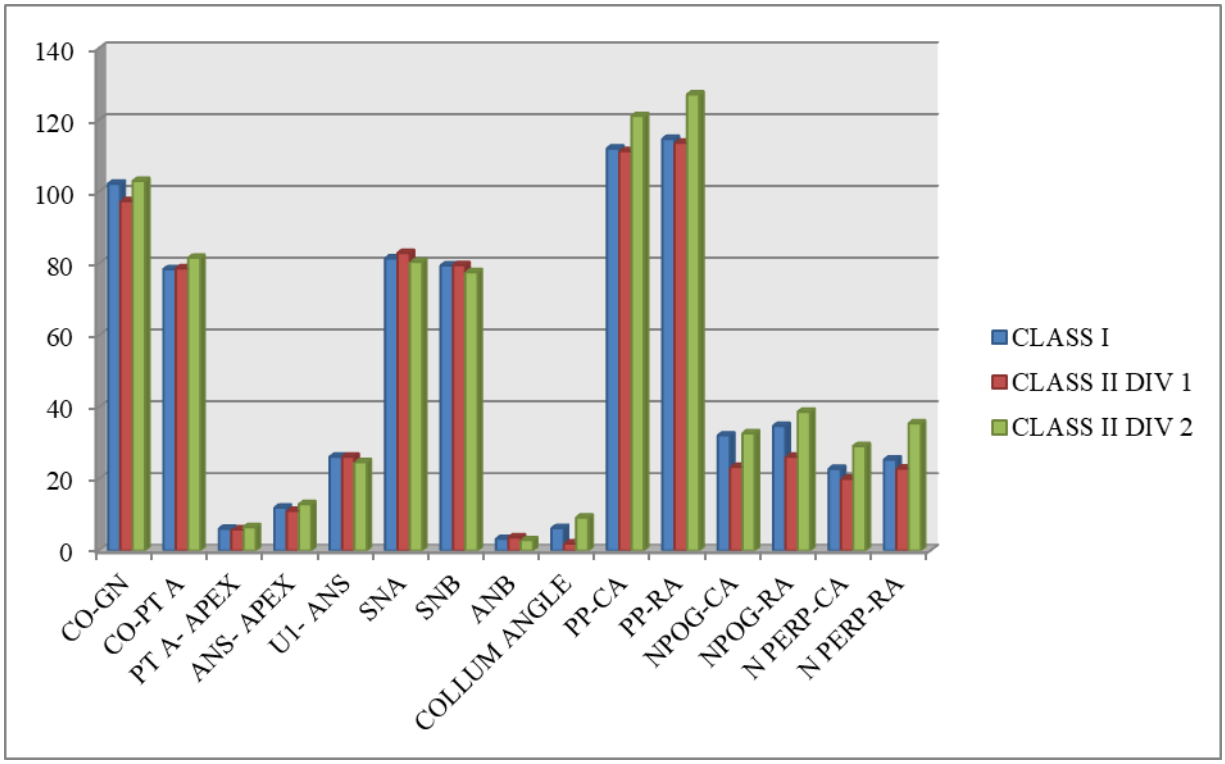
Group 1-Group 2	Test statistic	Std.error	P value
2-1	7.885	7.677	0.913
2-3	-33.769	7.677	0.000
1-3	-25.885	7.677	0.002

1-Class I; 2- Class II Div 1; 3-Class II Div 2

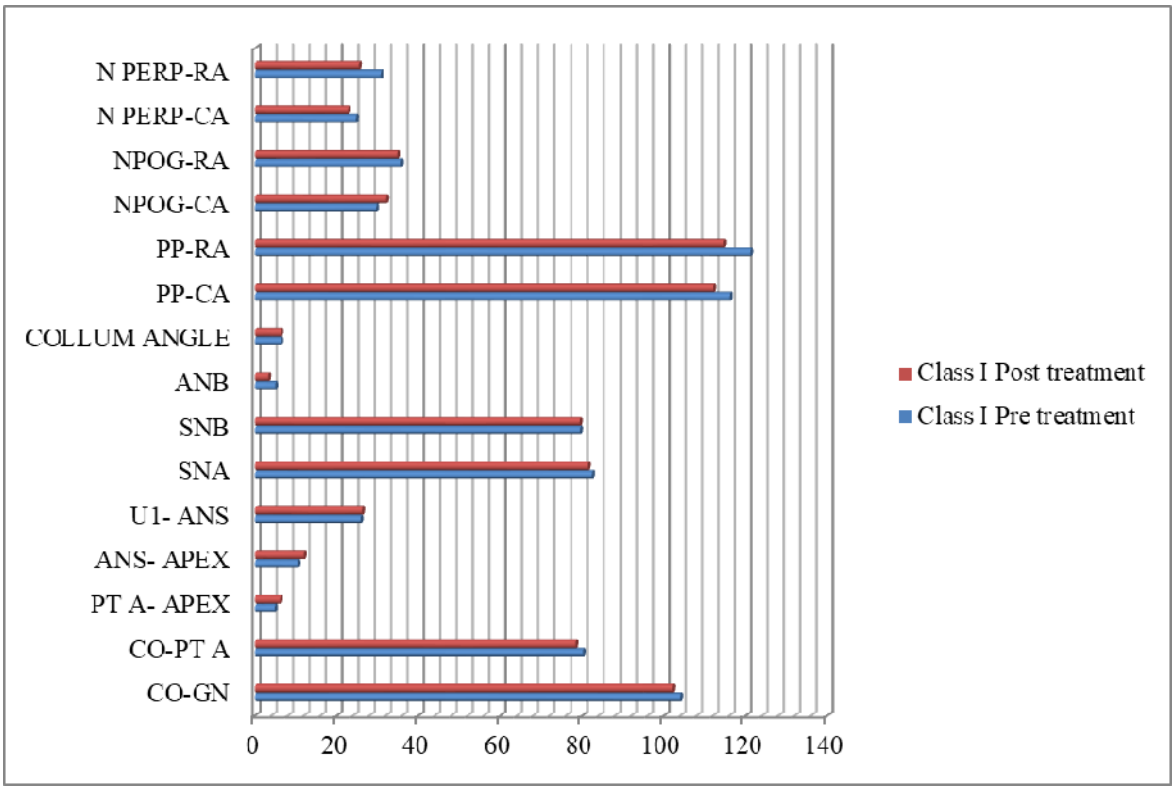
Graph 1: Comparison of Pre-treatment Linear and Angular parameters in group 1, 2 and 3



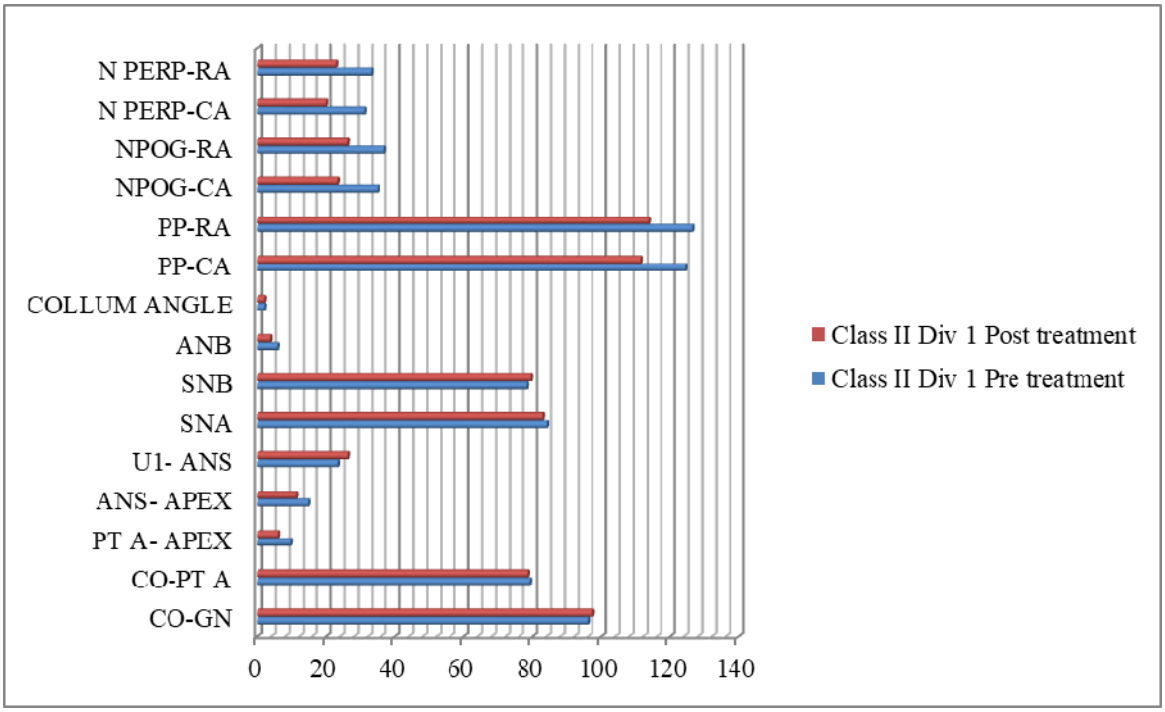
Graph 2: Comparison of Post-treatment Linear and Angular parameters in group 1, 2 and 3



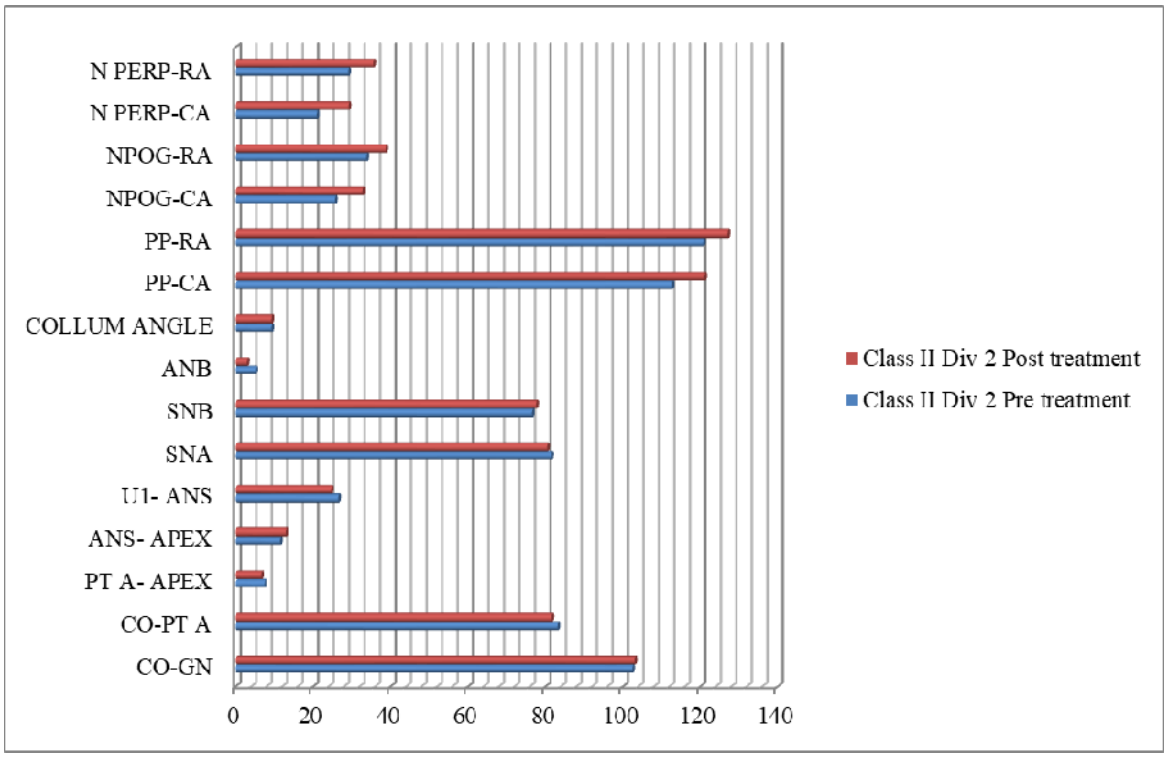
Graph 3: Comparison of linear and angular parameters in Class I patients pre and post treatment



Graph 4: Comparison of linear and angular parameters in Class II Div 1 patients pre and post treatment



Graph 5: Comparison of linear and angular parameters in Class II Div 2 patients pre and post treatment



The purpose of this study was to statistically assess the relationship between the collum angle of maxillary upper incisor and maxilla before and after treatment in Class II division 2 patients.

Linear and angular measurements were carried out on pre and post treatment lateral cephalograms of 117 patients. They were divided into 3 groups, each consisting of 39 subjects. All the parameters were manually assessed.

The statistical analysis was done using SPSS VERSION 25.0. The findings of the study were statistically analysed using Kruskal Wallis test for inter-group comparison and Wilcoxon signed rank test for intra-group comparison between the pre and post treatment of the 3 groups.

For the purpose of ease of interpretation, the results were categorized according to the p value:

- Statistically significant * indicates p value < 0.05
- Statistically not significant p value >0.05

Table 1 represents the statistical data of all the 3 groups

PRE-TREATMENT (Graph 1)

Co-Gn

The effective mandibular length showed statistically significant difference between all the 3 groups (.001) *. (Table No.1) Pairwise comparison showed statistically significant difference between group 1 and 2 and group 2 and 3 for effective mandibular length (0.000) *. (Table No.6)

Co- A

The effective maxillary length showed statistically significant difference between all the 3 groups (.004) *. (Table No.1) Pairwise comparison showed statistically significant difference between group 2 and 3 and group 1 and 3 for effective maxillary length (0.007 and 0.026) *. (Table No.7)

Pt A- Apex

The mean distance between subspinale to the apex of the root in groups 1, 2 and 3 was recorded to be 4.79± 3.39, 9.54± 1.931 and 7.45±6.500, respectively. The difference between the mean distance between subspinale to the apex of the root of the 3 groups was seen to be statistically significant (.000) *. (Table No.1) Pairwise comparison showed statistically significant difference between group 1 and 2 and group 3 and 2 (.000) *. (Table No.8)

ANS- Apex

The mean distance from ANS to apex of the root in group 1, 2 & 3 was seen to be 10.44± 4.27, 14.51± 2.23 and 11.44± 2.78, respectively. The difference between the mean distance from ANS to apex of the root of the 3 groups was seen to be statistically significant (.000) *. (Table No.1) Pairwise comparison showed statistically significant difference between group 1 and 2 and group 2 and 3 (.000) *. (Table No.9)

U1- ANS

The mean distance between incisor superioris and ANS was recorded to be 25.74± 3.51, 23.31± 1.89 and 26.44± 2.96, in group 1, 2 and 3, respectively. The difference between the mean distance from incisor superioris to ANS of the 3 groups was seen to be statistically significant (.000) *. (Table No.1) Pairwise comparison of groups across U1-ANS parameter showed statistically significant difference between group 1 and 2 and group 2 and 3 (.000) *. (Table No. 10)

SNA

The mean difference for SNA was seen to be statistically significant between group 1 and 2 and group 3 and 2 (0.014* and 0.010*, respectively). (Table No.11)

SNB

The mean difference for SNB in pairwise comparison showed a statistically significant difference between group 1 and 3 (0.008) *. (Table No.12)

ANB

The mean difference for ANB in pairwise comparison showed a statistically significant difference between group 1 and 2 and group 1 and 3 (.000* and .001*, respectively). (Table No.13)

Collum angle (CA- RA)

The mean collum angle in group 1, 2 and 3 was recorded to be 6.23± 5.81, 1.97± 8.25 and 9.21± 7.27, respectively. Group 1, 2 and 3 showed statistically significant difference for collum angle pre treatment (0.001). * (Table No.1) Pairwise comparison showed statistically significant difference between collum angles in group 2 and 3 (0.001) *. (Table No.14)

PP- CA

The mean values for the angle formed by the palatal plane and crown axis were recorded to be 116.08± 9.13, 124.36± 5.43 and 112.62± 13.43, respectively. Group 1, 2 and 3 showed statistically significant difference for the angle formed by the palatal plane and crown axis (.000) *. (Table No.1) Pairwise analysis showed significant difference between group 1 and 2 and group 3 and 2 (0.001* and .000*, respectively). (Table No.15)

PP- RA

The mean values for the angle formed by the palatal plane and root axis were recorded to be 121.05± 8.64, 126.38± 7.19 and 120.69± 11.09, respectively. A statistically significant difference was seen between the angle formed by palatal plane and root axis in group 1, 2 and 3 (.009) *. (Table No.1) Pairwise comparison shows statistically significant difference between group 1 and 2 and group 3 and 2 (0.017* and 0.031*). (Table No.16)

N pog- CA

The mean value for the angle formed by facial plane and crown axis in group 1, 2 and 3 were 29.59± 9.75, 34.77± 4.43 and 25.62± 14.95, respectively. (Table

No.1) A statistically significant difference was seen between the angle formed by facial plane and crown axis in group 2 and 3 (0.004) *. (Table No.17)

N pog- RA

The mean value for the angle formed by facial plane and root axis in group 1, 2 and 3 were 35.67± 8.64, 36.79±8.355 and 33.74±11.733, respectively. (Table No.1) No significant difference was seen for the angle formed between facial plane and root axis (.460).

N perp- CA

The mean value for the angle formed by Nasion perpendicular plane and crown axis in group 1, 2 and 3 were 24.66± 9.13, 30.92±5.93 and 20.92±15.32, respectively. A statistically significant difference was seen between the angle formed by N perpendicular plane and crown axis in group 1, 2 and 3 (.001) *. (Table No.1) Pairwise comparison showed statistically significant difference between group 1 and 2 and group 3 and 2 (0.017* and 0.001*). (Table No.18)

N perp- RA

The mean value for the angle formed by Nasion perpendicular plane and root axis in group 1, 2 and 3 were 30.71± 8.561, 32.95±10.42 and 29.03±11.986, respectively. (Table No.1) No significant difference was seen between the angle formed by N perpendicular plane and root axis in all the 3 groups studied.

POST-TREATMENT (Graph 2)

Co-Gn

The effective mandibular length showed statistically significant difference between all the 3 groups (.001) *. (Table No.2) Pairwise comparison showed

statistically significant difference between group 1 and 2 and group 2 and 3 for effective mandibular length (0.036* and 0.001*, respectively). (Table No.19)

Co- A

The effective maxillary length showed statistically significant difference between all the 3 groups (.030*). (Table No.2)

Pt A- Apex

The mean distance between subspinale to the apex of the root in groups 1, 2 and 3 was recorded to be 6.10± 1.82, 5.85± 1.89 and 6.55± 1.89, respectively. The difference in the mean distance between subspinale to the apex of the root was seen to be statistically insignificant between all the 3 groups (.282). (Table No.2) Pairwise comparison showed statistically significant difference between group 1 and 2 and group 3 and 2 (.000) *. (Table No.20)

ANS- Apex

The mean distance from ANS to apex of the root in group 1, 2 & 3 was seen to be 11.94± 2.49, 11.10± 3.12 and 12.90± 2.43, respectively. The difference in the mean distance between ANS to apex of the root was seen to be statistically significant between all the 3 groups (.020) *. (Table No.2) Pairwise comparison showed statistically significant difference between group 1 and 2 and group 3 and 2 (.000) *. (Table No.21)

U1- ANS

The mean distance between incisor superioris and ANS was recorded to be 26.15± 3.25, 26.15± 2.13 and 24.62± 3.67, in group 1, 2 and 3, respectively. The difference in the mean distance between incisor superioris and ANS was seen to be statistically significant between all the 3 groups (.017) *. (Table No.2) Pairwise

comparison of groups across U1-ANS parameter showed statistically significant differences between group 3 and 1 and group 3 and 2 (0.049* and 0.033*). (Table No.22)

SNA

The mean difference for SNA was seen to be statistically significant between group 1, 2 and 3 (.006) *. (Table No.2)

SNB

The mean difference for SNB was seen to be statistically insignificant between the 3 groups (.102). (Table No.2)

ANB

The mean difference for SNB was seen to be statistically insignificant between the 3 groups (.086). (Table No.2)

Collum angle (CA- RA)

The mean collum angle in group 1, 2 and 3 was recorded to be 6.23± 5.81, 1.97± 8.25 and 9.21± 7.27, respectively (0.001) *. (Table No.2) Pairwise comparison showed statistically significant difference between collum angles in group 2 and 3 (0.001) *. (Table No.23)

PP- CA

The mean values for the angle formed by the palatal plane and crown axis were recorded to be 112.03±8.45, 111.26±6.54 and 121.05±11.80, respectively. Group 1, 2 and 3 showed statistically significant difference for the angle formed by the palatal plane and crown axis (.000) *. (Table No.2) Pairwise analysis showed

significant difference between group 2 and 3 and group 1 and 3 (.000* and .001*, respectively). (Table No.24)

PP- RA

The mean values for the angle formed by the palatal plane and root axis were recorded to be 114.67±8.15, 113.59±8.54 and 127.05±11.90, respectively. A statistically significant difference was seen between the angle formed by palatal plane and root axis in group 1, 2 and 3 (.000) *. (Table No.2) Pairwise analysis showed significant difference between group 2 and 3 and group 1 and 3 (.000) *. (Table No.25)

N pog- CA

The mean values for the angle formed by the facial plane and crown axis were recorded to be 32.08±24.91, 23.28±6.54 and 32.67±11.49, respectively. A statistically significant difference was seen between the mean values for the angle formed by the facial plane and crown axis in the 3 groups (0.000) *. (Table No.2) Group 2 and 3 show a statistically significant difference in pairwise comparison for the angle formed between facial plane and crown axis (.000) *. (Table No.26)

N pog- RA

The mean values for the angle formed by the facial plane and root axis were recorded to be 34.72±25.04, 26.13±9.73 and 38.67±11.43, respectively. Statistically significant difference was seen for the angle formed between facial plane and root axis in all 3 groups (.000) *. (Table No.2) Pairwise comparison showed statistically significant difference between group 1 and 3 and group 2 and 3 (0.000* and 0.007*). (Table No.27)

N perp- CA

The mean values for the angle formed by the N perpendicular plane and crown axis were recorded to be 22.74±9.71, 19.95±6.68 and 29.10±13.55, respectively. A statistically significant difference was seen between the angle formed by N perpendicular plane and crown axis in group 1, 2 and 3 (.004) *. (Table No.2) Pairwise comparison showed statistically significant difference between group 2 and group 3 (0.003) *. (Table No.28)

N perp- RA

The mean values for the angle formed by the N perpendicular plane and root axis were recorded to be 25.38±10.04, 22.85±9.88 and 35.46±13.50, respectively. A statistically significant difference was seen between the angle formed by N perpendicular plane and root axis in group 1, 2 and 3 (.000) *. (Table No.2) Pairwise comparison showed statistically significant difference between group 1 and 3 and group 2 and 3 (0.002* and 0.000*). (Table No.29)

DIFFERENCE (Table No.3)

Group 1 (TABLE NO. 3 AND GRAPH 3):

The following intra group parameters were statistically significant:

PP- CA- The angle between palatal plane and crown axis was seen to reduce by 4.05° post treatment. (p-value .033*)

PP- RA- The angle between palatal plane and crown axis was seen to reduce by 6.38° post treatment. (p-value .000*)

N Pog- RA - The mean decrease in the angle formed by the facial plane and root axis was 0.95°. (p-value- .004*)

N Perp- RA - The mean decrease in the angle formed by the N- Perp plane and root axis was 5.33°. (p-value- .001*)

Group 2 (TABLE NO. 4 AND GRAPH 4):

The following intra group parameters were statistically significant:

Co- Gn- Mean increase in the effective mandibular length was seen to be 1.51mm post treatment (.000) *.

Pt A- Apex- Mean decrease of 3.69mm in the distance between point A and apex of the root was seen post treatment (0.000) *.

ANS- Apex- Mean decrease of 3.41mm in the distance between ANS and apex of the root was seen post treatment (0.000) *.

U1- ANS- Mean increase of 2.84mm in the distance between tip of the incisor and ANS was seen post treatment (0.000) *.

SNA- Mean decrease of 1.18° in the SNA angle was observed (0.000) *. SNB- Mean increase of 1.16° in the SNB angle was observed (0.000) *. ANB- Mean decrease of 2.05° in the ANB angle was observed (0.000) *.

PP- CA- Mean decrease of 13.1° in the angle between palatal plane and crown axis was observed (0.000) *.

PP- RA- Mean decrease of 12.79° in the angle between palatal plane and root axis was observed (0.000) *.

N Pog- CA- Mean decrease of 11.49° in the angle between facial plane and crown axis was observed (0.000) *.

N Pog- RA- Mean decrease of 10.66° in the angle between facial plane and root axis was observed (0.000) *.

N Perp- CA- Mean decrease of 10.97° in the angle between N Perpendicular plane and crown axis was observed (0.000) *.

N Perp- RA- Mean decrease of 10.1° in the angle between N Perpendicular plane and root axis was observed (0.000) *.

Group 3 (TABLE NO. 5 AND GRAPH 5):

The following intra group parameters were statistically significant:

Co- Gn- Mean increase in the effective mandibular length was seen to be 0.56mm post treatment (.000) *.

ANS- Apex- Mean increase of 1.46mm in the distance between ANS and apex of the root was seen post treatment (0.000) *.

U1- ANS- Mean decrease of 1.82mm in the distance between tip of the incisor and ANS was seen post treatment (0.000) *.

SNA- Mean decrease of 1.08° in the SNA angle was observed (0.001) *. SNB- Mean increase of 1.07° in the SNB angle was observed (0.001) *. ANB- Mean decrease of 2.13° in the ANB angle was observed (0.000) *.

PP- CA- Mean increase of 8.43° in the angle between palatal plane and crown axis was observed (0.000) *.

PP- RA- Mean increase of 6.36° in the angle between palatal plane and root axis was observed (0.000) *.

N Pog- CA- Mean increase of 7.05° in the angle between facial plane and crown axis was observed (0.000) *.

N Pog- RA- Mean increase of 4.93° in the angle between facial plane and root axis was observed (0.001) *.

N Perp- CA- Mean increase of 8.18° in the angle between N Perpendicular plane and crown axis was observed (0.000) *.

N Perp- RA- Mean increase of 6.43° in the angle between N Perpendicular plane and root axis was observed (0.000) *.

DISCUSSION

Maxillary central incisors are the most noticeable teeth at the time of unstrained facial activity. Variability in the morphology of tooth is an essential factor to consider when achieving optimal dental occlusion. Often even slight malalignments of these teeth are of concern to patients. One such morphological trait observed in the literature is the collum angle.[7]

The variation in collum angle in different forms of malocclusions is explained in lots of studies. Collum angle was seen to be significant in maxillary incisors in Class II/2 and mandibular incisors in Class III malocclusion. Due to the root bending, the morphologies of such teeth play an important part in torque changes, dehiscence, fenestration, & root resorption.[1] Delivanis and Kuftine suggested that the collum angle in Class II/2 malocclusions may complicate treatment mechanics, such as in, orthodontic intrusion & torque control of the incisors, and in severe cases, might elevate the danger palatal cortical plate perforation.[7]

With the risk of such complications, it is important to understand the maxillary incisor changes with respect to the maxilla after orthodontic treatment. No study has been found evaluating the collum angle of upper incisors in class II/2 cases before and after the correction of malocclusion. In this study, we have tried to quantitatively assess and describe the collum angle in maxillary incisors in class I, II/1 and II/2 pre and post treatment in relation to the maxilla. We used 15 parameters, 5 linear and 10 angular measurements in our study.

2 linear and 3 angular parameters were utilized to assess the skeletal malocclusion. A skeletal discrepancy between the maxillary base and the basis of the

skull is characterises the morphological Class II malocclusion, which is caused by maxillary protrusion and/or mandibular retrusion. [15]

The **effective mandibular length** showed significant difference between the 3 groups before & after treatment (0.000 and 0.001, respectively). A mean increase of 1.77mm, 1.51mm and 0.56mm in the effective mandibular length was seen after orthodontic treatment in group 1, 2 and 3, respectively. Difference in the mandibular apical basal length, pre and post treatment was seen to be statistically significant in all the 3 groups (Table- 3, 4 and 5). When compared to the lower jaw in patients having Class I malocclusions, the mandible in patients with Class II/2 malocclusions is explained as smaller & retrognathic in the literature.[2] Our results are consistent with the findings of a study by Al- Nimri et al[2], which shows a likelyhood for a shorter & more retrognathic mandible in Class II/2 malocclusion in comparison with Class I malocclusion, and disagrees with their findings between Class II/1 and II/ 2. Class II/2 individuals have been observed to present with longer & more prognathic mandible in comparison with Class II/1 malocclusion.[4] Our study shows Class II div1 group to have a shorter mandibular basal length compared to the other 2 groups, which is in agreement with a study by Renfroe[19], who found mandibles in Class II/2 to be comparatively longer.

Age of the patients involved in our study ranged from 11- 42 years. There was lack of standardization in terms of orthodontic treatment modality or growth status of the patients included in the study, which may be a ground for bias. However, sample subjects underwent orthodontic treatment for correction of the presenting malocclusion and this fits the objectives of our study. Studies on the effectiveness of dentofacial orthopaedics in young people are not required because the craniofacial

growth alterations in subjects with untreated Class II/1 are not significantly different from those in untreated participants with normal occlusion. Baccetti et al reported an increase of 0.5mm and 1.0 mm in the mean (Co-A) and (Co-Gn), respectively, in untreated individuals, both of which termed insignificant. [16] For growing patients, significant increase in the mandibular length was an obvious consequence of the orthopaedic therapy.

Statistically significant difference of the effective maxillary lengths was observed before & after treatment between all 3 groups (0.001 and 0.030, respectively). Pre treatment findings showed a significant difference in between group 1 & 2, and group 1 & 3 for **effective maxillary length** (0.000). Few of the previous studies reported that protrusion of the maxilla is a common feature of Class II malocclusion which is in agreement with our study for Class II/1.[19, 20] For group 3, the effective maxillary length was seen to be normal to slightly prognathic. The tendency of more prognathic maxilla was reported by Renfroe[19] and Hedges RB [21]. Al- Nimri et al[2], in their study observed a normal maxillary basal length, which is consistent with our study. Post treatment decrease in the effective maxillary length with a mean difference of 1.52mm, 0.62mm and 2.04mm was seen in group 1, 2 & 3, respectively. No significant difference between group 1 & 2 was seen in the pre and post treatment measurements. Difference in group 3 for effective maxillary basal length pre and post treatment was seen to be statistically significant (.043). Results from our study were in accordance with the results by Al- Nimri et al[2], Erverdi [17] and Arvysts[18] in their studies for Class II/2 group.

In our study we observed the **SNA** to be normal in group 1 & 3 which was in accordance with the study by Mills[24] for Class I & Class II/2. Group 2 showed

consistent results with other studies that found the maxilla in Class II/1 patients to be more protrusive & mandible was normal size & position.[26]

The mean SNB angle seen in Class II/2 group was substantially lower than in the Class I group, indicating a retrognathic mandible in group 3, which was consistent with a study by Ballard[27]. Pre treatment values for group 1 exhibited a normal position of the lower jaw and for group 2 showed a normal to relatively retruded mandibular position. Group 3 had a larger frequency of patients with retrognathic mandible than group 2. This finding was in agreement with some previous studies[19, 20] that indicated a retrognathic lower jaw in Class II/2 malocclusion.

The pretreatment mean **ANB** angles portrayed significant difference among group 1 & 2 and group 1 & 3, indicating their class II skeletal pattern. Post treatment mean ANB values portrayed no statistically significant difference. The skeletal form was identified using angle ANB, which is accepted in literature for indexing skeletal discrepancies.[28]

Three linear and seven angular measurements were considered pre and post treatment, to evaluate the position and inclination of the upper central incisor with maxilla and also studied for the changes undergone by the same with treatment.

We evaluated the **distance between subspinale (point A) to the root apex**, to ascertain the position of the tooth root with the anterior border of the maxilla. Pre treatment measurements were measured to be 4.79± 3.39mm, 9.54± 1.93mm and 7.45±6.50mm, respectively. Post treatment measurements were measured to be 6.10± 1.82mm, 5.85± 1.89mm and 6.55± 1.89mm, respectively. Enlow [23] explained the tendency of bone resorption of the maxillary anterior surface with age. Alveolar bone remodelling in association with orthodontic tooth movement of the maxillary incisors

is also thought to impact the position of subspinale (point A).[22] Erverdi[17] concluded that there is a substantial correlation between the axial inclination of the maxillary incisors and the location of subspinale (point A). These tendencies and responses of the maxilla explains the change in the location of point A and the differences in values obtained in our study. Significant difference was not observed between group 1 & 3 after treatment for this parameter. Group 2 showed a mean decrease of 3.69mm in the distance from point A to root apex post treatment. Though statistically insignificant, group 3 showed a mean decrease of 0.9 mm in the distance between point A and root apex post treatment. The difference between Group 2 & 3 can be due to the difference in the crown root angulation and the tooth inclination. In class II/1 the maxillary incisor correction is achieved by retroclination of the incisor, whereas, in class II/2 the maxillary incisor is proclined. This explains the decrease in distance in group 2. The decrease in distance in group 3 can be due to the change in position of point A, both due to bone remodelling with age and orthodontic treatment. The relative insignificance observed in Class II/2 for this parameter can be due to the presence of collum angle.

To overcome the shortcomings posed by the linear measurement Pt A- Apex of the root, another parameter was included in the study. D**istance between ANS to apex of the upper central incisor root** was calculated. The pre treatment mean distance from ANS to root apex in group 1, 2 & 3 was seen to be 10.44± 4.27mm, 14.51± 2.23mm and 1.44± 2.78mm, respectively (.000). Group 1 & 2 and group 2 & 3 showed significant differences across this parameter in the pretreatment values. This can be explained by significant inclination in class II/1 subjects, which justified because of their inclination. The post treatment mean distance from ANS to root apex in group 1, 2 & 3 was seen to be 11.94± 2.49, 11.10± 3.12 and 12.90± 2.43,

respectively (.020). A mean decrease of 3.41mm in the distance from ANS to root apex was seen post treatment in group 2 (0.000). A mean increase of 1.46mm in the distance from ANS to root apex was seen post treatment in group 3(0.000). Correction of crown inclination led to decrease and increase in the distance, respectively.

A vertical linear parameter was measured parallel to Nasion Perpendicular, to assess the relation of the maxillary bone to the crown of the tooth. **Distance between incision superioris (tip of the maxillary incisor) to ANS** was measured in the three groups, pre and post orthodontic treatment. The pre treatment mean distance between incisor superioris and ANS was recorded to be 25.74± 3.51mm, 23.31± 1.89mm and 26.44± 2.96mm, in group 1, 2 & 3, respectively. Differences observed between group 1 & 2 and group 2 & 3 were significant. It can be due to the flared upper central incisors in class II/1 as opposed to a relative normal inclination in class I and retroclined incisors in Class II/2 individuals. The mean distance between incisor superioris and ANS was recorded to be 26.15± 3.25mm, 26.15± 2.13mm and 24.62± 3.67mm, in group 1, 2 & 3, respectively. We observed a mean increase of 2.84mm and decrease of 1.82mm in the distance between tip of the incisor and ANS post treatment in group 2 and 3, respectively (0.000). This again can be reasoned due to correction of maxillary incisor inclination.

Collum angle is the angle formed by the long axis of the tooth crown and tooth root. This crown-to-root angulation can pose a challenge during the treatment of class II/2 malocclusion with the increase chance of root exposure, dihescence, fenestration or root resorption.[1] Our findings are consistent with prior research suggesting that the collum angle varies between groups with different forms of malocclusions.[7,29] The mean collum angle in group 1, 2 & 3 was recorded to be 6.23±

5.81°, 1.97± 8.25° and 9.21± 7.27°, respectively. statistically significant differences between group 2 & 3 (0.001) were seen. The collum angle in Class II/2 cases is observed to be greater than any other malocclusion in our study and this is consistent with the results obtained in several studies done to assess the collum angle. [1,7,9,11] Maxillary incisor position and angulation plays a prime role in the facial attractiveness, thus correction of malocclusion requires changes in the incisor tip, torque.[6] Thus, difference in the tooth morphology will lead to variable changes in relation to the maxillary bone throughout the treatment. In an attempt to understand these variations, we included 6 angular parameters: palatal plane to crown axis, palatal plane to root axis, facial plane to crown axis, facial plane to root axis, Nasion perpendicular to crown axis and Nasion perpendicular to root axis. The uncertainity of alveolar bone remodelling in terms of direction & amount of movement poses to be a significant challenge to the treatment outcome.[30] Studies have been assessed the change in the maxillary alveolar bone during various forms of orthodontic treatment[30]. Yodthong's[31] study believed that factors such as change in inclination may influence the alveolar bone thickness during orthodontic therapy. Steiner et al[32] and Batenhorst et al[33] observed marginal bone loss with incisor proclination. Thongudomporn et al[34] observed significant reduction in the palatal & total thickness of bone at the middle & apical levels of the tooth root in maxillary alveolar bone during proclination & extrusion mechanics. According to the literature, there is insufficient data on the change in inclination of the upper central incisor as a result of orthodontic treatment, particularly in Class II/2 cases, where the relationship formed between the root and crown of the tooth and the maxilla is taken into account.

The mean of **angle formed between palatal plane & crown axis** is used to study the inclination of the crown of the upper central incisor related to the maxilla. The pre treatment mean values for the angle formed by the palatal plane and crown axis were observed to be 116.08± 9.13°, 124.36± 5.43° and 112.62± 13.43°, respectively. Significant differences were portrayed between group 1 & 2 and group 2 & 3 (0.001 and .000, respectively). Group 1 & 2 showed a mean reduction of 4.05° and 13.1° post treatment. Group 3 showed a mean increase of 8.43° in the angle between palatal plane and crown axis post treatment.

The mean values for the **angle formed by the palatal plane & root axis**, at the start of the treatment were observed to be 116.08± 9.13°, 124.36± 5.43° and 112.62± 13.43° in group 1, 2 & 3, respectively. Significant difference was seen between Class I & Class II/1 and Class II/1 & Class II/2 in the pre treatment angulations of the maxillary central incisor roots. Hong et al [30] demonstrated resorption to occur in the labial cortical bone when upper incisors or the alveolar bone was proclined. The mean values after treatment were recorded to be 114.67±8.15°, 113.59±8.54° and 127.05±11.90°, in group 1, 2 & 3, respectively. The intergroup differences were significant between group 1 & 3 and group 2 & 3. The mean reduction in inclination of root axis to palatal plane was 6.38° in group 1 and 12.79° in group 2. Mean proclination of 6.36° of was observed in group 3.

Mean of **angle formed between facial plane to crown axis** was seen to be 29.59± 9.75°, 34.77± 4.43° and 25.62± 14.95°, respectively, in group 1,2 & 3. Significant difference was seen amongst group 2 & 3. This is due to the difference in maxillary crown proclination in class II/1 & Class II/2. The post treatment mean values for group 1, 2 & 3 were observed to be 32.08±24.91°, 23.28±6.54° and

32.67±11.49°, respectively. A mean decrease of 11.49° in the angle between facial plane and crown axis was observed in group 2 and a mean increase of 7.05° was observed in group 3. It can be understood with the logic that correction of the abnormal inclinations in Class II/1 would be achieved by retroclination of maxillary incisors and in Class II/2, it can be achieved by proclining the maxillary incisors.

The mean value for the **angle formed between facial plane and root axis** in group 1, 2 & 3 were 35.67± 8.64°, 36.79±8.35° and 33.74±11.733°, respectively. No significant difference was seen between these pretreatment values (NPog-RA) in the 3 groups. This parameter, in corelation to NPog- CA is an indicator of the variation in inclination of the crown & root of the tooth. Post treatment mean values for group 1, 2 & 3 were recorded to be 34.72±25.04°, 26.13±9.73° and 38.67±11.43°, respectively. statistically significant difference in between group 1 & 3 and group 2 & 3 was seen in post treatment values. Class I subjects showed a statistically significant reduction of 0.95°, Class II/1 subjects exhibited a statistically significant reduction of 10.66° and Class II/2 subjects exhibited a statistically significant increase of 4.93° across the NPog- RA parameter.

The mean value for the **angle formed between Nasion perpendicular plane and crown axis** in group 1, 2 & 3 were 24.66± 9.13°, 30.92±5.93° and 20.92±15.32°, respectively. A statistically significant difference is seen between all 3 groups. Significant difference in Nperp- CA was observed between group 1 & 2 and group 3 & 2 before treatment. The mean values for the angle formed between the N perpendicular plane and crown axis post treatment were recorded to be 22.74±9.71°, 19.95±6.68° and 29.10±13.55°, respectively. statistically significant difference was obtained between all 3 groups after treatment. Class II/1 & Class II/2 subjects

particularly showed a significant difference when observed post treatment. A mean decrease of 10.97° and a mean increase of 8.18° in the angle between N Perpendicular plane and crown axis was observed in Class II/1 & Class II/2, respectively, after treatment. The angular values seen with respect to crown axis are consonant with each other and the type of malocclusion they are seen in.

The pre treatment mean value for the **angle formed between Nasion perpendicular plane and root axis** in group 1, 2 & 3 were 30.71± 8.56°, 32.95±10.42° and 29.03±11.98°, respectively. Significant difference was not seen between the angle formed between N perpendicular plane and root axis in all the 3 groups studied before treatment. The post treatment mean values for the angle formed between the N perpendicular plane and root axis were recorded to be 25.38±10.04°, 22.85±9.88° and 35.46±13.50°, respectively. A statistically significant variation was seen in group 1, 2 & 3 for Nperp- RA post treatment. Mean value in group 3 showed significant difference when compared to that of group 1 and 2. The angular values with respect to root axis are consistent with each other. However, their inclination in different forms of malocclusions was seen to be different.

Orthodontic treatment along with various other movements, is liable to change the inclination of the tooth root and tooth crown which is evidently observed in our study. Our study tries to quantify the relation of collum angle in Class I, Class II/1 & Class II/2 with the maxilla after orthodontic treatment. We have incorporated a few other parameters which help in diagnosing the malocclusion and increase the range of the study by including the facial plane and N perpendicular plane.

CONCLUSION

In our study, we assessed the relationship between the collum angle of maxillary central incisor and maxilla before and after treatment in Class II division 2 patients.

We found that:

1. The collum angles in Class I, Class II division 1 and Class II division 2 were recorded to be 6.23± 5.81°, 1.97± 8.25° and 9.21± 7.27°, respectively. it suggests an increased risk of complications for maxillary central incisor after orthodontic treatment in relation to maxilla in Class II/2, if improper mechanics are used.
2. In our study Class II division 1 group showed a prognathic maxilla and a normal to slightly retrognathic mandible and Class II division 2 group showed a normal to slightly prognathic maxilla and a retrognathic mandible.
3. Apex of the root moved significantly by 3.69mm (mean value) towards point A of the maxilla after treatment in the Class II/1 group. Excessive retroclination in Class II/1 to correct flared maxillary incisor may lead to dehiscence and fenestration with maxillary labial cortical plate.
4. Apex of the root moved significantly by 3.41mm (mean value) towards ANS and 1.46mm (mean value) away from ANS after treatment in Class II/1 and Class II/2 group, respectively. Excessive change in inclination with orthodontic treatment of the maxillary central incisor can lead to dehiscence and fenestration with maxillary labial and palatal cortical plate for Class II/1 and II/2, respectively.

5. Distance between the tip of maxillary central incisor (U1) to ANS increased by 2.84mm (mean value) and decreased by 1.82mm (mean value) after treatment in group 2 and 3, respectively. Increased difference in the pre and post treatment value in Class II/1 and decreased difference in the pre and post treatment value in Class II/2 indicate a higher possibility of dehiscence and fenestration with maxillary labial and palatal cortical plate, respectively.
6. A mean clockwise rotation of 4.05° and 13.1° and mean counter-clockwise rotation of 8.43° of the maxillary central incisor **crown** in relation with the palatal plane of the maxilla was observed after treatment in group 1, 2 and 3, respectively.
7. A mean clockwise rotation of 2.79 ° and 13.1° and mean counter-clockwise rotation of 9.57° of the maxillary central incisor **root** in relation with the palatal plane of the maxilla was observed after treatment in group 1, 2 and 3, respectively.
8. A mean clockwise rotation of 11.49 ° and mean counter-clockwise rotation of 7.05° of the maxillary central incisor **crown** in relation with the facial plane was observed after treatment in group 2 and 3, respectively.
9. A mean clockwise rotation of 11.49 ° and 8.14° and mean counter-clockwise rotation of 11.5° of the maxillary central incisor **root** in relation with the facial plane was observed after treatment in group 1, 3 and 2, respectively.
10. A mean clockwise rotation of 10.97° and mean counter-clockwise rotation of 8.18° of the maxillary central incisor **crown** in relation with the N-perpendicular plane was observed after treatment in group 2 and 3, respectively.

11. A mean clockwise rotation of 1.74° and 11.3° and mean counter-clockwise rotation of 9.28° of the maxillary central incisor **root** in relation with the N-perpendicular plane was observed after treatment in group 1, 2 and 3, respectively.

Excessive clockwise rotation Class II/1 and excessive counter-clockwise rotation in Class II/2 may increase the risk of complications with respect to the maxillary labial and palatal cortical plate, respectively. Presence of large collum angle in Class II/2 malocclusion increases this risk of complications in relation to maxilla after orthodontic treatment.

SUMMARY

The purpose of this study was to evaluate Collum angle in Class II divison 2 malocclusion and its relationship with the maxilla before and after orthodontic treatment. Three groups were divided based on the type of malocclusion with 38 subjects in each group. Group 1 consisted of Class I, group 2 of Class II division 1 and group 3 of Class II division 2 malocclusion patients. All the subjects ranged between the age group of 11-42 years. 15 parameters were used in our study, 5 linear and 10 angular. The parameters used were: effective mandibular length (Co-Gn), effective maxillary length (Co-Pt A), Point A- Apex of the root, ANS – Apex of the root, U1- ANS, SNA, SNB, ANB, Collum Angle (CA-RA), Palatal plane (PP) to CA, PP to RA, Facial plane (NPog) to CA, NPog to RA, Nasion Perpendicular plane (NPerp) to CA, NPerp to RA. 5 of these measurements were used to determine the skeletal malocclusion, 2 linear and 3 angular. 10 parameters were used to assess the relationship of maxillary central incisor to maxilla and dentofacial complex. The collum angle in different types of malocclusions was determined. Position of the maxillary central incisor and its angulation within the maxilla in different types of malocclusions was studied and documented. Kruskal Wallis test was used to compare between the three groups like class I, class II division 1 and class II division 2. Wilcoxon signed rank test was used to compare between the pre and post op of class I, class II division 1 and class II division 2. Significantly high value was observed for collum angle in Class II division 2 group. All the parameters showed significant results for Class II division 2 group. The study highlights the importance of crown-root angulation of the maxillary central incisor during orthodontic treatment and its relation with the maxilla.

LIMITATIONS OF THE STUDY

1. Orthodontic treatment time and modality was not taken into account while selecting the subjects for the sample.
2. 114 samples were used in the study, even though both male and female subjects were included, gender was not considered as a differentiating criterion in the present study.
3. 2 Dimensional methods were used to assess a 3 dimensional change.

SCOPE OF THE STUDY

1. We assessed for the change in the inclination and position of the maxillary central incisor with respect to maxilla in our study, further study will be required to quantify the variation in the maxillary bone in relation to these changes.
2. Similar study with the use of 3D diagnostic aids will increase the reliability of the results obtained through our study and give a more accurate information with respect to the same.
3. Similar study can be performed taking particular types of treatment mechanics into account, for more accurate understanding of the relationship of collum angle in maxillary central incisor with maxillary bone changes.

APPLICATION OF THE STUDY

Class II division 2 malocclusion is a unique type of malocclusion, with peculiar dental and skeletal features. Maxillary incisor morphology is seen to be variable, often with the presence of bend in the tooth (collum angle). Foremost step in correcting this malocclusion involves proclination of the maxillary central incisors. With the presence of the crown to root angulation, this process is prone to risk of complications such as denuded roots, fenestration, dehiscence etc. Thus, a study to quantify the collum angle of the maxillary incisor in Class II division 2 malocclusion with the maxilla before and after treatment is of great importance. Even clinically, it would help us assess how much of proclination of the maxillary incisor is possible without risking damage to the tooth root with maxillary bone.

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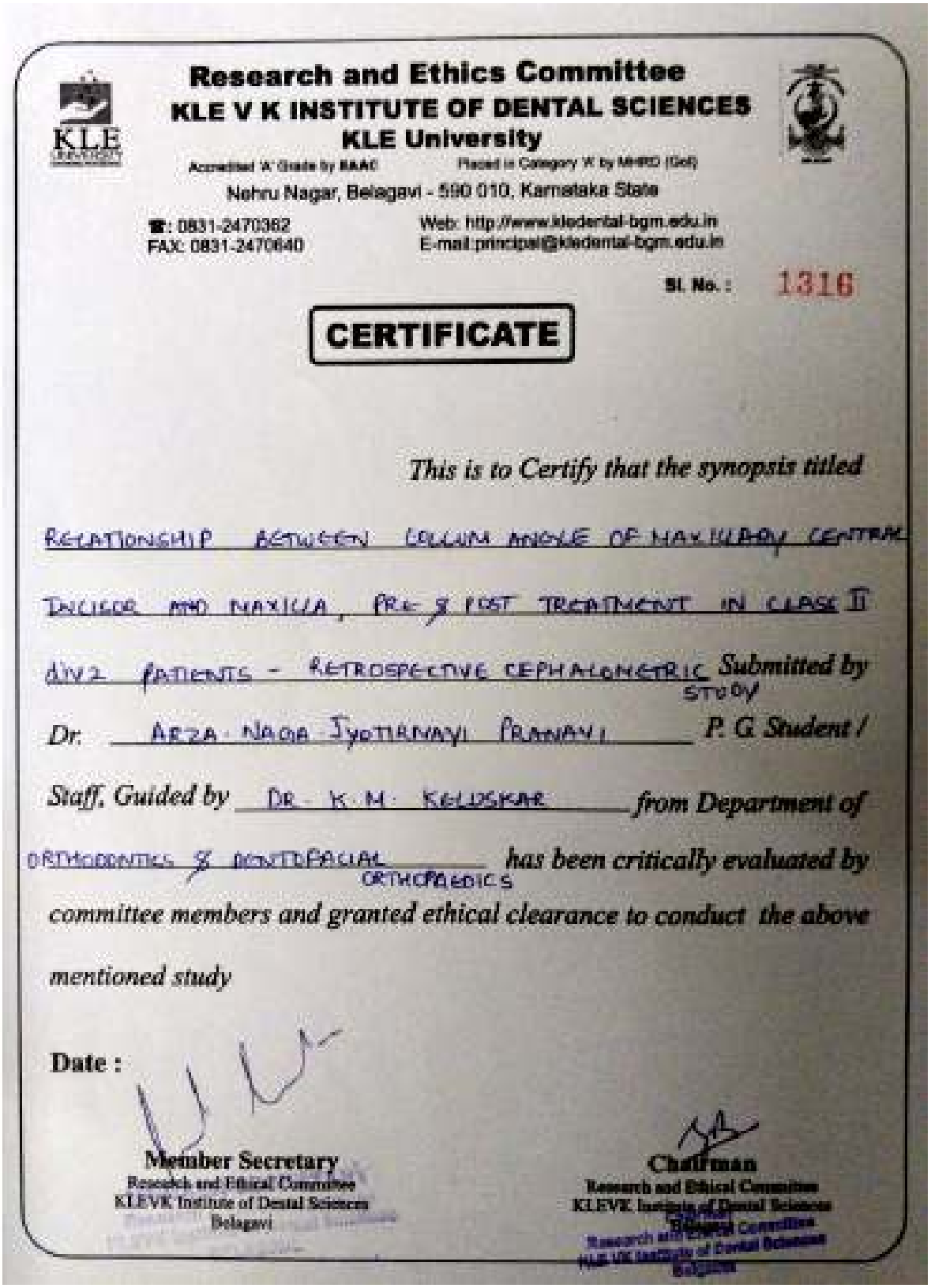
ANNEXURE – I - ETHICAL CLEARANCE



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CERTIFICATE

This is to Certify that the synopsis titled

RELATIONSHIP BETWEEN COLUMN ANGLE OF MAXILLARY CENTRAL INCISOR AND MAXILLA, PRE & POST TREATMENT IN CLASS II DIV 2 PATIENTS - RETROSPECTIVE CEPHALOMETRIC STUDY

Submitted by

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Date :

Member Secretary
Research and Ethical Committee
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Chairman
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