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Dentistry Section

# Comparison of Transverse Dentofacial Dimensions in Adults with Skeletal Class I and Class II Malocclusion, Horizontal Growth Pattern and Mild to Moderate Periodontitis using CBCT- A Retrospective Study

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## ABSTRACT

**Introduction:** Knowledge of transverse dentofacial dimensions is crucial for accurate diagnosis and treatment planning. Periodontitis can alter the widths of the arches by causing pathological migration of teeth and the concurrent bone loss can affect the transverse width of the arches.

**Aim:** To compare the transverse dentofacial widths in adults with skeletal class I and class II malocclusions with horizontal growth pattern and with mild to moderate periodontitis using Cone Beam Computed Tomography (CBCT).

**Materials and Methods:** This retrospective observational study was conducted in Department of Orthodontics, Faculty of Dental Sciences, Ramaiah University of Applied Sciences, Bengaluru, Karnataka, India, from January 2019 to January 2021. Total 96 CBCT samples (48 skeletal Class I, 48 skeletal Class II) of patients between age group of 25-35 years, patients having mild to moderate periodontitis based on bone loss seen on CBCT and patients having a horizontal growth pattern with the angle between sella-nasion and mandibular plane less than 32° were included in the study. Transverse dentofacial measurements were made on the coronal plane of the CBCT scans. Data were analysed using Statistical Package for Social Sciences (SPSS) version 20. Chi-square test and Student's t-test were used to compare age, linear measurements and angular measurements between the skeletal class I and skeletal Class II groups. A p-value of <0.05 was considered statistically significant at 95% class interval.

**Results:** In the present study, the mean age of patients with skeletal class I and class II was 30.89±3.23 and 30.97±3.28 years, respectively. There were 24 females and 24 males belonging to class I and class II groups, each. There was a statistically significant difference in the mean interjugal width and the antegonial width. The mean interjugal width in skeletal class I and class II group was 56.95±5.68 mm and 51.28±5.94 mm respectively (p-value <0.001). The maxillomandibular difference (p-value=0.002), the mean maxillary buccal alveolar crest width difference (p-value <0.001) and mandibular buccal alveolar crest width difference (p-value <0.001) was also statistically significant. The palatal height in skeletal class I group (21.77 mm) was significantly higher (p-value <0.001) and the mean maxillary palatal alveolar crest width in skeletal class I (36.47 mm) was lower than in the class II group (37.97 mm).

**Conclusion:** The dentofacial transverse widths such as the interjugal width, antegonial width, maxillomandibular difference, maxillary buccal alveolar crest width and mandibular buccal alveolar crest width were higher in skeletal class I groups compared to skeletal class II groups. The maxillary palatal alveolar crest width was higher in skeletal class II groups compared to skeletal class I group.

**Keywords:** Alveolar process, Cone beam computed tomography, Dental arch, Mandible, Maxilla, Orthodontics, Treatment

## INTRODUCTION

The growth of human face is a multidimensional and dynamic continuum [1]. Craniofacial growth consists of growth in all three planes, that is, transverse, sagittal and vertical. The growth of the transverse dimension is achieved first, then followed by sagittal and vertical growth [2]. This knowledge of transverse growth of maxilla and mandible is important in the diagnosis and treatment planning of transverse orthodontic problems as the timing of treatment can be planned early since transverse growth ceases first [2,3].

Transverse deficiencies are a significant component of many malocclusions [3]. Anomalies in maxillary transverse dimensions can further lead to occlusal problems such as crossbite and scissor bite [3,4]. The treatment of transverse issues must focus on reducing potential periodontal problems, improving dental and skeletal stability and the aesthetics of the patient [2,3].

The molar movement during growth mirrors the transverse maxillary arch growth [4]. The growth and the pattern of width changes in a gradient manner in the maxillary first molar, mandibular first molar and it reflects on the arch width respectively [4,5]. The maxillary transverse width at the intercanine width and intermolar width in class II division 1 malocclusion was found to be less when compared to the class I malocclusion [5,6]. Arch width also changes with growth [7]. The mandibular intercanine width was larger in class II division 1 groups [6,8].

Literature has focused on the importance of skeletal differences between the maxillary and mandibular width since an undiagnosed transverse discrepancy can result in adverse periodontal conditions [9-11]. In cases of periodontitis, there is not only pathological formation of pockets and destruction of alveolar bone but also labio-distal migration, spacing and extrusion of the teeth [10]. With the destruction of the alveolar bone, the teeth tend to tip, and this can affect the transverse width of the arches. Periodontitis can be one of the factors contributing to altered transverse dimension [11,12].

The aim of the present study was to evaluate transverse dentofacial widths of adults with skeletal class I and class II malocclusions having horizontal growth pattern and mild to moderate periodontitis using CBCT.

## MATERIALS AND METHODS

This retrospective observational study was conducted in Department of Orthodontics, Faculty of Dental Sciences, Ramaiah University of Applied Sciences, Bengaluru, Karnataka, India, from January 2019 to January 2021. The study protocol was approved by the Ethics Review Committee of the University. The research project protocol number was EC-2019/PG/26 and approval date was 16/10/2019. This study was conducted using the full skull CBCT scans collected from a private scan centre and the archives of the Department of Oral Medicine and Radiology. The CBCT is a useful tool in assessment of skeletal structures [13-15]. The scans were analysed using Carestream software (Carestream 9300). The CBCT used had the parameters of 6.3 mA, 90 kVp, and 300 microns resolution with full Field of View (FOV) of 17×13.5 cms.

The sample size was calculated using the G-Power software version 3.1.9.2 and was based on previous literature [5].

**Sample size calculation:** The sample size was calculated using the software with the following input criteria- Tail: two, effect size d=0.58 (based on previous study [5]), alpha error=0.05, power=0.8. With a power of 80% and the level of significance at 0.05, required sample for each category was 45. We selected 48 samples per group.

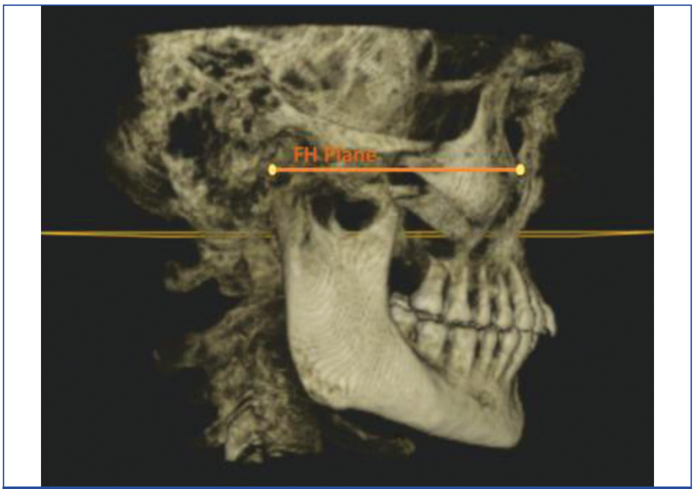
**Inclusion criteria:** CBCT scans of male or female patients between age group of 25-35 years, patients having mild to moderate periodontitis based on bone loss seen on CBCT [10,14,15] (mild periodontitis: 1.6-3 mm bone loss from CEJ to the crest of the alveolar bone and moderate periodontitis: 3.1-4.5 mm bone loss from CEJ to the crest of the alveolar bone) and patients having a horizontal growth pattern with the angle between sella-nasion and mandibular plane less than 32° [12].

**Exclusion criteria:** Unilateral or bilateral crossbite cases, severe periodontitis (more than 4.5 mm bone loss from CEJ to the crest of the alveolar bone), facial asymmetry greater than 2 mm as assessed on CBCT, dental crowding or spacing greater than 5 mm, prosthetic treatment of first molar, missing or extracted permanent teeth (excluding third molars), significant medical and dental history (cleft lip and palate, craniofacial syndrome or trauma) [16,17].

### Study Procedure

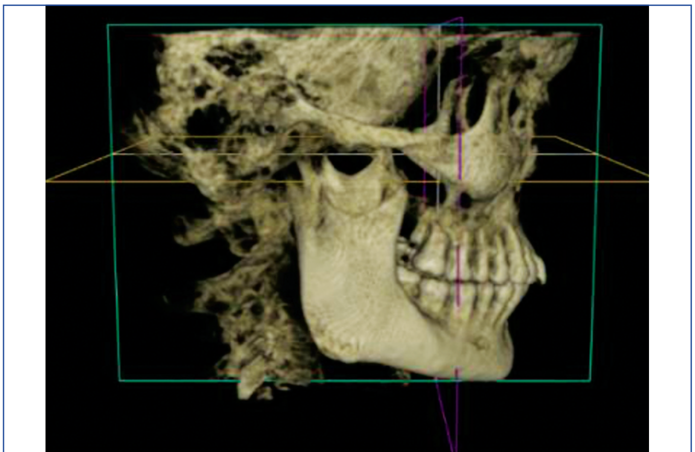
The cephalometric tracing was prepared from a 2-dimensional standardised sagittal section taken from the CBCT of the patients. The process of tracing and sampling was conducted by the first examiner (ST). Based on the inclusion and exclusion criterias, 96 subjects were selected and were divided into two groups (skeletal class I and II) based on the skeletal relation. Each group had 48 (males 24, females 24) subjects. The selected scans were divided into skeletal class I and class II by evaluating the following parameters: ANB angle (class I skeletal pattern- ANB angle 2°-4° and class II skeletal pattern- ANB angle greater than 4°), Witt's appraisal (AO ahead of BO greater than 2 mm were classified as class II skeletal pattern), molar relation and overjet (class I skeletal pattern- overjet of 2-4 mm and class II skeletal pattern- overjet greater than 4 mm) [6,7,10,12].

Once selected, each sample's three dimensional CBCT image was oriented in the axial view, sagittal view, and the coronal view, as shown in [Table/Fig-1-3]. The assessment of bone loss was done on the CBCT as seen in [Table/Fig-4]. This was carried out by a blinded 2$^{nd}$ examiner to reduce bias. Bone loss was evaluated in the buccal, lingual or palatal, mesial and distal surfaces of the maxillary and mandibular first molars, by measuring the distances from the CEJ to the alveolar crest in coronal and sagittal planes [Table/Fig-4]. The section of CBCT showing the maximum depth of bone loss was used and maximum bone loss was measured.

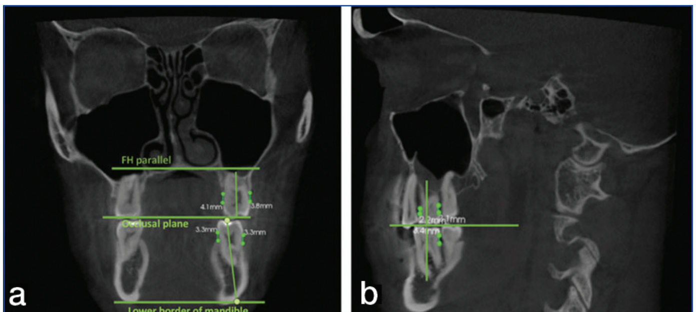



**[Table/Fig-1]:** The Frankfurt's Horizontal (FH) plane was oriented parallel to the axial plane (orange line).

**[Table/Fig-2]:** Orientation of CBCT image in sagittal plane (green line) such that the axial plane was perpendicular to the sagittal plane.

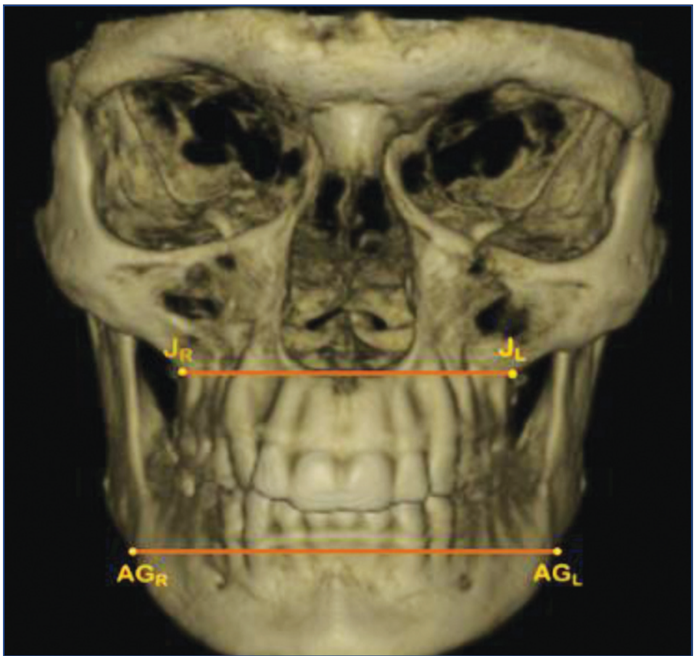


**[Table/Fig-3]:** Orientation of CBCT image in coronal plane (purple line) such that the axial plane and coronal plane were perpendicular to each other and coronal plane passes through the buccal groove of the maxillary first molar.

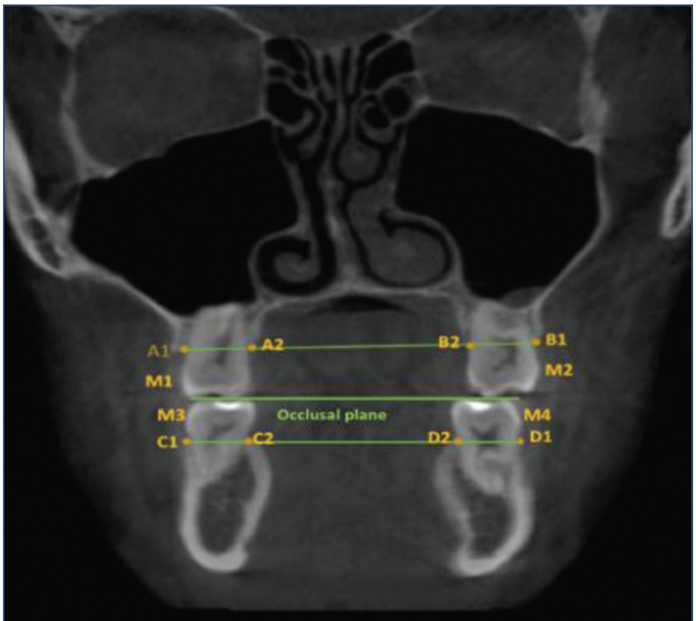



**[Table/Fig-4]:** Assessment of periodontitis by drawing a line parallel to the long axis of the maxillary and mandibular first molar and perpendicular to occlusal plane a) Assessment of bone loss on the buccal and lingual surfaces in coronal plane; b) Assessment of bone loss on the mesial and distal surfaces in sagittal plane.

The linear measurements were carried out as follows. The transverse measurements in the frontal view of CBCT were obtained by measuring the transverse distance between the bilateral jugal process (J point) and the bilateral Antegonial notches (AG point) [Table/Fig-5] [18]. The transverse measurements in the coronal view of CBCT were obtained by measuring the transverse width using the landmarks as seen in [Table/Fig-6] on the maxilla and the mandible keeping the occlusal plane as reference [17,18]. The palatal depth was evaluated by measuring the distance from the most superior point on palate to the functional occlusal plane [Table/Fig-7] [18-21].

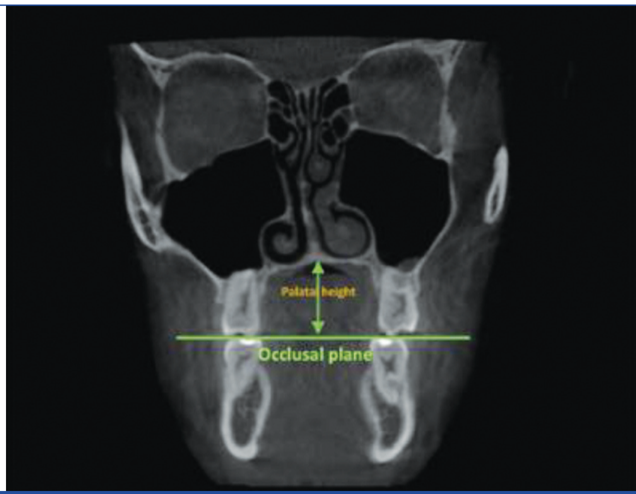



**[Table/Fig-5]:** Transverse width measurements on the frontal view; i) Bilateral inter jugular point ($J_R$-$J_L$); ii) Bilateral antegonial notch points ($AG_R$-$AG_L$).




**[Table/Fig-6]:** Landmarks for transverse dimensions measurement; A1, B1- Buccal alveolar crest point of maxillary molar; A2, B2- Lingual alveolar crest point of maxillary molar; C1, D1- Buccal alveolar crest point of mandibular molar; C2, D2- Lingual alveolar crest point of mandibular molar; M1, M2, M3, M4- most convex point on the buccal surface of molars.

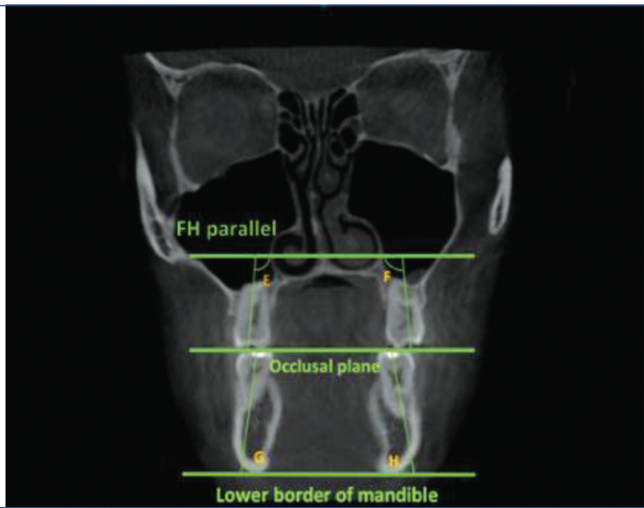
The following angular measurements were carried out: The lower border of the mandible and the occlusal plane were oriented parallel to the FH plane and the inclination angle of maxillary first molars were obtained by measuring the angles formed by the long axis of the maxillary first molar and Frankfort's horizontal plane ($E^0$, $F^0$-right and left first maxillary molar inclination angle respectively). The inclination angle of mandibular first molars were obtained by measuring the angles formed by the long axis of the mandibular




**[Table/Fig-7]:** Palatal depth measurement.

first molar and lower border of the mandible ($G^0$, $H^0$ -right and left mandibular molar inclination angle) [18-21] [Table/Fig-8].

[Table/Fig-9] depicts the linear and angular measurements which were made.




**[Table/Fig-8]:** Measurement of the angulation of maxillary and mandibular molars; $E^0$, $F^0$- angulation of the maxillary right and left molars; $G^0$, $H^0$- angulations of the mandibular right and left molars.

| S. No. | Linear measurements |
|---|---|
| 1. | Inter jugular width |
| 2. | Antegonial width |
| 3. | Maxillomandibular width difference (Antegonial width- Inter jugular width) |
| 4. | Transverse maxillary width at buccal alveolar crest (A1 to B1) |
| 5. | Transverse mandibular width at buccal alveolar crest (C1 to D1) |
| 6. | Buccal maxillary intermolar width (M1 to M2) |
| 7. | Buccal mandibular intermolar width (M3 to M4) |
| 8. | Palatal height |
| 9. | Transverse maxillary width at lingual alveolar crest (A2 to B2) |
| 10. | Transverse mandibular width at lingual alveolar crest (C2 to D2) |
| 11. | Buccolingual maxillary width at alveolar crest right side (A1 to A2) |
| 12. | Buccolingual maxillary width at alveolar crest left side (B1 to B2) |
| 13. | Buccolingual mandibular width at alveolar crest right side (C1 to C2) |
| 14. | Buccolingual mandibular width at alveolar crest right side (D1 to D2) |
| | **Angular measurements** |
| 1 | Maxillary right molar inclination angle ($E^0$) |
| 2 | Maxillary left molar inclination angle ($F^0$) |
| 3 | Mandibular right molar inclination angle ($G^0$) |
| 4 | Mandibular left molar inclination angle ($H^0$) |

**[Table/Fig-9]:** The linear and angular variables which were calculated.

## STATISTICAL ANALYSIS

The measurements obtained for the dentofacial transverse widths were assessed, tabulated and statistical analysis was carried out. The data collected was entered into an MS Excel spreadsheet. Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 20.0 (SPSS 22.0, IBM, Armonk, NY, USA). Chi-square test was used to assess difference in the distribution of demographic variables. Student's t-test was used to compare the mean of age, linear measurements and angular measurements between the skeletal class I and skeletal class II groups. A p-value of <0.05 was considered statistically significant at 95% class interval.

## RESULTS

There were no differences in the distribution of demographic variables as indicated by Chi-square test [Table/Fig-10].

| Demographic variables | Class I | Class II | p-value |
|---|---|---|---|
| Age in Years, (mean±SD) | 30.89±3.23 | 30.97±3.28 | 0.9 |
| **Gender, (n)** | | | |
| Male | 24 | 24 | 1 |
| Female | 24 | 24 | |

**[Table/Fig-10]:** Distribution of demographic variables as indicated by the Chi-square test.

[Table/Fig-11] depicts the linear CBCT measurements in skeletal class I and class II groups. Both the groups had mild to moderate periodontitis as measured in the CBCT. The mean interjugal width in skeletal class I and class II group was 56.95±5.68 mm and 51.28±5.94 mm respectively and the p-value was <0.001** indicating statistically significant difference. The mean antegonial width in skeletal class group I and class II were 74.95±4.39 mm and 65.17±8.71 mm with the p-value <0.001** indicating statistically significant results. The mean maxillomandibular difference in skeletal class I group was 18.00±6.59 mm and in class II was 13.88±6.00 mm with the p-value of 0.002* indicating statistically significant results. The mean maxillary buccal alveolar crest width in skeletal class I was 62.58±3.02 mm and skeletal class II was 58.79±3.20 mm with the p-value <0.001** indicating statistically significant results. The mean mandibular buccal alveolar crest width in skeletal class I was 60.43±5.71 mm and skeletal class II group was 56.06±4.04 mm with the p-value <0.001** indicating statistically significant results. Palatal height was more in skeletal class I group (p<0.001**) and maxillary palatal alveolar crest width was more in class II group (p=0.03*) and these differences were significant. The other linear measurements and angular measurements were not statistically significant.

| Parameters | Class I (Mean±SD) | Class II (Mean±SD) | Student's t-test p-value |
|---|---|---|---|
| Interjugular width (JR-JL) | 56.95±5.68 | 51.28±5.94 | <0.001** |
| Antegonial width (AGR- AGL) | 74.95±4.39 | 65.17±8.71 | <0.001** |
| Maxillomandibular difference | 18.00±6.59 | 13.88±6.00 | 0.002* |
| Maxillary buccal alveolar crest width (A1 to B1) | 62.58±3.02 | 58.79±3.20 | <0.001** |
| Mandibular buccal alveolar crest width (C1 to D1) | 60.43±5.71 | 56.06±4.04 | <0.001** |
| Buccal maxillary intermolar width (M1 to M2) | 57.44±4.17 | 58.64±3.31 | 0.12 |
| Buccal mandibular intermolar width (M3 to M4) | 53.53±4.41 | 54.74±3.87 | 0.15 |
| Palatal height (mm) | 21.77±2.78 | 19.55±1.68 | <0.001** |
| Maxillary palatal alveolar crest width (A2 to B2) | 36.47±3.27 | 37.97±3.69 | 0.03* |
| Mandibular lingual alveolar crest width (C2 to D2) | 36.63±3.81 | 37.14±3.55 | 0.50 |
| Buccolingual right maxillary molar width (A1 to A2) | 11.67±1.59 | 12.18±1.21 | 0.08 |
| Buccolingual left maxillary molar width (B1 to B2) | 11.61±1.65 | 12.13±1.51 | 0.07 |
| Buccolingual right mandibular molar width (C1 to C2) | 10.29±1.46 | 10.69±0.85 | 0.10 |
| Buccolingual left mandibular molar width (D1 to D2) | 10.30±1.46 | 10.66±1.11 | 0.17 |

**[Table/Fig-11]:** Linear CBCT measurements in skeletal class I and class II groups.
(p-value <0.05* statistically significant, p-value <0.001** statistically highly significant); All measurements are in mm

[Table/Fig-12] depicts the angular CBCT measurements in skeletal class I and class II groups. The mean maxillary right molar inclination angle (E$^0$) and maxillary left molar inclination angle (F$^0$) were more in skeletal class II groups compared to skeletal class I groups but the results were statistically insignificant amongst the groups. The mean mandibular right molar inclination angle (G$^0$) was more in skeletal class I groups compared to skeletal class II groups but the results were statistically insignificant amongst the groups. The mean mandibular left molar inclination angle (H$^0$) was significantly higher in class I group with p-value=0.009*.

| Parameters | Class I (Mean±SD) | Class II (Mean±SD) | Student's t-test p-value |
|---|---|---|---|
| Maxillary right molar inclination angle (E$^0$) | 92.08±8.44 | 93.93±7.77 | 0.26 |
| Maxillary left molar inclination angle (F$^0$) | 92.79±7.67 | 93.83±8.40 | 0.52 |
| Mandibular right molar inclination angle (G$^0$) | 81.14±7.23 | 79.16±6.89 | 0.17 |
| Mandibular left molar inclination angle (H$^0$) | 78.87±8.57 | 74.93±5.55 | 0.009* |

**[Table/Fig-12]:** Angular CBCT measurements in skeletal class I and class II groups.

## DISCUSSION

The transverse plane should be not be neglected in the diagnosis of craniofacial and dentoalveolar anomalies. Since research has mainly focused on the sagittal and vertical planes of the face, inferences on normal and abnormal growth patterns have been restricted to the study of just these two planes [1]. It is important that the diagnosis of maxillomandibular deformities and malocclusions be carried out in all three planes. The cone beam Computerised Axial Tomography (CAT) is one of the most valuable medical diagnostic imaging tools and this can be useful in detecting unidentified transverse discrepancies [9].

According to a study conducted by Bishara SE et al., it was found that the width of the maxillary and mandibular arches shows almost minimal growth related changes after the age of 25 years [11]. Since the aim was to compare class I and class II adult cases and to eliminate the effect of growth, the age range of 25-35 years was taken and older ages were excluded, since they were more likely to have severe bone loss and this would influence the results.

In horizontal growth pattern patients, there is increase in the muscle activity and mechanical loading and in turn increased bone apposition during transverse growth [12]. Ribeiro JS et al., conducted a longitudinal study to find the transverse changes in different growth patterns and they concluded that the intermolar width changes according to the growth pattern with the highest intermolar width was seen in horizontal growth pattern followed by average and vertical growth pattern [12].

In the present study, CBCT was used to evaluate the bone loss on the buccal, lingual, mesial and distal surfaces of the first maxillary and mandibular first molars. The normal bone height from CEJ to alveolar bone crest ranges from 1 to 2 mm [13]. In the present study the subjects who were selected had mild periodontitis with bone loss of 1.6-3 mm and moderate periodontitis with bone loss of 3.1-4.5 mm from CEJ to the alveolar crest, respectively [14]. In the present study the subjects who had stage I and stage II (Caton JG et al., 2018) of periodontitis were included [15].

According to the results obtained, transverse widths such as interjugal width, antegonial width, maxillomandibular difference, maxillary buccal alveolar width and mandibular buccal alveolar crest width, showed statistically significant values (p-values <0.05) indicating a higher transverse width in class I compared to the class II groups. This could be due the hyperfunction of muscle activity in class I horizontal growth pattern which tends to increase the mechanical loading and in turn cause bone apposition in transverse growth [12,16,17]. The values obtained were in accordance with the study conducted by Sayin MO et al., which was carried out on the Posteroanterior (PA) cephalograph and where it was concluded that the interjugular width, antegonial width and maxillomandibular difference was more in class I subjects [16]. In another study, it was found that the class II division 2 group had mean maxillary arch widths significantly smaller when compared with normal occlusions and significantly larger in comparison with class II division 1 group [17]. In a different study it was seen that the hypodivergent group showed greater interjugular width and buccolingual width 7 mm apically from the maxillary alveolar crest compared with the normodivergent and hyperdivergent groups in both sexes [18]. But the study done by Chen F et al., concluded that the interjugal width is more in the skeletal class II than compared to class I groups [19].

Maxillary transverse width at the buccal alveolar crest (A1 to B1) and mandibular alveolar crest (C1 to D1) was larger and statistically significant in class I when compared to the class II subjects. These results differ slightly from other studies [20,21]. In one such study, the authors found that the dimensions of the dental arches were related to gender as well as dentoalveolar class. It was found that class I and II subjects had similar maxillary dental arch dimensions, but a transverse deficit in the mandible were reported in class II patients [20]. In another study, it was found that the mandibular dental arch forms for both the class I and class II samples were essentially the same, except at the canines; this was likely due to the nature of the occlusion in class II division 1 patients. There was no difference in arch forms of the basal bone between the two groups [21].

In the present study, the maxillary palatal alveolar crest width (A2 to B2) was more in class II than in class I subjects and this difference was statistically significant with a p-value=0.03*. The mean values obtained in buccal maxillary intermolar width (M1 to M2) and buccal mandibular intermolar width (M3 to M4) was more in class II subjects than in class I subjects. There was no statistically significant difference between the two groups.

The amount of bone loss on the lingual and buccal surfaces may differ and this might lead to a pathological migration of the teeth [10]. The resting tongue posture of skeletal class II groups is higher compared to the class I groups. Hence the position of the teeth on the dental arch is affected by the tongue and surrounding musculature. The imbalance forces from the altered tongue posture will result in the changes in the arch forms [22,23].

In the present study, the palatal height was found to be more in class I subjects compared to class II subjects. This is similar to the results of another study where they found that the palatal depth was more in skeletal class I than class II groups with a p-value=0.001** [24].

In the present study, it was found that the maxillary buccal alveolar crest width and mandibular buccal alveolar crest width was more in class I than in class II subjects whereas the maxillary palatal alveolar crest width was more in class II than class I subject. A previous study comparing arch forms of class I normal occlusion or class I malocclusion patients with those of class II division 1 malocclusion patients concluded that the maxillary arch form of class II division 1 malocclusion patients was narrower [16].

Both the right and left maxillary molar inclination angle was more in skeletal class II compared to class I groups and it was statistically insignificant. Whereas the right and left mandibular molar inclination angle was more in skeletal class I than in class II groups but it was statistically insignificant. This result was in accordance of the study done by Hwang S et al., [18].

In orthodontics, the use of customised arch forms and light continuous forces, can help in favorable bone remodeling around the periodontally comprised tooth, and they also prevent us from further worsening the periodontal condition of the teeth. Such measures can help maintain stability of the arch form and prevent iatrogenic damage to the teeth and the basal bone [25].

Elimination of active inflammation is a key factor prior to the starting orthodontic tooth movements. If necessary, periodontal surgery should be done and 3 to 6 months after the periodontal therapy if it's required, before starting the orthodontic treatment. If patients with periodontitis are properly diagnosed and treated before starting the orthodontic treatment, then during orthodontic tooth movement their periodontal status is generally satisfactory and should not present a major problem [25,26]. Patients with severe bone loss and increased tooth mobility before the orthodontic treatment report improvement in chewing and biting during the treatment as a result of splinting properties of fixed orthodontic appliances. Preservation of final result from orthodontic treatment is a major goal in the long term. Hence a good balance between static and dynamic occlusion along with all the craniofacial structures should be maintained for oral rehabilitation and long-term stability [26,27].

### Limitation(s)

The present study was conducted using CBCT data and all the measurements were made by a single examiner. The inter examiner variability was not considered.

## CONCLUSION(S)

In the present study, it was found that certain parameters transverse dentofacial widths such as the interjugal width, antegonial width, maxillomandibular difference, maxillary buccal alveolar crest width and mandibular buccal alveolar crest width were significantly higher in skeletal class I groups as compared to class II. On the other hand, the maxillary palatal alveolar crest width was significantly higher in skeletal class II groups. The palatal height and mean mandibular left molar inclination angle (H0) was significantly higher in class I group.

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