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Using a Three-Dimensional Method, Angle's Class I And Class II Conditions Measure The Thickness Of Alveolar Bone In The Maxillary Anterior Region

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Abstract

Introduction: In the maxillary anterior region, the alveolar bone thickness of Angle's class I & class II patients was assessed & compared using CBCT.

Method: A retrospective CBCT study was carried out for evaluation of 30 patients was done in the study in order to ascertain the alveolar bone thickness in Angle's class I & class II in the maxillary anterior area. In the Central Incisors (11, 21) at Buccal & Palatal side, also measured & compared the alveolar bone thickness at different levels Line A at the labial alveolar crest, Line B 2.4 mm apically to line A, Line C 4.8 mm off, Line D 7.2 mm off as well as the overall thickness at different levels.

Results: Overall (21) line B varied statistically significantly ($p<0.01$) among the groups, with class II exhibiting higher values (3.38mm). For Buccal 11, line C (1.68), which had higher values in class 2, Palatal 11, line C (2.11)) which had higher values in class II & Buccal 21, line D (1.50) which had higher values in class II.

Conclusion: A statistically significant difference was observed between the groups based on the values for Overall (21) line B with higher values in class II, as well as the values for (Buccal 11) line C with higher values in class II, Palatal 11) line C with higher values in class II, and (Buccal 21) line D with higher values in class II.

Keywords: CBCT, Central Incisor, Angle’ s class I, Angle’ s class II.

Introduction

Cone-beam computed tomography (CBCT) is becoming more and more common in orthodontic treatment planning and diagnostics because it provides a three-dimensional view of the morphology of the tooth root and alveolar bone.[1]

Orthodontic walls are the dense cortical plates at the incisor apical area that are shifted during orthodontic tooth movement. To ensure that orthodontic tooth movement is successful, there must be appropriate alveolar bone support.[2]

Yodthong et al. [3] state that three important factors that may affect alveolar bone thickness during upper incisor retraction are the rate of tooth movement, the change in inclination and the extent of intrusion.

The 'envelope of discrepancy' was created by Proffit [4] to illustrate the bounds of tooth movement. In those with bimaxillary protrusion, there is an increased risk of periodontal disease due to excessive retraction of the anterior teeth.

This study analyses the maxillary central incisor alveolar bone thickness in Angle's class I and class II malocclusions using quantitative CBCT. The results of this investigation will broaden our understanding of the feasibility and importance of measuring anterior maxillary alveolar bone thickness with CBCT.[5]

For an appropriate orthodontic diagnosis and treatment plan, measuring the thickness of alveolar bone is crucial, especially when it comes to Angle's class I and class II malocclusions in the maxillary anterior region. The exactitude of traditional radiography assessments of alveolar bone thickness, such as periapical and panoramic radiographs, is hampered by factors such as the superimposition of anatomical features and magnification distortion.

The maxillary anterior region is very important in the field of orthodontics because it has a significant impact on patient satisfaction, smile aesthetics, and face aesthetics. In the region where Angle's Class I and Class II malocclusions are being treated, the alveolar bone thickness has a major impact on the stability and aesthetics of orthodontic treatments.

The morphology of the surrounding alveolar bone may change as a result of Angle's class I and class II malocclusions, which may additionally outcome in changes to the maxillary incisor and canine angulation and location. When there is excessive proclination or protrusion of the maxillary front teeth, labial or lingual alveolar bone dehiscences or fenestrations may be linked to class II malocclusions, which are characterized by a retrusive or retroclined maxillary incisor inclination and worsening overjet. A number of variables, such as the size, form, and breadth of the arch, can affect the thickness and structure of the alveolar bone in class I malocclusions.

Aim & Objectives

Using a three-dimensional method, Angle' s class I & class II conditions measure the thickness of alveolar bone in the maxillary anterior region.

1. To ascertain variations in the maxillary central incisors alveolar thickness.
2. To compare the differences between Angle's class I & class II.

Materials & Methods

This study was approved by ethical committee of Maharaj Vinayak Global University.

This investigation set out to evaluate the alveolar bone thickness in Angle's class I and class II cases in the maxillary front area.

Angle's class I and class II instances. 30 patients, aged 15 to 30 years had their CBCT data selected prior to therapy. Angle has 15 Class I and 15 Class II numbers.

A common plane of reference is required for CBCT analysis in order to precisely place and standardize landmarks. For every CBCT scan, the patient was positioned with their head in its natural posture, and the Frankfurt Horizontal Plane was aligned with the bottom boundaries of the orbit. Each tooth's center was measured on the sagittal plane.

The inclusion criteria were group 1 participants with an Angle's Class I and group 2 individuals with an Angle's Class II, and the entire complement of permanent dentition except for third molars and fully erupted first molars.

Patients with malignancy, malformed teeth, anodontia, oligodontia, transverse discrepancies, compromised periodontal health, patients on long-term medications that slow down bone metabolism, patients with unilateral chewing and parafunctional habits, TMJ dysfunction, patients, and impacted teeth in the measurement site were within the patients who met the exclusion criteria. Any of the following issues such as extra teeth, missing teeth, cleft lip or palate, or craniofacial dysmorphology.

Imaging And Processing

All of the CBCT data utilized in this investigation was recorded using the CS 8200 3D CBCT dental equipment (carestream Dental LLC, Atlanta, GA) using the following settings: 73 Kv at 12 mA of exposure. The data from the 3D Scanner X-rays, which were recorded in Carestream format, went through processing using version 8 of the CS 3D Imaging Carestream Direct view V5 DR and CR software.

Measurements

Four reference lines will be parallel to the upper incisor's long axis. maxillary anterior region's mid-sagittal plane will be used as a reference line for CBCT images, and the same measurements will be taken for every image. Line B will be drawn 2.4 mm apically to line A, line D 7.2 mm off, and line C 4.8 mm off. Line A will be drawn at the labial alveolar crest.

FIGURE 1. Measurements of alveolar bone thickness using a CBCT scan are shown in the reference lines stay the same, as was previously stated.

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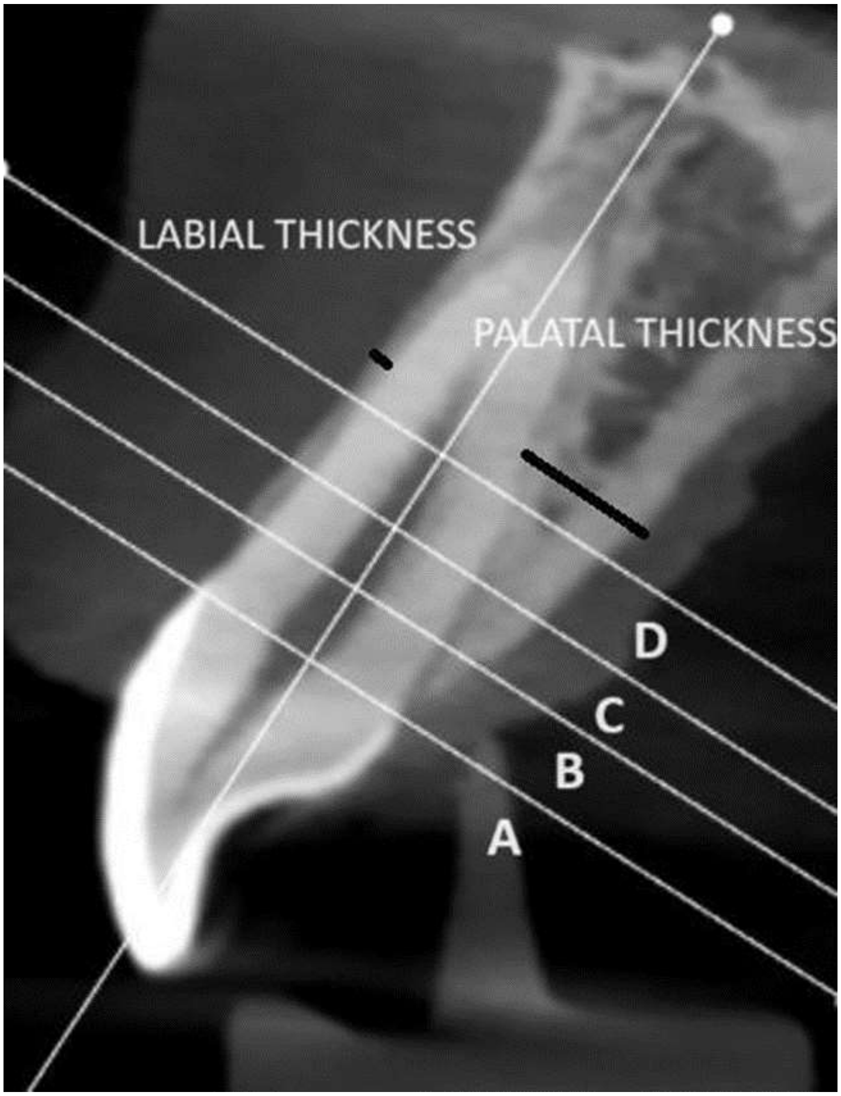


Results

Using a coding method to check for entry errors, each piece of data was entered into a computer. The data that was collected was created using a Microsoft Office Excel sheet (v 2019, Microsoft (Redmond Campus, Redmond, Washington, United States). The data was analysed using IBM's SPSS v 26.0 (Statistical Package for the social sciences, Stanford, United states) statistical software for social sciences. Examples of descriptive statistics that have been illustrated are percentages and frequencies for categorical data, and the mean and standard deviation for numerical data.

When the Shapiro-Wilk test was employed to determine whether numerical data was normal, it was found that the data corresponded to a normal curve; hence, parametric tests were utilized for comparisons. An intergroup comparison between two groups was carried out using the t test. With α and β errors maintained at 5% and 20%, respectively, the study's power was 80%, as all statistical tests were deemed statistically significant at $p<0.05$. In every table, a * denotes a statistically significant difference ($p<0.05$), a ** denotes a statistically highly significant difference ($p<0.01$), and a # denotes a non-significant difference ($p>0.05$).

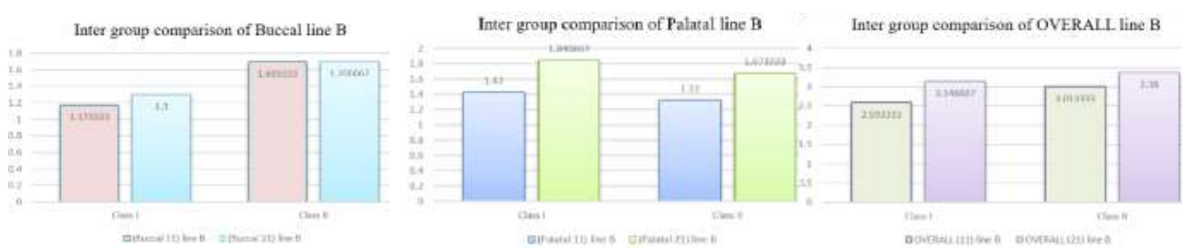
Table 1: Intergroup Comparison of Angle's Class I and Class II Malocclusion Values in 11 & 21 at Buccal, Palatal, and Overall Thickness

Class		N	Mean	Std. Deviation	Std. Error Mean	T value	P value of t test
Buccal (11) line B	1	15	1.1733	.22189	.05729	-6.197	.902#
	2	15	1.6933	.23740	.06130		
Buccal (21) line B	1	15	1.3000	.33166	.08560	-3.797	.180#
	2	15	1.7067	.24918	.06430		
Palatal (11) line B	1	15	1.4200	.51018	.13170	.614	.878#
	2	15	1.3200	.37071	.09570		
Palatal (21) line B	1	15	1.8466	.41725	.10770	1.301	.258#
	2	15	1.6733	.30347	.07836		
Overall (11) line B	1	15	2.5933	.54960	.14190	-2.427	.447#
	2	15	3.0133	.38330	.09898		
Overall (21) line B	1	15	3.1466	.61740	.15940	-1.318	.002**
	2	15	3.3800	.29809	0.7697		
Buccal (11) line C	1	15	1.0466	.20999	.05420	-6.076	.014*
	2	15	1.6800	.34476	.08900		
Buccal (21) line C	1	15	1.2266	.36736	.09486	-3.628	.104#
	2	15	1.6800	.24437	.06309		
Palatal (11) line C	1	15	1.8800	.53479	.13808	-2.667	.039*
	2	15	2.3066	.31270	.08075		
Palatal (21) line C	1	15	2.0733	.61929	.15990	-.221	.051#
	2	15	2.1133	.33138	.08557		
Overall (11) line C	1	15	2.9266	.56750	.14650	-5.787	.385#
	2	15	3.9866	.42570	.10992		
Overall (21) line C	1	15	3.3000	.73580	.18999	-2.114	.153#
	2	15	3.7533	.38520	.09946		
Buccal (11) line D	1	15	1.0066	.22189	.05729	-5.075	.109#
	2	15	1.5733	.37128	.09585		
Buccal (21) line D	1	15	1.1866	.33566	.08667	-3.077	.038*
	2	15	1.5000	.20700	.05346		
Palatal (11) line D	1	15	2.2600	.80070	.20670	-4.517	.374#
	2	15	3.4333	.60906	.15726		

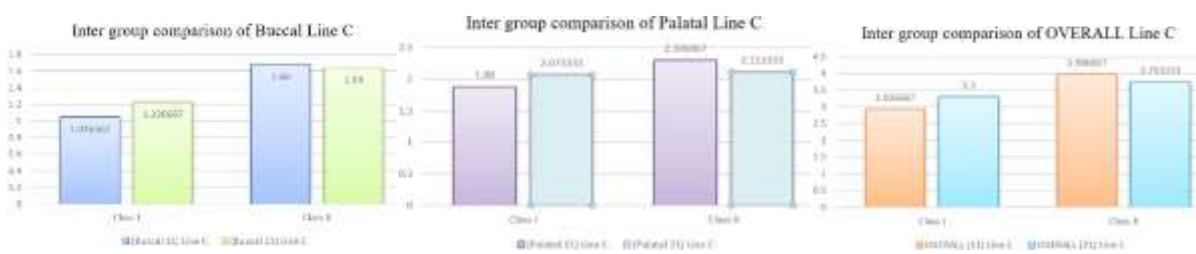
Palatal (21) line D	1	15	2.4733	.89799	.23186	-2.931	.170#
	2	15	3.2933	.60648	.15659		
Overall (11) Line D	1	15	3.2666	.78890	.20369	-6.700	.406#
	2	15	5.0066	.62389	.16109		
Overall (21) Line D	1	15	3.7266	1.0509	.27120	-3.285	.219#
	2	15	4.7933	.69120	.17848		

p< 0.01 is highly significant; p<0.05 significant; p> 005 not significant

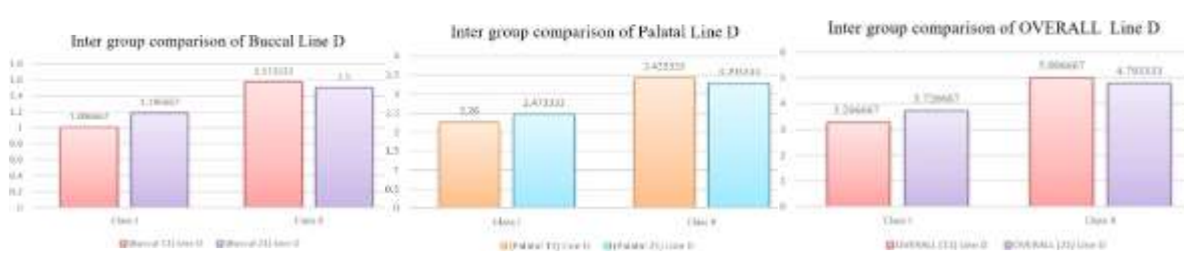
GRAPH 1 INTER GROUP COMPARISON OF LINE B IN ANGLE'S CLASS I & CLASS II IN 11 & 21 AT (a) BUCCAL (b) PALATAL (c) OVERALL



GRAPH 2 INTER GROUP COMPARISON OF LINE C IN ANGLE'S CLASS I & CLASS II IN 11 & 21 AT (a) BUCCAL (b) PALATAL (c) OVERALL



GRAPH 3 INTER GROUP COMPARISON OF LINE D IN ANGLE'S CLASS I & CLASS II IN 11 & 21 AT (a) BUCCAL (b) PALATAL (c) OVERALL



Discussion

The tension side experiences bone apposition and the pressure side experiences bone resorption when a force is applied during orthodontic tooth movement.

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The question of whether changes in the anterior alveolar bone during orthodontic tooth movement always correspond to the direction and magnitude of tooth movement is up for debate.[6]

The tooth should be able to stay in the bone with orthodontic movement.[2] Tissue mobility causes fenestration and dehiscence once it crosses the boundary of the alveolar bone. The "envelope of discrepancy" was developed by Proffit [4] to illustrate the boundaries of tooth movement. Individuals with bimaxillary protrusion are more susceptible to periodontal disease due to excessive retraction of their anterior teeth.[7]

Because the upper incisors are oriented vertically, 3–5 mm of the incisal border should be visible when the top lip is at rest. The nasal projection, the upper lip support, and cephalometric factors such as the thickness, angulation, and upper lip projection in reference to the true vertical line all influence the upper incisors' horizontal position.[8]

The study by Antonio et al. [9] examined each face type's upper incisors. The main distinctions between the two central incisors in the long face type group are the vestibular cortex height and the distance between the radicular apex and the center of resistance. Other than that, they matched quite well in every parameter examined. The two lateral incisors' measures were identical; the only differences were in the distance at point A between the vestibular cortex and the internal lingual cortex and the angle between the incisor axis and the bispinal plane within the norm face type group. The alveolar thickness at point A, the height of the lingual cortex, the angle between the incisor axis and the SN plane, and the separation between the apex and the bispinal plane were the only areas where the two central incisors in each of the three facial types differed significantly from the lateral incisors.

According to Yodthong et al. [3] three significant variables that may affect alveolar bone thickness during upper incisor growth are the rate of tooth movement, inclination shift, and degree of intrusion. Bone fenestration and dehiscence can be more likely when there is a large range of tooth movement and an incorrect perception of the thickness of the alveolar bone.

According to Gang et al. [10] research, the left upper central incisor was the most commonly impacted tooth with fenestration in Chinese patients with skeletal Class II division 1 malocclusions. The incidence of bone fenestration and dehiscence in the incisor region was found to be 30.78% and 36.15%, respectively.

Using CBCT, the study intends to assess and compare changes in alveolar bone thickness surrounding the maxillary central incisors in Angle's class I and class II. The thickness of the alveolar bone enclosing the central incisors was assessed and compared following the acquisition of CBCT images of 30 Angle's class I and class II cases from OPD. These patients were aged between 15 and 30 years.

A thorough and precise measurement of the maxillary incisor alveolar bone thickness is essential for optimal results in orthodontics, which strongly depends on accurate treatment planning. A number of studies have examined the maxillary incisor alveolar bone thickness using CBCT images, especially in the context of implant procedures.

Less than 10% of the sites had buccal bone walls thicker than 2 mm, according to Fuentes et al. [11] examination of the buccal to maxillary incisor bone.

The thickness of the buccal and palatal alveolar plates of maxillary incisors in a Korean subpopulation was examined by Lee et al. [12] using CBCT images. They discovered that the front buccal plate was incredibly tiny, measuring less than 1 mm, and that the palatal plate was properly large.

Chinese adults have extremely thin labial bone in the maxillary anterior region and lingual obliquity in the central incisor, which has even thinner bone. The results of this study showed that, in Chinese adults, the maxillary anterior region—which is located 3 mm below the mid- root level and the CEJ—had a mean thickness of less than 1 mm for the labial bone.13]

In compliance with the recommendations of Buser et al. [14], the labial bone thickness of the upper central incisor was found to be substantially thinner in lingual obliquity at the mid-root level and 3 mm below the CEJ compared to other teeth.

Similar findings were reported by Baumgaertel and Hans [15] and Kim et al. [16], demonstrating that the buccal side had the largest thickness at the greatest measured distance from the alveolar crest, also known as the cementoenamel junction. However, they both did demonstrate something our study did not 4 mm reduction in bone thickness in the buccal regions.

The palatal cortical bone was also studied by Kim et al. [16], who discovered a general thickening toward the basal bone. OMIs would therefore be inserted as high in the connected gingiva as feasible to provide the best primary stability and ensure the most mechanical retention in the alveolar cortical bone.

Previous investigations the maxillary anterior teeth's bone thickness has been measured. [17,18,19] Typically, the maxillary front teeth's labial bone wall was thin. [18] In a different study, the mean bone wall thickness of the maxillary right central and left central incisors at 2 mm from the CEJ was 0.63 ± 0.69 mm and 0.59 ± 0.71 mm17, respectively. The lateral maxillary incisors on the left and right showed 0.64 ± 0.81 mm and 0.61 ± 0.7 mm of outcomes.[19]

The average crestal bone thickness for the front maxilla was 0.82 mm. The labial, palatal, and overall alveolar bone thicknesses of the maxillary incisors should all be taken into consideration when making orthodontic treatment plan. Overall (21) Line B, which had higher values in Class II, showed a statistically significant difference between the groups' values in the current study; however, there was also a statistically significant difference between the groups' values for Overall (11) Line C, which had higher values in Class II, and (Buccal 21) Line D, which had higher values in Class II. For every other variable, there was a statistically insignificant variation in the values between the groups. Comparable results demonstrate that at 4 mm from the root center (80.1%) and the CEJ (62.9%), the labial bone thickness was less than 1 mm. Similarly, the labial bone thickness at the crest and center of the root was 1 mm or less in 83% and 92% of the anterior teeth, respectively. For the central incisor, the average bone thickness was 0.73, 0.69, and 0.60 mm in the coronal, middle, and apical thirds of the labial side of the roots; for the lateral incisors, it was 0.70, 0.61, and 0.49 mm. Compared to the labial bony wall, the palatal bony wall had a substantially greater thickness. Most of the crest's palatal thickness was thin.[20]

This study's relatively modest sample size was a limitation. Further investigation is advised, ideally with a bigger sample size, a male-female study group, and an exclusive focus on the examination of the maxillary incisors; the mandibular arch and posterior teeth were not taken into account.

Conclusion

Cone-beam computed tomography (CBCT) has made it possible to quantify the height and thickness of the alveolar bone as well as the length and thickness of the root objectively and subjectively. Overall (21) line B, which had higher values in class II, was the topic of a statistically highly significant difference between the groups in this study's Class II group. Nonetheless, for (Buccal 11) Line C with higher values in class II, (Palatal 11) Line C with higher values in class II, and (Buccal 21) Line D with higher values in class II, there was a statistically significant difference between the groups. The values of every other variable varied between the groups in a statistically insignificant way. Because the majority of changes in the alveolar bone, which are indicated by the transitional occurrence of the bone modelling process, occur during or shortly after the orthodontic treatment, Aass and Gjermo advocate long-term examination of the alveolar bone following orthodontic therapy. Because the anterior section migrates to resemble the alveolar bone, there may be a brief decrease in marginal bone height after orthodontic treatment.

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