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Original Research

Comparison of alveolar bone thickness in mandibular anterior retraction cases – A CBCT study- Original Research

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ABSTRACT:

Aim: The aim of this study was to compare the changes in the alveolar bone thickness around the mandibular anteriors pre and post retraction in class I Bimaxillary protrusion cases using Cone Beam Computed tomographic images. **Methodology**: Ten patients undergoing orthodontic treatment with MBT 3M (Abzil)- 0.022 slot appliance were selected. Changes in the alveolar bone was measured in the Mandibular anterior region using pre-retraction and post-treatment CBCT. Labial bone thickness (LaBT), Lingual bone thickness (LiBT), and Total bone thickness (TBT) were assessed at the Crestal, Midroot, and Apical levels. **Result**: Total alveolar bone thickness was reduced when compared to the pretreatment CBCT images. The difference value of the mean **Labial Bone Thickness [LaBT]** at Crestal level was 0.04 (p value=0.02), Midroot level was 0.06 (p value=0.057), Apical level was 0.1 (p value=0.02), The difference value of the mean **Lingual Bone Thickness [LiBT**] at Crestal level was 0.05 (p value=0.05), Midroot level was 0.057 (p value=0.07), Apical level was 0.067 (p value=0.07). The difference value of the mean. **Total Bone Thickness [TBT]** at Crestal level was 0.05 (p value=0.05), Midroot level was 0.15 (p value=0.157), Apical level was 0.011 (p value=0.02). **Conclusion**: The study showed that there was an increase in the labial bone thickness and decrease in the lingual bone thickness as well as total alveolar bone thickness.

Keywords: Cone Beam Computed Tomography, Labial bone thickness, Lingual bone thickness, Total alveolar bone thickness, SS-Stainless steel wires.

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INTRODUCTION

Orthodontic Tooth movement relies on coordinated tissue resorption and formation in the surrounding bone and periodontal ligament[1].Tooth loading causes local hypoxia and fluid flow, initiating an aseptic inflammatory cascade culminating in osteoclastic resorption in areas of compression and osteoblastic apposition in areas of tension[2,3]. Compression and

tension are associated with particular signaling factors, establishing local gradients to regulate remodeling of the bone and periodontal ligament for tooth displacement. Excessive retraction of the anterior teeth may result in iatrogenic sequelae such as Root resorption, Alveolar bone loss, Dehiscence, Fenestration and Gingival recession[4,5]. Therefore, morphometric evaluation of the alveolar bone and roots of the anterior teeth after enmasse retraction may be a good model with which to explain the therapeutic limitation of orthodontic tooth movement CBCT scans allow the orthodontist to assess the patient's hard and soft tissue in three dimensions[6]. The accuracy and reliability of three-dimensional images have been tested and found to be effective for orthodontic purposes, CBCT images can also be used to determine the factors affecting buccal bone changes for the maxillary posterior teeth after rapid maxillary expansion[7,8].

OBJECTIVES

To evaluate the Labial bone thickness [LaBT], Lingual bone thickness [LiBT], Total alveolar bone thickness [TBT] at Crestal, Midroot and Apical levels during pre-treatment [T0] and post treatment [T1] using Cone beam computed tomographic images.

MATERIAL AND METHODOLOGY

Ten Class I Bimaxillary protrusion cases between the age group of 15-30 years were selected who desired to undergo orthodontic treatment with Preadjusted edgewise appliance [PEA], MBT 3M (Abzil) extraction brackets [0.022 SLOT] was used. The retraction was carried out using 0.019" × 0.025" stainless steel wire. Initial levelling and aligning was carried out using 0.016NiTi archwire. Later, the wire sequencing followed was 0.016×0.022 Niti, 0.017×0.025 Niti, 0.019×0.025 NiTi and finally retraction was carried out using 0.019×0.025 SS archwire with soldered hooks placed in between the mandibular lateral incisors and mandibular canines as the Centre of resistance [CR] of the lower anterior teeth lie between the mandibular lateral incisors and the canines[9].

Changes in alveolar bone thickness in the retracted area was assessed using Pre-treatment (after levelling and aligning) (T0) and Post retraction (T1) cone-beam computed tomography images (Fig 1). Labial bone thickness (LaBT), Lingual bone thickness (LiBT) and Total Alveolar Bone thickness [TBT] at the Crestal, Midroot, and Apical levels of the retracted incisors was evaluated for the changes after lower incisor retraction in class I Bimaxillary protrusion cases (Fig 2)**.**

Field of view was 75mm×145mm with a voxel size of 0.25mm, 90 kvp and 12mA and exposure time of 15 seconds. On-demand Software was used for image processing and analysis with screen resolution of 1920×1200 pixels and 64-bit colour. Measurements on scan was made using On-demand software.

The thickness of the labial, lingual and total alveolar plates was measured on mandibular central incisor, at the site adjacent to the widest point of the labiolingual root, in three slices separated by 3 mm Crestal (LaBT1, LiBT1 and TBT1), Midroot (LaBT2, LiBT2 and TBT2) and Apical (LaBT3, LiBT3 and TBT3) respectively to evaluate bone thickness changes during retraction.

Fig 1: Soredex Scanora® 3D CBCT machine at Rajarajeswari Dental College and Hospital, Bangalore.

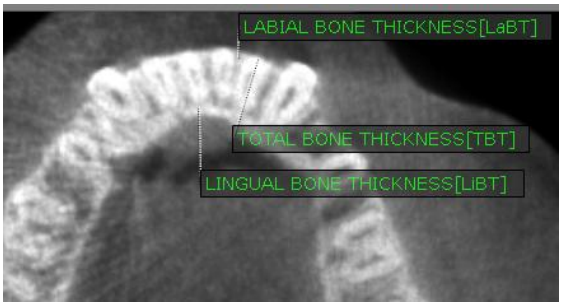


Fig 2: CBCT image of Labial bone thickness[LaBT], Lingual bone thickness [LiBT], and Total bone thickness [TBT] measurements.

RESULTS

The statistical analysis concluded that the mean Labial Bone Thickness [LaBT] (Fig 3) Pretreatment [T0] at Crestal level [LaBT1] was 0.77 mm and Post-treatment [T1] is 0.81 mm; the difference value of the mean Labial Bone Thickness [LaBT] at Crestal level [LaBT1] was 0.04 mm with p value=0.02. The mean Labial Bone Thickness [LaBT] at Midroot level [LaBT2] Pretreatment [T0] was 1.04 mm and Post-treatment [T1] was 1.1 mm, the difference value of the mean Labial Bone Thickness [LaBT] at midroot level [LaBT1] was 0.06 mm with p value = 0.057. The mean Labial Bone Thickness [LaBT] Pretreatment [T0] at the Apical level [LaBT3] was 1.35 and Post-treatment was 1.45; the difference value was 0.1 with p value=0.02 (Graph 1).

From the above results we can conclude that the Labial Bone Thickness [LaBT] was increased post treatment [T1] when compared to pre-treatment [T0] at the crestal [LaBT1], midroot [LaBT2] and the apical root level [LaBT3] (Graph 1&2) with statistically significant results.

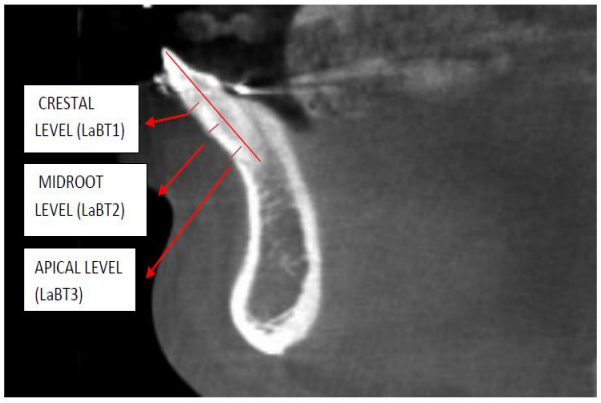


Fig 3: Labial bone thickness [LaBT] at crestal level- [LaBT1], midroot level- [LaBT2] and apical level-[LaBT3].

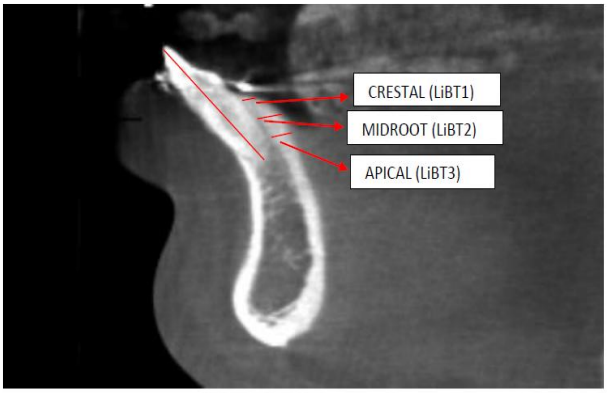
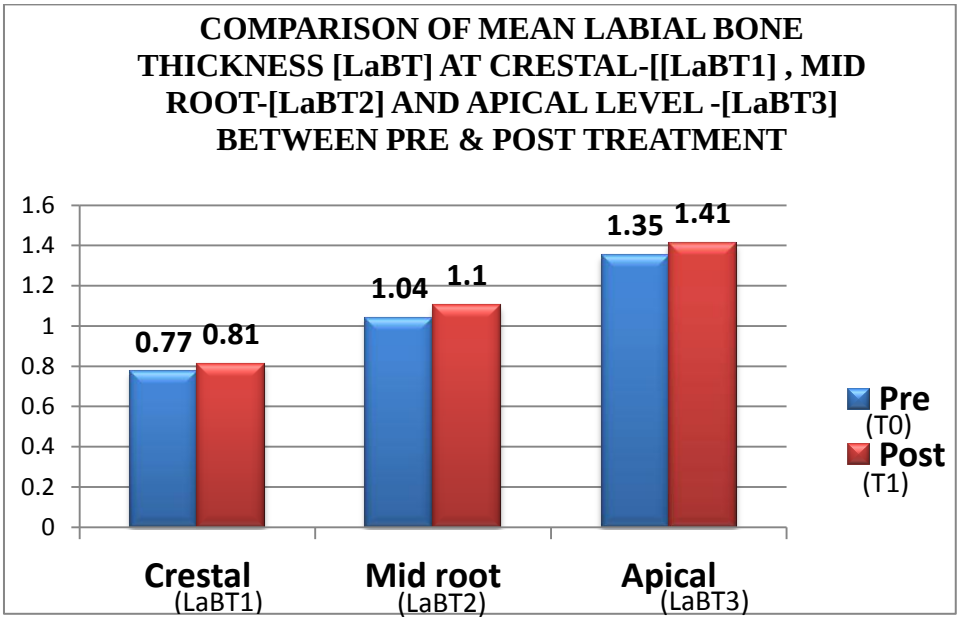
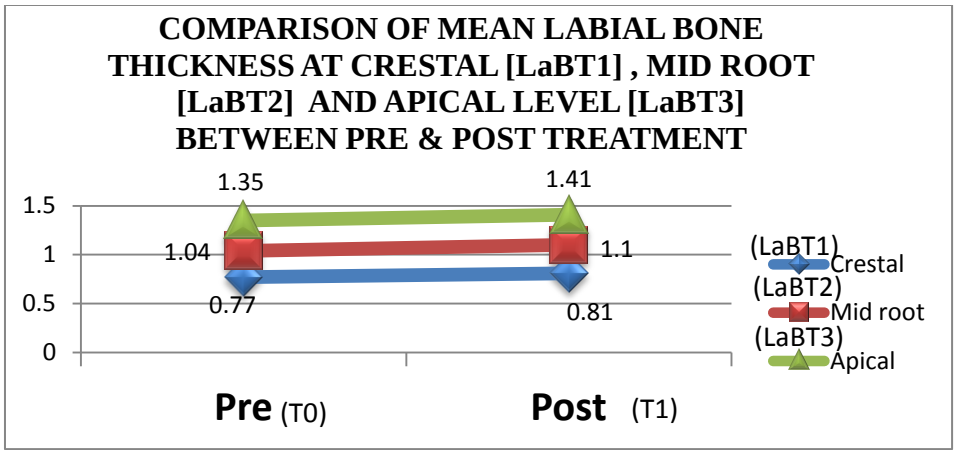


Fig 4: Lingual bone thickness LiBT at crestal level –[LiBT1], midroot level- [LiBT2] and apical level- [LiBT3].

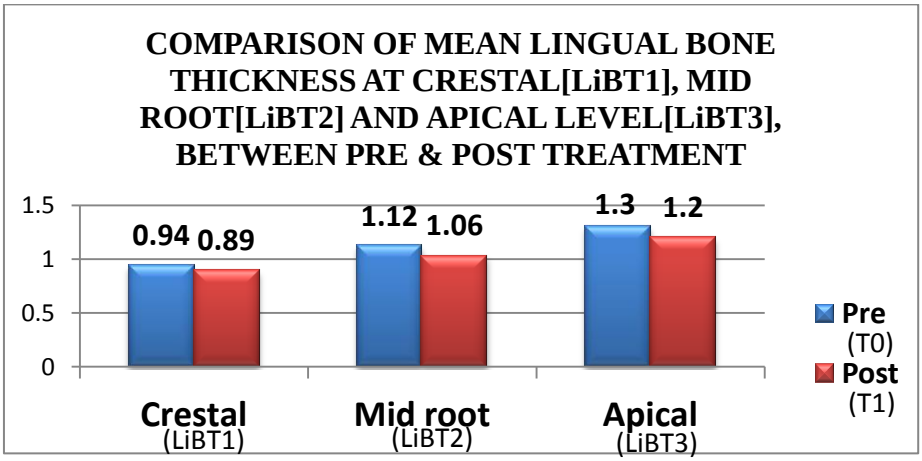


GRAPH 1- Bar graph representing the comparison of mean Labial bone thickness [LaBT] at crestal-[LaBT1], mid root- [LaBT2] and apical level- [LaBT3] between Pre [T0] & Post treatment[T1]

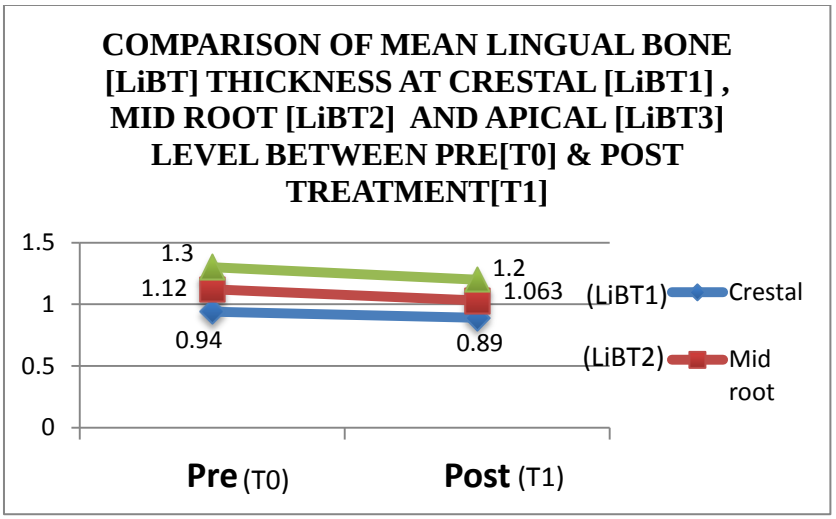


GRAPH 2- Comparison of mean Labial bone thickness[LaBT] at crestal-[LaBT1], mid root-[LaBT2] and apical level-[LaBT3] between pre[T0] & post treatment[T1].

Comparison of mean Lingual Bone Thickness [LiBT] at Crestal [LiBT], Midroot [LiBT2] and Apical level [LiBT3] between pretreatment [T0] and posttreatment [T1] demonstrate the mean lingual bone thickness [LiBT] (Fig 4). The mean Lingual Bone Thickness [LiBT] Pretreatment at Crestal level [LiBT1] was 0.94 mm and Post-treatment is 0.89 mm; the difference value of the mean Lingual Bone Thickness [LiBT] at crestal level [LiBT1] was 0.05 mm with p value=0.05. The mean Lingual Bone Thickness at Midroot level [LiBT2] Pretreatment was 1.12 mm and Post-treatment was 1.06 mm; the difference value of the mean Lingual Bone Thickness [LiBT] at crestal level [LiBT1] was 0.057 mm with a p value=0.07; The mean Lingual Bone Thickness [LiBT] at Apical level [LiBT3] Pretreatment was 1.3 mm and Post-treatment was 1.233 mm; the difference value of the mean Lingual Bone Thickness [LiBT] at apical level [LiBT3] was 0.067 mm of p value=0.07.
From the above results we can conclude that the Lingual Bone Thickness [LiBT] was decreased post treatment [T1] when compared to pretreatment [T0] at the Crestal [LiBT1], Midroot [LiBT2] and the Apical root level [LiBT3] (Graph 3&4).



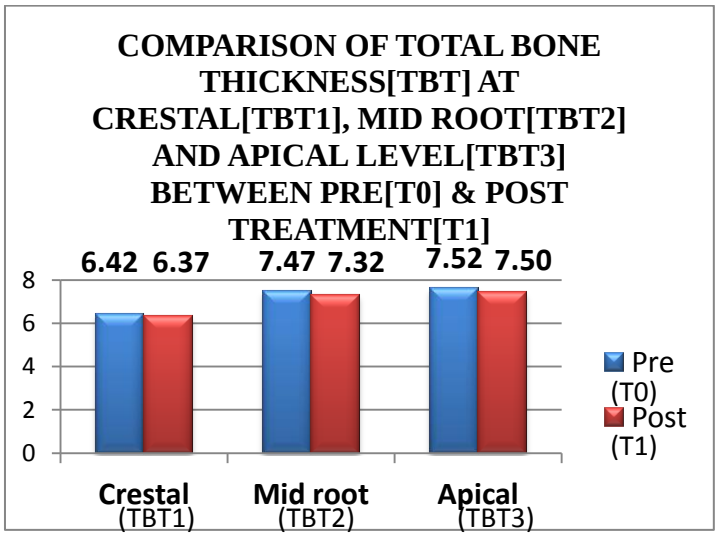
GRAPH 3- Bar graph representing the comparison of mean Lingual bone thickness at crestal[LiBT1], mid root [LiBT2] and apical level[LiBT3], between pre[T0] & post treatment[T1].



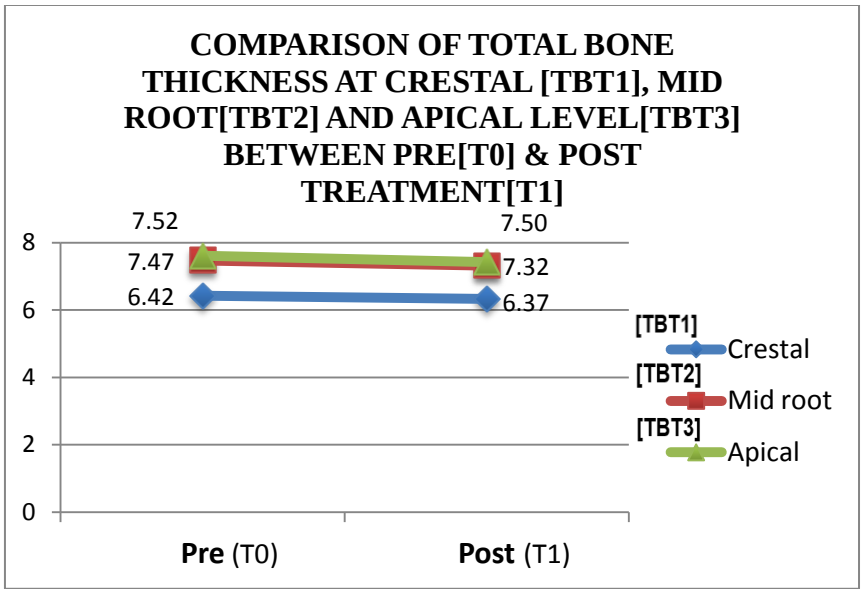
GRAPH 4- Comparison of mean Lingual bone [LiBT] thickness at crestal [LiBT1] , mid root [LiBT2] and apical [LiBT3] level between pre[T0] & post treatment[T1].

Comparison of Total Bone Thickness [TBT] at Crestal level [TBT1], Midroot [TBT2] and Apical level [TBT3] between pretreatment [T0] and posttreatment [T1] demonstrate the mean Total bone thickness [TBT] (fig 5). The mean Total Bone Thickness [TBT] Pretreatment at Crestal level [TBT1] was 6.42 mm and Post-treatment was 6.37 mm; the difference value of the mean Total Bone Thickness [TBT] at crestal level [TBT1] was 0.05 mm with p value=0.05; The mean Total Bone Thickness [TBT] Pretreatment at Midroot level [TBT2] was 7.47 mm and Post-treatment was 7.32 mm; the difference value of the mean Total Bone Thickness [TBT] at midroot level [TBT2] was 0.15 mm with p value=0.15 and the mean Total bone thickness[TBT] at Apical level Pretreatment was 7.52 mm and Postreatment was 7.50 mm; the difference value of the mean Total Bone Thickness [TBT] at apical level [TBT3] was 0.011 mm with p value=0.02.

From the above results we can conclude that the Total Bone Thickness[TBT] was decreased post treatment[T1] when compared to pre- treatment [T0] at the Crestal [TBT1], Midroot [TBT2] and the Apical root level[TBT3] (Graph 5&6).



GRAPH 5- Bar graph representing the comparison of Total Bone Thickness [TBT] at crestal [TBT1], mid root [TBT2] and apical level [TBT3] between pre [T0] & post treatment [T1]



GRAPH 6 -Comparison of Total Bone Thickness [TBT] at crestal [TBT1], mid root [TBT2] and apical level [TBT3] between pre [T0] & post treatment [T1].

DISCUSSION

Excessive retraction of the anterior teeth may result in iatrogenic sequelae such as root resorption, alveolar bone loss, dehiscence, fenestration and gingival recession[10,11]. Therefore, morphometric evaluation of the alveolar bone and roots of the anterior teeth after en masse retraction may be a good model to explain the therapeutic limitation of orthodontic tooth movement.

In the present study the sample size consisted of ten patients between age group of 15-30 yrs who desired to undergo orthodontic treatment with Preadjusted Edgewise Appliance [PEA] MBT 3M (Abzil) brackets extraction series, reporting to Department of Orthodontics and Dentofacial Orthopaedics, Rajarajeswari dental college and hospital, Bangalore. Class I Bimaxillary protrusion cases with ANB angle of $2^{o}\pm2$ selected according to inclusion criteria[1]. Retraction was carried out using 0.019″ × 0.025″ stainless steel wire. Changes in the Alveolar Bone Thickness [ABT] in the retracted area was assessed using pre retraction after levelling and aligning [T0] and Post retraction [T1], CBCT images was taken for both. Labial bone thickness [LaBT], Lingual bone thickness [LiBT] and Total bone thickness [TBT].[12,13.] Comparisons were performed using paired t test when compared the mean values of study parameters between pretreatment [T0] & post-treatment [T1] by using CBCT Scan, we found that they were statistically significant. The mean difference between the parameters after post retraction [T1] when compared to pretreatment [T0] the p value is 0.002. Mean labial bone thickness [LaBT], was statistically significant with P=0.02, P=0.057 & P=0.02 at crestal, midroot and apical levels respectively. Mean Lingual Bone Thickness [LiBT] was statistically significant with P=0.05, P=0.07 & P=0.07 at crestal, midroot and apical levels respectively. Total bone thickness [TBT] was statistically significant with P=0.05, P=0.15 & P=0.02 at crestal, midroot and apical levels respectively.

A study conducted by Nuengrutai Yodthonga, Chairat Charoemratrote and Chidchanok Leethanakul to investigate the factors related to changes in alveolar bone thickness during upper incisor retraction[1]. It was concluded that as the upper incisors were retracted, the LaBT at the crestal level and TBT at the apical level significantly increased (P >0.005). In their study CBCT images are taken during preretraction [T0] and postretraction [T1][1]. Labial bone thickness[LBT], Palatal bone thickness[PBT] and Total bone thickness[TBT] is assessed at crestal [S1], midroot [S2], and apical [S3] levels of retracted upper incisors. There is mild increase in Labial bone thickness [LBT], decrease in Palatal bone thickness [PBT], decrease in Total bone thickness [TBT] and total tooth length after upper incisor retraction[1]. Our study was conducted on the ten bimaxillary dentoalveolar protrusion cases, evaluation of the alveolar bone thickness [ABT] and the total tooth length[TTL] was done in the lower incisors. The results of our study is similar to their study where there was increase in the Labial Bone Thickness [LaBT] and decrease in the lingual bone thickness [LiBT] and the Total Bone thickness[TBT][1].

A study conducted by U S Nayak Krishna, Ashutosh Shetty, M P Girija, Reshma Nayak to evaluate the changes in alveolar bone as a result of maxillary and mandibular incisor retraction in patients with bimaxillary protrusion by means of using lateral cephalograms and computed tomography (CT) scans

and to investigate any occurrence of bony defects like dehiscence and fenestration[2]. It consisted of ten patients (age 15 ± 3 years) with bimaxillary protrusion treated by extraction of four first premolars were investigated by lateral cephalograms and CT scans during pre-treatment (T1) and after 3 months of completion of incisor retraction (T2). The labial and lingual cortex of all the incisors were assessed on the CT scan with measurements taken at site adjacent to widest point of the labiolingual root in three slices separated by 3 mm at crest level (S1), mid root level (S2), and apical level (S3)[1]. It was concluded that in the mandibular arch, after lingual movement of the incisors, the bone labial to the anterior teeth increased in thickness at the coronal level of the left lateral and left central incisors[2]. Left lateral incisor showed significant changes in all the three levels. In the maxilla the change in the labial bone thickness was not statistically significant. Lingual bone of all the incisors showed significant changes in S1 level and S3 levels[2,3]. Few patients demonstrated bone dehiscence that was not visible macroscopically or cephalometrically. The results of this study were similar to our study where there was significant decrease in the lingual bone thickness[LiBT] in the lower incisor region at all the 3 levels namely, Crestal, midroot and the apical level[2]. The results were contrary when compared with the Labial Bone Thickness [LaBT], there was no statistically significant changes which are seen compared to our study where there was increase in all the 3 levels.

A study conducted by Simten Sarikaya, Bulent Haydar and Semra Ciger et al in July 2002 on Changes in alveolar bone thickness due to retraction of anterior teeth[3].Nineteen patients with dentoalveolar bimaxillary protrusion treated by extracting the 4 first premolars were evaluated with lateral cephalograms and computed tomography (CT). Cephalograms and CT scans were made before treatment and 3 months after retraction of the incisors. The measurements of the cephalograms showed that maxillary and mandibular incisors were retracted primarily by controlled tipping of the teeth. For all maxillary and mandibular incisors, they assessed the labial and the lingual alveolar plates at crest level (S1), midroot level (S2), and apical level (S3) for bone-thickness changes during retraction of the maxillary and mandibular anterior segments[3]. In the mandibular arch, the labial bone maintained its original thickness, except the S1 measurements, which showed a significant decrease in bone thickness (P <.001). In the maxillary arch, the labial bone thickness remained unchanged. There was statistically significant decrease in lingual bone width in both arches after retracting the incisors. Some of the patients demonstrated bone dehiscence that was not visible macroscopically or cephalometrically. The results of their study were similar to our study where there was significant decrease in the lingual bone thickness[LiBT] in the lower incisor region at all the 3 levels namely, Crestal (S1), midroot (S2) and the apical level (S3)[2]. The results were contrary when compared with the Labial Bone Thickness [LaBT], there was no statistically significant changes which are seen compared to our study where there was decrease in the crestal level.

A study conducted by Hyo Won Ahn, Sung Chul Moon etal in March 2013 on Morphometric evaluation of changes in the alveolar bone and roots of the maxillary anterior teeth before and after en masse retraction using cone-beam computed tomography[4]. The sample consisted of 37 female adult patients who had Class I dentoalveolar protrusion (CI-DAP) and were treated by extraction of the first premolars and En mass retraction of maxillary anteriors (EMRMA). Using three-dimensional cone-beam computed tomography taken before treatment and after space closure. After alveolar bone area (ABA), vertical bone level (VBL), root length (RL), root area (RA), and prevalence of dehiscence (PD) were measured at the cervical, middle, and apical levels, statistical analyses were performed[4]. During EMR-MA in cases with CI-DAP, ABA and VBL on the palatal side and RL and RA of MXCI and MXLI were significantly decreased. The results of this study are similar to our study where there was significant decrease in the palatal bone thickness[PBT] in the maxillary anterior region at all the 3 levels namely, Crestal, midroot and the apical level [4].

CONCLUSION

It was concluded from the above results obtained, that the Alveolar bone thickness [ABT] and the Total Tooth Length [TTL] measurements of the CBCT images between Pretreatment [T0] and Post treatment [T1] showed significant changes.

- The **Labial Bone Thickness [LaBT]** was **increased** from Pretreatment [T0] to Post-treatment [T1] at Crestal by 0.04 mm, Midroot by 0.06 mm and Apical level by 0.1 mm.
- The **Lingual Bone Thickness [LiBT]** was **decreased** from Pretreatment [T0] to Post-treatment [T1] at Crestal by 0.05 mm, Midroot by 0.09 mm and Apical level by 0.1 mm.
- The **Total Bone Thickness [TBT]** was **decreased** from Pretreatment [T0] to Post-treatment [T1] at Crestal by 0.09 mm, Midroot by 0.15 mm and Apical level by 0.19 mm.

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