A Study to Evaluate the Alveolar Bone Thickness During Anterior Retraction using Computed Tomography

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ABSTRACT

Introduction: The present study aims to evaluate the changes occurring in the alveolar bone thickness during anterior retraction after premolar extraction.

Material and Methods: 10 maxillary as well as mandibular arches were included in the study that required retraction of anterior teeth after premolar extraction. En masse retraction was carried out using sliding mechanics in lower arch and loop mechanics in upper arch. The pre treatment and post treatment CT scans were evaluated to record the changes in the width of the alveolar bone at three levels S1, S2 and S3 for labial, palatal (lingual) and total alveolar bone. The results were compared.

Results: The maxillary labial alveolar bone thickness reduced at crestal level and increased at mid root and apical level. The maxillary palatal alveolar bone thickness reduced at all the three levels.The maxillary total alveolar bone thickness showed a significant decrease in thickness at crestal level. The mandibular labial, lingual as well as total alveolar bone thickness was found to be reduced at all the three levels i.e, crestal, mid root and apical levels for all the four incisors.

Conclusion: The alveolar bone remodeling occurs but there is a lag in the process of bone formation on the pressure side compared to the bone resorption on the tension side.

Keywords: Alveolar Bone, Anterior Retraction, Computed Tomography

INTRODUCTION

Orthodontic tooth movement is a process whereby the application of a force induces bone resorption on the pressure side and bone apposition on the tension side.[1] A basic axiom in orthodontics is "*Bone Traces Tooth Movement*".[2,3]

When sagittal movement is attempted the anatomical limit set by labial and lingual/palatal cortical plate may be regarded as the orthodontic wall,[4] defining the area for movement and excessive force might lead to fenestration and dehiscence. Moving the incisors this way might lead to alveolar bone loss, and there is disagreement about whether the remodelling capacity of the alveolar bone can compensate for the bone loss in every case.[5]

Optimal stability is considered to be achieved when the incisors are positioned in the medullary portion of the alveolar bone and in good balance with the labial and lingual musculature.[6]

The best model to study for the remodelling of the labial and lingual cortical plate is the one where incisors move a maximum distance.[4] As a general rule, patients with dentoalveolar protrusion and mild to moderate skeletal Class II Division1 fall into this category.

As the amount of literature available on assessment of remodelling of alveolar cortical plate is limited and they probe to have further studies to evaluate the same, this study is designed so as to evaluate the changes that occur in labial and lingual alveolar cortical plate. Computed tomography provides a better evaluation of the hard tissue model[7-9], hence this study was designed to be carried out using computed tomography.

MATERIAL AND METHODS

The study was conducted on pre and post treatment CT scans of 10 arches treated in Orthodontics and Dentofacial Orthopedics, Institute of Dental Sciences, Bareilly. The mean age of the sample was 18.10 ± 3.51 years with a range from 13 years to 23 years. An informed and written consent from the patients and their guardians was obtained for each subject. The study was approved by the ethical committee.

Inclusion Criteria

1. Individuals requiring retraction of anterior teeth in the extraction space of Ist premolar (Class I bimaxillary protrusion, Class II Division 1 and Class I Type 2 malocclusions).
2. Patients having anterior dentoalveolar protrusion with minimal crowding (≤3mm).
3. No significant medical history
4. No use of anti-inflammatory drugs for at least 6 months before or during the study.
5. Patients with good periodontal health and maintaining good oral hygiene were taken for the study.

Methodology

After patient selection, routine records such as a detailed case history, pre-treatment study models, extra oral and intra oral photographs, lateral cephalograms, orthopantomograms were taken. Along with this, computed tomographic scans were also acquired. All the records were taken at two stages, one at the starting of the treatment (pre-treatment, T_0) and second at the completion of retraction (post-treatment, T_1).

Indicated first premolars were extracted and then the patients were bonded with MBT brackets 0.022 slot (Unitek™ Gemini MBT™ Metal Brackets), initial alignment and leveling of the arches was done by using 0.016" NiTi arch wire and further, till a 0.017 x 0.025" stainless steel wire fits passively in the bracket slots. To reinforce the anchorage TPA (Trans Palatal Arch) was used in all the patients. In patients with vertical growth pattern[10]

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(FMPA>30°) along with TPA, 2nd molars were included in the anchorage unit by placing a bonded attachment and ligating first and second molars.

After completion of alignment and levelling, an en masse retraction was performed in lower arch (working wire 0.017 x 0.025" stainless steel) using sliding mechanics (Figure 1). Retraction was carried out using NiTi closed coil spring (GAC Sentalloy, extra heavy), exerting a force of 250gm on each side.

An en masse retraction in the upper arch was done using loop mechanics (Figure 2). Segmental mechanics with T-loop, fabricated using 0.017"× 0.025" TMA wire was used for the en masse retraction in the upper arch. Six pre activation bends were given in the T-loop.[11] The loops were activated at an interval of 6-8 weeks.

Computed Tomography Scan

To evaluate changes in alveolar bone; labial, palatal and total alveolar bone thickness was assessed at the crestal level, 2mm apical to CEJ (S1; L1,P1 and T1), midroot level, 3mm apical to crestal level (S2; L2,P2 and T2) and apical level, 3mm apical to midroot level (S3; L3,P3 and T3) of all 4 incisors in the maxillary as well as mandibular arch. (Figure 3). Pre-retraction, nine measurements were taken for each tooth, three on the labial side, three on the palatal side, and three for the total thickness. The same measurements were repeated after retraction was completed. T_1 measurements were taken at the same slice levels as the T_0 measurements, using first slice on the incisor edge of the tooth as a reference point. All measurements were determined by a single investigator.

Change in Inclination

Change in inclination was evaluated on the lateral cephalograms as the change in the angle between the long axis of incisor and palatal plane, pre and post retraction for maxillary incisors and same was evaluated by measuring the angle between long axis of lower incisors and mandibular plane (tangent to lower border of mandible).

STATISTICAL ANALYSIS

Data was summarized as Mean ± SD (standard deviation). Groups were compared by paired t test and Student's t test. Groups were also compared by Wilcoxon matched pairs (W) test. A two-tailed (α=2) p value less than 0.05 ($p<0.05$) was considered statistically significant. All analyses were performed on SPSS software (Windows version 17.0). An Inter examiner and intra examiner reliability test was performed by using intra class correlation coefficient (r) and was found to be very high i.e., r = 0.95 and r = 0.94 respectively. A confidence level larger than 5% was considered statistically not significant.

RESULTS

The outcome measure of the study was maxillary and mandibular alveolar bone thickness measured in mm at baseline (pre-treatment) and immediately after completion of retraction (post treatment).

Maxillary alveolar bone thickness

The pre and post treatment maxillary labial, palatal and total alveolar bone thickness of four teeth (maxillary right central incisor: 11, maxillary right lateral incisor: 12, maxillary left central incisor: 21 and maxillary left lateral incisor: 22) at three levels (crestal: S1, mid root: S2 and apical: S3) are summarized in Table 1a, 1b, 1c respectively.

Mandibular alveolar bone thickness

The pre and post treatment mandibular labial, lingual and total alveolar bone thickness of four teeth (mandibular right central incisor: 41, mandibular right lateral incisor: 42, mandibular left central incisor: 31 and mandibular left lateral incisor: 32) at three levels [crestal: S1, mid root: S2 and apical: S3] are summarized in Tables 2(a), 2(b) and 2(c), respectively.

Change in Inclination

The pre and post treatment inclination of maxillary central incisors (U1-PP) and mandibular central incisors (L1-MP) are summarized in Table 3.

DISCUSSION

Orthodontic treatment is based on the principle that if prolonged pressure is applied to a tooth, tooth movement will occur as the bone around the tooth remodels. Bone is selectively removed in some areas and added in others. In essence, the tooth moves through the bone carrying its attachment apparatus with it, as the socket of the tooth migrates.[12]

Tooth/Levels	Pre (T_0)	Post (T_1)	Mean change (Post-Pre)	t value	p value
Maxillary right central incisor (11)					
Crestal level (S1)	0.74 ± 0.07	0.55 ± 0.07	-0.19 ± 0.06	10.58	<0.001
Mid root level (S2)	0.83 ± 0.09	1.03 ± 0.12	0.20 ± 0.12	5.48	<0.001
Apical level (S3)	1.15 ± 0.10	1.65 ± 0.08	0.50 ± 0.08	19.36	<0.001
Maxillary right lateral incisor (12):					
Crestal level (S1)	0.68 ± 0.08	0.56 ± 0.05	-0.12 ± 0.06	6.00	<0.001
Mid root level (S2)	0.81 ± 0.07	1.08 ± 0.08	0.27 ± 0.09	9.00	<0.001
Apical level (S3)	1.15 ± 0.13	1.55 ± 0.14	0.40 ± 0.11	12.00	<0.001
Maxillary left central incisor (21):					
Crestal level (S1)	0.72 ± 0.06	0.52 ± 0.04	-0.20 ± 0.07	9.49	<0.001
Mid root level (S2)	0.81 ± 0.09	1.06 ± 0.08	0.25 ± 0.12	6.71	<0.001
Apical level (S3)	1.12 ± 0.11	1.58 ± 0.18	0.46 ± 0.11	13.53	<0.001
Maxillary left lateral incisor (22):					
Crestal level (S1)	0.66 ± 0.10	0.55 ± 0.07	-0.11 ± 0.12	2.91	0.017
Mid root level (S2)	0.79 ± 0.06	1.07 ± 0.08	0.28 ± 0.08	11.22	<0.001
Apical level (S3)	0.99 ± 0.03	1.44 ± 0.11	0.45 ± 0.10	14.64	<0.001
*- p<0.05, **- p<0.01, ***- p<0.001					

Table-1(a): Comparison of mean Maxillary labial alveolar bone thickness (mm) at Pre (T_0) and Post treatment (T_1) (Mean ± SD, n=10)

There are two concepts in orthodontic tooth movement in terms of alveolar bone remodeling. If the alveolar bone is remodeled with coordination of resorption and apposition, tooth movement and bone remodeling occur at a 1:1 ratio, and the tooth remains

Tooth/Levels	Pre (T_0)	Post (T_1)	Mean change (Post-Pre)	t value	p value
Maxillary right central incisor (11):					
Crestal level (S1)	1.03 ± 0.13	0.51 ± 0.09	-0.52 ± 0.10	15.92	<0.001
Mid root level (S2)	1.42 ± 0.15	0.94 ± 0.13	-0.48 ± 0.08	19.24	<0.001
Apical level (S3)	2.09 ± 0.22	1.73 ± 0.15	-0.36 ± 0.13	8.43	<0.001
Maxillary right lateral incisor (12):					
Crestal level (S1)	1.03 ± 0.14	0.53 ± 0.07	-0.50 ± 0.11	15.00	<0.001
Mid root level (S2)	1.34 ± 0.18	0.90 ± 0.09	-0.44 ± 0.13	11.00	<0.001
Apical level (S3)	2.20 ± 0.12	1.80 ± 0.11	-0.40 ± 0.09	13.42	<0.001
Maxillary left central incisor (21):					
Crestal level (S1)	1.09 ± 0.12	0.56 ± 0.13	-0.53 ± 0.07	24.83	<0.001
Mid root level (S2)	1.43 ± 0.14	0.99 ± 0.09	-0.44 ± 0.17	8.12	<0.001
Apical level (S3)	2.17 ± 0.15	1.80 ± 0.12	-0.37 ± 0.05	24.22	<0.001
Maxillary left lateral incisor (22):					
Crestal level (S1)	1.01 ± 0.11	0.51 ± 0.14	-0.50 ± 0.12	12.68	<0.001
Mid root level (S2)	1.37 ± 0.16	0.95 ± 0.14	-0.42 ± 0.10	12.86	<0.001
Apical level (S3)	2.17 ± 0.09	1.81 ± 0.07	-0.36 ± 0.07	16.28	<0.001
*- p<0.05, **- p<0.01, ***- p<0.001					

Table-1(b): Comparison of mean Maxillary palatal alveolar bone thickness (mm) at Pre (T_0) and Post treatment (T_1) (Mean ± SD, n=10)

Tooth/Levels	Pre (T_0)	Post (T_1)	Mean change (Post-Pre)	t value	p value
Maxillary right central incisor(11):					
Crestal level (S1)	6.30 ± 0.15	5.75 ± 0.18	-0.55 ± 0.12	14.76	<0.001
Mid root level (S2)	5.75 ± 0.10	5.58 ± 0.09	-0.17 ± 0.08	6.53	<0.001
Apical level (S3)	5.37 ± 0.26	5.67 ± 0.11	0.30 ± 0.27	3.50	0.007
Maxillary right lateral incisor (12):					
Crestal level (S1)	6.06 ± 0.32	5.56 ± 0.17	-0.50 ± 0.30	5.30	0.001
Mid root level (S2)	5.49 ± 0.36	5.51 ± 0.10	0.02 ± 0.39	0.16	0.875
Apical level (S3)	5.45 ± 0.15	5.64 ± 0.07	0.19 ± 0.13	4.67	0.001
Maxillary left central incisor (21):					
Crestal level (S1)	6.21 ± 0.16	5.50 ± 0.18	-0.71 ± 0.16	14.08	<0.001
Mid root level (S2)	5.59 ± 0.43	5.60 ± 0.16	0.01 ± 0.48	0.07	0.949
Apical level (S3)	5.35 ± 0.18	5.43 ± 0.22	0.08 ± 0.14	1.81	0.104
Maxillary left lateral incisor (22):					
Crestal level (S1)	5.91 ± 0.23	5.43 ± 0.08	-0.48 ± 0.19	7.86	<0.001
Mid root level (S2)	5.34 ± 0.38	5.37 ± 0.15	0.03 ± 0.45	0.21	0.837
Apical level (S3)	5.32 ± 0.15	5.36 ± 0.10	0.04 ± 0.14	0.88	0.399
*- p<0.05, **- p<0.01, ***- p<0.001					

Table-1(c): Comparison of mean maxillary total alveolar bone thickness (mm) at Pre (T_0) and Post treatment (T_1) (Mean ± SD, n=10)

Tooth/Levels	Pre (T_0)	Post (T_1)	Mean change (Post-Pre)	t value	p value
Mandibular right central incisor(41):					
Crestal level (S1)	0.50 ± 0.12	0.16 ± 0.08	-0.34 ± 0.10	11.13	<0.001
Mid root level (S2)	0.69 ± 0.13	0.60 ± 0.07	-0.09 ± 0.09	3.25	0.010
Apical level (S3)	1.13 ± 0.13	0.98 ± 0.08	-0.15 ± 0.14	3.50	0.007
Mandibular right lateral incisor (42):					
Crestal level (S1)	0.49 ± 0.12	0.18 ± 0.06	-0.31 ± 0.15	6.43	<0.001
Mid root level (S2)	0.72 ± 0.10	0.60 ± 0.08	-0.12 ± 0.15	2.57	0.030
Apical level (S3)	1.03 ± 0.12	0.94 ± 0.07	-0.09 ± 0.10	2.86	0.019
Mandibular left central incisor (31):					
Crestal level (S1)	0.50 ± 0.08	0.24 ± 0.08	-0.26 ± 0.13	6.09	<0.001
Mid root level (S2)	0.65 ± 0.05	0.59 ± 0.10	-0.06 ± 0.12	1.62	0.141
Apical level (S3)	1.13 ± 0.09	0.87 ± 0.07	-0.26 ± 0.12	7.01	<0.001
Mandibular left lateral incisor (32):					
Crestal level (S1)	0.47 ± 0.12	0.16 ± 0.07	-0.31 ± 0.09	11.20	<0.001
Mid root level (S2)	0.64 ± 0.10	0.66 ± 0.05	0.02 ± 0.09	0.69	0.509
Apical level (S3)	1.15 ± 0.10	0.97 ± 0.07	-0.18 ± 0.11	5.01	0.001
*- p<0.05, **- p<0.01, ***- p<0.001					

Table-2(a): Comparison of mean mandibular labial alveolar bone thickness (mm) at Pre (T_0) and Post treatment (T_1) (Mean ± SD, n=10)

Tooth/Levels	Pre (T_0)	Post (T_1)	Mean change (Post-Pre)	t value	p value
Mandibular right central incisor (41):					
Crestal level (S1)	0.84 ± 0.10	0.30 ± 0.11	-0.54 ± 0.11	15.89	<0.001
Mid root level (S2)	1.07 ± 0.11	0.55 ± 0.07	-0.52 ± 0.12	13.38	<0.001
Apical level (S3)	1.26 ± 0.11	1.02 ± 0.08	-0.24 ± 0.12	6.47	<0.001
Mandibular right lateral incisor (42):					
Crestal level (S1)	0.73 ± 0.08	0.22 ± 0.09	-0.51 ± 0.10	16.22	<0.001
Mid root level (S2)	0.98 ± 0.11	0.57 ± 0.05	-0.41 ± 0.12	10.83	<0.001
Apical level (S3)	1.25 ± 0.08	0.93 ± 0.07	-0.32 ± 0.09	11.01	<0.001
Mandibular left central incisor (31):					
Crestal level (S1)	0.84 ± 0.11	0.29 ± 0.10	-0.55 ± 0.08	20.47	<0.001
Mid root level (S2)	0.89 ± 0.07	0.52 ± 0.08	-0.37 ± 0.11	11.04	<0.001
Apical level (S3)	1.32 ± 1.09	1.04 ± 0.07	-0.28 ± 0.08	11.22	<0.001
Mandibular left lateral incisor (32):					
Crestal level (S1)	0.78 ± 0.09	0.18 ± 0.11	-0.60 ± 0.11	18.00	<0.001
Mid root level (S2)	1.01 ± 0.12	0.53 ± 0.07	-0.48 ± 0.12	12.35	<0.001
Apical level (S3)	1.30 ± 0.07	1.07 ± 0.07	-0.23 ± 0.08	8.84	<0.001
*- p<0.05, **- p<0.01, ***- p<0.001					

Table-2(b): Comparison of mean mandibular lingual alveolar bone thickness (mm) at Pre (T_0) and Post treatment (T_1) (Mean ± SD, n=10)

Tooth/Levels	Pre (T_0)	Post (T_1)	Mean change (Post-Pre)	t value	p value
Mandibular right central incisor (41):					
Crestal level (S1)	5.29 ± 0.19	4.45 ± 0.15	-0.80 ± 0.12	21.91	<0.001
Mid root level (S2)	4.63 ± 0.15	4.18 ± 0.08	-0.45 ± 0.15	9.43	<0.001
Apical level (S3)	4.40 ± 0.24	4.22 ± 0.12	-0.18 ± 0.25	2.25	0.051
Mandibular right lateral incisor (42):					
Crestal level (S1)	5.14 ± 0.20	4.37 ± 0.23	-0.77 ± 0.25	9.75	<0.001
Mid root level (S2)	4.63 ± 0.18	4.22 ± 0.09	-0.41 ± 0.21	6.08	<0.001
Apical level (S3)	4.45 ± 0.08	4.15 ± 0.07	-0.30 ± 0.08	11.62	<0.001
Mandibular left central incisor (31):					
Crestal level (S1)	5.20 ± 0.24	4.51 ± 0.16	-0.69 ± 0.22	9.99	<0.001
Mid root level (S2)	4.75 ± 0.11	4.28 ± 0.12	-0.47 ± 0.13	11.11	<0.001
Apical level (S3)	4.57 ± 0.20	4.18 ± 0.13	-0.39 ± 0.12	10.30	<0.001
Mandibular left lateral incisor (32):					
Crestal level (S1)	5.21 ± 0.13	4.42 ± 0.10	-0.79 ± 0.16	15.66	<0.001
Mid root level (S2)	4.64 ± 0.13	4.19 ± 0.06	-0.45 ± 0.12	12.07	<0.001
Apical level (S3)	4.42 ± 0.19	4.17 ± 0.11	-0.25 ± 0.18	4.44	0.002
*- p<0.05, **- p<0.01, ***- p<0.001					

Table-2(c): Comparison of mean mandibular total alveolar bone thickness (mm) at Pre (T_0) and Post treatment (T_1) (Mean ± SD, n=10)

Change in inclination (degree)	Pre (T_0)	Post (T_1)	Mean change (Post-Pre)	W value	P value
U1-PP	56.45 ± 6.00	74.55 ± 9.23	19.90 ± 5.76	55.00	0.002
L1-MP	102.75 ± 4.60	89.35 ± 2.33	-13.40 ± 4.05	55.00	0.002
*- p<0.05, **- p<0.01, ***- p<0.001					

Table 3: Comparison of change in inclination (Mean ± S.D.) of maxillary and mandibular incisors at Pre (T_0) and Post treatment (T_1)

in the alveolar housing. This kind of tooth movement is known as ''with-the-bone.'' However, if balance between resorption and apposition of the alveolar bone is not established during tooth movement, the tooth will move out of the alveolar housing, which is referred to as ''through-the-bone.''[13]

Several studies have indicated a lag in bone remodeling in response to tooth movement and reported that as the upper incisors are retracted, labial bone thickness at the crestal level and total alveolar bone thickness at the apical level significantly increase.[1] This finding disputes that of De Angelis, who presented the bending capacity of alveolar bone suggesting that highly synchronized, coordinated changes are triggered during tooth movement and the alveolar bone retains its structural characteristics and size as it moves due to coordinated apposition and resorption.[14]

A total of 10 maxillary and 10 mandibular arches which fulfilled the inclusion criteria were taken in the study. The sample consisted of 9 female patients and 1 male patient for maxillary arch and 8 females and 2 male patients for mandibular arch. Both maxillary and mandibular groups were age matched and thus were comparable.

Tian-Min Xu et al[15] stated that en masse retraction is an effective procedure as two step retraction technique is more time consuming and it also results in formation of unaesthetic spaces distal to the lateral incisor teeth.

The loop mechanics used was designed to control tooth movement with known moment to force ratios and was also designed to aim at optimal biologic response by delivering relatively constant forces at an optimal magnitude as suggested by Burstone[11] and Xia et al.[16]

In the mandibular arch the enmasse retraction was carried out using a closed coil spring. Samuels RHA[17], Dixon V et al[18], Barlow M et al[19] found in their study that coil spring produce a faster rate of retraction compared to modules and elastics and active ligatures.

The results obtained in present study demonstrated significant decrease in the maxillary labial alveolar bone thickness at crestal level in all teeth. Studies conducted by Vardimon et al[4] and Sarikaya et al[5] supported the decrease in maxillary labial alveolar bone thickness at crestal level though the decrease was statistically not significant while in contrast to this a study conducted by Yodthong et al[1] suggested a significant increase in labial alveolar bone at crestal level.

In the current study the maxillary labial alveolar bone thickness at mid root and apical level showed a statistically significant increase in thickness. This was in accordance with the studies conducted by Sarikaya et al[5], Ahn et al[20], Vardimon et al[4] and Yodthong et al.[1]

The maxillary palatal alveolar bone thickness showed a statistically significant decrease in all the four incisors at all the three levels. This was in accordance with the studies conducted by Sarikaya et al[5], Ahn et al[20] and Nayak et al.[21]

The maxillary total alveolar bone thickness reduced significantly at crestal level for all the four incisors and at mid root level for right central incisor, while it showed a significant increase at apical level for right central and lateral incisor and a non significant increase for right lateral, left central and left lateral incisor at mid root level and left central and lateral incisor at apical level. The result was in accordance with that of Yodthong et al[1] who had also reported significant increase in total alveolar bone thickness at apical level.

The mandibular labial alveolar bone thickness reduced significantly at crestal and apical level for all teeth. It also reduced significantly for right central and lateral incisors and reduced non significantly for left central incisor at mid root level. Other studies conducted by Sarikaya et al[5] and Nayak et al[21] were in agreement with the result obtained in present study while a study conducted by Bimstein et al[22] opposed the results.

The mandibular lingual alveolar bone thickness reduced significantly for all the four incisors at all the three levels. This was in accordance with the results obtained by Sarikaya et al.[5] On the other hand Nayak et al[21] also reported decrease in the mandibular lingual alveolar bone width at crest level but the changes were variable at mid root and apical level.

The total alveolar bone thickness in the mandibular arch showed a significant decrease in all the teeth at all levels except right central incisor at apical level where the decrease was statistically not significant. Nayak et al[21] reported that mandibular alveolar bone thickness did not remain the same. There was a 1mm of reduced thickness of alveolar bone from pre treatment to post treatment. The present study also report reduced thickness of mandibular total alveolar bone ranging from 0.18 ± 0.25 to 0.80 ± 0.32.

The distance of the incisal edge of maxillary and mandibular incisors from the pterygoid vertical was larger than that of distance between cervical margins of maxillary and mandibular incisors to the pterygoid vertical. So the resulting movement achieved was a controlled tipping.

In the present study, alveolar bone loss was more evident at the marginal and midroot regions than it was at the apical region. It may be because the movement was mostly controlled tipping. The retraction forces applied to the incisors were concentrated at the alveolar crest, leading to greater accumulation of force in the marginal region. The reason for the significant decrease of bone at crestal level could also be attributed to the inflammatory periodontal response concentrated in the cervical area.

The increase in the alveolar bone thickness in maxillary labial aspect was lesser compared to the decrease on the maxillary palatal alveolar bone thickness at the mid root level. This suggests that the rate of deposition of bone is slower than the rate of resorption on the pressure side. The same was suggested by Sarikaya et al[5] and Ahn et al.[20]

The thickness of the bone lingual to the maxillary lateral incisors decreased more than the thickness of the bone lingual to the centrals at mid root level. The reason for this may be that the force applied to the 4 incisors was spread equally among them. In the maxilla, the periodontal ligament area of the central incisors is much larger than the area of the laterals. Consequently, there was more concentrated pressure on the alveolar cortical plate of the maxillary laterals, leading to a greater reduction in the thickness of the cortical plate lingual to these teeth.

The total alveolar bone thickness reduced in mandibular arch. This suggests that there is a lag in bone remodelling process as is suggested by Sarikaya et al[5], Bimstein et al[22], and Vardimon et al.[4]

CONCLUSION

After anterior retraction the maxillary labial alveolar bone thickness was found to be reduced at crest level and was found to be increased at mid root and apical level. The maxillary palatal alveolar bone thickness was found to be reduced at all the three levels. The maxillary total alveolar bone thickness showed a significant decrease in thickness at crestal level for all teeth while change in thickness was variable and statistically insignificant at mid root and apical level. After anterior retraction mandibular labial, lingual as well as total alveolar bone thickness was found to be reduced at all the three levels i.e, crestal, mid root and apical level for all the four incisors. Inclination of upper and lower incisors were found to be in the normal range after anterior retraction.

Future Scope

As this was a cross sectional study, the changes in alveolar width was observed at one point of time. Thus the observation of complete process of bone remodelling was beyond the scope of this study design. So a further longitudinal study following up the patients is advised in order to understand the exact remodelling process.

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