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An evaluation of the impact of En-masse retraction on root resorption and vertical alveolar bone level using cone-beam computed tomography

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Abstract
The purpose of this study is to compare the CBCT images before and after en-masse retraction in patients with class II division 1 to evaluate the effect of en-masse retraction on the height of alveolar bone and the external apical root resorption. The sample consisted of 15 adult patients with class II division 1 (9 females and 6 males, mean ages of 20.82±2.01) treated with extraction of the first premolars and non-sliding mechanics using metal power arms. CBCT images for each subject were taken before and after en-masse retraction to evaluate external apical root resorption (EARR) and vertical alveolar bone level (VABL). Paired-sample t-tests were used to determine if there were any differences in EARR and VABL before and after en-masse retraction. There was significant root resorption for all teeth during en-masse retraction and significant difference in vertical alveolar bone level on palatal side just for upper incisor teeth. In contrast, there was no significant difference in alveolar bone level on labial side.

Keywords: Root resorption, En-masse retraction, alveolar bone

Introduction

Root resorption is a popular occurrence in orthodontic treatment. Histological studies have shown that 90% of teeth that were subjected to forces from orthodontic showed root resorption (RR). Radiographic studies also showed that about 73% of orthodontically treated teeth were subjected to radical resorption [1].

Since the upper incisors have been affected more frequently than any other tooth [1-3], several studies have been conducted targeting different treatment variables and their impact on the apical root resorption of maxillary anterior teeth. Whereas several studies indicated that resorption of apex of the roots of the upper incisors was greater in cases that required extraction compared to cases that did not require extraction of dental teeth [4, 5]. While other studies did not notice any difference in apical root resorption between the two previous groups [2, 6].

In addition to possibly increasing the risk of apical resorption in cases of upper incisor retraction, the possibility of damage to the periodontal tissues was also indicated. Zachrisson and Alnaes stated in their study that there was a mild loss of attachment and it was significantly greater in patients treated with extraction comparing with non-extraction in Class II cases division 1 [7]. While Alstad and Zachrisson did not notice any statistically significant difference in the periodontal health and gingival status for patients treated by extraction or untreated [8].

Cone beam computed tomography (CBCT) has been common in dentistry as a more accurate technique to diagnose and to get the treatment planning in true 3 dimensions (3D) providing reliable linear measurements in all planes of space rather than enlarged or distorted images [9, 10]. In addition, in conventional radiographs there are some difficulties related to posture of patients and measurement uncertainties associated with asymmetry cases, and these difficulties are not exist in CT images because the cranial orientation doesn't affected on these examinations [10, 11].

CBCT has become more used nowadays, using 3D images to examine the impact of retraction of the six anterior teeth on root resorption and alveolar bone is clinically significant, influencing the treatment plan of these teeth.

The aim of this study is to evaluate the CBCT images before and after en-masse retraction in patients with class II division 1 to determine the effect of en-masse retraction on the alveolar bone height and the apical root resorption.

Materials and Methods

The sample has consisted of 15 adult patients with class II division 1 (9 females and 6 males, mean ages of 20.82±2.01) treated at the Department of Orthodontics, Hama University School of Dentistry. Patients have been treated with extraction of the first premolars and non-sliding mechanics using metal power arms.

Alignment and levelling have been done until working wire 0.021×0.025-inch stainless-steel can get into brackets neutrally without any torque, and the appliance that used in this study was a 0.022-inch straight-wire appliance with MBT prescription (Fig 1).

Fig 1: (Non-sliding mechanics using metal power arms).

Skeletal anchorage by mini screw (1.6 mm diameter and 10 mm length) placed between the maxillary second premolar and first molar was used. En-masse retraction was done immediately after appliance placement by using nickel-titanium closed coil springs to provide consistent retraction force of 165 g according to Ricketts [12].

CBCT images (Full-FOV) were taken for each patient by the same technician using the CS 9300® (Carestream Dental, Atlanta, GA, USA) with a current of 5 mA, a voltage of 85 kV, and an exposure time of [11-12] hours. All CBCT images were stored as DICOM files (Digital Imaging and Communications in Medicine) and then entered into Invivo™ 6 Software (Anatomage, San Jose, CA, USA).

CBCT images for each subject were taken at the following two time points: 1. Before en-masse retraction was initiated (T1). 2. After en -masse retraction was completed (T2). Each CBCT image was orientated by the mid-sagittal plane vertically(N-Ba-ANS) and a horizontal plane perpendicular to the mid-sagittal plane passing through (Or-Po) on the left side (Fig 2).

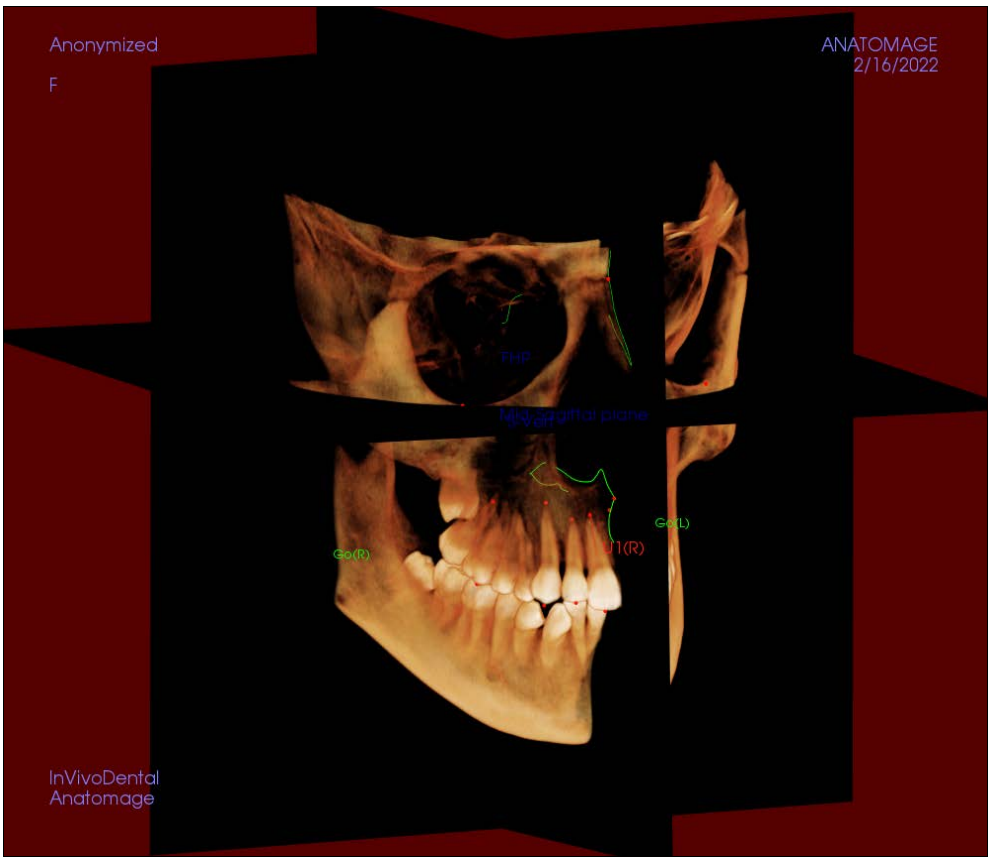

Fig 2: (The orientation of CBCT with the mid-sagittal plane vertically and a horizontal plane perpendicular to the mid-sagittal plane).

To evaluate the amount of root resorption (EARR), sagittal slices were taken that were parallel to the long axis (par-to-LA) of the upper anterior teeth and passed through the center of each (Fig 3). Length of teeth was measured from the incisal edge (IE) to the apical root that was parallel to the long axis of each tooth (Fig 5). These measurements were done before retraction T1 and after retraction T2. The value of EARR was obtained by subtracting the tooth length in T2 from the tooth length in T1.

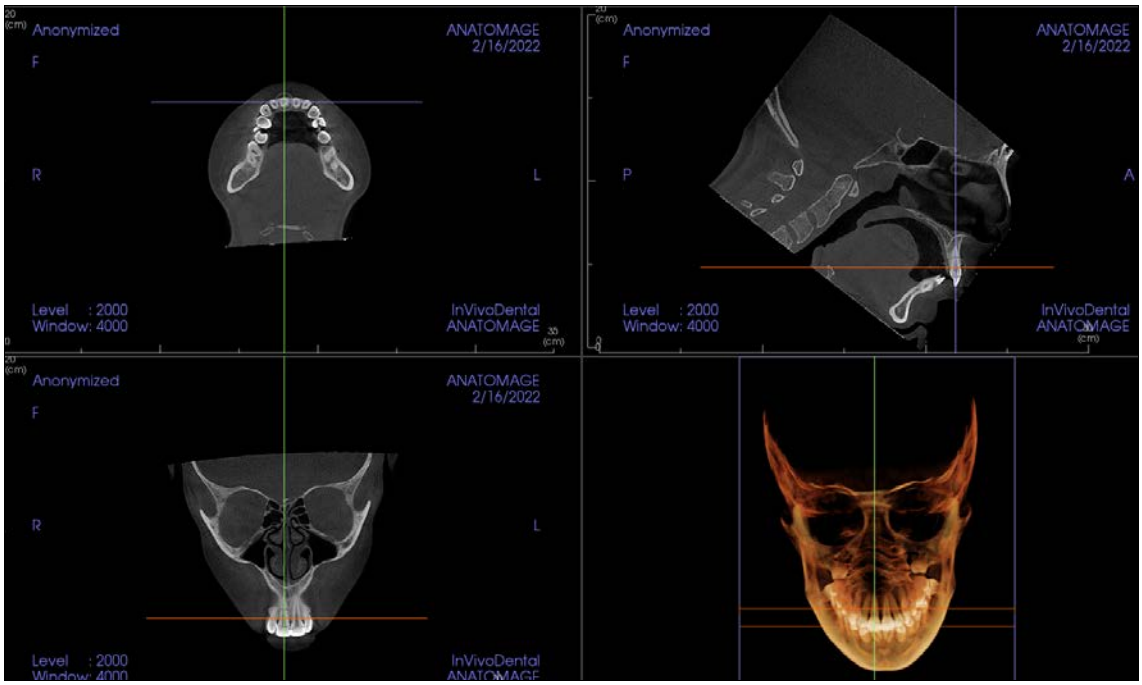

Fig 3: (Sagittal slices parallel to the long axis (par-to-LA) of the six anterior teeth through the center of each root).

Vertical alveolar bone level (VABL) has been evaluated both on the labial and palatal sides of the six anterior teeth. Sagittal slices were taken that were perpendicular to FH and passed through the center of each (Fig 4). All sagittal slices have been reorientated to facilitate the measurement while keeping all planes the same. The VABL have been measured from the apex of the alveolar Crest (AC) to the incisal edge, or the apex of the canine and that was parallel to the longitudinal axis of the teeth (AC-IE).

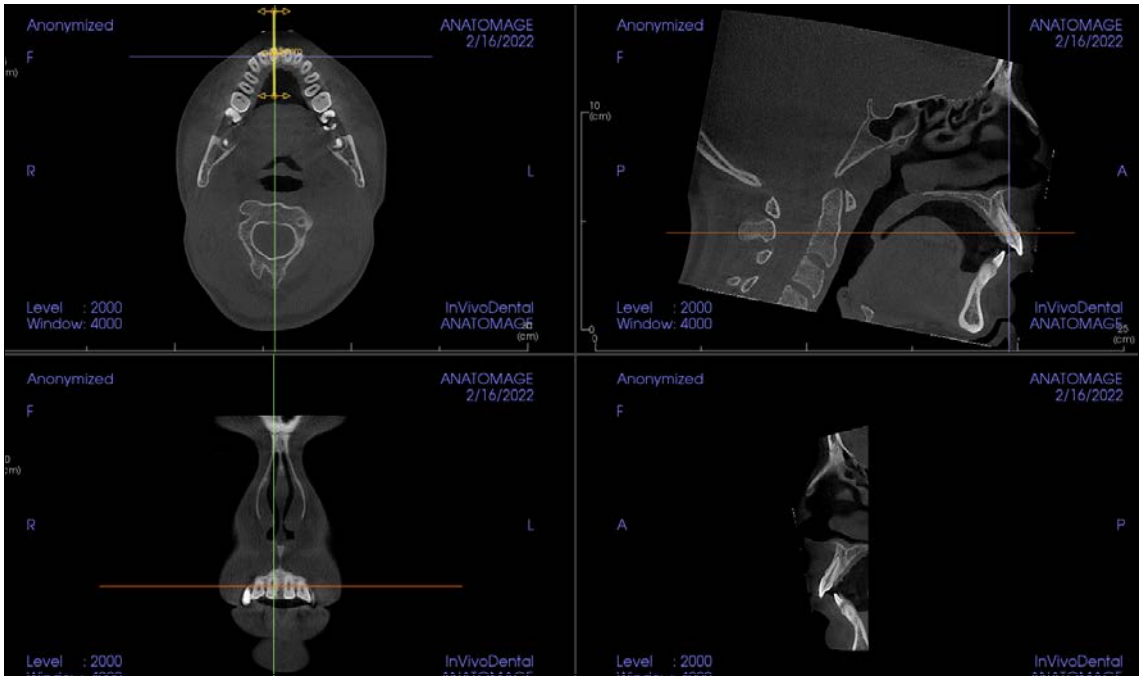

Fig 4: (Sagittal slice, perpendicular to FH, through the center of each root).

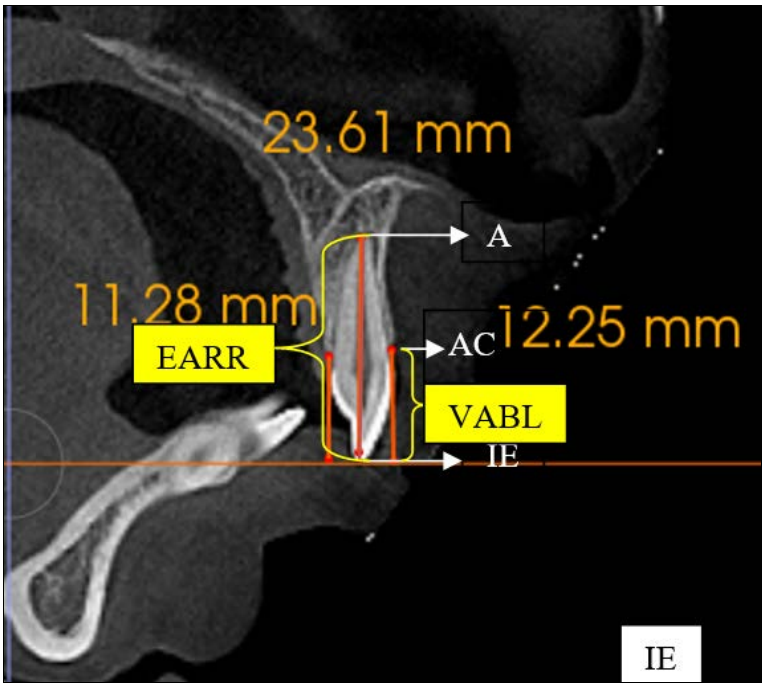

Fig 5: (A: apex of root; IE: Incisal Edge; AC: Alveolar Crest; EARR: External Apical Root Resorption; VABL: Vertical Alveolar Bone Level).

The data were analyzed using Spss (version 22.0; SPSS Inc., Chicago, IL, USA). Paired t-test was used to assess the change in tooth length and vertical alveolar bone level before and after en-masse. The significance level was at 0.05.

Results

Table 1 showed the mean teeth length before and after en-masse retraction a in each group of teeth in our sample (Table 1). There was a significant root resorption (p>0.05) in all different teeth.

Table 1: Comparison of external Apical Root Resorption before and after en-masse retraction

	Right side		P-value	Left side		P-value
	Mean	SD	T1vsT2	Mean	SD	T1vsT2
EARR-U1			**External Apical Root Resorption of Upper Central Incisor**			
TI	22.03	1.27	.031	22.17	1.29	.018
T2	21.23	1.21		21.34	1.18	
T2-T1	0.80	0.47		0.82	0.58	
EARR-U2			**External Apical Root Resorption of Upper Lateral Incisor**			
TI	21.58	0.91	.039	21.27	1.38	.038
T2	19.84	0.93		19.92	1.28	
T2-T1	1.74	0.97		1.35	0.99	
EARR-U3			**External Apical Root Resorption of Upper Canine**			
TI	25.55	1.56	.002	25.09	1.33	.040
T2	24.43	1.53		23.78	0.84	
T2-T1	1.35	0.97		1.18	1.05	

It was noticed that there was difference in vertical alveolar bone level on labial side before and after en-masse retraction, but not significant (p>0.05) (Table 2).

Table 2: Table 1: comparison of vertical alveolar bone level on labial side before and after en-masse retraction.

	Right side		P-value	Left side		P-value
	Mean	SD	T1vsT2	Mean	SD	T1vsT2
VABL-U1		**Vertical Alveolar Bone Level of Upper Central Incisor**				
T1	12.19	0.85	.227	12.34	1.02	.106
T2	13.48	4.02		13.46	3.01	
T2-T1	-1.28	3.32		-1.11	2.08	
VABL-U2		**Vertical Alveolar Bone Level of Upper Lateral Incisor**				
T1	10.34	1.10	.144	10.94	1.11	.567
T2	11.42	3.10		11.98	2.29	
T2-T1	-1.08	2.27		-1.04	1.43	
VABL-U3		**Vertical Alveolar Bone Level of Upper Canine**				
T1	13.26	5.29	.221	15.93	6.60	.346
T2	14.94	5.40		16.37	5.14	
T2-T1	-1.67	4.28		-0.43	1.59	

In contrast, there was a significant difference (p<0.05) in reported vertical alveolar bone level on palatal side for incisors before and after en-masse retraction. i.e., there was a significant resorption of bone on this area. However, this difference was not significant in canines' area (Table 3).

Table 3: Comparison of vertical alveolar bone level on palatal side before and after en-masse retraction.

	Right side		P-value T1vsT2	Left side		P-value T1vsT2
	Mean	SD		Mean	SD	
VABLi-U1			**Vertical Alveolar Bone Level of Upper Central Incisor**			
T1	11.51	1.45	<.001	12.32	0.91	.001
T2	13.48	4.02		15.85	2.29	
T2-T1	-5.01	3.25		-3.53	1.94	
VABLi-U2			**Vertical Alveolar Bone Level of Upper Lateral Incisor**			
T1	12.17	2.81	.003	14.04	4.09	.002
T2	15.95	3.24		16.17	3.34	
T2-T1	-3.53	2.52		-2.13	1.61	
VABLi-U3			**Vertical Alveolar Bone Level of Upper Canine**			
T1	11.80	1.94	.200	11.74	0.94	.251
T2	12.37	1.59		12.01	0.32	
T2-T1	-.57	0.84		-0.27	0.73	

Discussion

Studies have indicated that over-retraction of six anterior teeth leads to therapeutic results such as resorption of root, alveolar bone losing, dehiscence, fenestration and gingival recession [13]. Thus, morphological assessment of the alveolar bone and the roots of teeth after en-masse retraction may be useful to get information about the therapeutic limitations of teeth movement in orthodontic treatment.

The results of our study have showed that there was a significant difference in root length before and after en-masse retraction for all teeth and these differences had a positive value indicating the presence of root resorption of 0.81 mm for central incisors, 1.54 for lateral incisors, and 1.26 for canines. This result was agree with Marques *et al* who reported root resorption of 1.37 mm in cases of Class II model treated with extraction of the first premolars [14]. Liou *et al* stated that there was more root resorption for upper incisors than our results, reaching 2.5 mm with skeletal anchorage and 2.1 mm with conventional anchorage. This difference possibly due to the total length of treatment which lasted 28 months or using 250 g retraction force with 100 gr intrusion force [15]. Also, Simplício *et al* demonstrated the incidence of root resorption for all incisors (1.51-2.37 mm) after retraction using closing loops and retraction force of 300-350 gr. They denied any relationship between root resorption, apical movement, and axial inclination of these teeth [6].

There were no significant changes in the alveolar bone level on labial side, despite the stress forces concentrated in the cervical region resulting from the dental movement that occurred during en-masse retraction, which should lead to apposition of bone at the edge of the alveolar bone. In contrast, Ahn *et al* and Turk *et al* reported apposition of bone at the edge of the bone at the edge of the alveolar bone on labial side [16, 17]. Sarikaya *et al* indicated in their study of incisor retraction that changes in the alveolar bone on the labial side were so small that they could be attributed to measurement error [13].

Significant differences appeared in vertical alveolar bone level on palatal side, and it was of negative value, which indicated presence of resorption of the alveolar bone Hight for all teeth except canines' area. It was on average 4.27 for central incisors and 2.83 for lateral incisors). These results agreed with the study of Ahn *et al*, in which he indicated that bone loss occurred in the cervical region on the palatal side for both the central and lateral teeth (78%-80%) explaining that in controlled tipping movement of anterior teeth during retraction, a large accumulation of pressure occurs in the region of the crest of the alveolar bone on the palatal side [16]. Sarikaya *et al* also indicated that bone loss in the cervical region on both sides is inevitable, especially on palatal side despite waiting time of three months after retraction completed to get a CT scan to allow the osteoblasts to perform the repair in the event of any repair [13]. Park *et al* did not find any resorption in the bone or roots on the panoramic image of a patient treated with the double J retractor [18].

Also, it was observed that less resorption in the alveolar bone on the palatal side of the canines compared to the incisors. This could be explained by the difference between the direction of movement of the canines during retraction and the longitudinal axis of these teeth according to which the sagittal section was performed, and this is what Ahn *et al* also found in their study. They recorded a resorption of 1.2 mm in the canine region, compared to 2.35-2.9 mm in the central and lateral incisors [16].

Conclusion

1. Root resorption happens in all anterior teeth after en-masse retraction.
2. Vertical alveolar bone level in palatal side was significantly decreased after en- masse retraction just for upper incisors.
3. Also, on labial side vertical alveolar bone level decreased but not significant for all teeth after en- masse retraction.

Conflict of Interest

Not available

Financial Support

Not available

References

1. Weltman B, Vig KW, Fields HW, Shanker S, Kaizar EE. Root resorption associated with orthodontic tooth movement: a systematic review. American journal of orthodontics and dentofacial orthopedics. 2010;137(4):462-76.
2. Parker RJ, Harris EF. Directions of orthodontic tooth movements associated with external apical root resorption of the maxillary central incisor. American Journal of Orthodontics and Dentofacial Orthopedics. 1998;114(6):677-83.
3. Sharpe W, Reed B, Subtelny JD, Polson A. Orthodontic

relapse, apical root resorption, and crestal alveolar bone levels. American Journal of Orthodontics and Dentofacial Orthopedics. 1987;91(3):252-8.
4. Sameshima GT, Sinclair PM. Predicting and preventing root resorption: Part II. Treatment factors. American Journal of Orthodontics and Dentofacial Orthopedics. 2001;119(5):511-5.
5. Baumrind S, Korn EL, Boyd RL. Apical root resorption in orthodontically treated adults. American Journal of Orthodontics and Dentofacial Orthopedics. 1996;110(3):311-20.
6. Simplício H, Da Silva JSP, Fernandes Rabelo Caldas SG, Dos Santos-Pinto A. External apical root resorption in retracted incisors. Orthodontics-the Art and Practice of Dentofacial Enhancement. 2012;13:86.
7. Zachrisson BU, Alnaes L. Periodontal condition in orthodontically treated and untreated individuals I. Loss of attachment, gingival pocket depth and clinical crown height. The Angle Orthodontist. 1973;43(4):402-11.
8. Alstad S, Zachrisson BU. Longitudinal study of periodontal condition associated with orthodontic treatment in adolescents. American Journal of Orthodontics. 1979;76(3):277-86.
9. Ballrick JW, Palomo JM, Ruch E, Amberman BD, Hans MG. Image distortion and spatial resolution of a commercially available cone-beam computed tomography machine. American Journal of Orthodontics and Dentofacial Orthopedics. 2008;134(4):573-82.
10. Berco M, Rigali Jr PH, Miner RM, DeLuca S, Anderson NK, Will LA. Accuracy and reliability of linear cephalometric measurements from cone-beam computed tomography scans of a dry human skull. American Journal of Orthodontics and Dentofacial Orthopedics. 2009;136(1):17, e1-e9.
11. Ludlow JB, Laster WS, See M, Bailey LTJ, Hershey HG. Accuracy of measurements of mandibular anatomy in cone beam computed tomography images. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2007;103(4):534-42.
12. Ricketts RM. Bioprogressive therapy. Denver; c1979.
13. Sarikaya S, Haydar B, Ciğer S, Ariyürek M. Changes in alveolar bone thickness due to retraction of anterior teeth. American Journal of Orthodontics and Dentofacial Orthopedics. 2002;122(1):15-26.
14. Marques LS, Ramos-Jorge ML, Rey AC, Armond MC, De Oliveira Ruellas AC. Severe root resorption in orthodontic patients treated with the edgewise method: prevalence and predictive factors. American journal of orthodontics and Dentofacial Orthopedics. 2010;137(3):384-8.
15. Liou EJ, Chang PM. Apical root resorption in orthodontic patients with en-masse maxillary anterior retraction and intrusion with Miniscrews. American Journal of Orthodontics and Dentofacial Orthopedics. 2010;137(2):207-12.
16. Ahn HW, Moon SC, Baek SH. 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. The Angle Orthodontist. 2013;83(2):212-21.
17. Türk T, Elekdag-Türk S, Dinçer M. Clinical evaluation of the centre of resistance of the upper incisors during retraction. The European Journal of Orthodontics. 2005;27(2):196-201.
18. Park JH, Tai K, Takagi M, Miyajima K, Kojima Y, Joo BH. Esthetic orthodontic treatment with a double J retractor and temporary anchorage devices. American journal of orthodontics and Dentofacial Orthopedics. 2012;141(6):796-805.

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