Original Article

Evaluation of Morphometric Changes on Mandibular Incisor Roots by Various Intrusion Techniques – A CBCT Study

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Abstract

Background: Deep bite treatment can be done by the intrusion of incisor teeth, extrusion of posterior teeth or combination of both, up righting of posteriors or flaring of anterior teeth3.Intrusion of incisors is a preferred method to treat deep bite in many patients because it is a stable treatment and it doesn't affect the vertical dimension of face. Also, situations including elongated incisors with gummy smile could be better much better treated by incisor intrusion. Treatment of deep bite by intrusion consists of different techniques like K-SIR, j-headgear, RCS, Ricketts utility arch, Burstone arch, Connecticut intrusion arch, vertical loops, implants and three-piece arch2. **Materials and Methods:** A total of 30 patients who were undergone orthodontic treatment were randomly selected for the study in 3 groups of 10 each. The pre and post CBCT of lower incisor intrusion of the patient was taken to measure the root resorption of different methods. **Results:** Result were tabulated and statistically formulated as per standard protocol. Result will be tabulated and statically analyzed. The mean value and standard deviation (SD) will be calculated for every variable will be measured in 3D models. Paired t-test will be performed to compare the values in the T1 and T2 stages. One-way analysis of variance (ANOVA) with Duncan's multiple comparison test will be performed to assess the differences in the amount (T1-T2, ΔT) and ratio (ΔT/T1) of changes in the root length. In multiple comparisons, the mandibular anterior teeth are allocated into group 1 (mandibular central incisors) and group 2 (mandibular lateral incisors). **Conclusion:** The present study indicates that when the same intrusion force was applied with the 4 maxillary anterior teeth being intruded as a segment either with a base-arch or miniscrews, the degree of labial tilting and intrusion of the anterior teeth increased in both treatment groups, and to a greater extent in the miniscrew group. The degree of labial alveolar bone thickness and bone height decrease were also greater in the miniscrew group. The degree of change in labial inclination and intrusion should be taken into account during upper incisor intrusion, as these factors may increase the risk of alveolar bone loss.

Keywords: Deep bite, Intrusion, Mini screw, Utility arch, RCS arch, CBCT, Lower incisor intrusion

Introduction

Deep bite is considered as one of the most frequent malocclusions in adults[1] that is very difficult to treat and also to retain. Deep bite is a condition when maxillary incisor excessively overlaps the mandibular incisor when the mandible is brought into centric or habitual position.[2] Deep bite is present in 21–26% in normal people and 75% in the orthodontic patient.[3]

Most common factors that are responsible for the development of deep bite are diminished vertical skeletal growth, vertical positions of teeth, axial inclination of anterior teeth, and periodontal breakdown.[3]

Detrimental effects of deep bite include palatal impingement, incisal wear, gingival recession, and unesthetic appearance. Deep bite treatment can be done by the intrusion of incisor teeth, extrusion of posterior teeth or combination of both, uprighting of posteriors or flaring of anterior teeth.[3] Intrusion of incisors is a preferred method to treat deep bite in many patients because it is a stable treatment and it does not affect the vertical dimension of face. Furthermore, situations including elongated incisors with gummy smile could be better much better treated by incisor intrusion. Treatment of deep bite by intrusion consists of different techniques such as K-SIR, j-headgear, reverse curve of Spee (RCS), Ricketts utility arch, Burstone arch, connecticut intrusion arch, vertical loops, implants, and three-piece arch.[2]

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During the treatment of deep bite, we see several side effects of different techniques. Apical root shortening is a common side effect during all orthodontic treatment including intrusion because the apical area of the tooth bears the highest concentration of force as it is the surface which faces the movement direction during the intrusion.[4]

Patients seeking orthodontic treatment usually desire to change facial features which are important in establishing confidence and improving quality of life. Recent universalization of the temporary anchorage devices (TADs) and mini-plates has led to more stable and esthetic facial improvements through skeletal anchorage in orthodontic treatment. However, if there is excessive lingual inclination of anterior teeth as a result of putting too much emphasis on the esthetic aspect without considering the alveolar bone remodeling response following orthodontic tooth movement, unwanted iatrogenic sequelae such as root resorption, alveolar bone loss, and fenestration, dehiscence, and gingival recession would likely occur.[5]

Orthodontic tooth movement is a process where application of a force induces bone resorption on the pressure side and bone apposition on the tension side. However, there is evidence that this premise does not hold true in the anterior region. The excessive force causing fenestration and dehiscence might lead to alveolar bone loss.[6]

Commonly used diagnostic radiographs such as lateral cephalographs are ineffective in assessing three-dimensional bone levels and root morphology due to projection errors, superimposition, and magnification errors and also fails to represent the complex curving structures of tooth- alveolar complex.[7]

Three-dimensional analysis of specific regions by cone-beam computed tomography (CBCT) is a better method for accessing bony architecture or quantifying bone volume at a low radiation dose, and expenses; ensuring reliable and anatomically accurate measurements. CBCT has made it possible to qualitatively and quantitatively evaluate the height, thickness of the alveolar bone and the length and thickness of the root.[8]

Because it is difficult to select which is a better method for the intrusion of incisors, purpose of this study to compare the amount of root resorption by CBCT in mandibular incisors, achieved by three most commonly used technique: Ricketts utility arch, RCS arch, and mini screw implant.

Materials and Methods

Study type

Clinical prospective experimental.

Study design

Simple random sampling of the patient from the outpatient department of orthodontics and dentofacial orthopedics of the institute will be done for the period of 12 months (i.e., April 2021–April 2022).

1. Based on clinical examination patients fulfilling the inclusion criteria of the study (age - 13–35 years, skeletal and dental deep bite, Angles Class 1 and Angles Class 2) will be segregated with a signed consent form explaining about the study will be obtained from all patients
2. CBCT before intrusion treatment (T1) of the patient will be taken. Those patients who are not fit for CBCT scan will be further excluded from the study
3. With the commencement of the intrusion treatment the patient will be called for monthly follow up for their treatment. After the mandibular incisor intrusion, CBCT scans of the anterior teeth will be again taken (T2)
4. Comparison of the amount of root resorption between T1 and T2 stages in each tooth, that is, mandibular central incisor, mandibular lateral incisor (Area: Apical) will be done
5. After that statistical analysis will be performed and the result, the conclusion will be drawn.

Source of data

CBCT of patients undergoing orthodontic treatment in the department of orthodontics and dentofacial orthopedics, People’s College of Dental Sciences and Research Centre, Bhanpur, Bhopal (M.P.).

Participant size

30 orthodontic patients.

Study variables

1. Age of the patient
2. Gender of the patient
3. The skeletal growth pattern of patient
4. Labial and lingual bone loss
5. Root resorption of different teeth.

Inclusion criteria

The following criteria were included in the study:

1. Angles Class 1 and Class 2 malocclusion
2. Skeletal and dental deep bite
3. Patient with mean age 13–35 years
4. Patients with no other systemic illness or without taking any medication
5. Patient who agreed to provide signed consent were included in the study.

Exclusion criteria

The following criteria were excluded from the study:

1. Patient with periodontal problem
2. Unfavorable growth pattern
3. Patient with severe crowding
4. Patient requires intrusion of the upper incisors
5. Hypodivergent or hyperdivergent growth cases
6. Patient with systemic illness or on any type of medication
7. A patient who did not agree to provide signed consent.

Apparatus and materials

1. 3 D scaled images of 4 mandibular teeth (MNCI, MNLI)
2. Will be acquired using a CBCT scanner CS 8100 3D with the resolution of 75 microns
3. The scanning parameter of 90Kv 2.50Ma
4. The scan time 15 s
5. The CBCT data were transferred to Carestream (CS) 3D IMAGING software package for statistical analysis.

Precautions

Thyroid collar, lead apron will be given to the patients before taking the CBCT.

1. TAD's of company – Oro
2. Size – 1.2 × 6 mm
3. Site – in the safe zone (e.g., between mandibular lateral incisor and canine).

Data collection procedure

CBCT is taken before treatment (T1) and after incisor intrusion (T2). To set an identical reference plane in the T1 and T2 stage, first, long axis of each mandibular incisor tooth will be set on the sagittal image at the T1 stage. Then the T2 image will be reoriented on the same coordinate axis as the T1 image.

The length of the root of respected teeth measured at the apical level, respectively. The change in length of root length will be calculated.

Statistical analysis

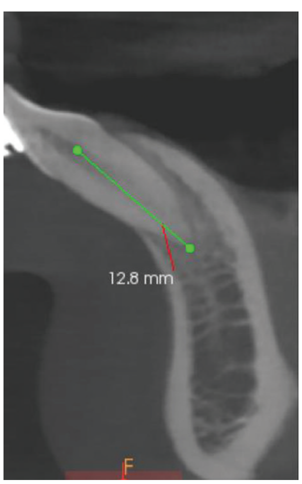
Result will be tabulated and statically analyzed. The mean value and standard deviation (SD) will be calculated for every variable will be measured in 3D models. Paired t-test will be performed to compare the values in the T1 and T2 stages.

One-way analysis of variance with Duncan's multiple comparison tests will be performed to assess the differences in the amount (T1-T2, ΔT) and ratio (ΔT/T1) of changes in the root length.

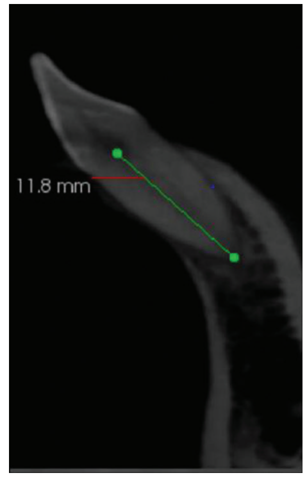
In multiple comparisons, the mandibular anterior teeth are allocated into Group 1 (mandibular central incisors) and Group 2 (mandibular lateral incisors).

The method error (ME) will be calculated as: $ME = \sqrt{(\sum d^2/2n)}$ (d is the deviation between the two measurements; n for the number of paired double measurements).

Cbct analysis with rcs

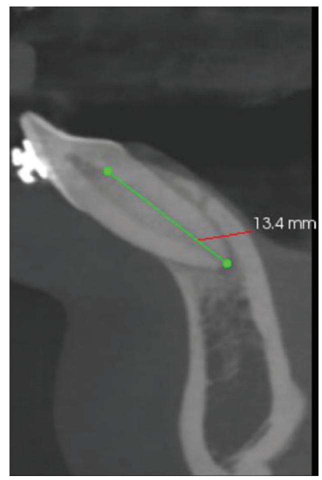


Pre-treatment

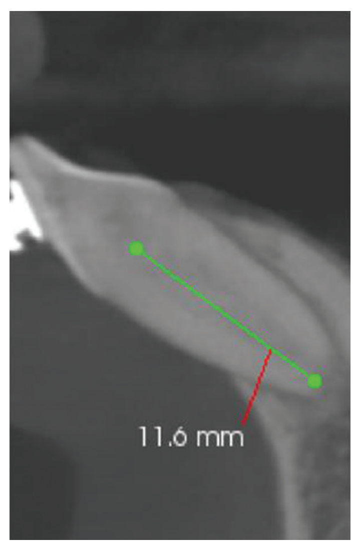


Post-treatment

CBCT analysis with intrusion arch

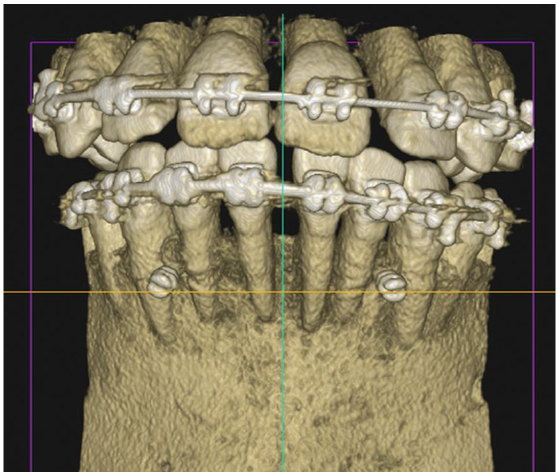


Pre-treatment

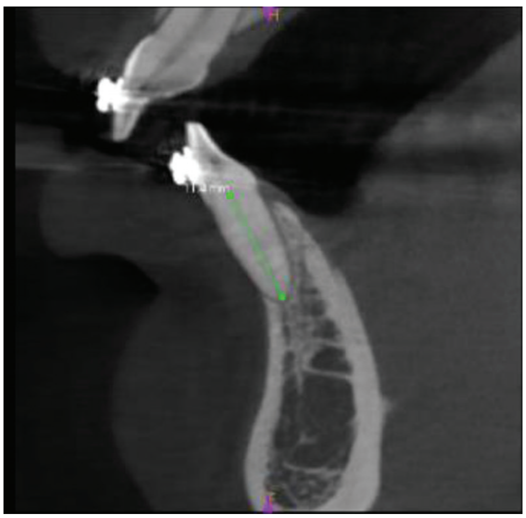


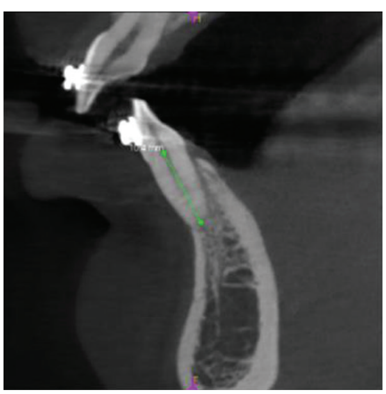
Post-treatment

CBCT analysis with implants



Implant placement





Post treatment

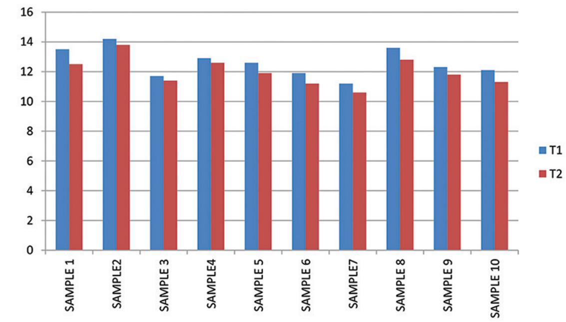
Pre- and post-intrusion measurements with the rcs

Discussion

In orthodontics, the main treatment goals are to maximize the desired tooth movement and to minimize the undesirable side effects on the periodontal structure surrounding the teeth. For

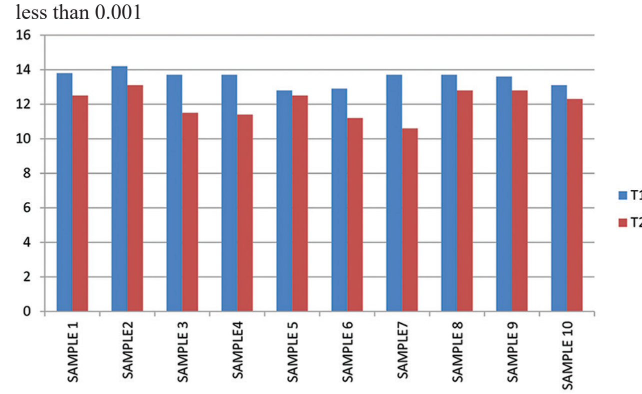
Sample	Pre-treatment (T1) (mm) Mean±SD	Post-treatment (T2) (mm) Mean±SD	Difference (mm) (T2–T1)	*P*-value
1.	13.5±2.3	12.5±2.1	−1	<0.001**
2.	14.2±4.3	13.8±1.2	−0.4	<0.018*
3.	11.7±3.3	11.5±2.1	−0.3	<0.001*
4.	12.9±2.3	11.4±3.2	−0.5	<0.012*
5.	12.6±4.1	12.5±4.2	−0.1	<0.001***
6.	11.9±2.1	11.2±3.2	−0.7	<0.001**
7.	11.2±1.2	10.6±2.1	−0.6	<0.001**
8.	13.6±1.2	12.8±3.2	−0.9	<0.012**
9.	12.3±1.1	11.8±2.1	−0.6	<0.001**
10.	12.1±1.7	11.3±1.1	−0.9	<0.001***

Stars(*) are only intended to flag levels of significance for 3 of the most commonly used levels. ** = p-value is less than 0.01 & *** = p-value is less than 0.001



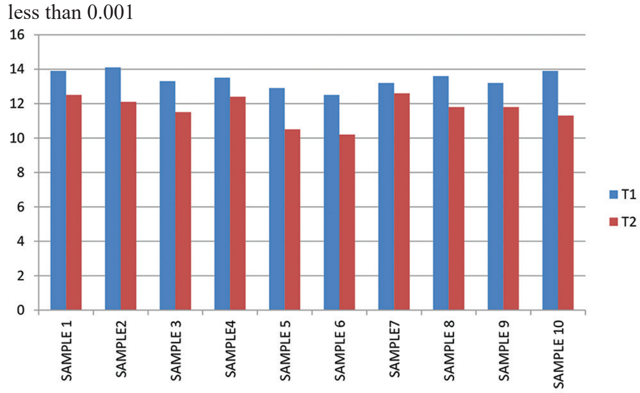
Sample	Pre-treatment (T1) (mm) Mean±SD	Post-treatment (T2) (mm) Mean±SD	Difference (mm) (T2–T1)	*P*-value
1.	13.8±2.3	12.5±2.1	−1.3	<0.001**
2.	14.2±4.3	13.1±1.2	−1.1	<0.018*
3.	13.7±3.3	11.5±2.1	−2.0	<0.001*
4.	13.7±2.3	11.4±3.2	−1.9	<0.012*
5.	12.8±4.1	12.5±4.2	−0.2	<0.001***
6.	12.9±2.1	11.2±3.2	−0.8	<0.000**
7.	13.7±1.2	10.6±2.1	−1.6	<0.001**
8.	13.7±1.2	12.8±3.2	−0.9	<0.013**
9.	13.6±1.1	12.8±2.1	−0.1	<0.001**
10.	13.1±1.7	12.3±1.1	−0.9	<0.001***

Stars(*) are only intended to flag levels of significance for 3 of the most commonly used levels. ** = p-value is less than 0.01 & *** = p-value is less than 0.001

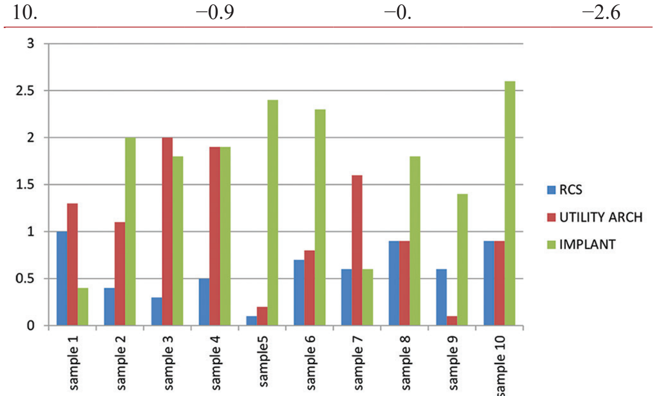


Sample	Pre-treatment (T1) (mm) Mean±SD	Post-treatment (T2) (mm) Mean±SD	Difference (mm) (T2–T1)	*P*-value
1.	13.9±2.3	12.5±2.1	−0.4	<0.001**
2.	14.1±4.3	12.1±1.2	−2.0	<0.018*
3.	13.3±3.3	11.5±2.6	−1.8	<0.001*
4.	13.5±2.3	12.4±3.8	−1.9	<0.012*
5.	12.9±4.0	10.5±4.0	−2.4	<0.001***
6.	12.5±2.1	10.2±3.2	−2.3	<0.001**
7.	13.2±1.2	12.6±2.3	−0.6	<0.001**
8.	13.6±1.8	11.8±3.6	−1.8	<0.012**
9.	13.2±1.5	11.8±2.8	−1.4	<0.001**
10.	13.9±1.3	11.3±1.8	−2.6	<0.001***

Stars(*) are only intended to flag levels of significance for 3 of the most commonly used levels. ** = p-value is less than 0.01 & *** = p-value is less than 0.001



Sample	RCS	Utility arch	Implant
1.	−1	−1.3	−0.4
2.	−0.4	−1.1	−2.0
3.	−0.3	−2.0	−1.8
4.	−0.5	−1.9	−1.9
5.	−0.1	−0.2	−2.4
6.	−0.7	−0.8	−2.3
7.	−0.6	−1.6	−0.6
8.	−0.9	−0.9	−1.8
9.	−0.6	−0.1	−1.4
10.	−0.9	−0.	−2.6



optimal stability of the teeth and periodontal health, alveolar bone support is an important factor to consider in orthodontic treatment. At present, using CBCT images are a highly accurate measuring method for evaluating the alveolar bone dimensions with a high degree of accuracy between direct measurements and CBCT. This retrospective CBCT study was performed to evaluate the alveolar bone loss around the maxillary central incisors that is induced by two different intrusion mechanics (base-arch or miniscrew), after the leveling and aligning stage. We found a statistically significant decrease in labial alveolar bone thickness at the crestal and midroot levels in the miniscrew group (Group II). Significantly greater changes were observed in the miniscrew group than in the base-arch group (Group I), which might be related to greater changes in inclination and intrusion of the maxillary incisors. In the base-arch group, the arch-wire was extended into the molar tube with cinching-back and a gable bend, and these mechanics may play a role in limiting the excessive labial tipping of the anterior teeth. However, in the miniscrew group, segmental archwire, including only the four maxillary incisors, was used, which may be the reason for the greater labial tipping of incisors in the miniscrew group. The biomechanical explanation for the different amounts of incisor intrusion may be related to the use of continuous force (NiTi coil in the miniscrew group) versus a linear decrease of force in the base-arch group. Tian *et al*. showed that lingual-inclined maxillary central incisors had less bony support and a greater frequency of alveolar bone defects than normally inclined maxillary incisors. In the present study, the lingual inclination of the maxillary incisors at the T0 was greater in the miniscrew group, which might be a factor in the greater labial alveolar bone loss in this group. However, our results showed that total alveolar bone thickness did not change, but was maintained in both treatment groups. This suggests that the rate of labial alveolar bone resorption was relatively higher than the rate of apposition on the lingual aspect in the miniscrew group, which may lead to a decrease in the LBT at the crestal level. Similarly, the findings of different studies19, 23–25 showed a significant decrease in bone thickness in the direction of tooth movement. However, Thongudomporn *et al*.[9,10] investigated changes in maxillary alveolar bone thickness after maxillary incisor extrusion and proclination and did not find significant changes in LBT in the direction of tooth movement. In contrast, they found significant changes in palatal and total alveolar bone thicknesses at the mid and apical levels of the root. Kaied and Tanielian[11,12] evaluated the effects of incisor intrusion using segmented and utility arches and found significant decreases in alveolar bone thickness in both treatment groups. However, in the present study, the base-arch group did not show a significant decrease in alveolar bone thickness. The differences between the studies may arise from the different type of biomechanics used, different force magnitudes, and individual response differences in terms of the bone remodeling rate. The results of this study showed that the percentage of dehiscence at the maxillary right and left incisors was significantly greater in the miniscrew group than in the base-arch group; in accordance with this result, the loss of the alveolar crestal height and bone height on the labial side in the miniscrew group was significantly greater than those in the other treatment group. However, clinically, no occurrence of gingival recession was encountered in the miniscrew group. Tooth movements, which decentralize the teeth from the alveolar ridge, may be a critical factor for developing bone dehiscence. In the present study, the upper anterior alveolar bone was subjected to an intrusion force with upward and forward direction, which might lead to concentration of stress and deformation on the labial alveolar ridge crest. Similarly, Bimstein *et al*. indicated that the change in alveolar bone height of protruded mandibular incisors may be influenced by the change in both the inclination and intrusion of the central incisors. However, there is no direct association between buccal movement of the incisors and the occurrence of gingival recession. Our results cannot be arbitrarily extrapolated to the success that can be achieved with other categories of malocclusions such as those characterized by growth patterns. Since our sample size was limited and the results might not be the same with a larger sample size, further investigation is necessary to elucidate the relationship of force, rate of intrusion, and root resorption. The findings of this study seem to emphasize that consideration should be given to treatment time when evaluating the possible occurrence of root shortening. When treatment is prolonged, a continued high degradative activity with osteoclasia causes severe root resorption. Therefore, control of treatment time is of importance in most cases when intrusion of the maxillary incisors is performed.

Conclusion

The null hypothesis of the study was rejected. When the same intrusion force was applied with the 4 maxillary anterior teeth being intruded as a segment either with a base-arch or miniscrews, the degree of labial tilting and intrusion of the anterior teeth increased in both treatment groups, and to a greater extent in the miniscrew group. The degree of labial alveolar bone thickness and bone height decrease was also greater in the miniscrew group. The degree of change in labial inclination and intrusion should be taken into account during upper incisor intrusion, as these factors may increase the risk of alveolar bone loss. The data on morphology of the alveolar bone as analyzed by means of CBCT can guide the orthodontic treatment plan and indicate the limits of tooth movement.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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