Journal of Chemical Health Risks

www.jchr.org

JCHR (2024) 14(3), 1190-1196 | ISSN:2251-6727

Assessment of Bone Thickness in Maxillary Bone After Tooth Movement; Using CBCT Technology

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(Received: 04 February 2024 Revised: 11 March 2024 Accepted: 08 April 2024)

KEYWORDS
Maxillary Bone, CBCT, Tooth Movement

ABSTRACT:

Objective: To determine the changes of the alveolar bone level following intrusion and extrusion orthodontic movement of mandibular incisors.

Material and methods: A total of twenty patients were split into two groups: (I) the extrusion group and (II) the intrusion group. CBCT observations were taken both before and after therapy, and Mimics software was used to quantify the alveolar bone level in each aspect of the mandibular incisors. The acquired data were examined statistically.

Findings: Relative to the mandibular central incisors in group (I), the mandibular lateral incisors displayed a higher amount of alveolar bone loss that was statistically non-significant ($P > 0.05$). Compared to the lingual aspect of the mandibular central incisor (0.70 + 0.13-0.60 + 0.14 correspondingly), the mandibular lateral incisors exhibited a larger and significantly greater loss ($P < 0.05$). The alveolar bone alterations between the mandibular central and lateral incisors were not statistically significant in cohort (II). When the sum of the sites from groups I and II were compared, it was found that group I had a significantly smaller loss ($P < 0.05$) in the mesial portion of the central incisors than the intrusion group (1.26 + 0.29-1.12 + 0.12, correspondingly), whereas group II had a significantly larger loss ($P < 0.05$) in the buccal and lingual side of the central incisors. The distal side of the extrusion category experienced a considerably larger reduction in the alveolar bone level of its lower lateral incisors compared to the intrusion cohort.

Conclusions: In comparison with mandibular central incisors, mandibular lateral incisors displayed more bone loss in the lower lateral incisor, especially in the lingual aspect. Accelerated bone loss in group II's mandibular central incisors' buccal and lingual regions.

Introduction

Anatomical research on dental and maxillofacial bone structures can be done in vivo using CBCT, a cross-sectional high-resolution scanning method. Accurate and reliable linear measurements of tooth and bone structures can also be made thanks to this imaging approach.[1] Technical factors that may vary depending on the CBCT system, such as nominal resolution, clarity of image, voxel size, kV, mA, the amount of basis pictures, field of view (FOV), and the software algorithm used in the acquisition and reconstruction of dimensional evaluations, can impact the accuracy of reorganised CBCT images. In terms of linear measurements, advanced CBCT devices with tiny FOV, narrower focal point, sub-millimeter voxel sizes, and high spatial resolution are thought to be greater in precision. [2]

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Orthodontic movement needs to be effective while causing the least amount of iatrogenic damage to teeth and alveolar bone. Alveolar bone height may be influenced by orthodontic care. The amount of reduction in alveolar bone will rise with the length of the treatments. In addition to causing resorption in the tooth roots, orthodontic therapy additionally leads to the top of the alveolar bone to recede in height.[4]

Yee et al.[3,4] said that light force application is thought to be an assumption of tooth motion in all directions since it did not influence the alveolar bone if the force that was used was kept low and light, which would result in displacement of the tooth, alveolar bone, and cortex bone. Periapical or bite wing x-ray films, which have a number of drawbacks including distortion, difficulty in standardising, and variances in angulations, can help in the evaluation of the alveolar bone height. Assessing alterations in the alveolar bone level following incisor intrusion has not been extensively studied using CBCT.[4] Therefore, the purpose of the research was to review and contrast the modifications in the alveolar bone level following lower incisor intrusion and extrusion.

Methodology

Twenty patients total, ten in each of two groups, participated in the present investigation. Extrusion or intrusion is required for every orthodontic treatment strategy. The following factors were taken into consideration when choosing the candidate: no history of trauma or accident; no orthodontic care received previously; no medication taken within six weeks of the procedure; no signs of serious overcrowding in the mandibular incisor area; sound gingival tissue free of inflammation; probing depths less than 3 mm; and no alveolar bone imperfections or loss. Edgewise appliances with prescriptions of 0.022 inches were the preferred appliance. Up until 16/22 stainless steel arch wire, initial alignment and levelling were accomplished. 16/22 stainless steel arch wire, with a one mm step up or step downward, is used for the intrusive or extrusive arch. It was tested for six months and produced a force of 40 grammes using a tension gauge. A CBCT was obtained six months following force application (T2) and shortly before to the placement of the intrusive or extrusive arch (T1). The alveolar bone crest and the CEJ's mesial, distal, buccal, and lingual distances were determined using the Mimics software (figure 1A, B, C, D, E, F, G, H & figure 2A, B& figure 3-11). The information gathered were then statistically analysed utilising a paired t-test at the significant level. ($P < 0.05$)

Fig. (1A): Deep bite indicated for lower anteriors intrusion

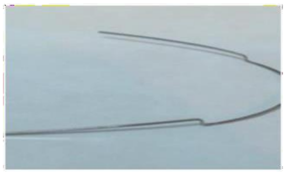

Fig. (1B):16/22 stainless steel arch wire with one mm step down

Fig. (1C): Intrusive arch not engaged in bracket slot

Fig. (1D): Intrusive arch after bracket engagement

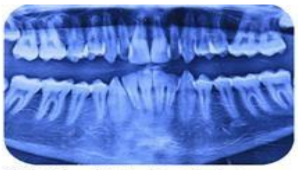

Fig. (1E): Deep bite indicated for lower anteriors intrusion

Fig. (1F): After 6 months of lower anteriors intrusion

Fig. (1G): Deep bite indicated for lower anteriors intrusion

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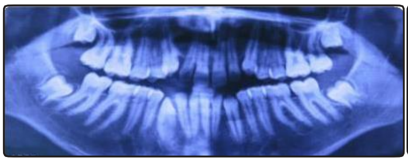
JCHR (2024) 14(3), 1190-1196 | ISSN:2251-6727

Fig. (1H): After 6 months of lower anteriors intrusion



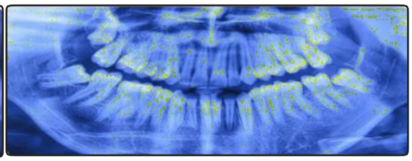


Fig. (2A): lower anteriors indicated for extrusion **Fig.(2B):** after 6 months of lower anteriors extrusion

Fig. (3) mesial and distal

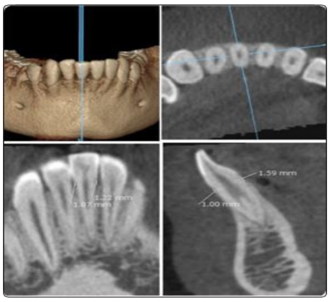


Fig. (4) mesiodistal and buccolingual measurements of lower right central incisor

Fig. (7): mesiodistal and buccolingual measurements of lower left lateral incisor

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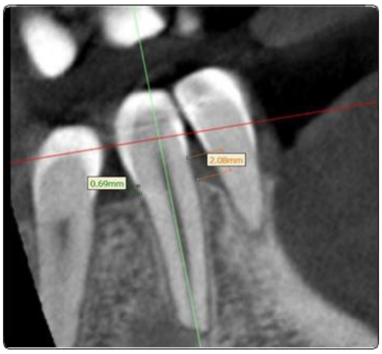

Fig.(8): mesial and distal measurements after extrusion

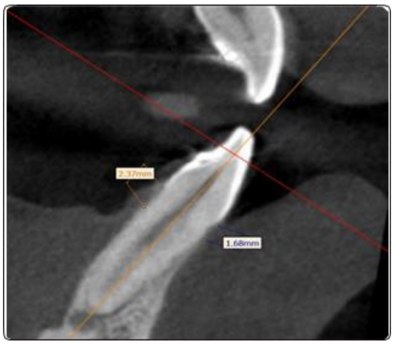

Fig. (9): buccal and lingual measurements after intrusion

Edge-to-edge appliances with prescriptions of 0.022 inches were the preferred appliance. Up until 16/22 stainless steel arch wire, initial alignment and levelling were accomplished. 16/22 stainless steel arch wire, with a one mm step up or step downward, is used for the intrusive or extrusive arch. It was tested for six months and produced a force of 40 grammes using a tension gauge. A CBCT was obtained six months following the use of force (T2) and shortly before to the placement of the intrusive or extrusive arch (T1). The range of distances (mesial, distal, buccal, and lingual) between the alveolar bone crest and the CEJ is measured using the Mimics software. The information gathered were then statistically analysed utilising a paired t-test with a significance level ($P < 0.05$).

Results

Following orthodontic tooth extrusion, the alveolar bone level changed by a percentage of 3/4 of the extrusion their distance, which is deemed non-statistically significant. Without reference to the extrusion group, the alveolar bone moves in the same direction as dentistry motion. As comparison to the mandibular central incisors, the mandibular lateral incisors displayed more bone loss in the mesial, distal, and labial tooth elements, although the difference was still statistically insignificant ($P > 0.05$). As contrasted to the mandibular CIs, only the lingual aspect of the mandibular lateral incisors exhibited a statistically significant bone loss. (P less than 0.05).

TABLE (1) Extrusion group: Average alveolar bone loss in different aspects of mandibular central and lateral incisors

Tooth	Central	Lateral	t-test	
	Mean ± SD	**Mean ± SD**	**t-value**	**p-value**
Mesial	1.26±0.293	1.27±0.365	-0.072	0.943

Distal	1.47±0.279	1.57±0.284	-1.176	0.247
Buccal	0.53±0.138	0.64±0.187	-2.019	0.051
Lingual	0.60±0.144	0.70±0.13	-2.306	0.027*

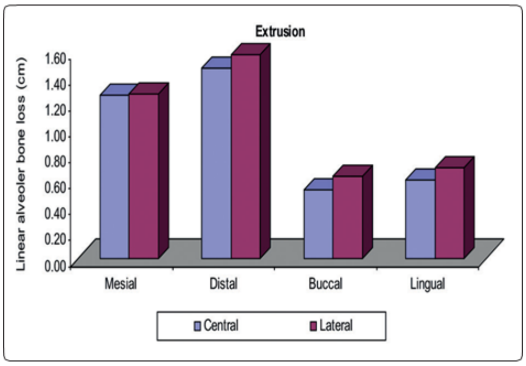

Fig. (10) Extrusion group: Average alveolar bone loss in different aspects of mandibular central and lateral incisors.

TABLE (2) Intrusion group: Average alveolar bone loss in different aspects of mandibular central and lateral incisors

Tooth	Central	Lateral	t-test	
	Mean ± SD	**Mean ± SD**	**t-value**	**p-value**
Mesial	1.12±0.123	1.13±0.226	-0.173	0.863
Distal	1.40±0.266	1.36±0.204	0.467	0.643
Buccal	0.66±0.175	0.61±0.165	0.928	0.359
Lingual	0.74±0.215	0.67±0.144	1.121	0.269

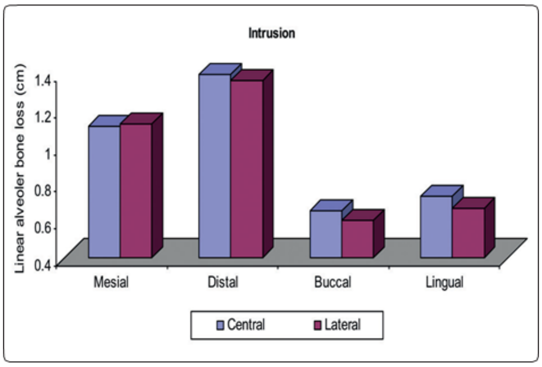

Fig. (11) Intrusion group: Average alveolar bone loss in different aspects of mandibular central and lateral incisors

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A statistically insignificant distinction was observed in every respect between the extrusion and intrusion categories, with the intrusions cohort exhibiting a larger loss of bone on the buccal and lingual sides of the mandibular incisors than the extrusion category. (p greater than 0.05)

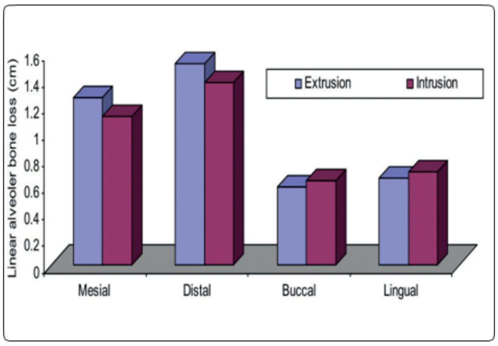

Fig. (12) Mean alveolar bone loss in extrusion and intrusion groups

TABLE (4) Comparison of average crestal bone loss related to mandibular central incisors between extrusion and intrusion groups.

Tooth	**Extrusion**	**Intrusion**	t-test	
	Mean ± SD	**Mean ± SD**	**t-value**	**p-value**
Central (Mesial)	1.26 ± 0.29	1.12 ± 0.12	2.043	0.048*
Central (Distal)	1.47 ± 0.28	1.40 ± 0.27	0.810	0.423
Central (Buccal)	0.53 ± 0.14	0.66 ± 0.18	- 2.505	0.017*
Central Lingual	0.60 ± 0.14	0.74 ± 0.22	-2.289	0.028*

P < .05

Discussion

One of the most important things to take into account when receiving orthodontic care is having a healthy supporting alveolar bone and periodontal ligament with the fewest unfavourable iatrogenic consequences. With correct identification, CBCT can produce cephalometric or panoramic-like views, obviating the need for several radiation exposures. It is possible to determine the linear, angular, height, width, and volumetric using the created 3D model. Some research[5,6] have revealed that both digital and manual measurements are dependable; other studies have found that 3D scanning technology, such as Mimics software, is more accurate and dependable than the conventional traditional approach.

The present investigation employed CBCT and Mimics software to assess alveolar height following orthodontic intrusion and extrusion, as many other studies have reported that CBCT is a very precise approach for evaluating alveolar bone dimensions.[8] There is ongoing discussion on the impact of orthodontic therapy on the on imaging measurable alveolar bone surrounding the teeth. After receiving orthodontic care for five years, Bondemark [8] studied the changes in the distance between the crest of alveolar bone and the CEJ. The research's mean alterations were between 0.7 and 1.0 mm.

The lingual side of the mandibular central and lateral incisors in the extrusion group showed higher alveolar bone loss (0.60 ± 0.144, 0.70 ± 0.13) than the buccal side (0.53 ± 0.138, 0.64 ± 0.187), according to the results of the present research. Our results are in line with those of Kim et al., 2009 [9], who reported that alveolar loss of bone

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occurs in the mandibular anteriors after shifting orthodontic teeth because the symphysial alveolar bone was gradually weaker.

Additionally, Szulc P 2000 [10] noted that a faster bone turnover rate in children compared to adults was the reason for the increased alveolar bone loss in the lingual region. The conclusion reached by Thongudomporna U in 2015[11] was in contrast to that of Lee et al. (2012), who discovered a non-significant association between alveolar bone loss and labial incisor tipping. Thongudomporna U 2015[11] thought about bone remodelling in children is rapid with apposition more than resorption thus maintaining labial alveolar bone width. Individuals in the extrusion category in the present research had higher interproximal bone loss of the mandibular incisors than patients in the intrusion group, and both groups had greater alveolar loss on the distal than on the mesial sides. This difference in bone reduction may have resulted from the distalization of teeth during orthodontic treatment.

Conclusion

Mimics software is a useful tool for measuring alveolar bone level in three dimensions. During extrusion, the connection between the alveolar bone crest and the CEJ was mostly preserved. Loss of alveolar bone more proximally, particularly distal than buccal or lingual. It is advised to monitor the alterations in the alveolar bone for a period of time following the conclusion of orthodontic therapy.

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