

THE ROOT LENGTH CHANGE IN POSTERIOR TEETH INTRUSION IN ANTERIOR OPEN BITE PATIENT

Kanwara VILAMAS¹ and Chidchanok LEETHANAKUL¹

¹ Faculty of Dentistry, Prince of Songkla University, Thailand; kanwara.v@gmail.com (K. V.); chidchanok.l@psu.ac.th (C. L.)

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ABSTRACT

This retrospective cohort study aimed to investigate the root length change in posterior teeth intrusion (upper second premolar, upper first, and second molar) in an open bite patient using fixed appliances with TADs and clear aligners. The CBCT was used to determine root length by segmentation upper posterior teeth into a 3D file and measuring root length from cusp tip to root apex. The difference in root length between pre-treatment and post-treatment indicated the level of change. All evaluated roots showed a significant decrease in root length. All evaluated roots showed a significant decrease in root length.

Fixed appliances with TADs had significantly greater root resorption after intrusion compared to the Clear Aligner group in the palatal root of the upper first molar.

Keywords: Clear Aligners, Open Bite, Posterior Teeth Intrusion, Root Length Change, TADs

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INTRODUCTION

Anterior open bites are complex cases in orthodontics because of their etiology and stability after treatment. An intrusion of posterior teeth was used to correct an anterior open bite. Intrusion of posterior teeth was used with temporary anchorage devices (TADs) (Alsafadi et al., 2016). TADs have the benefit of not requiring patient compliance, which makes it easier and more practical than orthognathic surgery. (Kuroda et al., 2007)

The combination of maxillary and mandibular incisor extrusion, maxillary and mandibular molar intrusion, and mild mandibular autorotation resulted in an open bite that was closed with clear aligners. Because of the thick plastic covering the occlusal surfaces of posterior teeth and the patient's masticatory forces, clear aligners are helpful for posterior teeth intrusion. (Harris et al., 2020)

Root resorption is the loss of the external root surface from a physiologic or pathologic process. Many studies have shown that orthodontic treatment induces root resorption and intrusion is the most common tooth movement that causes root resorption. (Dindaroğlu & Doğan, 2016)

Routine radiograph techniques, like as periapical and panoramic radiographs, are used to detect root resorption; nevertheless, they are a two-dimensional (2D) diagnostic tool that is often overestimated or underestimated. The three-dimensional (3D) Cone-beam computed tomography (CBCT) has been used in several studies to assess root resorption. (Dudic et al., 2008; Ren et al., 2013)

This study evaluated root resorption by root length change in cone-beam computed tomography (CBCT) after posterior tooth intrusion by fixed appliances with TADs and clear aligners in anterior open bite patients.

LITERATURE REVIEWS

Anterior open bite

Anterior open bite is a condition in which there is no contact between the upper and lower anterior teeth. (Subtelny & Sakuda, 1964) There are complex cases in orthodontics because of their etiology and stability after treatment. Etiology of anterior openbite is skeletal problems, dental problems, respiratory problems, abnormal habits, or combined factors.

Treatment for a non-growing anterior openbite patient is extrusion of anterior teeth, intrusion of posterior teeth, or a combination of both. Intrusion of posterior teeth was used with temporary anchorage devices (TADs) because it was simpler and less expensive than jaw surgery. (Kuroda et al., 2007) Sherwood et al. (2002) use TADs as anchorage for intruding upper posterior teeth in an open-bite patient. All patients achieved open-bite closure, with an average molar intrusion of 1.99 mm. In the study by Yao et al. (2005), the average intrusion of maxillary molars was more than three to four mm when a fixed appliance was used with TADs. Al-Falahi et al. (2018) use TADs to intrude on upper posterior teeth in an open-bite patient. The average molar intrusion was 2.79 ± 0.46 mm.

Clear aligners have gained popularity as a treatment for adult patients in recent years. Since they provide greater comfort and attractiveness than fixed appliances. A clear aligner was used to treat an open bite case because of the bite block effect that is useful to intrude posterior teeth in an open bite patient and can control the vertical dimension of occlusal coverage. By comparing the cephalometric analysis following open bite closure with clear aligners, Harris et al. (2020) assessed the dental and skeletal effects. Patients with open bites can effectively reduce their vertical dimension with the use of clear aligners. Because of the thick plastic covering the occlusal surfaces of posterior teeth and the patient's masticatory forces, clear aligners are helpful for posterior teeth intrusion. In their comparison of the cephalometrics of anterior open bite correction and the mandibular plane angle between fixed appliances and clear aligners in adult hyperdivergent anterior open bite patients, Garnett et al. (2019) found no statistically significant differences between the two groups.

Root resorption

Root resorption can be characterized as surface, inflammatory, replacement, or by location as cervical, lateral, or apical. It starts in the periodontium and affects the tooth's external surfaces first. It may or may not penetrate the dental pulp area. Resorption is a condition that causes dentin, cementum, and/or bone to be lost because of either a physiological or pathologic process.

Levander and Malmgren score the degree of root resorption. A score of 0 indicates no root resorption. 1 represents an irregular root contour. 2 refers to apical root resorption of less than 2 mm. 3 is root resorption apically, which ranges from 2 mm to one-third of the original root length. 4 represents root resorption that exceeds one-third of the original root length. (Levander et al., 1998)

Root resorption is related to the patient. These include genetic factors, chronological age, dental age, heavy occlusal force, tooth vitality, type of teeth, systemic factors, systemic drug use, and more. Root resorption can result from orthodontic therapy. These include the amount of orthodontic force, magnitude of orthodontic force, type of force, direction of tooth movement, amount of apical movement, type of orthodontic appliance, duration of orthodontic treatment, and treatment technique. (Dindaroğlu & Doğan, 2016)

Intrusion was found to be the most predictive type of vertical movement for external apical root resorption. Because the intrusive movement compresses the periodontium and root apex during intrusion, according to Han et al.'s comparison of root resorption in the same subject between intrusive and extrusive forces, root resorption resulting from intrusive force is approximately four times larger than that of extrusion. (Han et al., 2005)

Several studies compared root resorption between fixed appliances and clear aligner. The prevalence and severity of root resorption measured on CBCT in patients with clear aligners were less than those in patients with fixed appliances. (Li et al., 2020)

In dentistry, cone beam computed tomography is a diagnostic technique that becomes more accurate. The three-dimensional imaging eliminates the structural overlap that is present in two-dimensional methods.

RESEARCH METHODOLOGY

Study design Retrospective cohort study

The study protocol was approved by the institutional review board committee (protocol EC6703-016) of Faculty of Dentistry, Prince of Songkla University

Sample

The samples will be enrolled from patients in orthodontic clinic, Faculty of Dentistry, Prince of Songkla University.

The inclusion criteria

- 1) Adult males or females, age range between 18-35 years
- 2) Anterior open bite patient treated by molar intrusion with a fixed appliance with TADs or clear aligners (Withayanukonkij et al., 2023)
 - a) Fixed appliance with TADs (FA): A miniscrew, 2.0-mm in diameter and 6.0-mm in length (AbsoAnchor, Dentos, Daegu, Korea), was placed in the midpalatal area. The transpalatal arch (TPA) was placed 3.0 mm away from the palatal tissue. Segmental 0.018 x 0.025-inch stainless steel wire was passive in Roth 0.022 x 0.028-inch posterior slots. Two NiTi-closed coil springs were stretched from the miniscrew to the TPA hooks. A force gauge was used to calibrate 150 grams/ side of intrusive force every 3 weeks.
 - b) Clear Aligner Treatment (CA): The maxillary anterior teeth were set for extrusion of 0.2 mm/aligner with a 3-week change interval. The clear aligners were fabricated using 1-mm Duran thermoplastic sheets. Wear time was at least 22 hours/day, full time except when brushing and eating.

- 1) Dental overbite (OB) -4-0 mm
- 2) Skeletal Class I or mild Class II (ANB = 0-5 degrees)
- 3) Normo- to hyperdivergent facial pattern (MPA = 23-39 degrees)
- 4) CBCT volumes covered all maxillary posterior teeth

The exclusion criteria

- 1) Severe or moderate crowding
- 2) Loss of posterior teeth
- 3) History trauma of right and left posterior teeth
- 4) Systematic disease relates to bone metabolism.
- 5) History of first molar root canal treatment
- 6) Immunosuppressive drug, inhibited or accelerated tooth movement drug
- 7) Neuromuscular deficiencies

Sample size calculation

The sample size was calculated by G-power program. The level of significance was set at 95% ($\alpha = 0.05$), calculated effect size of 1.4 and the power of test (1-b) was set at 80% based on a study by Al-Falahi et al. (2018) and Castro et al. (2013) Ten subjects were needed per group.

Data to be included

Initial record (T0) at pre-treatment and Post-treatment record (T1) 6 months after posterior teeth intrusion including

- a) Base-line orthodontic treatment record
- b) Lateral cephalometric radiograph
- c) 1st CBCT record to evaluate right and left posterior teeth

The amount of intrusion

One Volume Viewer software was used to measure the amount of intrusion. The Palatal plane (PP) was set. The deepest point of the central pit (C-pit) was located in the coronal and sagittal views. The vertical distance between C-pit and PP (U6-PP) was measured. The amount of intrusion was calculated as the difference between T0 and T1, with the right and left sides averaged.

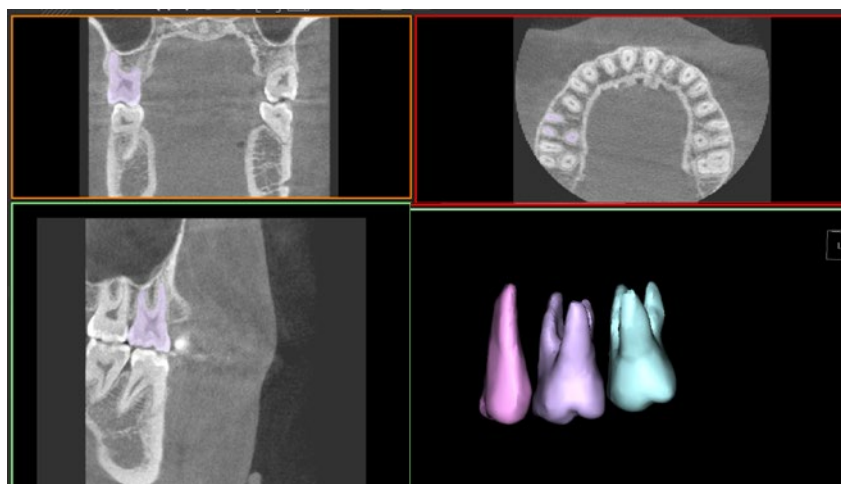


Figure 1 Segmentation of the upper posterior teeth

Root length measurement

Root length was measured by the direct method, the root was segmented, and the rendering was done in a 3D model by Mimics Medical Software. Root length at T0 and T1 was superimposed and measured with Geomegic Control X. A point-based superimposition between the T0 and T1 original models was carried out, followed by a global surface-based registration of the 3D tooth models.

Root length measurement. The distance between the buccal cusp (B) tip of the upper second premolar (U5) and the root apex was measured.

The difference between T0 and T1 represented the amount of root length change, and the right and left sides were averaged. The upper first (U6) and second molar (U7) mesiobuccal (MB), distobuccal (DB), and palatal (Pa) roots were measured using the same method as the upper second premolar.

Table 1 Mean, Standard Deviation of Dentoskeletal variables in FA and CA

Dentoskeletal variables	FA	CA
SN-MP(°)	38.55±6.17	32.09±5.18
ANB(°)	3.14±2.65	2.38±1.22
OB(mm)	2.01±0.75	2.34±0.85
Molar intrusion (mm)	2.10±0.12	0.86±0.13

RESEARCH RESULTS

Ten subjects in the FA group (2 males, 8 females) with a mean age of 28.60±6.64 years. Ten subjects in the CA group (3 males, 7 females) with a mean age of 23.30±2.98 years. SNMP, ANB, OB, and the amount of intrusion after 6 months of intrusion are shown in Table 1. All data were normally distributed by the Shapiro-Wilk test. To determine the changes within each group and between groups, paired and independent t-tests were performed. Table 2 displays the mean, standard deviation, and differentiation between pre-treatment and post-treatment of root length in both groups. The data shows that the root length was significantly decreased in all roots in both groups. U6-Pa in the FA group has a root length change of -0.50 ± 0.13 mm, which is the largest root length change of all root.

Table 2 Mean, Standard Deviation of root length

Root length (mm)	Fixed appliance with TADs (FA)				Clear aligner (CA)			
	T0	T1	T1-T0	P-Value	T0	T1	T1-T0	P-Value
U5-B	21.01±1.08	20.68±1.19	-0.32±0.17	<0.001	19.22±1.34	18.92±1.37	-0.30±0.10	<0.001
U6-MB	17.96±1.41	17.79±1.46	-0.17±0.14	0.003	16.82±1.45	16.52±1.56	-0.30±0.18	<0.001
U6-DB	17.24±1.88	16.99±1.82	-0.25±0.14	<0.001	16.71±1.52	16.37±1.53	-0.34±0.16	<0.001
U6-Pa	19.24±1.62	18.73±1.61	-0.50±0.13	<0.001	18.43±1.70	18.18±1.79	-0.29±0.15	<0.001
U7-MB	17.25±1.64	16.94±1.63	-0.31±0.18	<0.001	17.05±1.46	16.82±1.44	-0.22±0.14	<0.001
U7-DB	17.22±1.42	16.95±1.46	-0.27±0.1	<0.001	16.48±1.19	16.33±1.18	-0.15±0.10	0.001
U7-Pa	17.62±1.67	17.30±1.65	-0.32±0.18	<0.001	17.37±1.62	17.00±1.61	-0.37±0.24	<0.001

The mean and standard of differentiation for the root length change between the FA and CA groups shows that the U6-PA was significantly different in both groups. In the FA group, there was a change of 0.5 ± 0.13 mm, but in the CA group, there was a change of 0.29 ± 0.15 mm. The other root in both groups is not significant. (Table 3)

Table 3 Mean, Standard Deviation of root length change between FA and CA

Root length (mm)	Compare the root length change(T1-T0) between FA and CA			
	FA	CA	Differences	P-Value
U5-B	-0.32±0.17	-0.3±0.1	0.02	0.719
U6-MB	-0.17±0.14	-0.3±0.18	0.13	0.82
U6-DB	-0.25±0.14	-0.34±0.16	0.09	0.203
U6-Pa	-0.5±0.13	-0.29±0.15	0.21	0.04
U7-MB	-0.31±0.18	-0.22±0.14	0.09	0.241
U7-DB	-0.27±0.1	-0.15±0.10	0.12	0.11
U7-Pa	-0.32±0.18	-0.37±0.24	0.05	0.603

DISCUSSION & CONCLUSION

Resorption is a condition that causes dentin, cementum, and/or bone to be lost as a result of either a physiological or pathologic event. Changing the root length is useful to detect root resorption during orthodontic treatment. Several studies of orthodontic-induced root resorption used two-dimensional radiographs to evaluate root resorption because root resorption is detected when patients have routine radiographs. The image in two-dimensional radiographs may show the elongated or shortened roots due to overlapping structure and low image resolution, which can cause an overestimation or underestimation of the degree of root resorption. Then, three-dimensional radiographs had more accuracy to detect root resorption. In this study, root length was measured using CBCT segmentation in 3D files. Previous studies comparing the accuracy of CBCT to periapical radiographs or orthopantomography to identify root resorption have demonstrated that the three-dimensional approach is more accurate and effective. (Lima et al., 2016; Faisal & Al-Groosh, 2020; Alassiry, 2022) Previous study indicates that following orthodontic treatment, root length consistently decreased. Especially intrusions that result in more root resorption than other types of tooth movement. The FA group shows an amount of intrusion of 2.10 ± 0.12 mm, is more than the CA group, which has an amount of intrusion of 0.86 ± 0.13 mm. The statistically significant decrease in root length, especially in the U6-Pa root in the FA group, which had a root length change of 0.50 ± 0.13 mm after 6 months of intrusion as the result of Al-Falahi, every root under examination had a statistically significant ($p < 0.05$) change in root length. The average amount of intrusion in the upper posterior teeth was 2.79 ± 0.46 mm, with a range of 0.34 to 0.74 mm between the pre- and post-intrusion evaluations. The U6-Pa root had the greatest reduction in root length, measuring 0.7 ± 0.5 mm. (Al-Falahi et al., 2018) To compare the root length change between the FA and CA groups, there is only a U6-Pa root difference. Because the palatal root in the FA group was in the line of action force of the closed coil when posterior teeth intrusion and the FA group had more apical movement than the CA group, the risk of root length change was higher than in the CA group. Although it has been demonstrated that increased apical movement can result in increased root resorption. The amount of movement at the apex indicates that there are treatment-related factors affecting root resorption. (Segal et al., 2004) All roots have a significant decrease in root length, which ranges from 0.15 to 0.5 mm, but root lengths were lost by 1.42–2.13% of pre-treatment root length in both groups, so they should not have clinical significance. Posterior teeth intrusion by a fixed appliance with TADs and Clear aligners can cause root length change after 6 months of intrusion. But the amount of root length change was less than 2.13% of the initial root length. There is no significance in clinical. CBCT has good accuracy to detect root length change and can detect the surface of the root in three dimensions.

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Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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