A Comparative Study of Apical Root Resorption during Intrusion of Maxillary Anterior Teeth Treated with Intrusion Arch and Mini-Implants-A CBCT Study

Hetvi Suthar[1]*, Kalyani Trivedi[2] Alap Shah[2] Niyati Nathwani[2] Maulik Bhatt[3]

[1]*Department of Orthodontics & Dentofacial Orthopedics, Goenka Research Institute of Dental Science, Piplaj, Gujarat, India*

[2]*Department of Orthodontics & Dentofacial Orthopedics, Karnavati School of Dentistry, Uvarsad, Gujarat, India*

[3]*Department of Orthodontics & Dentofacial Orthopedics, Ahmedabad Dental College, Bhadaj - Ranchodpura Road, Gujarat, India*

Corresponding Author*

Hetvi Suthar
Department of Orthodontics & Dentofacial Orthopedics, Goenka Re search Institute of Dental Science, Piplaj, Gujarat, India
E-mail: hetvisuthar94@gmail.com

Received: 15-Feb-2023, Manuscript No. JDRP-23-89394**; Editor assigned:** 17-Feb-2023, PreQC No**.** JDRP-23-89394 (PQ); **Reviewed:** 24-Feb-2023, QC No. JDRP-23-89394 (Q); **Revised:** 26-Feb-2023, Manuscript No. JDRP-23-89394 (R); **Published:** 28-Feb-2023, DOI: 10.4172/jdrp.23.5(1).035

Abstract

Background: To evaluate and compare the relationship between the amount of root resorption after the intrusion of maxillary anterior teeth using two different intrusion mechanics i.e. Intrusion arch (Utility arch) and Mini-implants through CBCT scans. 20 patients randomly selected were divided into 2 groups: Group A: 10 patients with intrusion arch mechanics and Group B: 10 patients with mini-implant mechanics. Pre- and post-intrusion sectional CBCT scans of maxillary anterior teeth were taken. Changes in volumetric measurements (in mm^3), linear measurements (in mm), and angular measurements (in degree) between pre and post-intrusion scans were measured for each incisor in both groups using paired t-tests. An independent t-test was used for comparing the change in all three parameters between both groups. Pearson's correlation test was done for correlating the amount of root resorption with the amount of intrusion for each incisor in both groups.

Results: Changes in all three parameters between pre-and post-treatment CBCT scans for all incisors for each group and between both groups were statistically significant. Pearson's correlation shows a statistically non-significant correlation for all incisors in both groups except lateral incisors in group B.

Conclusion: Clinically significant root resorption is observed with the intrusion of maxillary anterior teeth either with utility arch or mini-implants. The amount of root resorption and range of intrusion is more with mini-implants, while the amount of proclination is more with the use of utility arch. More amount of root resorption is seen in lateral incisors than in central incisors in both groups.

Keywords: CBCT study • Intrusion • Root resorption • Mini-implants • Intrusion arch • Maxillary anterior teeth

Introduction

Correction of a deep bite is necessary due to the potential deleterious effects on the temporomandibular joint, occlusion, periodontal health, and facial esthetics. Maxillary incisor intrusion should be the preferred treatment in non-growing patients with anterior deep bites caused by overeruption of the maxillary incisors [1]. The treatment of choice depends on a variety of factors such as smile line, incisor display, and vertical dimension of the patient. Conventional methods of incisor intrusion usually involve 2 x 4 appliances such as utility arches, 3-piece intrusion arches, or reverse curved arches. Mini-implants have been used to intrude incisors since 1983 when Creekmore and Eklund reported using a metal implant to correct a deep overbite [2]. By using an even light amount of force and any intrusion method some degree of root resorption is always anticipated.

External Apical Root Resorption (EARR) is a frequent, undesirable side effect in orthodontic treatment having multifactorial etiology. Since one cause of root resorption is orthodontic movement, a correlation may exist between the type of movement and the degree of root resorption. The presence of risk factors along with orthodontic treatment like age, gender, root morphology, alveolar bone density, type of force (continuous/intermittent), force magnitude, and direction has been found to increase the extent of root resorption. Root resorption occurs 3-dimensionally, and 2D images cannot detect root resorption on lingual or buccal surfaces nor can measure the volume of root loss. Therefore, the quantification of treatment should be assessed with the help of 3- dimensional radiographic methods like Cone-Beam Computed Tomography (CBCT) which is a more accurate and reliable 3D measuring method for EARR investigation.

For correction of deep bite, mini-implant insertion being an invasive procedure, there are certain limitations in usage for different patients. While intrusion arches like utility arches are non-invasive and can be used in cases of mixed dentition and are easier to use. Comparing intrusion arches with mini-screws, some authors have reported significantly more incisor proclination when using intrusion archwires, while others have found significantly more intrusion using mini-screws. As with different intrusion mechanics used, the amount of force varies, so the amount of root resorption varies. Most of the studies quantifying upper incisor intrusion have used lateral cephalograms while only a few studies have evaluated root resorption using CBCT sagittal sections [3-7].

Thus, the present study aims to evaluate and compare the relationship between the amount of root resorption after the intrusion of maxillary anterior teeth using two different intrusion mechanics i.e. Intrusion arches like Utility arch and Mini-implants using CBCT scans of patients.

Materials and Methods

Ethical consideration

The study was undertaken at the department of orthodontics and dentofacial orthopaedics of our institution. The ethical approval for the study was taken from the ethical committee of the institution before the start of the study. The subjects were explained the whole procedure and written Informed Consent was obtained from them. All methods were carried out under relevant guidelines and regulations.

Inclusion criteria

- Patients with an overbite of more than 5 mm.
- The incisor displays more than 3 mm at rest.

- Males (n=10) and females (n=10) above 15 years of age.
- No history of marked root resorption before orthodontic treatment as evident on CBCT.
- No signs of any carious lesions.
- Patients undergoing MBT 0.022 fixed mechanotherapy treatment

Exclusion criteria

- Previous history of orthodontic treatment.
- Patients with active periodontal disease
- Root canal treated anterior teeth.
- Patients with mutilated dentition.
- Individuals with a history of medical conditions such as asthma, hypothyroidism, diabetes, or other endocrine problems.
- Patients who are not willing to participate.

Materials and equipment for the study

- Titanium Mini-Implants of 1.5 mm x 8 mm in size were selected.
- 0.017 inch x 0.025 inches Beta titanium (TMA) wire was used for the fabrication of Rickett's Utility arch.
- Sectional CBCT of upper anterior teeth was taken before and after the intrusion of maxillary anterior teeth.
- The CBCT scans were taken with the machine KAVO OP 3D PRO with the following specifications: 13 x15 field of vision; voxel size of 85 Voxel, tube volume of 85 Kvp, tube current of 10 mA, and scan time of 12 seconds.
- The measurements of CBCT scans were carried out in Ez-3Di software version 5.0.0.2 of the company Vatech, South Korea. The slice thickness and slice interval during these measurements were 0.1 mm each. All measurements were done by a single observer.

Methodology

20 patients randomly selected were divided into 2 groups:

Group A: 10 patients who were undergoing treatment with intrusion arch mechanics

Group B: 10 patients who were undergoing treatment with mini-implant mechanics

Pre-intrusion sectional CBCT scans and intraoral photographs were taken of the maxillary anterior teeth of patients in both groups. The intrusion of the patient's teeth using intrusion arches and mini-implant systems was carried out. After a mean period of 6 months ± 2 months of intrusion, post-intrusion records were taken. An intra-group comparison was done for measuring the amount of external root resorption, amount of intrusion, and amount of change in inclination by comparing differences in volume, change in linear measurement, and angular measurement of each incisor in pre- and post-intrusion CBCT scans for both group patients. The volumetric measurements were done by using the volumetric tool of the software in such a way that the entire tooth was covered in all three sections i.e. axial, coronal, and sagittal as shown in Figure 1. Figure 2(A) shows a sagittal view of the incisor for volumetric measurement in mm^3.

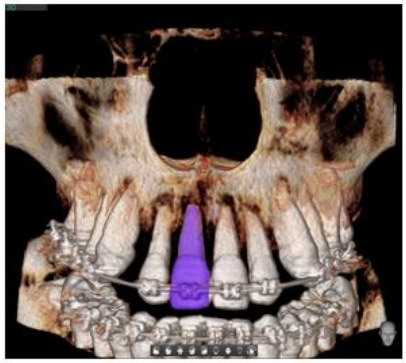

Figure 1. Three-Dimensional Sectioning of Tooth for Volumetric Measurement

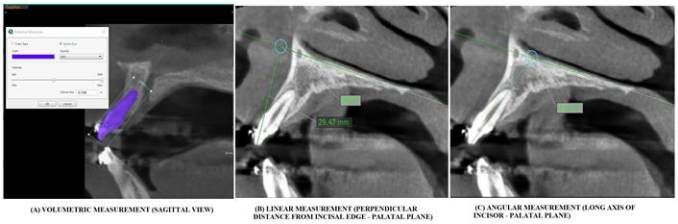

Figure 2. (A) Sagittal view of incisor for volumetric measurement in mm^3; (B) linear measurement (perpendicular distance from an incisal edge-palatal plane); (C) angular measurement (long axis of incisor-palatal plane).

As shown in Figure 2(B), for linear measurement, the palatal plane was taken as a reference plane passing from ANS (anterior nasal spine) to PNS (posterior nasal spine) and a perpendicular distance from each incisal edge onto the palatal plane was measured. Similarly, for angular measurement, the internal angle between the long axis of each incisor and the palatal plane was measured as shown in Figure 2(C). An inter-group comparison was done for the amount of external root resorption, amount of intrusion, and amount of change in inclination between both groups. The correlation was measured between the amount of volumetric measurement change during intrusion and the amount of intrusion for all incisors for both groups.

Intrusion mechanics

In group A, the intrusion was carried out with a utility arch after leveling and alignment of the upper four incisors. It was activated by placing a 30° occlusal directed gable bend in the vestibular segment as shown in Figure 3, to generate 50 gm-60 gm of force measured using a Dontrix gauge as shown in Figure 4(A). A trans palatal arch was given to every patient for minimal molar movement.

Figure 3. Intraoral lateral view showing gable bend in the vestibular segment of utility arch.

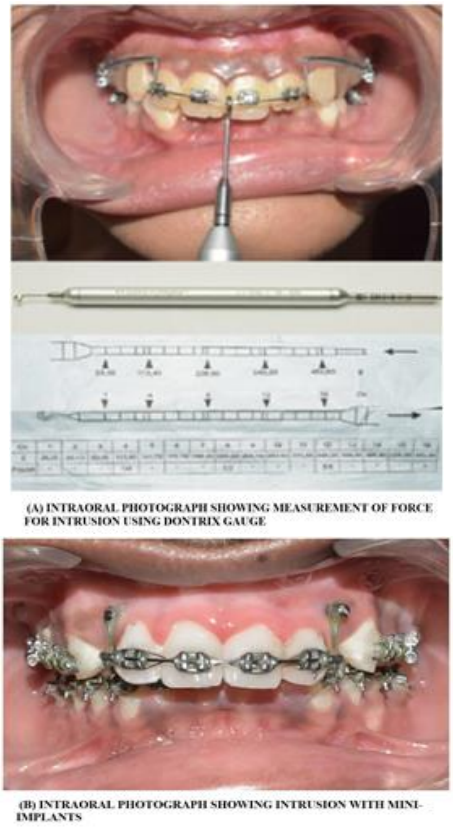

Figure 4.(A) Intraoral Photograph Showing Measurement of Force for Intrusion Using Dontrix Gauge; (B) Intraoral Photograph Showing Intrusion With Mini-Implants

In Group B, the intrusion of the maxillary anterior teeth of the patients was carried out with two mini-implants each placed 5 mm-6 mm apically and distal to the lateral incisor bilaterally as shown in Figure 4(B). Leveling and alignment of upper incisors were carried out until 0.017 x 0.025 or 0.019 x 0.025 stainless steel wire was engaged. A force of 50 gm-100 gm as recommended by Burstone, was measured using a Dontrix gauge and applied using an elastomeric chain from a mini-implant bilaterally onto the arch wire connecting four incisors [8].

STATISTICAL ANALYSIS

Statistical analyses were done with the help of SPSS software version 20.0.

Paired t-test was done for intra-group comparison of the amount of external root resorption (volumetric measurement in mm^3), amount of intrusion (linear measurement in mm), and amount of change in inclination (angular measurement in degree) of each incisor between pre-intrusion and post-intrusion CBCT scans in each group.

An Independent t-test was done for an inter-group comparison of all three parameters between group A and group B.

Pearson's correlation was done for the correlation between volumetric measurement difference and linear measurement difference of pre-treatment and post-treatment measurements of each incisor for both groups.

The p-value of <0.05 was considered statistically significant for all tests.

Result

As shown in Table 1 and Figure 5 and Figure 6, the results of paired t-tests for both groups show the mean values of volumetric and linear measurements for pre-treatment, which are higher than that of post-treatment and are statistically significant with a p-value of <0.001 for all incisors. While the mean values of angular measurement for post-treatment are higher than that of pre-treatment which all are statistically significant with a p-value of <0.05 for all incisors as shown in (Figure 7).

Table 1. Comparison of volumetric measurements (in mm^3), linear measurements (in mm), and angular measurements (in degree) of pre-treatment and post-treatment values using paired t-test in group A and group B

		Tooth number	Pre-treatment (n=10) Mean ± SD	Post-treatment (n=10) Mean ± SD	Mean difference ± SD	t	p-value
Volumetric Measurements	Group A	12	617.3 ± 168.12	606.4 ± 169.2	10.9 ± 4.1	8.42	<0.001
		11	810.5 ± 54.27	800.4 ± 53.87	10.1 ± 2.28	13.99	<0.001
		21	824.3 ± 60.6	814.7 ± 58.91	9.6 ± 2.59	11.72	<0.001
		22	617 ± 167.64	606.8 ± 169.24	10.2 ± 4.29	7.52	<0.001
	Group B	12	621.4 ± 167.83	606.4 ± 169.2	15 ± 5.64	8.42	<0.001
		11	783.4 ± 135.22	769.6 ± 134.93	13.8 ± 1.93	22.59	<0.001
		21	833.2 ± 111.61	820.1 ± 111.54	13.1 ± 1.45	28.59	<0.001
		22	695.6 ± 119.43	681.4 ± 118.07	14.2 ± 3.01	14.91	<0.001
Linear Measurements	Group A	12	28.05 ± 1.39	26.76 ± 1.41	1.29 ± 0.49	8.4	<0.001
		11	27.86 ± 1.43	26.66 ± 1.42	1.21 ± 0.35	11.02	<0.001
		21	27.05 ± 1.02	25.97 ± 0.98	1.08 ± 0.37	9.28	<0.001
		22	27.95 ± 1.32	26.72 ± 1.41	1.23 ± 0.53	7.28	<0.001
	Group B	12	29.14 ± 2.05	26.82 ± 2.23	2.32 ± 0.43	17.17	<0.001
		11	29.09 ± 2	27.46 ± 2.27	1.64 ± 0.52	9.89	<0.001
		21	28.92 ± 2.55	27 ± 2.46	1.92 ± 0.44	13.97	<0.001

		22	28.56 ± 2.21	26.53 ± 2.68	2.03 ± 0.76	8.43	<0.001
Angular Measurements	Group A	12	99.26 ± 11.57	103.2 ± 10.76	-3.94 ± 1.18	-10.6	<0.001
		11	99.26 ± 12.12	103.01 ± 11.13	-3.75 ± 1.62	-7.32	<0.001
		21	99.46 ± 11.57	103.5 ± 10.88	-4.04 ± 1.18	-10.8	<0.001
		22	99.26 ± 11.32	103.13 ± 10.53	-3.87 ± 1.01	-12.1	<0.001
	Group B	12	111.75 ± 4.97	113.15 ± 4.99	-1.4 ± 0.86	-5.18	0.001
		11	111.26 ± 6.45	113.11 ± 6.32	-1.85 ± 1.12	-5.23	0.001
		21	111.48 ± 5.89	113.4 ± 5.79	-1.92 ± 1.56	-3.9	0.004
		22	112.23 ± 6.18	113.24 ± 6.1	-1.01 ± 0.54	-5.96	<0.001
p<0.05-statistically significant, 01-Maxillary right lateral incisor, 11-Maxillary right central incisor, 21-Maxillary left central incisor, 22-Maxillary left lateral incisor							

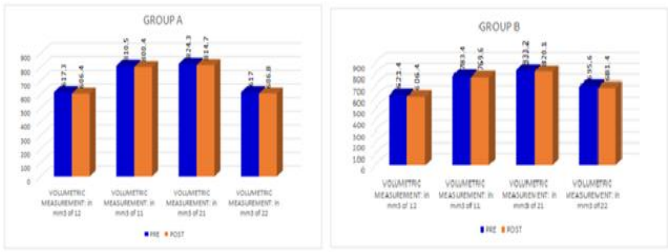

Figure 5. Graph showing volumetric measurements (in mm^3). Pre-treatment and post-treatment values of 12,11,21 and 22 of group A and group B.

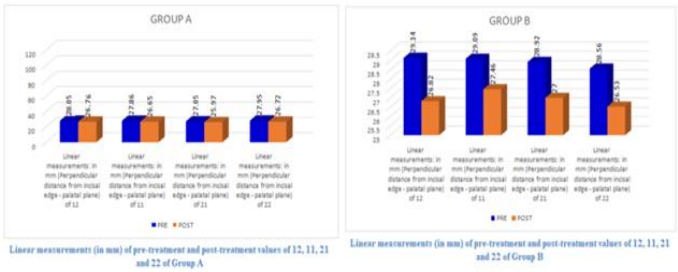

Figure 6. Graph showing linear measurements (in mm). Pre-Treatment and Post-Treatment Values of 12,11,21 and 22 of group A and group B.

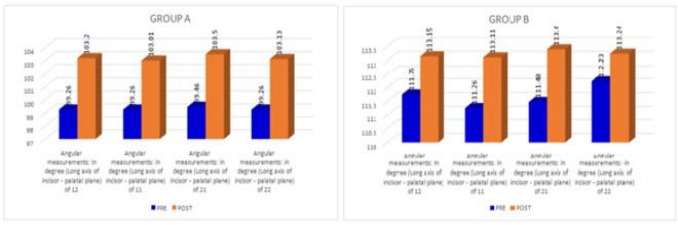

Figure 7. Pre-treatment and post-treatment values of 12,11,21 and 22 of a group and group b. Pre-treatment and post-treatment values of 12,11,21 and 22 of group A and group B.

Table 2 shows independent t-test results, in which for volumetric measurements, the mean value difference of all incisors is higher in group B than in group A with statistically significant results (p<0.05) except 12 which is statistically non-significant (p=0.079). For linear measurements, the mean value difference of all incisors is higher in group B while for angular measurements, the mean value difference of all incisors is higher in group A and is statistically significant with a p-value of <0.05.

Table 3 shows Pearson correlation test results. For group A, the correlation for all incisors shows non-significant results. For group B, 12 and 22 show a significant result while the correlation for 11 and 21 is non-significant.

Table 2. Independent t-test to compare mean differences of volumetric measurements (in mm^3), linear measurements (in mm), and angular measurements (in degree) of all incisors between group A and group B

		Group A(n=10) Mean ± SD	Group B(n=10) Mean ± SD	t	p-value
Volumetric Measurements	Mean Difference of 12	10.9 ± 4.1	15 ± 5.64	-1.861	0.079
	Mean Difference of 11	10.1 ± 2.28	13.8 ± 1.93	-3.912	0.001
	Mean Difference of 21	9.6 ± 2.59	13.1 ± 1.45	-3.729	0.002
	Mean Difference of 22	10.2 ± 4.29	14.2 ± 3.01	-2.414	0.027
Linear Measurements	Mean Difference of 12	1.29 ± 0.49	2.32 ± 0.43	-5.037	<0.001
	Mean Difference of 11	1.21 ± 0.35	1.64 ± 0.52	-2.173	0.043
	Mean Difference of 21	1.08 ± 0.37	1.92 ± 0.44	-4.71	<0.001
	Mean Difference of 22	1.23 ± 0.53	2.03 ± 0.76	-2.71	0.014
Angular Measurements	Mean Difference of 12	-3.94 ± 1.18	-1.4 ± 0.86	-5.51	<0.001
	Mean Difference of 11	-3.75 ± 1.62	-1.85 ± 1.12	-3.053	0.007
	Mean Difference of 21	-4.04 ± 1.18	-1.92 ± 1.56	-3.43	0.003
	Mean Difference of 22	-3.87 ± 1.01	-1.01 ± 0.54	-7.902	<0.001
p<0.05 -statistically significant, 12-Maxillary right lateral incisor,11-Maxillary right central incisor, 21-Maxillary left central incisor, 22-Maxillary left lateral incisor					

Table 3. Correlation between volumetric measurement difference (in mm^3) and linear measurement difference (in mm) of pre-treatment and post-treatment measurements of all incisors using Pearson's correlation

	PARAMETERS BEING CORRELATED	N	Correlation (r)	p-value
Group A	Volumetric measurement difference & linear measurement difference of 12	10	-0.074	0.839
	Volumetric measurement difference & linear measurement difference of 11	10	-0.339	0.339
	Volumetric measurement difference & linear measurement difference of 21	10	-0.546	0.103
	Volumetric measurement difference & linear measurement difference of 22	10	-0.232	0.52
Group B	Volumetric measurement difference & linear measurement difference of 12	10	0.746	0.013
	Volumetric measurement difference & linear measurement difference of 11	10	-0.38	0.279
	Volumetric measurement difference & linear measurement difference of 21	10	-0.222	0.537
	Volumetric measurement difference & linear measurement difference of 22	10	-0.676	0.032
p<0.05-statistically significant, 12-Maxillary right lateral incisor, 11-Maxillary right central incisor, 21-Maxillary left central incisor,22-Maxillary left lateral incisor				

Discussion

Graber has defined "deep bite" as a condition of an excessive overbite, where the vertical measurement between the maxillary and mandibular incisal margins is excessive when the mandible is brought into habitual or centric occlusion. In patients with excessive incisal display due to overeruption of maxillary anterior teeth, a deep bite can be corrected by the intrusion of maxillary anterior teeth. The samples selected in the present study had an overbite of more than 5 mm and an incisal display of more than 3 mm at rest, indicating a requirement for the intrusion of upper anterior teeth. Also, the patients were more than 15 years of age, justifying the growth status of most patients in the maturation or completion stage, so maxillary anterior intrusion is a more stable treatment option. Inflammatory root resorption is a side-effect related to the biological tissue response that enables teeth to be moved during orthodontic treatment. The patients selected for the study were more than 15 years of age, root resorption might be induced with age. Also, endocrine problems are related to root resorption and so patients with such conditions were excluded.

According to various studies, females are more susceptible to root resorption [9]. However, there were no differences in the incidence of root resorption between genders in an overview by Harris [10]. Based on this, the samples for the present study included equal males and females selected randomly. Radiographs are commonly used as a diagnostic aid for root resorption. In recent years, it is suggested that CBCT can detect precise images of small root defects with greater sensitivity and specificity compared to 2D radiographs. The present study was carried out to measure the amount of root resorption using CBCT scans after the intrusion of the upper four incisors with two different intrusion mechanics like intrusion arch (utility arch) and mini-implants. To avoid more radiation exposure by taking lateral cephalograms for linear and angular measurements, the measurements were done in sagittal sections of CBCT scans only.

For estimating root resorption, there was a significant decrease in volumetric measurements of each incisor being intruded in both the groups in post-treatment scans as compared to pre-treatment scans as shown in Table 1. The results concluded that with the intrusion of incisors, there occurs a significant amount of root resorption in all incisors for both groups. In many studies, resorption percentages are considered for root resorption measurement while in the present study, volumetric change was in mm3 (cubic millimeter) considering root resorption occurring three-dimensionally and so comparison with two-dimensional linear decreases (in mm) of root resorption is difficult. For the present study, the amount of intrusion (linear measurement) was measured by taking the palatal plane (ANS-PNS) as a reference plane as in a study by de Almeida in 2018 [6]. The post-treatment scans show a significant decrease in the values of linear measurement as compared to pre-treatment for both groups as shown in Table 1, suggesting a significant amount of intrusion of all incisors during treatment which is under various studies [11].

Utility arch was selected as a means for the intrusion of incisors in group A as it provides less force for intrusion, and is a simple and non-invasive procedure for the intrusion of anterior teeth. The activation of the utility arch was done by placing an occlusal-directed gable bend in the vestibular segment of the utility arch as suggested by McNamara in 1986 generating 50-60 grams of force [12]. Mini implants though being a more invasive procedure, have the advantages of immediate loading, multiple placement sites, uncomplicated placement, and removal procedures, and minimal expenditure for patients. In this study, a rigid stabilizing archwire was used for consolidation during incisor intrusion with two mini-implants so that the center of resistance of four incisors moves closer to each other. Therefore, undesirable side effects such as protrusion could be eliminated during incisor intrusion.

With the use of one mini-implant placed in the center of two incisors, the center of resistance is more anterior as compared to two mini-implants in which it is moved more distally. The center of resistance of the upper four incisors is estimated to be halfway between the crest of the alveolar bone and the apex of lateral incisor roots in the sagittal plane. Results in the present study show a significant amount of intrusion and proclamation of all four incisors after intrusion as shown in Table 1. This can be attributed to the fact that even though force is passing nearer to the center of resistance of all four incisors, it is still labial to it. In the present study, the amount of root resorption for group A for all four incisors is statistically non-significant ($p>0.05$) with the amount of intrusion as shown in Table 3, which is in favor of a study by Costopoulos and Nanda in 1996. There is a significant change in inclination from pre-treatment to post-treatment in both groups as shown in Table 1, suggesting the proclamation of all incisors in both groups. The amount of proclination is more for group A and is less than that achieved in a study done by Polat-Ozsoy in 2011 [5]. They concluded that, unlike utility arches, true maxillary incisor intrusion can be achieved by using mini-screws. Although the amount of proclination achieved in this study is less than in the above study when comparing both groups, there is more amount of proclamation in group A than in group B which is statistically significant as shown in Table 2, and so it can be concluded that relative intrusion is achieved in case of utility arch and true intrusion can be achieved with mini-implants which is in accordance of a study by Jain in 2014. The amount of root resorption achieved by intrusion in group B is more than that in group A for all four incisors as shown in Table 2 which could be presumed as more the distance traveled by the root

through the bone, the greater will be the time it is near the inflammatory process leading to root resorption. There was no correlation between the amount of intrusion and the amount of root shortening according to the findings of Dermaut and DeMunck in 1986 stating that in combination with the apical movement of the root, the nasal floor is also a limiting factor for intrusion which may have caused root resorption, and this can be related to the present study. As shown in Table 3, there is a negative correlation of root resorption with the intrusion of all incisors in group A as well as for both central incisors in group B. The maxillary right lateral incisor shows a more significant positive correlation whereas the left lateral incisor shows a significant negative correlation in group B. This suggests more amount of root resorption in the right lateral incisor along with intrusion, though the value of correlation is 0.746 and statistically significant, it is clinically insignificant. The correlation between root resorption changes and the amount of intrusion for both lateral incisors different can be due to variability in measurement by a single observer.

The mean volumetric difference of lateral incisors is more than those of central incisors for both groups as shown in Table 1. Maxillary lateral incisors have more narrowed or shortened roots and so more force would be orthodontically distributed over smaller root surface areas to intrude the root than with normal root shapes. This is under a study done by Kennedy in 1983. Lund measured slanted surface resorptions of buccal and palatal surfaces of upper incisors using CBCT during orthodontic treatment. For this study, the amount of intrusion is less in group A than that in group B while the number of angular changes is more in group A. It can be inferred that the amount of root resorption in group A can be a combination of both apical root resorption as well as slanted surface resorption on labial surfaces.

Conclusion

- Clinically significant root resorption is observed with the intrusion of maxillary anterior teeth either with utility arch or mini-implants.
- The amount of root resorption and range of intrusion is more with mini-implants, while the amount of proclination is more with the use of utility arch.
- More amount of root resorption is seen in lateral incisors than central incisors in both groups

References

1. Nanda, R., "Correction of deep overbite in adults." *Dent Clin N Am.* 41.1 (1997): 67-87.
2. Creekmore, T.D., "The possibility of skeletal anchorage." *J Clin Orthod.* 17 (1983): 266-269.
3. El N., et al. "Intrusive arch versus miniscrew-supported intrusion for deep bite correction." *Open Access Maced J Med Sci.* 7.11 (2019): 1841.
4. Kumar, P., et al. "Rate of intrusion of maxillary incisors in Class II Div 1 malocclusion using skeletal anchorage device and Connecticut intrusion arch." *Med J Armed Forces India.* 73.1 (2017): 65-73.
5. Polat-Ozsoy, O., et al. "Comparison of the intrusive effects of miniscrews and utility arches." *Am J Orthod Dentofac Orthop.* 139.4 (2011): 526-532.
6. De A., et al. "A comparative study of the effect of the intrusion arch and straight wire mechanics on incisor root resorption: A randomized, controlled trial." *Angle Orthod.* 88.1 (2018): 20-26.
7. Aras, I., et al. "Comparison of anterior and posterior mini-implant-assisted maxillary incisor intrusion: Root resorption and treatment efficiency." *Angle Orthod.* 86.5 (2016): 746-752.
8. Burstone, C.R., et al. "Deep overbite correction by intrusion." *Am J Orthod.* 72.1 (1977): 1-22.
9. Harry, M.R., et al. "Root resorption in bicuspid intrusion: a scanning electron microscope study." *Angle Orthod.* 52.3 (1982): 235-258.
10. Harris, E.F. et al. "Root resorption during orthodontic therapy." *Semin Orthod.* Vol. 6. No. 3. WB Saunders, 2000.
11. Aras, I. et al. "Comparison of anterior and posterior mini-implant-assisted maxillary incisor intrusion: Root resorption and treatment efficiency." *Angle Orthod.* 86.5 (2016): 746-752.
12. McNamara, J.A. et al. "Utility arches." *J Clin Orthod.* JCO 20.7 (1986): 452-456.

Cite this article: Suthar H. *et al.* A Comparative Study of Apical Root Resorption during Intrusion of Maxillary Anterior Teeth Treated with Intrusion Arch and Mini-Implants-A CBCT Study. J Dent Res Pract. 2023, 5 (1), 001-006