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Assessment of root resorption in utility arch and mini-implants

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Abstract:
Deep bite correction often requires maxillary incisor intrusion, which may increase the risk of external apical root resorption. Therefore it is of interest to assess the root resorption of maxillary incisors following intrusion using utility arches and mini-implants. Twenty patients aged 15–25 years undergoing fixed orthodontic treatment were equally allocated to utility arch and mini-implant groups and root resorption was evaluated using CBCT. Mini-implant intrusion showed significantly higher root resorption than utility arch intrusion. Thus, data shows that utility arch is a safer option for maxillary incisor intrusion during deep bite correction.

Keywords: Root resorption, intrusion, utility arch, mini-implants

Background:
Correcting a deep overbite by intruding the incisors is an important step in orthodontic treatment **[1]**. Conventional techniques for incisor intrusion often use appliances like utility arches **[2]**. The integration of temporary anchorage devices (TADs), specifically orthodontic mini implants, has expanded the scope of achievable tooth movements, including those requiring absolute anchorage **[3]**. These devices provide important clinical benefits: they can withstand immediate loading, require minimally invasive procedures for placement and removal, allow placement at multiple intraoral sites with sufficient bone density and serve as a cost-effective treatment option **[4]**. Studies on the link between root resorption and orthodontic treatment are mostly inconclusive **[5]**. Therefore it is of interest to report the root resorption of anteriors using utility arch and mini implants.

Materials and Methods:
The sample had 20 patients with overbites who sought orthodontic treatment at the Department of Orthodontics and Dentofacial Orthopedics at Thai Moogambigai Dental College and Hospital in Chennai. This study focused on patients aged 15 to 25 years undergoing fixed orthodontic treatment. Group 1 consisted of 10 patients with deep bites treated with a utility arch **(Figure 1)**, while Group 2 included 10 patients treated with mini implants **(Figure 2)**. Cone Beam CT (CBCT) scans was done to assess root resorption between the two groups. The committee has approved ethical clearance for the study after all concerns raised in the meeting were satisfactorily addressed NO. 219/2023/IEC/TMDCH Dt. 2.6.23

Activation in utility arch:
Intrusion of the anterior teeth can be achieved using two main methods. The first involves bending a utility arch passively to fit the patient's current bite. After attaching the utility arch to the front teeth brackets, an intrusive force is applied by adding an occlusally directed gable bend-this is similar to the angle formed between the two slopes of a pitched roof-on the back part of the archwire's vestibular segment. This activation also includes placing a tip-back bend in the molar area. The tip-back bend causes the front segment of the archwire to rest in the vestibular sulcus (the area between the teeth and the inner cheek). The intrusion force is then exerted through the incisal segment of the utility arch when it is engaged in the incisor brackets. The tooth is measured in CBCT cross-sectional view. The linear measurement is done on long axis of tooth from incisal edge to apex of the incisors. In this patient, the pre-treatment measurement value was 21.37mm. The post-treatment measurement value was 20.00mm **(Table 2)**.

Activation in mini implants:
Mini-implants measuring 1.5 mm x 8 mm was placed in the buccal alveolar bone in between the roots of the maxillary lateral incisor and maxillary canine. It was inserted under local anesthesia by a contra-angle implant driver (SK Surgicals). A panoramic radiograph which was taken mid-treatment confirmed that the implants did not come into contact with the root of nearby teeth. The implant was loaded with e chains applying a force of fifty grams on each side to achieve complete intrusion of the six maxillary front teeth. In the lower arch, alignment and leveling were mainly accomplished through interproximal reduction. The tooth is measured in CBCT cross-sectional view. The linear measurement is done on long axis of tooth from incisal edge to apex of incisors. In this patient, the pre-treatment measurement value was 20.39 mm. The post-treatment measurement value was 18.01mm **(Table 2)**.

Table 1: Comparing the post-treatment root resorption values for both utility arch and mini-implants using paired t-test.

Utility arch Post-treatment Mean ± SD (N=10)	Mini-implants Post-treatment Mean ± SD (N=10)	t- value	p-value
20.42 ± 1.4	18.28 ± 1.5	12.96	0.003*

Table 2: Comparing the post-treatment intrusion values for both utility arch and mini-implants using paired t-test.

Utility arch Post-treatment	Mini-implants Post-treatment	t- value	p-value
Mean ± SD (N=10)	Mean ± SD (N=10)		
26.76 ± 0.7	25.63 ± 0.5	3.49	0.007*

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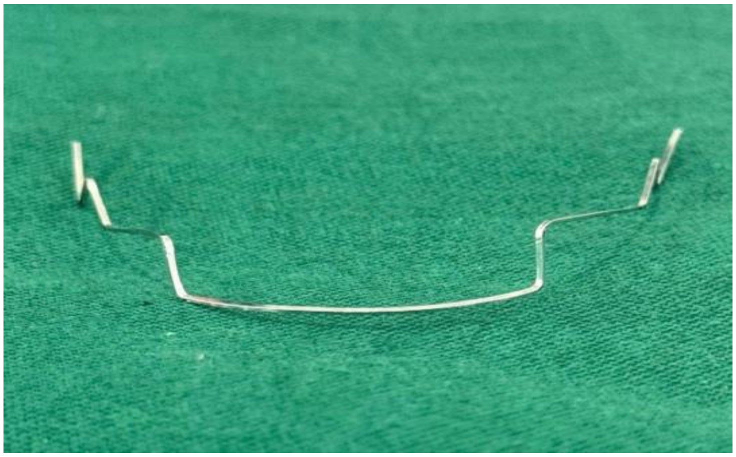

Figure 1: Utility arch

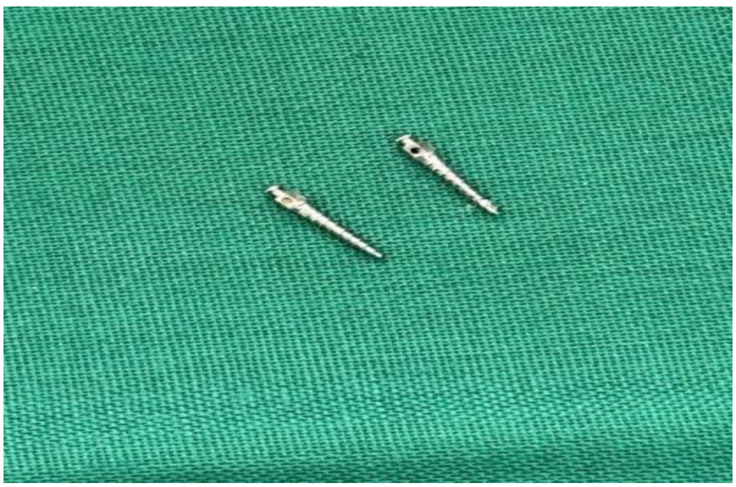

Figure 2: Miniscrews

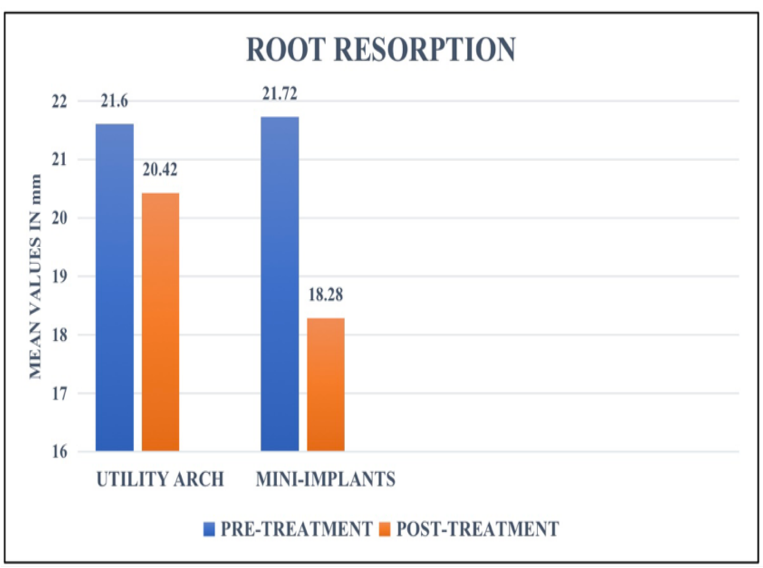

Figure 3: Pre- and post-treatment root resorption values for utility arch and mini-implants

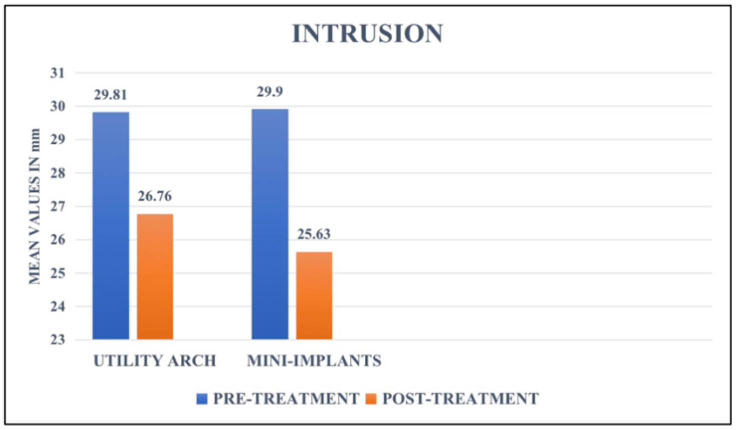

Figure 4: Pre- and post-treatment intrusion values for utility arch and mini-implants

Results and Discussion:

Data analysis was done using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Basic statistics like the mean, range, minimum, maximum and standard deviation were calculated for the clinical data. The Shapiro–Wilk test showed that the data followed a normal distribution. As a result, a paired sample t-test was used to compare values before and after treatment. A p-value of less than 0.05 was considered statistically significant. On comparing the post-treatment root resorption values of the maxillary incisors for the utility arch and mini-implants, a statistically significant difference was observed (p=0.003) **(Table 1)**. It is therefore inferred that the utility arch has lower resorption values with a mean difference between the pre and post-treatment, to be 1.18mm compared to mini-implants (3.44mm) **(Figure 3)**. On comparing the post-treatment intrusion values of the maxillary incisors for both the utility arch and mini-implants showed a major significant difference with a p-value of 0.007 **(Figure 4)**. It is therefore inferred that the mini-implants have higher intrusion rates with a pre- and post-treatment mean difference of about 4.27mm compared to the utility arch (3.05mm) **(Table 2)**. The biomechanical findings of Krishna Reddy *et al.* **[16]** support that the design of the intrusion appliance influences periodontal stress distribution and tooth displacement, which may contribute to differences in the biological response observed with various intrusion mechanics. DeShields **[5]** in 1964 stated that **[1]** root resorption occurs in nearly all orthodontic patients who undergo treatment **[2].** Sex does not seem to influence an individual's susceptibility to root resorption. **[3]** Maxillary central and lateral incisors were equally affected by resorption **[4].** The severity of resorption partly relates to the treatment time and the mechanics employed **[5].** Further research is needed to understand the pulp's role in resorption. In this study root resorption is seen in both utility arch and mini implant group. The mean per and post treatment root resorption values for the utility arch were found to be 21.60+1.3mm and 20.42+1.4mm respectively. Similarly the mean pre and post treatment resorption values for the mini implant were found to be 21.72+1.4mm and 18.28+1.5mm respectively **(Figure 3)**. According to Dermaut and Bulcke **[6]**, two intraoral radiographs were taken during their study: the first after alignment but before the initiation of intrusion and the second following the completion of the active intrusion phase. This methodology ensured that any observed root resorption could be attributed specifically to the period of active incisor intrusion. To minimize radiation exposure, both incisors from the equal quadrant was captured on an intraoral radiographic film. For purpose of resorption assessment, the radiographs were magnified by a factor of three and imprinted on photographic paper. This facilitated accurate identifications of landmarks and improved measurement precision. On the enlarged images, each tooth was carefully outlined and a longitudinal axis was constructed by drawing a line passing through the centre of the incisal edge toward the direction of the canal of pulp. This method of construction axis was consistently applied to both pre-intrusion and post-intrusion images, ensuring reliable comparisons **[7]**. In this study the intrusion was measured using Cone Beam Computed Tomography. The incisors are measured from the apex to the incisor tip of the tooth for both utility arch and mini implant group. The mean pre and post intrusion values for the utility arch were found to be 29.81+0.8mm and 26.76+0.7mm respectively. Similarly pre and post treatment intrusion values for the mini implants were found to be 29.90+0.6mm and 25.63+0.5mm respectively. Senısık and Türkkahraman **[8]** reported that the rate of incisor intrusion was comparable on the intrusive arch and miniscrews systems. Both approaches resulted in protrusive and intrusive of the maxillary front tooth, along with protrusive and extrusive of the mandibular front tooth. However, a key distinction was observed in molar anchorage control. In the intrusive arch group, movement of the maxillary molars resulted to a loss of sagittal and vertical anchorage during the intrusive process. In contrast, anchorage was effectively maintained in the miniscrews group, showing the superior anchorage control provided by skeletal anchorage systems. In this study there is a major difference in intrusion of front teeth in both utility arch group and mini implant group. The intrusion mean value in utility arch group was 3.05mm and the intrusion mean value in mini implant group was 4.27mm respectively. Polat-Özsoy *et al.* **[9]** reported that maxillary intrusion using miniscrews is effective in decreasing incisor protrusion. Additionally, nil signs of resorption were observed in their study, which contrasts with the findings of the present study. Arne Bjork **[14]** observed a natural decrease in overbite throughout adolescence, a trend also supported by Bergersen, who documented a reduction in overbite in the age of 12 and 18 years. In the point to Sinclair and Little **[10]**, deepbite increases between the ages of 8 and 13, followed by a decrease from 13 to 20 years in untreated individuals undergoing normal growth. Specifically, they reported an average increase of 0.40 mm during the change from mixed to permanent dentition and an average reduction of 0.59 mm during the growth of the permanent dentition. This anticipated decrease in overbite during adolescence is considered beneficial for both the correction and retention of overbite in patients treated with the utility arch technique. Concerning the optimal force for tooth intrusion, Burstone recommended applying 20 g of force to intrude anterior teeth, while Gianelly and Goldman **[11]** suggested a range of 15–50 g for smaller teeth. In this study, elastic chains was used to apply 50–60 g of intrusion force on both side, corresponds to 16–20 g per tooth. Despite the forces being within a highly physiologic range, some degree of the root resorption is observed in the periapical radiographs at the finishing of treatment. Early studies on this issue identified the upper incisors as the teeth most prone to root resorption. Current studies suggest that a typical orthodontic treatment course results in a resorption at apex of 1–2 mm in the upper incisors. Our finding are consistent with those of Bardideh *et al.* **[12]** who concluded that mini-implant-supported anterior intrusion is an effective approach for deep bite correction and it is associated with only a limited degree of external apical root resorption that is generally considered clinically acceptable. The findings of the present study are in agreement with Polat-Ozsoy *et al.* **[13]** who showed that mini-implant-supported intrusion produces true maxillary incisor intrusion with effective overbite reduction and minimal changes in incisor inclination. The present findings are consistent with those of Vinu *et al.* **[15]** who reported that mini-implant-assisted intrusion achieved greater maxillary incisor intrusion than conventional intrusion arches.

Conclusion:

Mini-implant assisted intrusion achieved greater maxillary incisor intrusion but was associated with increased external apical root resorption compared with utility arches. No significant sex-related differences in root resorption were observed. CBCT proved to be a sensitive and reliable imaging modality for the early and accurate assessment of root resorption, supporting its use in monitoring patients undergoing orthodontic intrusion.

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