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Comparative evaluation of conventional and mini-implants anchorage for en-masse retraction in Class II Division 1 malocclusion

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Abstract:

Aim & Objective- There has never been a comparison of the treatment results of en-masse retraction of maxillary anterior teeth assisted by mini-implants versus the two-step sliding retraction procedure using traditional anchorage devices.

Methodology- A 133 patients with maxillary dentoalveolar protrusion were examined, out of those only 80 fulfil inclusion criteria with class II division 1 malocclusion were treated. Computer-generated tables were used for randomization, and allocation was concealed using sequentially numbered opaque and sealed envelopes.A total of 56 people (mean age- 22.34±4.56 years) examined. They were divided into two classes at random, each with 28 patients (1:1 allocation ratio). Closure ofspace was achieved using either the en-masse technique with mini-implants or the two-step technique with transpalatal arches after first premolar extraction (TPAs).On lateral cephalograms, the antero-posterior shift of upper incisal edges and upper first molars were assessed at three separate assessment times. The blinding of the assessors was used.

Results-The mini-implants group achieved bodily movement (-4.42 mm; $P<0.001$) by a minor intrusion (-1.53 mm; $P<0.001$) of the maxillary anterior teeth, while by TPA maxillary anterior teeth retraction achieved with controlled palatal tipping.

Conclusion- In terms of tempo, dental adjustments, anchorage loss, and cosmetic outcomes, the en-masse shift based on mini-implants anchorage outperformed the two-step shift based on traditional anchorage

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while retracting anterior teeth in mild to extreme protrusion cases.

Introduction:

To compensate for an inherent jaw difference, camouflage treatment includes moving teeth away from their supporting bone.[1] To avoid mesial shift of the posterior teeth during retraction of the anterior, anchorage can be achieved by extracting two maxillary premolars in class II maloclusion.[2]Many equipment and techniques have been developed to solve the problem of anchorage loss, includingnance holding arch, transpalatal bars, extraoral traction and multiple teeth serving as one anchorage section, anchorage preparation and using light forces.[3]Mini-implants made of titanium alloy have recently been proposed as a basis of skeletal anchorage.[4]

To withdraw the anterior teeth, various orthodontic techniques were identified, including sliding mechanics[5], frictionless loop mechanics[6], labial and lingual orthodontic appliances, and labial and lingual orthodontic appliances.[7] Sliding mechanics can be used to close the spaces created due to extraction either by canine retraction onlyorbyen-masse retraction with anchorage reinforcement.[1,8]

Various researchers investigated the effectiveness of mini-implants for en-masse retraction of anterior teeth since their introduction[2,9-12] and compared with conventional orthodontic mechanics,[2,9-13]however, no research has been performed to assess sliding en-masse retraction with mini-implants as an anchorage system to two-step sliding retraction techniques with conventional anchorage devices.

Over last decade, a rising number of adults have heard about the advantages of orthodontic care.[14]Not only are orthodontists and their patients involved in completingacceptable functional occlusal and consistent clinical outcomes, but also gainingsuperior treatment and an ideal cosmetic look in a specific time is critical priorities for both orthodontists and patient.

The disguise treatment of class II division 1 malocclusions using two-step retraction techniques using sliding mechanics with TPAs as an anchorage method is still used in orthodontic practice today.[15]However, there is no evidence to compare the consistency of the results between this and sliding en-masse retraction assisted by mini-implants anchorage. The aim of this research was to compare the skeletal, dental, and soft tissue treatment outcomes of sliding en-masse retraction of maxillary anterior teeth using mini-implants versus the two-step sliding retraction method using traditional anchorage for class II division 1 malocclusion.

Methodology:

The present study was done in the Department of Orthodontics and Dentofacial Orthopedics of the Dental College. The Dental institution approved the ethical clearance for the study. All the patients were informed regarding the study, and their consent was obtained. The shift of the maxillary incisal edges and first molars antero-posteriorly were used as primary outcome indicators in thisresearch. A sample size of 8 patients were used for each group to assess the horizontal shift of maxillary first molars and 27 patients for each group in relation to the horizontal shift of maxillary incisal edges, as determined by a previous paper.[16]As a result, we selected the larger number as our goal size.

This analysis included 56 participants (35 females and 21 males), whose baseline sample characteristics are described in Table 1. Their informed consent was obtained after they were given information sheets. Figure 2 illustrates a recruiting and follow-up flow map.One of the Orthodontist (who was not interested in this study) conducted basic randomization. He used Minitab® Version 15 to build a randomization list with a 1:1 allocation ratio. The principal researcher, who was registering and testing participants in sequentially numbered opaque and sealed envelopes, was unaware of the distribution sequence.To avoid interfering with the distribution sequence, each participant's name and date of birth were mentioned on the envelope and added to the distribution card for each envelope. When it was time to allocate the intervention, the related envelopes were opened after baseline tests had been completed. The bilateral extraction of maxillary first premolars was the care strategy for both patients in both classes. MBT pre-

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adjusted appliances (RMO®, Denver, Colorado, USA) with a slot size of 0.022″ x 0.028″ is bonded.

There were 28 patients in the mini-implants community (19 females and 9 males). To prevent contact with dental roots, IOPA radiographs with metal guide bars were taken to determine the exact position for the placement of implant.The implants used were self-drilling titanium mini-implants (1.6 mm in diameter and 7 mm in length). They were inserted at approximately 8–10 mm above the archwiresin the mucogingival junction between the roots of maxillary second premolar and first molar and tested for primary retention.Arectangular stainless steel archwire (0.019″ x 0.025″) with 8 mm height anteriorly,soldered hook distal to the lateral incisiors were placed and a force of 150 g applied on either side using two elastic chains connected between the mini-implants and the hook in a position roughly parallel to the occlusal plane for performing an en-masse shift (Figure 3).Every three weeks, the elastic chains were replaced. When a class I canine relationship and a strong incisor relationship were reached, retraction avoided.

There were 28 subjects in the TPAs group (16 females and 12 males). At the start of the procedure, passive TPAs were soldered to the maxillary molar bands (Figure 4).After leveling and alignment, rectangular stainless steel archwire (0.019″ x 0.025″) used and canines pushed distally utilizing closed elastic chain. They were attached with the posterior units to form one group after space closure or achieving a class I canine relationship, and the four incisors then retracteden masse (Figure 5). Patients were examined every three weeks before the four incisors were fully retracted or the incisor relationship was fine.

T1- at the start of treatment; T2- after leveling and alignment; T3- after achieving a class I canine and a strong incisor relationship independent of the molar relationship and slightly potential remaining minor space distal to the canines.Figures 6 and 7 depict dental measurements (linear and angular). The primary outcome measures in this analysis were the shift of the maxillaryanteriors and first molars beside the mid-sagittal axis, while the secondary outcome measures were landmark shift in the vertical plane and skeletal and soft tissue components.To prevent evaluation bias, the cephalograms were blinded by a trained PhotoshopTM designer who, after a period of training and adaptation, became familiar with the presence of TPAs, miniimplants, and soldered hooks on radiographs. Predesigned outline reflecting the mini-implants and soldered hooks were placed into cephalogramsof TPA group while outlines simulating the form of TPAs were placed into cephalogramsof mini-implant group using Adobe Photoshop.The native resolution of the images was not altered and care was taken to avoid masking significant landmarks. As a result, regardless of which category they belonged to, all radiographs had the three essentials (TPAs, soldered hooks, and mini-implants).

To measure landmark displacements, a co-ordinate scheme was developed on the initialcephalogram and then shifted to the T2 and T3 tracings. To locate of these landmarks, a coordinate system used, as shown in Figure 7.The cephalometric application Viewbox® used and data were recorded as Excel to analyze statistically.

Minitab® 15 was used to conduct all statistical analyses (Minitab Inc.). To check the data distribution, Anderson–Darling normality tests were used, paired-sample t-test and Wilcoxon matched-pairs signed-rank test were applied to determine intragroup shifts, and two-sample t-testand Mann–Whitney U-test were applied to assess intergroup variances.

Results:

The method's error was small when calculated using formula of Dahlberg.[17]The calculations were extremely precise, and no errors was observed in any of the variables. The TPA group had a shorter treatment time for the upper dental arches (from T1 to T3) than the mini-implants group (12.90 and 16.97 months, individually). Three mini-implants loose throughout the retraction phase, while 53 remained stable during the procedure. Loosened implants were eventually repositioned in the adjacent bone.

The SNA angle in the mini-implants group (Table 2) and the TPAs group (Table 3) was substantially

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reduced (T3–T1), while there was no substantial variation in the SNB angle for both groups. The TPAs group had a substantial reduction in the SN-MP angle when assessed vertically, but difference wasnot significant compared to the mini-implants group.Both groups A and B encountered major shifts in the MM angle. Statistically important decreases in the mean face height index values were observed in the mini-implants group and TPAs group during the retraction process (T2–T3). At all measurement times, no substantial changesrecorded between the groups for the majority of the skeletal variables (Table 4).

The maxillary incisor edges were withdrawn significantly and intruded in the mini-implants group (Table 2), but they were retractedand extruded significantly in the TPAs group (Table 3). At T2 and T3, there were substantial intergroup discrepancies (Table 4).The apices of the maxillary incisors were retracted and intruded substantially in the mini-implants group, but not in the TPAs group.

Following retraction, the maxillary molars in the mini-implants group were significantly distilised by 0.89 mm, while in the TPAs group were significantly forward displaced (1.50 mm). At T3, the TPAs group showed substantial molar extrusion (P = 0.009). In both groups, there was a statistically important backward retraction of the upper and lower lips (upper 2.98 mm and lower 2.47 mm in groups A and B, respectively). Soft tissue changes were more evident in the mini-implants group than in the TPAs group.

Discussion:

The mini-implants acted like ankylosed teeth in this study, give not only complete anchorage but also statistically significant distal shift (0.89 mm) of the maxillary molars as a result of the force of retraction applied to anteriors, that was converted to posterior teeth through interdental relations; a outcome recorded in another published articles.[10-12]Surprisingly, even though the use of mini-implants as an anchorage method, some papers recorded mesial shift of the maxillary molars.[2,13,18]It may be because of the natural movement that occurs due to early extraction of the maxillary first premolars at the start of treatment with a delayed start of the retraction process[2,13] or the use of retraction utility archwires directly assisted by mini-implants without involving the maxillary molars in treatment.[2,13,18]while using an indirect molar anchorage by tightening a ligature wire from molar tubes to mini-implants, the image of posterior teeth action will be different. This form of indirect anchorage warrants further researches.

Even though retracting anteriors in two stages, TPA significantly did not increase orthodontic anchorage in present study.This is consistent by the idea that TPAs are secondary anchorage options that can't be used in situations where optimum anchorage is necessary, such as extreme crowding or protrusion. TPAs with en-masse retraction of the maxillaryanteriors may have been used to determine anchorage loss in this study, as Liu et al. (2009)[12] found a mean of 1.47 mm anchorage loss, but a decision was taken in this study to avoid en masse retraction of the anterior six teeth and instead use a two-step sliding process in the hopes of minimizing anchorage needs.Though, target was not reached, and a mean anchorage loss of 1.50 mm was discovered in presentresearch.

This research is similar to one performed by Sharma *et al.*, (2012)[15], who compared mini-implants and TPAs as anchorage strategies in relation to dental shift following retraction. Though, their research just looked at canine retraction, while this paper looks at the entire upper anterior teeth retraction.Sharma et al. (2012)[15] found no molar movement with mini-implants and a mean of 2.48±0.71 mm mesial shift with TPAs, while this research found distal molar movement with mini-implants and fewer anchorage loss with TPAs. This research differs from the two reported researches by Upadhyay et al. (2008)[10,11] in that we compared en-masse retraction of anterior teeth to the two-step retraction technique, while he did not take into account the two-step retraction findings.

While Xu et al. (2010)[19]assessed the relative efficacy of anchorage preservation between the en-masse and two-step retraction techniques in cases that need maximumanchorage, the results of this research cannot be directly related. Between the two researches, the entire study plan and several minor proceduralfacts are dissimilar. As a result, we conclude that this research plan introduced and contrasted two treatment situations that were similar to orthodontic practice in patients with dentoalveolar protrusion

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than Xu et al (2010).[19]

A mean of 4.5 mm of translational backward shift of maxillary incisors was achieved using sliding mechanics with mini-implants anchorage and a horizontal force axis positioned 8 mm over the archwire. It wasbecause of the applied force axis moving near to the maxillary anterior teeth's center of resistance, that is difficult to do when the axis of force travels along the simple archwire, as seen in the TPA group. The maxillary incisor edges were retracted an average of 5 mm in the TPA community, but their apices did not show any noticeable improvement.As a result, palatal tipping was primarily regulated by upper incisors without bodily movement. These findings are consistent with traditional anchorage group in Lee and Kim's (2011)[20] study, which used headgears and TPAs as anchorage instruments, and Upadhyay et al.,(2008)[11]research, that used a variety of conventional anchorage reinforcement to better fit patients' needs.

The amount of upper incisor translational movement differs between studies using mini-implants as anchorage strategies during en-masse retraction. Park and Kwon (2004)[5]achieved up to 7 mm of bodily retraction, while Yao et al. (2008)[13] found that their mini-implants had more translational movement than controlled tipping. This study done about 4.5 mm of bodily retraction, while Upadhyay et al. (2008)[11] recorded only about 1.0 mm, which could be explained by their use of 0.017″ x 0.025″ stainless steel archwires in 0.022″ bracket-slots, that made torque control challengingwhile retraction.[11]

The maxillary incisor edges and apices were intruded significantlyin the mini-implants group, because of the location of the anterior hooks at 8 mm gingival to the bracket slot in the mini-implants group, while the maxillary incisor edges and apices were extrudedsignificantly in the TPA group.The current research found that at the end of the retraction point, the upper incisor axis in the mini-implants group had an ideal inclination of 102.20^0±2.91 with the anterior cranial base, while they weretippedpalatally in the TPA group (a mean of 97.79^0±1.45). Particularly, the first methodenhanced incisal tendency, that is one of the most challenging treatment targets in typical camouflage corrections.[21]

In relations of soft tissue alterations, it is proposed that the way in which anterior dental retraction is handled regulates the degree of anterior dental retraction and the subsequent shift in lip position.[22]Both upper and lower lips were retracted and the nasolabial angle increased more in the mini-implants group than in the TPA group because the upper incisors shifted more distally in the mini-implants group. These findings are close to those of Upadhyay et al., (2008)[10,11] and Liu et al., (2009).[12]

Owing to the likelihood of passing the axis of force near to the centre of resistance of the upper anterior teeth, it appears that en-masse retraction with mini-implants not only simplify the biomechanics involved, but also regulates the antero-posterior and vertical motions of both anterior and posterior teeth. The en-masse retraction technique is favoured by orthodontists and patients because it prevents disto-palatal rotations and distal flipping of retracted canines, as well as the presence of unsightly distal spaces of lateral incisors following canine retraction.Management with mini-implants helps to stop using molar bands andtubes, as well as reducing the time spent in the lab fabricating TPAs. Another downside of the two-step method over the en-masse technique is that the latter method greatly decreases recovery time and encourages patients to see substantial progress in a short duration, which is supposed to increase patient support and inspiration.

Lastly, the findings in this study lead us to conclude that en-masse retraction with sliding techniques and mini-implants anchorage is a safer substitute to the standard two-step retraction with TPA anchorage, and that it can be a superior option when preparing an extraction-based procedure with mild to extreme maxillarydentoalveolar protrusion.

Conclusion:

The en-masse retraction based on mini-implants anchorage outperformed the two-step retraction based on traditional anchorage in relations of speed, anterior and posterior dental improvements, anchorage loss, and cosmetic consequences when retracting maxillary anterior teeth in patients with moderate to extreme

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protrusion.

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