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Comparison between the Treatment Effects of Retraction Using Mini-Implant Method of Anchorage and Conventional Method of Anchorage Using Sliding Mechanics

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ABSTRACT

Background: The employment of extraoral (headgear, facemask) or intraoral (transpalatal arch, nance holding arch, multiple teeth as anchor segments) appliances in the past has not been without drawbacks, including poor patient compliance and unfavourable reactive tooth motions. Temporary Anchorage Devices (TADs), which are anchored in bone, were developed to get around these restrictions. They may be employed as direct anchors or to support the anchorage unit's posterior teeth (indirect anchorage).

Aim: This study compares the treatment effects of retraction using two methods of anchorage, namely, mini-implant and conventional methods, using sliding mechanics.

Methods and Materials: 32 participants were enrolled and divided into two groups of 16 each. Following sampling, the traditional group (Group 2) had 4 males and 12 females, while the implant group (Group 1) included 8 males and 8 females (mean age 19.87 years) (mean age of 22.25 years). The 0.022" slot MBT appliance with readjusted edges was selected, and the molars were banded. A 19 x 25 ss wire that was passively engaged was used for retraction. A lateral cephalogram, an OPG, study models, extraoral and intraoral pictures, as well as other pre-retraction data, were taken at this time and repeated after 4 months of retraction.

Results: The implant group's molar displayed a small amount of net distal displacement, measuring -0.45 0.94 mm on the mesial and -0.48 ± 0.93 mm on the distal side of the tooth. However, the conventional group demonstrated a highly substantial mesial movement of 1.18 mm on the distal and 1.0 mm on the mesial. There was a statistically significant difference between the groups (p 0.05). There was some extrusion in the implant group as well as a net intrusion of -0.61±0.78 mm on the mesial and -0.78±0.10 mm on the distal in the vertical direction. The typical group, however, displayed extrusion.

Conclusion: In terms of effective tooth movement or anchoring management, it may be said that mini-implants offer a better therapeutic outcome. As a result, they shorten the length of therapy, which is advantageous for both the patient and the orthodontist.

Keywords: Mini-implant, Anchorage, Orthodontic treatment

INTRODUCTION

Facial aesthetics is one of the main issues facing orthodontic patients. Patients also desire quick turnaround times for their treatments that don't last for years and don't necessitate ongoing oral hygiene maintenance. This will enhance both dental health and general health without wearing patients out with prolonged treatment sessions. Young adults have more confidence when they look better. In situations of Angle's Class II Div I malocclusion and Class I bimaxillary protrusion, cases of protruding upper lips are also present.[1] Such situations necessitate the therapeutic extraction of the first premolar, and ideally, the anterior teeth are totally retracted without any unintentional reactionary mesial molar movement.

The third law of Newton states that there is an equal and opposite reaction to every action. Consequently, one of the main issues for orthodontists has been anchoring management. The term "base against which orthodontic force or reaction of orthodontic force is applied" was used by Louis Ottofy in 1923.[2] Williams and Hosila discovered that in first premolar extraction cases, only 66.5% of the extraction space is used while retracting anterior teeth.[3] As the posterior segment slides mesially when retraction is attempted, only two-thirds of the extraction space is available for the retraction of the anterior segment and relieve of crowding, according to Creekmore.[4]

The employment of extraoral (headgear, facemask) or intraoral (transpalatal arch, nance holding arch, multiple teeth as anchor segments) appliances in the past has not been without drawbacks, including poor patient compliance and unfavourable reactive tooth motions. Temporary Anchorage Devices (TADs), which are anchored in bone, were developed to get around these restrictions. They may be employed as direct anchors or to support the anchorage unit's posterior teeth (indirect anchorage). In order to intrude maxillary incisors in a 25-year-old girl, Creekmore and Eklund employed a vitallium implant for anchorage for the first time in 1983.[5] In 1997, 14 years later, Konami used orthodontic anchors from mini-implants.[6] As a result, numerous screws with various designs were created.

When anterior retraction is required in the first premolar extraction space (Angles Class II div I or Angles Class I with bialveolar protrusion), this study compares the treatment effects of retraction using two methods of anchorage, namely, mini-implant and conventional methods, using sliding mechanics. A 4-month period's worth of tooth movement, including the amount of retraction and anchor loss, was noted.

MATERIALS AND METHODS

There was a prospective clinical trial. The following were the patient selection criteria: (1) Thorough medical and dental records demonstrating a lack of any systemic diseases (2) lack of all teeth, save third molars, that are congenitally absent. (3) Cases with little to no anterior crowding; (4) situations where excision of the first premolar is necessary for therapeutic reasons. (5) Angles Class II malocclusion with proclined anteriors or Angles Class I bimaxillary protrusion, requiring a maximum anchoring of 75% to 100% space closure. (6) Young patients who are between the ages of 16 and 25, far past pubertal development.

Individuals who had undergone orthodontic treatment in the past or had a history of periodontal disease were not included in the study.

32 participants were enrolled and divided into two groups of 16 each. Following sampling, the traditional group (Group 2) had 4 males and 12 females, while the implant group (Group 1) included 8 males and 8 females (mean age 19.87 years) (mean age of 22.25 years).

The 0.022" slot MBT appliance with readjusted edges was selected, and the molars were banded. A 19 x 25 ss wire that was passively engaged was used for retraction. A lateral cephalogram, an OPG, study models, extraoral and intraoral pictures, as well as other pre-retraction data, were taken at this time and repeated after 4 months of retraction.

The fundamental retraction mechanism has three components.

1. Anterior segment
2. The rear portion.
3. Retraction A Niti coil spring with a power arm and an anchor source attached to either end.

The position between the second premolar and the first molar was chosen for the implantation of implants on either side for patients in group 1 (the implant group). The titanium implants from SK Surgical (Pune) were chosen. A template composed of 17 25ss wire was used for exact positioning. To avoid a deepening of the bite during the closing of the space, the implants were positioned as high as feasible in the associated gingiva. The parallex approach was then used to take IOPAs to verify the proper placement of the template.

Local anaesthetic was administered above the location following thorough cleaning and asepsis. To identify the location of the implant, a bleeding point was created in the middle of the template's eyelet. A 1.3 x 8 mm self-tapping implant was placed at the location of the bleeding point on both sides after the jig was removed. Another IOPA was done to confirm proper implant placement after the primary stability of the implant was examined. Power arms were soldered hooks between the lateral incisor and canine on the functioning archwire. As proposed by Park, retraction force was delivered a week following implant implantation using closed coil Niti springs, producing 150–160 grammes of force calibrated using a dontrix gauge. The force levels were examined after starting the retraction mechanics.

Traditional anchorage techniques were used for group 2. The second premolar, first molar, and second molars were connected together to form the buccal stabilising segment after levelling and alignment, when a passive 19 x 25 ss wire was reached. To prevent anchoring loss, the posterior segments on either side of the arch were connected using TPA (transpalatal arch). 0.019 x 0.025 inch ss wire was used for the retraction phase in order to strengthen the stability of the posterior segment and prevent lingual tilting of the anterior section while retracting. Similar to the implant group, a power arm was soldered. While comparing the pre- and post-retraction stages of a lateral cephalogram, it was possible to detect molar anchoring loss and incisal retraction. The movements of the molar and incisor were then evaluated using the stable cranial reference of the SN plane.

Type of Tooth Movement

The quotient of the moved distance of the most apical point (Ia) and the moved distance of the most occlusal point (Io) was calculated to look for changes in the location of the central incisors. If the apical point moved in the opposite direction from the coronal point or vice versa, a negative sign was assigned to the quantity. Classification of tooth movement was performed using the following scale: (Ia/Io): 0, uncontrolled tipping; = 0, controlled tipping; > 0, controlled tipping and bodily movement; 1, bodily movement; and > 1, root movement. Calculated and evaluated were the 3 sorts of tooth movement's numbers and percentages.

Statistical analysis

For the statistical analysis, the SPSS software package (version 20.0, Chicago, Illinois) was utilised. For all results obtained from the lateral cephalogram, the mean and standard deviation were calculated. Paired sample t-test was used to gauge treatment changes in the implant and conventional groups. The mean treatment changes between the two groups were compared using the independent-samples t test. The threshold for significance was set at $P < 0.05$.

RESULTS

Retraction was assessed for 4 months and comparison was done for anchorage loss and incisor retraction. Changes were assessed when pretreatment values were subtracted from the post-treatment. Positive values reflected mesial movement, crown anterior movement, and posterior root movement and indicated a significant post-treatment value. A negative number denotes root modifications at the anterior and angular front, as well as distal movement.

Molar movements

The implant group's molar displayed a small amount of net distal displacement, measuring -0.45 0.94 mm on the mesial and -0.48 ± 0.93 mm on the distal side of the tooth. However, the conventional group demonstrated a highly substantial mesial movement of 1.18 mm on the distal and 1.0 mm on the mesial. There was a statistically significant difference between the groups (p 0.05). There was some extrusion in the implant group as well as a net intrusion of -0.61±0.78 mm on the mesial and -0.78±0.10 mm on the distal in the vertical direction. The typical group, however, displayed extrusion. However, the conventional group displayed considerable mesial tilting of -2.36±1.33 (anchor gain) while the implant group displayed net distal molar tipping of 0.563±0.07 (anchor loss).

Movements of maxillary incisor

As comparison to the conventional group (-3.23 ± 0.55 mm), the implant group saw greater incisor retraction (-5.12 ± 1.21 mm). The crown shifted distally exhibiting primarily controlled incisor tilting, but the incisal root apex moved distally in implant anchoring only minimally (-0.73 ± 0.06 mm). However, the conventional group's mesial (+0.6 ±1.49 mm) and distal (+0.6 ± 1.49 mm) apex and crown movements resulted in uncontrollable tilting. In the implant group, the maxillary incisor apex showed a substantial incursion of -1.1±0.86 mm, but the incisal edge showed a less significant intrusion of -0.64 ±1.16 mm. There was noticeable incisal extrusion in the conventional group. Thus, there was a considerable intergroup difference. In the implant group, the incisal proclination (I Angle) fell by -12.36°±3.55°, while in the conventional group, it decreased by -7.67°±3.92°. (Table 1)

Rate of Retraction

Retraction with implants was 5.0 mm (1.36 mm/month) and 3.136 mm (0.89 mm/month) in the traditional group throughout a 4-month period.

Type of Tooth Movement

The implant anchoring brought about controlled tipping with some translation (Ia/Io = 0.22 ± 0.27). The majority of the conventional group's tipping was uncontrolled (Ia/Io= -0.24 to 0.53). Statistics showed that the intergroup differences were not significant.(Table 2)

In the implant group, controlled tipping occurred in 63.6% of cases. There was also some controlled tipping accompanied by physical motion. The percentage of this movement was higher than that of the traditional group (26%). The typical group exhibited uncontrolled tipping in the majority (76%). In the implant group, there was no uncontrolled tilting (0%).

Table 1: Intergroup Comparison Of Changes In Linear And Angular Measurements.

Parameter	***n***	**Group 1**		**Group 2**		**95% Confidence Interval**		***t***	***P***	**Sig.**
		Mean	**SD**	**Mean**	**SD**	**Lower**	**Upper**			
U6M-SV (mm)	16	-0.354	0.85	1.11	0.389	-2.049	-0.65	-4.16	0.01	S
U6D-SV (mm)	16	-0.386	0.84	1.199	0.383	-2.17	-0.842	-4.99	0.01	S
U6M-PP (mm)	16	-0.529	0.68	0.198	0.541	-1.358	-0.054	-2.21	0.05	S
U6D-PP (mm)	16	-0.682	0.9	0.574	0.188	-2.078	-0.412	-3.57	0.02	S
U6 Angle (°)	16	0.574	3.09	-2.261	1.236	0.183	5.464	2.653	0.04	S
Ia-SV (mm)	16	-0.636	0.97	0.61	1.39	-2.429	0.179	-1.9	0.09	NS
Io-SV (mm)	16	-5.11	1.11	-3.136	0.443	-2.807	-0.865	-4.17	0.01	S
Ia-PP (mm)	16	-1.11	0.77	0.563	0.331	-2.226	-0.921	-5.39	0	HS
Io-PP (mm)	16	-0.542	1.07	0.761	0.546	-2.21	-0.364	-3.07	0.02	S
I Angle (°)	16	-11.36	3.45	-7.574	3.823	-7.597	0.223	-2.14	0.07	NS

Table 2: Comparison of incisor movement in the sagittal plane.

Parameter	***n***	**Group 1**		**Group 2**		**95% Confidence Interval**		***t***	***P***	**Sig.**
		Mean	**SD**	**Mean**	**SD**	**Lower**	**Upper**			
Ia/Io	16	0.126	0.18	-0.149	0.44	-0.123	0.628	1.57	0.16	NS

DISCUSSION AND CONCLUSION

In order to improve their appearance and consequently their psychological well-being, patients seek orthodontic treatment. The best treatment outcomes come from retracting protruding teeth while maintaining the anchorage, and numerous procedures have been developed for this purpose. If enough control is maintained, the patient may receive shorter appointment times and overall shorter treatment duration. Traditional anchorage needs are more important, and several techniques including banding the first and second molars, using the transpalatal arch, and wearing headgear are used.

Self-tapping screws or miniscrews/microimplants have been developed to improve anchoring while trying space closure. They can be utilised to obtain direct anchorage without unintentional movements of the anchor tooth because they are fastened inside the alveolar bone. According to studies, they shorten the retraction period without patient cooperation.[1,8] In our study, there were no implant failures, hence the success rate was 100 percent. The retraction force was delivered near to the centre of resistance of the anterior six teeth in order to prevent uncontrollable tipping and incisor intrusion.[9]Force had a greater horizontal component than vertical component.

In the traditional group, the retraction force was applied anteriorly from the power arm on the first molar tube to the soldered hook, moving the line of force further from the anterior teeth's centre of resistance. This resulted to extrusion and uncontrolled tilting.

Although small, the implant group (Group 1) in our study demonstrated net distal movement of 0.46 mm and distal tipping of 0.67° (anchor gain) of maxillary molar. When molar distalization takes place, the mandibular plane opens up due to the wedging effect caused by the molars' concomitant extrusion. Although though it was minimal (-0.62 mm on the mesial and -0.77 mm on the distal side), we nevertheless managed to achieve molar intrusion. According to Nanda, the continuous archwire may have moved the posterior portion, resulting in distal tilting and intrusion, when performing enmasse retraction of anterior teeth utilising implants. The distal tip and molar intrusion could be caused by this.

The forces were not severe and frequent activation was avoided, as advised by Nanda, therefore distal tipping and intrusion were not excessive enough to result in an anterior open bite. The standard group, which included 2.nd molar banding and anchorage with TPA, experienced considerable anchor loss of 1.91 mm and mesial molar tipping of -2.36°. When the canines were retracted, 5 to 50% of the anchor loss occurred when the anchor unit only included the second premolar and the first molar.[12] According to a study, mesial molar movement using conventional mechanics ranged from 1.6-4 mm.[13] Intraoral transpalatal arch helps with anchoring to some extent.

However research by Bobak et al[14] and Ingervall[13] and others has demonstrated that the transpalatal arches do not appreciably alter the orthodontic anchoring. In an attempt to retract the canines using traditional molar anchoring, Thiruvenkatachari et al. recorded anchorage loss of 1-2 mm with a mean of 1.6 mm in the maxilla.[15] According to Basha et al., the traditional group experienced 1.73 mm more anchor loss than the implant group, which was statistically significant.[16] In addition, Upadhyay et al.[10] reported substantial mesial movement of 1.95 mm with molar mesial tipping of 3.7° in the traditional techniques of anchorage. Thus, it is very likely that implants are better in providing anchorage. More recently, implants gave stronger anchoring, according to Davis et al[17] and Khlef et al.[18] Becker et al. observed an increase in anchoring when mini-implants were used as anchors.[19] These findings were consistent with our research.

In four months of retraction, our study revealed incisor retraction of 6 mm in the implant group and 3.24 mm in the conventional group, with a statistically significant difference ($P <0.05$). The implants were positioned so that the forces were applied slightly below the six anterior teeth's centre of resistance. In the implant group, this led to mostly controlled tipping, which is ideal.

The greater incisor retraction in the implant group may be explained by the absence of mesial molar movement during incisor retraction, whereas mesial molar movement decreased retraction force in the conventional group. This result was consistent with those of the study by Thiruvenkatachari et al., in which canine retraction moved more quickly in the implant group (4.29 mm) than in the traditional group (3.79 mm).[15]

In the implant group, there was a considerable mean intrusion at the apex (1 mm), but only a 0.53 mm intrusion at the incisal edge. The implant group's net incursion at the apex and incisal edge was caused by the retraction force vector's little vertical component of force despite its primarily horizontal orientation.

In contrast, the traditional group saw significant extrusion at the incisal edge (0.86 mm) and apex (0.67 mm), as the force vector was horizontal and farther from the anterior teeth's centre of resistance. This resulted in unintentional tipping and bite deepening. These findings are supported by research by Rajni et al., Upadhyay et al[20], etc. Differences between the two groups were very significant at the apex and significant for the maxillary incisal edge because the implant group's intrusion was more obvious at the apex. Even though a hefty 19 x 25 ss wire was employed, the angular incisal alterations in the implant group (-12.36°) were greater than the typical (-7.67°).

This is understandable given that the patient sample in the implant group had, on average, more proclined anteriors preretraction and that the conventional group's wires had a mild curve of spee to prevent bite deepening. With implants, controlled tipping was the most common tooth movement. The traditional group, however, exhibited a lot of uncontrolled tipping. As the apex in the conventional group only migrated mesially by a mean of 0.6 mm to create uncontrolled tipping, the intergroup difference was inconsequential. The width of the alveolar bone and the palatal cortical bone may be some of the constraints during orthodontic retraction, according to Horiuchi et al.[21] For each patient, the alveolar bone's width was sufficient.

The mid-root and alveolar edges of the bone reformed with tooth movement, but not at higher levels, according to a research by Edward et al.[22] He deduced that the alveolar bone in the anteropalatal curve interfered more with tooth retraction. This might be the cause of the implant group's restricted distal apical mobility. Moreover, the forces were focused at the anterior segment's centre of resistance, resulting in controlled tilting, which is desirable when teeth are strongly proclined. In the traditional group, tipping was mainly uncontrolled because the retraction force vector was primarily horizontal and away from the anterior teeth's centre of resistance. The generation of a clockwise moment resulted in lingual extrusion and tipping..

The implant group in Upadhyay's study[10] shown controlled tipping and partial translation. This was comparable to our research. However in his study, the typical group exhibited primarily controlled tipping along with some uncontrolled tipping (-0.15± 0.56 mm). In his investigation, the intergroup difference was statistically significant. In contrast to our study, just a small amount of controlled tipping accompanied with movement was observed in the traditional group. The apex moved in the opposite direction from the incisal edge to create uncontrolled tipping, but this movement was very slight and the change was non-significant (Ia-SV P <0.05), therefore the intergroup difference of Ia/Io was also inconsequential.

In terms of effective tooth movement or anchoring management, it may be said that mini-implants offer a better therapeutic outcome. As a result, they shorten the length of therapy, which is advantageous for both the patient and the orthodontist.

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