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Comparison and Measurement of Molar Anchorage Loss during En-Masse Retraction Using Mini-Implant and Conventional Mechanics

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Abstract

Aim: To compare and measure molar anchorage loss during en-masse retraction using mini-implant and conventional mechanics. ***Objectives****:* 1) To evaluate the molar anchorage loss during en-masse retraction of anterior teeth by using conventional mechanics. 2) To evaluate the molar anchorage loss during en-masse retraction of anterior teeth by using the orthodontic mini-implant as absolute anchorage. 3) To measure and compare the molar anchorage loss during en-masse retraction using mini-implant and conventional mechanics. ***Methods:*** The study was carried out on 10 patients requiring extraction of four first premolars and maximum retraction. On the right side (experimental side) mini-implants were placed between the second premolar and first molar and an e-chain was engaged from the head of the implant to the crimpable hook. On the left side (control side) an e-chain is given from crimpable hook to molar hook for en masse retraction. The retraction space closure was calculated using vernier caliper on the study model after 28weeks of retraction. Lateral cephalogram was taken before and after orthodontic retraction for calculating molar anchor loss. ***Results:*** The retraction space closure after 28 weeks showed a mean value of 3.59±0.68mm on the mini-implant side and 3.98±0.62mm on the conventional mechanics side, which was statistically significant. The anchor loss of 0.17±0.3 mm was observed on the mini-implant side and 1.32±0.62 mm was observed in the conventional mechanics after retraction, which was found to be statistically significant. ***Conclusion:*** In this study, the molar anchor loss of 0.17± 0.3mm was seen on the mini-implant side and 1.32±0.6mm on the conventional mechanics side which was significantly more by 1.15mm than the mini-implant side. The closure of extraction space on the mini-implant side was done by retraction of anterior teeth and minimal anchorage loss, while in the conventional mechanics side there was anchor loss of anterior as well as posterior teeth.

Keywords: Mini-implants, conventional mechanism, anchor loss, retraction, space closure.

Introduction

Tooth levelling and aligning is normally the first objective for the early stage of orthodontic treatment; along with it another important objective is anchorage control [1].

Anchorage control turned out to be highly demanding as the conventional approaches were commonly associated with anchorage loss, i.e., mesial migration of the posterior dental anchorage units [2]. To improve anchorage control, differential moments and monitoring in clinical studies are required. The outcomes of the conventional treatment were promising, but anchorage loss and unexpected space opening have also been reported due to activation failures. Some authors recommend that sequential retraction may be more effective than en masse retraction of the anterior segment to preserve anchorage [3, 4].

According to Williams and Hosila (1975) [5] in a patient whose first premolars are extracted, only 66.5% of the available extraction space was taken up by retraction of the anterior segment. In 1997 Creekmore [6], stated that as a rule of thumb when first premolars are extracted, one can expect the posterior teeth to move forward approximately one-third of the space for relief of crowding and incisor retraction.

Ravindra Nanda and Charles J. Burstone [7] described three types of anchorages. *Group A* which is considered as a critical anchorage, involves 75% movement of anterior teeth and 25% posterior teeth. Group *B* is considered moderate, which involves 50% movement of both anterior and posterior teeth. *Group C* is considered non-critical and involves posterior teeth moving forward 75% and front teeth moving backward 25%. *Absolute* anchorage is needed in treatment when there is a need for 100% movement of anterior teeth backward. This type of anchorage is usually produced by adjunctive anchorage systems like using mini-implants or temporary anchorage devices.

In the MBT system, during the early treatment phase, the anchorage control needs for a case can be assessed by comparing the position of the upper and lower incisor with the planned incisor position (PIP) at the end of the treatment. There are different methods to maintain the anchorage such as viz, laceback, bend back, lingual arch, etc. [1].

In recent times, orthodontic mini-implants have gained enormous popularity and are considered the absolute source of orthodontic anchorage. When compared to conventional anchorage preparation, they have a key advantage, such as easy placement and removal of mini-implants, immediate loading, placement at various anatomic locations (between the roots of teeth), and cost-effectiveness. These mini-implants have procreated numerous clinical applications, like an en-masse retraction of anterior teeth, intrusion etc.

Mini implants should ideally remain fixed when orthodontic force is applied. The mini-implants stability has become a problem because it does not ground on osseointegration, but it depends on mechanical locking of threads into the bony tissues which aid in supporting the orthodontic treatment. The success of mini-implants may be associated with various factors such as the design, patient compliance, or related to the clinician aspect [8].

It has been reported that a patient's age can also be one of the factors showing a higher failure rate in adolescents when compared to adults, as a result of the difference in the buccal plate thickness [8]. Poor oral hygiene and smoking are further factors related to the patient that reduce the efficiency of mini-implants [14-17].

About miniscrew design factors, it has been previously concluded that miniscrews with a diameter of 1.1mm and 1.6 mm provide the highest success rate [9]. Also, mini-implants longer than 5–8 mm is more stable than shorter ones [9, 10]. Factors that may significantly affect the survival of mini-implants implicated by clinicians are sterilization and asepsis, clinician's experience, loading protocol [11], implant placement torque [12], and insertion angle [13].

Literature studies show not many treatment effects of skeletal anchorage for en-masse retraction, except for a few case reports. So, the question arises, do mini-implants perform significantly better than conventional anchorage reinforcements during en-masse retraction? Therefore, this study was undertaken to investigate the efficiency of mini- implants as intraoral anchorage and assess and compare the amount of molar anchorage loss that occurred during en mass retraction while using the mini-implant and conventional methods of anchorage reinforcements.

MATERIALS

The study was conducted in a sample of 10 patients who had reported to the Department of Orthodontics & Dentofacial Orthopedics of Yenepoya Dental College. All the patients were explained the treatment procedure before the commencement of treatment. The patient's consent was taken before placement of the mini-implant.

Patient Records

After patient selection, routine records of all the patients such as a detailed case history, pre-treatment study model, extraoral and intraoral photographs, lateral cephalograms orthopantomograms, and intraoral periapical radiographs were acquired.

Inclusion Criteria

1. Class I bimaxillary protrusion.
2. Upper first premolar teeth extracted for orthodontic reasons.
3. Age group 18-45.
4. No systemic disease.

Exclusion Criteria

1. Patients with cleft lip and palate.
2. Medically compromised patients.
3. Patients with periodontally compromised teeth.
4. Uncooperative patients.
5. Periodontal disease.
6. Long-term use of antibiotics, phenytoin, cyclosporine, anti-inflammatory drugs, Systemic corticosteroids, and calcium channel blockers.

All the patients in the study required first premolar extraction. Both sides of the upper jaw i.e., control and experimental sides were treated with the standard method of treatment with MBT™ bracket prescription (0.022inch slot). The leveling and aligning were carried out with 0.016" NiTi, rectangular NiTi (0.016"x 0.022", 0.017"x 0.025")

During the retraction phase, 0.019”x 0.025” SS (stainless steel) archwires were placed and crimpable hooks are placed distal to lateral incisors that are between the upper lateral incisor and canine bilaterally.

En masse retraction in mini-implant and conventional mechanics

On the left side (control side) e-chain is given from crimpable hook to molar hook for en masse retraction. On the right side (experimental side) mini-implants were placed after extraction, between the upper second premolar and first upper molar, and an e-chain was engaged from the head of the implant to the crimpable hook. After retraction lateral cephalogram was taken.

Lateral cephalogram after placement of mini implant (before retraction)

To differentiate between the right and left molars on the lateral cephalogram, a 0.017” x0.025” SS L-shaped wire of 1 cm of horizontal length was placed on the left side, to differentiate the right and left molars on the lateral cephalogram.

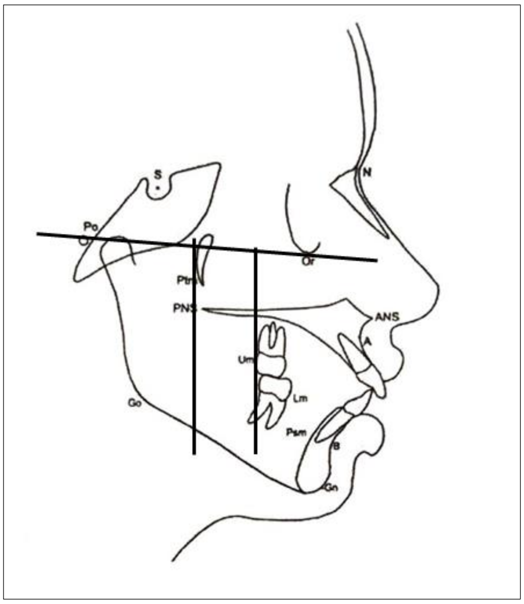
Prior to placement of mini-implant records such as study model, lateral cephalogram, and intraoral photograph were made. The mini-implant of approximately 1.4 mm in diameter and 8 mm in length was used.

Immediate Loading

Mini implants were immediately loaded with an e-chain.**.** Both mini-implant and conventional mechanics sides were loaded with 150-200 grams of force and the force was measured with a dial gauge.

Collection of Data

Pretreatment (T0) and post-treatment (T1), lateral cephalograms are compared to find out the amount of anchorage loss that took place on both sides. Pre-treatment (T0) and post-treatment (T1) cephalograms are superimposed with the help of Dolphin software (version 11.95). The parameter used to measure anchor loss is from upper molar to pterygoid vertical (linear) to a stable landmark in the cranium.



Cephalometric references planes and linear measurement

Measurement of Extraction Space

Before space closure, the distance between the contact point of the canine and the second premolar was measured using a vernier caliper. The same method was used to measure the amount of retraction after 28 weeks.

Statistical Analysis

The results were calculated using Paired *t-test*, and the statistical software SPSS was used. Descriptive statistical analysis was carried out in this study. Significance is assessed at a 5% level of significance. The statistical software namely SPSS 15.0, and Stata 8.0 used for the analysis of the data and Microsoft word and excel have been used to generate tables and graphs.

RESULTS

In this study, the molar anchorage loss during en-masse retraction using mini-implant and conventional mechanics after completion of space closure is measured and tabulated.

The amount of anchorage loss is measured using Dolphin software (version 11.95). The paired test was used to compare pre and post-treatment changes between groups. p-value ≤ 0.05 was considered to be statistically significant.

Compare Anchor Loss in Mini Implant and Conventional Mechanics Side

Parameter anchor loss (mm)	Mini Implant side (mm)	Conventional Mechanics side (mm)
Mean + SD	0.17+0.3	1.32+0.62

The anchor loss of 0.17mm was observed on the implant side and 1.32 mm was observed in the conventional mechanics after retraction.

Measurement of Extraction Space after 28 Weeks

	Mini Implant Side	Conventional mechanics Side	t value	p-value
Pre-retraction	7.64±0.53	7.62±0.61	0.07	0.93
After 28 weeks of retraction	4.05±0.38	3.64±0.42	2.28	0.03*
Mean space closure	3.59±0.68	3.98±0.62		

p-value <0.05 consider significant

Paired 't' test analysis within the group reported that significant reduction (p=0.0001) within both mini implant and conventional mechanics side with respect to space closure. Analysis between the group reported a significant difference in 28 weeks of retraction values(p=0.03) whereas analysis did not report any significance with respect to pre retraction values (p>0.05).

DISCUSSION

Anchorage control is a critical component of en-masse retraction. Orthodontists pay special attention to maintaining anchorage to obtain successful treatment outcomes [18]. The problem of anchorage loss during fixed mechanotherapy treatment is of great concern, especially in maximum or critical anchorage cases.

Many techniques have been developed to efficiently retract the anterior teeth. In tooth-borne anchorage cases, complicated mechanics or additional appliances are needed to control anchorage. The retraction of four incisors after canine retraction is accepted, as this minimizes the mesial movement of the posterior teeth. But studies have shown that there is no difference between en-masse retraction and 2-step retraction, as anchorage loss is seen in both methods [24].

In recent times skeletal anchorage systems such as mini-implants have been developed as an adjunct to tooth-borne anchorage. Studies have shown that the entire anterior segment can be retracted successfully with nickel-titanium coil springs or e-chains with mini-implants placed between the second premolar and first molar roots. But only a few studies have measured the anchorage loss with implant-assisted en masse retraction [2, 28, 32].

With the introduction of the MBT (McLaughlin, Bennett, and Trevisi) [1] appliance system, where anterior bracket torque was increased and tip was reduced that helped in treating the cases with anterior protrusion effectively with light continuous force during en-masse retraction [34]. The increasing use of sliding mechanics in orthodontics has led to considerable research interest in the frictional forces developed between the archwire and bracket, which may inhibit tooth movement, require larger retraction forces and lead to anchorage assessment [27]. Hence, this study aimed at evaluating the anchorage loss in patients requiring extraction of 4 first premolars and maximum retraction of anterior teeth with implants and patients treated with conventional sliding mechanics (MBT system).

As per the guidelines of Park HS *et al.*, [16] patients were selected with a mean age group of 17.35 + 4.5 years. The implants were immediately loaded with an initial force of 150-200 grams [21] and the retraction was started using an e-chain attached from the mini-implant head to the crimpable hooks on the right side and from molar hook to crimpable hook on the left side in 0.019" x 0.025" stainless steel wire. Lateral cephalograms were taken before and after retraction in the patients to measure the anchor loss on both sides.

In this study e-chain was preferred for retraction, a study was done by Nightangle *et al.*, [20] stated that the rate of retraction with e-chain is similar to NiTi coil spring, also an initial force of NiTi coil spring is slightly heavier than an e -chain, which could have a deleterious effect on mini-implants. Maintenance of oral hygiene is also better with the e-chain.

In this study on the mini-implant side, molar anchor loss was measured from Ptm vertical to distal of the first molar, the pre-treatment (T0) value was

22.34+0.57mm and post-treatment (T1) was 22.59+0.63, which showed a mean anchor loss of 0.17+0.3mm. In a study by Upadhyay *et al.*, [25] where he had concluded that mini-implant is an efficient reinforcement for anchorage when compared with the conventional method.

The amount of extraction space was measured on the mini-implant side, the pretreatment value showed 7.64+0.53mm and after 28 weeks it showed 4.05+0.38mm with a mean space closure was 3.59+0.68mm. The molars anchor loss by 0.17 mm and mean space closure was 3.59mm, showing there is minimal, unwanted mesial molar movement. Similarly, a study done by Becker k *et al.*, [2] stated that mini-implants are associated with lower anchorage loss when compared to conventional mechanics.

In the conventional mechanics side, the molar anchor loss was measured from Ptm vertical to distal of the first molar, pre-treatment value was 22.92+0.9, and post-treatment measurement was 24.79+1.01 the mean anchor loss of 1.32+0.62mm. A study done by Willian and Hosila [5] had found that in patients whose first premolar was extracted, only 66.5% of space was taken up by anterior segment. Creekmore [6] stated that the posterior teeth tend to move forward to the extraction space to relieve the crowding and incisor retraction.

The amount of extraction space was measured in the conventional mechanics side, pre-treatment showed 7.62+0.61 and after 28 weeks it showed 3.64+0.42 with mean closure of 3.98+0.62. The molars anchor loss of 1.32mm and mean space closure was calculated as 3.98 mm, which showed the undesirable mesial movement of the molar, a similar result was obtained by Basha *et al.*, [26] which showed that anchorage loss was statistically significant on the non-implant side.

This study shows that 1.15mm of anchor loss was more on the conventional side when compared to the implant side. The possible reason may be, closure of extraction space was done by retraction of anterior teeth on the mini-implant side and simultaneous movement of anterior as well as posterior teeth on the conventional mechanics side. The result of this was matched with another study done by Davis *et al.*, [29] which showed mean anchor loss of 0.1mm on the implant side and 1.3 mm on the conventional side of the maxilla, stating implant anchorage is an efficient alternative to molar anchorage.

Limitations of Study and Scope of the Study

1. It had a sample size of 10 patients, and the result obtained from this study must be verified with a larger sample.
2. Only female patients were used for the study. Gender-based comparison is needed.
3. Lateral cephalograms were analyzed for assessment of anchorage loss. Lateral cephalograms have their own limitations, which affect the results of the study.
4. No study was conducted on the mandibular arch. If the implants were placed in the mandibular arch, then a more pronounced profile change might have been expected, because of better vertical control of the mandibular posterior teeth.
5. Axial inclination of anterior teeth was not compared.

CONCLUSION

In this study, the molar anchorage loss during en-masse retraction using mini-implant and conventional mechanics after completion of space closure is measured and tabulated.

- The molars anchor loss on the mini-implant side was 0.17 mm, and in conventional mechanics side was 1.32 mm.
- The molars anchor loss by 0.17 mm and mean space closure was 3.59mm, showing minimal, unwanted mesial molar movement on the mini-implant side, whereas, on the conventional mechanics side, the molars anchor loss of 1.32mm and mean space closure of 3.98 mm, shows the undesirable mesial movement of the molar.
- This study shows that 1.15mm of anchor loss was more on the conventional side when compared to the implant side.
- Mini-implants can be used as intraoral anchorage reinforcement for en-masse retraction, as minimal anchor loss was seen when compared with conventional mechanics.

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