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Research Article

Comparison of Rate of Canine Retraction and Anchorage Loss between Mini-Implant and Mini-Implant with Micro -Osteoperforation

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Abstract

Aim: The study was conducted to evaluate the rate of canine retraction and anchorage loss between mini-implant versus mini implant supported micro-osteoperforation. This study will help to accelerate orthodontic treatment time and for better prognosis.

Materials and Method: Total sample size was 40, sample size was divided into four groups both maxilla and mandible. So, each quadrant got 10 sample, total patient was 10. Canine retraction rate and amount of molar anchorage loss were measured by with Electric Caliper and the lateral cephalogram (pre and post radiographs). After obtaining data, all the statistical analyses were performed using specialized statistical software (SPSS for Windows, Version 22.0, Chicago, 22, USA). The significant value was set at $P<0.05$.

Results: Significant difference of canine retraction rate and anchorage loss was found between implant side and micro-osteoperforation (MOP) side in maxilla and mandible. MOP side showed more retraction rate of orthodontic tooth movement and less anchorage loss than the control mini-implant side statistically.

Conclusion: Micro-osteoperforation increases the effectiveness and usefulness of orthodontic treatment. The utilization of low-cost, straightforward techniques for micro-osteoperforation has demonstrated notable benefits and acceleration. In canine retraction procedure anchorage has a major role for orthodontic outcome, if anchorage is not maintained properly, it will be difficult to make a stable result. So that mini-implant shows a great efficacy to maintain a good anchor unit to move the canine and micro-osteoperforation make it more faster and better.

Keywords: Mini-Implant; Micro -Osteoperforation (MOP); Canine Retraction; Anchorage

Introduction

Planning of Anchorage has significant effects on orthodontic treatment to attain the goals. Every action has an equal and Opposite reaction. For the movement of the tooth, we give appropriate force that has an opposing equal magnitude. Structures resisting the opposite force are termed Anchorage [1]. Jackson's Triad based on functional efficacy, esthetics harmony and structural balance is the pillar of Orthodontics. Based on aspects of orthodontic treatment for a specific patient is imperative to consider not only the forces required for the desire tooth movement to achieve the patient's objectives but also the undesired tooth movement that may occur in response to these forces. Anchorage preparation has long been one of the greatest problems in orthodontic treatment, because teeth even molars move in response to orthodontic forces [2]. Prolonged duration of treatment procedure is one of the major concerns for the patient in orthodontic treatment [3-5]. A large number of patients deny to going orthodontic treatment for this long duration [6]. Thus, acceleration of orthodontic treatment is always a fascinating condition for both patient and Orthodontist. Due to interplay of multiple biological and biomechanical factors such as duration of type of force, periodontal condition, regional molecular and cellular activity orthodontic tooth movement is a complex process [7].

To achieve a successful orthodontic outcome, it is required intraoral anchorage with a high resistance to displacement. To prevent unwanted tooth movement extra oral and intra oral devices are used, but the effectiveness of these measures is dependent upon the level of patient cooperation. Around 5%–55% of the total extraction space can be taken up by an anchor unit made up of the first molar and second bicuspid when used for the retraction of a cuspid tooth [8].

New advance in orthodontic treatment aid in recent years is the introduction of skeletal anchorage with mini-implant, which is widely used in orthodontic treatments for expanding the boundary of tooth movement and has no patient compliance requirements [9].

Anchorage from implant has burst into the clinical orthodontic scene to assist the orthodontists in controlling tooth movement. Early advantage is that implants provide absolute anchorage that is too much stable and acceptable than other method. Many authors have suggested temporary anchorage devices for tooth movements that could not be achieved otherwise, such as in patients with insufficient number of teeth, in patients with a need for asymmetrical tooth movements in all planes of space, and as an alternative to orthognathic surgery [2].

Considerably fewer failures are noted when the implants are placed in the areas of attached gingiva rather than movable soft tissue. The best sites for miniimplant placement for retraction are the interdental spaces between the second premolars and first molars [10].

With temporary anchorage device there also has different method invented in past for accelerate orthodontic tooth movement such as vibratory force, regional drug application, light emitting diode inciting regional osteopenia to accelerate the remodeling activity and flapless corticotomy procedure [11-15]. In the anatomic region of interest regional osteopenia can be induced in several ways. Which can be classified as flap or flapless approaches, corticotomy, medullary osteotomy using bar or piezo instruments [12,15,16]. Among these most of procedures have produced promising results suggesting an increase in rate of Orthodontic tooth movement from 1.5 to 3 times [17].

But many of these procedures need additional surgeries, substantial increase in costs and increased morbidity [18]. So far, a more conservative procedure called micro-osteoperforation in the cortical alveolar bone without elevation of periodontal flap is used. The human and animal studies suggest that this approach may increase the orthodontic tooth movement 2-3 fold. The procedure is done by bony biological principles that has been developed to address the growing demand for rapid orthodontic treatment especially by adult patients. This minimally invasive technique is safe and that can be used in conjunction with any orthodontic appliances, not only to accelerate tooth movement but in many other clinical situations, namely to change the type of tooth movement or create differential anchorage [17,18]. Purpose of the study to evaluate the rate of canine retraction in maxillary first premolar extraction patients by using mini-implants and mini-implant with flapless cortical perforation.

Materials and Methods

It was a Comparative cross-sectional study. Place of study was Department of Orthodontics, BSMMU, Shahbagh, Dhaka. Purposive sampling procedure was followed for this study. Patient number is 10, total sample size was distributed in two group both maxilla and mandible. So, each quadrant got 20 samples and total sample size was 40.

The participants were selected those fulfilling the exclusion and inclusion criteria. Sample was consisting of 02 groups named Group 01 (Mini-implant supported micro-osteoperforation was used), Group II (Mini implant anchorage was used). Total 10 numbers of patients were employed in the study. Study included both upper and lower jaw, Maxilla and Mandible right side was the control side and follows 20 sample in right side of jaw, Left side or intervention site receive 20 sample in both maxilla and mandible include total 40 sample divide into two group. The samples were included natives of Bangladesh.

All the ten selected patients (Age range:18-25 years) were treated with preadjusted edgewise appliance system (Roth 0.018" slot). After completing leveling and aligning with SS arch wires, a 16 SS arch wire was placed. The titanium miniimplants, Vector TAS (Ormco, Germany), was placed in maxilla and mandible for 10 patients.

Mini-implant as anchorage was used for all the ten patients. All the miniimplants were positioned at the maximum thickness of interdental bone between the roots of the second premolar and first molar in the patients at right side. In the maxilla, the miniimplant was inserted at an angle of 30°–40°, and in the mandible, 10°–20° angulation to the long axis of the teeth to increase the surface contact between the miniimplant and the bone.

Orthodontic forces were applied with Orthodontic elastic to deliver a force of 100 g (measured with the Dontrix gauge; American Orthodontics) by stretching it between the implant and the canine on the implantanchored side and between the molar and the canine on the flapless micro-osteoperforation site.

Micro-osteoperforation is a surgical less invasive technique which can accelerate orthodontic tooth movement creating predictable results. Micro-osteoperforation can be completed chair side in a minute and does not require any advance training [19].

Micro-osteoperforation is performed in experimental group under local anesthesia using temporary anchorage device (TAD) like miniscrews. The TAD was screwed slowly into alveolar bone, perpendicular to the bone surface, till slight blanching of surrounding soft tissue was obtained to ensure full-length penetration of the TAD then the TAD was unscrewed and removed (Figure 1) [20].

Three flapless cortical perforation was performed in left and right side distal to the canine by a TAD. Flapless cortical perforation done once only. The canine retraction commenced in both groups with a power chain approximate force is 100g. All patients were asked for a recall visit every 21 days for change of power chain.

Analysis of the rate of retraction and anchor loss was performed on lateral cephalograms as well as study models. The rate of canine retraction was evaluated on the first day of the first week and after 90 days of tooth movement. Canine retraction rate was measured by mesial of the canine and distal of the premolar with Electric Caliper (Figure 2). The amount of molar anchorage loss was measured from pterygoid vertical in the maxilla and sella nasion perpendicular in mandible.

Evaluation on the lateral cephalogram (Figure 3), the pre- and post-retraction cephalometric radiographs were obtained. On the cephalogram, the SN plane was traced, and a perpendicular line was drawn from sella. The perpendicular distance from the drawn line till the respective vertical segment of L shaped wire (terminal point) was measured for right and left molar wire and canine wire. Then the post retraction distance was measured, and the difference was calculated for their respective sides. Pre-treatment and Post-treatment values were compared for the same.

Figure 1: Procedure of micro-osteoperforation (MOP).

Figure 2: Digital Electric Caliper.

Figure 3: Lateral cephalogram on the view box.

Statistical analysis

After collection of data, it was checked for any discrepancy and incompleteness. A database was prepared by using (SPSS for windows version 22.0, Chicago, 22 USA). After completion of data collection, it was entered in data base one by one. It was further checked for presence of any missing or abnormal values on the data. A data file was prepared, and all data was re- checked in hard and soft copy and contacting with the patients for missing, abnormal values on data or distorted lateral cephalogram. After consideration of all issues data was ready for final data analysis.

As data was normally distributed so frequency distribution was carried out and two sample Test was used for analysis. All the statistical analyses were performed using specialized statistical software (SPSS for Windows, Version 22.0, Chicago, 22, USA). The significant value was set at $P < 0.05$.

Results

This invasive method was done by tooth extraction on both sides and after motivating the patient who came here for orthodontic treatment. It was decided to make a split mouth comparison for the data collection and result. To measure the amount of canine retraction electric caliper is used the distance between distal of the canine and mesial of the premolar was measured for approximately 3 months for compare. After 3-month retraction of canine, it was divided to for one month retraction rate as final analysis.

Rate of canine retraction in maxilla, implant side was 1.076 ± 0.306 and MOP Side it they tend to lose their strength as time goes by, it was preferred to apply 150 g of force and renew the chains every 15 days to was 1.449 ± 0.333, p-value was 0.018 (Table 1).

	Implant side) (n = 10) Mean ± SD	MOP side (n = 10) Mean ± SD	Mean difference	p-value
Rate of canine retraction (mm)	1.076 ± 0.306	1.449 ± 0.333	-.373	0.018[s]

Table 1: Data were expressed as mean ± SD. Independent sample t-test was done to compare the mean canine retraction rate between Implant and MOP side in maxilla.

P > 0.05 - statistically not significant (ns), *P* < 0.05 – statistically significant (s).

Rate of canine retraction between mini-implant and mini-implant supported micro osteoperforation in mandible implant side, mini-implant side was 0.863 ± 0.364 and MOP side 1.277 ± 0.227, where p-value was 0.007 (Table 2).

	Implant side (n = 10) Mean ± SD	MOP side (n = 10) Mean ± SD	Mean difference	p-value
Rate of canine retraction (mm)	0.863 ± 0.364	1.277 ± 0.227	-.414	0.007[s]

Table 2: Data were expressed as mean±SD. Independent sample t-test was done to compare the mean canine retraction rate between Implant and MOP side in mandible.

P > 0.05 - statistically not significant (ns), *P* < 0.05 – statistically significant (s).

Comparison of anchorage loss between mini implant and mini implant with micro osteoperforation on maxillary region where anchorage loss(mm) in implant side was 1.073± 0.812 and MOP side 0.249± 01547 where p-value was 0.005 (Table 3).

Comparison of anchorage loss between mini impant and mini-implant with micro osteoperforation at mandibular region where Anchorage loss(mm) at implant side was 0.547± 0.403 and MOP side 0.184± 0.141 where p-value was 0.015 (Table 4).

MOP Side showed more retraction rate of orthodontic tooth movement and less anchorage loss than the control mini-implant side. The movement of canine in control side showed different type of undesired movement like tipping and uprighting. This type of undesirable movement seemed to be less noticeable in MOP side.

	Implant side) (n = 10) Mean ± SD	MOP side (n = 10) Mean ± SD	Mean difference	p-value
Anchorage loss (mm)	1.073 ± 0.812	0.249 ± 0.154	0.824	0.005[s]

Table 3: Data were expressed as mean±SD. Independent sample t-test was done to compare the mean anchorage loss between Implant and MOP side in maxilla.

P > 0.05 - statistically not significant (ns), *P* < 0.05 – statistically significant (s).

	Implant side) (n = 10) Mean ± SD	MOP side (n = 10) Mean ± SD	Mean difference	p-value
Anchorage loss (mm)	0.547 ± 0.403	0.184 ± 0.141	0.363	0.015[s]

Table 4: Data were expressed as mean ± SD. Independent sample t-test was done to compare the mean anchorage loss between Implant and MOP side in mandible.

P > 0.05 - statistically not significant (ns), *P* < 0.05 – statistically significant (s).

Discussion

As mini-implant is a revolutionary invention for orthodontic treatment micro-osteoperforation makes it more efficient and helpful. Simple methods and low cost of micro osteoperforation have shown significant advantages and acceleration [17]. In canine retraction procedure, anchorage has a major role for orthodontic outcome, if anchorage is not maintained properly it will be difficult to make a stable result. So, mini-implant shows a great efficacy to maintain a good anchorage unit to move the canine and micro-osteoperforation make it more faster and better.

Kole., *et al*. [21]. discovered that interproximal cuts in the bone cortex speed up tooth movement, but he also noted a drawback of the technique-that is, some patients found the surgery to be difficult and uncomfortable. The outstanding and satisfactory outcome of micro-osteoperforation for tooth mobility was reported in a previous study [17]. In the split mouth investigation, faster movement was observed when compared to standard approach with micro-osteperforation. These results have great impact since they come from the same patient tooth movement with MOP [22].

This invasive method was done by tooth extraction on both sides and after motivating the patient who came here for orthodontic treatment. It was decided to make a split mouth comparison for the data collection and result. To measure the amount of canine retraction electric caliper is used the distance between distal of the canine and mesial of the premolar was measured for approximately 3 month for compare. After 3-month retraction of canine it was divided to one month retraction rate as final analysis.

Rate of canine retraction in Maxilla implant side was 1.076 ± 0.306 and MOP Side it they tend to lose their strength as time goes by, it was preferred to apply 150 g of force and renew the chains every 15 days to was 1.449 ± 0.333, p-value was 0.018. Rate of canine retraction between mini-implant and mini-implant supported micro osteoperforation in mandible implant side it was 0.863 ± 0.364 and MOP side 1.277 ± 0.227, where p-value was 0.007. Difference in the maxilla and mandible regarding the rate of canine retraction showed statistically significant. A study conducted by Thiruvenkatachari., *et al*. [23] found the significant differences of canine retraction rate in maxilla.

Comparison of anchorage loss between mini implant and mini implant with micro osteoperforationon maxillary region where anchorage loss(mm) in implant side was 0.863 ± 0.364and MOP side 1.277 ± 0.227 where p-value was 0.007. Comparison of anchorage loss between mini implant and mini implant with micro osteoperforation at mandibular region where Anchorage loss(mm) at implant side was 0.547 ± 0.403 and MOP side 0.184 ± 0.141 where p-value was 0.015.

The result of the current study conflicted with a previous study where canine retraction rate on MOP site was 0.49 ± 0.42 mm and 0.47 ± 0.42 mm at control side; p-value >0.05 which was statistically not significant in Maxilla. In mandible rate of canine retraction on MOP side was 0.06 ± 0.72 and control side was 0.37 ± 0.63 mm; p-value< 0.05 that was statistically significant [20].

A number of publications advocate for the use of mini-implants as an anchoring for upper anterior mobility in orthodontics [24-26]. A study by Kuroda., *et al*. [27] established a force of 100g with close NiTi coil spring for canine retraction using a mini-implant screw between teeth #1.5 and 1.6. 150 grams were used in this operation at both sites. Since elastomeric chains were used for traction and they deteriorate over time, it was deemed preferable to apply 150g of force magnitude and replace the power chains every 21 days in order to maintain the desired force.

MOP Side showed more retraction rate of orthodontic tooth movement and less anchorage loss than the control mini-implant side. Movement of canine in control side showed different type of undesired movement like tipping and uprighting. This type of undesirable movement seemed to be less noticeable in MOP side.

Conclusion

In conclusion from the present study, micro-osteoperforation increases the effectiveness and usefulness of orthodontic treatment, as mini-implants are a breakthrough invention. The utilization of low-cost, straightforward techniques for micro-osteoperforation has demonstrated notable benefits and speed. Anchorage plays a crucial part in the orthodontic success of the canine retraction process; if anchorage is not maintained appropriately, a stable outcome will be difficult to achieve. In order to relocate the canine, the mini-implant exhibits excellent efficacy in maintaining a strong anchor unit, and micro-osteoperforation makes it even faster and more effective.

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