Effect of Alveocentesis on the Rate of Tooth Movement

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Abstract

Introduction: The need to accelerate tooth movement and to decrease orthodontic treatment time has long been the area of research in the field of orthodontics. This study uncovers the modern day techniques in the field of orthodontics to address the issue of prolonged treatment time. Objective: The purpose of the study is to evaluate the effect of microosteoperforations on the rate of tooth movement. Material and Method: This is a randomized control trial in which 30 patients with class II division I were selected. Microosteoperforation side was randomly assigned to 1 side of the maxillary arch at the canine premolar region, and the other side served as the control. By using miniscrews as anchorage, canine retraction was initiated via powerchain. After 4 weeks rate of tooth movement is evaluated. Results: Rate of tooth movement on microosteoperforation side was significantly higher than the control. Rate of tooth movement after micro osteoperforations is 2.04 mm per 4 weeks. Conclusion: The findings of the research successfully aimed to develop a road map for conducting future researches. An increased tooth movement achieved by micro osteoperforation has opened gates for faster and quicker orthodontics.

Key Words: Micro-osteoperforations, Canine movement, Accelerated tooth movement

Introduction

The purpose of orthodontic treatment is to enhance dentofacial functions and esthetics. For years there has been a search of an efficient method that can work expeditiously, accurately and competently to reduce treatment time in fact one of the reasons for adults to defer orthodontic treatment is prolonged treatment time. The biologic response of the tooth is the factor that has control over the rate of tooth movement. But what controls the biologic response of a tooth is still need to be investigated.

Orthodontic tooth movement is the response to mechanical stimuli sequenced by bone apposition and resorption at the pressure and tension site respectively. It has been proposed that the rate of tooth movement is dependent on the rate of bone resorption which in turn is influenced by the osteoclastic activity [1,2]. Various methods have been introduced to surge osteoclastic activity in order to accelerate tooth movement. These methods fall in 3 categories. The first one, the biological approach encompasses the local or systemic administration of Interleukin, Prostaglandins, Cyclic adenosine monophosphate and leukotrines [3,4]. The second, physical stimulation which includes direct electric currents, pulsed electromagnetic fields, static magnetic field and low level laser [4]. According to literature these two methods increase the rate of tooth movement 0.3 to 1 fold when compared with the placebo. However these methods are not free of complications.

The third, surgical approach consist of interseptal alveolar surgery and corticotomy [5]. A deliberate surgical injury to the cortical bone in order to reduce its resistance to tooth movement is referred as corticotomy. In 2001 Wilcko developed a technique which was called Periodontally Associated Osteogenic Orthodontics (PAOO) in which he added a bioabsosorbable grafting material in the osteomatized bone to enhance healing [6]. Later on, a less invasive technique Piezocision was introduced by Dibart which constitute the incisions on the buccal cortex via piezo surgical knife [7]. These procedures had low patient acceptance due to high morbidity, pain, swelling and being invasive in nature.

More recently a new technique called Alveocentesis has been introduced in which Micro perforations were introduced in bone to accelerate bone turnover [8]. Animal studies have shown that by doing micro-osteoperforations (MOPs) on alveolar bone during orthodontic tooth movement accelerates the expression of these inflammatory cytokines, leading to rise in osteoclastic activity and the rate of tooth movement [8]. Teixeira et al. [9] demonstrated that the mice received micro-osteoperforations showed greater tooth movement 0.62 mm in 28 days which is significantly higher than the control group. A study conducted at dental school at Cairo university showed that there is a statistically significant difference ($P<0.01$) in the rates of anterioposterior movement of the canine in the osteoperforated and non-perforated side [10]. Alikhani et al. [8] concluded that there was 2.3 fold increases in tooth movement after microosteoperforation. MOPs can considerably reduce the density of bone and let safer and faster movement of tooth at the same time augmenting remodeling of alveolus in that particular area [11].

Objective

The objective of the study is to evaluate mean tooth movement after alveocentesis.

Materials and Methods

A randomized single center, single blinded study commenced in the orthodontic department. After the approval of the study by the ethical committee, patients who fulfilled the inclusion criteria and completed the informed consent form were included in the study. A sample of 30 patients was selected. The inclusion and exclusion criteria was

Inclusion criteria

- Both male and female patients with age of 15- 28 years,
- Dental Class II div I cases (Angle's classification) (annexure attached),
- Probing depth < 4 mm in all teeth (measured by CPITN probe).

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Exclusion criteria

- No history of trauma,
- Long term use of systemic corticosteroids calcium channel blockers and anti-inflammatory drugs,
- Extreme class II malocclusion (overjet > 10 mm, ANB > 7 degrees),
- Poor oral hygiene,
- Probing depth greater than 4 mm (measured by CPITN probe),
- No evidence of bone loss confirmed by a radiograph,
- No current active periodontal disease (no bleeding on probing),
- No systemic disease (confirmed by patients' history).

The experimental side receiving MOP was randomly (coin toss) allotted either left or right side, while control side did not receive any MOP. The subjects and the residents administering the treatment were aware of the group assignment and therefore were not blinded. The investigators performing the measurements and data analysis were blinded from the group assignments. Treatment was initiated by bonding fixed appliance in both arches. After leveling and alignment patient was referred for extraction of premolars. Miniscrews were placed bilaterally between upper second premolar and molar, to enhance anchorage. Before extractions an impression was taken, distance from the miniscrew to the canine (T1) was recorded with the help of the Vernier caliper on the cast. Periapical x rays were taken to evaluate canine root. Three (apical, middle and cervical) MOPs were performed distal to canine, using Physiodispenser under local anesthesia (2% lidocaine with 1:100,000 epinephrine). Perforations were done up to the depth of 3 mm. Pain killer and chlorhexidene mouthwash was prescribed and patient was recalled after 1 week. Anchorage was further reinforced by co-ligation of 2nd premolar, 1st and 2nd molar followed by the initiation of canine retraction by stretching power chain to approximately twice its resting length and refreshed after every 2 weeks.

After 4 weeks Alginate impressions were repeated and readings recorded (T2). Mean tooth movement in millimeters per 4 weeks (T1-T2) was calculated and recorded. Data was entered and analyzed by using SPSS version 16. Paired T-test was applied to determine mean change in tooth movement in 2 groups and the difference in tooth movement in experimental and control side. Effect modifiers like age and gender were controlled through stratification, post stratification t-test was applied by taking P values less than 0.05 significant.

Results

30 patients who fulfilled the inclusion and exclusion criteria were selected. Average age range of patients was 18 to 28 years of ages. The average age of the patients was 23 + 1.6 years. Female patients were more common in the sample group (*Figure 1*).

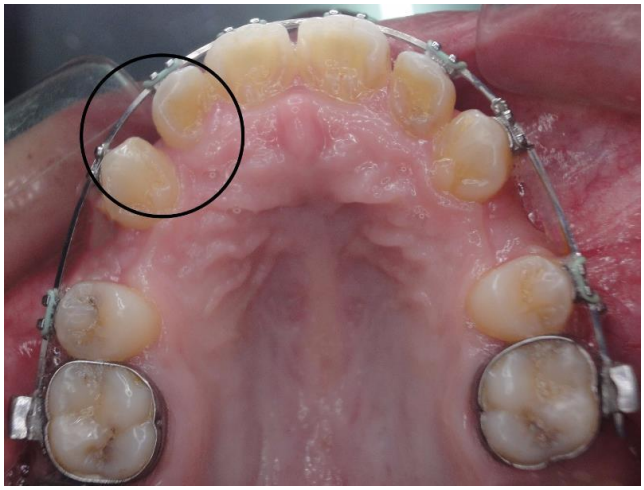

Figure 1. *Tooth movement on micro-osteoperforation side.*

A statistically significant tooth movement on the MOP side has been observed after 4 weeks of canine retraction, evaluated by applying paired T-test, considering the P- value being less than 0.05 significant. Mean tooth movement after micro osteoperforation is 2.04 SD 0.699 mm while on the control side is 1.02 SD 0.22 mm. (*Table 1*). There was 2 fold increased tooth movement on MOP side in comparison with the control side.

Table 1. *Rate of tooth movement in all patients (paired t test).*

	MOP side before canine retraction	MOP side after 4 weeks of retraction	Tooth movement in MOP sides	Control side before canine retraction	Control side after 4 weeks of retraction	Tooth movement on the control side
Mean	20.7880	18.7460	2.042	20.24	19.13	1.02
Std. Deviation	1.945	1.763	0.699	1.63	1.59	0.228

9 male patients were recruited in the study. Mean tooth movement observed in male patients was observed to be 2.38 SD 1.14 mm. 21 female patients demonstrated mean tooth movement of 1.89 mm. Mean tooth movement in patients below or equal to 23 years is 2.04 mm while those above 23 years is 1.98 mm/ 4 weeks.

Amount of canine movement in 4 weeks after micro osteoperforation (*Figure 2*).

Independent T test is applied to evaluate the difference in rate of tooth movement in male and female patients considering the P- value less than 0.05 being significant. The results demonstrated that there is no statistically significant difference in rate of tooth movement in male and female patients after micro osteoperforations (*Table 2*). Difference in tooth movement between ages is evaluated by applying independent T test taking P value less than 0.05 to be significant, the results showed no significant difference between the age groups (*Table 3*).

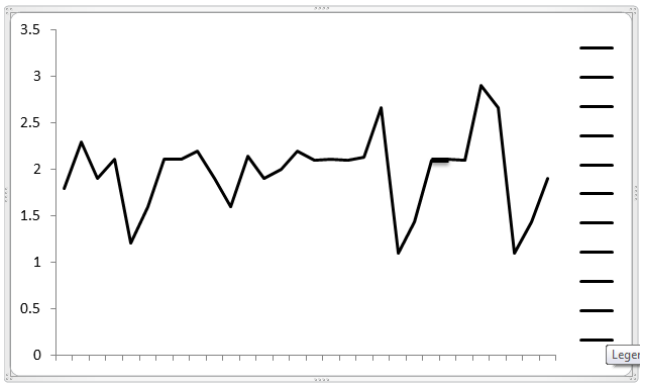

Figure 2. *Canine movement in 4 weeks.*

Table 2. *Difference in rate of tooth movement in both the genders (independent t-test).*

	Sender	N	Mean	Std. Deviation	P-value
Tooth movement on MOP side	male	9	2.3833	1.1469	
	female	21	1.8957	0.3296	0.18*
P=0.05* is significant					

Table 3. *Difference in rate of tooth movement between ages of <23 and above 23 years.*

	Age (years)	N	Mean	Std. Deviation	P-value
tooth movement on MOP side		19	2.04	0.822	
	<23				0.834*
		11	1.98	0.45	
	Above 23				
P=0.05*					

Discussion

The requirement and accessibility of orthodontic care has increased but has also been accompanied by patients' demand for shorter treatment times. Longer orthodontic treatment increases the danger of decalcification, gingival recession, and root resorption and so shorter treatment times have multiple advantages as well as fulfilling patient's desires [6]. For the past few years, the ways and techniques of tooth movement have changed the perception of various orthodontists. Tooth movement has become an important area of research, assuming optimized mechenotherapy and cooperation of the patient, the rate limiting step of orthodontic treatment time is the patients' biological response to the force applied. In order to reduce the treatment duration multiple procedures have been tested, including the use of prostaglandin, Vitamin D injections along with the use of surgical techniques. Light mechanical forces can also be applied to accelerate the tooth movement. The above mentioned procedures were successful in accelerating tooth movement but with the burden of cost, morbidity, technique sensitivity and efficiency, techniques like AcceleDent, Wilckodontics, micro-osteoperforation and Piezoincisions are also recommended. Among these, micro-osteoperforation is the topic on the horizon in the field of acceleration biology [3,12].

It has been demonstrated that the forces of occlusion has great influence on the rate of tooth movement [13]. To avoid the biasness due to effect of occlusion in our study, patients with analogous severity of malocclusion were selected. Patients having crossbite and deviation on closure because of occlusal interference were excluded from this study. Besides, to eradicate the possibility of unbalanced occlusal forces from habitual occlusion predominantly on one side, Micro osteoperforations were randomly allocated to the right or left side of each patient. Furthermore, the canines were chosen to measure tooth movement because in class II division I cases canines are free from occlusal interferences. During canine retraction occlusal interference were specially assessed, but none was found that demanded occlusal adjustment. Type of tooth movement is another crucial factor that effects rate of tooth movement [14]. In this study, an effort was made to obtain bodily movement by retracting on 19×25 SS wire. But some amount of tipping is however unavoidable. Age of the patient has significant role in the rate of tooth movement because of the difference in bone density or rate of osteoclast recruitment or activation [15,16]. For the evaluation of the difference in the results due to age difference independent T test was applied and no significant difference in rate of tooth movement between the age groups was found. This may be because the sample we took mostly consists of adult patients.

Fluctuating female sex hormone during the menstrual cycle is another confounding variable that can affect the bone metabolism [17]. There were more women than men in the study; however, to evaluate the difference between the two genders independent T test was applied. The results demonstrated no statistically significant difference between two groups. However due to more number of females and less males the results may be biased.

Common practice is to retract canine via placing power chains between canine and the anchorage segment or by placing loops between the canine and the anchorage segment. Different studies are carried out to evaluate the rate of canine retraction which illustrated different results. Bokas et al. [18] demonstrated mean tooth movement over a period of month by power chains to be 1.08 mm. Cacciafesta showed 1.1 mm/ month of canine movement using NITI coil springs [19], Nightingale and Jones illustrated canine movement of 0.21 mm per week using power chain [20]. These rates of tooth movement are significantly slower than those derived from our study using micro osteoperforations i.e., 2.08 mm/ 4 weeks.

A study conducted to evaluate the potency of relaxin consisted of 40 subjects they evaluated the incisor movement in the period of 8 weeks [21]. Mean tooth movement observed was 0.88 mm which was not significantly higher maybe due to ineffective dose of relaxin which was 50 micro grams. Another study conducted on rats for the assessment of parathyroid hormone on the rate of tooth movement demonstrated that on twelfth day, tooth movement observed was 0.54 ± 0.04 mm in the parathyroid hormone group [22]. Tooth movement with micro osteoperforation was faster than

these biological methods as demonstrated by this study. These biological methods did carry a burden of side effects without being potent in accelerating tooth movement. These were the reasons they were not adopted in the common practice.

In this study, on the buccal plate cortical perforations were performed only without vertical or subapical cuts and without palatal flap reflection [10]. Tooth movement observed after corticotomy was 1.89 mm per 4 weeks, while tooth movement in our study after micro osteoperforation was 2.04 mm per 4 weeks. Besides having faster movement with micro osteoperforation, it has an advantage of being minimally invasive. There is no need to reflect the flap for micro osteoperforation which had an additional psychological benefit as compared to the corticotomy [23].

Explaining about the effectiveness of MOPs, Alikhani et al. [8] demonstrated that the change in tooth movement and micro osteoperforations are strongly linked to each other. The results have shown a prominent change in canine. In addition, discomfort and pain were also recorded with a rating scale. Mean tooth movement observed in his study was 4.26 mm per 4 weeks which is higher than results in our study this change may be due to difference in method of retraction and difference in method of performing MOPs. Along with the significant increase in tooth movement on the experimental side, it was also reported that the patients did not suffer from discomfort or pain after or during the procedure. The researchers concluded that micro-osteoperforation is a secured, contended and efficient procedure to boost up the tooth movement. In addition, this method has remarkably been proved as a way to lessen the time period of orthodontic treatment in an efficient and effective manner. An animal study conducted by Tsai et al. [24] demonstrated the effect of corticison and micro-osteoperforation on change in tooth movement of rats. They were divided into 4 groups depending upon the kind of force being exerted on their teeth. The movement was recorded up to six weeks. At second week, the distance of tooth movement in the Corticision plus orthodontics group was 1.43 + 0.38 mm and micro osteoperforation plus orthodontics was 1.39 + 0.49 mm which was significantly greater than that in the orthodontic group (0.93 + 0.49 mm). Tooth movement in rats was a bit slower than in human. Conducting the research in the same domain, Cheung et al. examined various techniques for enhanced tooth movement that involved MOPs with mini implants and surgical procedures; however, it is significant to know best technique. The results depicted that mean tooth movement in 21 days on MOP side was 0.54 + 0.13 mm, while our study illustrated mean tooth movement in 28 days to be 2.04 mm which is higher showing human shows faster tooth movement as compared to animals. The researchers of the presented study considered that current techniques for enhancing tooth movement comprise of surgical procedures which are invasive, whereas flapless MOPs assist orthodontic tooth movement [25].

Our study evaluated the rate of tooth movement after MOPs, the comparison of MOPs with the other techniques or with the control having no technique can give more precise results. Root resorption has not been evaluated plus study was discontinued after one month so long term effects of MOPs still need further studies.

Conclusion

From a very long time, shorter treatment duration is the major demand of the orthodontic patients, now we are able to accelerate orthodontic treatment via different techniques without compromising safety. The method used is micro-osteoperforations which showed the rate of tooth movement 2.04 mm per 4 weeks which is significantly higher when compared with the control side. The nature of all these procedures is to achieve the Regional Acceleratory Phenomenon. MOPs are not only minimally invasive but also they are more acceptable to the patients.

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