

Efficacy of micro-osteoperforations on the rate of maxillary canine retraction: A randomized controlled trial

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ABSTRACT

Objectives: The purpose of this study to evaluate the effectiveness of micro-osteoperforations on the rate of maxillary canine retraction. **Materials and Methods:** Twelve subjects (4 males, 8 females; mean age, 16.17 ± 2.29 years) who required therapeutic extraction of maxillary 1st premolars. Both maxillary canines, in each patient, were randomly assigned to either an experimental or control side in a split-mouth design. In the experimental side, MOPs were performed distal to the canine before starting retraction, while the other side served as a control. Patients were followed up every 28 days until complete canine retraction. **Results:** Mean overall monthly rate of canine retraction showed statistically non-significant difference (1.59 ± 0.49 mm in MOPs and 1.50 ± 0.42 mm/month without MOPs). Although there was an increase in the rate of canine retraction especially during the 1st month (1.51 ± 0.50 mm in MOP and 1.10 ± 0.51 mm/month without MOPs), which is statistically non-significant ($P=0.059$). **Conclusions:** Effectiveness of micro-osteoperforations is questionable unless the technique becomes repeated on monthly basis during canine retraction.

KEY WORDS: Accelerated tooth movement, Micro-osteoperforation, Canine retraction, .

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Introduction

Recently, as a result of increasing demand for aesthetics, an increasing number of adult patients are seeking orthodontic treatment. However, the primary concern for adult patients, as a result of their life style and job issues is the prolonged treatment duration.^{1,2} Prolonged treatment time can increase the incidence of iatrogenic consequences of appliance therapy such as, root resorption (RR), periodontal problems, enamel demineralization, caries and loss of patient cooperation. Therefore, acceleration of orthodontic tooth movement (OTM) is not only to shorten the treatment time, but also to reduce the incidence and severity of these iatrogenic problems.^{3,4}

Accordingly, investigators have considered new interventions that are applied in conjunction with orthodontic treatment to accelerate OTM via improving the bone remodeling. These interventions can be classified into three categories: (1) use of certain biochemical drugs, (2) mechanical or physical stimulation of the alveolar bone, and (3) surgical interventions.^{5,6}

From the above mentioned techniques, surgical procedures are the most clinically applied for accelerating OTM. Surgical irritations may include any cuts or holes of bone cortex able to stimulate cell recall and the expression of inflammatory markers which in turn increased catabolic activity of alveolar bone and accordingly faster OTM.⁵⁻¹¹

Patient's acceptance for old surgical procedures such as osteotomies and corticotomies was low as a result of its invasiveness, postoperative morbidity and damaging effects on periodontal tissues, therefore, more conservative minimal invasive flapless corticotomy techniques have been recently proposed. These techniques have been documented to achieve the same results, but with minimal trauma, morbidity and at a lower cost.^{2,5}

First described by Alikhani et al, Micro-osteoperforations (MOPs) is one of the most minimally invasive surgical techniques that

form the basis for all subsequent types of microosteoperforations.⁷ Alikhani et al used a Propel device to produce minute holes in the bone cortex, later on, and for economic reasons, MOPs was tried with less expensive tools such as small surgical burs and lately orthodontic miniscrews.¹² In the light of the available literature, it seems valuable to evaluate micro-osteoperforations as a minimal invasive procedure on the rate of canine retraction by using orthodontic miniscrews.

Materials and Methods

This was a split mouth randomized clinical trial. Ethical approval was obtained from the ethical committee, faculty of dental medicine (boys), AL-Azhar University, Cairo, Egypt. Patients were selected from the outpatient clinic of the Department of Orthodontics, Faculty of Dental Medicine (Boys), Al- Azhar University, Cairo, Egypt. The patients selected for this study had met the following criteria: An age between 14 to 18 years with Class II division 1 malocclusion or Class I bimaxillary protrusion with no or mild symmetrical crowding on both sides. Patients who diagnosed to require extraction of at least maxillary first premolars bilaterally as a part of their treatment plan.

Sample size calculation and randomization

Sample size calculation was based on a previous study, for an alpha error of 0.05 and power of 80 %, the minimum sample size required was estimated to be 12 patients.⁸ The randomization was performed with coin tosses to prevent selection bias. Both maxillary canines, in each patient, were randomly assigned to either an experimental or control side.

Interventions

All patients fitted with directly bonded 0.022×0.028-inch slot Roth preadjusted edgewise metallic brackets (Ormco Corporation, Orange, CA). Prior to undergoing dental extractions bilateral 1st and 2nd molars

were banded and connected with a transpalatal arch and connected together with a 0.9 mm stainless steel wire soldered palatally for anchorage reinforcement. Extraction was done at the start of treatment, before bonding of the fixed orthodontic appliance. Upper arches were leveled and aligned using conventional sequences of NiTi archwires (Ortho Organizer Super Elastic Nitanium® Archwires, USA). A final working wire 0.016 × 0.022-inch SS archwires (Ortho Organizer Stainless Steel® Archwires, USA) were placed for at least 3 weeks to ensure that the archwires were passive by sliding the archwire through the bracket slots.

Micro-osteoperforation Procedure:^{8,12-14}



Fig 1: Miniscrew insertion

After the leveling and alignment phase and before canine retraction, MOPs were performed in the experimental side according to randomization. Under local anesthesia three Mops of 1.6 mm width and 4 mm depth inside the bone was made by using miniscrews (HUBIT, Korea) of 1.6 mm diameter and 8 mm length at 3 points distal to the canine midway in the extraction space (Fig 1). First insertion point was 6 mm from the free gingival margin then second insertion point was marked 5 mm from the first one and third point was marked 5 mm from the second point.

Canine retraction and follow up

After application of the MOPs on the experimental side, maxillary canine retraction was started at the same time on both sides with the same mechanics. Canines were retracted using a NiTi closed coil springs (Modern Orthodontics, India) deliver 150 gm force, stretched between the hooks on the buccal surface of the 1st molar bands and the canine

brackets. The applied force was checked by force gauge at each visit (4 weeks) and the appliances were examined for any distortion or change in position and the amount of retraction was measured at each appointment during space closure. Canine retraction was considered completed when Class I canine relationships were established. Post retraction records (intra-oral photographs, and study models) were taken.

Patients were evaluated before canine retraction and every 28 days to assess the rate of canine retraction.¹⁵ It was based on measuring the bilateral distance between the distal contact points of the canines and the mesial contact points of the second premolars.¹⁶ Measurements done with a digital calliper (Digimatic Caliper, Mitutoyo, China) by the same investigator. Each measurement was done twice and the mean of the two values was recorded in the data recording sheet to be used for statistical analysis.¹⁷ The rate of canine retraction (mm-month) will be calculated as the total amount of retraction (mm) divided by the total time of retraction (months).

Statistical analysis

Statistical analysis was accomplished using the SPSS software (version 20.0; IBM, Armonk, NY). Probability values equal or less than 0.05 were considered significant. Independent sample-t tests were calculated to compare the difference between the MOP and control sides.

Results

All 12 patients had successfully completed the canine retraction phase. The age range of patients was 13-19 years with a mean age was (16.17 ± 2.29) years, the sample was consisted of 8 females and 4 males. The results have showed non-statistically significant differences between the two groups in the monthly rate, during 1st month, after 3 months and after total duration of maxillary canine retraction (Table 1).

Table (1): Descriptive statistics and test of significance (Independent Samples t-test) for the mean monthly rates of canine retraction between the two groups.

		Control group (mm/month)			MOPs group(mm/month)			Test value	P-value	Sig.
		Mean	SD	SE	Mean	SD	SE			
1 st month	T1-t2	1.10	0.51	0.15	1.51	0.50	0.14	1.991	0.059	NS
2 nd month	T2-T3	1.32	0.45	0.13	1.31	0.60	0.17	-0.039	0.970	NS
3 rd month	T3-T4	1.18	0.43	0.13	1.36	0.44	0.14	0.924	0.367	NS
4 th month	T4-T5	1.21	0.41	0.13	1.07	0.29	0.10	-0.815	0.427	NS
5 th month	T5-T6	1.22	0.27	0.13	0.90	0.05	.028	-2.007	0.101	NS
6 th month	T6-T7	1.25	0.64	0.45	0.88	0.32	0.23	-0.745	0.534	NS

SD= standard deviation, SE= standard error, P = Probability value, NS = non significant at P > 0.05.

Discussion

The present in-vivo split-mouth study was done to evaluate the effectiveness of MOPs as a minimal invasive surgical approach on the rate of canine retraction in a sample of Egyptian orthodontic patients, in addition, the potential risk for RR of canines during retraction was also evaluated.

The split-mouth design was selected to reduce the inter-subject biologic variability and each patient acts as his/her own control, thus decreasing the number of participant required.¹³ The age ranged between 13 and 19 years (16.17 ± 2.29). Narrow age range was selected to obtain as much as possible the same biological response in all subjects.

It was recommended that the use of medication for treating certain underlying systemic conditions can affect the rate of OTM. Therefore, patients with long-term use of any medication or a systemic disease were excluded.¹³

Extraction is considered a surgical insult that can change the rate of OTM by increasing the activity of inflammatory factors, which could obscure the effect of MOPs. To minimize this possibility in the current study, extraction was done at the start of the treatment, and before fitting of the orthodontic appliance..^{8,13}

Double transpalatal arches on both maxillary 1st and 2nd molars were used in order to control the posterior segment and reduce the torsion of molars. Orthodontic mini-screws were not used for retraction as the process of screw insertion might mimic a MOPs.

NiTi closed coil springs were used to retract canines since they generate a continuous light force of 150 g during the whole treatment period, as they do not exhibit rapid force decay such as seen with elastomeric chains.^{13,16}

The utilization of conventional orthodontic mini-screw for creation of MOPs offers great potential because they are readily available in some orthodontic offices, and most orthodontists are already trained in their use for multiple orthodontic cases.

In the present study, the possibility of increasing the rate of maxillary canine retraction by using MOPs has been positively demonstrated only during the 1st month of retraction. The average amount of distal canine movement achieved on the MOPs side as measured clinically was 1.51 ± 0.50 mm, while the average amount of canine movement on the control side was 1.10 ± 0.51 mm (Table.1). Although there was an increase in the rate of canine retraction on the MOPs side more than on the control side, this increase was very close but didn't reach a statistically significant

level ($p=0.059$). This result is generally agreed with the results of most previous studies tested the effects of MOPs during the first month of retraction.^{8,14}

The lack of a significant increase in OTM on the MOPs side in this study can be a result of the minimal surgical insult of MOPs that may not be able to trigger an adequate inflammatory response to activate an ideal RAP effect.

In the present study, most of acceleration had occurred during the 1st month only, and then the rate of canine retraction gradually decreased thereafter. This phenomenon could be attributed to the transient nature of the RAP, as it was reported by Wilcko et al. that RAP had a specific pattern in its emergence and quantity since it begins within few days following injury reaching its peak after 4 to 8 weeks and lasting for 2 to 4 months.^{18,19}

Regarding the total rate of canine movement all over the retraction period (3.52 ± 1.33 month MOPs, 3.68 ± 1.11 month conventional) showed no statistically significant difference between MOPs and control sides (1.59 ± 0.49 versus 1.50 ± 0.42 mm/month) ($p=0.621$). (Table.1) This result is in agreement with the results of Alkebsi et al.¹³

Future studies are recommended to evaluate the effect of different numbers, sites, and repetition of MOPs on the rate and type of OTM.

Conclusions

- Micro-osteoperforations increases the rate of maxillary canine retraction during the 1st month, this increase seems clinically significant, although it was not statistically significant. This could give a clue about the ineffectiveness of the technique unless become repeated on monthly basis.

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