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Clinical Evaluation of the Effect of Micro-Osteoperforations on the Rate of Tooth Movement During Alleviation of Mandibular Anterior Crowding

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Abstract:

Objectives: To investigate the influence of micro-osteoperforation (MOP) on rate of orthodontic tooth movement during alleviation of mandibular anterior crowding, pain perception and root resorption.

Design: 2 arm parallel randomized controlled trial with an allocation ratio of 1:1.

Setting: The outpatient department of the dental college, Ain Shams University

Participants: 26 female patients having moderate lower anterior crowding **Methods**: The experimental group consisted of 13 patients bonded with a fixed appliance(mini diamond brackets roth 0.022) who received 3 linear MOP between the lower central incisors, distal to the lower central incisors, distal to the lower lateral incisors, and distal to the lower canines, and followed each 2 weeks. These were compared with a control group treated with identical brackets without MOP and were assessed for rate of tooth movement(alignment improvement), pain perception usingaVisualAnalogueScale(VAS) of 10 mm, and root resorption by CBCT.

Results: A statistically significant increase in rate of tooth movement in the MOP group ($p<0.05$).

Conclusion: MOP appears to enhance the rate of tooth movement with slight discomfort in the first day of the procedure and didn't have effect on the root resorption

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Introduction

One of the common deterrents that faces orthodontics and leads patients, especially the adults, to avoid orthodontic treatments or seek alternative options is the prolonged duration of fixed orthodontic treatment which takes about 2-3 years [1]the treatment plan, and the practitioner's office were examined to evaluate causes for variation in the duration of orthodontic treatment. From six offices 118 patients were evaluated. All patients were treated in a single phase with fixed appliances. Appliances were worn for an average of 23.1 months. The mean duration for offices ranged from 19.4 to 27.9 months. Thirty-eight percent of the patients had extractions, and 32% wore headgear. Fifty percent of the variation in treatment duration among patients was explained by a five-step multiple regression equation. The variables entering this equation were (1[). In addition to decreased patient compliance [2] the long treatment time poses high risk of caries and external root resorption[3]. Therefore a number of attempts have been made to create different approaches both preclinically and clinically in order to achieve quicker results, but still there are a lot of uncertainties and unanswered questions towards most of these techniques. Procedures aimed to reduce treatment duration fall into 3 major categories [4]. The first is biologic, through local or systemic administration of drugs such as Vitamin D, Prostaglandins, Cytokines, Parathyroid hormone. This approach showed numerous adverse reactions and drug induced side effects. For this reason research turned towards trying to find physical, mechanical or surgical approaches that can accelerate tooth movement without side effects. The second category is mechanical or physical stimulation such as direct electric currents, pulsed electromagnetic field, static magnetic field, resonance vibration, and low-level laser which was mostly investigated and gave the most promising results but more experiments are needed to differentiate the optimum energy, wavelength, and the optimum duration for usage. The final category is surgically facilitated orthodontic treatment, such as osteotomy, corticotomy, dentoalveolar distraction, piezocision and micro-osteoperforations. The surgical approach is the most clinically used and most tested with known predictions and stable results. However, it is invasive, aggressive, and costly, and patients are not open to the ideas involving surgery unless it is the only option that is needed to have a proper occlusion. Micro-osteoperforations is one of the newest techniques in accelerating tooth movement. It has good clinical outcome and is considered innovative and least invasive in the surgical approach, but it has not been widely studied in the orthodontic literature. Therefore, the idea of this study was aroused to study the effect of micro-osteoperforations on the rate of tooth movement during alignment of mandibular anterior crowding.

Material and Methods:

A total of 26 patients were recruited from the outpatient clinic of the Orthodontic Department at the Faculty of Dentistry Ain Shams University, they were allocated randomly 1:1 ratio into 2 groups, control group and MOP group. Inclusion criteria: Adult female patients with age ranging from 18 to 25 years, no previous orthodontic treatment, presence of permanent dentition from first molar to first molar, mandibular anterior irregularity index from 4 to 10, no spaces in the mandibular arch, the lower incisor mandibular plane angel is less than 98 degrees, patients requiring non-extraction orthodontic treatment in the mandibular arch, treatment plan did not require any therapeutic interventions involving intermaxillary or other intraoral or extraoral appliances including elastics, lip bumpers, maxillary expansion appliances, or

headgear was needed prior to the complete alignment of mandibular anterior teeth. Exclusion criteria: Medical problems that affect tooth movement, presence of primary teeth in the mandibular arch, inability to place brackets on the mandibular anterior teeth (100% deep bite, blocked or severely rotated teeth), pregnant patients.

Methods: An informed consent was signed by each patient before their enrollment in the current study in which the aim of the study , the methodology and possible complications will be clearly described. Full orthodontic records were taken for the patients who met the inclusion criteria. These records are: Extra-oral and intra-oral photographs, orthodontic study casts, panoramic and cephalometric radiographs, Cone Beam Computed Tomography.

Mandibular teeth from right first molar to left first molar were bonded with 0.022-inch conventional minidiamond brackets Roth prescription and bands or tubes were placed on first molars. In both groups the initial wire used was 0.014- Cu-NiTi. This wire was placed immediately after bonding of the brackets. The principal of changing the initial wire was to achieve 50 % relief of the initial crowding in both groups. The second wire placed was always 0.016 Cu-NiTi and was changed to 0.016x0.022-NiTi when 80% of the initial crowding was relieved in either group. 13 patients received 3 linear MOPs at each of the following areas: mesial to the lower central incisors , distal to the lower central incisors , distal to the lower lateral incisors and distal to the lower canines. The MOPs were performed on the day of initial wire placement. The other 13 patients didn't receive MOPs and thus considered the control group.

Methods of assessment: The rate of tooth movement was analyzed on digital orthodontic casts at each visit (every 2 weeks). When an irregularity index of 0 mm is achieved between the mandibular anterior teeth the alignment was considered complete, this will be assessed visually by 2 operators. All patients received a survey (visual analog scale) to fill during the first week after initial arch wire placement according to their pain perception. Cone beam computed tomography (CBCT) was taken for all patients pre-treatment and post-alignment (lower anterior segment only) to assess the amount of root resorption.

Error of measurement: The error of measurement in this study was assessed through assessing the intra-operator and inter-operator reliability.

Statistical Analysis: Numerical data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests. All data showed non-normal (non-parametric) distribution except for age and time for leveling data which showed normal (parametric) distribution. For parametric data, Student's t-test was used to compare between the two groups. For non-parametric data; Mann-Whitney U test was used to compare between the two groups. Friedman's test was used to study the changes by time within each group. Dunn's test was used for pair-wise comparisons when Friedman's test is significant. Intra – and inter-observer reliability were assessed using Cronbach's alpha reliability coefficient and Intra-Class Correlation Coefficient (ICC). The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

Results: Figure(1)illustrates the subject flow through the trial using a CONSORT diagram, Out of the 26 subjects enrolled in the study, 3patients from control group and 2 patients from MOP group were lost to follow up leaving a total of 21 subjects completing the study and analyzed (11 experimental and 10 control).

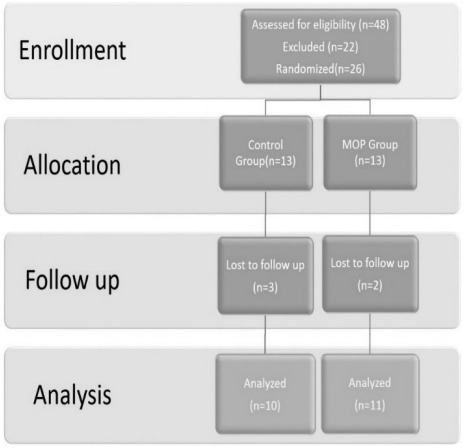

Figure 1: CONSORT flow-chart

1. Overall time for leveling and alignment:

MOP group showed statistically significantly lower mean time for leveling and alignment than Control group. For MOP group the overall time for leveling and alignment was (57.3+/-19.9) while it was (109.5+/-34.7) for control group.

2. Alignment improvement (%)

Alignment improvement % was calculated as:

Pre-operative value – Post-operative value / Pre-operative value x 100 After 14 days; there was no statistically significant difference between alignment improvement percent in the two groups.

After 1, 1.5, 2, 2.5, 3 as well as 3.5 months; MOP group showed statistically significantly higher mean alignment improvement % than Control group.

After 4, 4.5, 5, 5.5 as well as 6 months; there was no statistically significant difference between alignment improvement percent in the two groups.

Table (1): Mean, standard deviation (SD) values and results of Mann-Whitney U test for the comparison between alignment improvement % in the two groups

Time	MOP		Control		*P*-value	*Effect size (d)*
	Mean	SD	Mean	SD		
Day 14	31.2	13.2	27.6	14.4	0.398	0.375
1 Month	62	19.2	41.4	17.9	0.029*	1.084
1.5 Months	83.3	22	58.8	19.6	0.019*	1.177
2 Months	92	14.1	69.8	19.6	0.007*	1.355
2.5 Months	97.1	6.4	78.9	19.2	0.004*	1.439
3 Months	100	0	86.1	17.7	0.004*	1.177
3.5 Months	100	0	92	15.3	0.024*	0.718
4 Months	100	0	94.9	13.1	0.056	0.524
4.5 Months	100	0	96.4	11.4	0.294	0.170
5 Months	100	0	97.6	7.6	0.294	0.170
5.5 Months	100	0	98.5	4.7	0.294	0.170
6 Months	100	0	99.5	1.6	0.294	0.170

**: Significant at P ≤ 0.05*

3. Little's Irregularity Index

Comparison between the two groups

There was no statistically significant difference between Little's Irregularity Index in the two groups through the whole study period.

Table (5): Mean, standard deviation (SD) values and results of Mann-Whitney U test for the comparison between Little's Irregularity Index in the two groups

Time	MOP		Control		*P*-value	*Effect size (d)*
	Mean	SD	Mean	SD		
Pre-operative	8.48	0.86	6.4	2.77	0.294	0.794
Day 14	6.15	1.45	4.60	3.55	0.456	0.546
1 Month	3.63	2.25	3.87	3.44	0.881	0.106
1.5 Month	2.68	2.45	2.5	2.29	0.724	0.270
2 Months	1.95	1.69	1.5	1.8	1.000	0.000
2.5 Months	1.42	0.23	1.4	0.85	0.564	0.535
3 Months	0	0	0.7	0.99	0.414	0.535
3.5 Months	0	0	0	0	1.000	0.000

*: Significant at $P \leq 0.05$

Changes by time within each group

As regards MOP group; there was a statistically significant decrease in mean Little's Irregularity Index at day 14, from day 14 to 1 month, 1 to 1.5 months as well as from 1.5 to 2 months. From 2 to 2.5 months; there was no statistically significant change in mean Little's Irregularity Index. From 2.5 month to 3 months, there was a statistically significant decrease in mean Little's Irregularity Index. From 3 to 3.5 months; there was no statistically significant change in mean Little's Irregularity Index.

While for control group; there was a statistically significant decrease in mean Little's Irregularity Index after 14 days. From day 14 to 1 month; there was no statistically significant change in mean Little's Irregularity Index . From 1 month to 1.5 months as well as 1.5 month to 2 months; there was a statistically significant decrease in mean Little's Irregularity Index. From 2 months to 2.5 months as well as 2.5 to 3 months; there was no statistically significant change in mean Little's Irregularity Index. From 3 months to 3.5 months; there was no statistically significant change in mean Little's Irregularity Index, however; 3.5 months score showed statistically significantly lower value than 2.5 months score.

4. Amount of root resorption

Amount of root resorption was calculated as: Pre-operative root length – Post-operative root length. As regards all teeth; there was no statistically significant difference between amounts of root resorption in the two groups.

5. Pain (VAS) score:

After 1 day; MOP group showed statistically significantly higher mean pain (VAS) score than Control group. After 2, 3, 4, 5, 6 as well as 7 days; there was no statistically significant difference between pain (VAS) score in the two groups.

6. Intra- and inter-observer agreement

For root resorption, there was very good intra-observer reliability with Cronbach's alpha values ranging from 0.758 to 0.919. There was very good inter-observer reliability with Cronbach's alpha values ranging from 0.815 to 0.903.

For irregularity index there was very good intra-observer reliability with Cronbach's alpha values ranging from 0.877 to 0.931. There was very good inter-observer reliability with Cronbach's alpha values ranging from 0.823 to 0.902.

Discussion:

In this study the primary aim was to evaluate the effectiveness of MOPs in accelerating orthodontic tooth movement for leveling and alignment in subjects with mandibular anterior crowding. The study revealed that MOPs accelerated leveling and alignment and reduced the overall time needed to complete it.The results showed that overall treatment time was 57.3 +/-19.9 days for the MOP group and 109.5 +/- 34.7 days for the control group, and therefore performing MOPs reduced the total leveling and alignment time by 47.7%. The mean treatment time to alignment for the mandibular anterior teeth in conventional orthodontics with LII > 4 mm has been shown to take from 117.1 +/- 46 days, which is consistent with our results for control group[5]. Our findings are not consistent with another randomized control trial evaluating the effect of piezotome-corticision in alleviating mandibular anterior crowding. Uribe et al (2017)[6] found that the mean total number of days to complete alignment in the piezotome-corticision group was 102+/- 34.7 days compared to 112+/- 46.2 days in the control group. Owing to the fact that the duration, size and intensity of RAP response varies directly with the magnitude of the injury or stimulus, Uribe et al findings may be due to reduced number of cuts in which only 3 linear corticisions have been performed, one between the lower central incisors and two mesial to the lower canines, compared to 21 perforations that have been performed in our study.Charavet et al. (2016) [7] study showed that a piezocision procedure was able to reduce the treatment duration by 43% compared to the conventional orthodontic group. Our study differs from theirs in that our primary goal was to evaluate the alignment phase only but they studied the whole treatment time until debonding of the fixed appliances, which may vary between patients according to specific treatment needs, patient compliance and quality of the outcome.

Concerning the effect of MOPs to induce RAP and accelerate the rate of tooth movement, human studies yielded conflicting results. Alikhani et al (2013) [8] reported that MOPs increased the rate of canine retraction 2.3 fold compared to the control group and they claimed that MOPs could reduce orthodontic treatment time by 62%. Attri et al (2018)[9] Evaluated the effect of MOPs on the rate of tooth movement during en-masse space closure, the results of their trial concluded that the rate of canine retraction at right and left sides were faster. All of the previous studies used Propel appliance to perform the MOPs in their studies. On the contrary, Alkebsi et al(2018)[10] found that MOPs have had no effect on the rate of OTM during canine retraction. This could stem from the fact that a temporary anchorage device, instead of Propel device, was used to perform MOPs in the previous trials. According to the claim of Propel company that Propel appliances have specific thread pitch that has been chosen to create the maximum fracture in the alveolar bone, high powered trials are needed to shed further light on this conundrum comparing factors as the

sole usage of the Propel device to perform MOP's or its effective substitution with a TAD. Furthermore, since the device does pose an additional cost increase to the patient, the comparison of the PROPEL device and pseudo-MOP device like TADs from cost versus benefit aspect would also be beneficial especially during the planning stages.

The fundamental aim of all minimally invasive surgical procedures was to accelerate OTM utilizing patient-friendly approaches, So patients' feedback was of utmost importance. All patients have been asked to assess their pain levels on the day of MOP procedure and each day after for the first week using a VAS scale similar to Alikhani et al. (2013) [8] and Attri et al (2018) [9].

After one day; MOP group showed statistically significantly higher mean pain (VAS) score than control group, but most of the MOP patients told us that the pain in the first day was just as a tingling sensation which rapidly faded away after few hours.

Patients were required to fill a questionnaire regarding their intake of any analgesics during the first week, their satisfaction with the procedure, the ease of the procedure and whether they had recommend the procedure to a friend. All patients in both groups had the same answers. They all did not take any pain medications (as instructed by the operator) during the first week after initial arch wire placement. All of the patients were satisfied by the procedure, and would recommend it to a friend. So MOP procedure was well tolerated by the patients which was the same finding reported by Alikhani et al [8], and Attri et al [9]. In this study the mean of VAS score during the first day for MOPs group was 5.5 ± 1.3 without consumption of any pain medication which is slightly less than that reported by Charavet et al [7] who evaluated the pain level after piezocision via (10 maximum) VAS and found that the average score was 6 ± 1.9 in the first day with 2.2 g paracetamol consumption in the seven days after the piezocision. The pain score of MOP procedure is much less than that reported by corticotomies which are more invasive, painful and associated with some post-operative swelling [11].

Conclusion:

1- The results of the trial indicate that MOPs reduced the overall time of lower mandibular alignment by 47.7%.

2- Minimal discomfort was observed post procedure for participants who had undergone MOPs.

3- MOP procedure has no effect on root resorption

References:

1. Fink, D. F. & Smith, R. J. *The duration of orthodontic treatment. Am. J. Orthod. Dentofac. Orthop.* ***102****, 45–51 (1992).*

2. Royko, A., Denes, Z. & Razouk, G. *The relationship between the length of orthodontic treatment and patient compliance. Fogorv. Sz.* ***92****, 79–86 (1999).*

3. Pandis, N., Nasika, M., Polychronopoulou, A. & Eliades, T. *External apical root resorption in patients treated with conventional and self-ligating brackets. Am. J. Orthod. Dentofac. Orthop.* ***134****, 646–651 (2008).*

4. Uribe, F., Padala, S., Allareddy, V. & Nanda, R. *Patients', parents', and orthodontists' perceptions of the need for and costs of additional procedures to reduce treatment time. Am. J. Orthod. Dentofac. Orthop.* ***145****, (2014).*

5. Pandis, N., Polychronopoulou, A. & Eliades, T. *Self-ligating vs conventional brackets in the treatment of mandibular crowding: a prospective clinical trial of treatment duration and dental effects. Am. J. Orthod. Dentofac. Orthop.* ***132****, 208–215 (2007).*

6. Uribe, F. et al. *Efficiency of piezotome-corticision assisted orthodontics in alleviating mandibular anterior crowding—a randomized clinical trial. Eur. J. Orthod.* ***39****, 595–600 (2017).*

7. Charavet, C. et al. *Localized piezoelectric alveolar decortication for orthodontic treatment in adults: a randomized controlled trial. J. Dent. Res.* ***95****, 1003–1009 (2016).*

8. Alikhani, M. et al. *Effect of micro-osteoperforations on the rate of tooth movement. Am. J. Orthod. Dentofac. Orthop.* ***144****, 639–648 (2013).*

9. ***Attri, S. et al.*** *Comparison of rate of tooth movement and pain perception during accelerated tooth movement associated with conventional fixed appliances with micro-osteoperforations–a randomised controlled trial. J. Orthod.* ***45****, 225–233 (2018).*

10. Alkebsi, A., Al-Maaitah, E., Al-Shorman, H. & Alhaija, E. A. *Three-dimensional assessment of the effect of micro-osteoperforations on the rate of tooth movement during canine retraction in adults with Class II malocclusion: a randomized controlled clinical trial. Am. J. Orthod. Dentofac. Orthop.* ***153****, 771–785 (2018).*

11. ***Hassan, A. H., Al-Fraidi, A. A. & Al-Saeed, S. H.*** *Corticotomy-assisted orthodontic treatment. Open Dent. J.* ***4****, 159 (2010).*