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Evaluation of the Effectiveness of Mini-screw-facilitated Micro-osteoperforation Interventions on the Treatment Process in Patients with Orthodontic Treatment: A Systematic Review and Meta-analysis

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ABSTRACT

Background and aim: Given that MOP is a new method, the discrepancy in the research results and its effectiveness on tooth movements and possible side effects of this method are controversial. The present study aims to evaluate the efficacy of mini-screw-facilitated micro-osteoperforation interventions on the treatment process in patients with orthodontic treatment.

Materials and methods: From the electronic databases, PubMed, Cochrane Library, Embase, ISI have been used to perform systematic literature between January 2018 and July 2020. Therefore, a software program (Endnote X8) has been utilized for managing electronic titles. Searches were performed with mesh terms. The quality of the included studies has been assessed using the Cochrane Collaboration's tool. For Data extraction, two reviewers blinded and independently extracted data from the abstract and full text of the studies included. Moreover, the mean differences between the two groups (MOP and without MOP) with a 95% confidence interval (CI). The Meta-analysis and forest plots have been evaluated using a software program available in the market (i.e., Comprehensive Meta-Analysis Stata V16).

Results: In the electronic and manual search process, a total of 102 potentially relevant abstracts and titles were found. Finally, a total of eight publications met the inclusion criteria required by this systematic review. Mean difference was (MD, 0.56mm 95% CI 0.53, 0.60. P= 0.00) among 8 studies.

Conclusion: The present study shows positive effects and statistically significant mini-screw-facilitated micro-osteoperforation interventions on the treatment process in patients with orthodontic treatment.

1. Introduction

One of the main reasons patients choose orthodontic treatment is the long duration of treatment.[1] Other causes include white spot lesions and caries, periodontal problems, root irritation, and soft tissue trauma directly related to the duration of treatment.[2] Researchers and Dentists are always trying to reduce the time of orthodontic treatment using different methods and achieve the same degree of success.[3] Non-surgical methods to reduce the duration of treatment include self-ligating brackets, drugs, low-level laser and photodynamic, custom-made brackets and wires, and injection of cell mediators. Surgical procedures are also used to increase teeth speed and reduce the duration of orthodontics, including corticotomies with or without bone grafts, piezocisions, and micro-osteoperforations (MOP).[4-6] Orthodontic tooth movement is a process in which applying a force causes bone resorption on the pressure side and bone apposition on the stress side.[7] PDL stress by releasing cytokines improves and enhances the purposeful targeting of osteoclasts for bone resorption.[8, 9] For the first time, Frost reported that an increase in inflammatory mediators could increase absorption and bone metabolism and affect the rate of teeth movement.[10] Studies have shown that the concentration of catabolic bone biomarkers and TRAP+ osteoclasts after surgical interventions is high. Surgical procedures have the greatest and Best effect on the movement of the orthodontic tooth.[6, 11-13] In the past few years, various surgical procedures have been introduced, one of which is the regional acceleratory phenomenon (RAP) used by Wilckodontics to increase tooth movements.[14, 15] However, this procedure requires corticotomy surgery, a relatively invasive procedure involving the full elevation of the mucoperiosteal flap, sutures, and even side effects of surgery, which involve pain, swelling, and insignificant interdental bone and attached loss of gingiva.[5, 16] All of which cause orthodontists should not use it. The use of minimally invasive invasion methods has been suggested, for example, corticision, piezocision, and MOP.[17, 18] Given that MOP is a new method, the

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discrepancy in research results and its effectiveness on tooth movements and possible side effects are controversial. Hence, the present study aims to evaluate the efficacy of the treatment process in patients with orthodontic treatment by mini-screw-facilitated micro-osteoperforation interventions.

2. Materials and methods

Search strategy

From the electronic databases, PubMed, Cochrane Library, Embase, ISI have been used to perform systematic literature between January 2018 and July 2020. Therefore, a software program (Endnote X8) has been utilized for managing electronic titles. Searches were performed with mesh terms:

((“Tooth Movement Techniques/adverse effects"[Mesh] OR “Tooth Movement Techniques/methods"[Mesh] OR “Tooth Movement Techniques/therapy"[Mesh])) AND "Intraoperative Complications"[Mesh]) AND “micro-osteoperforation"[Mesh]).

Selection criteria

Inclusion criteria

1. Randomized controlled trial studies, controlled clinical trials, and prospective and retrospective cohort studies.
2. Studies with the control group (treatment without MOP)
3. Evaluation rate of tooth movement then mini-screw-facilitated micro-osteoperforation interventions
6. in English

Exclusion criteria

1. In vitro studies, case studies, case reports, and reviews.
2. Animal studies

Table 1. PICO OR PECO strategy.

PICO OR PECO strategy	Description
P	Population/ Patient: Patients that do orthodontic treatment.
E	Exposure/ Intervention: MOP
C	Comparison: MOP group vs. control group
O	Outcome: determine the rate of movement of the tooth

Data extraction and method of analysis

The data extracted from the research included the study, years, study design, Intervention group, control group, Gender, sample size, mean/range of age, Malocclusion, and duration of the intervention. The quality of the included studies has been assessed using the Cochrane Collaboration's tool.[19] The scale scores for low risk were one and for High and unclear risk was 0. Scale scores range from 0 to 6. A higher score means higher quality. For Data extraction, two reviewers blinded and independently extracted data from the abstract and full text of the studies included.

Moreover, the mean differences between the two groups (MOP and without MOP) with a 95% confidence interval (CI), fixed-effect model, and Inverse-variance method were calculated. Random effects were used to deal with potential heterogeneity, and I2 showed heterogeneity. The Meta-analysis and forest plots have been evaluated using a software program (i.e., Comprehensive Meta-Analysis Stata V16).

3. Results

According to the research design, 102 potentially relevant research abstracts and titles have been discovered in our electronic searches. In the first phase of the study selection, 56 research has been about the topics and abstracts. Therefore, we thoroughly assessed the complete full-text papers of the rest 41 studies in the second stage. We excluded 33 publications due to the lack of the defined inclusion criteria. Then, eight papers remained in agreement with our inclusion criteria required (Fig. 1). Table 2 reports the individual studies in this meta-analysis.

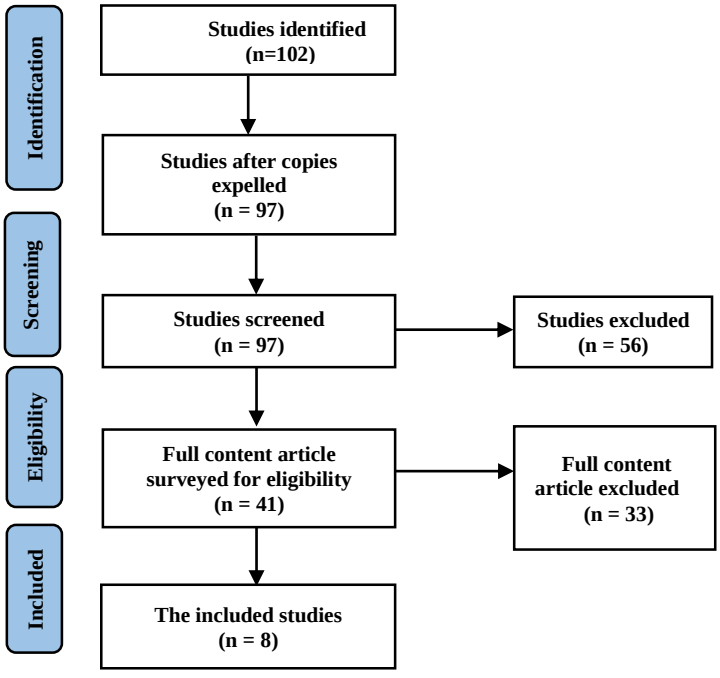

Fig. 1. Study attrition.

Sample size

Therefore, eight studies (Randomized controlled trial) have been included. The number of females and man was 89 and 136, respectively. The total was 225. The mean age was 19.76 years (Table 2).

Bias assessment

According to the Cochrane Collaboration tool, one study had a total score of 6/6, five studies had an overall score of 5/6, one study had a total score of 4/6, and one study had a total score of 3/6. This outcome showed a low risk of bias in all studies, except[25] (Table 3).

Table 2. Studies selected for systematic review and meta-analysis.

Study. Year	Design	Number of Patients		Mean/ Range of age		Intervention Group (MOP)	Control Group (without MOP)
		MOP	Control	MOP	Control		
		Male	Female				
Babanouri et al. 2020[20]	RCT	25		26.08		MOP1: On the experimental side, 3 MOPs were provided on the buccal surface of the alveolar bone to accelerate canine retraction, whereas patients. MOP2: Has received three experimental buccal MOPs and three palatal MOPs.	One side of the mouth functioned as a control side in each patient, which earned no MOPs.
		25	25				
		11	14				
Sivarajan et al. 2019[21]	RCT	60		22.2		Group 1 (4-weekly in the maxilla, MF-MOP-4; 8-weekly in mandible, MF-MOP-8); Group 2 (8-weekly in the maxilla, MF-MOP-8; 12-weekly in mandible, MF-MOP-12); and Group 3 (12-weekly in the maxilla, MF-MOP-12; 4-weekly in mandibular, MF-MOP-4).	One side of the mouth functioned as a control side in each patient, which earned no MOPs.
		60	60				
		7	23				
Aboalnaga et al. 2019[22]	RCT	36		24.8		Three MOPs were assigned at random on either the left or the right sides. The MOPs were conducted using a mini-screw distal to the canine (1.8 mm diameter, 8 mm length).	Every side of the patient's jaws was separated randomly into control groups.
		18	18				
		-	18				
Shah et al. 2019[23]	RCT	20		19.80		The Experimental-side quadrant that received Orthodontic treatment and the Micro osteoperforations (MOPs) both.	Side of the patients' jaws that received Orthodontic treatment only.
		10	10				
		6	4				
Kundi et al. 2018[24]	RCT	60		27.9		First maxillary premolars were extracted, and canine retractions in both groups were started. A 1.5 mm diameter disposable MOP tool (PROPEL Orthodontics, Ossining, NY) conducted three FCPs in the left and right side distal to the canines.	One side of the mouth functioned as a control side in each patient, which earned no MOPs.
		30	30				
		18	12				
Feizbakhsh et al. 2018[25]	RCT	40		28		Were used a bone screw and a handheld screwdriver, interventional community of maxilla and mandible provided micro-osteoperforations with two holes. Micro-osteoperforations were the prime predictor component.	Every side of the patient's jaws was separated randomly into control groups.
		20	20				
		12	8				
Attri et al. 2018[26]	RCT	120		18		Patients bonded with a fixed apparatus (Gemini 3 M) that provided MOP distal to canines every 28 days during retraction.	They were treated with identical brackets without MOP.
		60	60				
		27	33				
Alkebsi et al. 2018[27]	RCT	64		19.26		Three MOPs on the buccal bone distal to the canines on the randomly chosen side were performed using miniscrews (5 mm depth, 1.5 mm width).	One side of the mouth functioned as a control side in each patient, which earned no MOPs.
		32	32				
		8	24				

RCT: randomized clinical trial.

Table 3. Risk of bias assessment.

Study	Generation of Random Sequences.	Allocation concealment.	Participants and personnel blinded.	It was blinding of outcome assessment.	Data on the incomplete result.	Selective reporting.	Total score
Babanouri et al. 2020[20]	+	?	+	+	+	+	5
Sivarajan et al. 2019[21]	+	?	+	+	+	?	4
Aboalnaga et al. 2019[22]	+	?	+	+	+	+	5
Shah et al. 2019[23]	+	?	+	+	+	+	5
Kundi et al. 2018[24]	+	?	+	+	+	+	5
Feizbakhsh et al. 2018[25]	?	?	+	+	?	+	3
Attri et al. 2018[26]	+	+	+	?	+	+	5
Alkebsi et al. 2018[27]	+	+	+	+	+	+	6

Low (+), unclear (?), high (-).

Tooth movement between control and MOP group

The mean difference between 8 studies and heterogeneity was observed (MD, 0.56 mm 95 % Cl 0.53, 0.60. P=0.00) (I2 = 97.92 %; P = 0.00). This result revealed a statistically significant difference (p=0.00) between MOP and control group.

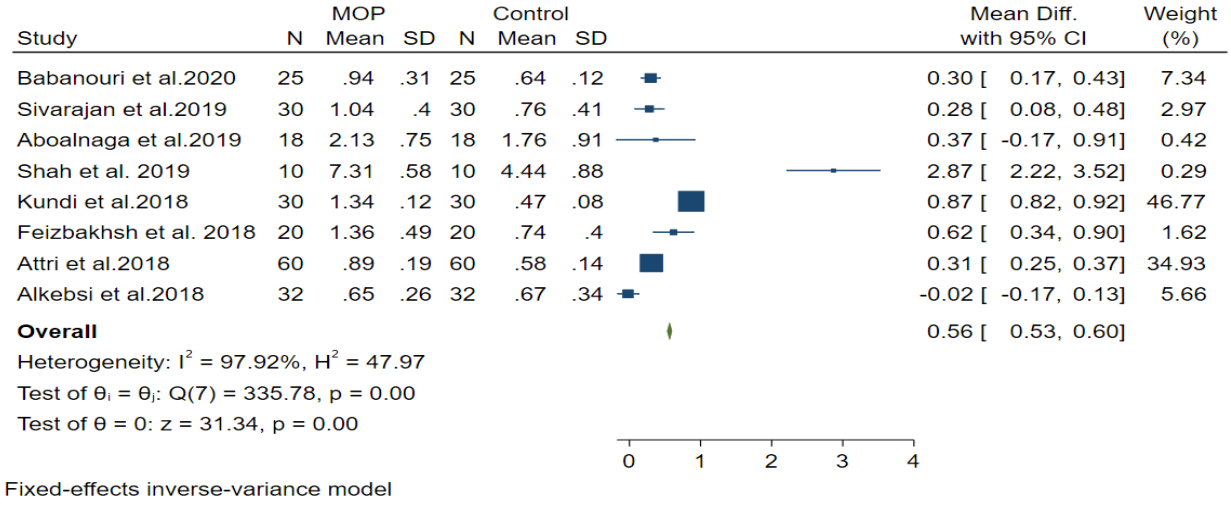

Fig. 2. Mean difference of orthodontic tooth movement with MOP vs whiteout MOP.

4. Discussion

The present systematic review and meta-analysis results indicate that the group with MOP and without MOP had a statistically significant difference. This result showed Micro-osteoperforations were effective in accelerating orthodontic tooth movement. Babanouri et al. 2020.[20] reported that MOP interventions positively affect the rate of tooth movement over three months. Sivarajan et al. 2019[21] showed a minimum difference in tooth movement when 4, 8, and 12-week MOP intervals were used. Feizbakhsh et al. 2018[25] reported that MOP interventions significantly increased the tooth movement rate. However, comparing the differences in tooth movement rate in both interventional and control sides when maxillary and mandibular canine retraction yielded negligible results. As a result, Alkebsi et al. 2018[27] Observed that the different findings from another study were included in the systematic review and meta-analysis percentage. This study did not show any statistically significant difference in the rate of tooth movement at all-time points between the MOP and the control sides. Several studies have evaluated surgical and non-surgical adjunctive procedures aimed at improving OTM.[17, 28] While known to be active, patients are unwilling to undergo corticotomies to minimize the duration of orthodontic treatment.[29] Attri et al. 2018[26] Comparison of tooth movement and pain perception during rapid tooth movement showed a statistically significant improvement in tooth movement rate in the MOP group and no differences in pain perception. The limitations of this study include the differences in how interventions are performed by the selected studies, data analysis methods. However, we tried to reduce the inconsistency in the studies to reach a more comprehensive result. Since the risk of bias in all the studies was low, the findings of this study can be used to reduce the treatment time and increase the rate of tooth movement in orthodontic treatment.

5. Conclusion

The present study demonstrates positive and statistically significant effects of mini-screw-facilitated micro-osteoperforation interventions on the treatment process in orthodontic treatment patients. As a result, considering the advantages and disadvantages of MOP, orthodontists can recommend an effective response to increase the rate of tooth movements.

Conflict of Interest

The authors declared that there is no conflict of interest.

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