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Research Article

Clinical Effectiveness Of Micro-Implant In Orthodontic Treatment Among Class I Or Ii Malocclusion Patients: A Systematic Review And Meta-Analysis

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Abstract

Background and aim: The aim of current systematic review and meta-analysis study was evaluate the clinical effectiveness of Micro-Implant in Orthodontic Treatment among Class I or II Malocclusion Patients.

Methods: From the electronic databases, PubMed, Scopus, LILACS, Web of Science, EBSCO, LIVIVO, and Embase have been used to perform a systematic literature over the last ten years between 2011 and September 2021. Mean differences with 95% confidence interval (CI), fixed effect model with Inverse-variance method were calculated. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

Results: 452 studies were selected to review the abstracts, the full text of 48 studies was reviewed. Finally, seven studies were selected. The mean difference of molar mesiodistal and mesiodistal incisor movement was -0.53 mm and -0.65 mm; (MD, -0.53 95 % CI -0.69, -0.38. P= 0.00) and (MD, -0.65 95 % CI -0.94, -0.37; P= 0.00), respectively.

Conclusions: Micro-Implant in Orthodontic Treatment among Class I or II Malocclusion Patients is more effective than the conventional anchorage devices.

Keywords: Micro-Implant, Malocclusion Patients, Micro-Implant

Introduction

Class I malocclusion when the mesiobuccal cusp of the maxillary first permanent molar occludes with the mesiobuccal groove of the mandibular first permanent molar. Class II malocclusion is when the mesiobuccal cusp of the maxillary first molar occludes mesial with the mesiobuccal groove of the mandibular first molar(1). Decreased arch length due to mesial movement is one of the methods to treatment malocclusion(2). Trans-Palatal Arch and multi-tooth differential moments in the anchorage segment are old methods of treatment Class I and II malocclusion(3). In traditional and old methods, due to the anchorage loss, their use is not recommended, therefore Micro-Implant are used for maximum anchorage(4). Studies reported 80 to 90 % survival rate for Micro-Implant (5, 6). Studies showed anchorage losses are observed after the use of Micro-Implant(7, 8). As a result, more studies are needed to be able to compare new and traditional methods. Over the past few years, differences between study results have left little evidence for the exact effects of Micro-Implant. Lack of studies showing significant anchorage losses and movements of Micro-Implant. Sufficient and sufficient evidence has not been provided in the studies, in the studies the sample size is low and the quality of the studies was very low, so the present study tries to provide sufficient and stronger evidence. The aim of the current systematic review and meta-analysis study was evaluate the clinical effectiveness of Micro-Implant in Orthodontic Treatment among Class I or II Malocclusion Patients.

Methods

Search strategy

From the electronic databases, PubMed, Scopus, LILACS, Web of Science, EBSCO, LIVIVO, and Embase have been used to perform a systematic literature over the last ten years between 2011 and September 2021. The reason for choosing studies in the last ten years is to be able to provide sufficient evidence in this area and use newer studies. Therefore, a software program (Endnote X8) has been utilized for managing the electronic titles.

Searches were performed with mesh terms:

((((("Malocclusion"[Mesh] OR "Malocclusion, Angle Class II"[Mesh] OR "Malocclusion, Angle Class I"[Mesh]) AND ("Orthodontic Appliances"[Mesh] OR "Tooth Movement Techniques"[Mesh])) AND "Orthodontic Anchorage Procedures"[Mesh]) OR "Dental Abutments"[Mesh]) AND "Treatment Outcome"[Mesh].

This systematic review has been conducted on the basis of the key consideration of the PRISMA Statement–Perfumed Reporting Items for the Systematic Review and Meta-analysis(9), and PICO strategy (Table1).

Selection criteria

Inclusion criteria: Randomized controlled trials studies, controlled clinical trials, and prospective and retrospective cohort studies; only patients with Class I and II malocclusion; maxillary and mandibular dental arches; miniscrew insertion; maxillary buccal; Micro-Implant /Micro-Implant s temporary anchorage devices; in English. In vitro studies, case studies, case reports and reviews were excluded from the study.

Table 1. PICO OR PECO strategy.

PICO OR PECO strategy	Description
P	Population/ Patient: Class I or II Malocclusion Patients
E	Exposure/ Intervention: Micro-Implant
C	Comparison: traditional anchorage
O	Outcome: treatment outcome

Data Extraction and analysis method

The data were extracted from the research included years, study design, Classification of Malocclusion, space closure, traditional anchorage group, sample size, mean/range of age, and group of Micro-Implant . Collaboration's tool(10). The scale scores for low risk was 1 and for High and unclear risk was 0. Scale scores range from 0 to 6. A higher score means higher quality

The quality of non-randomized studies included was assessed using Newcastle-Ottawa Scale (NOS) (11) used to assessed quality of the cohort studies and case-control studies, This scale measures three dimensions (selection, comparability of cohorts and outcome) with a total of 9 items. In the analysis, any studies with NOS scores of 1-3, 4-6 and 7-9 were defined as low, medium and high quality, respectively.

For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included. Prior to the screening, kappa statistics was carried out in order to verify the agreement level between the reviewers. The kappa values were higher than 0.80.

Mean difference with 95% confidence interval (CI), fixed effect model and Inverse-variance method were calculated.

Random effects were used to deal with potential heterogeneity and I^2 showed heterogeneity. I^2 values above 50% signified moderate-to-high heterogeneity. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

Results

In the review of the existing literature using the studied keywords, 452 studies were found. In the initial review, duplicate studies were eliminated and abstracts of 434 studies were reviewed. At this stage, 396 studies did not meet the inclusion criteria, so they were excluded, and in the second stage, the full text of 38 studies was reviewed by two authors. At this stage, 31 studies were excluded from the study due to incomplete data, inconsistency of results in a study, poor studies, lack of access to full text, inconsistent data with the purpose of the study. Finally, seven studies were selected (Figure1).

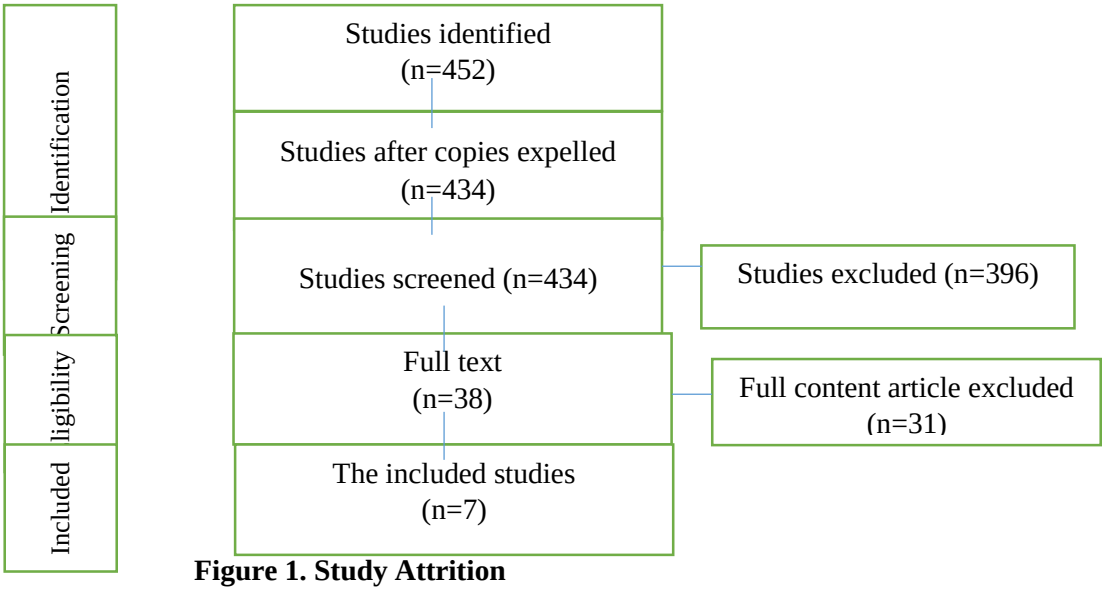

Figure 1. Study Attrition

Characteristics

Seven studies (five prospective cohort studies and two randomized clinical trials) have been included in present article. The number of patients in Micro-Implant group was 141 with mean age of 21.03 years (male: 46; female: 95) and in control group was 141 with mean age of 21.05 years (male: 50; female: 91). Other specifications are reported in the Table 2.

Bias assessment

According to NOS tool, two studies had a total score of 5/9 and three studies had a total score of 6/9. All studies had moderate quality or medium risk of bias (Table3).

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

Studies. Years	Study design	Number of Class I or II Malocclusion Patients				Mean/ Range of age (years)		Measurement Techniques	Orthodontic Space Closure (month)	
		Micro-Implant		Control		Micro-Implant	Control			
		male	female	male	female				Micro-Implant	Control
Chopra et al. 2017 (12)	prospective	12	13	12	13	15.12	15.08	Lateral cephalometric analysis	21.16	21.76
Chen et al. 2015 (13)	prospective	6	9	7	9	26.53	25.25	Lateral cephalometric analysis	21.93	23.88
Sandler et al. 2014 (14)	RCT	11	16	19	7	14.15	14.26	3D study model analysis	26.83	27.72
Al-Sibaie et al	RCT	12	16	9	19	23.02	20.46	Lateral cephalometric analysis	12.90	16.97
Park et al. 2012 (15)	prospective	4	8	1	11	18.8	25.4	3D study model analysis	8.6	9.8
Koyama et al. 2011 (16)	prospective	1	13	2	12	25	24.8	Lateral cephalometric analysis	not reported	
Lee et al. 2011 (17)	prospective	0	20	0	20	24.64	22.16	Lateral cephalometric analysis	not reported	

Table 3. Risk of bias assessment (Randomized clinical trials).

Study	Random generation of sequences	Concealment of Allocation	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete data on outcomes	Selective reporting	Total score
Sandler et al. 2014 (14)]	+	+	-	+	+	+	5
Al-Sibaie et al. 2013 (18)]	+	+	-	+	+	+	5

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

Table4. Risk of bias assessment (NOS tool)

Study. Years	**Selection (5 score)**				**Comparability (2 score)**	**Outcome (2 score)**		Total score
	representative sample	Sample size	Non respondents	Ascertainment of the exposure	Based on design and analysis	Assessment of outcome	Statistical test	
Chopra et al. 2017 (12)	1	1	1	1	1	0	1	6
Chen et al. 2015 (13)	1	1	1	1	1	0	1	6
Park et al., 2012 (15)	1	1	1	1	2	0	1	7
Koyama et al., 2011 (16)	1	1	1	1	1	0	1	6
Lee and Kim, 2011 (17)	1	1	1	1	2	0	1	7

Mesiodistal dental movement

Molars

The mean difference of molar mesiodistal movement among seven studies was -0.53 mm (MD, -0.53 95 % CI -0.69, -0.38. P= 0.00) with high heterogeneity (I^2 = 96.52 %; p=0.00). There was significant statistical difference between Micro-Implant and control group; maximum reinforcement with fewer mesial movement in Micro-Implant was observed.

Incisors

Mean difference in mesiodistal incisor movement was -0.65 mm (MD, -0.65 95 % CI -0.94, -0.37; P= 0.00) among six studies with high heterogeneity (I^2 = 73.58 %; 0.00). There was statistically significant difference between Micro-Implant and control group; Micro-Implant had more retraction than control group.

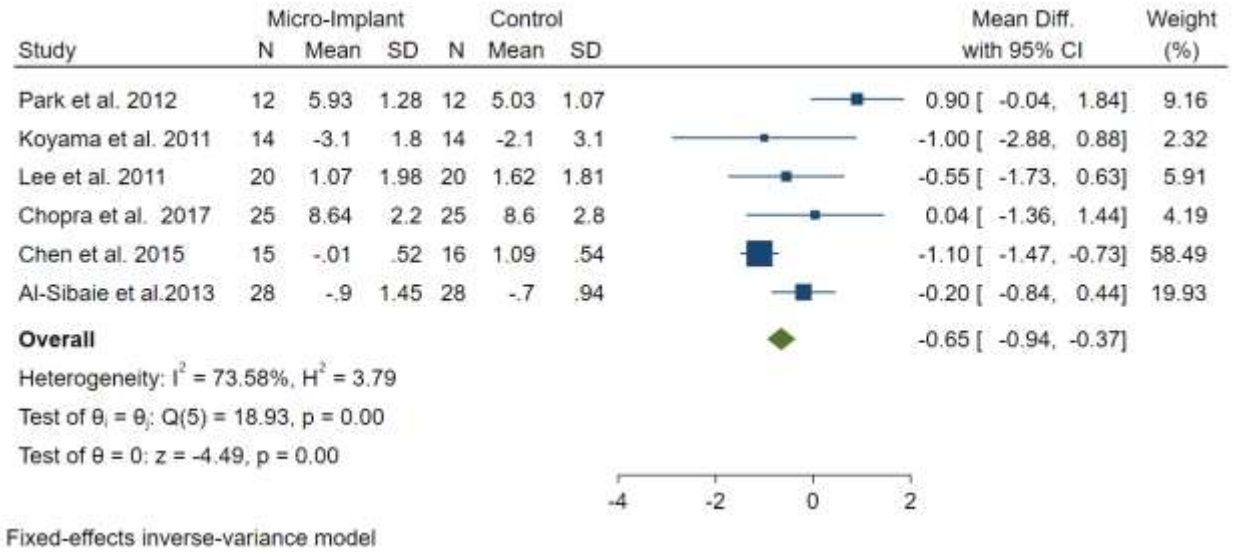

Figure 2. The Forest plot showed Mesiodistal movement of incisors

Vertical dental movement

Molars

Mean difference of vertical movement of molars was -0.52 mm (MD, -0.52 95% CI -1.13, 0.08. P= 0.09) among three studies with high heterogeneity found (I^2 = 92.77%; p=0.00). This result shows no statistically significant difference between Micro-Implant and control group (Figure 3); maxillary molars have a higher intrusion in Micro-Implant.

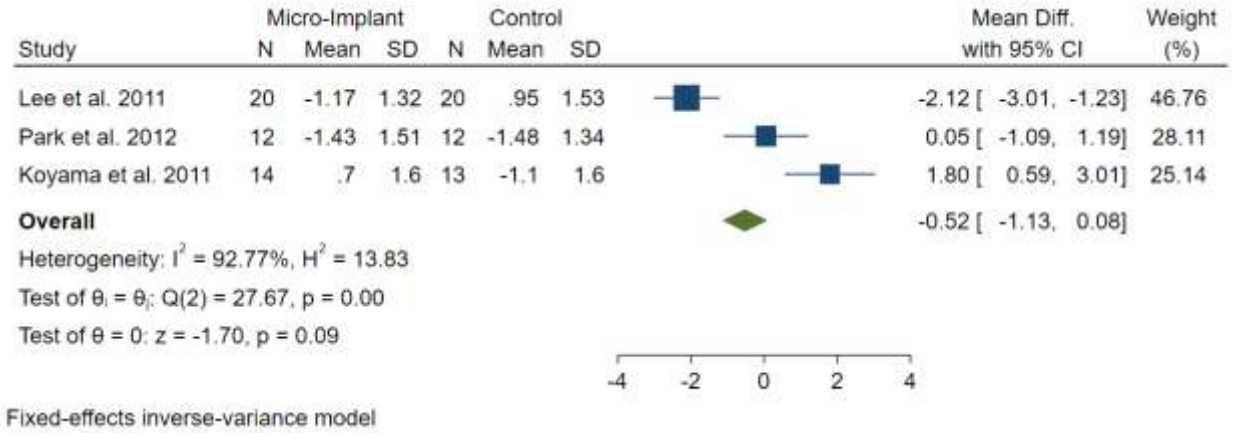

Figure 3. The Forest plot showed the vertical movement of molars

Incisors

Mean difference of vertical movement of incisors was -0.19 mm (MD, -0.19 95% CI -0.50, 0.13. P= 0.25) among four studies with high heterogeneity (I^2 = 87.36%; p=0.00). This result shows no statistically significant difference between Micro-Implant and control group (Figure 4); better intrusion observed in Micro-Implant.

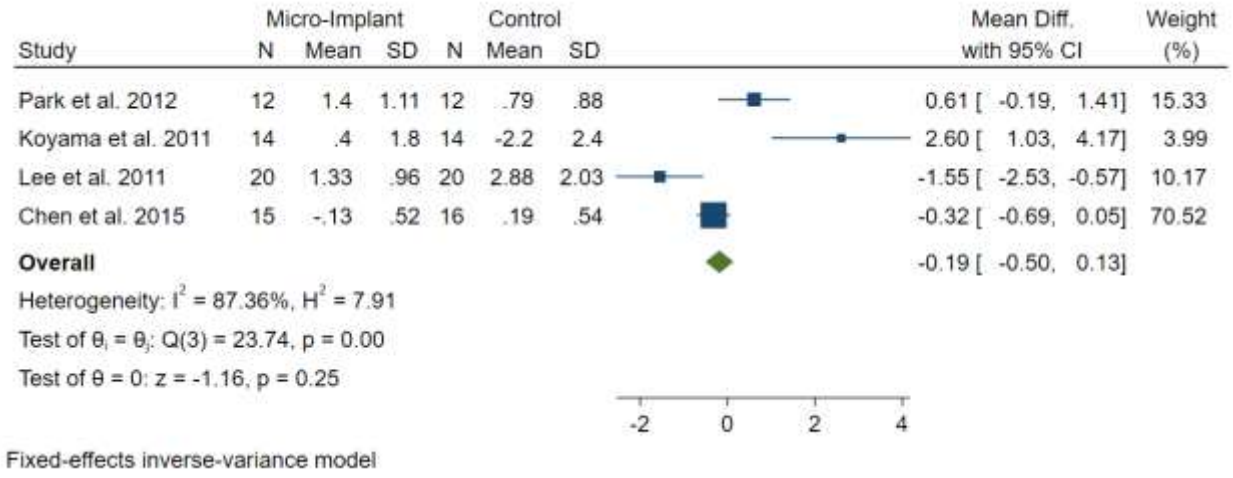

Figure 4. The Forest plot showed the vertical movement of incisors

Discussion

The aim of current systematic review and meta-analysis study was evaluate the clinical effectiveness of Micro-Implant in Orthodontic Treatment among Class I or II Malocclusion Patients. Anchorage reinforcing appliances are available for orthodontic treatment, however achieving the desired result in absolute anchorage control during treatment is very challenging and important. There are many factors to consider when choosing an anchorage booster(19). It has been reported that Micro-Implant s can enhance orthodontic anchors well, they attach to bony appendages and perform the ideal movement only on the desired teeth(19, 20).

Meta-analysis showed maximum reinforcement with fewer mesial movement in Micro-Implant and more retraction for Micro-Implant. Studies showed Micro-Implant were better than vontrol group (14, 21, 22). Consolaro et al., reported in class II malocclusion patients, in Micro-Implant group molar intrusion observed. Studies have shown that Micro-Implant cannot achieve absolute anchorage(23). Meta-analysis showed maxillary molars have a higher intrusion in Micro-Implant and better intrusion observed in Micro-Implant. Clinically, the traditional anchorage is more suitable in some cases that require a maximum anchorage. In any case, no side effects have been reported in the included studies. Patient Reported Outcome Measures should be obtained from the patient better to determine treatment outcomes(24, 25).

Conclusion

The current systematic review and meta-analysis study showed in patients with class II and I malocclusion, Micro-Implant helps to maintain the anchorage better than the old methods and reduce potential side effect of orthodontic mechanotherapy (anchorage loss) by minimization of molar mesial movement.

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