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Original Article

Evaluation of the clinical effectiveness of miniscrews in class i and ii malocclusion patients: a systematic review and meta-analysis

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Aim: The present systematic review and meta-analysis aimed to evaluate the clinical effectiveness of miniscrews in Class I and II Malocclusion Patients. **Methods:** From electronic databases, between 2010 and 2020, PubMed, Embase, Cochrane Library, ISI were used to conduct systematic literature. Two reviewers extracted data blindly and independently from the abstract and full text of the studies they used for data extraction. The mean differences between the two groups (miniscrews vs. conventional anchorage) with a 95 % confidence interval (CI), the Inverse-variance method, and the fixed-effect model were calculated. The Meta-analysis was evaluated using the statistical software Stata/MP v.16 (The fastest version of Stata). **Results:** A total of 186 potentially relevant titles and abstracts were found during the electronic and manual search. Finally, the inclusion criteria required for this systematic review were met by a total of seven publications. The mean difference of molar mesiodistal movement among seven studies and heterogeneity was -0.53 mm (MD, -0.53 95 % CI -0.69, -0.38. P= 0.00) (I^2 = 96.52 %). This result showed maximum reinforcement in miniscrews with fewer mesial movements. **Conclusion:** The result of the current systematic review and meta-analysis shows that miniscrews in patients with class II and I malocclusion help maintain better anchorage preservation than traditional anchorage devices.

Keywords: Orthodontic anchorage procedures. Malocclusion, Angle Class II.

Introduction

Malocclusion was first introduced by Edward Angel, the father of modern orthodontics. Malocclusion is a misalignment between the two dental arches' teeth when they approach each other as the jaws close with a bite[1]. It is also a growing problem in public health due to its high prevalence[2]. Malocclusions feature the third-highest prevalence among oral pathologies, second only to tooth decay and periodontal disease, and therefore rank third among worldwide dental public health priorities[3-5]. One of the skeletal classes' treatment methods is to limit the decreased arch length due to mesial movement[6]. In class I and II malocclusions, traditional methods such as Trans-palatal arches and multi-tooth differential moments in the anchorage segment are used[7]. However, traditional methods are not recommended, because in some cases, anchorage loss has been observed. Miniscrews are used for maximum anchorage[8].

The survival rate in studies reported between 80 and 90%. The difference between this method and other methods is That they are not directly connected to the teeth[9-12]. It is important to note that miniscrews do not allow any unnecessary movement after placement[13,14]. Recent studies show that anchorage losses are observed after the use of miniscrews[15-17]. 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 Miniscrews. Lack of studies showing significant anchorage losses and movements of miniscrews. In previous studies, insufficient evidence has been provided, the sample size is low, and the quality of studies is very low, so the present study was conducted to provide stronger evidence. However, previous studies have been written as literature; the present study is a meta-analysis. Also, for successful treatment results, a comparison of miniscrews effectiveness in malocclusion class I or II is required. The aim of the systematic review and meta-analysis study is to evaluate the miniscrew outcomes in patients with Class I and II Malocclusion, given the importance of the subject and the gap between the studies' results.

Materials and methods

Search strategy

PubMed, Embase, Cochrane Library were used from electronic databases to conduct systematic literature between 2010 and 2020. Therefore, to manage the electronic titles, a software program (Endnote X8) was used. Searches have been performed with mesh terms:

("Orthodontic Anchorage Procedures"[Mesh] OR "Dental Abutments"[Mesh]) AND "Orthodontic Brackets"[Mesh]) OR ("Malocclusion"[Mesh] OR "Malocclusion, Angle Class II"[Mesh] OR "Malocclusion, Angle Class I"[Mesh]), and keywords Orthodontic Anchorage Procedures, Dental Abutments, skeletal anchorage, temporary anchorage devices, Orthodontic Brackets, miniscrew implant, micro-implant, Malocclusion, Angle Class II, Angle Class I were used for other databases. On PRISMA guidelines, this systematic review and meta-analysis were conducted[18] and PICO or PECO strategy (Table1).

Table 1. PICO OR PECO strategy.

PICO OR PECO strategy	Description
P	Population/ Patient: patients with class I and II malocclusion
E	Exposure/ Intervention: miniscrews
C	Comparison: miniscrews vs. traditional anchorage
O	Outcome: Mesiodistal and Vertical movement of incisors and molars

Selection criteria

Inclusion criteria

1. Randomized controlled trial studies, controlled clinical trials, prospective and retrospective cohort studies.
2. Patients treated with fixed orthodontic treatment
3. Only patients with Class I and II malocclusion
4. maxillary or bimaxillary protrusion
5. efficiency outcomes of buccal inserted maxillary miniscrews
6. Intervention group: Miniscrews/mini-implants temporary anchorage devices (TAD)
7. control group: Traditional anchorage
8. Mesiodistal movement of the maxillary first molars, vertical movement of the molars
9. English language

Exclusion criteria

1. In vitro studies, reviews, case-Control Studies, case report, and animal studies
2. Incomplete or inconsistent data for the present study.
3. Onplant, Orthosystem, mini-plates
4. patients with class III malocclusion
5. Miniscrews placed in palatal or zygomatic areas

Data Extraction and analysis method

The data were extracted from the research included years, study design, malocclusion type, duration of space closure, traditional anchorage group, sample size, mean/range of age, group of miniscrews, measurement Techniques. Using the Cochrane Collaboration tool, the quality of the randomized clinical trials the studies included was analyzed[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. Also Non- randomized clinical trial studies were evaluated using the Newcastle-Ottawa Scale (NOS)[20]; the scale scores range from 0 (lowest grade) to 8 (highest grade). Two reviewers extracted data blindly and independently from the abstract and full text of the studies they used for data extraction. The mean differences of mesiodistal dental movement, vertical dental movement between the two groups (miniscrews vs. conventional anchorage) with a 95 % confidence interval (CI), the inverse-variance method, and the fixed-effect model were calculated. To deal with potential heterogeneity, random effects were used, and I^2 showed heterogeneity. For the meta-analysis, Stata V16 Software was used.

Results

According to the purpose of the study, in the initial search with keywords, 186 articles were found. In the first step of selecting studies, 184 studies were selected to review the abstracts. Then, studies that did not meet the inclusion criteria were excluded from the study. In the second step, the full text of 43 studies was reviewed. Finally, seven studies were selected (Figure1).

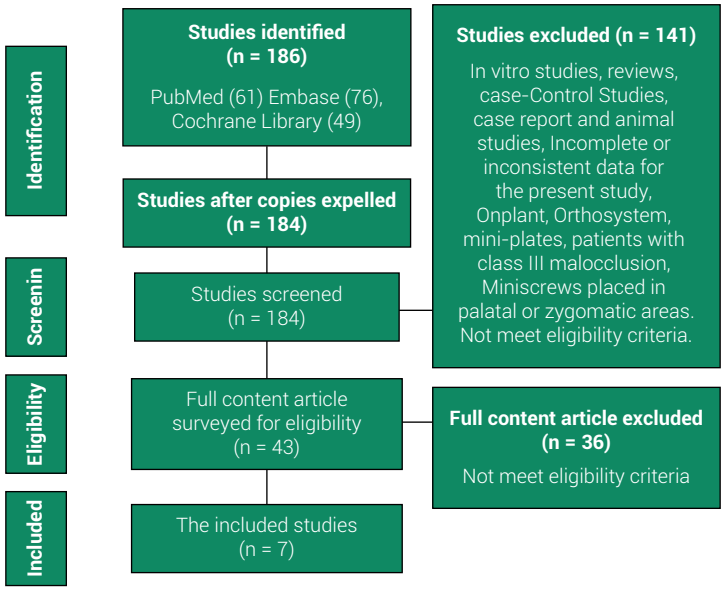

Figure 1. Study Attrition

Bias assessment

According to Cochrane Collaboration's tool, two studies, 23, 24 had a total score of 5/6 with high quality and a low risk of bias (Table 3). According to NOS, three studies 19,22,21 had a total score of 6/8, two studies 25, 27 had a total score of 7/8. This outcome showed scores ranged from 6 to 8 and low risk of bias or high quality of all studies (Table 4).

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

Studies. Years	Study design	Number of patients				Mean/ Range of age (years)		Type of Malocclusion	Methods of anchorage	Measurement Techniques	Orthodontic Space Closure (month)	
		MS		CA		MS	CA					
		Male	Female	Male	Female						MS	CA
Chopra et al. 2017[21]	P	12	13	12	13	15.12	15.08	class I or class II	Nance Button; lingual arch	LCA	21.16	21.76
Chen et al. 2015[22]	P	6	9	7	9	26.53	25.25	class I or class II	Headgear	LCA	21.93	23.88
Sandler et al. 2014[23]	RCT	11	16	19	7	14.15	14.26	class I or class II	Headgear and Nance Button	3D	26.83	27.72
Al-Sibaie and Hajeer 2014[24]	RCT	12	16	9	19	23.02	20.46	class I or class II	transpalatal arch	LCA	12.90	16.97
Park et al. 2012[25]	P	4	8	1	11	18.8	25.4	class I or class II	transpalatal arch, Headgear	3D	8.6	9.8
Koyama et al. 2011[26]	P	1	13	2	12	25	24.8	class I	Headgear	LCA	NR	
Lee and Kim 2011[27]	P	0	20	0	20	24.64	22.16	class I	transpalatal arch, Headgear	LCA	NR	

P: prospective study; RCT: randomized clinical trials; MS: miniscrews; CA: traditional anchorage; LCA: Lateral cephalometric analysis; 3D:3D study model analysis; NR: 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[23]	+	+	-	+	+	+	5
Al-Sibaie and Hajeer 2014[24]	+	+	-	+	+	+	5

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

Table 4. Risk of bias assessment (Non-randomized clinical trials).

Study	Select the main group	Select the group of control	Determination of the Main Group	Demonstration that the outcome of interest at the beginning of the study was not present	Comparability of both group participants	The Independent Blindness Poutcomes Evaluation	Suitability of follow-up for outcomes to occur	Lost to follow-up acceptable	Total score
Chopra et al. 2017[21]	+	+	+	+	+	-	+	-	6
Chen et al. 2015[22]	+	+	+	+	+	-	+	-	6
Park et al., 2012[25]	+	+	+	+	++	-	+	-	7
Koyama et al., 2011[26]	+	+	+	+	+	-	+	-	6
Lee and Kim, 2011[27]	+	+	+	+	++	-	+	-	7

+=1, +=2, -=0

Mesiodistal dental movement

Molars

Seven studies (two randomized controlled trials and five prospective studies) have been included. There were 46 and 95 male and female patients, with a mean age of 21.03 years, respectively, in the miniscrews group. The number of male and female patients was 50 and 91, with a mean of 21.05 years, respectively, in the traditional anchorage group. Measurement techniques in five studies were lateral cephalometric analysis, and in two studies17, 22 were 3D study model analysis. The mean of orthodontic space closure in the miniscrews and traditional anchorage groups was 18.24 and 20.02 months, respectively (Table 2). The mean difference of molar mesiodistal movement among seven studies and heterogeneity was -0.53 mm (MD, -0.53 95 % CI -0.69, -0.38. P= 0.00) (I2 = 96.52 %). This result shows no sig-

nificant statistical difference between the traditional anchorage and miniscrews (p=000) (Figure 2). This result showed maximum reinforcement with fewer mesial movements in miniscrews.

Incisors

Six studies (one randomized controlled trial and five prospective studies) have been included. There were 35 and 79 male and female patients, with a mean age of 22.18 years, respectively, in the miniscrews group. The number of male and female patients was 31 and 84, 22.19 years, respectively, in the traditional anchorage group. Measurement techniques in five studies were lateral cephalometric analysis and, in one study, 22 were 3D study model analysis. The mean of orthodontic space closure in the miniscrews and traditional anchorage groups was 16.04 and 18.10 months, respectively (Table 2). The mean difference in mesiodistal incisor movement among seven studies and heterogeneity found was -0.66 mm (MD, -0.66 95 % CI -0.94, -0.37. P= 0.00) (I2 = 73.76 %). No statistically significant difference between miniscrews and traditional anchorage groups (p=0.00) is shown in this result (Figure 2). In the miniscrew group, this result showed more retraction than in the traditional anchorage group.

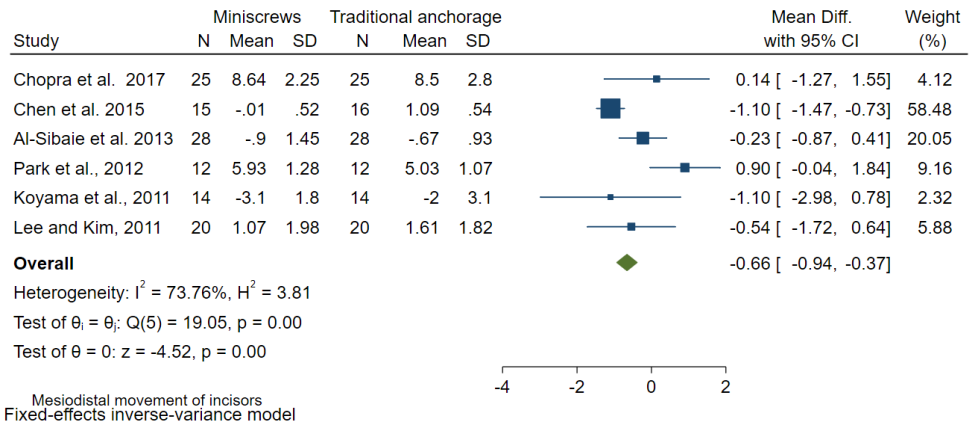

Figure 2. The Forest plot showed the Mesiodistal movement of incisors between miniscrews vs. traditional anchorage.

Vertical dental movement

Molars

Three studies (prospective study) have been included. There were 5 and 41 male and female patients, with a mean age of 22.81 years, respectively, in the miniscrews group. The number of male and female patients was 3 and 42, with a mean of age 24.21 years, respectively, in the traditional anchorage group. Measurement techniques in three studies were lateral cephalometric analysis, and in one study were 3D study model analysis. The mean of orthodontic space closure in the miniscrews and traditional anchorage groups was 8.6 and 9.8 months, respectively (Table 2). Mean difference of vertical movement of molars was -0.5 mm (MD, -0.5 95% CI -1.11, 0.1.

P= 0.1) among three studies and heterogeneity found (I2 = 92.91%). This result shows no statistically significant difference between miniscrews and traditional anchorage groups (p=0.1) (Figure 3). This result showed in the miniscrews group, maxillary molars have a higher intrusion.

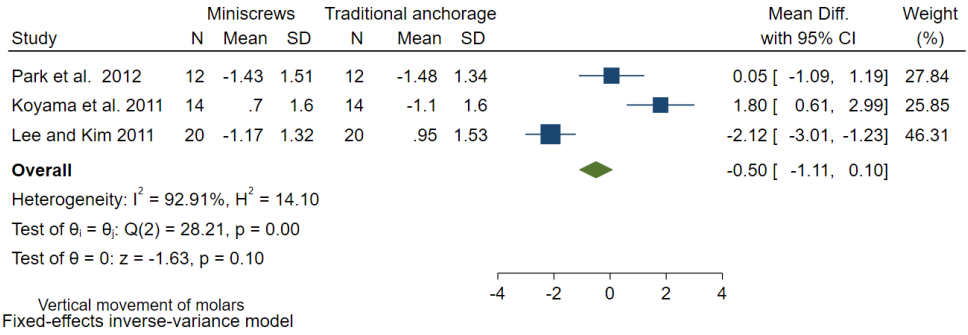

Figure 3. The Forest plot showed the vertical movement of molars between miniscrews vs. traditional anchorage.

Incisors

Four studies (prospective study) have been included. There were 11 and 50 male and female patients, with a mean age of 23.74 years, respectively, in the miniscrews group. The number of male and female patients was 10 and 52, with a mean of age 24.4 years, respectively, in the traditional anchorage group. Measurement techniques in five studies were lateral cephalometric analysis and in one study were 3D study model analysis. The mean of orthodontic space closure in the miniscrews and traditional anchorage groups was 15.26 and 16.84 months, respectively (Table 2). Mean difference of vertical movement of incisors was -0.19 mm (MD, -0.19 95% CI -0.5, 0.13. P= 0.25) among four studies and heterogeneity found (I2 = 87.36%). This result shows no statistically significant difference between miniscrews and traditional anchorage groups (p=0.25) (Figure 4). This result showed better intrusion in the miniscrews group than the traditional anchorage group.

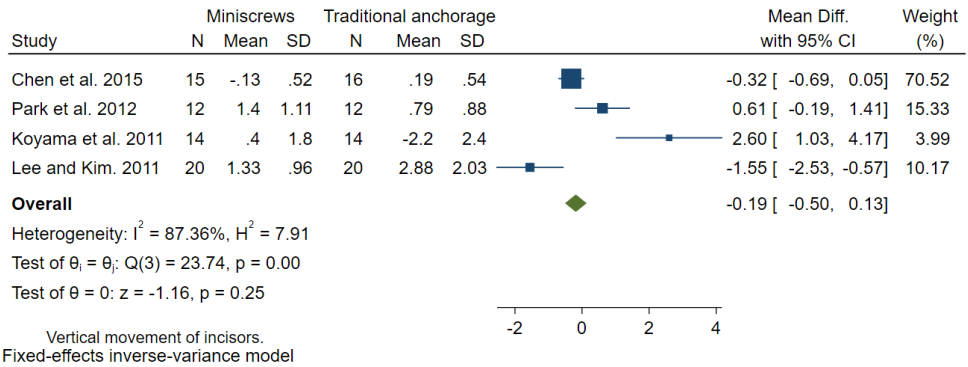

Figure 4. The Forest plot showed the vertical movement of incisors between miniscrews vs. traditional anchorage.

Discussion

Many anchorage reinforcing appliances are available, but achieving the desired result and controlling the absolute anchorage during treatment bimaxillary is very important and challenging. Several factors must be considered to select a suitable anchor booster. Miniscrews can enhance orthodontic anchors and have received a great deal of attention recently because they attached to the bony appendages and provided the ideal movement of only the targeted teeth[20]. The first part of the Meta-analysis findings showed maximum reinforcement in miniscrews with the fewer mesial movement of molars vs. traditional anchorage. Clinically, a reduction of 2 mm on each side can show better results. Sandler et al. study showed miniscrews were better than headgear and Nance groups[23]. Meta-analysis findings showed that incisors' mesial movement was more retraction in the miniscrews group than the traditional anchorage group. In molars' vertical movement, more retraction in miniscrews than traditional anchorage and vertical movement of incisors was a better intrusion in the miniscrews group than the traditional anchorage group. Papadopoulos et al.[3] evaluate the clinical effectiveness of miniscrew implants used for anchorage reinforcement compared with conventional anchorage. The result showed the mean difference of anchorage loss between the two groups was −2.4 mm (95% CI = −2.9 mm to −1.8 mm, p = 0), miniscrew implants significantly decreased or negated loss of anchorage[3]. Yao et al. showed only in the miniscrews group molar intrusion observed, thereby improving class II malocclusion. Although there are advantages to using miniscrews, some studies have shown that miniscrews cannot achieve absolute anchorage[28]. Horiuchi et al. suggest that the movement of the anterior teeth using conventional anchoring devices depends more on the forces acting on the posterior teeth and the patient's adaptation and is therefore, less than miniscrews[29].

Although numerous benefits are available for miniscrew implants, some studies have shown that miniscrew implants can not achieve absolute anchorage compared to miniplates. However, it is better than conventional anchorage, and no side effects have been reported in the included studies[28].

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. A patient-reported outcome measures should be obtained from the patient better to determine treatment outcomes[30,31]. The limitations of the present study are low sample size, low RCT studies, high heterogeneity in the selected study. Large sample size, follow-up period, RCT, and prospective and retrospective cohort studies are required in this field. It is suggested that more studies be performed for the present study. Due to the high heterogeneity between the studies and the working method, a similar way of evaluating the data is required. In the present study, patients' opinions about comfort and quality of life satisfaction with traditional anchorage and miniscrews were not reported because a study that addressed all these dimensions was not found, so the patient's perceived benefit is not recognizable. However, most traditional anchorages are extraoral; they are uncomfortable for patients, which can negatively affect[21]. Further studies are needed to address these parameters.

In conclusion, the present systematic review and meta-analysis show that miniscrews in patients with class II and I malocclusion help maintain better anchorage preservation than traditional anchorage devices. Miniscrews can also reduce anchorage loss by minimization of molar mesial movement.

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