Comparison of the effects of mini-implant and traditional anchorage on patients with maxillary dentoalveolar protrusion

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ABSTRACT

Objective: To compare the treatment effects of mini-implants as anchor units with conventional methods of anchorage reinforcement in maxillary dentoalveolar protrusion patients in terms of skeletal, dental, and soft tissue changes.

Materials and Methods: We searched the databases of the Cochrane Library, PubMed, OVIDSP, CBM, VIP, WanFang Data, and CNKI covering December 1966 to March 2016 for randomized controlled trials (RCTs) and clinical controlled trials that compared the treatment effects of mini-implants with conventional anchorage reinforcement in maxillary dentoalveolar protrusion patients. Literature filtering, data extraction, and methodological quality evaluation were finished independently by two researchers and disagreements were solved by discussion. Meta-analysis was performed when possible; otherwise descriptive assessment was done.

Results: Through a predefined search strategy, we finally included 14 eligible studies. Eight outcomes were evaluated in this study: maxillary incisor retraction, maxillary molar movement, U1-SN, SNA, SN-MP, UL-E Plane, NLA and G-Sn-Pg.

Conclusions: Mini-implant anchorage was more effective in retracting the anterior teeth, produced less anchorage loss, and had a greater effect on SN-MP for the high-angle patients than did traditional anchorage. Both mini-implants and traditional anchorage underwent decreases in on U1-SN and SNA. More qualified RCTs are required to make reliable recommendations about the anchorage capacity of mini-implant and traditional anchorage in patients with maxillary dentoalveolar protrusion, especially on the UL-E plane, NLA, and G-Sn-Pg. (*Angle Orthod.* 2017;87:320–327)

KEY WORDS: Systematic review; Implant; Traditional anchorage; Protrusion

INTRODUCTION

Anchorage control in treating severe maxillary dentoalveolar protrusion patients is a difficult problem.[1] Treatment of this malocclusion often includes extraction of maxillary (or bimaxillary) first or second premolars and maximum anchorage.[2] To reinforce

anchorage, various auxiliaries can be used, including a Nance holding arch, headgear, transpalatal arch,[3] and others. However, all these methods have inherent disadvantages, such as complicated designs, need for exceptional patient cooperation, and elaborate wire bending.[4] Thus, some anchorage loss or mesial movement of the maxillary molars is usually observed.

In recent years, the mini-implant has gained enormous popularity in the orthodontic community.[5] *Mini-implant* is used herein as a generic term for all temporary bone-anchored devices. It can provide stable bony anchorage and overcome problems of anchorage loss during extraction space closure, which usually occurs with traditional methods of anchorage preparation.[6] However, there is little accurate scientific evidence pertaining to the superiority of the mini-implant anchorage system over traditional anchorage technique in patients with

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Table 1. Characteristics of Included Studies

Study ID: Author and Year	Design Study	Interventions		Malocclusion	Loading Force	Rate of Mini-implant (%)
		Mini-implant Anchorage	Traditional Anchorage			
Yu et al. 2011[12]	RCT	Maxillary mini-implant (n = 16)	Headgear (n = 16)	Class I or II	100–150 g	100
Huang et al. 2007[13]	RCT	Maxillary mini-implant (n = 10)	Headgear (n = 10)	Class I	150 g	100
Wei et al. 2011[14]	RCT	Maxillary mini-implant (n = 10)	Headgear (n = 10)	Class I or II	1.96 N	90
Su et al. 2009[15]	RCT	Maxillary mini-implant (n = 15)	Headgear (n = 15)	Class I or II	100−150 g	80
Upadhyay et al. 2008[1]	RCT	Maxillary and mandibular mini-implant (n = 20)	Headgear or TPA[a] (n = 20)	Class I	150 g	90
Al-Sibaie et al. 2014[16]	RCT	Maxillary mini-implant (n = 28)	TPA (n = 28)	Class II Division 1	150 g	100
Liu et al. 2009[17]	RCT	Maxillary mini-implant (n = 17)	TPA (n = 17)	Class I or II	–	–
Ma et al. 2008[18]	RCT	Maxillary and mandibular mini-implant (n = 15)	Headgear (n = 15)	Class I or II	100 g	–
Park et al. 2008[19]	CCT	Maxillary and mandibular mini-implant (n = 16)	Headgear (n = 14)	Class I or II	150-200 g	100
Upadhyay et al. 2008[4]	CCT	Maxillary and mandibular mini-implant (n = 15)	Choose to use as needed (n = 15)	Class I or II	150 g	100
Yao et al. 2008[20]	CCT	Maxillary mini-implant (n = 25)	Headgear plus TPA (n = 22)	Class I or II	–	100
Chen et al. 2015[21]	CCT	Maxillary mini-implant (n = 15)	Headgear (n = 16)	Class I or II	–	–
Koyama et al. 2011[22]	CCT	Maxillary mini-implant (n = 14)	Headgear (n = 14)	Class I	200 g	–
Kuroda et al. 2009[23]	CCT	Maxillary mini-implant (n = 11)	Headgear plus TPA (n = 11)	Class II Division 1	100 g	80–95

[a] TPA indicates transpalatal arch.

maxillary dentoalveolar protrusion, with the few published studies demonstrating conflicting results. Upadhyay[1] found intrusion and distalization of maxillary molars using mini-implants as anchorage in patients with dentoalveolar protrusion. However, Lai et al.[7] found that mini-implant anchorage afforded greater anterior tooth retraction and less maxillary molar mesialization than did the headgear.

In clinical practice, orthodontists' concern is which anchorage type—traditional anchorage or the implant—would be more effective.[8] The aim of this review is to compare the treatment effects with mini-implants in maxillary dental protrusion patients with conventional methods of anchorage reinforcement in terms of dentoskeletal and soft-tissue changes.

MATERIALS AND METHODS

Search Strategy

An electronic literature search was carried out using PubMed, OVIDSP, the Cochrane Library, CBM, VIP, WanFang Data, and CNKI. Terms used in the search included mini-implant, orthodontic anchorage, and protrusion. In order to improve the search, the Related Articles tool was used in the PubMed search.

Inclusion Criteria

Studies were selected if they satisfied all the following inclusion criteria:

1. Publication date from December 1966 to March 2016,

Table 2. Methodological Quality[a] of Selected RCT Trials

Study	Random Sequence Generation	Allocation Concealment	Blinding	Incomplete Outcome Date	Selective Reporting	Other Bias	Jadad Score	Quality
Yu et al. 2011[12]	Yes	Unclear	Unclear	Yes	Yes	Yes	4	High
Huang et al. 2007[13]	Yes	Unclear	Unclear	Yes	Yes	Yes	4	High
Wei et al. 2011[14]	Yes	Unclear	Unclear	Yes	Yes	Yes	4	High
Su et al. 2009[15]	Yes	Unclear	Unclear	Yes	Yes	Yes	5	High
Upadhyay et al. 2008[1]	Yes	Yes	Unclear	Yes	Yes	Yes	5	High
Al-Sibaie et al. 2014[16]	Yes	Yes	Unclear	Yes	Yes	Yes	4	High
Liu et al. 2009[17]	Yes	Unclear	Unclear	Yes	Yes	Yes	4	High
Ma et al. 2008[18]	Yes	Unclear	Unclear	Yes	Yes	Yes	4	High

[a] Quality was categorized as low (1–3 Jadad scores) or high (4–7 Jadad scores).

PubMed	OVIDSP	Cochrane Library	CBM	VIP	WanFang	CNKI
Search: 47	Search: 236	Search:13	Search:94	Search:179	Search:169	Search:244

982 studies identified

Records after duplicates removed: 576

Reasons for exclusion of 495 studies:
-Opinion leader, case reports letters (324)
- Molar distalization (171)

Primary selection by reviewing titles and abstract: 81

Reasons for exclusion of 68 studies:
- No control groups (37)
- No quantitative data (31)

Full text articles assessed for eligibility: 13

Additional records identi ed through reference list: 1
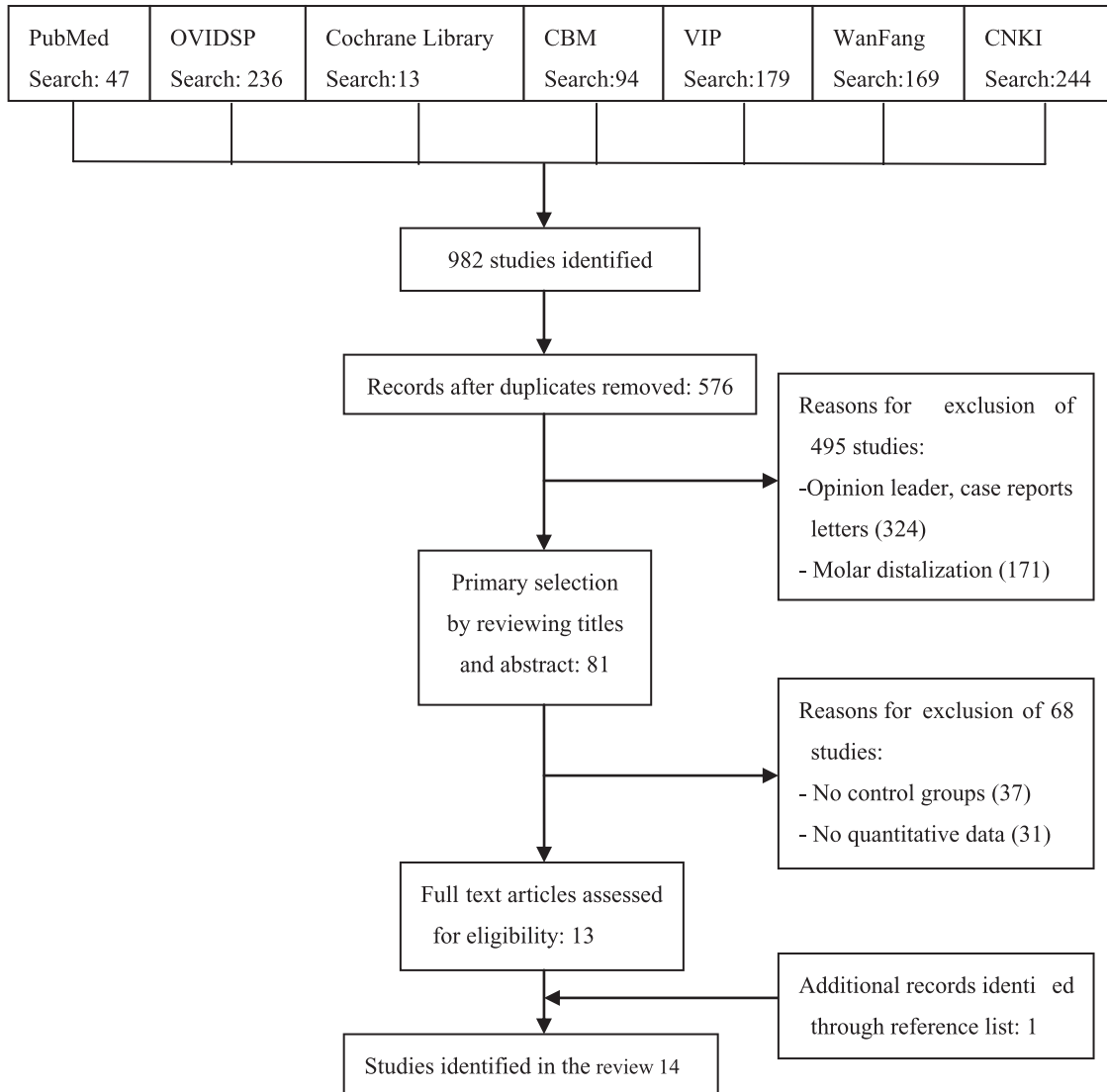
Studies identified in the review 14

Figure 1. Flow chart summarizing literature search.

2. Original studies based on humans,
3. Randomized controlled trials (RCTs) or clinical controlled trials (CCTs); prospective or retrospective controlled studies,
4. Age of patients over 14 years,

5. Studies conducted on patients with maxillary or bimaxillary dental protrusion, patients whose orthodontic treatment called for extraction of maxillary or bimaxillary premolars, and maximum anchorage during anterior segment retraction,
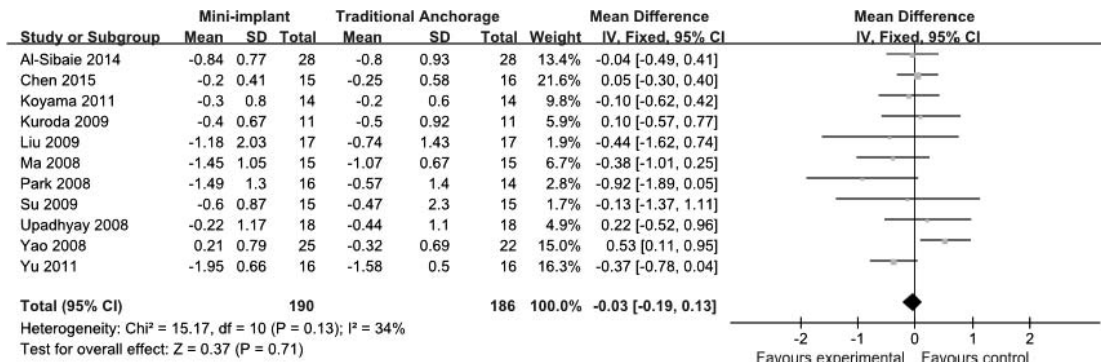
Study or Subgroup	Mini-implant Mean	SD	Total	Traditional Anchorage Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Al-Sibaie 2014	-0.84	0.77	28	-0.8	0.93	28	13.4%	-0.04 [-0.49, 0.41]
Chen 2015	-0.2	0.41	15	-0.25	0.58	16	21.6%	0.05 [-0.30, 0.40]
Koyama 2011	-0.3	0.8	14	-0.2	0.6	14	9.8%	-0.10 [-0.62, 0.42]
Kuroda 2009	-0.4	0.67	11	-0.5	0.92	11	5.9%	0.10 [-0.57, 0.77]
Liu 2009	-1.18	2.03	17	-0.74	1.43	17	1.9%	-0.44 [-1.62, 0.74]
Ma 2008	-1.45	1.05	15	-1.07	0.67	15	6.7%	-0.38 [-1.01, 0.25]
Park 2008	-1.49	1.3	16	-0.57	1.4	14	2.8%	-0.92 [-1.89, 0.05]
Su 2009	-0.6	0.87	15	-0.47	2.3	15	1.7%	-0.13 [-1.37, 1.11]
Upadhyay 2008	-0.22	1.17	18	-0.44	1.1	18	4.9%	0.22 [-0.52, 0.96]
Yao 2008	0.21	0.79	25	-0.32	0.69	22	15.0%	0.53 [0.11, 0.95]
Yu 2011	-1.95	0.66	16	-1.58	0.5	16	16.3%	-0.37 [-0.78, 0.04]
Total (95% CI)			190			186	100.0%	-0.03 [-0.19, 0.13]

Heterogeneity: Chi² = 15.17, df = 10 (P = 0.13); I² = 34%
Test for overall effect: Z = 0.37 (P = 0.71)

Mean Difference
IV, Fixed, 95% CI
Favours experimental   Favours control

Figure 2. Meta-analysis of SNA.

Table 3. Methodological Quality[a] of Selected CCT Trials

Study	Diagnostic Criteria	Grouping Method	Blinding	Baseline Consistency	Confounder Control	Lost to Treatment	Score	Grade
Park et al. 2008[19]	Clinical diagnosis	Not mentioned	Not mentioned	Good	Better	No	6	B
Upadhyay et al. 2008[4]	Clinical diagnosis	Not mentioned	Not mentioned	Better	Better	No	8	B
Yao et al. 2008[20]	Clinical diagnosis	Not mentioned	Not mentioned	Better	Better	No	7	B
Chen et al. 2015[21]	Clinical diagnosis	Not mentioned	Not mentioned	Better	Good	No	6	B
Koyama et al. 2011[22]	Clinical diagnosis	Not mentioned	Not mentioned	Better	Better	No	7	B
Kuroda et al. 2009[23]	Clinical diagnosis	Not mentioned	Not mentioned	Better	Better	No	6	B

[a] Quality was categorized as grade A (10–12 score), B (6–9 score), or C (0–5 score).

6. The experimental group and control group used mini-implants and conventional anchorage as anchorage reinforcement,
7. Mini-implants were screwed into the buccal alveolar bone between the maxillary second premolars and first molars,
8. Lateral cephalometric analysis that assessed dental and skeletal movements.

Exclusion Criteria

1. Trials evaluating only the effects of implant or conventional anchorage,
2. Studies exploring measurement methods,
3. Studies concerning other anchorage situations, such as molar distalization,
4. Case reports, reviews, or letters.

Data Extraction and Quality Analysis

Data were extracted and recorded independently by two reviewers, and in duplicate using a customized data collection form, on the following items: author and year of publication, study design, number, gender, type of malocclusion, anchorage devices, and reported outcomes.

A quality evaluation of the methodological soundness of RCT articles was performed according to the standards described in the *Cochrane Handbook for Systematic Reviews of Interventions* (version 5.1.0).[9] Meanwhile, a quality score was calculated by a modified version of the method described by Jadad.[10] Otherwise, a methodological quality assessment of the

Table 4. Cephalometric Variables Investigated in This Review

Measurements	WMD (95% CI)	P value
SNA (°)	−0.03 (−0.19, 0.13)	.71
SN-MP (°)	−1.12 (−2.21, −0.03)	.04*
Maxillary incisor retraction (mm)	−1.50 (−1.84, −1.17)	.00*
Maxillary molar movement (mm)	−2.01 (−2.45, −1.58)	.00*
U1-SN (°)	0.61 (−0.84, 2.05)	.41
UL-E plane (mm)	−0.73 (−1.17, 0.28)	.001*
NLA (°)	3.52 (1.17, 5.87)	.003*
G-Sn-Pg (°)	−0.77 (−1.55, −0.02)	.06

* $P < .05$.

methodological soundness and quality score of CCT articles was performed according to the standards described in the *Cochrane Handbook*.[9] The methods and results sections of each article were read and scored by two independent, blind readers. The evaluators discussed their findings, and when disagreement occurred, it was resolved through further discussion and rereading.

Data Analysis

In this systematic review, evaluation of anchorage effects mainly includes eight aspects, as follows:

1. maxillary incisor retraction,
2. maxillary molar movement,
3. axial inclination of the maxillary central incisor to the SN plane (U1-SN),
4. angle between the SN plane and the NA plane (SNA),
5. inclination of the mandibular plane to the cranial base (SN-MP),
6. upper lip to E-plane (UL-E pane, mm),
7. nasolabial angle (NLA),
8. facial convexity (G-Sn-Pg).

Original outcome data, if possible, underwent statistical pooling through fixed or random effects models by using Review Manager 5.3. Statistical analysis was assessed by a statistician, especially regarding the choice between fixed and random-effect models.[11]

RESULTS

Description of Studies

Finally, we selected 14 studies,[1,4,12–23] including 8 RCTs[1,12–18] and 6 CCTs.[4,19–23] Summary details of included studies are given in Table 1. Flow of the selection process is demonstrated in Figure 1.

Methodological Quality of Included Studies

Of the 14 included studies, the 8 RCTs[1,12–18] were of high quality, and the 6 CCTs[4,19–23] were grade B (quality score, 6–9). The methodological quality for RCT and CCT trials are presented in Tables 2 and 3, respectively.
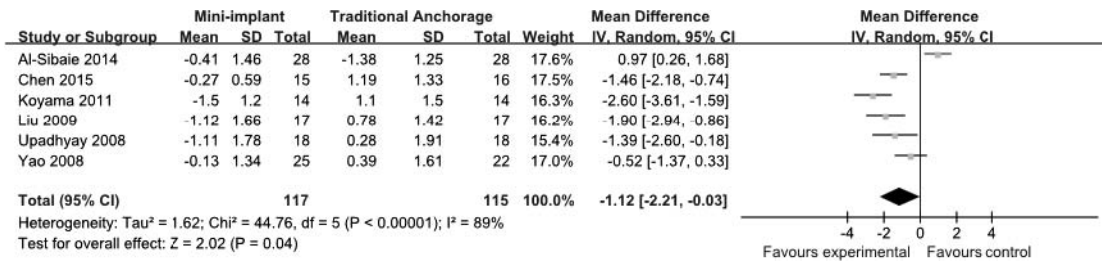
Figure 3. Meta-analysis of SN-MP.

Effects of Interventions

The cephalometric variables investigated in this review are shown in Table 4.

Skeletal Effects

SNA. Eleven articles[1,12,15–23] reported the SNA. A forest plot is demonstrated in Figure 2, showing that there was no significant difference between the mini-implant and the traditional anchorage technique ($P = .71$) and that the weighted mean difference (WMD) 95% confidence interval (95% CI) was −0.03° (−0.19°, 0.13°).

SN-MP. Six studies[1,16,17,20–22] investigated this outcome. Because of existing heterogeneity, a random-effect model was adopted. As presented in Figure 3, the WMD (95% CI) between the two groups was −1.12° (−2.21°, −0.03°), with a significant difference ($P = .04$).

Dental Effects

Maxillary incisor retraction. Thirteen articles[1,4,13–23] were categorized into this study. The forest plot is shown in Figure 4. The WMD (95% CI) was −1.50 mm (−1.84 mm, −1.17 mm), with a significant difference between the two groups ($P < .00001$).

Maxillary molar movement. Thirteen articles[1,4,12–17,19–23] were categorized into this study. A meta-analysis

was done (Figure 5). Because of existing heterogeneity ($I^2 = 80\%$), a random-effect model was adopted. The WMD (95% CI) between the mini-implant and traditional anchorage was −2.01 mm (−2.45 mm, −1.58 mm), and there was a significant difference between the two groups ($P < .00001$).

U1-SN. Twelve articles[1,4,12–14,16–22] reported U1-SN. A forest plot is demonstrated in Figure 6. Results of the meta-analysis show significant heterogeneity among these 12 trials ($I^2 = 76\%$), so a random-effect model was adopted. As shown in Figure 6, the WMD (95% CI) was 0.61° (−0.84°, 2.05°), and results from the two groups showed no statistical significance ($P = .41$).

Soft Tissue Effects

UL-E plane (mm). Five articles[1,16,17,19,23] were categorized into this study. A meta-analysis was done; the forest plot is shown in Figure 7. It indicates that there was a significant difference between the mini-implant and the traditional anchorage technique on the UL-E plane ($P = .001$); the WMD (95% CI) was −0.73 mm (−1.17 mm, 0.28 mm).

NLA. Four articles[1,16,17,23] reported the nasolabial angle. A forest plot is demonstrated in Figure 8. Heterogeneity was detected, so a random-effect model was adopted. The meta-analysis indicates that there was a significant difference between the mini-implant
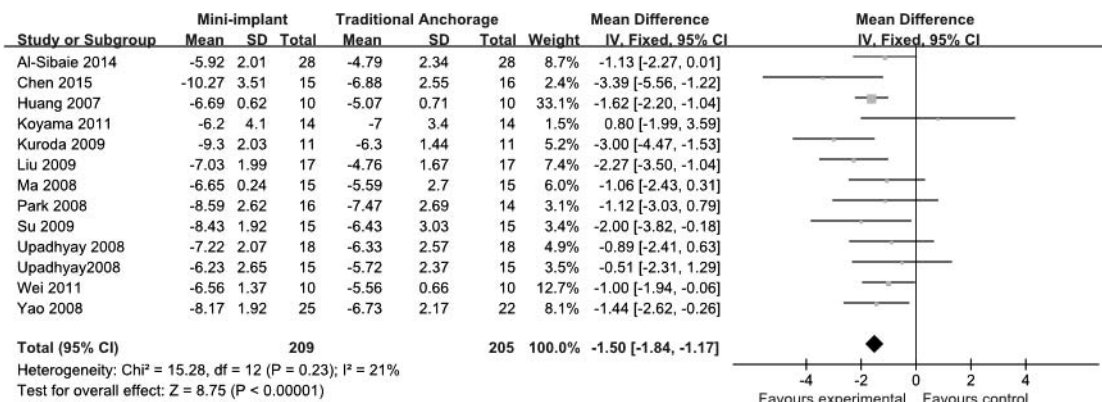

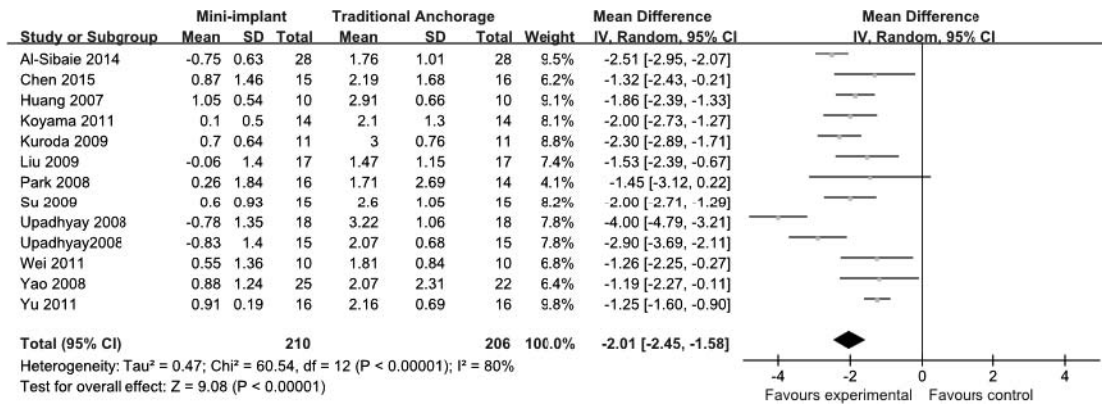**Figure 4.** Meta-analysis of maxillary incisor retraction.

Study or Subgroup	Mini-implant Mean	SD	Total	Traditional Anchorage Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Al-Sibaie 2014	-0.75	0.63	28	1.76	1.01	28	9.5%	-2.51 [-2.95, -2.07]
Chen 2015	0.87	1.46	15	2.19	1.68	16	6.2%	-1.32 [-2.43, -0.21]
Huang 2007	1.05	0.54	10	2.91	0.66	10	9.1%	-1.86 [-2.39, -1.33]
Koyama 2011	0.1	0.5	14	2.1	1.3	14	8.1%	-2.00 [-2.73, -1.27]
Kuroda 2009	0.7	0.64	11	3	0.76	11	8.8%	-2.30 [-2.89, -1.71]
Liu 2009	-0.06	1.4	17	1.47	1.15	17	7.4%	-1.53 [-2.39, -0.67]
Park 2008	0.26	1.84	16	1.71	2.69	14	4.1%	-1.45 [-3.12, 0.22]
Su 2009	0.6	0.93	15	2.6	1.05	15	8.2%	-2.00 [-2.71, -1.29]
Upadhyay 2008	-0.78	1.35	18	3.22	1.06	18	7.8%	-4.00 [-4.79, -3.21]
Upadhyay2008	-0.83	1.4	15	2.07	0.68	15	7.8%	-2.90 [-3.69, -2.11]
Wei 2011	0.55	1.36	10	1.81	0.84	10	6.8%	-1.26 [-2.25, -0.27]
Yao 2008	0.88	1.24	25	2.07	2.31	22	6.4%	-1.19 [-2.27, -0.11]
Yu 2011	0.91	0.19	16	2.16	0.69	16	9.8%	-1.25 [-1.60, -0.90]
Total (95% CI)			210			206	100.0%	-2.01 [-2.45, -1.58]

Heterogeneity: Tau² = 0.47; Chi² = 60.54, df = 12 (P < 0.00001); I² = 80%
Test for overall effect: Z = 9.08 (P < 0.00001)

Figure 5. Meta-analysis of maxillary molar movement.

and traditional anchorage technique ($P = .003$); the WMD (95% CI) was 3.52° (1.17°, 5.87°).

G-Sn-Pg. Three articles[1,17,23] were categorized into this study. The meta-analysis is shown in Figure 9. The result was that the WMD (95% CI) between the two groups was −0.77° (−1.55°, −0.02°), and there was no statistical significance ($P = .06$).

DISCUSSION

Skeletal Effects of Intervention

SNA. Results showed that both groups underwent decreases in SNA. This indicates that point A moved back during retraction of the maxillary incisor. Moreover, the meta-analysis showed that there was no significant difference. Therefore, both anchorage methods produced significant basal bone changes.

SN-MP. Results showed that there was a significant difference between the two groups, the WMD (95% CI) was −1.12° (−2.21°, −0.03°), although it could not be considered clinically significant. We cannot suggest that mini-implant anchorage would be more effective

than the traditional anchorage technique for high-angle patients.

Dental Effects of Intervention

Maxillary incisor retraction. The WMD (95% CI) between the two groups regarding accumulative distance moved was −1.50 mm (−1.84 mm, −1.17 mm), with a significant difference, namely, that more maxillary incisor retraction occurred in the mini-implant group than in the traditional anchorage group.

Maxillary molar movement. Results showed that there was a significant difference between the two groups, namely, that the mini-implant group experienced less movement of the maxillary molars and less anchorage loss compared with the traditional anchorage group; the WMD (95% CI) being −2.01 mm (−2.45 mm, −1.58 mm). Maxillary molar movement was also an important factor in the treatment quality of the maxillary dental protrusion patients. In the clinical situation, 1 mm of maxillary molar distal movement has a negative effect on treatment. Therefore, we
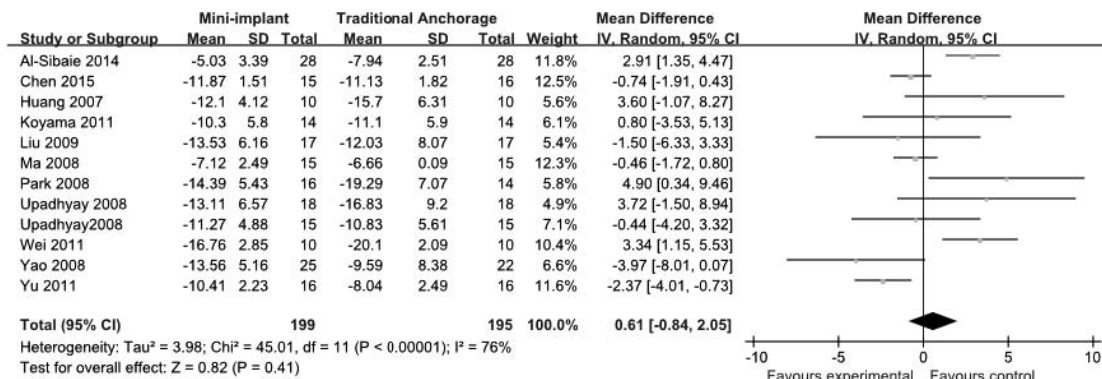
Study or Subgroup	Mini-implant Mean	SD	Total	Traditional Anchorage Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Al-Sibaie 2014	-5.03	3.39	28	-7.94	2.51	28	11.8%	2.91 [1.35, 4.47]
Chen 2015	-11.87	1.51	15	-11.13	1.82	16	12.5%	-0.74 [-1.91, 0.43]
Huang 2007	-12.1	4.12	10	-15.7	6.31	10	5.6%	3.60 [-1.07, 8.27]
Koyama 2011	-10.3	5.8	14	-11.1	5.9	14	6.1%	0.80 [-3.53, 5.13]
Liu 2009	-13.53	6.16	17	-12.03	8.07	17	5.4%	-1.50 [-6.33, 3.33]
Ma 2008	-7.12	2.49	15	-6.66	0.09	15	12.3%	-0.46 [-1.72, 0.80]
Park 2008	-14.39	5.43	16	-19.29	7.07	14	5.8%	4.90 [0.34, 9.46]
Upadhyay 2008	-13.11	6.57	18	-16.83	9.2	18	4.9%	3.72 [-1.50, 8.94]
Upadhyay2008	-11.27	4.88	15	-10.83	5.61	15	7.1%	-0.44 [-4.20, 3.32]
Wei 2011	-16.76	2.85	10	-20.1	2.09	10	10.4%	3.34 [1.15, 5.53]
Yao 2008	-13.56	5.16	25	-9.59	8.38	22	6.6%	-3.97 [-8.01, 0.07]
Yu 2011	-10.41	2.23	16	-8.04	2.49	16	11.6%	-2.37 [-4.01, -0.73]
Total (95% CI)			199			195	100.0%	0.61 [-0.84, 2.05]

Heterogeneity: Tau² = 3.98; Chi² = 45.01, df = 11 (P < 0.00001); I² = 76%
Test for overall effect: Z = 0.82 (P = 0.41)
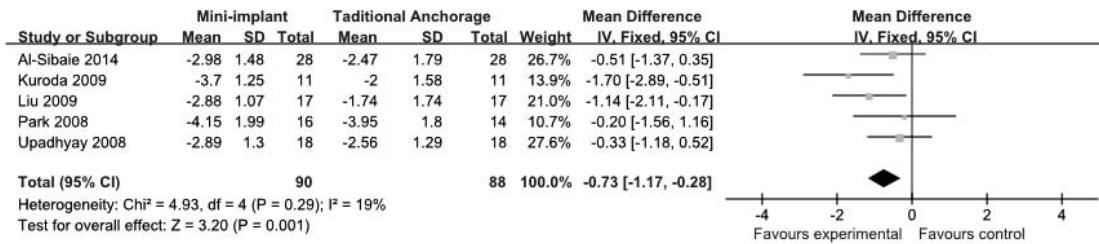
Figure 6. Meta-analysis of U1-SN.

Figure 7. Meta-analysis of UL-E plane.

suggest the use of the much stronger anchorage capacity of mini-implants.

U1-SN. The result of meta-analysis showed that the WMD (95% CI) between the two groups was 0.61° (−0.84°, 2.05°), but there was no statistical significance in U1-SN.

Soft Tissue Effects of Intervention

UL-E plane (mm). The results showed that there was a significant difference between the two groups. However, soft tissue changes are affected by many factors. Oliver[24] found that patients with a high lip or thin-lip strain exhibited a significant correlation between incisor retraction and lip retraction, but those having a low lip or a thick-lip strain showed no such correlation. Therefore, in clinical practice, to predict lip morphology, orthodontists need to consider not only the inclination of the maxillary incisors, but also the lip muscle structure and other factors.

NLA. Results of the meta-analysis showed a statistically significant difference between the two groups. However, in view of the small number of high-quality studies, we cannot determine whether the mini-implant is more effective than traditional anchorage in reducing NLA.

G-Sn-Pg. Only three studies were included in this systematic review. Kuroda et al.[23] showed that facial convexity was significantly improved in both groups, but there was no statistical significance. However, Upadhyay et al.[1] revealed that there was a greater change in the soft tissue profile in the mini-implant anchorage group, with statistical significance. In the third study,[17] mini-implant anchorage produced greater

improvement than did traditional anchorage, with no significant difference. Therefore, because of unreliable methodology and results, we cannot determine the effectiveness of mini-implant vs traditional anchorage technique. To investigate the effect of the two anchorage types, more RCTs are needed.

Meta-analysis Limitations

This meta-analysis may have some limitations. First, the included studies have a risk of bias. The absence of information on method error analysis and blind measurements were examples of failures that may have affected the results across studies. Moreover, baseline differences existed mainly in the types of interventions and outcomes. For instance, most studies reported the amount of maxillary molar movement, but cephalometric measurements were based on different reference planes—the FH plane and the PP plane—resulting in evaluating quality and control of bias of the included eight RCTs[1,12–18] as high quality and the six CCTs[4,19–23] as grade B (Tables 2 and 3). Otherwise, the internal validity of a meta-analysis can only be as good as the quality of the studies reviewed. Thus, quality-related differences in the treatment effect should be treated as hypothesis-generating observations.

CONCLUSIONS

- Mini-implant anchorage was more effect in retracting the anterior teeth and had less anchorage loss.
- Both mini-implants and traditional anchorage were equally effective on U1-SN and SNA.
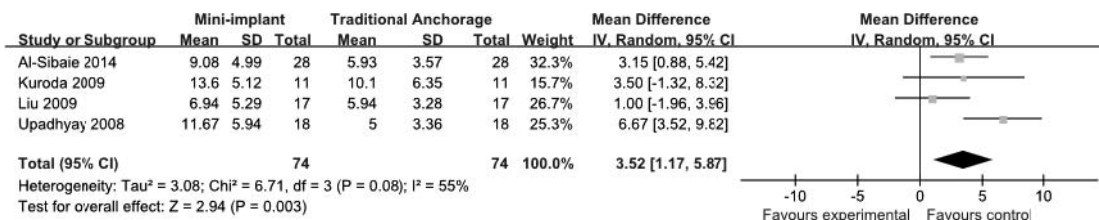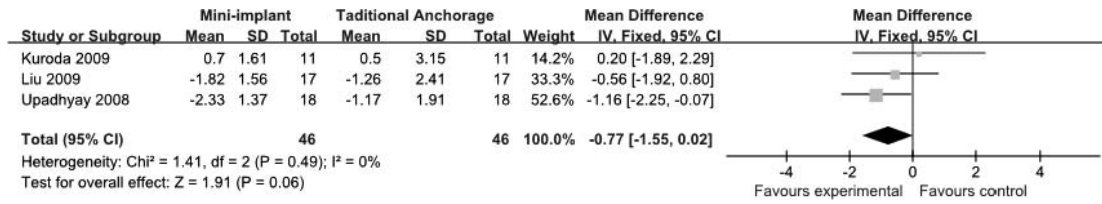

Figure 8. Meta-analysis of NLA.

Figure 9. Meta-analysis of G-Sn-Pg.

• More qualified RCTs are required to make reliable recommendations about the anchorage capacity of mini-implant vs traditional anchorage on patients with maxillary dentoalveolar protrusion, especially in SN-MP and soft tissue effects.

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