Review Article

Comparing the Effect of Miniscrew-Supported and Conventional Maxillary Incisor Intrusion on the Inclination of Maxillary Incisors and Molars – A Systematic Review and Meta-Analysis

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Abstract

Objective: The objective of this study was to compare the effect of miniscrew-supported maxillary incisor intrusion and conventional intrusion mechanics on maxillary incisors and molar inclination. **Material and Methods:** Search databases (PubMed, Scopus, Web of Science, Embase, EBSCOhost, and the Cochrane Library) were searched for randomized trials on intrusion of maxillary incisors via miniscrew-supported and conventional mechanics. The revised Cochrane risk-of-bias tool for randomized trials (RoB 2.0) was used. Five outcomes ([i] inclination change of upper incisors, [ii] inclination change of upper molars, [iii] intrusion of incisors, [iv] vertical change in upper first molars, and [v] overbite correction achieved) were statistically pooled using Review Manager 5.3. Subgroup analysis was conducted to receive sturdiness in meta-analysis. The quality of evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation. **Results:** Out of 1777 studies, 7 were finally subjected to quality assessment, and 6 were included in the meta-analysis. The incisor inclination following maxillary incisor intrusion increased in miniscrew-supported intrusion in comparison to Connecticut intrusion arch (CTA) subgroup with standard mean difference of 0.66 mm (95% confidence interval = 0.16, 1.03, I^2 = 0%). All the included studies showed an increase in molar inclination (distal tipping) in the CTA subgroup compared to the micro-implant group. Of all the seven included studies, only one study was identified with some concerns for the risk of bias, and the other six were judged to have an overall high risk of bias. **Conclusion:** The incisal proclination during deep-bite correction by miniscrew-supported incisal intrusion is more than that in the CTA subgroup; however, the difference may not be clinically very relevant. There is a very low quality of evidence in favor of miniscrew-supported intrusion as compared to conventional intrusion, necessitating the need for good-quality trials.

Keywords: *Absolute intrusion, Connecticut intrusion arch, deep-bite correction, intrusion arches, meta-analysis, miniscrew-supported intrusion, systematic review*

Introduction

Deep bite due to supra-erupted incisors often results in the dentoalveolar gummy smile and periodontally compromised teeth.[1] The management of deep-bite correction in adults with hyperdivergency indicates absolute intrusion mechanics.[2] Thus, the treatment often solely includes near true intrusion to avoid any further clockwise rotation of the mandible. The intrusion arch mechanics need careful monitoring due to their undesirable side effects on anchor units such as distal tipping and extrusion.[3] To avoid these deleterious effects, skeletal anchorage either extraoral via J-hook headgear or intraoral via miniscrew implants has gained importance. Miniscrew implants were introduced in orthodontics way back in 1977. Existence of moderate-quality evidence suggested that miniscrew anchorage reinforcement is more effective than conventional anchorage.[4] On comparison with other intrusive mechanics, miniscrew implants are low cost with low-failure rate.[5] Its small size allows easy intraoral placement and removal.

A previous systematic review with meta-analysis concluded that segmental arch approach produces true intrusion during orthodontic treatment.[6] Intrusion can be achieved successfully by 2 × 4 appliances such as Ricketts utility arch, Connecticut intrusion arches (CTAs), and Burstone's three-piece intrusion arch and its base-arch approach, but these

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appliances also add to incisor proclination and distal tipping of molars which may not be always desirable in all the cases. The soft tissue paradigm dictates the appropriate inclination and position of anterior teeth to obtain optimal facial esthetics. Thus, the increase in inclination along with intrusion obviously affects the esthetics of subjects undergoing orthodontic treatment.

A systematic review[7] has evaluated the maxillary incisor intrusion with its effect on molar extrusion and root resorption, but an important side effect of incisor intrusion is the changes in maxillary incisor and molar inclinations that may markedly affect the clinical results of fixed orthodontic treatment and has not been considered. The literature is deficient regarding the comparison of inclinational changes of incisors and molars during incisor intrusion using miniscrew implants and other conventional methods. Therefore, the objective of this systematic review is to compare the impact of intrusion using miniscrew implants and other conventional methods on inclinational changes and linear dimensional changes of incisors and molars.

Material and Methods

Protocol and registration

This systematic review was conducted and reported in adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses standards. The review protocol was registered with Prospective International Register of Systematic Reviews registration no. CRD42020150778.

Information sources

Research databases including PubMed, Scopus, Web of Science, Embase, EBSCOhost, and the Cochrane Library were searched. The search commenced in the last week of December 2020 irrespective of country, time line, language, and status of the publication. Handsearching on Google Scholar was performed for gray literature search. The cross-references of all articles were manually explored for additional studies [Supplementary Table 1].

Search strategy

Authors "HG" and "SV" made the search strategy, and all the included studies were added to an EndNote Library. The duplicates were removed cautiously, and a two-step screening was done independently by title and abstract reading, followed by full-text reading to fulfill the insufficient information in the abstract, if required. The disagreements between authors were resolved by consensus after discussion with author "AG." After qualifying the inclusion and exclusion criteria, final articles were subjected to data extraction and risk of bias assessment, followed by the qualitative and quantitative synthesis.

Study selection

Inclusion criteria

Only randomized trials were included with no restriction on age, gender, race, or country. Articles which had participants with deep bite >4 mm, where intrusion mechanotherapy was performed on maxillary incisors, performed with or without first premolar extraction or any initial alignment, were included. Articles, where implants were placed bilaterally in the premaxillary region, were included. Both published and unpublished researches were considered [Supplementary Table 2].

Population (P)	Orthodontic patients with overbite >4 mm
Intervention (I)	Miniscrew-supported intrusion approach
Comparator (C)	Any other intrusion mechanics
Outcome (O)	Inclination change among incisors and first molar linear dimensional change among incisors and first molar
Time Frame (T)	Intrusion for 4–6 months
Study Design (S)	Randomized trials.

Exclusion criteria

Articles other than those published in the English language or not originally translated in the English language were excluded. Articles which had participants with the previous history of trauma or injury, or disorders, or syndromes, or disability were excluded. Letter to editor; conferences proceedings, and policy statements were not included. Articles, where miniscrew implants were placed on the anterior nasal spine, were not considered.

Data collection process

A self-designed data extraction form was pilot tested and later used for systematically gathering relevant information from each of the included studies. Both authors extracted the data individually and compiled and rechecked for accuracy. Incomplete information was tried to be filled with additional data provided by contacting authors of the included studies.

Data items

The data extraction form included the study identification, design, participants (number, age range, and gender distribution), randomization (method, dropouts, and blinding), miniscrew (insertion site, manufacturer, and dimensions), force application (method, time interval, and time duration), and outcomes (incisal and molar inclinational changes, incisal and molar vertical positional changes, and overbite correction).

Risk of bias and quality assessment of individual studies

The risk of bias of all included studies was assessed using the "revised Cochrane risk-of-bias tool for randomized trials (RoB 2.0)"[8] – by reviewers "HG" and "SV" independently, and

disagreements between them were resolved by discussion with "AG." Based on five domains, quality assessment was done for all included studies and categorized into three distinct levels: low risk, some concerns, or high-risk studies.[8]

Summary measure and synthesis of results

Statistical pooling of only original outcome data from all included studies was done by Review Manager 5.3 (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014). Standard mean difference (SMD) was used for continuous data, and heterogeneity was assessed across included studies through I^2 statistics, with random effects in 95% confidence interval (CI). All included studies were meta-analyzed for (i) inclination change of upper incisors, (ii) inclination change of upper molars, (iii) intrusion of incisors, (iv) vertical change in upper first molars, and (v) overbite correction achieved.

Publication bias was prespecified through standard funnel plots only if more than ten studies were included in the meta-analysis.[9] Moreover, Egger's regression test was planned if <10 studies were available for data pooling with respect to an outcome.[10]

Additional analysis

Subgroup analyses were planned to be performed based on the type of conventional intrusion mechanics. Sensitivity analyses were predetermined to receive sturdiness in the meta-analysis by exploring the source of heterogeneity associated with a high risk of bias within the studies.

Quality of evidence

The overall quality of evidence was assessed by "The Grading of Recommendations Assessment, Development and Evaluation" using the interventions and the outcomes of individual studies.[11,12] Based on assessment at the level of risk of bias, inconsistency, indirectness, imprecision, and publication bias, the overall body of evidence was rated as high, moderate, low, and very low. The quality of evidence could be downgraded for the first four domains as "serious" or "very serious" risks, whereas the publication bias could either be suspected or undetected.

Results

Study selection

The search strategy yielded a total of 1777 records, and details are presented in Figure 1. After eliminating duplicates and abstract screening, 14 records were considered for full-text evaluation. Finally, seven studies for qualitative assessment and six for quantitative synthesis were included. Of all the seven studies, two randomized controlled trials (RCTs)[13,14] were three-arm-parallel, where one had included J-hook headgear[13] group and other used controls[14] along with intrusion arches and miniscrew-supported intrusion groups. There was a total sample of 217 postpubertal subjects with either Class I or Class II malocclusion. An overview of all the included studies is presented in Table 1. Quantitative synthesis via meta-analysis could be performed only on selected studies which had reported relevant outcome data.

Study characteristics

India[13,15,16] and Turkey[14,17,18] take the lead with three clinical trials and one from Egypt.[19] Two intervention groups were miniscrew-supported intrusion and other conventional intrusion methods for maxillary incisor intrusion. For miniscrew-supported intrusion group, miniscrews 1.3–1.5 mm diameter and 5–8 mm length were placed either distal or mesial to upper lateral incisor's root. These were loaded within 1–2 weeks after placement with NiTi coil springs or elastomeric chain. In contrast to this, conventional intrusion group comprised three intrusion arches: Ricketts utility arch,[20] CTAs,[21] and Burstone's base-arch approach[22] and one extraoral appliance, i.e., J-hook headgear.[23] Both the groups were loaded with 60–120 g of force and followed up every 3–4 weeks for 4–6 months [Supplementary Table 3].

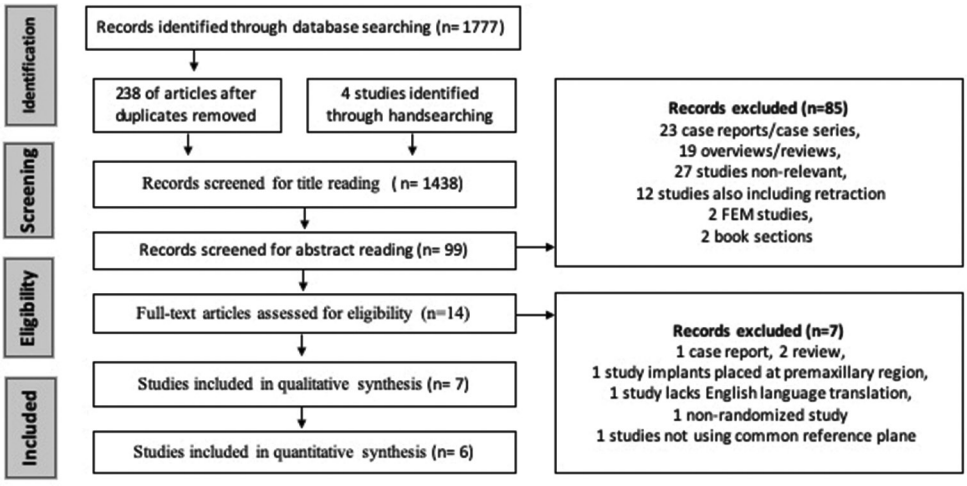

Figure 1: PRISMA flow diagram, PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Risk of bias within studies

Of all the seven included studies, only one study was identified with some concerns[17] for the risk of bias, and the other six were judged to have an overall high risk of bias. Details of randomization process and allocation concealment and measurement of the outcome by blinding/masking of outcome accessor personnel were insufficient. Only Gürlen and Aras[17] reported the involvement of independent examiner for cephalometric analysis who was unaware of the group to which the patients had been allocated. Shortcomings at selective reporting by an included study[13] reveal insufficient data to allow the assessment and predetermination of results. Further meta-analysis was performed by omitting another study[16] in primary outcome assessment as it is using SN plane as reference plane, rather than a common reference plane as palatal plane [Figure 2].

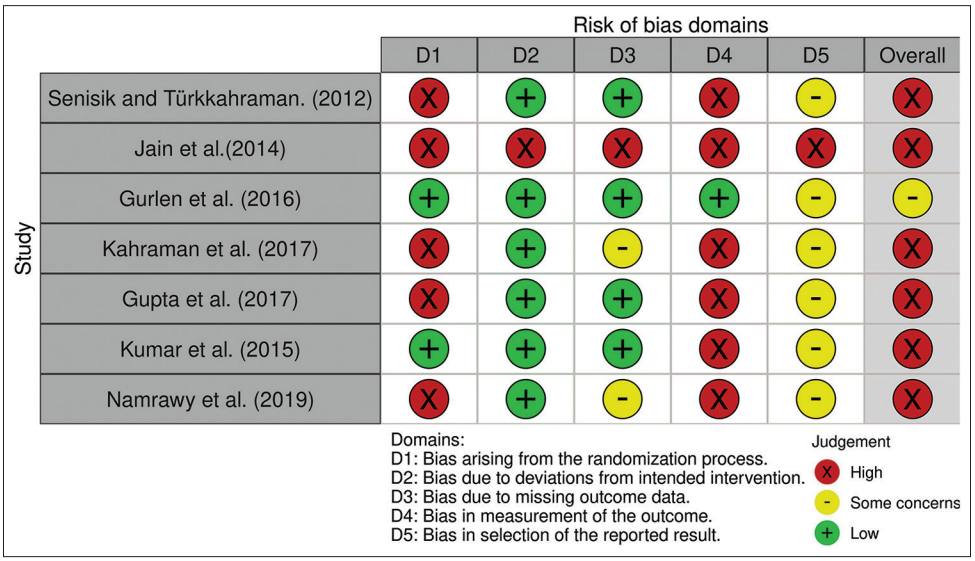

Figure 2: Risk of bias assessment of all included studies according to the RoB 2.0 assessment tool, RoB: Risk of bias

Table 1: An overview of all included studies elaborating on study design, method of assessment, time duration and arch preparation (before intrusion)

Study	Population	Assessment	Sample	Time	Arch-preparation	Follow-up interval
Namrawy, *et al*.[19] (2019) Egypt	30 (21 female; 9 male) Age=17-29	Lateral cephalogram	Miniscrew (*n*=15, 19.50±2.5 years) Utility arch (*n*=15, 22.6±5.3 years	5.3±1 months 4.8±1 months	-NM-	Every 4 weeks
Kahraman, *et al*.[18] (2017) Turkey	34 (27 female; 9 male)	CBCT scans	CTA (*n*=18, 15.99±0.97 years) Miniscrew (*n*=18, 16.68±0.92 years)	3.64±0.82 months 3.36±1.25 months	Only TPA placed	Follow-up after every 3 weeks
Gupta, *et al*.[15] (2017) India	24 patients Age=15-25	Lateral cephalogram	Miniscrew (*n*=12, 17.75±3.49 years) CTA (*n*=12, 18.75±3.47 years)	4.6±2.3 months 5.8±2.9 months	Alignment TPA placed	Follow-up after every 4 weeks
Kumar, *et al*.[16] (2017) India	30 patients Age=15-20	Digital lateral cephalogram	Miniscrew (*n*=15, 15-20 years) CTA (*n*=15, 15-20 years)	6 months	Alignment 0.017”X0.025”SS	Recalled after 4 weeks
Gürlen and Aras[17] (2016) Turkey	32 (16 female; 16 male)	Lateral cephalogram	Miniscrew (*n*=16, 14.1 years) CTA (16, 14.6 years)	5 months	Alignment 0.017”X0.025”SS	-NM-
Jain, *et al*.[13] (2014) India	30 (19 female; 11 male) Age=16-22	Lateral cephalogram	Miniscrew (*n*=10, 16-22 years) J-hook headgear (*n*=10, 16-22 years) Utility arch (*n*=10, 16-22 years)	-NM-	-NM-	Reviewed after 3 weeks
Senisik and Tükkahraman[14] (2012) Turkey	45 (26 female; 19 male)	Lateral cephalogram	CTA (*n*=15, 20.32±3.22 years) Miniscrew (*n*=15, 20.13±2.48 years) Controls (*n*=15, 20.49±2.80 years)	6.88±0.95 months 6.93±1.17 months 6.90±1.01 months	No alignment Passive 0.016”ss wire (Class II Div 2 malocclusion)	-NM-

NM: Not mentioned; CBCT: Cone-bean computed tomography; TPA: Transpalatal arch; CTA: Connecticut intrusion arch

Results of individual studies

Primary outcome

Inclination change of upper incisors with respect to palatal plane

Four studies[14,15,17,19] investigated this outcome with high heterogeneity. On subgroup analysis, the CTA subgroup was favored in comparison with miniscrew, with complete statistical homogeneity (I^2 = 0%) and SMD was 0.60 mm (CI = 0.16, 1.03) [Figure 3].

Inclination change of upper molars with respect to palatal plane

Four studies investigated this outcome[14,15,18,19] and presented high heterogeneity (91%). Subgrouping was conducted, the CTA subgroup had three studies,[14,15,18] and there was one study in utility arch subgroup.[19]

Secondary outcome

The intrusion of incisors with respect to palatal plane

All the five studies[14-17,19] that investigated this outcome showed that more intrusion was possible with miniscrew-supported subgroup in comparison with conventional intrusion mechanics. The SMD was -0.91 mm (CI = −1.35, −0.47) and I^2 = 38%; and on CTA subgroup[14-17] analysis, it showed similar results with I^2 = 53% [Figure 4].

Vertical linear change in upper first molars with respect to palatal plane

The conventional group showed more extrusion of molars in all the included studies, but the results of meta-analysis were nonconclusive due to high heterogeneity (I^2 = 73%). On subgrouping, CTA subgroup consisted of four studies,[14-16,18] with I^2 = 57%.

Overbite correction

The three studies were included in the CTA subgroup,[14,15,17] which showed more overbite correction in miniscrew-supported intrusion. However, the included studies revealed SMD of − 0.58 mm (CI = −1.30, 0.11) and heterogeneity (I^2 = 61%).

Publication bias

Funnel plot could not be explored either statistically or graphically as none of the outcomes had ten or more studies. Egger's regression test presented nonsignificant results with respect to publication bias for incisor inclination (P = 0.398) and linear changes during maxillary incisor intrusion (P = 0.306) with miniscrew-supported and conventional intrusion method.

Quality of evidence

The quality of evidence was very low for all assessed outcomes on inclination and linear changes of incisors and molars during maxillary incisor intrusion with either miniscrew-supported or conventional method. CTA intrusion mechanics has shown better control over incisor inclination in comparison with miniscrew-supported intrusion mechanics; however, the quality of evidence is adjudged to be very low [Table 2].

Discussion

Summary of evidence

In the present meta-analysis, data from six studies were pooled to evaluate five outcomes. Qualitative analysis of these six studies categorized them having an overall high risk of bias except Gürlen and Aras,[17] which has some concerns. Most of the studies lost their grading in bias arising from the randomization process and outcome measurement. A high risk of bias was also generated due to deviation from the intended intervention, which was judged in a study[13] comparing miniscrew-supported intrusion with J-hook headgear. Co-intervention with J-hook headgear could not be matched due to more horizontally directed force vectors. Even poor patient compliance resulted in two dropouts in headgear group (n = 10) in the study.

The intrusion of anteriors in nongrowing or adult patients has been invariably considered more stable for deep-bite correction rather than extrusion of posteriors.[22] The skeletal anchorage by mini-implants has progressively achieved credibility in the management of deep-bite correction by absolute intrusion along with various orthodontic movements such as extrusion of impacted canine, tooth rotations, molar distalization,

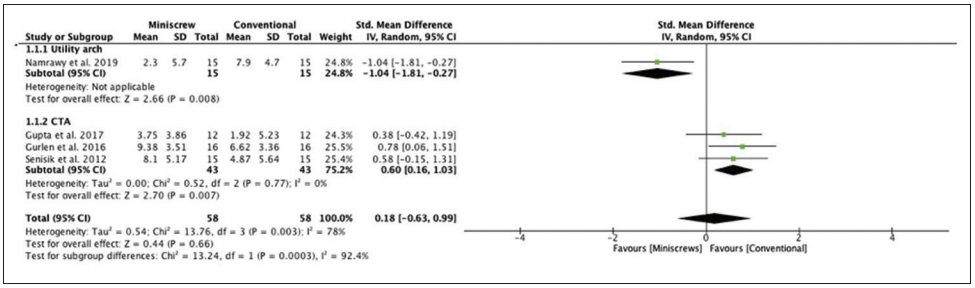

Figure 3: Forest plot of pooled SMD of inclination change of incisors on miniscrew-supported maxillary intrusion versus conventional methods, SMD: Standard mean difference

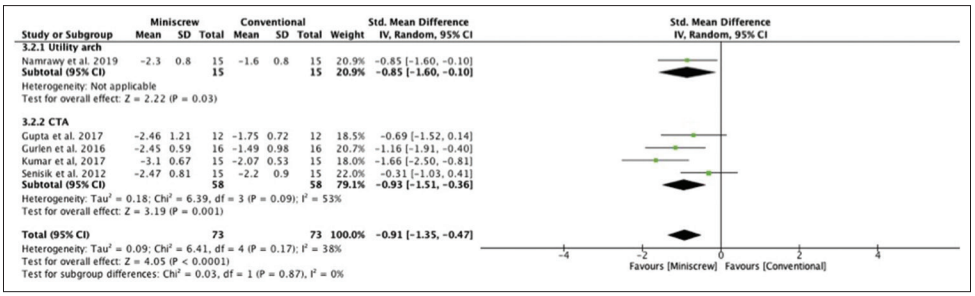

Figure 4: Forest plot of pooled SMD of Linear change of incisors of miniscrew-supported maxillary intrusion versus conventional methods, SMD: Standard mean difference

and en-masse retraction without taxing the molar anchorage.[4] Instead of lateral cephalogram, cone-bean computed tomography (CBCT) evaluation was done in a study.[18] Three-dimensional assessment is considered to be more reliable than manual, digital, and CBCT-generated lateral cephalogram.[24]

Description of outcomes

Inclination change

Quantitative analysis declared a noticeable change in inclination of incisors and molars following the intrusion of maxillary incisors. This proclination of incisors occurs in intrusion arches due to the lingual root torque moment created within the bracket slot and forward slippage of archwire within the molar tube if it is not cinched back.[21] The molars were undisturbed in miniscrew-supported intrusion whereas, distal tipping occurred in molars which was significant in CTA and utility arch subgroups of the conventional intrusion methods; this might be due to the tip-back bend at the molars in conventional intrusion arches.[21] To maintain homogeneity, all the studies have used the palatal plane as a reference plane; thereafter, the CTA subgroup in incisor inclination parameters revealed complete homogeneity (I^2 = 0%) with SMD of 0.60 mm (CI = 0.16, 1.03).

Linear dimensional change

In this systematic review, positional change of incisors depicted actual intrusion as the center of resistance (CR) of maxillary incisors was used as a reference point rather than CR of the maxillary anterior segment or the incisal edges. This result can be attributable to two reasons; one high reproducibility of CR and another could be a false perception of intrusion occurring due to proclination of incisors.[25] A meta-analysis of four studies[14,15,17,19] was performed to evaluate the intrusion. The miniscrew-supported intrusion correction was found to be considerably higher than the conventional group, irrespective of intrusion arches.

Overbite correction can also be due to pseudo intrusion, specifically by incisor proclination. However, no statistically significant change in mandibular plane angle (GoGn-SN) was identified in these studies,[14,15,17,19] suggesting an absolute intrusion of the incisors. In the CTA subgroup, miniscrew-supported intrusion proved to correct overbite more efficiently whereas, in the utility arch subgroup, incisor proclination resulted in relatively more overbite correction.

Miniscrew versus utility arch

Tip-back bends introduced by Bench *et al*.[26] for activation of utility arch result in unintentional distal tipping of molars. Therefore, it is suggested that gable bend at the posterior aspect of the vestibular segment used for activation could avoid unwanted tipping of the molars. Cinching the wire can avoid unwanted proclination of incisors, whereas, in Class II Div 2 malocclusion cases, the wire is intentionally left uncinched to improve retroclination. In the study by El Namrawy *et al*.,[19] utility arch produced significant proclination of incisors in comparison to miniscrew, probably because the author did not cinch the wire, which allowed free tipping of incisors and overbite correction. In the same study, the molars showed intrusion, but the reason is still unclear; contrastingly, similar research by Jain *et al*.[13] concluded molar extrusion.

Miniscrew versus Connecticut intrusion arch

CTA intrusion arch mechanics revealed better control over incisal flaring as wire is cinched at posterior segment. However, miniscrew-supported intrusion produced more absolute intrusion, but there is a considerable amount of anterior flaring due to separate posterior wire segment and lack of anchor unit at anteroposterior level. The posterior anchorage in the CTA subgroup also produced molar extrusion as compared to miniscrew-supported intrusion. This could be due to the reactive clockwise moment generated at the molars. Therefore, this systematic review reveals absolute intrusion in miniscrew-supported intrusion, but there is a lack of control on incisor inclination. This incisor inclination could be controlled by concentrating on the mechanics and thus taking advantage of anchorage provided by miniscrew-supported intrusion mechanics.

This systematic review is in accordance with the previously published meta-analysis[7] except this present meta-analysis has included recently published RCTs,[19] secondly, concentrated on studies originally published in the English language and has omitted studied with major shortcomings in qualitative

Table 2: Quality assessment and Summary of findings table according to the Grading of Recommendations Assessment, Development and Evaluation

Quality assessment							Summary of findings					Quality
							Number of patients		Random effect			
										Absolute		
Number of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Miniscrew-supported intrusion	CTA	Relative (95% CI)	Risk with conventional	Risk with miniscrew	
Upper incisor inclination change (angular change)												
4	RCT	Very serious[a]	Serious[c]	Not serious	Serious[b]	Undetected	58	58	-	-	SMD 0.18 SD higher (0.63 lower to 0.99 higher)	⊕OOO Very low
Upper incisor intrusion (linear change)												
5	RCT	Very serious[a]	Not serious	Not serious	Serious[b]	Undetected	73	73	-	-	SMD 0.91 SD lower (1.35 lower to 0.47 lower)	⊕OOO Very low

[a]Downgraded due to high risk of bias in individual studies; [b]Downgraded due to low sample size; [c]Downgraded due to moderate heterogeneity. CTA: Connecticut intrusion arch; RCT: Randomized controlled trial; CI: Confidence interval

analysis.[13] The heterogeneity generated in the amount of vertical changes in incisors ($I^2 = 38\%$) and molars ($I^2 = 70\%$) parameters is in par with the previous systematic review ($I^2 = 41\%$; $I^2 = 68\%$). The present review has focused on inclination changes whereas the previous systematic review concentrated on true intrusion, overbite correction, and root resorption. As a point of discussion, changes in molars (inclinational and vertical) and overbite correction results are nondecisive due to high heterogeneity ($I^2 > 40\%$)

In orthodontic literature, the certainty of 79% of the prevailing meta-analysis had been reported as low or very low.[27] Similarly, the quality of evidence from all the individual meta-analyses of this secondary research was very low. Few serious concerns are admitting to the limit of the present study; none of the meta-analyses involved more than 100 participants, widening and overlapping of confidence of interval of the estimated effect, high heterogeneity, and mostly all studies having a high risk of bias.

Limitations and recommendations

The limitation of this systematic review mainly lies in the lack of high quality or low risk of bias studies. Since the certainty of the evidence is very low, more good-quality randomized studies are required to compare miniscrews supported and other conventional intrusion methods for a similar outcome to maintain uniformity and to extract a concrete result. Inclination change among incisors and molars during intrusion is an interesting topic. Still, a limited number of studies have evaluated this outcome, and thus, it prevented us from performing in-depth analysis. There are insufficient data on the utility arch and other conventional intrusion mechanics; therefore, a critical meta-analysis of these subgroups was not possible. There are numerous approaches to intrude incisors such as Kalra Simultaneous Intrusion and Retraction arch, Burstone's three-piece intrusion arch, tip-back springs, and lingual/palatal arch for the intrusion; future clinical trials are expected to include these mechanics for comparison with miniscrew-supported intrusion to establish confirmatory results.

Conclusion

This review suggests that the incisal proclination during deep-bite correction by miniscrew-supported incisal intrusion is more than that in the CTA subgroup; however, the difference may not be clinically very relevant. There is a very low quality of evidence in favor of miniscrew-supported intrusion as compared to conventional intrusion. Very low-quality evidence displayed methodological drawbacks in the existing literature, therefore high-quality randomized controlled investigations are needed for generating a robust evidence.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Supplementary Table 1: Search strategy of the databases

Citation screened from electronic	Number of articles screened (*n*=1002)
The Cochrane Library (Cochrane review, Trials)	8
Only Trials matching maxillary AND anterior AND Intrusion AND (miniscrew OR miniscrew-implants OR screw OR temporary anchorage device OR TADS) AND orthodontics in All Text - (Word variations have been searched)	
PubMed-NCBI	82
anterior[All Fields] AND (Intrusion[All Fields] OR deepbite[All Fields]) AND (miniscrew[All Fields] OR miniscrew-implants[All Fields] OR ("bone screws"[MeSH Terms] OR ("bone"[All Fields] AND "screws"[All Fields]) OR "bone screws"[All Fields] OR "screw"[All Fields]) OR (temporary[All Fields] AND anchorage[All Fields] AND ("equipment and supplies"[MeSH Terms] OR ("equipment"[All Fields] AND "supplies"[All Fields]) OR "equipment and supplies"[All Fields] OR "device"[All Fields])) OR TADS[All Fields])	
EBSCOHost Research Database (Dentistry and Oral Sciences, CINAHL Plus full text, Open dissertations)	849
maxilla+AND+anterior+AND+(Intrusion+OR+deepbite)+AND+(miniscrew+OR+miniscrew-implants+OR+screw+OR+temporary+anchorage+device+OR+TADS)+AND+orthodontics	
SCOPUS (scientific journals, books and conferences proceedings)	743
ALL (intrusion AND (miniscrew OR miniscrew-implants OR screw OR temporary AND anchorage AND device OR tads))	
Web of Science (core collection)	47
ALL FIELDS: ("anterior" AND ("Intrusion") AND ("miniscrew" OR "miniscrew-implants" OR "screw" OR "temporary anchorage device" OR "TADS") AND "orthodontics")	
EMBASE (European studies, pharmacological literature, conferences)	48
('all fields' OR (all AND fields AND ('maxillary'/exp OR 'maxillary') AND 'anterior' AND ('intrusion'/exp OR 'intrusion') AND ('miniscrew'/exp OR 'miniscrew' OR 'miniscrew-implants' OR 'screw'/exp OR 'screw' OR 'temporary anchorage device'/exp OR 'temporary anchorage device' OR 'tads') AND ('orthodontics'/exp OR 'orthodontics'))) AND all AND fields AND 'maxillary' AND 'anterior' AND 'intrusion' AND ('miniscrew' OR 'miniscrew-implants' OR 'screw' OR 'temporary anchorage device' OR 'tads') AND 'orthodontics'	

Supplementary Table 2: PICOT (S) strategy showing the inclusion criteria

PICOT(S)	Criteria
Population (P)	Orthodontic patients with overbite >4mm
Intervention (I)	Miniscrew-supported intrusion approach
Comparator (C)	Any other intrusion mechanics
Outcome (O)	Inclination change among incisors and first molar
	Linear dimensional change among incisors and first molar
Time Frame (T)	Intrusion for 4-6 months
Study Design (S)	Randomized trials

Supplementary Table 3: Summary of dimensions of Miniscrew used for intrusion, company, placement site, loading time, mode of force application and total intrusive force applied

Study	Implant	Placement	Loading	Force
Namrawy *et al*.[19] (2019)	1.4 mm diameter, 6 mm length Jeil Medical Co., Seoul, Korea	Distal to maxillary lateral incisors	After 2 weeks with NiTi closed-coil springs	100 g
Kahraman *et al*.[18] (2017)	1.5 mm diameter, 6 mm length Absoanchor®, Dentos, Daegu, Korea	Between the roots of lateral incisor and canine	One week after insertion with closed NiTi coil	80 g
Gupta *et al*.[15] (2017)	1.3 mm diameter, 8 mm length Absoanchor®, Dentos, Daegu, Korea	Between the roots of maxillary lateral incisor and canine	One week after insertion with closed NiTi coil	60 g
Kumar *et al*.[16] (2017)	1.3 mm diameter, 7 mm length Absoanchor®, Dentos, Daegu, Korea	Between maxillary lateral incisors and central incisors	Loaded 2 weeks after insertion with e-chain	60 g
Gürlen and Aras[17] (2016)	1.4 mm diameter, 7 mm length Ortholution, Seoul, South Korea	Between the central incisors and lateral incisors	Elastic power chain	60 g
Jain *et al*.[13] (2014)	1.4 mm diameter, 6 mm length Absoanchor®, Dentos, Daegu, Korea	Distal to lateral incisors	NiTi closed coil springs	1.5 ounces on each side
Senisik and Tükkahraman[14] (2012)	1.3 mm diameter, 5 mm length Absoanchor®, Dentos, Daegu, Korea	Between the roots of lateral incisor and canine	Immediately with NiTi coil springs	90 g

NiTi: Nickel titanium wire