Orthodontics & Craniofacial Research

WILEY

SPECIAL ISSUE Facial Orthopedics With Skeletal Anchorage

REVIEW ARTICLE OPEN ACCESS

Facial Orthopedics With Skeletal Anchorage

Effects Produced by Fixed Functional Appliances With and Without Skeletal Anchorage for the Treatment of Class II Malocclusion in the Growing Patient: A Review of Systematic Reviews

Valentina Rutili | Michele Nieri | Veronica Giuntini | Ersilia Vaccari | Lorenzo Franchi

Department of Experimental and Clinical Medicine, Università Degli Studi di Firenze, Firenze, Italy

Correspondence: Lorenzo Franchi (lorenzo.franchi@unifi.it)

Received: 12 August 2025 | **Revised:** 19 December 2025 | **Accepted:** 7 January 2026

Keywords: Angle Class II | functional appliance | orthodontic treatment | skeletal anchorage

ABSTRACT

To summarise the scientific evidence from systematic reviews on the differences between fixed functional appliances (FFA) with and without skeletal anchorage for the treatment of Class II malocclusion in growing patients. A systematic search on six major databases was performed. Primary outcomes were changes in Co-Gn, SNB angle and the lower incisor inclination. ROBIS tool to assess risk of bias and GRADE instrument to assess evidence quality were used. Mean differences (MD) or risk ratios (RR) with their 95% confidence intervals were calculated from random-effects meta-analyses. A total of 10 systematic reviews were identified, six at high risk of bias, three at unclear risk of bias and one at low risk of bias. The meta-analysis with only RCTs studies indicated that FFA with skeletal anchorage did not produce a statistically significant increase in Co-Gn (pooled MD = +1.37 mm, 95% CI from −0.88 to 3.62; $p = 0.23$, $I^2 = 96\%$, three studies, GRADE low). No statistically significant differences were identified for SNB angle between FFA with and without skeletal anchorage (pooled MD = +0.31 degrees, 95% CI from −0.03 to 0.66; $p = 0.08$, $I^2 = 51\%$, three studies, GRADE low). FFA with skeletal anchorage showed a statistically greater decrease for lower incisor inclination (pooled MD = −5.03, 95% CI from −8.49 to −1.58; $p = 0.004$, $I^2 = 89\%$, four studies, GRADE low). Low evidence of findings from exclusively RCTs studies suggested that FFA with skeletal anchorage could reduce the lower incisor inclination with a greater percentage of complications. However, no significant differences were found for mandibular dimensions and mandibular protrusion between FFA with and without skeletal anchorage.

1 | Introduction

Class II malocclusion constitutes a common skeletal disharmony in orthodontics, with a global prevalence of about 23% in the mixed dentition [1]. Mandibular skeletal retrusion is the most commonly associated characteristic of this malocclusion [2, 3].

Functional appliances aim to correct Class II malocclusion by producing mandibular advancement, posturing the mandible forward and modifying craniofacial muscle activity [4].

Whether functional appliances can promote mandibular growth and lead to an increase in mandibular length has been a debated issue. Several studies have shown increases in total mandibular length, particularly in pubertal patients [5–8], with effects persisting long-term [9]. Responsiveness to functional treatment can be more or less pronounced in the individual patient [10] and varies according to each patient's growth potential [11, 12].

Functional appliances can be either fixed or removable [13, 14]. Fixed functional appliances (FFAs) offer a compliance-free alternative to removable ones, especially during the pubertal growth peak, a period in which compliance is typically low [15]. However, they are associated with more breakages, additional chair time and dentoalveolar side effects, including lower incisor proclination due to anchorage loss [16–19]. This effect is due to posteriorly directed forces on the upper arch and anteriorly directed forces on the lower arch, leading to distal tooth movement in the upper arch and mesial tooth movement in the lower arch [20]. Up to 85% of the Class II correction with FFAs takes place due to lower incisor proclination [19]. The resultant of these side effects is an overjet reduction and, consequently, a decrease in space for mandibular advancement [20, 21]. These dento-alveolar effects are associated with reduced efficacy on skeletal mandibular changes which are probably of minor clinical importance [22]. Attempts to limit these effects, such as negative torque or larger rectangular archwires, were found to be unsuccessful [23–25].

Skeletally anchored functional appliances have recently emerged to minimise dentoalveolar effects and enhance skeletal outcomes [25, 26]. Although numerous systematic reviews have compared skeletally anchored and tooth-anchored FFAs, their findings included conflicting results [27, 28]. Some authors have observed statistically greater increases in mandibular length and SNB angle, together with better control of lower incisor proclination, when temporary anchorage devices (TADs) are combined with FFAs, suggesting a potential enhancement of skeletal effects and anchorage control compared with tooth-anchored devices [27, 29]. Other reviews have failed to demonstrate superior skeletal outcomes and have concluded that the main benefit of skeletal anchorage lies in reducing lower incisor proclination, with only limited or clinically questionable additional skeletal effects [19, 30].

These discrepancies likely reflect substantial heterogeneity in appliance design, anchorage protocols (miniscrews vs. miniplates and maxillary vs. mandibular anchorage), patient age and growth stage, outcome variables, follow-up duration and the overall low-to-moderate quality of the primary studies [19, 27, 29]. Therefore, the present review of systematic reviews aims to synthesise the current evidence on the comparative effects of fixed functional appliances with and without skeletal anchorage in the treatment of Class II malocclusion.

2 | Materials and Methods

This review of systematic reviews was registered on PROSPERO (CRD42024511961 available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42024511961).

The conduct and reporting of this umbrella review followed the PRIOR (Preferred Reporting Items for Overviews of Reviews) statement [31], an extension of the PRISMA 2020 guidelines specifically developed for reviews of systematic reviews.

It adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting systematic reviews evaluating health care interventions and follows prescribed methodologies for summarising systematic reviews [32, 33].

2.1 | Eligibility Criteria

Systematic reviews were selected based on eligibility criteria structured according to the PICOS framework (Table S1). Eligible systematic reviews must compare two treatment groups using fixed functional appliances: one group utilising skeletal anchorage (e.g., temporary anchorage devices like miniscrews or miniplates) and another group without it (e.g., connected via a traditional bracket system or lingual arch).

2.2 | Information Sources

A comprehensive electronic search was performed across six major databases (PubMed/MEDLINE, Cochrane Library, Scopus, Embase, Web of Science, OpenGrey) to identify relevant studies.

The final database access occurred on May 8th, 2025. Additionally, reference lists from selected articles were manually reviewed for any potentially overlooked references from electronic searches. With regard to the screening of registers, the International Clinical Trials Registry Platform (ICTRP), ClinicalTrials.gov and the European Clinical Trials Register were included in the Cochrane Library database.

2.3 | Search Strategy

No restrictions on publication status, language, or year were imposed. The search strategy was written using the Medical Subject Headings (MeSH) and Health Sciences Descriptors (DeCS) terms available in English: adolescent, malocclusion, Angle Class II, functional orthodontic appliances, orthodontic anchorage procedures and bone screw adjusted for each database specifications. The search strategy is illustrated in Table S2. Searching was carried out with two separate but combined search strings to enhance retrieval of relevant results for this topic. Duplicate references were then removed automatically using Endnote software (EndNote X9 Thomson Reuters, Philadelphia, PA). After removing duplicates (by software), records were scrutinised manually to confirm the absence of any remaining duplicates.

2.4 | Selection Process

Two reviewers (VR and EV) conducted an independent initial screening based on titles and abstracts following established inclusion/exclusion criteria. Articles failing these criteria were discarded. Following this initial evaluation stage, full-text versions were procured for studies meeting inclusion standards or lacking clarity based solely on title/abstract data. Disagreements were settled through discussion among authors. The inter-reviewer agreement for study selection was assessed using Cohen's kappa (κ).

2.5 | Data Collection Process and Data Items

Data extraction adhered strictly to predefined criteria established prior by two reviewers (VR and EV), focusing on study characteristics (authors/year), population demographics (sample size/nation/setting), research attributes (search period/languages/quality assessment tools/funding sources), clinical evaluations (appliance type/skeletal anchorage points/outcome measures), along with results summaries. The authors of the articles were contacted via e-mail if there was any absence of information and/or missing elements.

The degree of overlap among primary studies included in the selected systematic reviews was assessed using the Corrected Covered Area (CCA) method, as recommended by Pieper et al. [34] and the Joanna Briggs Institute Manual for Evidence Synthesis [32].

2.6 | Risk of Bias Assessment

Two reviewers (MN and VR) independently evaluated risk of bias within included studies using the ROBIS tool [35]. Disagreements between the review authors over the risk of bias in specific studies were resolved by discussion, with the involvement of a third review author where necessary.

Each systematic review was classified according to risk domains: eligibility criteria bias (domain 1); identification/selection bias (domain 2); data collection/study appraisal bias (domain 3); synthesis/findings bias (domain 4); all categorised as low/high/unclear risk of bias.

2.7 | Effect Measures and Synthesis Methods

A narrative synthesis described findings from included systematic reviews alongside evaluations of methodological, clinical and statistical heterogeneity.

Quantitative synthesis via meta-analysis was re-conducted specifically for every appliance indagated and for RCTs only if original meta-analyses exhibited inaccuracies or omissions. A review Manager software (RevMan, 5.4.1 version) enabled meta-analysis execution employing a random-effect model where applicable. For the aggregation of continuous data, the mean of the differences (MD) between groups was applied. The outcome effect measure for binary outcomes was expressed as risk ratio (RR). The inverse of the variance method and a 95% confidence interval (95% CI) were utilised for data analysis. The heterogeneity of the data was assessed using both the Chi^2 test (a P value <0.1 indicated a statistically significant heterogeneity) and the inconsistency index (I^2). Heterogeneity was considered substantial when values exceeded 50%.

The result of the meta-analysis was reported with a forest plot. Subgroup analysis by age (children versus adolescents) was planned if possible. A further subgroup analysis was planned to include only studies with low risk of bias. If possible, a subgroup analysis was planned by maturational stage of patients (prepubertal versus pubertal versus postpubertal stage) and by type of functional appliance. A possible subgroup analysis was performed by including only studies with low risk of bias.

2.8 | Reporting Bias Assessment

The risk of bias in the included systematic reviews was described graphically using a tabular presentation for ROBIS results [35]. The investigation into the presence of publication bias was planned to be conducted using both a funnel plot and an Egger test. This was to be conducted if the meta-analysis includes a minimum of 10 studies.

2.9 | Certainty Assessment

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was utilised to assess the certainty of the evidence [36, 37]. The following factors were estimated by two reviewers (MN and VR): RoB [38], inconsistency (heterogeneity) [39], indirectness [40], imprecision [41] and publication bias [42]. The quality of the evidence was then classified into one of four levels: high, moderate, low, or very low. A 'Summary of findings' (SoF) Table was created regarding all outcomes included to give information concerning the quality of evidence from the selected systematic reviews.

3 | Results

3.1 | Study Selection

The PRISMA 2020 flowchart is presented in Supplementary Figure S1. The database search yielded 4426 records, of which 2427 were duplicates. The title and abstract of the remaining records were assessed, leading to the identification of 26 potentially eligible full-text studies. Following a thorough review, 16 records were excluded, resulting in a final number of 10 systematic reviews. The inter-reviewer agreement for study selection showed substantial agreement (κ = 0.70), indicating substantial consistency between reviewers. The excluded articles and the rationale for exclusion are detailed in Table S3.

3.2 | General Characteristics of the Selected Systematic Reviews

Nine systematic reviews with meta-analysis [19, 27–30, 43–46] and one systematic review [47] were included (Table S4). Several characteristics were investigated such as the type of appliance used, skeletal anchorage points and main results of the meta-analysis included.

Authors of some original articles included in systematic reviews [48, 49] were contacted to specify some information regarding the conduct of the study.

All systematic reviews came from a public setting and from different geographic regions. One systematic review [27] reported effects of the Herbst appliance, five systematic reviews [19, 28, 43, 45, 47] assessed skeletal and dental effects in the Forsus appliance, and four systematic reviews included studies about the Forsus and Herbst appliances together [29, 30, 44, 46].

All systematic reviews, except one [46], included all languages for the research. A heterogeneous set of risk of bias assessment tools was used, particularly for non-randomised trials.

Three systematic reviews [27, 29, 46] concluded that skeletally-anchored FFA can have greater skeletal effects than tooth-anchored FFA, while four other systematic reviews concluded that skeletal anchorage did not improve skeletal mandibular outcomes [19, 28, 30, 44]. Two systematic reviews asserted that miniplate- instead of miniscrew-anchored FFA can increase skeletal outcomes [43, 47], while all systematic reviews concluded that skeletal anchorage in the lower arch could control or reduce the lower incisor inclination of FFA.

3.3 | Primary Study Overlap

The overlap analysis revealed a high overlap between the included systematic reviews (CCA = 30%), suggesting great redundancy of primary studies across reviews.

3.4 | Risk of Bias Assessment

ROBIS tool was assessed for every systematic review included (Table 1). Overall, one systematic review was rated as 'low' risk of bias [29], three as 'unclear' risk of bias [30, 44, 45] and six were assessed as 'high' risk of bias [19, 27, 28, 43, 46, 47]. The graphical summary of all domains of ROBIS (Table 1) indicated that most systematic reviews (six out of 10) had a high risk of bias in 'synthesis and findings' domain.

3.5 | Results of Individual Studies and Data Synthesis

A meta-analysis was performed for Herbst appliance with and without a skeletal anchorage based on the systematic review of Al-Dboush et al., 2022 [27] that included an incorrect number of patients for one included study (Figure 1). This meta-analysis showed that Herbst appliance with a skeletal anchorage resulted in a statistically significant increase of SNB angle compared to dentally anchored Herbst (pooled mean difference, MD = +1.80 degrees favouring TADs group, 95% CI from −0.01 to 3.61; $p = 0.05$, one study, GRADE very low). Lower incisor inclination was significantly reduced in skeletally anchored Herbst (pooled MD = −4.85 degrees favouring TADs group, 95% CI from −6.97 to −2.73; $p < 0.00001$, $I^2 = 28\%$, five studies, GRADE low) (Figure 1).

A meta-analysis for Forsus appliance (Forsus Fatigue Resistant Device) with and without skeletal anchorage was performed based on the systematic review of Liu et al., 2021 [45] as heterogeneity through I^2 was not assessed (Figure 2). This meta-analysis reported that total mandibular length was significantly increased in Forsus with skeletal anchorage compared to the traditional tooth-anchored Forsus (pooled MD = +1.63 mm favouring TADs group, 95% CI from 0.46 to 2.80; $p = 0.006$, $I^2 = 83\%$, five studies, GRADE very low). SNB angle showed an increase in TADs group compared to the Forsus group; however, this increase was non-statistically significant (pooled MD = +0.58 degrees favouring TADs group, 95% CI from −0.07 to 1.23; $p = 0.08$, $I^2 = 90\%$, six studies, GRADE very low). On the contrary, lower incisor inclination was found statistically significantly reduced in Forsus with a skeletal anchorage (pooled MD = −7.56 degrees favouring TADs group, 95% CI from −11.37 to −3.76; $p < 0.0001$, $I^2 = 91\%$, four studies, GRADE very low) (Figure 2).

A meta-analysis of RCTs studies only was performed from the systematic review of Huang et al., 2021 [29], as some information was unreadable (e.g., the P values) (Figure 3). In this meta-analysis, Co-Gn showed no statistically significant increase at the end of treatment in the skeletally anchored group (pooled MD = +1.37 mm, 95% CI from −0.88 to 3.62; $p = 0.23$, $I^2 = 96\%$, three studies, GRADE low). No statistically significant differences between the two groups were identified for SNB angle (pooled MD = +0.31 degrees, 95% CI from −0.03 to 0.66; $p = 0.08$, $I^2 = 51\%$, three studies, GRADE low). Lower incisor inclination was significantly reduced in the TADs group compared to the control group (pooled MD = −5.03 degrees, 95% CI from −8.49 to −1.58; $p = 0.004$, $I^2 = 89\%$, four studies, GRADE low).

With regard to complications, the meta-analysis of all articles included in systematic reviews showed a higher rate of complications in the TADs group compared to the control group, with an almost 30% percentage in the TADs group compared to 3.9% in the control group (pooled risk ratio, RR = 4.28 favouring the TADs group, 95% CI from 2.01 to 9.13; $p = 0.0002$, $I^2 = 0\%$, nine studies, GRADE low) (Figure 4).

3.6 | Certainty Level

The summary of Findings Table (SoF) for GRADE statement is presented in Table 2. The certainty of evidence for all the findings was low or very low. The evidence was downgraded mainly for the lack of randomised trials, high risk of bias or high heterogeneity.

4 | Discussion

In this systematic review of systematic reviews, skeletal and dental variables and complications were assessed to compare the effectiveness of fixed functional appliances with and without a skeletal anchorage in growing patients with Class II malocclusion.

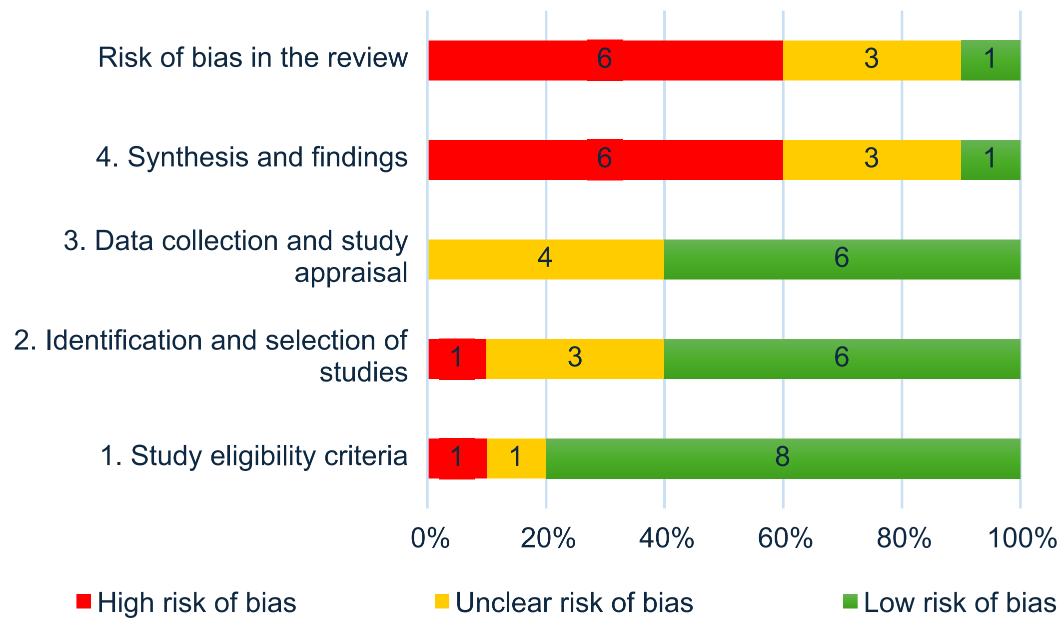
Over the past two decades, the number of systematic reviews indexed in MEDLINE has increased by more than 3000%, rising from 264 in the year 2000 to 8425 in 2020 [50].

In recent years, a substantial number of systematic reviews have been published on the topic of skeletal anchorage. Indeed, the

TABLE 1 | Risk of bias of multiple systematic reviews according to the ROBIS tool (A). Graphical presentation for ROBIS results (B).

A	Systematic review	First author nationality	Setting	Domain 1 study eligibility criteria	Domain 2 identification and selection of studies	Domain 3 data collection and study appraisal	Domain 4 synthesis and findings	Overall risk of bias
1	Al-Dboush et al., 2022	Jordanian	Public	Low	High	Low	High	High
2	Arvind & Jain, 2021	Indian	Public	Low	Unclear	Unclear	High	High
3	Bakdach & Hadad, 2021	Syrian	Public	Low	Low	Low	High	High
4	Eissa et al., 2024	Egyptian	Public	Low	Unclear	Low	High	High
5	Elkordy et al., 2016	Egyptian	Public	Low	Low	Unclear	Unclear	Unclear
6	Huang et al., 2021	Chinese	Public	Low	Low	Low	Low	Low
7	Liu et al., 2021	Chinese	Public	Unclear	Low	Unclear	Unclear	Unclear
8	Muley et al., 2023	Indian	Public	High	Low	Unclear	High	High
9	Rajamanickam & Sundari, 2023	Indian	Public	Low	Unclear	Low	Unclear	Unclear
10	Xiang et al., 2021	Chinese	Public	Low	Low	Low	High	High

B



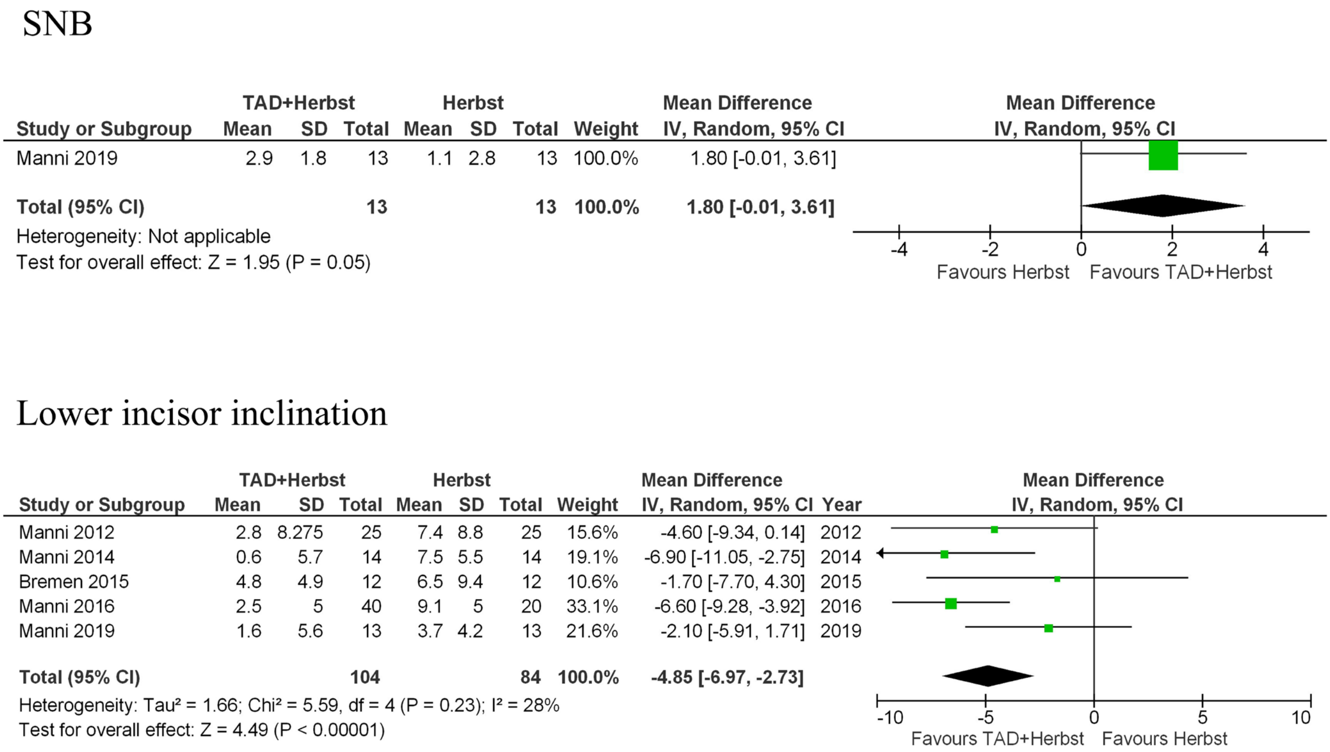


FIGURE 1 | Meta-analysis for Herbst appliance.

majority of the systematic reviews that have been included in the present review have been published within the last 4 years [19, 27–30, 43, 45, 46].

In this study, meta-analyses were repeated separately rather than reporting the results of the meta-analysis reported in the original reviews, as published systematic reviews often presented inappropriate statistical models or lack some information [51].

4.1 | Summary of the Main Results

Some systematic reviews included both Forsus and Herbst appliances [29, 30, 44, 46]. In order to address the appliance heterogeneity in the existing studies, which influences the reported outcomes, we performed distinct meta-analyses for Forsus and Herbst appliances.

In this overview, the meta-analysis for Herbst appliance showed that there was very low evidence that skeletal anchorage may produce a greater mandibular protrusion assessed through SNB angle (mean difference +1.80 degrees). However, this finding was not clinically significant. Lower incisor inclination was significantly reduced (by almost 5 degrees) in the group with skeletally anchored Herbst.

Herbst appliances can have different configurations, which may lead to different clinical results. In particular, the Herbst with total acrylic splint proved to be more effective in controlling the inclination of the lower incisors than the reduced acrylic splint [52] and that acrylic splint Herbst can better control the flaring of the lower incisors [53]. The studies included in systematic reviews comprised both cast Herbst appliances and acrylic splint appliances. However, no review to date has specifically investigated the differences between the various types of Herbst appliances and skeletally anchored Herbst appliances. The biomechanical differences between Forsus and Herbst appliances (semi-rigid versus rigid construction) result in distinct skeletal and dentoalveolar responses. Pooling these appliances within the same analysis, as in most existing reviews, likely contributes to outcome heterogeneity and limits interpretability. Future studies should assess these appliances separately, considering their mechanical behaviour and anchorage configuration.

The meta-analysis on the Forsus appliance demonstrated statistically significant evidence of a greater increase in total mandibular length when the appliance was used in combination with temporary anchorage devices (TADs). However, this increase was not clinically significant (+1.63 mm) and the certainty of evidence for this outcome was very low. Additionally, skeletally anchored Forsus did not show a significantly greater mandibular protrusion (mean difference +0.58 degrees). The indirect anchorage provided by the miniscrew-anchored Forsus appeared to be insufficient to stimulate mandibular growth, particularly due to the risk of bending the wire connecting the lower arch to the miniscrew. This deformation, caused either by functional activities or the force exerted by the appliance itself, may compromise anchorage [43]. On the contrary, a greater reduction in lower incisor inclination was found (−7.56 degrees). This is consistent with all meta-analyses of included systematic reviews of Forsus appliance which reported a heterogeneous but still negative value (−1.8 to −7.6 degrees). The question therefore arises as to why a reduction in lower incisor inclination does not lead to enhanced results from a skeletal point of view. This effect might be attributed to the flexible mandibular positioning that semi-rigid functional appliances provide [43].

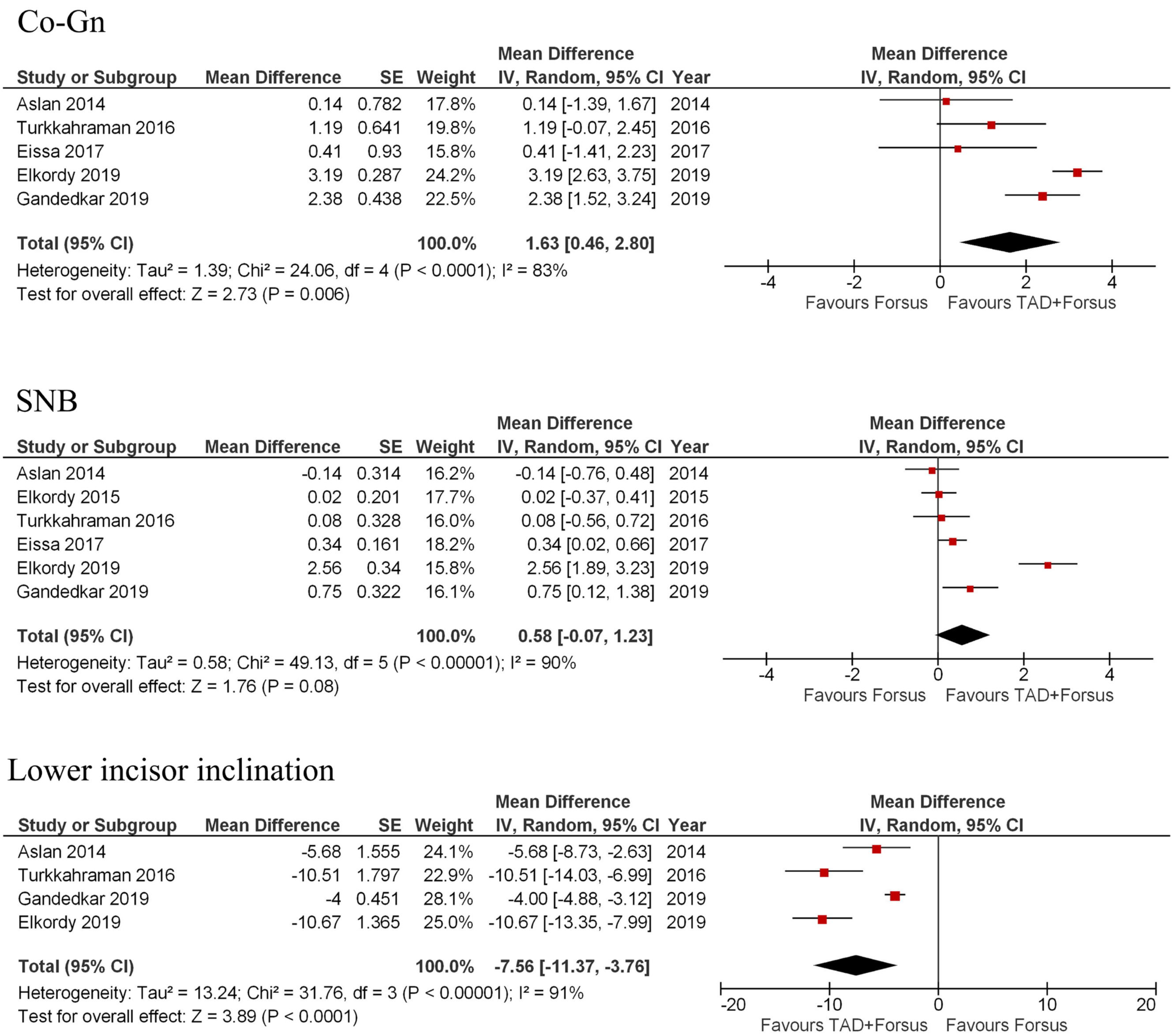


FIGURE 2 | Meta-analysis for Forsus appliance.

In meta-analyses including only randomised controlled trials, no statistically significant differences in Co-Gn length or SNB angle were found between the two treatment approaches. Conversely, a statistically significant reduction in lower incisor inclination was observed (−5.03 degrees). The certainty of evidence for Co-Gn, SNB and lower incisor inclination values, however, was rated as low. A lack of mandibular increases could be due to the short-term observational period, as treatment with fixed functional appliances ranged from 4.8 to 6.5 months in RCTs studies. This period may not be enough to produce an effective stimulation of mandibular growth [28]. Although the biomechanical rationale for skeletal anchorage in FFAs is compelling—by theoretically transferring forces directly to bone and minimising dentoalveolar side effects [28]—the clinical outcomes identified in this review remain modest. The limited skeletal improvements observed, despite consistent control of lower incisor proclination, indicate that anchorage reinforcement alone may not substantially enhance mandibular growth. To provide a robust evaluation of these findings, it is important to consider the paucity of existing RCTs included and the low certainty of the evidence of these assertions.

Complications were evaluated in nine articles included in the systematic reviews, eight of which involved miniscrews as skeletal anchorage, while one study utilised miniplates. These complications were statistically increased in the miniscrews and miniplates group compared to the control group. The complication rate in the TAD group (30%) was higher than that reported in the literature [52], possibly due to the inclusion of additional related issues, such as appliance breakage.

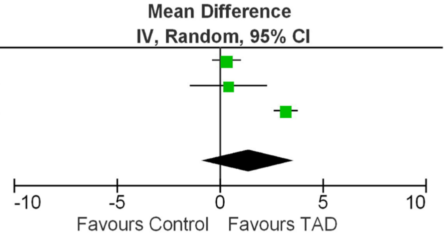
4.2 | Miniscrews or Miniplates as Skeletal Anchorage

An important clinical consideration is whether the use of miniscrews versus miniplates can influence the skeletal and dentoalveolar effects of FFAs.

Co-Gn

Study or Subgroup	TAD Mean	TAD SD	TAD Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI	Year
Elkordy 2015	1.18	0.9	15	0.86	0.98	16	35.2%	0.32 [-0.34, 0.98]	2015
Eissa 2017	1.02	2.258	15	0.61	2.74	14	29.2%	0.41 [-1.42, 2.24]	2017
Elkordy 2019	4.05	0.78	16	0.86	0.79	16	35.6%	3.19 [2.65, 3.73]	2019
Total (95% CI)			**46**			**46**	**100.0%**	**1.37 [-0.88, 3.62]**	

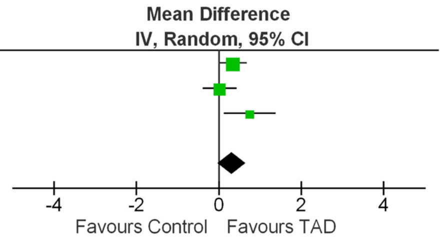
Heterogeneity: Tau² = 3.63; Chi² = 45.97, df = 2 (P < 0.00001); I² = 96%
Test for overall effect: Z = 1.19 (P = 0.23)



SNB

Study or Subgroup	TAD Mean	TAD SD	TAD Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI	Year
Elkordy 2015	0.69	0.41	15	0.35	0.48	16	42.7%	0.34 [0.03, 0.65]	2015
Eissa 2017	0.17	0.593	15	0.15	0.48	14	35.7%	0.02 [-0.37, 0.41]	2017
Elkordy 2019	0.97	1.06	16	0.22	0.66	16	21.6%	0.75 [0.14, 1.36]	2019
Total (95% CI)			**46**			**46**	**100.0%**	**0.31 [-0.03, 0.66]**	

Heterogeneity: Tau² = 0.05; Chi² = 4.10, df = 2 (P = 0.13); I² = 51%
Test for overall effect: Z = 1.78 (P = 0.08)



Lower incisor inclination

Study or Subgroup	TAD Mean	TAD SD	TAD Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI	Year
Manni 2012	2.9	3.98	25	7.4	3.31	25	25.6%	-4.50 [-6.53, -2.47]	2012
Elkordy 2015	5.26	2.71	15	9.05	2.91	16	25.7%	-3.79 [-5.77, -1.81]	2015
Eissa 2017	4.7	4.047	15	6	2.96	14	24.3%	-1.30 [-3.87, 1.27]	2017
Elkordy 2019	-1.49	4.7	16	9.17	2.42	16	24.3%	-10.66 [-13.25, -8.07]	2019
Total (95% CI)			**71**			**71**	**100.0%**	**-5.03 [-8.49, -1.58]**	

Heterogeneity: Tau² = 11.03; Chi² = 27.88, df = 3 (P < 0.00001); I² = 89%
Test for overall effect: Z = 2.86 (P = 0.004)

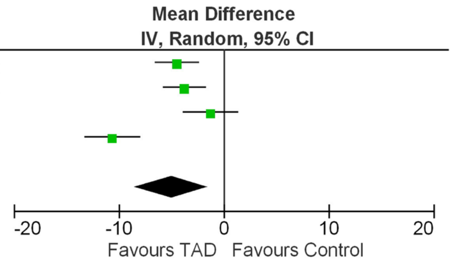


FIGURE 3 | Meta-analysis for RCT studies.

The majority of the systematic reviews (80%) included in this study [20, 28, 39, 41–45] analysed studies that employed both miniscrews and miniplates as skeletal anchorage. Two additional reviews [27, 40] focused exclusively on studies using miniscrews. In the studies included in the reviews, the miniplates were placed bilaterally at the mandibular symphysis and utilised a direct anchorage system [44, 48, 54–56].

Most of the studies included in systematic reviews that assessed the effect of using skeletally anchored FFA used two mandibular TADs to reinforce the anchorage in the lower arch. The miniscrews of FFA with skeletal anchorage were used as indirect anchorage and positioned between the lower first and second premolars, or between the lower canine and first premolar, or between the lower second premolar and the first molar.

Only one study incorporated four miniscrews, two miniscrews in the upper arch and two in the lower arch [49]. Findings from this pilot study suggested that the use of two miniscrews in the upper arch may help limit anchorage loss of the maxillary molars and was associated with a greater mandibular bone base length compared to studies using only two miniscrews in the lower arch [49]. However, further RCTs should be performed in order to provide a solid clinical indication and the selection of the most appropriate procedure.

In all studies included in the systematic reviews, miniscrews were used with an indirect anchorage system involving a metallic ligature to the stainless-steel archwire. One study [55] compared this approach with a system using an elastic chain. An acrylic splint Herbst appliance combined with miniscrews and elastic chain ligation was found to exert an active force that provided improved control of mandibular incisor inclination and resulted in a greater skeletal effect compared to the same appliance anchored with TADs and metallic ligatures [57].

The stability of different skeletal anchorage systems should also be taken into consideration [45]. Miniplates have been shown to provide stable anchorage when assessed using bone markers in superimposition analyses [56], whereas miniscrews

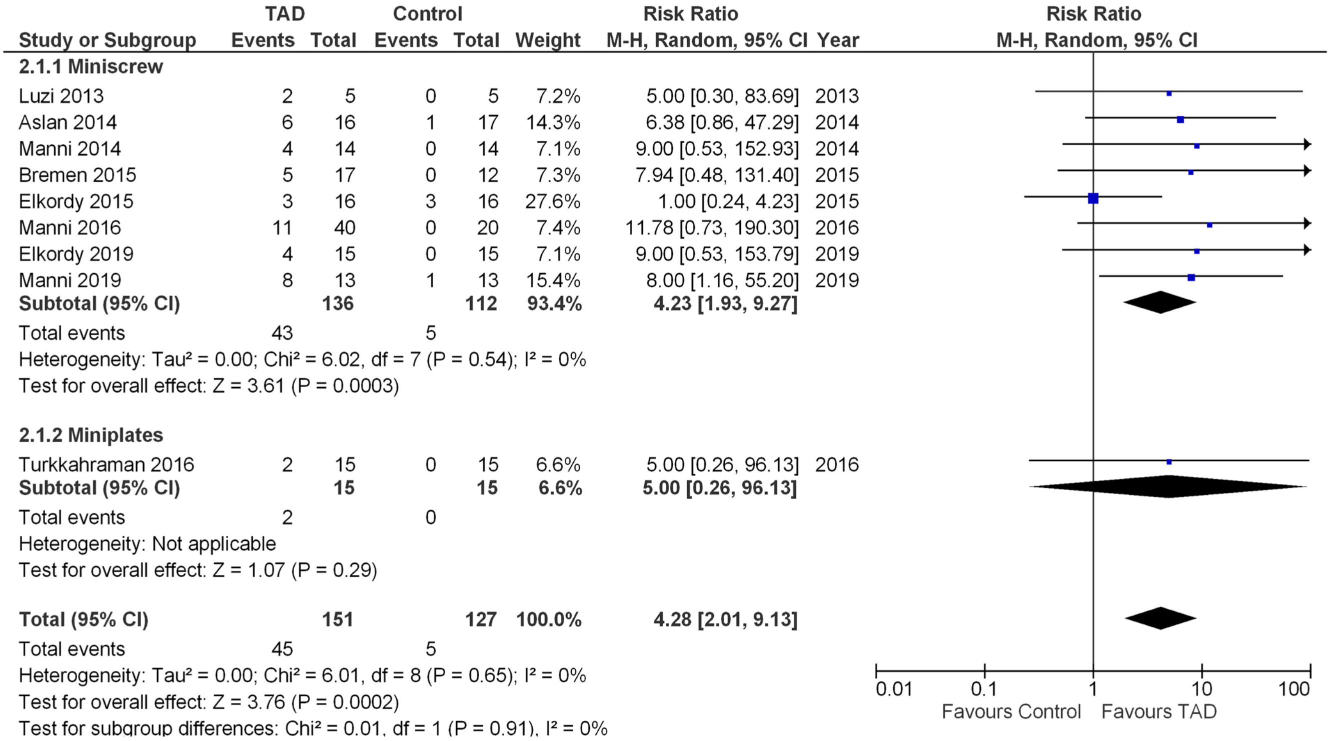


FIGURE 4 | Meta-analysis for complications.

demonstrated slight forward movement and a degree of tipping (2.6° ± 6.2°) under orthodontic loading [57]. Two systematic reviews reported that the use of miniplates offers greater potential for preventing lower incisor proclination compared to fixed functional appliances (FFAs) anchored with miniscrews [39, 42], and may even allow for retraction of the mandibular incisors [28]. One review [20] emphasised that direct anchorage with miniplates resulted in clinically more significant differences in incisor inclination compared to the indirect anchorage provided by miniscrews [19].

A systematic review by Xiang and colleagues [47] also concluded that miniplates appeared to be more efficacious in enhancing mandibular skeletal effects of FFA than miniscrews. However, no meta-analysis was performed in this review. Moreover, the existing systematic reviews consistently utilised the same original studies.

Taken together, these systematic reviews suggest that the direct anchorage system provided by symphyseal miniplates may be more effective in controlling lower incisor position compared to miniscrews.

4.3 | Quality of the Evidence, Advantages and Potential Biases in the Review Process

The presence of a considerable risk of bias is a significant concern, particularly given that a substantial proportion of the systematic reviews included in this analysis exhibit a high risk of bias.

None of the systematic reviews included only randomised controlled trials (RCTs) in their analysis.

We conducted a meta-analysis of RCTs only, that revealed a lack of statistical significance in relation to mandibular measurements (mandibular total length increase and mandibular protrusion) between FFAs with and without skeletal anchorage. However, a non-significant increase in total mandibular length was observed in the group treated with FFAs with skeletal anchorage (average difference of 1.37 mm).

The inclusion of patients from different age groups in individual studies limits the generalizability of the results, as only a few studies employed a reliable method for assessing skeletal maturation. Therefore, the term 'growing patient', used in the inclusion criteria of the reviews, should be validated through an appropriate maturational assessment.

A very high degree of overlap was observed among the included systematic reviews (CCA = 30%), indicating that several primary studies were shared across multiple reviews. Such overlap may have led to partial duplication of evidence and could reduce the independence of the pooled data. This limitation, which is common in umbrella reviews of clinical orthodontic interventions, highlights the need for cautious interpretation of aggregated outcomes. Future systematic reviews should include more details on the search strategy used and the sources of funding for the studies, as well as studies free of publication bias.

The use of different skeletal anchorage sites represents an additional factor that may influence treatment outcomes. However, systematic reviews have not thoroughly analysed or distinguished between the anchorage sites.

This review of systematic reviews offers several advantages but also presents certain limitations, particularly the exclusion of features not examined in the included reviews. To address this,

TABLE 2 | Summary of Findings Table (SoF) for GRADE statement.

	Outcomes	Mean difference (MD) or risk ratio (RR) (95% CI)	Number of participants (studies)	Certainty of evidence (GRADE)	Key messages in simple terms
Herbst	• SNB	1.80 [−0.01 to 3.61] (MD)	26 subjects (1 CCT)	⊕○○○[a] Very Low	There is very low evidence that Herbst appliance with skeletal anchorage results in a greater increment in SNB angle after treatment compared to traditional dental-anchored Herbst.
	• Lower incisor inclination	−4.85 [−6.97 to −2.73] (MD)	188 subjects (1 RCT; 4 CCTs)	⊕⊕○○[b] Low	There is low evidence that the use of a skeletal anchorage in Herbst treatment is associated with less proclination of the lower incisors compared to traditional Herbst.
Forsus	• Co-Gn	1.63 [0.46 to 2.80] (MD)	140 subjects (2 CCTs and 3 RCTs)	⊕○○○[c] Very Low	There is very low evidence that the use of a skeletal anchorage in Forsus appliance is associated with increment in total mandibular length compared to traditional Herbst.
	• SNB	0.58 [−0.07 to 1.23] (MD)	171 subjects (2 CCTs; 4 RCTs)	⊕○○○[c] Very Low	There is probably no difference between skeletal and dental anchorage in the treatment with Forsus appliances in SNB changes.
	• Lower incisor inclination	−7.56 [−11.37 to −3.76] (MD)	111 subjects (2 CCTs; 2 RCTs)	⊕○○○[c] Very Low	There is very low evidence in lower incisor inclination difference between skeletal and dental anchored Forsus
RCTs only	• Co-Gn	1.37 [−0.88 to 3.62] (MD)	92 subjects (3 RCTs)	⊕⊕○○[d] Low	There is low evidence that functional appliances with skeletal anchorage resulted in a greater increment in total mandibular length after treatment compared to traditional functional appliances.
	• SNB	0.31 [−0.03 to 0.66] (MD)	92 subjects (3 RCTs)	⊕⊕○○[d] Low	There is probably no difference between skeletal and dental anchorage in the treatment with functional appliances in SNB changes.
	• Lower incisor inclination	−5.03 [−8.49 to −1.58] (MD)	142 subjects (4 RCTs)	⊕⊕○○[d] Low	There is low evidence of a reduction of lower incisor inclination in skeletal anchorage group compared to the dental-anchored group.
Complications		4.28 [2.01 to 9.13] (RR)	278 subjects (3 RCTs, 6 CCTs)	⊕⊕○○[b] Low	There is low evidence of more complications at the end of treatment with skeletally anchored functional appliance.

Note: Participants: growing patients with a Class II malocclusion with mandibular retrusion. Intervention: treatment with fixed functional appliances with a skeletal anchorage. Comparison: treatment with fixed functional appliances with a traditional dental anchorage. Outcome: Co-Gn, SNB angle, mandibular incisor inclination, complications. Study: RCTs and CCTs included in systematic reviews. GRADE: Evidence grades. Grading of Recommendations Assessment, Development and Evaluation.
Abbreviations: 95% CI, 95% confidence interval; CCT, controlled clinical trial; RCT, randomised clinical trial.
[a]Downgraded by 3 for nonrandomization, one point less for risk of bias and one point less as one study included.
[b]Downgraded by 2 for nonrandomization, one point less for risk of bias.
[c]Downgraded by 3 for nonrandomization, one point less for risk of bias and one point less for high heterogeneity.
[d]Downgraded by 2 for risk of bias, one point less for high heterogeneity.

we conducted an analysis of the original studies included to obtain additional information on the number of complications associated with each treatment approach.

Several methodological limitations of the underlying randomised controlled trials (RCTs) likely contribute to the inconclusive findings. Most trials are small, short-term and heterogeneous in terms of appliance design, skeletal maturity and anchorage configuration. Observation periods of approximately 5–6 months are insufficient to capture growth-related skeletal changes, particularly in late-pubertal or post-pubertal subjects. Moreover, many RCTs rely on two-dimensional cephalometric outcomes such as SNB and Co-Gn length, which lack sensitivity to detect subtle remodelling at the condyle or glenoid fossa. Few studies include three-dimensional assessments or standardised maturation indicators, making cross-study comparisons unreliable.

Another major limitation is the variability and fragility of skeletal anchorage systems themselves. Miniscrews used as indirect anchorage can bend or loosen under functional loading, partially dissipating the force vectors intended for mandibular advancement. Miniplates, while more stable, require surgical placement and are used in small, heterogeneous samples. The inconsistent reporting of anchorage site, insertion torque and healing time further limits the reproducibility of outcomes. Operator-dependent factors such as torque application, oral-hygiene control and biomechanical setup may also confound results but are rarely standardised or blinded in clinical trials.

The overall low certainty of evidence observed across outcomes is therefore unsurprising. Many of the systematic reviews included in this umbrella review suffer from overlapping primary studies, small sample sizes and unclear risk of bias, conditions that amplify uncertainty in pooled estimates.

4.4 | Implication for Practice

From systematic reviews included, it emerged that both FFAs, with and without skeletal anchorage, were effective in correcting Class II dental malocclusion.

Low evidence from RCTs studies showed that FFAs with skeletal anchorage can be useful to control the dento-alveolar side effects as the proclination of the lower incisors. Reduction of the lower incisor proclination is essential to benefit periodontal health, avoiding fenestration, dehiscence and gingival recession, particularly in patients with a thin gingival or alveolar phenotype [29, 58, 59]. Therefore, the ability of skeletal anchorage to better control incisor inclination could be clinically meaningful in protecting periodontal health, especially in patients who present with pre-existing incisor proclination [28], reduced alveolar bone thickness, or a thin periodontal biotype. In such cases, minimising further proclination may prevent soft-tissue complications and preserve long-term gingival stability. However, these potential benefits must be weighed against the higher complication rate associated with skeletal anchorage, such as screw loosening, soft-tissue inflammation, or the need for minor surgical procedures, which may limit its routine indication. Identifying patient subgroups who would most benefit from skeletal anchorage, and quantifying the periodontal advantages in long-term follow-up studies, should be key priorities for future clinical research.

Confounding factors, such as operator bias and preference, were included in non-RCTs when a fixed appliance was used with a FFA [19]. Furthermore, factors such as the type and position of skeletal anchorage, along with patient compliance (particularly with oral hygiene), can significantly influence the final treatment outcome. Additional limitations associated with skeletally anchored fixed functional appliances (FFAs) include the need for at least two surgical procedures for miniplate insertion and removal, and a higher risk of complications, whether using miniscrews or miniplates, especially in patients with poor oral hygiene [39]. Finally, the increased cost of these procedures may further limit their clinical applicability [39].

4.5 | Implication for Research

Given the paucity of well-structured studies, there is a need for a greater number of randomised controlled trials to provide a more comprehensive evaluation of fixed functional appliances (FFAs) with and without skeletal anchorage. In particular, further studies comparing miniplate and miniscrew anchorage in the lower arch should be conducted to determine whether miniplates offer superior outcomes. These trials should also place greater emphasis on patient-related factors, especially discomfort and complications. Moreover, patient characteristics such as gender and skeletal maturation stage should be better standardised to improve the comparability and clinical relevance of future research.

Future high-quality randomised controlled trials with longer treatment durations are essential to better elucidate the true skeletal potential of FFAs with and without skeletal anchorage. Particular attention should be given to more rigid appliance designs that prevent the condyles from sliding posteriorly into the glenoid fossae during mouth closure, as such devices may enhance mandibular remodelling and favour more stable skeletal advancement. Moreover, long-term follow-up studies are needed to evaluate the post-treatment stability of these effects, since most of the current evidence is based on short-term outcomes. These studies could specify if an extended treatment time and more stable mandibular positioning could reveal more clinically relevant skeletal improvements than those observed in existing short-duration trials.

5 | Conclusions

The published SRs on the effects of FFAs with and without skeletal anchorage generally exhibited poor methodological quality, with most showing high or unclear risk of bias. Only one SR demonstrated better methodological rigour, reporting a low risk of bias. In terms of skeletal effects, the miniscrew-anchored Herbst appliance was associated with greater mandibular protrusion compared to the tooth-anchored Herbst appliance. Similarly, the skeletally-anchored Forsus appliance showed a significantly greater increase in total mandibular length than the Forsus with dental anchorage. However, despite statistical significance, these differences were not clinically relevant. Additionally, a meta-analysis limited to

RCTs found no statistical superiority of skeletal anchorage combined with FFAs in producing additional skeletal effects.

FFA with skeletal anchorage presented a statistically significant greater reduction of lower incisor inclination compared to traditional tooth-anchored FFA. This element is of particular significance in the management of patients who exhibit a proclination of the lower incisors at the start of treatment.

A greater percentage of complications, such as mobility of the miniscrew, failure of the miniscrew and breakage of the appliance, were registered for fixed functional appliances with skeletal anchorage (miniscrews or miniplates).

Given the overall low or very low certainty of the evidence supporting these findings, further high-quality randomised controlled trials are needed to strengthen the conclusions and guide clinical decision-making.

Author Contributions

Conceptualization: L.F. and M.N. Data curation: V.R. and E.V. Methodology: L.F. and M.N. Supervision: V.G. Writing – original draft: V.R. Writing – review and editing: V.R. and L.F.

Acknowledgements

The authors have nothing to report. Open access publishing facilitated by Universita degli Studi di Firenze, as part of the Wiley - CRUI-CARE agreement.

Funding

The authors have nothing to report.

Ethics Statement

The authors have nothing to report.

Consent

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. M. S. Alhammadi, E. Halboub, M. S. Fayed, A. Labib, and C. El-Saaidi, "Global Distribution of Malocclusion Traits: A Systematic Review," *Dental Press Journal of Orthodontics* 23, no. 6 (2018): 40.e10–e41.

2. J. A. McNamara, Jr., J. E. Peterson, Jr., and R. G. Alexander, "Three-Dimensional Diagnosis and Management of Class II Malocclusion in the Mixed Dentition," *Seminars in Orthodontics* 2, no. 2 (1996): 114–137.

3. S. E. Bishara, "Class II Malocclusions: Diagnostic and Clinical Considerations With and Without Treatment," *Seminars in Orthodontics* 12, no. 1 (2006): 11–24.

4. L. W. Graber, K. W. Vig, G. J. Huang, and P. S. Fleming, *Orthodontics: Current Principles and Practice*, 7th ed. (Elsevier, 2023).

5. P. Cozza, T. Baccetti, L. Franchi, L. De Toffol, and J. A. McNamara, Jr., "Mandibular Changes Produced by Functional Appliances in Class II Malocclusion: A Systematic Review," *American Journal of Orthodontics and Dentofacial Orthopedics* 129, no. 5 (2006): 512–599.

6. G. Perinetti, J. Primožič, L. Franchi, and L. Contardo, "Treatment Effects of Removable Functional Appliances in Pre-Pubertal and Pubertal Class II Patients: A Systematic Review and Meta-Analysis of Controlled Studies," *PLoS One* 10, no. 10 (2015): e0141198.

7. G. Perinetti, J. Primožič, G. Furlani, L. Franchi, and L. Contardo, "Treatment Effects of Fixed Functional Appliances Alone or in Combination With Multibracket Appliances: A Systematic Review and Meta-Analysis," *Angle Orthodontist* 85, no. 3 (2015): 480–492.

8. L. G. Santana, K. Avelar, C. Flores-Mir, and L. S. Marques, "Incremental or Maximal Mandibular Advancement in the Treatment of Class II Malocclusion Through Functional Appliances: A Systematic Review With Meta-Analysis," *Orthodontics & Craniofacial Research* 23, no. 4 (2020): 371–384.

9. G. Cacciatore, A. Ugolini, C. Sforza, O. Gbinigie, and A. Plüddemann, "Long-Term Effects of Functional Appliances in Treated Versus Untreated Patients With Class II Malocclusion: A Systematic Review and Meta-Analysis," *PLoS One* 14, no. 9 (2019): e0221624.

10. L. Franchi and T. Baccetti, "Prediction of Individual Mandibular Changes Induced by Functional Jaw Orthopedics Followed by Fixed Appliances in Class II Patients," *Angle Orthodontist* 76, no. 6 (2006): 950–954.

11. A. G. Petrovic, "A Cybernetic Approach to Craniofacial Growth Control Mechanisms," *Nova Acta Leopoldina* 58 (1986): 27–67.

12. A. G. Petrovic, J. Stutzmann, and J. Lavergne, "Mechanism of Craniofacial Growth and Modus Operandi of Functional Appliances: A Cell-Level and Cybernetic Approach to Orthodontic Decision Making," in *Craniofacial Growth Theory and Orthodontic Treatment*, vol. 23 (Vol Craniofacial Growth Monograph Series; Monograph, 1990), 13–74.

13. D. P. Singh and R. Kaur, "Fixed Functional Appliances in Orthodontics—A Review," *Journal of Oral Health and Craniofacial Science* 3 (2018): 1–10.

14. V. Koretsi, V. F. Zymperdikas, S. N. Papageorgiou, and M. A. Papadopoulos, "Treatment Effects of Removable Functional Appliances in Patients With Class II Malocclusion: A Systematic Review and Meta-Analysis," *European Journal of Orthodontics* 37, no. 4 (2014): 418–434.

15. V. Giuntini, J. A. McNamara, and L. Franchi, "Treatment of Class II Malocclusion in the Growing Patient: Early or Late?," *Seminars in Orthodontics* 29, no. 2 (2023): 183–188.

16. M. M. Pacha, P. S. Fleming, and A. Johal, "A Comparison of the Efficacy of Fixed Versus Removable Functional Appliances in Children With Class II Malocclusion: A Systematic Review," *European Journal of Orthodontics* 38, no. 6 (2016): 621–630.

17. Y. Lena, A. P. Bozkurt, and E. Yetkiner, "Patients' and Parents' Perception of Functional Appliances: A Survey Study," *Turkish Journal of Orthodontics* 30, no. 2 (2017): 33–41.

18. T. C. Dandajena, "Hybrid Functional Appliances for Management of Class II Malocclusions," in *Current Therapy in Orthodontics*, ed. R. N. A. S. Kapila (Mosby, 2010), 103–114.

19. P. T. Arvind and R. K. Jain, "Skeletally Anchored Forsus Fatigue Resistant Device for Correction of Class II Malocclusions—A Systematic Review and Meta-Analysis," *Orthodontics & Craniofacial Research* 24, no. 1 (2021): 52–61.

20. H. Pancherz and K. Hansen, "Mandibular Anchorage in Herbst Treatment," *European Journal of Orthodontics* 10, no. 2 (1988): 149–164.

21. A. Manni, S. Mutinelli, C. Cerruto, and M. Cozzani, "Influence of incisor position control on the mandibular response in growing patients

with skeletal Class II malocclusion," *American Journal of Orthodontics and Dentofacial Orthopedics* 159, no. 5 (2021): 594–603.

22. V. F. Zymperdikas, V. Koretsi, S. N. Papageorgiou, and M. A. Papadopoulos, "Treatment Effects of Fixed Functional Appliances in Patients With Class II Malocclusion: A Systematic Review and Meta-Analysis," *European Journal of Orthodontics* 38, no. 2 (2016): 113–126.

23. G. Cacciatore, L. Alvetro, E. Defraia, L. T. Ghislanzoni, and L. Franchi, "Active-Treatment Effects of the Forsus Fatigue Resistant Device During Comprehensive Class II Correction in Growing Patients," *Korean Journal of Orthodontics* 44, no. 3 (2014): 136–142.

24. L. Franchi, L. Alvetro, V. Giuntini, C. Masucci, E. Defraia, and T. Baccetti, "Effectiveness of Comprehensive Fixed Appliance Treatment Used With the Forsus Fatigue Resistant Device in Class II Patients," *Angle Orthodontist* 81, no. 4 (2011): 678–683.

25. T. Unal, M. Celikoglu, and C. Candirli, "Evaluation of the Effects of Skeletal Anchoraged Forsus FRD Using Miniplates Inserted on Mandibular Symphysis: A New Approach for the Treatment of Class II Malocclusion," *Angle Orthodontist* 85, no. 3 (2015): 413–419.

26. M. Celikoglu, S. K. Buyuk, A. Ekizer, and T. Unal, "Treatment Effects of Skeletally Anchored Forsus FRD EZ and Herbst Appliances: A Retrospective Clinical Study," *Angle Orthodontist* 86, no. 2 (2016): 306–314.

27. R. Al-Dboush, R. Soltan, J. Rao, and T. El-Bialy, "Skeletal and Dental Effects of Herbst Appliance Anchored With Temporary Anchorage Devices: A Systematic Review With Meta-Analysis," *Orthodontics & Craniofacial Research* 25, no. 1 (2022): 31–48.

28. O. Eissa, S. Diar-Bakirly, H. Saltaji, and T. El-Bialy, "Skeletal and Dental Effects of Skeletally Anchored Forsus Fatigue Resistant Devices During Class II Malocclusion Treatment: A Meta-Analysis and Systematic Review," *Journal of Orthodontic Science* 13 (2024): 54.

29. Y. Huang, W. Sun, X. Xiong, Z. Zhang, J. Liu, and J. Wang, "Effects of Fixed Functional Appliances With Temporary Anchorage Devices on Class II Malocclusion: A Systematic Review and Meta-Analysis," *Journal of the World Federation of Orthodontists* 10, no. 2 (2021): 59–69.

30. P. Rajamanickam and K. K. S. Sundari, "Fixed Functional Appliance Therapy With and Without Skeletal Anchorage in Class II Malocclusion: A Systematic Review of Randomized Controlled Trials," *Journal of Advanced Oral Research* 14, no. 2 (2023): 101–109.

31. M. Gates, A. Gates, D. Pieper, et al., "Reporting Guideline for Overviews of Reviews of Healthcare Interventions: Development of the PRIOR Statement," *BMJ* 378 (2022): e070849.

32. E. Aromataris, R. Fernandez, C. M. Godfrey, C. Holly, H. Khalil, and P. Tungpunkom, "Summarizing Systematic Reviews: Methodological Development, Conduct and Reporting of an Umbrella Review Approach," *International Journal of Evidence-Based Healthcare* 13, no. 3 (2015): 132–140.

33. M. J. Page, J. E. McKenzie, P. M. Bossuyt, et al., "The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews," *BMJ (Clinical Research Ed.)* 372 (2021): n71.

34. D. Pieper, S. L. Antoine, T. Mathes, E. A. Neugebauer, and M. Eikermann, "Systematic Review Finds Overlapping Reviews Were Not Mentioned in Every Other Overview," *Journal of Clinical Epidemiology* 67, no. 4 (2014): 368–375.

35. P. Whiting, J. Savović, J. P. Higgins, et al., "ROBIS: A New Tool to Assess Risk of Bias in Systematic Reviews Was Developed," *Journal of Clinical Epidemiology* 69 (2016): 225–234.

36. M. Kirmayr, C. Quilodrán, B. Valente, C. Loezar, L. Garegnani, and J. V. A. Franco, "The GRADE Approach, Part 1: How to Assess the Certainty of the Evidence," *Medwave* 21, no. 2 (2021): e8109.

37. C. Quilodrán, M. Kirmayr, B. Valente, J. Pérez-Bracchiglione, L. Garegnani, and J. V. A. Franco, "The GRADE Approach, Part 2: Evidence to Decision Frameworksoutlining Decision-Making in Health," *Medwave* 21, no. 4 (2021): e8182.

38. G. H. Guyatt, A. D. Oxman, G. Vist, et al., "GRADE Guidelines: 4. Rating the Quality of Evidence—Study Limitations (Risk of Bias)," *Journal of Clinical Epidemiology* 64, no. 4 (2011): 407–415.

39. G. H. Guyatt, A. D. Oxman, R. Kunz, et al., "GRADE Guidelines: 7. Rating the Quality of Evidence—Inconsistency," *Journal of Clinical Epidemiology* 64, no. 12 (2011): 1294–1302.

40. G. H. Guyatt, A. D. Oxman, R. Kunz, et al., "GRADE Guidelines: 8. Rating the Quality of Evidence—Indirectness," *Journal of Clinical Epidemiology* 64, no. 12 (2011): 1303–1310.

41. G. H. Guyatt, A. D. Oxman, R. Kunz, et al., "GRADE Guidelines 6. Rating the Quality of Evidence—Imprecision," *Journal of Clinical Epidemiology* 64, no. 12 (2011): 1283–1293.

42. G. H. Guyatt, A. D. Oxman, V. Montori, et al., "GRADE Guidelines: 5. Rating the Quality of Evidence—Publication Bias," *Journal of Clinical Epidemiology* 64, no. 12 (2011): 1277–1282.

43. W. M. M. Bakdach and R. Hadad, "Is There Any Enhanced Treatment Effect on Class II Growing Patients When Forsus Fatigue Resistant Device Is Reinforced by Either Miniplates or Miniscrews? A Systematic Review and Meta-Analysis," *International Orthodontics* 19, no. 1 (2021): 15–24.

44. S. A. Elkordy, A. A. Aboelnaga, M. M. Fayed, M. H. AboulFotouh, and A. M. Abouelezz, "Can the Use of Skeletal Anchors in Conjunction With Fixed Functional Appliances Promote Skeletal Changes? A Systematic Review and Meta-Analysis," *European Journal of Orthodontics* 38, no. 5 (2016): 532–545.

45. L. Liu, Q. Zhan, J. Zhou, et al., "A Comparison of the Effects of Forsus Appliances With and Without Temporary Anchorage Devices for Skeletal Class II Malocclusion," *Angle Orthodontist* 91, no. 2 (2021): 255–266.

46. A. Muley, S. Chavan, W. Bhad, S. Shekokar, and D. Khade, "Effects of Skeletal Anchorage on Mandibular Rotation With Fixed Functional Appliance Therapy in Class II Malocclusion Patients – A Systematic Review and Meta-Analysis," *APOS Trends in Orthodontics* 13 (2023): 1–8.

47. J. Xiang, Y. Yin, Z. Gan, S. Shim, and L. Zhao, "Mandibular Effects of Temporary Anchorage Devices in Class II Patients Treated With Forsus Fatigue Resistant Devices: A Systematic Review," *Australasian Orthodontic Journal* 37, no. 1 (2021): 50–61.

48. H. Turkkahraman, S. K. Eliacik, and Y. Findik, "Effects of Miniplate Anchored and Conventional Forsus Fatigue Resistant Devices in the Treatment of Class II Malocclusion," *Angle Orthodontist* 86, no. 6 (2016): 1026–1032.

49. A. Manni, M. Migliorati, C. Calzolari, and A. Silvestrini-Biavati, "Herbst appliance anchored to miniscrews in the upper and lower arches vs standard Herbst: A pilot study," *American Journal of Orthodontics and Dentofacial Orthopedics* 156, no. 5 (2019): 617–625.

50. K. Slim and T. Marquillier, "Umbrella Reviews: A New Tool to Synthesize Scientific Evidence in Surgery," *Journal of Visceral Surgery* 159, no. 2 (2022): 144–149.

51. L. Belbasis, V. Bellou, and J. P. A. Ioannidis, "Conducting Umbrella Reviews," *BMJ Medicine* 1, no. 1 (2022): e000071.

52. J. Bremen, B. Ludwig, and S. Ruf, "Anchorage Loss due to Herbst Mechanics-Preventable Through Miniscrews?," *European Journal of Orthodontics* 37, no. 5 (2015): 462–466.

53. J. R. Valant and P. M. Sinclair, "Treatment Effects of the Herbst Appliance," *American Journal of Orthodontics and Dentofacial Orthopedics* 95, no. 2 (1989): 138–147.

54. S. A. Elkordy, A. M. Abouelezz, M. M. S. Fayed, M. H. Aboulfotouh, and Y. A. Mostafa, "Evaluation of the Miniplate-Anchored Forsus Fatigue Resistant Device in Skeletal Class II Growing Subjects: A Randomized Controlled Trial," *Angle Orthodontist* 89, no. 3 (2019): 391–403.

55. N. H. Gandedkar, S. Shrikantaiah, A. K. Patil, et al., "Influence of Conventional and Skeletal Anchorage System Supported Fixed

Functional Appliance on Maxillo-Mandibular Complex and Temporomandibular Joint: A Preliminary Comparative Cone Beam Computed Tomography Study," *International Orthodontics* 17, no. 2 (2019): 256–268.

56. S. A. Elkordy, M. M. Fayed, A. M. Abouelezz, and K. H. Attia, "Comparison of Patient Acceptance of the Forsus Fatigue Resistant Device With and Without Mini-Implant Anchorage: A Randomized Controlled Trial," *American Journal of Orthodontics and Dentofacial Orthopedics* 148, no. 5 (2015): 755–764.

57. A. Manni, S. Mutinelli, M. Pasini, L. Mazzotta, and M. Cozzani, "Herbst appliance anchored to miniscrews with 2 types of ligation: Effectiveness in skeletal Class II treatment," *American Journal of Orthodontics and Dentofacial Orthopedics* 149, no. 6 (2016): 871–880.

58. D. Ciavarella, M. Tepedino, C. Gallo, et al., "Post-Orthodontic Position of Lower Incisors and Gingival Recession: A Retrospective Study," *Journal of Clinical and Experimental Dentistry* 9, no. 12 (2017): e1425–e1430.

59. E. Kalina, A. Grzebyta, and M. Zadurska, "Bone Remodeling During Orthodontic Movement of Lower Incisors—Narrative Review," *International Journal of Environmental Research and Public Health* 19, no. 22 (2022): 15002.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Figure S1:** PRISMA 2020 flow diagram. **Table S1:** Inclusion and exclusion criteria for systematic review selection (PICOS). **Table S2:** Search strategy. **Table S3:** Excluded articles and reason for exclusion. **Table S4:** Characteristics of included systematic reviews.