Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2025; Vol: 14 Issue 2
Open Access

Comparison of Effect of Twin Block and Fixed Functional Appliances on Lower Incisor Inclination – A Systematic Review

RUNNING TITLE - Twin Block vs Fixed Appliances: Incisor Inclination

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Cite this paper as: Santosh J. Chavan; Suchita Daokar; Wasundhara A. Bhad (Patil); Jyoti Manchanda; Rishika Arya; Priyanka Badu (2025), Comparison of Effect of Twin Block and Fixed Functional Appliances on Lower Incisor Inclination – A Systematic Review. Frontiers in Health Informatics, 14(2) 2836-2851

Abstract

Introduction: Class II malocclusions, prevalent in orthodontic practice, necessitate effective treatment for optimal dental alignment and enhanced facial aesthetics. Functional appliances, either removable or fixed, address these concerns. Patient compliance is crucial and fixed functional appliances reduce this need. However, the literature indicates a notable forward movement of lower incisors in patients treated with both removable and fixed functional appliances. This systematic review aims to compare the impact on lower incisor inclination of twin block and fixed functional appliances.

Materials and Methods: Eligible studies, retrieved from electronic databases and orthodontic journals, underwent a selection process. Inclusion criteria involved participants with skeletal class II malocclusion treated with fixed functional or twin-block appliances in retrospective and prospective studies.

Results: Six studies, five retrospective and one prospective, met the inclusion criteria. The studies compared lower incisor proclination of twin block and various fixed functional appliances such as Forsus, Herbst, and XBow. The risk of bias assessment revealed five studies with low risk and one with high risk due to participant selection bias.

Conclusion: Four out of six studies demonstrated a significant increase in mandibular incisor proclination for twin block as well as fixed functional appliances. However, fixed functional appliances consistently led to a more significant effect.
Keywords: Twin Block, Fixed functional appliance, Lower incisor inclination

Main Points:

- This systematic review aimed to draw comparison between the effect of twin block and fixed functional appliances on lower incisor inclination.
- This systematic review includes six studies, five of which are retrospective and one of which is prospective.
- Of the six studies, risk of bias of 5 studies was found to be low, except one study, in which risk of bias was high due to bias in the selection of participants in the study.
- All studies showed that fixed functional appliances lead to a significant amount of lower incisor proclination in comparison to Twin block.

Introduction

Patients with Class II malocclusion are commonly encountered in an orthodontic clinic, and they can present either skeletal or dental issues, leading to various clinical signs(1). Orthodontics has long aimed achieving a proper dental alignment but also enhancing facial aesthetics. However, this can only be accomplished when the jaw structures are in harmony with each other(2). To attain the aforementioned goal, functional appliances can be put into use(3)(4)(5)(6).

Either removable or fixed functional appliances can be used. Although compliance is an important factor, growth stage and dentition stage remain crucial considerations when planning treatment (7)(8). Typically, removable functional appliances lack tactile sensitivity, and are uncomfortable. They exert pressure on the mucosa, leading to gingivitis, and can result in issues with swallowing, speech, and reduced space for the tongue. These adverse effects collectively make it challenging for patients to adapt to and accept these appliances(9).

This need for compliance is greatly reduced with the use of fixed functional appliances(10). While fixed functional appliances reduce the need for patient cooperation, they are tooth-borne devices. While Twin Block being more tissue-borne, has a higher likelihood of inducing skeletal changes(11).

In the literature, studies consistently reported a notable forward movement of lower incisors in patients treated with twin block(12). This complication is due to the forward pressure on the lower incisors caused by lingual components of the appliance as the mandible attempts to return to its resting posture(13). This increased inclination leads to increase in risk of relapse and periodontal implication.

Pacha et al. (2015)(14) compared fixed and removable functional appliances in Class II malocclusion, while Xu et al. (2024)(15) focused on Twin Block versus Herbst. Both highlighted differences in treatment effects, particularly on lower incisor inclination. However, no review has specifically compared Twin Block with the broader group of fixed functional appliances, which is the focus of the present study.

This systematic review aims to draw comparison between Twin Block and fixed functional appliance in terms of lower incisor proclination.

Materials and methods

Protocol Registration

The systematic review protocol was officially recorded in the PROSPERO International Prospective Register of Systematic Reviews under the registration number CRD42023444955. The review process was conducted following the 2020 guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Eligibility Criteria

Domain	Inclusion Criteria	Exclusion Criteria
Participants	Patients with Skeletal class II malocclusion due to retrognathic mandible	In vitro studies
Intervention	Fixed functional appliance	Case reports using modified or hybrid appliances.
Comparison	Twin block appliance	Other removable functional appliances
Outcome	Lower incisor proclination	
Study design	Retrospective and prospective studies	Case reports and case studies, narrative reviews, cross-sectional studies, expert opinions, conference abstracts.

Information Sources, Search Strategy, and Selection Process

To conduct a systematic review evaluating the impact of twin block and fixed functional appliances on lower incisor inclination, a comprehensive search was carried out across multiple electronic databases, including PubMed, Cochrane Library Central, and Google Scholar, covering publications from January 2000 to June 2023. Additional unpublished studies were identified through ClinicalTrials.gov, while reference lists of pertinent studies, systematic reviews, meta-analyses, and other review articles were also examined to identify eligible studies.

Search Strategy: A detailed search strategy was devised using a combination of relevant keywords and Medical Subject Headings (MeSH) terms. The search included the following terms and their combinations: “skeletal class II”, “retrognathic mandible”, “Twin block”, “functional appliance”, “fixed functional appliance”, “forsus”, “powerscope”, “Xbow”, “Herbst”, “lower incisor inclination”, “lower incisor proclination”, “Dentoalveolar effects” with Boolean characters ‘AND’ and ‘OR’ combination.

Selection Process: The selection process followed PRISMA guidelines. Two reviewers independently screened the titles and abstracts of all identified articles to assess their eligibility for inclusion. Rayyan

Software was used for screening and duplicate removal. Studies deemed potentially eligible underwent full-text evaluation by both reviewers to confirm their inclusion in the systematic review. Any disagreements were resolved through discussion or, if necessary, consultation with a third reviewer.

Data Collection Process and Data Items:

After identifying the relevant studies, data were collected from each study with the help of a predefined extraction form. The extracted information included author's name, publication year, study design, country, details of participants treated with fixed functional appliances, details of participants treated with twin block appliances, and the outcome measure (lower incisor proclination).

Risk of Bias Assessment:

This assessment was carried out using the recommended method for evaluating risk of bias with ROBINS-I. The tool is especially beneficial for those conducting systematic reviews that involve non-randomized studies and utilize the RevMan 5.4.1 software.

Synthesis of Results

Study Selection

A search conducted on PubMed and Google Scholar identified 25 articles. After eliminating duplicates, 21 articles were evaluated for potential inclusion. Many articles were excluded due to irrelevant titles and abstracts, narrowing the selection to 10 articles. Four review articles were excluded, resulting in six original articles being included in this systematic review. The PRISMA flowchart outlining the electronic database search process is displayed in Figure 1.

Study Characteristics

Six studies were included, study population included patients with Skeletal class II malocclusion owing to retrognathic mandible.

Out of six studies, five studies involved 3 groups of participants (2,10,16–18), wherein, one group was treated with fixed functional appliance, one was treated with twin block appliance and one group received no treatment and acted as control. One of the studies only included two groups(19), wherein, one group was treated with fixed functional appliance while the other group was treated with twin block appliance. Out of these six studies, five studies were retrospective (2,16–18) and only one study was prospective(10). However, all of them were cephalometric studies. Different skeletal and dentoalveolar parameters were compared between different groups of participants. However, this systematic review only reviewed comparison of lower incisor proclination.

General characteristics and grouping of these participants as well as outcome obtained are described in Table I.

RoB with studies

The assessment of risk of bias is summarized in Figures 2 and 3. Overall, five studies were determined to have a low risk of bias (10,14–17), however, one study exhibited a high risk of bias (2) owing to issues related to the selection of participants.

Discussion

Class II malocclusion due to mandibular retrognathia is one of the most common clinical problems encountered in orthodontics. Functional appliances—both removable and fixed—have been widely used to correct this discrepancy. Previous systematic reviews have already explored this area. For instance, Pacha et al. (2016)(14) compared the overall efficacy of fixed versus removable functional appliances in children with Class II malocclusion, concluding that both modalities achieved correction, but through different dentoalveolar and skeletal effects. More recently, Xu et al. (2024)(15) conducted a meta-analysis specifically comparing the Twin Block appliance and the Herbst appliance, and reported differences in dentoalveolar effects, particularly regarding lower incisor inclination.

While these studies provide valuable insights, they either focused broadly on all fixed versus removable appliances(14) or restricted their analysis to a comparison between Twin Block and Herbst(15). To date, no systematic review has specifically synthesized and compared the influence of Twin Block versus the wider group of fixed functional appliances on lower incisor proclination. This focused clinical question underlines the rationale for the present review.

By thoroughly screening the literature, 6 articles including 1 prospective (10) and 5 retrospective studies were found to fit the inclusion criteria (2,16–18).

Although only six studies were included, the focused scope of this review ensures that the synthesis remains clinically meaningful. The relatively small number of eligible studies is explained by the use of stricter inclusion criteria, particularly the requirement for cephalometric data to allow precise assessment of lower incisor proclination.

Since Clark introduced it, the Twin Block (TB) appliance has become a popular choice among orthodontists globally for treating Class II malocclusion due to retrognathic mandible(20)(21). In a survey of British orthodontists, 75% expressed a preference for TB as their functional appliance of choice. TB achieves a favourable forward displacement of the mandible upon closure by utilizing interlocking bite-blocks on upper and lower acrylic plates (21).

Fixed functional appliances are popularly known as "Non-compliance class II correctors" in contrast to removable appliances, indicating that they demand significantly less compliance (22).

It is important to note that functional appliances primarily impact the dentoalveolar region, resulting in consistent mandibular incisors proclination and maxillary incisors retroclination. The mandibular incisors proclination is intrinsically unstable and highly prone to relapse. As a result, functional appliances may not be the most suitable option for patients with pre-existing proclined lower incisors. (23).

A systematic review and meta-analysis of TB studies reported a significant proclination of lower incisors. This complication is due to the forward pressure on the mandibular incisors caused by lingual components of appliance as the mandible attemps to return to its resting posture (12).

Literature on Fixed Functional Appliances (FFAs) indicates that the correction of Class II malocclusion is primarily attributed to dentoalveolar modifications rather than skeletal adjustments. These modifications encompass retroclination of upper incisors, protrusion of lower incisors, and mesialization of lower molars. All these factors constrict the space for mandibular advancement and pose challenges to the long-term stability of the treatment (24–26).

Mahamad et al. (2012) performed a study in India comparing the Twin-block and Forsus groups. Both groups showed a significant increase in lower incisor inclination (Twin-block: 1.12°, *P* = 0.011; Forsus: 1.42°, *P* = 0.012), with the Forsus group exhibiting a greater degree of lower anterior proclination (2). Tarvade et al. (2013) carried out a comparable study in India, reporting a significant reduction in lower incisor inclination for the Twin-block group (4.08°, *P* = 0.007) and a significant increase for the Forsus group (5.25°, P = 0.002) (19).

Baysal et al. (2013) conducted a prospective study in Turkey, comparing Herbst and Twin-block groups. They reported a non-significant decrease in lower incisor inclination for Twin-block (0.15° ± 3.00, P = 0.027) and a significant increase for Herbst (1.77° ± 2.29°, P = 0.003) (10).

Hanoun et al. (2014) conducted a retrospective study in the USA, comparing the Forsus and Twin-block groups. Both groups exhibited a significant increase in lower incisor inclination (TB: 2.1°±5.7°, P = 0.03; Forsus: 3.9°±4.6° and P = 0.00), with a greater amount of lower anterior proclination in the Forsus group(16).

Giuntini et al. (2015) conducted a retrospective study in Italy, comparing the Forsus and Twin-block groups, showing a significant increase in lower incisor inclination for both groups (TB: 3.3°± 3.4°, P = .000; Forsus: 6.2°± 5.9°, P = .000), with a greater amount of lower anterior proclination in the Forsus group (17).

Ehsani et al. (2015) carried out a retrospective study in Canada, comparing the XBow and Twin-block groups. Both groups demonstrated a notable increase in the inclination of the lower incisors (TB: 6.3°± 4.3°, P < .001; XBow: 9.6°± 4.7°, P < .001), with the XBow group showing a greater amount of lower anterior proclination (18).

These findings collectively highlight the impacts of functional appliances on lower incisor inclination, emphasizing the appliance-specific considerations in Class II malocclusion treatment.

Conclusion

Out of the six studies reviewed, four reported a significant and statistically notable increase in lower incisor proclination in both the Twin-block and fixed functional appliance groups (2,16–18). However, all the studies agreed that fixed functional appliances caused a higher degree of lower incisor proclination in comparison to the Twin-block. Overall, five studies were determined to have a low risk of bias (10,16–19), however, only one study (2) was deemed to have a high risk of bias due to participant selection issues.

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Table I - Overview of Studies

Sr no.	Study ID	Study design	Country	Fixed functional appliance	Comparator/Control groups	Outcome – Lower incisor proclination
1.	Mahamad et al (2012)	Retrospective study	India	Forsus group: 25 patients (12 Males and 13 Females); mean age: 12.9 years	Twin-block group: 25 patients (10 Males and 15 Females); mean age: 10.6 years Control group: 25 untreated Class II subjects (10 Males and 15 Females); mean age: 10.2 years	The inclination of lower incisors showed a significant increase in TB group (1.12° and P = 0.011) as well as Forsus group (1.42° and P = 0.012). Amount of lower anterior proclination was greater in Forsus group.
2.	Tarvade et al (2013)	Retrospective study	India	Forsus group: 10 patients; Age range: 13-17 years	Twin-block group: 10 patients; Age range: 13-17 years	The inclination of lower incisors showed a significant decrease in TB group (4.08° and P = 0.007) and a significant increase in Forsus group (5.25° and P = 0.002).
3.	Baysal et al (2013)	Prospective study	Turkey	Herbst group: 20 patients (11 girls and 9 boys); mean age = 12.74 ±1.43 years	Twin-block group: 20 (10 girls and 10 boys); mean age = 13.0±1.32 years Control group: 20 (9 girls and 11 boys); mean age = 12.17±1.47 years	The inclination of lower incisors showed a non-significant decrease in TB group (0.15 ± 3.00and P = 0.027) and a significant increase in Herbst group (1.77° ± 2.29° and P = 0.003).
4.	Hanoun et al (2014)	Retrospective study	USA	Forsus group: 30 (12 girls and 18 boys); mean age: 12.9±1.1 years	Twin-block group: 37 (24 girls and 13 boys); mean age: 11.2±1.6 years Control group: 25 (12 girls and 13 boys; mean age: 11.9±1.9 years	The inclination of lower incisors showed a significant increase in TB group (2.1°±5.7° and P = 0.03) as well as Forsus group (3.9°±4.6° and P = 0.00). Amount of lower anterior proclination was greater in Forsus group.

5.	Giuntini et al (2015)	Retrospective study	Italy	Forsus group: 36 patients (16 females and 20 males); mean age: 12.3 years	Twin-block group: 28 (19 females and 9 males); mean age: 12.4 years Control group: 27 (13 females and 14 males); mean age: 12.2 years	The inclination of lower incisors showed a significant increase in TB group (3.3°± 3.4° and P = .000) as well as Forsus group (6.2°± 5.9°and P = .000). Amount of lower anterior proclination was greater in Forsus group.
6.	Ehsani et al (2015)	Retrospective study	Canada	XBow group: 25; mean age: 10–14 years	Twin-block group: 25; mean age: 10–14 years Control group: 25; mean age: 10–14 years	The inclination of lower incisors showed a significant increase in TB group (6.3°± 4.3° and P < .001) as well as XBow group (9.6°± 4.7°and P < .001). Amount of lower anterior proclination was greater in XBow group.

Figure 1 - Prisma flow diagram of study selection

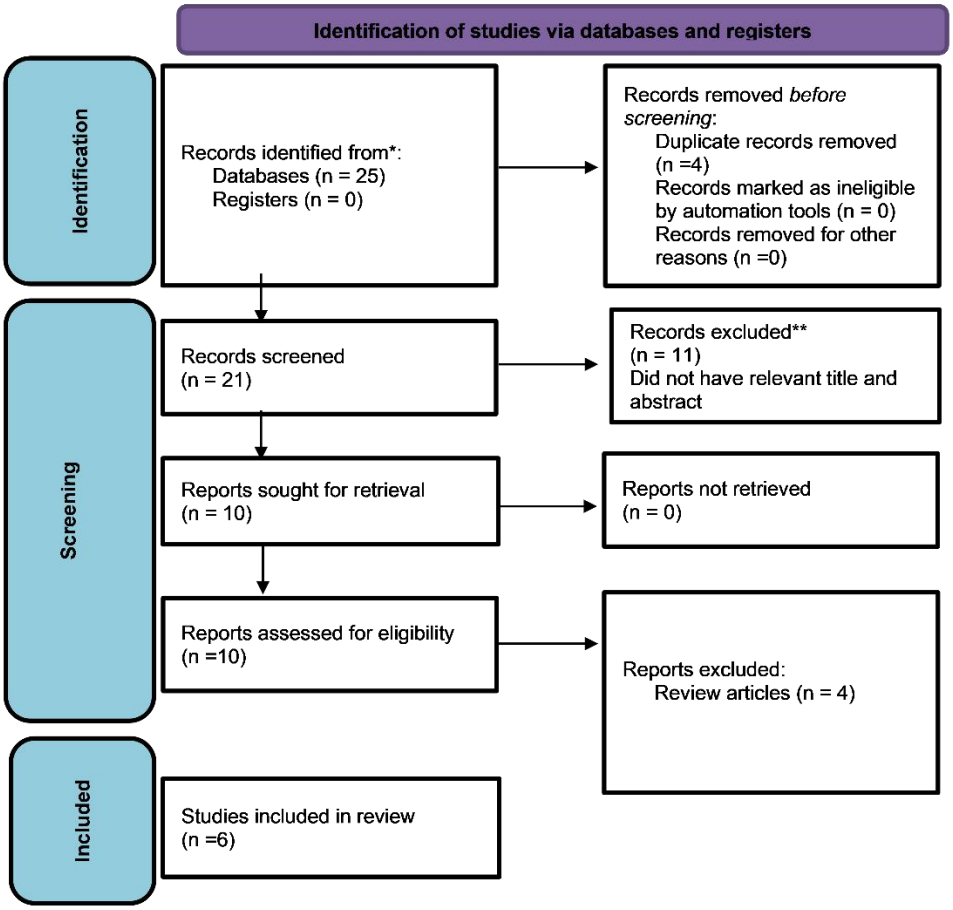

Figure 2: Risk of bias graph

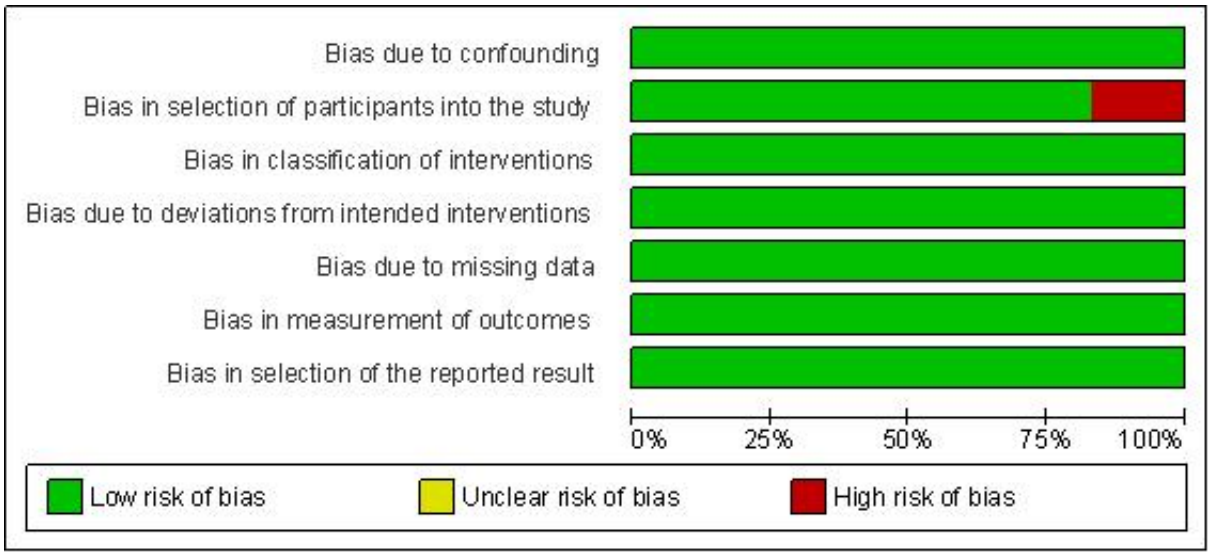

Figure 3 - Risk of bias summary

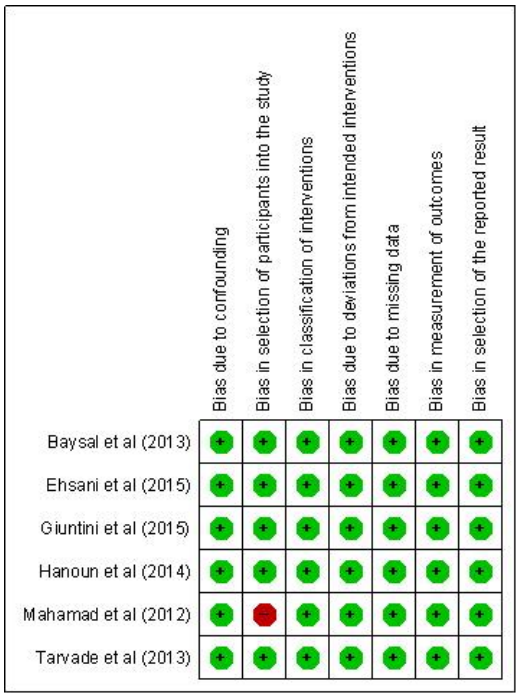

Table and Figure Legends:

Table I: Overview of studies

Figure 1: Prisma flow diagram of study selection

Figure 2: Risk of bias graph

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