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Review

Effects of Mandibular Advancement with Clear Aligners on Class II Patients and Their Comparison with Traditional Functional Appliances: A Scoping Review

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Abstract

Clear aligners are increasingly used for various orthodontic treatments, including mandibular advancement in patients with skeletal Class II. Mandibular advancement with clear aligners (MA) aims to achieve skeletal effects by promoting mandibular growth. This scoping review aims to evaluate the dental and skeletal effects of mandibular advancement with clear aligners and to compare it with traditional functional appliances. A literature search was conducted in PubMed, Scopus, Web of Science, and Google Scholar for studies published between 2017 and February 2025. The search identified 53 articles, of which 10 studies meeting the eligibility criteria were included. The quality of the studies was examined using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist. Most studies reported a reduction in A point–Nasion–B point (ANB) angle and Wits appraisal after MA treatment. Comparisons with Twin Block (TB) showed similar skeletal outcomes, although MA caused less lower incisor protrusion. Studies comparing MA and Herbst appliance found greater lower molar mesialization with the Herbst appliance, while Sella–Nasion–A point (SNA), Sella–Nasion–B point (SNB), and ANB values were similar. It is important to note that the effects of the Herbst appliance reported in the included studies were evaluated in patients at the pubertal growth peak, although the appliance can also be used in the post-peak period. The included studies show that mandibular advancement with clear aligners can induce forward mandibular growth and achieve skeletal improvement. Reported advantages in these studies include simultaneous dental alignment during advancement, improved aesthetics, and potentially higher patient compliance compared to conventional appliances. Additionally, clear aligners may allow better control of lower incisor inclination during mandibular advancement. However, the findings should be interpreted with caution due to the limited number of high-quality studies and heterogeneity in study designs.

Keywords: Clear aligners, functional appliances, Herbst appliance, mandibular advancement, skeletal class II, twin block.

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Class II malocclusion is a common orthodontic issue caused by anteroposterior discrepancies in the positioning of the upper and lower jaws.[1] This can occur when the maxilla is anteriorly positioned, the mandible is posteriorly positioned, or a combination of both conditions.[2] In many cases, the primary goal of treatment is to stimulate mandibular growth and inhibit maxillary growth.[3] Class II malocclusion is often associated with mandibular retrusion. To correct this, functional appliances are used to advance the mandible. These devices displace the mandibular condyle beyond the fossa, which reduces condylar pressure and alters muscle tension, promoting additional mandibular growth. In the early 1900s, Robin introduced the Monoblock appliance as a precursor to functional appliances. However, Andresen later refined the Activator, the first widely accepted functional

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appliance. Since then, numerous removable and fixed functional appliances have been developed. Functional appliances produce dental and skeletal effects that correct Class II malocclusion associated with mandibular retrognathia. These effects include increased mandibular length, decelerated maxillary forward growth, anterior movement of the lower arch, and distal inclination of the upper incisors.[4]

Various fixed and removable functional appliances are used to treat class II malocclusion. Removable functional devices include Activator, Bionator, and Twin Block, while fixed functional devices include Herbst, Forsus, and Jasper Jumper. It is crucial to time the treatment correctly when using functional appliances. The optimal time to initiate treatment is at the onset of the pubertal growth spurt.[2] The treatment protocol is different in adult patients, where the stimulation of mandibular growth may be unattainable. Orthodontic camouflage or orthognathic surgery are treatment options for these patients.[1]

The history of clear aligners dates back to 1945, when Kesling developed the 'positioner.' However, the widespread use of clear aligners began with the launch of Invisalign in 1999 by Align Technology, founded in 1997. Clear aligners were initially used only in patients with Class I malocclusion and mild crowding but are currently used in many situations, from preparation for orthognathic surgery to interdisciplinary treatments.[5]

Increasing clinical demand for aesthetic treatment options, such as clear aligners, has driven interest in their potential for functional mandibular advancement. In 2017, Align Technology™ produced the Invisalign Mandibular Advancement appliance for Class II patients with ongoing growth and development. This appliance, similar to the Twin Block, allows for further positioning of the mandible with the wings on both lateral sides attached to the Invisalign aligners (Fig. 1).

The aligners can reposition the mandible while aligning the teeth. This functional treatment occurs in three stages. The first stage is the pre-mandibular advancement phase, which eliminates molar rotation, overjet, and overbite problems that hinder the mandible's forward positioning. The second stage is the mandibular advancement stage. Unlike other functional appliances, the mandible is gradually advanced during this stage, using eight aligners for every 2 mm of advancement. The final stage is the transition phase, which aims to preserve the corrected Class II relationship.[6]

Despite the increasing interest in clear aligner-based mandibular advancement, the available literature remains limited and highly heterogeneous in terms of appliance design, advancement protocols, and outcome measures. Notably, previous reviews have often grouped studies involving fundamentally different biomechanical systems—such as Precision Wings, occlusal bite blocks, or aligners combined with Class II elastics—under a single category of "mandibular advancement with clear aligners." However, these systems differ markedly in their mechanisms of action: for example, occlusal bite blocks primarily induce vertical opening, while Class II elastics apply distalizing and extrusive forces, complicating direct comparisons with the Precision Wings design. To minimize heterogeneity, only studies using the Precision Wings design for mandibular advancement were included.

Moreover, although there is a growing number of studies exploring clear aligner-based mandibular advancement, much of the current literature consists of case reports or uncontrolled observational studies, limiting the ability to draw evidence-based conclusions. To address this gap, our scoping review specifically included studies with control or comparison groups to enable a more structured and clinically meaningful synthesis of outcomes. For these comparative studies, an untreated control group was not mandated, as the primary focus was on evaluating relative efficacy between active treatments.

The available literature is both limited and heterogeneous. While systematic reviews aim to synthesize high-quality, homogeneous studies to answer specific clinical questions, scoping reviews are valuable, especially when

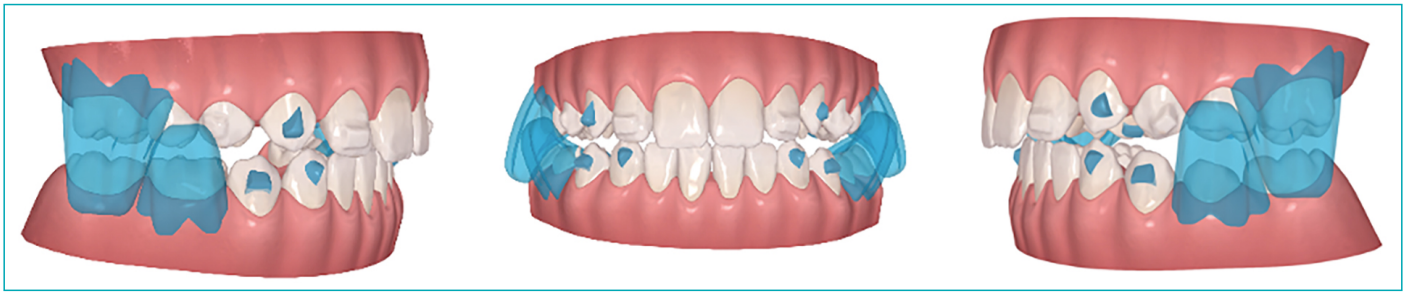

Figure 1. Wings on both lateral sides, visible in blue, attached to the Invisalign aligners are called precision wings.

there is limited, heterogeneous literature. Given the limited number of well-executed primary studies and the variability in study designs, a scoping review was selected as the most appropriate methodology. This approach allows for comprehensively mapping the existing evidence, identifying research gaps, and guiding future studies.

To assess the effects of mandibular advancement with clear aligners on Class II patients and their comparison with traditional methods, our scoping literature review addresses the following two research questions:

1. What are the dental and skeletal effects of mandibular advancement with clear aligners?
2. Does mandibular advancement with clear aligners have the same effects as traditional functional appliances?

Materials and Methods

The present scoping review was designed and developed following the Preferred Reporting Item for Systematic Reviews and Meta-analysis extension for scoping review guidelines (PRISMA-ScR).[7]

Eligibility Criteria

All clinical studies published from 2017 to February 2025 that evaluated mandibular advancement with clear aligners were screened for eligibility based on titles and abstracts. Observational studies and clinical trials with control groups were included, while case reports, reviews, and animal studies were excluded. In clinical studies comparing MA with other functional appliances, the requirement for a control group was not mandated to allow for the broader inclusion of relevant comparative studies. Due to the authors' linguistic proficiency, the search was limited to English-language studies.

Search Strategy

The literature search used PubMed, Scopus, Web of Science, and Google Scholar to identify relevant studies. The search was restricted to articles published from 2017 to 2025, as 2017 marked the year mandibular advancement with clear aligners was first introduced. Articles containing the following keywords or MeSH (Medical Subject Heading) terms were included: 'Clear aligners OR Invisalign OR Aligner AND Mandibular Advancement OR Functional Orthodontic Appliances OR Functional Appliances AND Class II Malocclusion OR Retrognathism OR Mandibular Deficiency.'

Data Charting and Result Synthesis

Two reviewers independently screened titles, abstracts, and full texts for eligibility. Disagreements were resolved through discussion or by consulting a third reviewer. From each selected article, the following items were summarized and recorded: year of publication, clinical interventions and related outcomes, first author, methodology, study aim, study design, and patient selection.

To assess the methodological quality of the included studies, we used the JBI Critical Appraisal Checklists, selecting the appropriate version based on study design. Two reviewers independently performed the assessments. Disagreements were resolved through discussion or consultation with a third reviewer. The results of the quality appraisal were used to contextualize the findings during synthesis, not to exclude any studies.

We divided the 10 selected articles into three separate groups. Our focus was specifically on comparing the outcomes of mandibular advancement with clear aligners treatment against the control group and consolidating the effects of mandibular advancement. The remaining two groups consisted of articles comparing removable functional appliances, the Twin Block and MA, while the other compared fixed functional appliances, Herbst and MA.

Results

Study Selection

In total, 204 references were initially identified across various online databases. After removing duplicates, 139 unique titles remained. After carefully reviewing the titles and abstracts, 53 potentially relevant full-text articles were examined. Finally, 10 studies that met the inclusion criteria were included in this scoping review (Fig. 2).

Study Characteristics

A total of ten studies from six countries were included: the United States of America (n=2), Italy (n=1), China (n=3), Saudi Arabia (n=1), Korea (n=1), and Canada (n=2). Table 1 presents the studies' publication year and author, number of patients and their age, aims, design, outcomes, and main findings related to each intervention.[8–17]

Critical Review

The Joanna Briggs Institute (JBI) Critical Appraisal Checklists were used to assess the methodological quality of the included studies. All studies except Zybutz et al.[11] were designed as cohort studies and were therefore assessed using the JBI Critical Appraisal Checklist for Cohort Studies, while Zybutz et al.[11] was assessed using the JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies. Two reviewers independently performed the quality assessment, with disagreements resolved through discussion or consultation with a third reviewer.

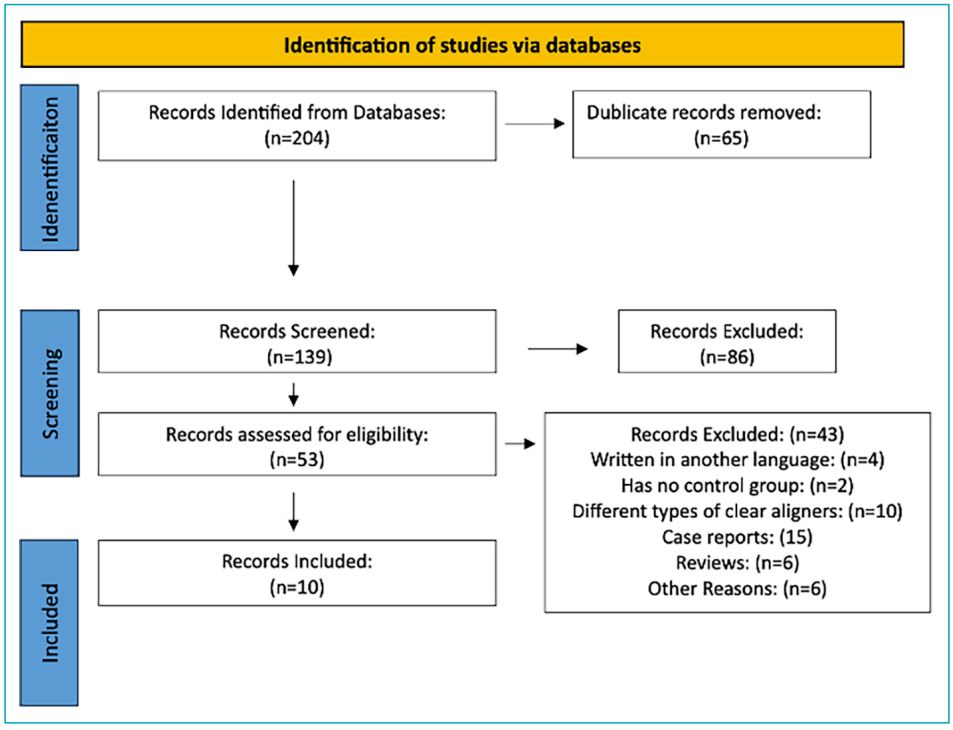

Figure 2. Flow chart for literature search.

According to the JBI checklists, the studies demonstrated moderate to good methodological quality, based on the number of "yes" responses. However, it should be noted that most were retrospective in nature, and clinical factors such as patient compliance, reasons for incomplete correction, or full achievement of the planned mandibular advancement could not be consistently evaluated across studies. Table 2 summarizes the critical appraisal of the included articles. For clarity and space, the JBI checklist items are presented in abbreviated form in Table 2. The full wording of each item can be found in the original JBI Critical Appraisal Checklists.[18,19]

Discussion

In clinical practice, the selection of a functional appliance depends largely on patient compliance, growth stage, and vertical growth pattern. Removable functional appliances require a high level of cooperation, whereas fixed functional appliances can be used independently of compliance and are therefore suitable for non-cooperative patients. In terms of treatment timing, skeletal effects are most pronounced when therapy is initiated around the pubertal growth peak; however, fixed appliances may also be indicated in the post-peak period. Patients with a normodivergent or hypodivergent growth pattern may represent the most favorable candidates for functional appliance therapy. Nevertheless, since functional appliances tend to increase lower incisor inclination, they may be contraindicated in patients who already present with excessive proclination. When considering the clinical application of these appliances, these factors should always be taken into account during patient selection.[4,20]

Skeletal Effects of Mandibular Advancement with Clear Aligners

Studies showed that mandibular advancement with clear aligners may be associated with skeletal changes. A reduction in the ANB angle was consistently observed across studies, reflecting improved sagittal relationship. An et al.[15] found a significant difference in the female group and stated that it was about better cooperation in the female group. These findings suggest that patient cooperation may be crucial to the effectiveness of treatment.[8,9,12,13,17] While increases in SNB values, indicative of mandibular advancement, were reported by Blackham et al.,[8] Wu et al.[13] and Subaie et al.,[17] other studies showed limited changes.[9,12] Interestingly, no significant changes in SNA values were observed across any study, indicating that the treatment predominantly affects mandibular positioning rather than the maxilla.[8,9,12,13,15,17]

Regarding Wits values, Blackham et al.,[8] Ravera et al.,[9] and Subaie et al.[17] reported significant reductions compared to control groups, indicating sagittal skeletal improvements. However, other studies observed

Table 1. Study characteristics

	Author and year	Number of patients	Age	Appliance	Comparison	Aim	Outcome
1	Blackham et al, 2017[8]	38 patients	13.15±1.37 to 11.82±1.74	Invisalign Mandibular Advancement	Twin Block Historical Control Group	Compare short-term effects of MA to TB and historical controls on Class II malocclusions in skeletal, dental, and soft tissue aspects.	MA is effective correcting Class II malocclusion. MA may result less protrusion compared to TB.
2	Ravera et al., 2021[9]	72 patients	9.2±1.4 to 12.10±1.4	Invisalign Mandibular Advancement	Control Group (Untreated)	Dentoskeletal effects of the MA in pre-pubertal and pubertal stages.	In pre-pubertal stage, MA mainly has dentoalveolar effects, while during puberty, it transitions to dento-skeletal effects.
3	Caruso et al., 2021[10]	20 patients	10±1.03 to 10±1.05	Invisalign Mandibular Advancement	Twin Block	Dentoskeletal effects of the MA compared to TB	Both appliances are effective correcting skeletal Class II. MA has better control of upper teeth position.
4	Zybutz et al., 2021[11]	68 patients (37 female, 31 male)	10.6±1.92 to 13.6±1.54	Invisalign Mandibular Advancement	Twin Block	Comparison of patient experiences with MA versus TB	Both MA and TB experiences were generally similar. TB patients found their appliance more intimidating and harder to insert.
5	Lombardo et al., 2022[12]	71 patients (40 female, 31 male)	10.9±1.1 to 12.0±1.3	Invisalign Mandibular Advancement	Twin Block Control Group (Untreated)	Dentoskeletal effects of the MA compared to TB	Both treatment groups had improvements in overjet and overbite compared to control group (untreated).
6	Wu et al., 2023[13]	63 patients (26 female, 36 male)	10.71±1.44 to 12.11±1.16	Invisalign Mandibular Advancement	Vanbeek Activator, Herbst, Twin Block, Control Group (Untreated) Herbst	Dentoskeletal effects of the MA compared to traditional functional appliances	All four appliances effectively advance the mandible, improve facial profiles, and correct skeletal Class II. MA allows aligning while leading the mandible and has good control of incisor inclination.
7	Hosseini et al., 2023[14]	40 patients (22 female, 18 male)	12.7±1.8 to 13.1±1.5	Invisalign Mandibular Advancement	Vanbeek Activator, Herbst, Twin Block, Control Group (Untreated) Herbst	Dentoskeletal effects of the MA compared to Herbst followed by comprehensive orthodontic treatment	Both appliances are effective correcting Class II malocclusion. MA has better control of mandibular incisor inclination.
8	An et al., 2023[15]	40 patients (20 female, 20 male)	6 to 18 Treatment group mean age 9.3	Invisalign Mandibular Advancement	Control Group (Untreated)	Dentoskeletal effects of the MA	MA usage during the growth phase significantly reduces anteroposterior discrepancies in skeletal, dental, and soft tissue structures in Class II Division 1 malocclusion.
9	Yue et al., 2023[16]	32 patients (17 female, 15 male)	8 to 11.5 Mean Age 10.2±0.84 years	Invisalign Mandibular Advancement	Twin Block	Upper airway and hyoid bone position improvements treated with Invisalign mandibular advancement and Twin-Block appliances	Both MA and TB improved narrowness of the upper airway and hyoid bone position.
10	Subaie et al.,[17]	70 patients (34 female, 36 male)	11.98±2.18 to 11.75±1.59	Invisalign Mandibular Advancement	Control Group (Untreated)	Dentoskeletal and soft tissue effects of the MA	MA in growing patients with Class II malocclusion achieved significant skeletal correction. Soft tissue was significantly improved.

MA; Mandibular Advancement with Clear Aligners, TB; Twin Block

Table 2. Critical appraisal for included studies[18]

Author and year	Group similarity	Exposure assignment	Exposure validity	Confounders identified	Confounding strategies	Ourcome-free at baseline	Outcome validity	Follow-up duration	Follow-up completeness	Incomplete follow-up strategies	Statistical appropriateness	Objective criteria
Blackham et al, 2017[8]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Not applicable	Yes	-
Ravera et al., 2021[9]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	-
Caruso et al., 2021[10]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Not applicable	Yes	-
Zybutz et al., 2021[11]	Yes	Yes	Yes	Yes	No	-	Yes	-	-	-	Yes	No
Lombardo et al., 2022[12]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Not applicable	Yes	-
Wu et al., 2023[13]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Not applicable	Yes	-
Hosseini et al., 2023[14]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Not applicable	Yes	-
An et al., 2023[15]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Not applicable	Yes	-
Yue et al., 2023[16]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Not applicable	Yes	Yes
Subaie et al.,[17]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Not applicable	Yes	Yes

reductions in Wits values that did not reach statistical significance, possibly due to variations in patient characteristics, particularly growth stages.[12,15]

Various parameters were used to evaluate vertical skeletal development post-MA treatment, but none of these studies demonstrated a significant increase compared to the control group.[8,9,12,13,15,17] We can attribute this finding to clear aligners' biomechanical advantage due to their thickness, which provides better vertical control. However, Lombardo et al.[12] observed an increase in the lower facial height ratio, as did Ravera et al.[9] and Wu et al.[13] with the bispinal plane-gonion measurement, although these were not statistically significant when compared with the control group. Additionally, all studies except for Blackham et al.[8] indicated an increase in lower jaw length compared to the control group, highlighting the ability of MA to promote mandibular development.[9,12,13]

Dental Effects of Mandibular Advancement with Clear Aligners

Mandibular advancement with clear aligners resulted in significant dental changes, particularly in overjet reduction. However, other parameters, such as incisor inclination and molar relationships, showed variability. Overjet reduction was consistently reported across all studies, demonstrating the efficacy of clear aligners in addressing Class II malocclusions.[8,9,12,13,17]

Upper incisor inclination changes were generally insignificant across most studies, except for Ravera et al.,[9] who reported significant decreases in the CVM2 group, whereas no significant changes were noted in the CVM3 group. Ravera et al.[9] also observed more pronounced dental effects in the CVM2 group, which might explain these findings. Upper incisor retrusion was observed in some studies, though the findings were not consistent. For example, Blackham et al.[8] and An et al.[15] reported no significant differences in U1-NA values, but Blackham et al.[8] noted significant retrusion in U1-APo values.[8,15] Wu et al.[13] also observed substantial reductions in U1-PP values after MA treatment. It is important to note that measurement parameters differed across studies, and upper incisor retrusion could also result from ClinCheck planning strategies customized for each case.

Lower incisor changes demonstrated variability across studies. Blackham et al.[8] reported a significant increase in L1-APo values, indicating incisor protrusion. Conversely, An et al.[15] noted a significant decrease in L1-NB values in female patients, attributing the

findings to better cooperation and treatment adherence. However, this variable was only examined in two studies, and it's crucial to remember that measurement parameters differed between them. Therefore, making a definitive statement regarding lower incisor protrusion may not be appropriate, as the results remain controversial.

Across all studies, IMPA values showed no significant differences between treatment and control groups. [8,9,12,13,15,17] Unlike the lower incisor protrusion commonly observed as a side effect in traditional functional appliances, this finding emphasizes the advantage of clear aligners in preserving lower incisor axis inclination.

Improvements in molar relationships were primarily attributed to skeletal corrections resulting from mandibular advancement. Blackham et al.[8] and Subaie et al.[17] reported mesialization of lower molars, although Blackham et al.[8] found these changes to be statistically insignificant. Subaie et al.,[17] however, observed significantly greater mesialization of lower molars compared to the control group, highlighting the dental compensatory effects of MA treatment.

Overbite changes varied significantly between studies. Lombardo et al.[12] reported a significant reduction in overbite, aligning with the skeletal and dental improvements achieved through treatment. In contrast, Blackham et al.[8] and Subaie et al.[17] both observed reductions in overbite; however, these changes were not statistically significant. Blackham et al. specifically highlighted that the decrease in overbite was primarily attributed to the inhibition of lower incisor eruption, possibly due to the complete coronal coverage provided by the clear aligner. The combined effect of managing lower incisor eruption and controlling the inclination of incisors (IMPA) is critical for effective overbite correction. This ability of the aligner to prevent lower incisor eruption is a notable advantage. Achieving this balance—stabilizing IMPA while controlling incisor eruption—is inherently challenging but offers a distinct benefit in maintaining overbite without unwanted vertical changes.

Soft Tissue Effects of Mandibular Advancement with Clear Aligners

The impact of treatment on soft tissues showed variation across studies. Blackham et al. reported a significant decrease in facial convexity but found no significant changes in the nasolabial angle compared to the control group. In contrast, An et al.[15] and Subaie et al.[17] also observed improvements in facial convexity; however, these changes were not statistically significant. Additionally, An et al.[15] reported a significant decrease in the nasolabial angle, specifically in the female group.[8,17] Variations in age, growth stages, patient compliance, and the wear time of functional appliances may contribute to these differences in soft tissue outcomes.

Twin Block versus Mandibular Advancement with Clear Aligners

Current research shows conflicting results regarding the comparative effects of MA and TB appliances. Most studies found no significant differences in the SNA angle when comparing TB and MA appliances.[8,12,13] However, Caruso et al.[10] observed a statistically significant reduction in the SNA angle with TB treatment. This effect was attributed to the retroclination of the upper incisors, which led to bone remodeling around the incisor roots and displacement of point A.

When examining the SNB angle, no study reported statistically significant differences between the two appliances. This indicates that both devices achieve comparable mandibular advancements, consistent across multiple investigations.[8,10,12,13]

Most studies, excluding Caruso et al.,[10] did not report significant differences in the ANB angle between TB and MA treatments. In contrast, Caruso et al. observed a significant reduction in the ANB angle in the TB group. This finding was linked to changes in the SNA angle caused by upper incisor retroclination and its skeletal remodeling effects.[8,10,12,13] When Wits appraisal values were examined, no significant differences were found between TB and MA groups across studies. This consistency in Wits values further supports the notion that the skeletal effects of both appliances are comparable.[8,12]

Dentoalveolar changes also varied between the two appliances. TB demonstrated a greater retroclination of upper incisors, as reported by Caruso et al.,[10] however, this difference was not observed in other studies.[8,12,13] Although no significant differences were found in the lower incisor inclination (L1-MP angle),[8,10,12,13] lower incisor protrusion was notably less with MA in two studies.[8,13]

During the promotion of Invisalign Mandibular Advancement, one of the main focuses was its potential for improved aesthetics and increased patient compliance. In a valuable study conducted by Zybutz et al.,[11] comparing MA and TB, it was found that, although there was no significant overall difference between the two groups, the MA group preferred the appliance due to its aesthetic appeal and ease of application. Additionally, the TB group experienced more instances of breakage and fitting issues. Beyond these findings, patients reported that the

TB appliance was perceived as more intimidating at first impression, while MA was considered more discreet and acceptable. Parents also more easily noticed the TB, further emphasizing the aesthetic advantage of MA. Moreover, patients using TB reported greater embarrassment in social settings, which strongly supports the notion that MA provides a superior aesthetic and psychological benefit compared to TB. In addition, patients in the MA group more frequently reported sore lips and dental pain, which may be explained by the fact that during MA therapy, all teeth are fully covered by the aligners while simultaneous dental movements are incorporated into the treatment plan. On the other hand, although TB patients faced higher rates of appliance breakage, MA patients expressed greater dissatisfaction when clinical visits were required for appliance adjustments. This suggests that the population choosing MA may place a higher value on comfort and aesthetics.[11]

When discussing functional therapies, it is important to consider the impact on the upper airway, as studied by Yue et al.,[16] who examined developments in the upper airway and the position of the hyoid bone following TB and MA using CBCT. It was found that both MA and TB appliances effectively decreased respiratory resistance and increased the upper airway's structural narrowness. In contrast to TB, MA was more successful in enlarging the hypopharynx's narrowest segment. Additionally, both appliances promoted anterior downward movement of the hyoid bone. Yue et al.[16] also suggested that MA might be more effective in increasing the upper airway volume because it can intrude lower incisors without extruding the posterior teeth and causing less clockwise rotation. However, it is important to note that CBCT-based airway measurements can be influenced by factors like head position, breathing during the scan, and tongue posture, which may affect the accuracy of the results.[19]

Herbst versus Mandibular Advancement with Clear Aligners

Only two studies have compared a fixed functional appliance, Herbst, with a removable functional appliance, MA. Both studies found no differences in SNA, SNB, and ANB values after using Herbst and MA. These findings suggest that both appliances successfully treat Class II malocclusions, producing similar skeletal results, despite their differences in design and application.

Hosseini et al.[14] found no significant difference between the Herbst and MA groups when analyzing the distal movements of upper molars. However, Wu et al.[13] determined that the distal movement of upper molars with Herbst was greater than that achieved with MA. Regarding the mesial movement of lower molars, both studies found that Herbst resulted in greater movement than MA. The improvement in molar relationship: Hosseini et al. observed that both Herbst and MA resulted in more skeletal component-related improvement in the molar relationship, while Wu et al. discovered that Herbst produced more dental improvement, while MA produced more skeletal improvement.

Both studies found that mandibular incisors were significantly more proclined with Herbst than MA when examining L1-MP values. This finding highlights the critical role of mandibular incisor angulation, especially in cases where incisor inclination is already a limiting factor. Excessive proclination may lead to dental compensation, potentially impacting the skeletal and dental balance achieved during treatment.

Hosseini et al.[14] reported that overjet reduction was significantly more with Herbst, whereas Wu et al.[13] found no significant difference. While Hosseini et al. suggested that overjet reduction with both appliances was more skeletal, Wu et al. noted that with Herbst, it was predominantly skeletal. In contrast, with MA, it was primarily dental. Hosseini et al. attributed the greater overjet reduction with the Herbst appliance to overcorrection and the longer treatment duration associated with the Herbst protocol. On the other hand, the discrepancies in findings may be due to leveling and alignment in the upper incisors during the MA phase, as suggested by Wu et al.

The combined evidence suggests the following clinical implications and considerations for patient selection:

The findings of this review suggest that mandibular advancement with clear aligners may be a suitable treatment modality for growing patients with mild to moderate Class II malocclusion, particularly those who are highly cooperative and motivated.

Notably, several included studies reported that lower incisor inclination remained relatively stable, indicating that this technique may be advantageous in cases where proclination of the lower incisors is contraindicated.

Moreover, although definitive conclusions cannot be drawn due to the observational nature of the included studies, the majority did not report substantial changes in vertical skeletal parameters. This may suggest that aligner-based mandibular advancement is more appropriate for patients with horizontal or mildly normo-divergent growth patterns, rather than those with vertical, high-angle growth. The lack of occlusal opening or the potentially intrusive influence of the aligner material could explain the minimal

vertical effects observed. While these hypotheses remain speculative, they highlight areas for further investigation.

Due to the heterogeneity in study designs, short follow-up durations, and the absence of randomized controlled trials, further high-quality prospective research is necessary to validate these trends and better define the ideal patient profile and long-term outcomes of aligner-based mandibular advancement protocols.

In contrast to the previous review by Yu et al.,[21] our study differs significantly in terms of accessibility and scope. Their study also includes trials that use Class II elastics in addition to aligners, broadening their focus beyond the use of clear aligners alone with mandibular advancement. Furthermore, the full text of their review is published in Chinese, which limits its accessibility to a global audience.

Limitations and Future Directions

This review is limited by the small number of available articles on Invisalign Mandibular Advancement. Moreover, long-term follow-up and monitoring for relapse are essential for evaluating treatment stability, yet most studies lacked sufficient follow-up duration. The heterogeneity in methodology, patient characteristics, and outcome measures made it difficult to perform data synthesis. Variations in skeletal maturation stages, compliance levels, and diagnostic tools further complicated the comparability of results.

Additionally, most studies did not report whether mandibular advancement was initiated immediately or preceded by a leveling and alignment phase (pre-mandibular advancement phase), making it difficult to evaluate the influence of treatment sequencing on skeletal and dental outcomes. Relapse risk—especially in growing Class II patients—remains insufficiently explored due to the lack of long-term data.

Aligner-based mandibular advancement commonly follows a staged protocol; however, the clinical implications of gradual versus single-step advancement have not been clearly defined, particularly in comparisons with traditional functional appliances. Future studies should aim to standardize advancement protocols across different appliance systems, treatment phases, and durations to facilitate meaningful clinical comparisons and determine whether certain methods provide superior outcomes or long-term stability.

A critical gap also lies in the lack of measurement standardization. The included studies utilized a wide range of cephalometric parameters with limited consistency. Establishing a core set of diagnostic and outcome variables would greatly improve inter-study comparability and enhance the validity of future meta-analyses.

Furthermore, due to the retrospective design of many studies, key clinical details were frequently not mentioned—such as levels of patient cooperation, reasons for incomplete correction, and whether the planned mandibular advancement was fully achieved. These missing data points limit the interpretation of treatment effectiveness. To overcome these limitations, there is an urgent need for well-designed randomized controlled trials to provide higher-level evidence and address the existing gaps in treatment efficacy and long-term outcomes. Lastly, this review included only English-language publications, which may have led to the exclusion of relevant findings from non-English sources, introducing potential language bias.

Conclusion

Mandibular advancement can be achieved through the use of clear aligners. These aligners induce forward growth of the mandible while also enabling alignment. Additionally, they offer enhanced comfort and aesthetics compared to other functional appliances. However, there is currently limited literature on this subject, with only a few studies addressing the efficacy of mandibular advancement using clear aligners. Upon examination of the studies conducted thus far, the following results have been obtained regarding the use of MA;

1. Clear aligners with mandibular advancement features may promote forward mandibular growth and assist in the correction of skeletal Class II malocclusion in growing patients. Current evidence suggests favorable skeletal and dental outcomes though further high-quality studies are needed to confirm these results.
2. MA and the Twin Block may produce similar skeletal effects, though only a few studies have directly compared them.
3. MA and Herbst appliances can correct Class II molar relationships and reduce overjet. Some studies suggest that MA may better preserve lower incisor inclination compared to Herbst, which may be beneficial in selected cases. On the other hand, fixed appliances might be more appropriate in patients with poor compliance.

In summary, further research with larger sample sizes, standardized methodologies, and extended follow-up periods is necessary to fully understand the long-term effects and clinical potential of mandibular advancement using clear aligners.

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