# Scoping Review of Clinical Outcomes in Arch Expansion with Invisalign

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### Abstract

**Background**: Clear aligners, particularly Invisalign®, are increasingly used for maxillary arch expansion due to their aesthetic appeal and non-invasive nature. However, their effectiveness in achieving predictable results, especially for posterior arch expansion, remains a subject of debate, particularly for adult patients with fully erupted dentition. **Aim**: This scoping review aims to assess the clinical outcomes, predictability, and effectiveness of Invisalign® for maxillary arch expansion, focusing on key factors influencing treatment success. **Methodology**: This scoping review followed the PRISMA guidelines and systematically searched multiple electronic databases, including PubMed and Scopus, for studies on arch expansion with Invisalign® and other clear aligners. A total of 8 studies were included, focusing on clinical outcomes, efficacy, predictability, and factors like age, compliance, and treatment protocols. Data extraction and synthesis were performed through narrative analysis, including relevant systematic reviews, randomized controlled trials, and observational studies, ensuring a comprehensive and transparent approach. **Results**: The studies reviewed reveal that anterior teeth show higher predictability in arch expansion with Invisalign® compared to posterior teeth, where accuracy diminishes. Virtual planning often overestimates achievable expansion, particularly for posterior regions. Factors such as age, compliance, treatment protocols, and attachment use significantly affect outcomes, with attachments improving results, especially for molars. Overall, aligner systems offer moderate-to-high predictability for anterior and premolar regions, but posterior corrections remain challenging, requiring effective planning and adjunctive methods. **Conclusion**: Invisalign® is a promising option for maxillary arch expansion, particularly for mild to moderate discrepancies in younger patients. However, achieving significant posterior expansion requires adjunctive techniques and careful treatment planning, particularly for adult patients.

**Key words:** Clear Aligners, Dental Arch Expansion, Maxillary Expansion, Orthodontics, Tipping Movements

**Introduction**

Clear aligners, especially Invisalign®, have become increasingly popular for orthodontic treatment because of its comfort, cosmetic appeal, and ability to effectively address a variety of dental malocclusions. One of the most important areas where Invisalign® has shown promise among the many uses is maxillary arch extension. For individuals who have narrow arches that need to be corrected to enhance both functional results and facial and dental aesthetics, arch enlargement is crucial. For adults wanting orthodontic treatment with little to no appliance visible, the Invisalign® system is frequently seen as a less intrusive and more patient-friendly option than traditional fixed appliances [1].

The effectiveness and predictability of maxillary arch extension with Invisalign® in both adolescent and adult populations have been the subject of recent studies. According to research, Invisalign® has a lot to offer in terms of patient comfort and compliance, but its ability to produce predictable arch expansionparticularly in adult patientsis still being assessed. Although the system's limits are evident when compared to conventional fixed expanders, especially about the degree of expansion, several studies indicate that it might be useful in some situations for attaining mild to moderate expansion [2,3]. Researchers and physicians continue to focus on the system's capacity to produce steady and regulated arch movements in the upper jaw [4,5]. The patient's age, the intricacy of the situation, and the accuracy of the treatment planning all affect how predictable the results of Invisalign® will be. Invisalign® First has been shown to provide predictable results in youngsters, especially for minor repairs, especially in individuals with mixed dentition. Adjunctive devices, however, might be necessary in more complicated cases that call for substantial transverse alterations in order to attain the best outcomes [6,7]. On the other hand, adult patients who have fully grown dentition could have more difficulty achieving significant arch expansion with clear aligners alone. To get over these restrictions, the use of adjuncts such mini-implants or certain aligner modifications has been investigated [8,9].

More recent advancements in Invisalign® technology, including as its capacity to accurately model tooth movements using third-party software, have also improved treatment results. However, despite breakthroughs in technology, some research highlights that Invisalign® might not be as successful as traditional fixed appliances in addressing severe malocclusions or accomplishing large-scale arch extension [10,11]. The optimal treatment protocols are still being investigated by clinicians to improve treatment efficiency and predictability. These procedures may involve combining the system with conventional fixed appliances or incorporating additional equipment.Although Invisalign® has demonstrated efficacy in numerous orthodontic applications, such as modest alignment and expansion, the research indicates that the system's capacity to generate consistent, extensive maxillary arch extension is still uncertain. The end outcome is greatly influenced by elements like the severity of the

dental problem, patient cooperation, and treatment planning [12,13]. Determining which patients are the best candidates for Invisalign®-based arch extension and being aware of the system's limits are therefore essential when handling more complicated cases [14,15]. Although Invisalign® is a promising treatment for expanding dental arches, several factors affect how effective and predictable it is. Continued research into optimizing treatment protocols and better understanding its capabilities in achieving larger expansions will help guide clinicians in utilizing this system more effectively in clinical practice.

The rationale for this scoping review stems from the growing use of Invisalign® in orthodontic treatment, particularly for maxillary arch expansion. While clear aligners offer aesthetic and comfort benefits, their efficacy and predictability in achieving arch expansion remain underexplored, particularly for complex cases. This review aims to systematically evaluate and synthesize the available literature on the clinical outcomes of arch expansion with Invisalign®, assessing the predictability, effectiveness, and factors influencing treatment success. By mapping the current evidence, this review seeks to provide insights into the capabilities and limitations of Invisalign® for arch expansion, informing clinical practice and guiding future research in orthodontics.

**Methodology**

**Research Question**: This scoping review was guided by the following research question: What are the clinical outcomes, efficacy, and predictability of arch expansion with the Invisalign® system in orthodontic treatment?

**Timeline of the Study:** 2017 TO 2024

**Search Strategy**: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for scoping reviews was followed to ensure a systematic and transparent approach (Figure 1). Comprehensive searches were performed across multiple electronic databases, including PubMed, Scopus, Web of Science, Embase, Cochrane Library, Google Scholar, CINAHL, PsycINFO, and ProQuest Dissertations and Theses. Keywords and Boolean operators were used strategically to refine the search, employing combinations of "Invisalign", "clear aligners", "arch expansion", "maxillary expansion", "dental arch expansion", "transverse expansion", "predictability", "efficacy", "clinical outcomes", "orthodontics", and "clear aligner therapy". Boolean operators such as AND, OR, and NOT were used to ensure comprehensive coverage and minimize irrelevant results. Additionally, grey literature sources, conference proceedings, and reference lists of included articles were screened to capture relevant studies not indexed in the primary databases.

**Selection criteria:** Studies included in this review focused on clinical outcomes of arch expansion using Invisalign® or other clear aligner systems, specifically reporting

on efficacy, predictability, or patient-related outcomes. Eligible publications were systematic reviews, meta-analyses, retrospective studies, prospective studies, and randomized controlled trials published in English. Studies were excluded if they centered solely on fixed appliances without comparisons to Invisalign®, comprised case reports, opinion articles, or lacked quantitative or qualitative data. Additionally, studies that did not report relevant outcomes of interest or were conducted on non-human subjects were excluded from the review.

**Data Extraction, Synthesis, and Quality Assessment**: Out of a total of 480 articles, only 8 were included in the present scoping review based on thew inclusion and exclusion criteria. Three independent reviewers, JS, AB, and KP, played distinct roles throughout the review process to ensure rigor and minimize bias. JS was responsible for developing the standardized data extraction form and leading data collection on study design, sample size, intervention details, outcomes measured, and results. AB focused on synthesizing the extracted data narratively and conducting thematic analysis to identify patterns and trends. KP oversaw the assessment of methodological quality and consistency across the included studies. Any discrepancies among the reviewers were resolved through collaborative discussion or, if necessary, consultation with a fourth reviewer. This multi-step approach ensured a comprehensive and systematic synthesis of the available evidence.

**Figure 1: PRISMA 2020 flow diagram**

| Identification of studies via databases and registers |
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**Identification**

Records identified from PubMed, Web of Science, Google Scholar:
(n= 480)

→ Duplicate records removed (n = 112)

**Screening**

Records screened (n = 368)

→ Records excluded
 Articles removed after reading abstract (n = 190)
Articles from other languages (n = 15)

Reports sought for retrieval (n =163)

→ Reports not retrieved (n = 108)

Studies included in present scoping review (n = 08)

**Included**

Reports assessed for eligibility (n = 55)

→ Reports excluded:
  Studies not relevant to the present review criteria (n = 12)
Result not clear (n =21)
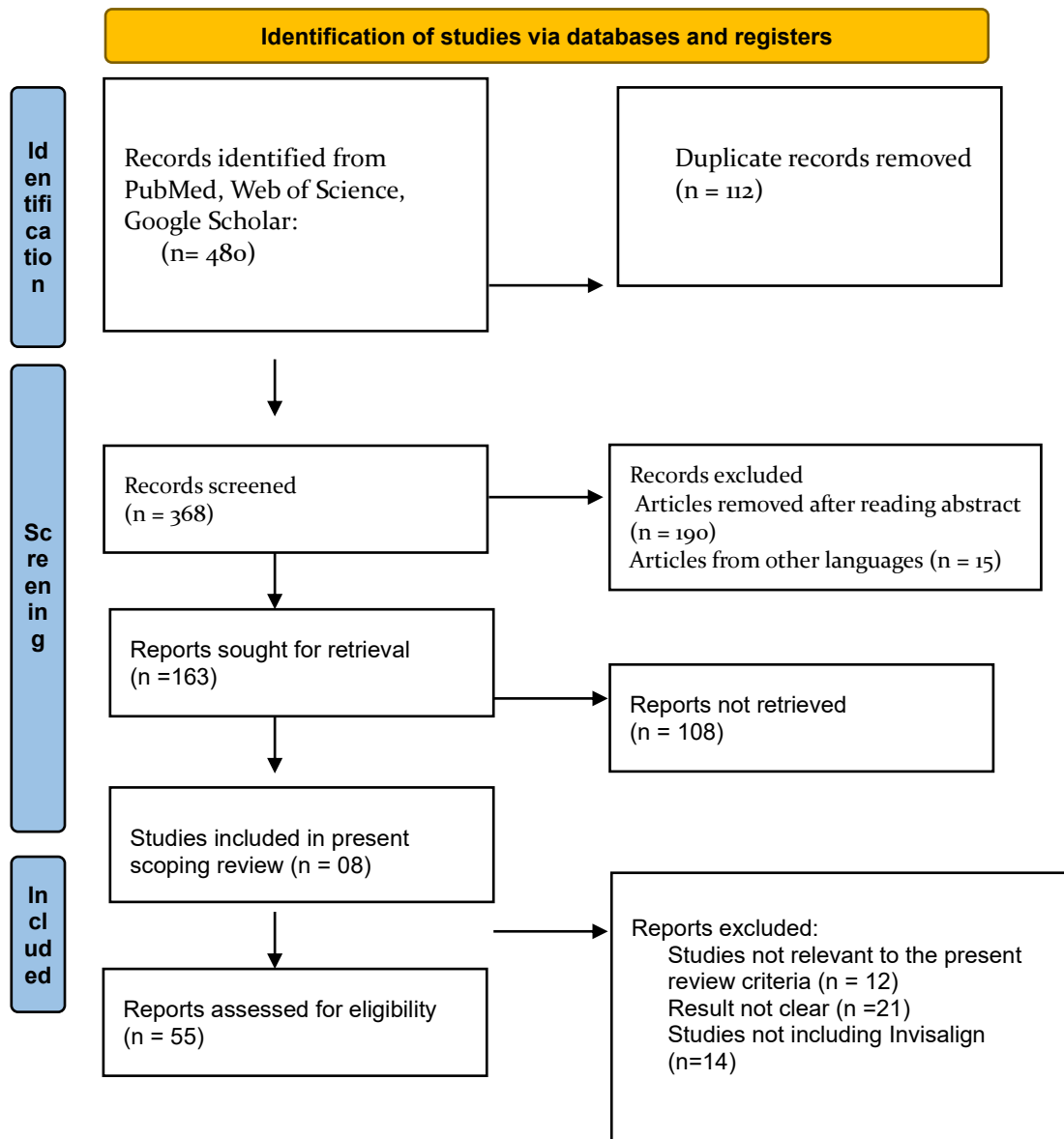Studies not including Invisalign (n=14)

**Table 1: Summary of Studies on Clinical Outcomes of Maxillary Arch Expansion with Invisalign®: Predictability, Effectiveness, and Treatment Approaches**

| Author/Year | Place of Study | Study Design/Type | Sample Population and Size | Treatment Approach and Method | Post-Treatment Key Findings | Clinical Outcomes (Predictability, Effectiveness, and Factors Influencing Treatment Success) |
|---|---|---|---|---|---|---|
| Houle et al., 2017 [16] | Australia | Retrospective study | 64 adult patients (41 females, 23 males); mean age: 31.2 years (range: 18–61 years). 20 patients had dentoalveolar crossbite involving at least one tooth, primarily premolars. | Pre- and post-treatment digital models (.stl files) obtained using iTero scanner. Measurements of upper and lower arch widths at cusp tips and gingival margins of canines, premolars, and first molars. Arch expansion planned with Invisalign only, no refinements, and aligners worn for two weeks per stage. Measurements performed using | Maxillary expansion accuracy: 72.8% (anterior: 88.9%; posterior: 52.9%). Lower arch expansion accuracy: 87.7% (anterior: 98.9%; posterior: 61%). Clincheck overestimated bodily movement; observed more dental tipping. Overcorrection recommended for posterior maxillary regions. Larger planned changes not correlated with larger errors. | Invisalign predictability: high in anterior regions, reduced toward posterior regions. Predictability and effectiveness influenced by careful planning, compliance, overcorrection in posterior regions, and use of auxiliary methods to minimize refinements. Refinements may be necessary for complex posterior corrections. Predicted expansion involved more bodily |

| | | | | Geomagic Qualify software. | | movement than achieved clinically, with increased tipping in outcomes. |
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| Morales-Burruezo et al., 2020 [17] | Spain | Retrospective Study | 114 patients, aged 18-75 years, with transverse malocclusion | Maxillary expansion using SmartTrack aligners (minimum of 15 aligners) | Significant improvements in arch widths, particularly at the canine, premolar, and molar levels. Virtual planning overestimated the achieved expansion, except at the second molar. | Aligners were effective for arch expansion, especially in the premolar region. Predictability ranged from 65.2% (second molar) to 81% (second premolar). Overcorrection should be considered in the planning stage to achieve expected results. Factors such as patient compliance and the severity of malocclusion influenced success. |
| Zhou N et al. 2020 [4] | China | Retrospective Study | 20 Chinese adult patients (28.5 ± 6.3 years old), including 5 males and 15 females | Arch expansion with Invisalign aligners (0.15 ± 0.5 mm per stage) for upper arch expansion | Significant differences between designed and achieved expansion amounts for canine, | Aligners can increase arch width, but expansion was achieved by tipping movement. Expansion |

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| | | | | | first premolar, second premolar, and first molar. Expansion efficiency was 79.75% for canine, 76.1% for first premolar, 73.27% for second premolar, and 68.31% for first molar. | was more efficient for canines and premolars than for molars. Negative correlations between preset expansion amounts and efficiency of bodily expansion were found. Predictability of expansion varied based on initial molar torque and expansion amount. Factors influencing treatment success include initial torque, expansion preset, and patient compliance. |
| Vidal-Bernárdez et al., 2021 [5] | Spain | Retrospective study | 64 upper arches, 51 lower arches from 167 patients treated with Invisalign® | Invisalign® system (SmartTrack® material) | Statistically significant differences in expansion between upper and lower arches (p<0.00005). Larger changes in the upper arch. | High predictability (98-100% at coronal level, 85-90% at gingival level), moderate expansion showed highest predictability, with the lower arch showing |

| | | | | | higher predictability at the gingival level. |
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| Levrini et al., 2021 [15] | Italy | Retrospective study | 20 patients (12 females, 8 males), mean age 8.9 years, aged 6.9-11.2 years | Invisalign® First system for maxillary expansion with clear aligners | Significant increases in arch width, arch perimeter; decreases in arch depth and molar inclination. Alveolar expansion observed at all reference points. | Effective for mild crowding and limited transverse maxillary deficiency. Predictable improvements in arch expansion, with reliable outcomes. Treatment success influenced by age, absence of complex malocclusion, and adherence to treatment regimen. |
| Galluccio G et al., 2023 [3] | Italy | Prospective study | 28 patients (15 males, 13 females), mean age 17 ± 3.2 years. Inclusion criteria: complete permanent dentition, no missing teeth in posterior sectors, treatments requiring | Invisalign® aligners with Smart-Track® material. Transverse expansion planned for correcting crowding and transverse discrepancies without auxiliaries, except for Invisalign® | Statistically significant differences were observed between T0 (pre-treatment) and T1 (post-treatment) for all transverse measurements. Clinical accuracy was 70.88% overall. Predictability was | Overall effectiveness of expansion treatment was 70%. Predictability varied by tooth type: higher at the cusp level (e.g., first premolars: 93.53%) and lower at the gingival level (e.g., intermolar level: ~55%, intercanine |

| | | | transverse expansion (2–4 mm), sufficient crown height (>4 mm), good compliance. Exclusion criteria: systemic diseases, advanced caries, periodontal diseases, need for orthodontic surgery, etc. | attachments. No interproximal enamel reduction (IPR) or extractions performed. Aligners changed weekly, and progress was monitored every four stages. Measurements taken at T0 (pre-treatment), T1 (post-treatment), and TC (virtual ClinCheck® model). | higher at the cusp level (70%-82%) compared to gingival level (~50%). Differences between planned (TC) and achieved (T1) expansions indicated more tipping movement than bodily movement. The intercanine and intermolar measurements showed lower accuracy. | level: ~46%). Tipping movements were more frequent than body movements, impacting outcomes. Planning considerations should account for overcorrection to improve accuracy and ensure predictable results. Results highlight limitations in aligner systems for achieving precise bodily movements. |
| Kim et al., 2024 [6] | Korea | Retrospective Study | 90 children (42 boys, 48 girls), aged 7-9 years, with early mixed dentition and fully erupted first permanent molars | Invisalign First® system, arch expansion planned with aligners changed every 7 days | Maxillary arch expansion predictability was 63.85%, mandibular arch expansion predictability was 76.25%. Predictability was higher in the mandibular arch. | Predictability of expansion was significantly influenced by predicted expansion per aligner, number of attachments, and placement location (buccal/palatal). Attachments |

| | | | | | Predictability was significantly lower in permanent first molars compared to primary canines and molars | improved predictability for certain teeth (e.g., maxillary first molars). Increased predicted expansion per aligner reduced predictability. |
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| Levrini et al., 2024 [14] | Italy | Retrospective Study | 64 patients (30 male, 34 female), aged 6-12 years, mixed dentition | Invisalign® First, aligners worn for 14 days initially, then weekly changes | Achieved expansion was significantly less than planned, with predictability of 59.68%-66.99% at the cuspid level and 49.87%-53.36% at the gingival level. Statistically significant differences (p < 0.05) between planned and achieved outcomes. | Maxillary expansion was effective but less predictable than planned, especially at the cuspid and gingival levels. The overall predictability ranged from 45.16% to 66.99%. Factors such as age, tooth eruption stage, and treatment protocol (aligner duration and frequency) influenced the effectiveness and predictability of the expansion. |

**Results**

Table 1 provides an extensive overview of studies evaluating the predictability and effectiveness of arch expansion using Invisalign and other aligner systems across varied populations and clinical settings. The chief highlights include a consistent trend where anterior teeth demonstrate higher predictability in expansion compared to posterior teeth. Houle et al. (2017) [16] noted that maxillary expansion accuracy diminished in posterior regions, recommending overcorrection to improve outcomes. Similarly, Morales-Burruezo et al. (2020) and Zhou et al. (2020) [4] found that virtual planning frequently overestimates achievable expansion, with better predictability at anterior teeth due to tipping movements being predominant. Levrini et al. (2021, 2024) [14,15] and Kim et al. (2024) [6] further emphasized the influence of age, compliance, and treatment protocols on predictability, noting that younger patients with mixed dentition experienced varied results depending on tooth eruption stages and aligner duration. Factors such as attachment use and placement significantly impacted outcomes, with attachments improving results for specific teeth like molars. Galluccio et al. (2023) [3] underscored that aligner systems often favor tipping movements over bodily movements, with planning overcorrection being crucial for addressing transverse discrepancies. Overall, the studies highlight the moderate-to-high predictability of aligner systems for anterior and premolar regions, while posterior corrections remain challenging. Effective planning, compliance, and auxiliary methods play pivotal roles in optimizing clinical outcomes and addressing inherent limitations in aligner-based treatments.

**Discussion**

Maxillary arch expansion is a common treatment goal in orthodontics, aimed at correcting transverse discrepancies that affect both aesthetics and function. The use of clear aligners, particularly the Invisalign® system, has gained popularity due to its non-invasive nature, comfort, and aesthetic appeal compared to traditional fixed appliances. Over the years, numerous studies have examined the effectiveness of Invisalign® in achieving arch expansion, focusing on its predictability and precision across different patient populations. While the system has proven successful in addressing anterior and premolar crowding, its ability to achieve significant expansion in the posterior regions of the maxillary arch remains a topic of debate. Factors such as the stage of dentition, the level of cooperation from patients, and the mechanical limitations of the aligner system itself play pivotal roles in determining the success of the treatment. Although aligner therapy continues to evolve, challenges remain in optimizing its effectiveness for more complex cases, especially for adult patients requiring substantial expansion.

**Predictability and Effectiveness of Arch Expansion**

Anterior teeth are more predictable in their expansion than posterior teeth, according to the evaluated research. This result is consistent with the findings of Houle et al. (2017) [16], who observed that the posterior locations, where physical tooth motions are more challenging to accomplish with clear aligners, exhibit a decline in maxillary expansion accuracy. Virtual planning frequently overestimates the amount of arch expansion that is possible, especially for posterior teeth, as noted by Morales-Burruezo et al. (2020) [17] and Zhou et al. (2020) [4]. This points to a major drawback of Invisalign®: its incapacity to effectively manage and produce noticeable expansion in the maxillary arch's posterior portions.The physical movements needed to widen the posterior arch are more difficult to forecast and carry out than the tipping movements in the anterior teeth, which appear to be more easily achieved by the existing aligner system [3,16]. In the literature, the necessity of overcorrection in treatment planning is a recurring subject. Both Houle et al. (2017) [16] and Galluccio et al. (2023 [3] stress the importance of overcorrection in compensating for the lack of control over body motions. According to the studies, the virtual planning stages may forecast results that are higher than what the system can accomplish, especially in the posterior regions. Therefore, clinicians need to incorporate a safety margin into their treatment plans to ensure that the intended expansion is reached. This is especially critical in cases where the goal is to correct significant transverse discrepancies in the maxillary arch.

**Influence of Age and Dentition Stage**

The success of Invisalign®-based arch expansion has been found to be significantly influenced by age and dentition stage. According to Kim et al. (2024), Levrini et al. (2021, 2024) [14,15], and Morales-Burruezo et al. (2020) [17], younger patients with mixed dentition might have better results than adults with fully erupted teeth. Children's teeth are still in transition, so their response to treatment may be more predictable. The ease with which aligners can move teeth depends on their developmental stage. This may help to explain why, especially for modest corrections, Invisalign® First has produced more consistent results in individuals with mixed dentition [7,15]. In contrast, fully grown adult dentition presents more resistance to movement, particularly in the posterior regions, making significant arch expansion more difficult. These findings are consistent with research by Putrino et al. (2021) [7], who suggested that fully erupted adult teeth require the use of adjuncts like mini-implants or modified aligners to achieve the desired expansion.

**Compliance and Treatment Protocols**

The efficacy of clear aligner treatments is largely dependent on compliance, as demonstrated by Kim et al. (2024) [6] and Levrini et al. (2024) [14]. Compared to fixed equipment, clear aligners demand more patient participation because they must be worn for a minimum of several hours every day to guarantee proper tooth mobility. Because the aligners will not put enough pressure on the teeth, non-compliance may produce less than ideal results. Better clinical results are also ensured by the application of suitable therapy techniques, such as attachment placement. According to Galluccio et al. (2023) [3], molars that are challenging to shift with aligners alone benefit most from attachment utilization. Attachments provide aligners the grip they need to move teeth more precisely, particularly in the posterior arch. For Invisalign® to be more successful in expanding the arches, doctors should stress the value of patient compliance and customize their treatment plans accordingly.

The treatment success with clear aligners is influenced by factors such as patient age, dentition stage, and the complexity of the malocclusion. Research indicates that clear aligners are effective for arch expansion, especially in younger patients with mixed dentition, as they tend to respond better to orthodontic treatment due to greater dental mobility [18,19]. However, when compared to traditional fixed appliances, clear aligners often face limitations in producing significant posterior arch expansion, especially in adults [9]. The role of attachments in improving aligner effectiveness has been emphasized in several studies, with attachments providing the necessary force for more precise tooth movement, particularly in the posterior region [20,21]. Furthermore, studies suggest that clear aligner systems, despite their limitations, show promising results in addressing both anterior and premolar arch expansion when treatment is well-planned and patient compliance is high [22,23]. Moreover, recent reviews have reinforced that Invisalign® can be effective in treating deep bites and achieving transverse expansion, especially with the latest system features [24]. Thus, a comprehensive approach tailored to the patient's specific needs, including effective use of attachments, and emphasizing treatment adherence, is essential for optimizing clinical outcomes.

**Limitations of Invisalign® in Maxillary Arch Expansion**

Despite its advantages in aesthetic appeal and patient comfort, Invisalign® faces limitations when it comes to achieving large-scale maxillary arch expansion, particularly in adult patients. Studies such as Zhou et al. (2020) [4]andVidal-Bernárdez et al. (2021) [5] confirm that clear aligners are not as effective as traditional fixed appliances for major expansions, particularly in cases where significant transverse changes are needed. The inherent limitation of Invisalign® in generating sufficient

force for bodily tooth movement, particularly in the posterior regions, makes it a less reliable choice for cases requiring substantial arch expansion.

In adults, the fully grown dentition is less responsive to the forces exerted by clear aligners compared to the more flexible, erupting teeth in children and adolescents. This challenge has led to investigations into adjunctive methods to overcome these limitations. For example, the use of mini-implantsortemporary anchorage devices (TADs)has been suggested to provide additional anchorage and facilitate more extensive expansion of the maxillary arch [3,5]. These adjuncts can help create the necessary forces to achieve significant movement in adult patients, compensating for the mechanical limitations of the Invisalign® system.The findings from this scoping review underscore the need for continued innovation in clear aligner therapy to improve the efficacy of maxillary arch expansion. Technological advancements in virtual treatment planning and aligner materials, along with improved attachment systems and adjunctive tools, are likely to enhance the predictability and effectiveness of Invisalign® for arch expansion. Future research should focus on the development of tailored aligner systems that can achieve better control over bodily movements, particularly in adult patients, and investigate the role of adjuncts such as mini-implants in combination with aligner therapy.Clinicians should continue to consider patient age, dentition stage, compliance, and treatment planning protocols when opting for Invisalign®-based arch expansion. For younger patients, Invisalign® First may provide a highly effective solution for addressing minor to moderate transverse discrepancies. However, for adult patients requiring significant expansion, a multidisciplinary approach incorporating fixed appliances or adjunctive devices may offer a more predictable and effective solution.

## Conclusion

Thus, this scoping review underscores that while Invisalign® clear aligners show considerable promise for maxillary arch expansion, especially in the anterior and premolar regions, achieving substantial posterior expansion remains challenging. The effectiveness of this treatment modality is highly influenced by factors such as age, patient compliance, and the complexity of the malocclusion. Clinically, Invisalign® proves to be a viable option for patients seeking a less visible and more comfortable alternative to traditional fixed appliances, particularly for mild to moderate transverse discrepancies. However, in cases requiring more significant expansion, adjunctive methods, such as attachments, overcorrection strategies, or even the combination with fixed appliances, may be necessary to achieve optimal outcomes. Future research should focus on refining treatment protocols, improving the accuracy of virtual planning tools, and exploring the role of additional orthodontic devices in enhancing the predictability of results. Clinicians should carefully assess each patient's specific needs and tailor their treatment approach accordingly, considering the limitations of

clear aligners for addressing complex maxillary arch expansion cases. Further advancements in aligner technology, along with a better understanding of their biomechanical capabilities, are expected to enhance the overall success and predictability of treatment. By incorporating these considerations, orthodontists can provide more effective and personalized care for patients seeking the benefits of clear aligner therapy.

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