

Efficiency of Clear Aligners in Growing Patients: A Narrative Review

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ABSTRACT

Orthodontic aligners have revolutionized the field of orthodontics, providing an esthetically pleasing and comfortable solution for the treatment of malocclusions. In recent years, there has been a growing interest in the use of aligners in growing patients, including those with mixed and primary dentition. This review aims to assess how well orthodontic clear aligners work for young patients and offer insights into their usage. Clear aligners are currently being utilized to address dental malocclusions in growing patients, including crossbites, facilitating skeletal modifications, such as arch expansion, and managing skeletal issues like class II malocclusion.

Keywords: Clear aligners, Children, Growing patients, Mixed dentition aligners.

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INTRODUCTION

Technological advancements have enabled numerous inventions that were once merely conceptual to materialize into reality. The same could be attributed to clear aligners whose history began at the start of the 20th century. Clear aligners are a sequential set of removable plastic appliances that are used for moving teeth.¹ Harold Dean Kesling's fundamental idea of a "tooth positioning appliance"² was revamped and became mainstream with the introduction of CAD/CAM-based clear aligner system by Align Technology (Santa Clara, CA, USA) in 1999.³ From that point onwards, the clear aligner therapy (CAT) is changing the dental and orthodontic landscape.⁴

The utility of clear aligners in growing patients is particularly intriguing due to their convenience, comfort, and virtually invisible appearance.⁵ Orthodontic intervention during the mixed dentition phase has both dental health benefits as well as psychosocial benefits.⁶ Patients also appear to show acceptance and willingness to cooperate with CAT as well as expressing a higher level of satisfaction, with the end outcome.⁷ Mixed dentition treatment goals primarily aim toward skeletal rather than dental correction. Thus, to devise a treatment plan, the clinician must acknowledge the growth and development patterns and understand the potential effects of the same.⁸

The efficacy, safety, and acceptability of aligners in the mixed dentition stage require thorough evaluation. Recently, research has begun to investigate the applicability of aligners in growing patients, evaluating various factors, such as dental movement control, patient experience, and clinical outcomes.

However, the literature related to this topic is still fragmented, and thus, this review aims to assess how well orthodontic clear aligners work for young patients and offer insights into their usage.

MATERIALS AND METHODS

Electronic databases, "Cochrane Database," "PubMed," "Science Direct," and "Google Scholar," were searched to identify related studies published in the period from 2014 to 2024. Abstracts and full texts were evaluated to identify studies that described the use and

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effectiveness of clear aligners in patients up to the age of 15 years. Keywords used in the search were "Clear aligners," "Orthodontic," "Children" and "Growing patients."

DISCUSSION

Upon examining the literature, it was discovered that clear aligners are being utilized to address dental malocclusions in growing patients, including crossbites, facilitating skeletal modifications such as arch expansion, and managing skeletal issues like class II malocclusion.

Class II Malocclusion

Class II malocclusion affects nearly 20–25% of individuals and is the most common form of jaw misalignment problem in orthodontics.⁹ There remains an ongoing debate regarding the efficacy of functional appliances in effectively stimulating mandibular growth over short- and long-term periods.¹⁰ But since excessive overjet and overbite associated with class II malocclusion influences the functional, psychological, and social health of the patient early intervention is often advocated.¹¹ Studies have shown that to encourage growth of the mandibular bone, functional therapy should coincide with the period of pubertal growth.^{11–13}

Align Technology™ introduced the Invisalign with mandibular advancement feature (IMAF) in the year 2017. This innovation attempts to replicate the functionality of a twin block (TB) appliance by incorporating buccal “precision wings” positioned typically between the first molar and premolars. These wings engage the mandible in a forward position when the mouth is closed by the patient similar to TB. Simultaneously, it addresses malocclusion and crowding concerns.¹⁴

Ravera et al.¹⁵ also reported that the usage of Invisalign® mandibular advancement (MA) device effectively treats growing patients with the retrognathic mandible in the short term. Treatment outcomes, however, varied according to the growth stages. When used during the pre-pubertal growth stage, IMAF has mainly demonstrated dentoalveolar effects and when used during the pubertal growth phase, the short-term effects of IMAF are mainly dento-skeletal.

Blackham¹⁶ reported that treatment with Invisalign® featuring the IMAF effectively corrects class II malocclusions by significantly reducing overjet through upper incisor retraction and lower incisor protrusion. Additionally, they found that treatment with IMAF may lead to lower incisor proclination but to a lesser extent compared with the TB appliance. This finding of reduced lower incisor proclination was also supported by Ravera et al.¹⁵ and Koukou et al.¹⁷ in their respective studies.

Subaie et al.¹⁸ reported that both dental and skeletal corrections contributed to the treatment outcomes with MA. A decrease in the overjet, correction of the molar relationship, reduced flaring of the lower incisors, and an improvement in the growth and position of the mandible with non-significant effects on the maxilla were demonstrated in their study.

An alternative approach for class II malocclusion cases could be utilizing clear aligners enhanced with optimized attachments and class 2 elastics. Staderini et al.¹⁹ observed favorable esthetic outcomes with this method and noted consistency between the software anticipated tooth movements and the achieved clinical results. Clear aligners with elastics can be used as an alternative for correcting cases with mild class II malocclusion.²⁰

Several case reports further support the effectiveness of clear aligners in treating class II malocclusions in growing patients.^{21–23} Evidence suggests that clear aligners, as an alternative to traditional functional appliances, are more readily accepted by patients owing to their esthetic appeal. Consequently, patients demonstrate better compliance without necessitating constant motivation at each step, despite adhering to a strict wearing protocol. Moreover, their removable nature facilitates improved maintenance of oral hygiene, thus reducing the risk of periodontal complications.

When compared with TB, Both TB and MA are based on the mechanism of “inclined planes” forcing the lower jaw in an advanced position. According to Caruso et al.²⁴ both MA and TB lead to statistically significant MA. Opposed to MA therapy a significant variation in SNA angle is observed with TB therapy. Mandibular advancement therapy controls not just the inclination of lower incisors but its biomechanical design also impedes vertical eruption of incisors. The annual rate of change described with the TB appliance was “5.6 mm per year”²⁵ while with MA its “5.8 mm per year.”¹⁵

That being said, there are still some lingering speculations surrounding the application of clear aligners in growing patients with class II malocclusions that warrant further consideration and addressing. A retrospective investigation by Meade and Weir²⁶ suggests that the mean overjet measurement gained at the end of

the treatment was only 42.5% of its planned overjet measurement and less than one-third of the planned anteroposterior first permanent molar correction were achieved by MA. Almost 20% of patients treated with the MA showcased an increased overjet despite a reduction being planned. This could be attributed to incisor interference, patient non-compliance with prescribed wear schedule, variation in biologic responses, aligner material deficiencies, clinician experience, or software shortcomings. Hence, it is crucial to conduct thorough pretreatment analysis and maintain regular follow-ups, supplemented by software checks, to ensure desired treatment outcomes.

Orthodontic Arch Expansion

Clear aligner therapy can be utilized for achieving arch expansion, particularly in the premolar area. The predictability of expansion movement was also found to be reasonable. Nogal-Coloma et al. stated that greater expansion was achieved in the second premolar region with the highest percentage increase in initial width.^{27,28} However, the observed expansion was lower than the planned expansion. Thus, during the stage of treatment planning, the clinician should aim for overcorrection in the program.

Kim et al., in their case-control study with children in early mixed dentition, found that expansion was more effective on deciduous molar than first permanent molar.²⁹ Lione et al. further concluded that greater expansion was seen in the intermolar region due to rotation around palatal root.³⁰

Levrini et al.³¹ evaluated the efficacy of clear aligners for the expansion of the palate in patients during a mixed dentition period. Patients treated with Invisalign® First, demonstrated significant changes in arch width. The study further acknowledged the advantage of clear aligners over traditional fixed appliances in terms of comfort and esthetics.^{32,33}

Achieving simulated transverse goals with aligners was ~ 45% effective. To ensure treatment stability, a specific retention protocol is necessary.³⁴

Studies suggest clear aligners can achieve dentoalveolar expansion, correct crossbites, resolve to crowd, and modify arch shape.³⁵

Studies also suggest that maxillary arch expansion using clear aligners occurs via tooth tipping rather than bodily movement. The amount of transverse change decreases from anterior to posterior due to factors like cortical bone thickness, soft tissue resistance, masticatory forces, and root anatomy.

Anterior Crossbite

A reversed anteroposterior relationship between the maxillary and mandibular incisors characterizes an anterior crossbite. Based on evidence-based triage, treatment for AC is necessary if occlusal interference pushes the mandible toward class III growth pattern.³⁶

3D Space analysis is performed by the software to check for adequate space. The thickness of the aligner is important determinant for overbite control. Use of bite ramps is recommended if overbite is less than two-third.³⁷ Further, Castroflorio et al.³⁸ recommended the incorporation of Power Ridges to optimize torque control further. AC should be slightly overcorrected to ensure the settlement of incisors into the proper alignment.

Zou et al.³⁹ used clear aligners to intervene in anterior crossbite and facial asymmetry in a 4-year-old child and the desired tooth position was obtained in 18 weeks.

Thus, CAT is allegedly a viable and comfortable option for the correction of crossbites in young individuals. Clear aligner

therapy allows children to engage in their social activities without any esthetic concerns. A removable appliance facilitates optimum oral hygiene and prevents periodontal status from deteriorating, dental decalcifications during orthodontic treatment, and speech impairment due to the bulkiness of the removable appliance.^{40,41}

Comparison between Clear Aligners and Fixed Appliances

Borda et al.⁴² evaluated the treatment outcome for CAT group and fixed appliance therapy groups, ABO scores were recorded at the end of treatment and 6 months into retention phase. No statistically significant difference was found between the two scores for both the groups and both the groups at the end of the treatment, had similar buccolingual inclination and occlusal relationship.

Da Silva et al.⁴³ compared clear aligners and 2 × 4 mechanics in mixed dentition, and found that both modalities had similar efficacy and efficiency.

However, based on several systematic reviews at the post-treatment stage, fixed appliances displayed better outcomes in terms of buccolingual inclination and occlusal contact.^{44,45}

CONCLUSION

Clear aligners undoubtedly offer superior features in terms of esthetics, patient comfort, and maintenance of adequate oral hygiene but the available data suggests that there is a lack of high-quality randomized controlled trials to suggest the application and efficacy of clear aligners in growing patients.

Growing patients constantly evolve during the treatment subject to the growth potential of the jaws, thus, making it difficult for a clinician to clearly layout the treatment plan. However, early correction of malocclusion or preventing the worsening of malocclusion during the mixed dentition stage is nevertheless tempting.

With the forthcoming advancement in the technology, we can expect better science backing the use of clear aligners for growing patients as the data available do suggest the great potential for clear aligners in growing patients. Future research should focus on various types of clear aligner materials, attachment designs, force-delivering biomechanics, and their influence on orthodontic tooth movement.

Furthermore, conducting studies to evaluate how well aligners work, their safety, and how acceptable they are, during the transitional stages of tooth development could help in suggesting clear aligners as a viable choice compared with existing treatment options, for young patients.

Clinical Significance

Clear aligners offer a more comfortable, esthetic, and effective treatment option for certain orthodontic needs, and their utility in growing patients should be further explored.

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