

Clear Aligners In Mixed Dentition: A Review

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INTRODUCTION:

Following caries and periodontal diseases, malocclusion ranks as the third most prevalent dental issue globally. In children and young adults, it emerges as the second most common dental condition, affecting approximately 30%-40% of this demographic and compromising both appearance and the functionality of the dentofacial apparatus. Malocclusion leads to various negative consequences, such as periodontal diseases, difficulties in chewing, speaking, and swallowing, an elevated risk of injury, and diminished aesthetic appeal. Research indicates that individuals with attractive smiles and proper occlusion experience greater confidence and enhanced health-related quality of life compared to those with malocclusion. This impact extends to children, as poor aesthetics can significantly influence their psychological well-being. When considering methods to correct malocclusion, braces and metallic wires often come to mind, highlighting the importance of addressing aesthetic concerns, especially in younger patients. Before the introduction of braces fixed to the labial surfaces, more primitive methods were employed for correcting malocclusion. However, patients are increasingly concerned with their appearance during orthodontic treatment, making both adults and children reluctant to wear conventional metallic braces. In response to this aesthetic demand, researchers have developed various alternatives to traditional braces, such as composite brackets, ceramic braces, and lingual orthodontics, each with its own set of drawbacks. A contemporary solution for non-extraction cases is the use of clear aligners, specifically designed to address issues such as misaligned teeth, mild crowding, deep overbites, spacing concerns, and narrow arches. One of the most recognized brands in this category is Invisalign, a thin, transparent plastic aligner that facilitates effective tooth movement into the desired position.

To create an accurate dental cast, impressions of the patient's teeth are taken, which can then be scanned to generate a detailed virtual 3D model. This model serves as a crucial tool in orthodontics, allowing dentists to edit and refine it using proprietary software. Remarkably, this process can address and nearly resolve malocclusion, achieving about 89% correction rate.

Once the 3D model is finalized, it is used to design a series of custom-made transparent plastic aligners that systematically and gently move the teeth into their desired positions. The production of these aligners employs advanced computer-aided design and computer-aided manufacturing (CAD-CAM) technology, paralleling the techniques used for creating splints that cover both the clinical crowns of the teeth and the marginal gingiva. For the aligners to be effective, patient compliance is critical. They must be worn for at least 20 to 22 hours a day, accumulating a total wear time of approximately 400 hours throughout the treatment period. This dedicated adherence ensures that the aligners can effectively guide the teeth into alignment, enabling a successful orthodontic outcome.

History: The history of clear aligners dates back to 1945, when orthodontist Dr. Harold Kesling first introduced the concept. His early work laid the foundation for orthodontic treatment using clear aligners. Subsequently, in 1964, Dr. Nahuom advanced this idea by developing a dental contour appliance designed for orthodontic tooth movement, which utilized thermoformed plastic sheets for shaping and aligning teeth. The evolution continued in 1993 when Dr. John Sheridan and his team refined the concept further, leading to what is known as the Essix appliance. This innovation provided a more effective approach to clear alignment solutions.

A significant milestone occurred in 1997 when Zia Chishti and Kelsey Wirth, two graduates from Stanford University, founded Align Technology in San Jose, California. They took the idea of clear aligners a step further by developing a digitally created version, which they named Invisalign. This product revolutionized orthodontic treatment by offering an aesthetic and comfortable alternative to traditional metal braces. In 2005, the clear aligner market saw increased competition with the entry of OrthoClear®, a product independently developed by Zia Chishti, one of Align Technology's founders. This emergence of competitors highlighted the growing popularity of clear aligners as an effective treatment option for correcting dental overlaps and malalignments.

Today, clear aligners are recognized as removable orthodontic appliances that have gained substantial traction in recent decades, offering patients a discreet and flexible method for achieving a straighter smile.¹

Material used in Clear Aligners: Polyethylene terephthalate glycol (PET-G) is the predominant material utilized in the manufacturing of clear aligners. In addition to PET-G, other materials that are also used include polypropylene, polycarbonate, thermoplastic polyurethanes, and ethylene vinyl acetate. Each of these materials contributes unique properties that can enhance the performance and comfort of the aligners.²

Indications: In orthodontics, different types of dental malocclusions often require treatment to ensure optimal alignment and functional harmony of the teeth. One common issue is mild crowding, which occurs when there is a spacing discrepancy of 1 to 5 mm between teeth. This challenge is frequently encountered by orthodontists and typically necessitates intervention.

Additionally, spacing issues can arise within the same range, also requiring corrective measures to achieve proper dental alignment. Another significant concern is deep overbite, particularly in cases classified as Class II, division 2. In these instances, there is an excessive overlap of the upper front teeth over the lower front teeth, which can affect both aesthetics and function. Addressing these malocclusions is essential for improving the overall dental health and appearance of patients.³

Narrow arches indicate a lack of space needed for proper dental alignment and require intervention to improve both aesthetics and functionality. Distal tipping of molars, which occurs when the molars tilt toward the back of the mouth, can be corrected through various orthodontic treatments. Furthermore, anterior crossbites—where the upper front teeth are positioned behind the lower front teeth—also require corrective measures to create a harmonious bite.

Orthodontic treatments designed for these conditions focus on optimizing dental alignment, enhancing oral function, and improving the overall health and appearance of individuals' smiles.

Indications in Mixed Dentition: Clear aligner therapy serves as an effective option for treating mild to moderate malocclusions in children, including issues like crowding, spacing, and minor adjustments. In addition to their functional advantages, clear aligners provide a discreet alternative to traditional braces, making them especially attractive to both children and parents who are concerned about the aesthetic implications of orthodontic treatment. This preference stems from their subtle appearance, which can positively influence a child's self-esteem throughout the treatment process.⁴

Moreover, clear aligners can facilitate early intervention during the mixed dentition stage, taking a proactive approach to address orthodontic issues before they worsen. However, the effectiveness of CAT in children relies heavily on their adherence to the prescribed wear schedule, highlighting the critical role of compliance in achieving optimal treatment results.

Contraindications for clear aligner therapy include:⁵

- Open bite cases
- Situations requiring teeth extrusion

- Cases with more than one missing tooth
- Teeth with short clinical crowns
- Crowding or spacing issues exceeding 5 mm
- Anteroposterior skeletal discrepancies greater than 2 mm
- Centric relation and centric occlusion discrepancies
- Severely rotated or tipped teeth

These factors may limit the effectiveness of treatment and should be carefully assessed before proceeding.

Practitioner Perspectives and Considerations: When using clear aligners for pediatric cases, practitioners must keep several key aspects in mind throughout the treatment journey:

Comprehensive Evaluation: An initial thorough assessment by an orthodontist or pediatric dentist is vital to determine if clear aligners are appropriate for a child in the mixed dentition stage. This evaluation will include:

- The child's overall dental development.
- Specific orthodontic needs.
- Current oral hygiene habits.

Personalized Treatment Plan: After the assessment, a tailored treatment plan should be created, detailing:

- The total number of aligners required.
- The expected duration of the treatment.
- The anticipated outcomes based on the child's unique dental situation.

This plan must take into account the child's growth and the timeline for the eruption of new teeth, ensuring that the treatment adapts to any changes in the child's dental landscape.

Involvement of Parents: The role of parents is crucial in the success of clear aligner therapy. They should:

- Encourage and monitor their child's adherence to good oral hygiene practices.
- Ensure consistent and proper wear of the aligners throughout the treatment duration as prescribed by the practitioner.

Regular Follow-Up Appointments: Scheduling consistent follow-up appointments is essential for:

- Monitoring progress and making necessary adjustments to the treatment plan.
- Addressing any concerns or challenges that may arise during the course of treatment.

By considering these factors, practitioners can enhance the effectiveness of clear aligner therapy and support positive outcomes for their pediatric patients.

Fabrication of Clear Aligners: The production of clear aligners is a complex process that combines both manual and digital techniques. These aligners, designed to gradually shift teeth into alignment, have gained popularity due to their aesthetic appeal compared to traditional metal braces. Below, we delve deeper into the two primary fabrication techniques: manual fabrication and digital (CAD-CAM) fabrication.

Manual Fabrication: Manual fabrication involves traditional techniques that rely on the skill and expertise of orthodontic professionals. The steps in this process typically include:

1. Impressions: The process begins with taking precise impressions of the patient's teeth using dental putty or alginate. These impressions capture the detailed anatomy of the teeth and gums.
2. Model Creation: The impressions are then used to create stone models of the patient's dental arch. This involves carefully pouring dental stone into the impressions and allowing it to set to produce a solid representation of the patient's teeth.
3. Treatment Planning: Using the models, orthodontists manually analyze the patient's bite and alignment. They determine the necessary movements required to achieve the desired final positions of the teeth.
4. Aligner Design: Based on the treatment plan, the orthodontist crafts each aligner by hand, considering the tooth movement and ensuring a snug fit. They often create multiple aligners, each one designed for a specific stage in the treatment.
5. Trimming and Finishing: After each aligner is formed, it is meticulously trimmed and polished to ensure comfort and effectiveness during wear. Attention to detail is crucial, as poorly finished edges can affect the fit and function of the aligners.

Digital (CAD-CAM) Fabrication: Digital fabrication, utilizing Computer-Aided Design and Computer-Aided Manufacturing (CAD-CAM) technology, streamlines the process and enhances precision. This method typically involves the following steps:

1. **Digital Scanning:** Instead of traditional impressions, the process begins with a digital scanner capturing high-resolution images of the patient's dental structures. This technology allows for accurate 3D modeling without the discomfort associated with impression materials.
2. **3D Modeling:** The scanned data is processed to create a detailed 3D digital model of the patient's mouth. This model serves as the foundation for the aligner design.
3. **Treatment Simulation:** orthodontists use specialized software to simulate tooth movements and visualize the treatment plan in a 3D environment. This allows for better assessment and modification of the treatment strategy.
4. **Aligner Fabrication:** Based on the finalized treatment plan, the software generates the specifications for the aligners. The design is then sent to a milling machine or 3D printer that fabricates the aligners using high-quality thermoplastic materials. This not only speeds up the production process but also enhances consistency and precision.
5. **Post-Processing:** After the aligners are manufactured, they undergo post-processing, which may include trimming and polishing to ensure comfort and a proper fit, similar to manual fabrication.

Both manual and digital fabrication techniques have their advantages and shortcomings. Manual fabrication relies heavily on the artisan skills of orthodontists and allows for personalized touches, while digital (CAD-CAM) fabrication enhances efficiency, precision, and overall consistency in aligner production. The choice of technique often depends on the practices of individual orthodontists and the needs of the patients. Regardless of the method, the goal remains the same: to create effective, comfortable, and aesthetically pleasing clear aligners that contribute to successful orthodontic treatment.

Principles of Clear Aligner Therapy: Clear Aligner Therapy employs two fundamental principles to effectively straighten misaligned teeth.

Creating Space: The first principle focuses on generating space within the dental arch. Various techniques can facilitate this space creation, with one commonly used method being Interproximal Reduction (IPR). IPR involves the selective removal of enamel between crowded teeth, allowing for better alignment. This careful removal aims to create sufficient room for the teeth to shift into their proper positions without causing significant harm to the dental structure.

Application of Force and Pressure: The second principal centers on the gentle and consistent application of force. Clear aligners are designed to move teeth incrementally into alignment by exerting steady pressure on targeted teeth. To enhance the effectiveness of this process, additional devices such as attachments, dimples, digital power chains, and elastics may be incorporated. These tools help stabilize the aligners and facilitate more precise movements. The adjustments in force—both in tension and direction—are customized based on the individual characteristics of each tooth, including size, shape, and the specific movement required. This tailored approach ensures that each tooth is moved effectively and safely into its ideal position.

Together, these principles of CAT enable orthodontists to create a comprehensive and personalized treatment plan, leading to successful outcomes in teeth straightening.

Advantages and Limitations of Clear Aligner Therapy in Pediatric Dentistry: Clear Aligner Therapy (CAT) offers several advantages in pediatric dentistry, making it an appealing option for young patients. Firstly, its aesthetic appeal is significant, as aligners are nearly invisible, allowing children to feel more confident during treatment. Additionally, aligners are often more comfortable than traditional braces, reducing the risk of irritation to the gums and cheeks. They also allow for better oral hygiene since they can be removed for brushing and flossing, promoting healthier dental practices among children. Furthermore, the treatment process is often more straightforward and requires fewer office visits for adjustments. However, there are notable limitations to CAT in this demographic. One of the main challenges is the necessity for patient compliance; children must consistently wear the aligners for the prescribed duration each day to achieve optimal results. This can be difficult for younger patients who may forget to wear them or take them out during meals. Additionally, CAT may not be suitable for complex orthodontic cases that require more extensive tooth movement or adjustments that traditional braces can more effectively address. Lastly, certain attachments or auxiliary devices used to enhance

treatment can be uncomfortable or might deter some children from fully committing to their aligner regimen.

In summary, while CAT presents valuable benefits for pediatric patients, including improved aesthetics and comfort, its effectiveness hinges on adherence and may not be ideal for all orthodontic needs.

REVIEW OF LITERATURE:

In 2016, Abraham and colleagues reported the use of modified clear tray aligners to correct an anterior crossbite in an 8-year-old child. The growing preference for orthodontic treatment has highlighted the importance of aesthetics and convenience, as children are more aware of their appearance while wearing orthodontic devices.⁶

In 2020, Staderini and colleagues reported successful treatment of anterior crossbites in two 8-year-old children using CAT. The treatment was completed in five months without significant discomfort or complications. These findings suggest that CAT could be particularly effective for correcting teeth that are still developing and adaptable enough to realign.⁷

In 2022, Zou and colleagues treated a 4-year-old child with an anterior crossbite and facial asymmetry using CAT for approximately 18 weeks. The results demonstrated significant potential for early intervention in malocclusion cases involving primary teeth.⁸

In 2023, Lombardo and colleagues studied 32 children undergoing two types of orthodontic expansion treatments: 17 received rapid maxillary expansion, while 15 used clear aligners. The findings revealed that the clear aligner system was more effective than rapid maxillary expansion, providing better control over the angulation of the upper first molar crowns and increasing the palatal area, allowing for greater expansion in the anterior segment of the arch.⁹

In 2023, Lione and colleagues assessed the transverse development of the maxillary arch in 23 subjects with an average age of 9 years, who underwent non-extraction treatment using the Invisalign First System® clear aligners. The system was effective for individuals requiring maxillary arch development. Notably, the most significant net increase was observed in the upper first deciduous molars, with rotational movement around the palatal root contributing to greater mesial breadth in the upper first molars.¹⁰

CONCLUSION:

Clear Aligner Therapy represents a significant advancement in orthodontic treatment for pediatric patients, offering a modern, discreet, and comfortable approach to correcting misaligned teeth. Its aesthetic appeal and ease of use promote better compliance among young patients, while the removable nature of the aligners allows for improved oral hygiene, fostering healthier dental habits. However, the effectiveness of CAT heavily relies on patient adherence, as children need to consistently wear the aligners for optimal results. Furthermore, while CAT suits many orthodontic cases, it may not be the best choice for complex alignments requiring greater adjustments.

Overall, CAT can be a beneficial option in pediatric dentistry, providing a tailored solution to meet the unique needs of young patients. By balancing its advantages and limitations, orthodontists can effectively incorporate Clear Aligner Therapy into treatment plans, ultimately leading to successful outcomes and enhanced confidence for children as they achieve healthier, straighter smiles.

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