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Review Article

Clear aligner therapy in mixed dentition: A narrative review

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ABSTRACT

Clear aligners are considered as one of the most comfortable substitute to fixed orthodontic therapy. It has gained much popularity recently among dentists as well as patients. Researchers are still in progress to understand and improve the functionality of clear aligners. It is widely been used in the correction of malocclusion in permanent dentition but more clarity is required in treatment of mixed dentition. With the limited literature available on the use of clear aligners in mixed dentition, this narrative review aimed to discuss the principles of clear aligner treatments in the dynamic occlusion of children.

1. Introduction

Malocclusion at an early stage can lead to various problems that might affect the dental health which further results in breathing and speech difficulties, facial asymmetry and even social well being of the child. According to American Orthodontist Association, orthodontic consultation is recommended for all kids atleast by the age of 7 years.[1] Main aim of early orthodontic intervention is to correct developing skeletal, dento-alveolar, and muscular imbalances to improve the orofacial environment before eruption of permanent teeth.[2,3] Treating class II malocclusion at an early stage is essential to decrease the incidence of premolar extraction, root resorption, ectopic cuspid eruptions, and for reduced need for surgical orthodontics.[4,5]

Apart from the traditional fixed orthodontic treatment considered within the orthodontic society, clear aligners have been introduced as an alternative for teeth alignment. It has been named as CAT (clear aligners technology) and initially it was designed to correct minor spacing and crowding.[6] Conventional orthodontic methods can result in compromise of facial appearance which is a major concern among patients seeking orthodontic therapy. In order to overcome these limitations, techniques and materials which are esthetic has been introduced into clinical practice. Due to the esthetic concern, less discomfort, less plaque deposition, control over gingival and periodontal problems clear aligners have gained popularity among dentists.[7] Diminished periodontal health in orthodontic therapy due to fixed bands, brackets and ligature wires have become out of question after the introduction of Clear aligners. Various recent literature have thrown light on complex malocclusion cases which has been resolved by CAT including correction of rotated teeth with spacing more than 5mm and extraction cases as well.

2. Review

This review was done manually by searching electronic databases like PubMed, Web of Science and Scopus by using the terms ‘clear aligners, clear aligner therapy in mixed dentition, dimensional arch changes in clear aligner

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therapy, distalization of molars using clear aligners, clear aligner therapy in pulpectomised teeth, invisalign system'.

3. Background

Since its development in 1998 (FDA approval for Align Technology to employ clear aligners for orthodontic use, it has been has been established world wide as an alternative to labial fixed appliances in terms of esthetics. Usually aligners are produced in various thickness levels (0.020 inch, 0.025 inch or 0.030 inch) through manual methods. The use of gradually thickening aligners provide more control on tooth movement and reduces the pain caused by orthodontic forces.[8] As per the manufacturer, clear aligners can effectively perform major tooth movements, such as de-rotation of bicuspids up to 50 degree and up to 4mm of root movements of upper central incisors.[9] With the introduction of digital technology, orthodontic practices started to get revolutionized.

Like all orthodontic modalities, clear aligner therapy has its own advantages and disadvantages. Comparing with Fixed Orthodontic Appliances, clear aligners have been associated with better oral hygiene, fewer appointments, shorter time duration, fewer emergency visits and less overall chair side time.[10–12] In recent years, the scope of aligner treatment has been greatly expanded by improvements in materials and computer assisted manufacturing methods which helps in a better understanding of aligner biomechanics, treatment staging and overcorrection; and availability of such auxiliaries as buttons, hooks, elastics and attachment of engagers.[13] Patient considerations such as lifestyle, convenience and compliance also affect the choice of appliances.

If we take account of latest innovations, among them Align technology (Santa Clara, CA, USA) introduced the Invisalign First System for the treatment of patients from age 6 to 10 with crossbite, deepbite, crowding and spacing.[14] One of the main challenges faced with the use of these clear aligners was the appliance fit during exfoliation of primary teeth and eruption of permanent successors. Many authors have reported that clear aligners are able to treat almost every malocclusion in adult patients from mild to severe, but treatments on mixed dentition are still under research. This review article is a humble attempt to compile the available literature of Clear aligner therapy in mixed dentition.

3.1. Clear aligner systems

Recently, different types of aligner systems are introduced in the market (Table 1).

The most complex CAT appliance available currently is Invisalign – which offers the utilization of both scanning and impression submission. It is a clinically adjustable (to a high degree of detail) computerized treatment plan and appliance design and pressure-formed tooth borne aligners which contains a wide range of computer-analyzed and designed attachment types, anterior bite ramps, precision cuts and button cut-outs which aids in the easy incorporation of elastics in treatment, and power arms and power ridges for improved axial root movement and torque control, respectively. For complicated uprighting and tooth-intrusion movements pressure points are also built in the aligners.[13,15]

Table 1: Various clear aligner systems

Minor tooth movement with limited clinical applicability	It is a cheaper and faster alternative to comprehensive orthodontic treatment, these includes Originator, Simpli 5, MTM Clear aligner and Clearguide system.[15]
Direct to consumer alternatives	This category includes Crystal braces and Smile care club. These are "at home" alternatives available for patients.[15]
Make your own aligners	It is integrated with scanners and 3D printers which enables full in-house or laboratory fabrication through a 3D planning software. Available products include Suresmile, 3 Shape and Orchestrate.[15]
Complex, comprehensive systems	To improve the control of tooth movement in different planes of space in products such as Invisalign, ClearCorrect, eClingers etc 3D CAD CAM tooth movements were incorporated which is a computerized 3D interactive treatment planning and appliance design which enables bonded resin attachments and certain complex and comprehensive tooth movements.[15]

Apart from these, there is an invisible method of orthodontic treatment called as Lingual braces which bonds behind the teeth.

Different generations of Invisalign are explained in (Table 2).

4. Discussion

The process of understanding effectiveness of clear aligners in growing individuals is still going on through various researches. With the current knowledge on Clear aligners, in this review we have attempted to elucidate utilization of Clear aligners in mixed dentition.

It is always advisable to follow certain patient inclusion criteria while using clear aligners such as crown length; a minimum of 4mm crown height is recommended usually with presence of atleast 2 incisors in an arch. In terms of predictions of arch expansion treated with Invisalign system, there was lower predictability in expansion of maxillary arch comparing to that of mandibular arch and also predictability was lower in mandibular molars.

Table 2: Generations of invisalign

1^{st} Generation	Driven by displacement i.e, it solely depends upon shape of aligners for results and there were no involvement of attachments.[16]
2^{nd} Generation	Introduced by Smart Force attachments in the year 2009 for extrusions and rotations which are patient specific and tooth specific which can continuously deliver forces to the teeth.[17]
3^{rd} Generation	Developed in the year 2010. For enabling optimized rotation control of premolars (which were only available for canine earlier) G3 attachments were introduced. It also improved the outcome in class II and class III malocclusion. Precision cuts were also introduced at the same time, which would help in easy attachment of class II and class III inter arch elastics.[18]
4^{th} Generation	Developed in 2013, it contained G4 attachments which could enhance the clinical outcome in open bite cases with multiple teeth and improved optimized extrusion attachments in cases with anterior open bite.[19]
5^{th} Generation	It is multilayered aromatic material made of a copolymer and thermoplastic polyurethane smart track (LD3O) were used. G5 attachments were introduced for the correction of deep bite that helps to level the curve of spee by controlled premolar extrusion and anterior intrusion.[20]
6^{th} Generation	In 2014, Invisalign G6 was introduced for cases with first premolar extraction. Optimized retraction attachments were introduced which can initiate bodily movements of canine that eliminate unwanted tipping and anterior extrusion with/without elastics. Posterior anchorage were strengthened using optimized anchorage attachments.[21]
7^{th} Generation	It aimed to deliver better finishing outcomes of cases which was faced by some clinicians. It helps in upper lateral movement control, improved root movement control and features to address prevention of posterior open bites.[22]
8^{th} Generation	8^{th} generation were designed for crowding and crossbite cases. Optimized expansion support and rotation attachments were incorporated to reduce the potential of buccal crown tipping during posterior arch expansion and aligner activation for anterior intrusion with improvements in the treatment plan setups to level the curve of spee and demonstrates upto 2 times improvement in predictability of incisor intrusion for cases with deep bite.[23]

This may be attributed to the differences in bucco-lingual inclinations of mandibular and maxillary posteriors in children. Mandibular posterior teeth are inclined more lingually compared to that of maxillary posteriors in occlusal plane. After arch expansion in most of the cases with clear aligners it have shown to maintain the arch shape.[24]

According to a study by the Lione et al, their treatment didn't involve any extraction of teeth or interproximal reduction of enamel for the expansion of maxillary arch and tooth alignment. The amount of changes near to first molars were less compared to that of maxillary canine and deciduous molar area and amount of expansion remained same at level of second deciduous molar. To which they concluded that aligners can achieve satisfactory arch expansion in growing patients without any auxiliaries.[25] This is in par with another study by Galluccio et al, they observed using aligners it was rather easy to expand the arch and increase the arch perimeter, correct single tooth crossbites as these aligners also acts as a bite plane that eliminate occlusal interferences.[26]

On the contrary in a randomized control trial by da Silva et al, he mentioned it was difficult to achieve a good control of angulation of maxillary lateral incisors with clear aligners in comparison to 2*4 appliances, suggesting that fixed mechanotherapy is a better choice to control root movement. Even though clear aligners is said to be very effective in correcting moderate to minimal malocclusion and tipping, still there is an ambiguity in consistent outcomes. To understand this new studies are required in manifold cases.[27]

There are various factors involved in fabrication of clear aligners in mixed dentition like previously pulpectomised tooth especially using calcium hydroxide based obturating material has revealed increased rate of resorption when orthodontic forces are applied. The changes in morphology of crown structure after pulpectomy treatments like loss of crown structure, cast metal crowns, stainless steel crowns can also inhibit the desired tooth movement.[28] Another factor to be considered is the premature loss/over retained deciduous teeth. To overcome these hurdles 'Eruption compensation' is a feature added into clear aligner technology. At the same time if eruption compensation wells are more, this might affect the retention of aligners in the oral cavity.[29]

There is a scarcity of literature on molar distalization using clear aligner therapy and there are no conclusive results of comparison between molar distalization using clear aligners and other methods of distalization.[30] But, Garino et. al in one of their study mentioned that, a noteworthy result was achieved through three-attachment protocol comparing to that of five-attachment protocol. There was anterior attachment loss as well due to molar distalization and proclination was noted mid treatment but

incisor retraction was achieved at the end of the therapy.[30,31]

Apical root resorption is a common scenario encountered in orthodontic therapy. If force exerted rise above the optimum orthodontic force there is a high probability that it might result in apical root resorption. To understand this Michael Inchingolo et al has done a comparative study between clear aligners and fixed mechanotherapy in apical root resorption. They have yielded varying results depending upon the complexity of the treatment and most of them showed no significant differences in apical root resorption chances.[32] In another systematic analysis by Bustabul et al comparing almost 16 studies they observed that clear aligners cause minimal root resorption and highest amount of root resorption was found in maxillary central incisors.[33]

In mixed dentition, maxilla and mandible are in a continuous growth stage; hence how the treatment might interact with this growth must be established forehand. In this regard, traditional braces might be more adjustable to changes in dentition comparing to clear aligners. Another factor might be the presence of oronasal/oral breathing habits which can influence the clear aligner therapy in the same way as it affects the fixed orthodontic therapy. Therefore, in such cases habit cessation is mandatory before initiation of the treatment. Even after the completion of different phases of treatment using clear aligners, fine tuning of occlusion might be required at a later stage according to the eruption and exfoliation pattern in deciduous dentition.

While considering school-aged children/pre-adolescent, treating a child in their pre-adolescent stage can yield a very good result as they show better cooperation at this period. Psychosocial benefits of the children, minimal chances of incisor trauma during growth period, reduced incidence of extraction of premolars in the future, reduced incidence of surgery in the future, all of these can be considered as added advantages.

5. Conclusion

Clear aligners can be very effective in mixed dentition as it offers good esthetics, comfort and hygiene. It has shown to provide satisfactory results in mixed dentition with better alignment. However the outcomes can depend upon the severity of malocclusion. In most of the studies clear aligners are able to produce significant changes in maxillary arch compared to rapid maxillary expansion even though in some cases uncontrolled tipping has been noticed.

Another challenge that dentists might have to encounter is ensuring the children wear it as per clinician's instructions (20-22 hours); which can be difficult to attain in uncooperative children. Long term stability is also necessary after aligner therapy. In primary dentition, where there is a dynamic occlusion, the effectiveness and retention of the appliance requires more research.

Overall considering the available literature, clear aligners can be considered as a good treatment option in mixed dentition, but the decision should absolutely depend on individual patient needs, their compliance level, the rapidly changing occlusion and the type of orthodontic issue being addressed. It is apt to say that the most appropriate treatment plan prepared by analyzing all possible outcomes delivers the best result. For a successful treatment outcome a thorough interdisciplinary approach is required as foreseeing the growth changes and behavior modifications are crucial in young patients.

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None.

7. Conflict of Interest

Nil.

References

1. Jameson M. How early is too early for children to wear braces? Special To The Times Los Angeles Times Monday; 1999.
2. Bishara SE. Facial and dental changes in adolescents and their clinical implications. *Angle Orthod*. 2000;70(6):471–83.
3. Dibiase AT. The timing of orthodontic treatment. *Dent Update*. 2002;29(9):434–41.
4. Keski-Nisula K, Hernesniemi R, Heiskanen M, Keskinisula L, Varrela J. Orthodontic intervention in the early mixed dentition: a prospective, controlled study on the effects of the eruption guidance appliance. *Am J Orthod Dentofacial Orthop*. 2008;133(2):254–60.
5. Dugoni S, Aubert M, Baumrind S. Differential diagnosis and treatment planning for early mixed dentition malocclusions. *Am J Orthod Dentofacial Orthop*. 2006;129(4 Suppl):80–1.
6. Galluccio G. Is the use of clear aligners a real critical change in oral health prevention and treatment? *Clin Ter*. 2021;172(2):113–15.
7. Kim CH, Moon SJ, Kang CM, Song JS. The predictability of arch expansion with the Invisalign First system in children with mixed dentition: a retrospective study. *J Clin Pediatr Dent*. 2024;48(1):91–100.
8. Kim TW, Öztürk-Ortan Y. Clear Aligner Appliances: Fabrication and Clinical Application. *Turk J Orthod*. 2009;22(3):256–66.
9. The CA® Clear Aligner Splint. Available from: https://www.ca-clear-aligner.com/en/b2c/index.html.
10. Cardoso PC, Espinosa DG, Mecenas P, Flores-Mir C, Normando D. Pain level between clear aligners and fixed appliances: a systematic review. *Prog Orthod*. 2020;21(1):3.
11. Abbate GM, Caria MP, Montanari P, Mannu C, Orrù G, Caprioglio A, et al. Periodontal health in teenagers treated with removable aligners and fixed orthodontic appliances. *J Orofac Orthop*. 2015;76(3):240–50.
12. Gou Y, Ungvijanpunya N, Chen L, Zeng Y, Ye H, Cao L. Clear aligner vs fixed self-ligating appliances: Orthodontic emergency during the 2020 coronavirus disease 2019 pandemic. *Am J Orthod Dentofacial Orthop*. 2022;161(4):e400–6.
13. Weir T. Clear aligners in orthodontic treatment. *Aust Dent J*. 2017;62(Suppl 1):58–62.
14. Chan E, Darendeliler M. The Invisalign appliance today: A thinking persons orthodontic appliance. *Semin Orthod*. 2017;23:12–64.
15. Why Invisalign. Available from: https://www.invisalign.com/provider/invisalign-solutions/why-invisalign.
16. Pazzini L, Cerroni L, Pasquantonio G, Pecora A, Mussi V, Rinaldi A, et al. Mechanical properties of "two generations" of teeth aligners: Change analysis during oral permanence. *Dent Mater J*. 2018;37(5):835–42.

17. Align Technology Introduces Innovative New Features for Invisalign(R) Products. 2009. Available from: https://investor.aligntech.com/news-releases/news-release-details/align-technology-introduces-innovative-new-features-invisalignr/.
18. Align Technology Introduces Invisalign G3. 2010. Available from: https://investor.aligntech.com/news-releases/news-release-details/align-technology-introduces-invisalign-g3/.
19. Align Technology Introduces Invisalign G4; 2011. Available from: https://investor.aligntech.com/news-releases/news-release-details/align-technology-introduces-invisalign-g4/.
20. Align Technology Announces Invisalign G5 Innovations for Treatment of Deep Bite; 2013. Available from: https://investor.aligntech.com/news-releases/news-release-details/align-technology-announces-invisalign-g5-innovations-treatment.
21. Align Technology Announces Invisalign G6 Clinical Innovations for Orthodontic Treatment of First Premolar Extractions; 2014. Available from: https://investor.aligntech.com/news-releases/news-release-details/align-technology-announces-invisalign-g6-clinical-innovations/.
22. Align Technology Announces Next Series of Innovation with Invisalign(R) G7 and ClinCheck Pro 5.0 Software; 2016. Available from: https://investor.aligntech.com/news-releases/news-release-details/align-technology-announces-next-series-innovation-invisalignr-g7/.
23. Align Technology Announces Invisalign® G8 with New Smartforce® Aligner Activation Features; 2020. Available from: https://investor.aligntech.com/news-releases/news-release-details/align-technology-announces-invisalign-g8-new-smartforce/.
24. Vidal-Bernárdez ML, Vilches-Arenas A, Sonnemberg B, Solano-Reina E, Solano-Mendoza B. Efficacy and predictability of maxillary and mandibular expansion with the Invisalign® system. *J Clin Exp Dent*. 2021;13(7):669–77.
25. Lione R, Lombardo EC, Paoloni V, Meuli S, Pavoni C, Cozza P. Upper arch dimensional changes with clear aligners in the early mixed dentition : A prospective study. *J Orofac Orthop*. 2023;84(1):33–40.
26. Galluccio G, DeStefano AA, Horodynski M, Impellizzeri A, Guarnieri R, Barbato E, et al. Efficacy and Accuracy of Maxillary Arch Expansion with Clear Aligner Treatment. *Int J Environ Res Public Health*. 2023;20(5):4634.
27. Silva VMD, Ayub PV, Massaro C, Janson G, Garib D. Comparison between clear aligners and 2 × 4 mechanics in the mixed dentition: a randomized clinical trial. *Angle Orthod*. 2023;93(1):3–10.
28. Kim CH, Moon SJ, Kang CM, Song JS. The predictability of arch expansion with the Invisalign First system in children with mixed dentition: a retrospective study. *J Clin Pediatr Dent*. 2024;48(1):91–100.
29. Tuncay O, Bowman SJ, Amy B, Nicozisis J. Aligner treatment in the teenage patient. *J Clin Orthod*. 2013;47:115–9.
30. Katib HS, Hakami AM, Albalawei M, Alhajri SA, Alruwaily MS, Almusallam MI, et al. Stability and Success of Clear Aligners in Orthodontics: A Narrative Review. *Cureus*. 2024;16(1):e52038.
31. Garino F, Castroflorio T, Daher S, Ravera S, Rossini G, Cugliari G, et al. Effectiveness of Composite Attachments in Controlling Upper-Molar Movement with Aligners. *J Clin Orthod*. 2016;50(6):341–7.
32. Inchingolo F, Inchingolo AM, Palmieri G, Pede CD, Garofoli G, Ruvo ED, et al. Root Resorption during Orthodontic Treatment with Clear Aligners vs. Fixed Appliances—A Systematic Review. *Appl Sci*. 2024;14(2):690.
33. Butsabul P, Kanpittaya P, Nantanee R. Root resorption in clear aligner treatment detected by CBCT: a Systematic review and Meta-analysis. *Int Dent J*. 2024;74(6):1326–36.

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