

Clear aligners in Orthodontics – A narrative review

Sangeetha RV^{1*}, Manjula KT², Madhusudan V³, Chethan Kumar²,
Sharmada Kumar³

¹PG Student, ²Senior Lecturer, ³Reader
Department of orthodontics
Sri Siddhartha Dental College and Hospital
Sri Siddhartha Academy of higher education

Abstract

Clear Aligners are an alternative to traditional braces and is designed to guide the teeth into their desired position. They are made up of strong plastic material and are fabricated to fit teeth. Aligners are arranged in sequence to achieve desired correction. It is changed for every 2-3 weeks. This article provides a brief description about Invisalign.

Key words: Clear aligners, Invisalign, Transparent braces.

Introduction

Facial beauty is an important concern in today's social life. A good facial look is crucial in framing an appealing grin, and a smile is one of the most significant human facial characteristics, adding to the face's beauty. People's quality of life and social experiences are harmed by malocclusions. The majority of people seek orthodontic treatment to improve the aesthetics of their face and smile. Malocclusions are treated using a fixed orthodontic appliance that includes the use of metallic brackets and wires, which have an unappealing appearance. To overcome this unappealing look, aesthetic appliances such as transparent braces, arch wires, lingual Orthodontics and the clear aligners system have been developed in the field of orthodontics.^[1]

Clear aligner or transparent braces are a series of clear, removable teeth aligners that is used as an alternative to traditional metal/ceramic braces. It aligns the teeth while maintaining the patient's

facial aesthetics.^[2]

History of aligners

Remensyner et al first proposed the movement of teeth in successive phases, individually arranged by a set up in casts, and the use of elastomeric appliances. In 1926, he produced the flex-o-lite gum massaging appliance, through which tiny tooth movements were corrected. Kesling invented the tooth positioner, a vulcanite device, in 1945. Though thermoplastic sheets have been made since 1896, thermoforming as a method was not understood until about 1950. Nahoum et al. created the dental contour appliance in 1964, which was made with an industrial grade vacuum forming. Modlin et al described tooth realignment using vacuum produced appliances in 1974.

Address for Correspondence:

Dr. Sangeetha RV, PG Student, Department of Orthodontics, Sri Siddhartha Dental College and Hospital, Sri Siddhartha Academy of higher education
Email : rv.sangeetha15@gmail.com

Ponitzand et al and McNamara et al described the use and efficacy of invisible retainers in 1985. Sheridan et al created the Essix technique for producing retainers in 1993. Rinchuse et al described active tooth movement with retainers in 1997. In 1998, align technology created the Aligners system. This was the first 3D digital technology-based approach. Align technology was founded by Zia Chisti and Wirth, two MBA students from Stanford University.^[3]

Generation of clear aligners

First generation: Consists of a simple aligner

system with no auxiliary parts.

Second generation: Attachments are used in the second generation to enhance tooth movement. Clinicians can include composite buttons on the teeth, and they can also use for engaging inter-maxillary elastics.

Third generation: When extrusion, de-rotation, and root movements are necessary, attachments are now placed automatically by the manufacturer's software. Indentations are made in the aligners where root torque is required.^[4]

Table -1: Materials used in aligners

Product name	Uses	Material used
Orthodontic positioners	Remove braces 3 -6 months earlier	Soft rubber/ crystal flex
Orthodontic positioners	Minor tooth movement	Polyurethane
Nite guide; occluso-o-guide, Ortho-t	Arch formation and guided eruption, minor tooth movement	Polyurethane
Myobrace	Myofunctional development use Frankel principles	Soft: silicone Hard: polyurethane
MTM clear aligner	Minor movement of upper and lower anterior teeth	RaintreeEssix ace plastic: Copolyster-proprietary
Straight n clear cosmetic correctors	Minor movement of upper and lower anterior teeth	RaintreeEssix ace plastic: Copolyster-proprietary
Inman aligner	Minor movement of upper and lower anterior teeth	Acrylic
Clear aligners	Minor movement of upper and lower anterior teeth	-
Aligners	Range from minor anterior tooth movement to complex treatment of all teeth	Smart track: multilayer polyurethane and copolyster proprietary material
Clear correct	Range from minor anterior tooth movement to complex treatment of all teeth	Zendura- rigid polyurethane ⁵

Patients' selection

A candidate for clear aligner's treatment should include completely erupted permanent teeth with completed growth. There are no age restrictions, but the ability to adhere to the treatment regimen of practically full-time wear is required. Mildly crowded (1-5mm), spacing (1-5 mm), a severe overbite (Class II div 2 cases), narrow arches can be expanded without tipping the teeth too forward.^[6,7]

Clincheck software

ClinCheck is the software used for clear aligners. It enables the Orthodontist to observe the treatment from all angles and superimpose one stage of treatment over another to visualise individual tooth movement in order to assess the likelihood of achieving the final position of teeth that is biologically viable. ClinCheck has the benefit of being extremely effective as a tool for therapeutic diagnosis. If crowding is present, a particular treatment strategy, such as a non-extraction technique with some expansion and proclination, might be prescribed. The effect of either extractions or interproximal reduction may be used as a treatment protocol.^[8,9]

Work flow of aligners

Impression is made using polyvinyl siloxane impressions material (Figure 1). Impression, wax bite in centric occlusion, photographs, radiographs are sent to Align technology with a detailed treatment-planning form.

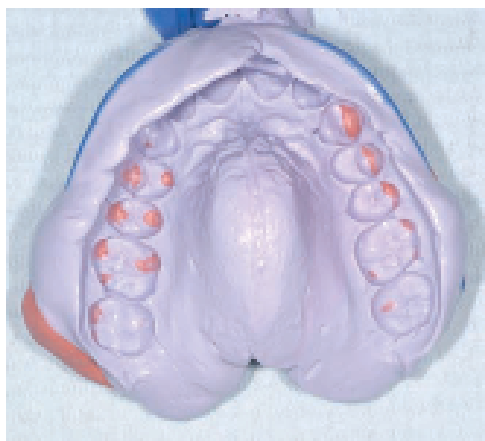


Figure 1: Polyvinylsiloxane impression

- Align technology converts the impressions into a 3D computer picture (Figure 2). The impression is poured with dental plaster, which is then placed on a tray and encased in epoxy and urethane.

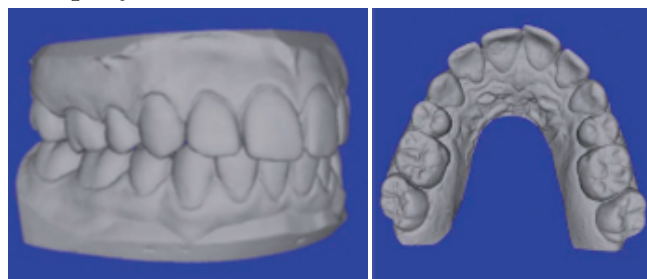


Figure 2: 3D computer image from impression

- The tray is put in a destructive scanner, and the revolving blades of the scanner make repeated passes over the epoxy-encased models, removing a small layer with each pass.
- A scanner coupled to a computer that assembles scanned data to generate a three-dimensional depiction of the models.
- After the bite has been determined, a "virtual treatment" is performed, in which a software programme is used to cut the virtual model and separate the teeth, allowing them to be moved separately.
- The clinician provides feedback on the proposed final position and intermediate tooth movements to Align technology, and adjustments are made until the orthodontist is satisfied with the treatment plan and results.
- Once treatment is approved by orthodontist, Align technology fabricates a set of clear plastic aligners, with the help of "stereolithography" where the computer images are converted to physical models (Figure 3).



Figure 3: 3: Clear aligner

8. The Aligners should be worn 20-22 hours per day and removed only for eating, drinking, and toothbrushing or flossing. The aligner is worn for 1-2 weeks and next set is used after achieving initial corrections. These appliances are disposable and virtually undetectable from about two feet away. Each aligner about 0.030" thick. Each pair of upper and lower aligners in the series (single-arch treatment is also an option) incorporates a small adjustment, allowing for 0.25 - 0.33mm of movement. The number of aligners per patient depends on the number of stages required to complete the treatment.⁷

Biomechanics

In aligner, the plastic encapsulating the tooth provides both retention and activation to move the teeth. Tooth movement takes place by elastic deformation of the aligner material and retention is obtained by the undercuts of the teeth and tight fit of the aligner to the tooth. Tooth movement is within the elastic deformation of aligner i.e., 0.2-0.5mm. The aligners are made in a sequence to achieve desired tooth movement. For vertical movement the aligner stretches within the matrix of the plastic and at the same time maintain

retention of the tooth. In aligners, there is very limited ability for elasticity within the plastic itself, these movements must be divided into very small increments and are considered difficult. This is the basic nature of how aligners move teeth, there are multiple movements that are considered unpredictable with aligners. Some of these difficult movements include controlling torque, root parallelism, rotations and extrusions.^[5]

G4–Model: attachments, power ridges and auxiliaries

Attachments can be used for retention of the aligner as well as to enhance or facilitate specific tooth movements. Movements that are termed “difficult movements” require a more sophisticated approach to attachment design based on the principles of biomechanics, is composed of three parts: virtual modelling, in vitro testing, and clinical evaluation of the resulting designs (Figure 4).^[10]

SmartTrack: It is a medical grade polymer with supplemental additives to make the material clear, thin, strong and flexible. It has Improved control and gentle force and can be constant, highly elastic, more precise aligner fit and more patient comfort.^[9]

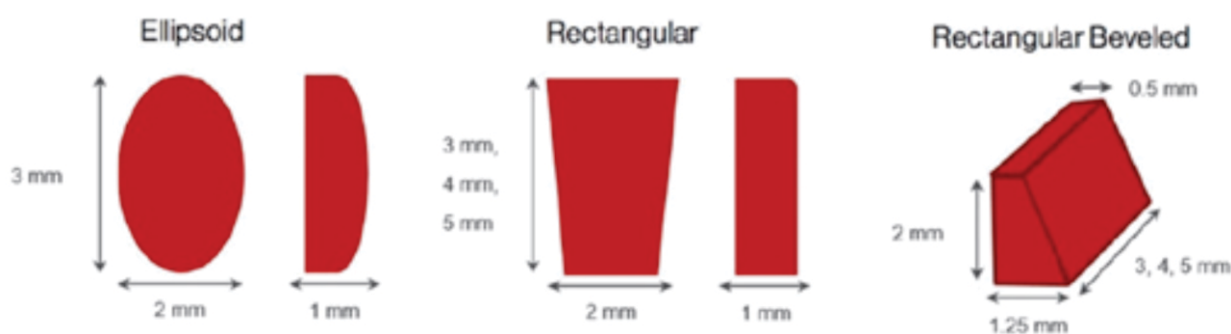
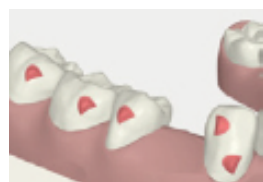
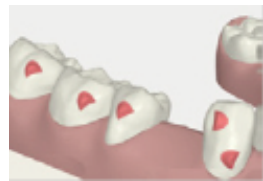


Fig. 4: Three types of conventional attachments are shown. The ellipsoid is rarely used due to poor retention. The rectangular attachment is effective for additional retention and is used for couple (moment) of teeth. The bevelled attachment is a good choice for extrusion.

Placement of attachments for various tooth movement

Attachment	Tooth movement	Attachment placement	Picture
Buccal power ridge	Lingual root torque	Upper and lower incisors	
Buccal power ridge and lingual power ridge	Lingual root torque and retraction	Upper incisors	
Rotation	Rotation	Upper and lower canines, premolars	
Extrusion	Extrusion	Upper and lower incisors and canines	
Multiple anterior tooth extrusion	Extrusion	Incisors	
Root control	Tipping	• upper central and lateral incisors • upper and lower canines and premolars	
Multi-plane movement features	Extrusion ± crown tipping ± rotation	Upper lateral incisors	
Deep bite attachments	During anterior intrusion, deep bite attachments are used for anchorage/retention or activated	Upper and lower premolars	

Pressure areas	Anterior intrusion	Incisors and lower canines	
Precision bite ramps	Disocclude the posterior teeth	Upper incisors	
Multi-tooth Unit	Optimized Retraction Attachment	Canine retraction Upper and lower canines	
Multi-tooth Unit	Optimized Anchorage Attachment	Posterior anchorage Upper and lower second Premolars and molars	

Advantages

- 1) Aligners use light continuous orthodontic forces perceived as intermittent by the periodontium, and orthodontic intermittent forces are able to produce orthodontic tooth movement with less cell damage in the periodontium.
- 2) Treatment with Aligners provides better esthetics and comfort and lesser plaque accumulation, and is gentler for gingival tissue than fixed orthodontic appliances. It is easier to maintain oral hygiene.
- 3) Aligners resulted in superior functional and psychological differences compared with fixed appliance, as well as significantly reduced pain.
- 4) Aligners are also very effective for the treatment of cranio-mandibular disorder patients when combined with splints.^[4]

Disadvantages

- 1) Aligners might not be able to produce

adequate occlusal contacts as well as braces, probably because it is difficult for aligners to extrude a tooth unless due to the undercut and also aligners cover the occlusal surface of the teeth preventing settling of the teeth. Strict requirement of patient compliance is needed for successful outcomes.

- 2) There is release of BPA (bisphenol -A) from plastic materials and auxiliaries such as adhesives and polycarbonate brackets and aligners. The release of BPA increases alkaline environment at high temperature and exposes the aligners to transient heat shock during consumption of hot liquids. Aligners are limited to patients whose permanent teeth are erupted.
- 3) The clear aligners are made of transparent thermoplastic materials which may undergo staining over time.^[4]

Retention

After completion of treatment, all attachments

and auxiliaries are removed, and impression is taken for fabrication of retainers. Retainers may be fixed or removable. Removable retainers include Hawley retainers, clear vacuum-formed retainers, and Vivera retainers. Clear vacuum-formed retainers with full palatal coverage may also be considered in cases where there has been maxillary arch expansion. Vivera and clear vacuum-formed retainers may be fabricated over bonded lingual wires. In this case, the lingual wire should first be bonded and then a digital scan or impression taken for the retainers.^[11,12]

Conclusion

The aesthetics of patients wearing Aligners increases due to its transparent nature. Patients should be well educated about the advantages and disadvantages of clear aligner therapy. The Aligners appliance can provide an excellent esthetics during treatment, comfort of wear, ease of use, and superior oral hygiene.

References

1. Kumar K, Bhardwaj S, Garg V. Invisalign: A Transparent Braces. *J Adv Med Dent Scie Res* 2018;6(7):144-147.
2. Shivaprakash G. Invisible Orthodontics: Gen Next. *CODS*. 2012;4(1):08-11.
3. Phulari B. History of orthodontics. 1st ed: Jaypee Brothers Med. Publ. 2013.
4. Sharma R, Rajput A, Gupta K, Sharma H. Clear aligner: Aligners: A review. *J Indian Orthod. Soc.* 2018;4(4):173-5.
5. Graber L, Vanarsdall R, Vig K, Huang G. 6th ed. *Orthodontics*. St. Louis, Mosby. 2017.
6. Thukral R, Gupta A. Aligners: invisible Orthodontic Treatment- a review. *J Adv Med Dent Scie Res*. 2015;5(3):42-4.
7. Ahmad E, Kalra A, Bansal K, Jasuria G, Jadon AK, Shamim W. The Aligners: A Review. *I J Pre Clin-Dent Res* 2014;1(4):76-79.
8. Boyd RL. Complex Orthodontic treatment using a new protocol for the Aligners appliance. *J Clin Orthod*. 2007;41(9):525-547.
9. Chang, Dr. Ming-Jen. "Introduction to Invisalign Smart Technology: Attachments Design, and Recall-Checks." :2019.
10. Brin I, Ben-Bassat Y, Heling I, Engelberg A. The influence of orthodontic treatment on previously traumatized permanent incisors. *Eur J Orthod*. 1991;13:372-377.
11. Becker A, Chaushu S. Long-term follow-up of severely resorbed maxillary incisors after resolution of an etiological associated impacted canine. *Am J Orthod Dentofacial Orthop*. 2005;127:6650-654.
12. Tai S. Clear Aligner Technique. 1 st ed. Batavia: Quintessence Publishing Co. 2019.

How to cite this article:

Sangeetha RV, Manjula KT, Madhusudan V, Chethan Kumar, Sharmada Kumar. Clear aligners in Orthodontics – A narrative review. *JDSR*. 2022 Sep; 13(2): 13-19