

Clear aligners – A review

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ABSTRACT

Orthodontic treatment with clear aligners is a quickly growing sector of orthodontic treatment. Both the increase in awareness of esthetics and the increase in orthodontic treatment demand from adults have fueled the demand for a more esthetic orthodontic treatment technique. Fixed appliances area of clear aligners, much of the early research was focused on trying to discredit the use of aligners as an option for orthodontic treatment except for minor crowding or spacing cases. Even so, there was some research that was done to further improve and progress the clear aligner technique which has become smaller and more esthetically acceptable with the development of ceramic brackets, but they are still more noticeable than clear aligners. Dozens of companies worldwide now offer some type of clear aligner orthodontic product.

KEY WORDS: Crowding, Dental braces, Fixed appliances, Orthodontics, Spacing

INTRODUCTION

Clear aligners, also known as clear-aligner treatment, are orthodontic devices that are a transparent, plastic form of dental braces used to adjust teeth. Clear aligners have undergone changes, making an assessment of effectiveness difficult.^[1] A 2014 systematic review concluded that evidence was of insufficient quality to determine effectiveness. Experience suggests that they are effective for moderate crowding of the front teeth, but less effective than conventional braces for several other issues and are not recommended for children. In particular, they are indicated for “mild to moderate crowding (1–6 mm) and mild to moderate spacing (1–6 mm),” in cases, where there are no discrepancies of the jawbone.^[2] They are also indicated for patients who have experienced a relapse after fixed orthodontic treatment.

With the recent increase in adults seeking orthodontic treatment, there has been a corresponding increase in demand for appliances that are both more esthetic and more comfortable than conventional fixed appliances.

Clear aligners are more noticeable than lingual braces but are probably more comfortable. They can be removed, which make cleaning of the teeth easier and they are faster for the dentist to apply.

Treatment begins with taking X-ray, photographs, a bite registration, and polyvinyl siloxane impressions of the person’s teeth and gums.^[3] The dentist/orthodontist completes a written evaluation that includes diagnosis and treatment plan. Dental impressions are scanned to create a digital three-dimensional representation of the teeth. Technicians move the teeth to the desired location with the program treatment, which creates the stages between the current and desired teeth positions. Anywhere from six to 48 aligners may be needed. Each aligner moves teeth 25–33 mm.^[4]

Aligners are thin clear flexible plastic “mouthguards” which fit closely over the teeth. A series of aligners are used to move the teeth incrementally according to a treatment plan developed by the orthodontist. Aligner appliances are ideally suited to adult patients whose lifestyle or work commitments make it difficult for them to wear more visible conventional fixed appliances.

As with any other form of orthodontics, a proper orthodontic assessment, diagnosis and treatment plan is essential to successful aligner treatment. An accurate impression of the mouth is used to create the customized aligners. Each appliance moves the teeth

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a small distance toward the intended position before moving onto the next in the series until the final result is achieved. Aligners need to be worn full time, day, and night except for meal times.

A randomized and controlled clinical trial was performed at the University of Florida in 2005, evaluating the safety, tolerability, and efficacy of recombinant human relaxin during orthodontic tooth movement (OTM) using clear aligners.^[5] This study found no significant difference between the treatment and control groups concluding that the use of relaxin did not affect the rate or amount of OTM. However, several interesting observations were noted including the following:

1. More OTM occurred during the 1st week than during the 2nd week of aligner wear for each 2-week prescription cycle
2. The full prescription of the aligners was not expressed
3. OTM was highly variable among individuals.

These observations have clinical implications and require further research.

USES OF ALIGNERS

Aligners are most commonly used in cases needing alignment of teeth without extractions.

Routine aligner treatments include:

- Mild-moderate dental irregularity
- Crowding which can be corrected with mild-moderate expansion of the dental arch
- Crowding which can be corrected with reductions in tooth width (interproximal reduction or slenderizing)
- Mild spacing.

The following cases are examples of when an aligner treatment may require the use of additional techniques such as fixed appliances to achieve an ideal result:

- Severe crowding
- Treatments that require tooth extraction
- Treatments that require complex tooth movements
- Problems that reflect an underlying discrepancy in size or position of the jaws.

TOOTH MOVEMENTS

Tooth movements that are performed well with clear aligner therapy.

- Tipping
- Rotation of incisors
- Intrusion (1–2 teeth)
- Expansion
- Constriction.

Tooth movements that are not performed well with clear aligner therapy.

- Extrusion: This is considered to be one of the most difficult movements to achieve. Attachments are required to facilitate movement by creating an undercut area
- Bodily movement during extraction space closure: This is primarily because the system has a limited ability to keep teeth upright during space closure
- Torque (labiolingual tip)
- Severe rotations (more than 20°), especially premolars and canines. A survey by Sheridan revealed that “uncorrected rotations” were one of the most prevalent problems encountered by orthodontists using Invisalign, often resulting in the need for refinement or fixed appliance
- Mesiodistal tip – (Tipping) more than 45° certain movements are possible using attachments
- Translation of molars
- Extrusion of incisors.

Efficacy of tooth movements with clear aligner therapy can be evaluated by comparing the planned virtual treatment with the actual treatment outcome. This information can help improve the appliance, guide future treatment decisions, and clarify treatment indications.^[6]

ADVANTAGES OF CLEAR ALIGNERS

One of the benefits of wearing the aligners and removing them to eat allows patients to consume food without limitations.^[7] With traditional braces, certain foods can become entangled within the wire structure and make them difficult to clean. With the clear aligner systems, there are no limitations, in which foods can be consumed, as long as patients are diligent with their oral hygiene in brushing and flossing after each meal.^[8] Some of the other advantages of clear aligners and clear braces include:

1. Approximating the treatment duration a little more precisely than braces
2. Avoiding extractions of premolars by creating interdental space through interproximal reduction
3. Less frequent trips to the dental chair by allowing the patients to replace their aligners on their own every few weeks
4. Healthier periodontal tissue and less risk of enamel decalcification by avoiding brackets
5. Esthetics: Clear aligners are often not visible, allowing patients to smile with greater confidence.

Unevenly spaced teeth and other alignment issues can significantly diminish smile esthetics. Correcting alignment issues are often an important part of improving smile esthetics, but it can also be absolutely essential for balancing out bite forces and preserving overall tooth health.

Greater Confidence throughout Treatment

Clear aligners are extremely popular among teens and adults who are seeking inconspicuous orthodontic treatments.^[9] Unlike traditional wire braces, these trays are virtually impossible to detect and can be worn comfortably both at school and in the professional arena. It is never too late to improve the structural arrangement of the teeth and clear plastic aligners are making it possible to undergo these improvements at any stage of life, without feeling self-conscious or embarrassed.^[10]

Aligners Take Less Time to Work

Surprisingly, clear aligners can also produce impressive results within a small fraction of the average treatment time for traditional wire braces. In some cases, orthodontic correction with wire braces can take up to 5 years. Most patients with clear aligners, however, will have treatment plans that last just 1–2 years.^[11]

Clear Aligners are Comfortable

Having the teeth straightened and correcting overbites, underbites, and gaps can be an uncomfortable experience. This is especially true with wire braces that must be tightened regularly and is prone to get caught on random items. Aligners have smooth surfaces that cannot get snagged on clothing, hair, or any other miscellaneous items that are brought near the mouth.^[12] Moreover, these trays are entirely removable and can be easily lifted out of the mouth when the patient wants to enjoy a hot beverage or indulge in extremely crunchy, chewy, or sticky foods. Putting aligners back in the mouth is a breeze, and this also makes it easier for people to perform diligent oral care and to effectively protect the well-being of the underlying tooth structures.^[13]

Increased Safety

Although metal braces provide a perfectly suitable form of cosmetic correction for many people, clear aligners are decidedly safer given that there are no protruding wires or bits of metal that can get caught on or scratch the lips and gums. Since these trays can be taken entirely out of the mouth, it is also easier for patients to avoid the development of tartar and plaque deposits. Both brushing and flossing are infinitely easier when access to the natural tooth surfaces is unimpeded by metal brackets or wires.

Fully Computerized Treatment Plans

Clear aligners allow for an overall orthodontic treatment plan that is far easier to follow and understand than many of the most common corrective measures of the past. These treatment plans are entirely computerized, meaning that patients can assess their treatment results phase by phase and can develop feasible expectations for forthcoming improvements in smile esthetics. This

eliminates all guesswork from the treatment process and keeps people well informed of how well their treatments are working and of what lies ahead.^[14]

DISADVANTAGES

All orthodontic appliances, including braces, have mechanical advantages and disadvantages. Some aligner mechanics are similar to braces and some are opposite.

- Short range of action
- Poor three-dimensional control of tooth movement
- Limited effectiveness with other types of movements such as bodily movements, rotations, extrusions, and severe intrusion of teeth cannot control the angulation of a tooth when they are being moved
- Compliance dependent
- Possible loss of appliance
- The current virtual dental models used in computer-assisted treatment planning and manufacturing are still considered to be incomplete
- Compliance is probably the major factor to be considered. If patients wear aligners as designed for 20–22 h daily. Once a routine is formed, aligner compliance is mostly not an issue for my patients
- As the aligners are clear and lightweight, aligner loss may be an issue; however, we instruct our patients carefully on how to use and store aligners when eating, cleaning, or on that special night out
- Tooth discomfort may be an issue in the first 1–2 days of a new aligner as teeth are moved; however, this is variable between patients and if bothersome is controlled with a mild analgesic.

TREATMENT PLAN

The field of aligner therapy has advanced from the early days of positioners to much more complex designs with more capability for advanced tooth movements such as bodily movement and space closure. The design of aligners and accompanying features, such as engagers (also known as buttons or attachments) and trimlines, tremendously affect their performance.^[15]

A fundamental of aligner therapy is that the aligner must be retained over the dentition for successful and predictable tooth movement. Once the aligner lifts, efficiency of tooth movement is compromised and mistracking begins. Methods to achieve aligner retention include placing engagers and extending the gingival trimline.^[16,17]

CORRECTIONS WITH CLEAR ALIGNERS

Open Bite

As with fixed appliances, anterior open bites can be addressed by either intrusion of posterior teeth to

allow the mandible to rotate closed, or by extrusion of the anterior teeth, or a combination of both. It is up to the practitioner to decide the best approach within the framework of treatment objectives and stability.^[18]

Extrusion of anterior teeth can be accomplished with attachments. Attachment shape and location have been shown to affect retention of aligners. Even with extrusion of anterior teeth, an advantage of using aligners for treatment is the posterior intrusive effect that the aligners will have on the posterior teeth which also facilitates closure of the anterior open bite. This posterior intrusive effect is beneficial in treating cases with crowding and minimal overbite. With fixed appliances, posterior arch expansion may tip the molars or premolars with equal ease.^[19] This tipping results in extrusion of the lingual cusp. In turn, the anterior open bite is made worse. Furthermore, with fixed appliances, if crowding is resolved with incisor proclination, the outcome of this tipping is a relative intrusion of the teeth again making the open bite worse. Extrusion of anterior teeth with attachments and intrusion of posterior teeth with the aligner could take an extended amount of time depending on the amount necessary or may need either a greater force (particularly for posterior intrusion).

Deep Bite

Deep bites are generally treated by anterior intrusion which can be difficult with aligners. Incisor intrusion can be difficult with aligners or take a protracted amount of time and no data exist on the effectiveness of these auxiliaries.^[20]

Space Closure

Closure of extraction spaces presents the challenge to finish with parallel roots. While this is true with any appliance, when using fixed appliances, root tip bends can be placed in archwires as necessary to finish the case. However, aligners present a unique challenge because the goal is to move the teeth with pure translation to prevent the tipping from occurring in the first place because a tipped tooth is difficult to correct and can take a prolonged time to upright with aligners alone. As a result, when using aligners, methods to address this issue include aligners in combination with fixed appliances.^[21]

Crossbites

Difficulty in the correction of crossbites is a factor of location in the mouth and the depth of the bite. Minor anterior or posterior crossbites with a bite depth up to about 10% are usually not difficult to treat with just the usual aligner treatment. Anterior or posterior crossbites with a bite depth greater than approximately 10% usually require some other considerations to open the vertical to allow the tooth in crossbite to clear the opposing teeth such as anterior bite ramps.

Class II Correction

The correction of a Class II malocclusion with aligners can be treated much like as it is done with fixed appliances. While no clinical trials have been done to determine which methods might be the better choice with aligners, treatment options range from distalization of the upper dentition to protraction of the lower dentition or a combination of both. In younger patients, mandibular growth can also help in the correction of the Class II malocclusion.^[22] Fischer presented several cases where he used attachments on molars and premolars to sequentially distalize the maxillary dentition to a Class I without the use of Class II elastics. In one of the cases, the second molars were extracted to facilitate the distalization. As in space closure, pure translation during distalization can be difficult with aligners or fixed appliances. Often, the posterior teeth are tipped back and care must be taken to then distalize the root and prevent the crown from relapsing and tipping forward. This movement can be difficult with aligners due to force necessary to create the moment that will distalize the root. In addition, anchorage for the distalization comes from the anterior teeth and flaring or anterior movement may occur. This is usually controlled using the lower arch for anchorage with Class II elastics which can then also assist in distalizing the upper dentition as well as protracting the lower dentition.^[22]

Class III

Treatment approach to Class III malocclusions with aligners is similar to those with fixed appliances. Class III elastics and either maintaining dental compensations or creating dental compensations are often done when a Class III malocclusion is treated by orthodontics only. When surgery is a consideration, the case is decompensated before surgery.

CONCLUSIONS

Flexible removable appliances are evolving rapidly. At present, the use of esthetic removable appliances has not been shown to be as efficient as fixed appliances in the treatment of malocclusions, especially more complex cases. The appliance is dependent on patient compliance being a removable appliance. New compliance detectors are intended to overcome this disadvantage. In the future, these appliances may become as efficient as fixed appliances as technology evolves.^[23]

Educating patients on the advantages and disadvantages of clear aligner therapy or clear braces significantly depend on patient's expectations and compliance. First, as a provider, orthodontist must rule out conventional braces by having a clear communication with the patient. If the patient desires no treatment responsibilities, is compliant in visiting

the office monthly, and wishes to have all of the treatment performed by the dentist, then conventional braces are the only treatment to recommend. Clear aligner therapy can be ruled out immediately. However, if patients desire the benefits of clear aligner therapy, the pros and cons must be presented to them. First, the patient must understand their compliance and responsibilities. They need to consistently wear the aligners 22–23 h/day and only remove them to eat. One of the benefits of the aligner systems is the opportunity to see the end result of straight teeth and the progression of tooth movement during the multitude of stages. It is essential to continuously motivate each patient during treatment to properly wear aligners to avail benefits of the treatment, ensure patient compliance as well as patient self-discipline.

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