

**Review article:**

## **Aligners: the rapidly growing trend in orthodontics around the world.**

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**Abstract:**

When patients think about orthodontics, braces are the first thing to come to mind. However, orthodontics is more than just braces. Clear Aligners are clear plastic tooth moving removable appliance; an excellent esthetic option for those adults who are reluctant to wear fixed appliance and whose chief complaint centers around mild to moderate alignment problems. Since the introduction of aligners, controversy has existed over whether moderate to difficult orthodontic treatment can be routinely accomplished. A wide range of cases can be effectively corrected. Orthodontists should gain significant clinical experience in the treatment of mild malocclusions before attempting to treat more complex cases. One needs to understand that Aligners are only an appliance, and the technique for working with it is continually being developed and honed. Refinement, adjustment at each appointment, and rebooting are all a part of the technique, and everything depends on the orthodontist's skill just as with patient with any fixed appliance.

**Keywords:** Clear Aligners, Esthetic, Orthodontics.

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**Introduction:**

The Invisalign system was introduced at an orthodontic meeting in 1991 and first described in a peer-reviewed publication in 2000. Controversy remains whether this system is appropriate for moderate-to-difficult cases.<sup>1</sup> Invisalign is a proprietary method of orthodontic treatment which uses series of clear removable teeth aligners used as an alternative to traditional dental braces. As of April 2008, more than 730,000 patients have completed or are currently in treatment.<sup>2</sup>

When patients think about orthodontics, braces are the first thing to come to mind. However, orthodontics is more than just braces. Orthodontists are concerned with the position of the teeth, what has caused them to arrive at their current position, and what future movement may be needed so that a

patient's bite is fully functional. Influence of appearance in personal and professional lives have led to a considerable interest among the adult population seeking orthodontic treatment in the last few years. Many other esthetic appliances have come into market like ceramic brackets and lingual appliance to cater the esthetic demands of adult population where in Clear Aligners are the most preferred. They are clear plastic tooth moving removable appliance; an excellent option for those adults who are reluctant to wear fixed appliance and whose chief complaint centers around mild to moderate alignment problems.

The first clinical trial found tipping movements, rotations of incisors, and space closure as the most predictable movements.<sup>3,4</sup> However, this trial was limited as new and better-performing materials

have been upgraded for use in these appliances since then. A more recent longitudinal clinical study reported that, in addition to tipping, space closure and anterior tooth rotations, intrusion was also successful.<sup>5</sup>

#### **History:**

Zia Chishti and Kelsey Wirth were graduate students in Stanford University's MBA program. Zia Chishti had finished adult treatment with traditional braces, and wore a clear plastic retainer. He noticed that if he did not wear his retainer for a few days, his teeth shifted slightly-but the plastic retainer soon moved his teeth back to the desired position. Together they started Align Technologies in April 1997 and with the help of a handful of forward thinking orthodontists, they applied 3-D computer imaging graphics and created the Invisalign method. This appliance was the first orthodontic treatment method to be based solely on three-dimensional (3D) digital technology. Align Technologies received FDA clearance to market Invisalign in August 1998, and began commercial operations in July 1999. In 2003, Align Technology formed a Clinical Advisory Board (CAB) and adopted some new elements in a "Best Practices Protocol", which would be recommended for all treatment performed after Jan. 1, 2007.<sup>6</sup>

#### *Aligners other than Invisalign*

A brief overview of some different aligners other than Invisalign is added below.

#### *Clearpath Aligners*

ClearPath was incorporated in USA in 2008 after over 8 years of Research & Development. ClearPath introduced USFDA APPROVED aligners through its unique proprietary process which provides a hygienic, convenient and a clear solution for the correction of malocclusion. A case report<sup>7</sup> demonstrates the use of clearpath aligners in the space management of patients having unilateral

missing lateral incisors as one of the options in orthodontic treatment. Aligners have the advantage of being an invisible appliance and also offer better oral hygiene as compared with fixed appliance treatment.<sup>7</sup>

#### *Inman Aligners*

The Inman Aligner, a versatile removable appliance, is a unique modification of the traditional spring retainer. It uses superelastic open-coil springs to create light and constant forces on both the labial and lingual surfaces of the anterior teeth. The appliance is designed to correct crowding, spacing, and rotations of the anterior teeth with force levels that can be adjusted to meet the requirements of each case.<sup>8</sup> Unlike the Invisalign system, the Inman Aligner is not entirely clear and has a visible metal bar that shows across the front of the teeth.<sup>8</sup>

#### *Nuvola And Fantasmio System*

In a study by Federica et al a comparison between two different clear aligner systems was done.<sup>9</sup> This study aimed to compare the 'Nuvola®' system with 'Fantasmio®' system, examine their material properties, and define the indications for use of the aligners. Two groups of patients were selected and were respectively treated with Nuvola® aligner and Fantasmio® system. The two types of aligners showed differences during the treatment. Fantasmio® system had elastic properties of high performance, but its size did not encourage compliance throughout the day. Nuvola® system determined good tooth movement and its size facilitated the patient's collaboration.<sup>9</sup>

After the initial examination of a patient, the primary decision to be made is whether they can be effectively treated with a removable aligner. Digital photographs can be e-mailed to Align Technology for an evaluation regarding the feasibility of the treatment.<sup>2</sup> A 2004 article by Spears in the *Journal*

of the California Dental Association showed that patients who require minor restorative dentistry and/or bleaching, can be good candidates for orthodontic treatment.<sup>10</sup>

Another group of patients are teenagers who wish to improve their esthetics but are not interested in having fixed appliances. Many patients will only have complaints about the appearance of their anterior teeth. These patients can be good candidates for aligner treatment, if there is an acceptable posterior occlusion .

One of the most commonly encountered types of patients who wish to have aligner treatment are individuals who have previously received orthodontic treatment using fixed appliances or who do not want fixed appliances for their present orthodontic treatment. Another type of patient who is a good candidate may be an individual with a history of successful periodontal treatment. This is primarily because of the decrease in plaque and gingivitis associated with aligners versus the increased plaque and gingivitis associated with fixed appliances<sup>4,11,5,12,13</sup> .

Patients with short roots may also be better candidates for aligners as a recent University of Florida study has shown no measurable root resorption in their longitudinal study of 100 consecutive aligner-treated patients (Wheeler T. in preparation). This is in contrast to fixed appliances, which generally show an average of 10 percent of patients having clinically significant root resorption of 3 millimeters or more<sup>14,15</sup>. However in a study by Naphtali et al , Root Resorption was reported following treatment with Aligners<sup>16</sup> where in the four upper incisors show root resorption apically, from 2 mm to one third of the original root length.<sup>17</sup>

The author concluded that the preference of the Invisalign treatment modality versus another

treatment modality should not be related to the OIIRR phenomenon.

An interesting finding with the use of the aligners is that patients who have a shallow overbite, an edge-to-edge bite, or a slight open bite, can experience improvement in the overbite by approximately 1-2 mm during treatment<sup>5</sup>. This is most likely due to the intrusive effect on the posterior teeth. This is in contrast to fixed appliances, which may often cause a decrease in overbite in these types of open bite patients due to their generally extrusive nature.

Patients who have excessive wear on their teeth from grinding or bruxing may also be good candidates for aligners because the appliance acts in a similar fashion to a nightguard during treatment. A recent study by Nedwed and Meitke et al. showed that even among patients who had a history of parafunctional habits, i.e., clenching, grinding and bruxing, that aligner treatment had no increases in myofascial discomfort, but rather decreases as compared to those with fixed orthodontic appliances.<sup>18</sup>

Another advantage of aligners is found in patients with extensive porcelain, gold, or highly restored mouths. Dental anterior and posterior crossbites can also be effectively treated by aligners because of the disclusion effect, as long as the cross-bites are dental and not skeletal in origin. Tipping of teeth had been a problem during the initial years of aligner treatment for premolar extraction cases, but new protocols using thicker buccolingual diameter (1 mm) types of rectangular attachments have more recently allowed a higher percentage of patients to have premolar extraction treatment completed with aligners only<sup>5,12,4,19,20</sup> .

#### **Recent Invisalign Protocol Improvements<sup>21</sup>:**

Recently, numerous improvements have been introduced to the protocol for use of the Invisalign

system<sup>1</sup>. These changes fall into the categories of anterior/posterior corrections, staging for interproximal reduction, staging for tooth movements, attachments, and staging of tooth movements.

#### Anterior/Posterior (A/P) Corrections

- Setups are designed to allow easier visualization of the anticipated treatment goal when incorporating interarch elastics in the treatment plan.
- Elastic wear is recommended from the start of treatment, continuing until the desired A/P correction has been achieved.
- Setups will default to display A/P bite corrections incorporating the effects of interarch elastics.
- The effect of elastics is simulated as a one-stage anterior-posterior movement at the end of treatment.
- Fewer aligners are required when simultaneous staging is employed.
- Distalization staging may be requested in the special instructions of the treatment form or during ClinCheck Review.

#### Staging for Interproximal Reduction (IPR)

- The timing of IPR is automatically staged when there is better access to interproximal contacts.
- IPR will be staged when there is not a significant overlap between teeth to avoid performing IPR on surfaces that may be damaged by instruments.
- Saving necessary IPR may be needed for Bolton's discrepancies are aligned to avoid removing enamel on an angle.

#### Staging for Tooth Movements

- Cases are staged to enable combination movements to occur simultaneously for each tooth.
- The tooth that needs to move the most (lead tooth) will determine the minimum number of stages required.
- All teeth move throughout the duration of treatment.

#### Attachments

- Attachments are now placed in the middle of the crown vs. 2 mm from the gingival margin.
- There are reduced rotational and extrusion values to trigger automated attachment placement.
- Rotational attachments are automatically sized in proportion to the clinical crown.
- One mm thick vertical rectangular attachments are used for rotations of round teeth or canines as well as translation of teeth adjacent to an extraction site.
- Use of 1 mm thick (buccal-lingual dimension) horizontal beveled rectangular attachments is standard on premolars for retention of aligners during intrusive movements such as leveling the lower curve of Spee in deep overbite, for extrusions, and for control of the tooth long axis during torquing movements.

#### Staging of Tooth Movements

- Linear and rotational velocities of teeth are tracked separately.
- The minimal number of treatment stages is determined via the lead tooth based on its rotational or linear maximum velocity.

- Slower rotations are staged in treatment.
- Movements of all teeth are simultaneous.  
This has the advantage of creating the necessary space for movements and slowing down the velocity of all tooth movements except for movement on the tooth that takes the most stages to complete at a given velocity (the lead tooth).
- Visible space (approximately 0.05 mm) is provided between teeth during movements past other teeth.<sup>21</sup>

Expansion instead of IPR is used as a primary way to increase space available for correction of crowding.

#### **Selection criteria :**

Fully erupted permanent teeth, Growth has minimal or no effect on treatment (i.e., late adolescents and adults). Mild spacing (1-3 mm), moderate spacing (4-6 mm), Mild crowding (1-3 mm), moderate crowding (4-6 mm), Narrow arches that are dental in origin(4-6 mm), Treated cases with relapse Orthodontic movements which can be reproduced effectively<sup>22,23,24,25</sup>. Tooth movement following Interproximal reduction, Dental (not skeletal) expansion, Flaring, Distalization, Space closure following the extraction of a lower incisor

#### **Certain malocclusion more difficult to treat<sup>4,23</sup>:**

Crowding and spacing over 5mm, Skeletal antero-posterior discrepancies, Centric relation and centric occlusion discrepancies, Severely rotated teeth (more than 20 degrees), Open bites (anterior and posterior), Extrusion of teeth, Severely tipped teeth (more than 45 degrees). Teeth with short clinical crowns, Arches with multiple missing teeth, Closure of bicuspid extraction spaces.

#### **Discussion:**

Patient cooperation is a critical factor in achieving success with Invisalign treatment. The aligners

should be worn at least 20 hours per day, seven days a week. Successful clear aligner treatment requires considerable clinical experience with other orthodontic methods, proper implementation of diagnosis and treatment planning, and a thorough knowledge of biomechanics<sup>1</sup>. These skills form the basis for reviewing the staging process with the ClinCheck software before treatment. Nearly all patients needing lower extractions still require completion of treatment with fixed appliances, because the spaces are more difficult to close. In any case, if the teeth tip more than 5° from the vertical axis during space closure, fixed appliances will probably be needed to upright them. Although Invisalign can hold teeth upright during the closure of upper extraction spaces, it cannot upright teeth adjacent to an extraction space once they have developed clinically significant tipping. If tipping exceeds 10°, the clinician should either incorporate a fixed appliance segment to upright the tipped teeth or convert to full fixed appliances to finish treatment.<sup>1</sup>

Recently, Nelson, described several advantages of the aligner software that were summarized from a meeting<sup>20,6</sup>. “The ClinCheck set-up can be used for diagnosis and treatment planning — evaluate the need for IPR, expansion, extraction, distalization, or proclination” as well as:

- Verifying that the technician has performed modifications,
- A consultation device to show treatment limits to patient,
- Verifying that the aligner is tracking,
- Evaluating anchorage with the superimposition or surgical simulation tools and staging, and
- Addressing the patient’s chief concern (of anterior tooth alignment) at the beginning of the series, and applying

simultaneous movements to reduce the overall number of aligners.”

**Advantages**<sup>26</sup>:

- Unlike traditional braces, the trays can be removed for brushing, flossing, and eating.
- The trays are clear, esthetic, comfortable - no metal brackets or wires to cause mouth irritation.
- Better oral hygiene than fixed. Teeth can be bleached with the appliance at the beginning and during treatment
- Shorter appointments.
- Decreased doctor & auxiliary time.
- Decreased allergic response.
- Retention facilitated.
- Ideal for retreatment.
- Decreased occlusal abrasion from parafunctional habits during treatment.
- Disarticulation of the teeth may be advantageous for patients with TMJ problems. Technically much easier than lingual appliances.
- Ability to present case to patient with final result prior to treatment.

**Limitation**<sup>27,28</sup>:

- Primary among them is compliance. Because the aligners are removable, the orthodontist must rely on the patient's motivation and dependability to achieve the desired results.
- All permanent teeth should be fully erupted for treatment using this appliance.
- There is currently no capability to incorporate basal orthopedic change with this appliance system.

- Due to the fact that the surface anatomy of the teeth cannot undergo change during treatment as it will affect the fit of aligners, major restorative work should be performed for the commencement of treatment.
- Lack of operator control.
- Inability to integrate hard and soft tissues of the head into the computer treatment. Thus, the clinician has no direct indication of where teeth are in relation to basal bone or in relation to the lips or other soft tissues of the head.

**Conclusion:**

A wide range of cases can be effectively corrected. The key to success is for the doctor to thoroughly review the entire staging process using ClinCheck software, which show the details and pathways of all of the individual tooth movements of all consecutive appliances in entirety before any treatment is started to determine the biologic and biomechanical feasibility of treatment.<sup>29,30</sup>

Clinicians who tried Invisalign in the first few years after its introduction, but abandoned it because of shortcomings such as unpredictable tooth movement, may have more success with the improved protocol. The new Invisalign protocol can be used successfully in a variety of complex cases, including malocclusions with deep and open bites, moderate to severe overjet, and upper premolar extractions. Further testing is needed by other clinicians to determine whether similar outcomes can be obtained in comparable cases<sup>1</sup>. Orthodontists will increase their chances of success with the Invisalign system if they take the time to acquire appropriate standardized instruction before using this relatively new form of treatment. They should also gain significant clinical experience in the treatment of

mild malocclusions before attempting to treat more complex cases.

One needs to understand that Invisalign is only an appliance, and the technique for working with it is continually being developed and honed.

Refinement, adjustment at each appointment, and rebooting are all part of the technique, and all depend on the orthodontist's skill just as with a patient in any fixed appliance<sup>31</sup>.

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