EFFECTIVENESS OF CLEAR ALIGNERS IN ORTHODONTIC TREATMENT - A REVIEW

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Abstract:
As the demand for aesthetic treatments is increasing, more people are seeking alternatives to fixed orthodontic appliances. Over the past few decades, clear aligners, a convenient and aesthetic alternative to traditional braces, have become extremely popular. By detailing some common aligner systems currently in use, this review will illustrate the growing appeal of clear aligners. We discuss the scope, limitations, efficacy, and stability of this approach in relation to the treatment outcomes. This review article will also consider any potential disadvantages of clear aligner orthodontic therapy.

Keywords: Orthodontic treatment, CAD-CAM, clear aligners

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Introduction:

The need for aesthetic and comfortable alternatives to traditional fixed appliances has increased due to the rise of adult orthodontic patients [1-4]. Clear aligners that meet this need are similarly bound to quick technological advances in aligner components and manufacturing processes [1]. The number and complexity of cases addressed using this strategy have expanded as a result of advancements in clear aligner procedures [5]. When compared to fixed orthodontic appliances, clear aligners are more comfortable and aesthetically pleasing, make dental hygiene easier, are less painful, require fewer and shorter consultations, and decreased emergency visits [6–8]. However, the use of clear aligners is constrained because to production costs, the need for patient cooperation, and the difficulty to correct some malocclusions [1, 3, 5, 9–12].

Aligners Produced by Manual Set up:

The manual method involves manual tooth repositioning, wax setting, and the creation of vacuum-formed retainers, all of which are laborious tasks.

Using polyvinyl siloxane material, full arch imprints are taken, and a working cast is produced. The teeth that are intended to be shifted in each aligner are identified on the working casts, and they are taken out of the cast using a 0.25-mm handsaw. Once in the desired position, the target teeth are then relocated and cemented with the block-out wax. At this point, the interproximal reduction is carried out if necessary. Following this adjustment, a pressure moulding machine or a vacuum machine is used to mould plastic sheets onto the setup model. A 3-piece set of aligners is provided to the patient after the final trimming treatments [13].

Different thickness levels of aligners (0.020 inch, 0.025 inch, or 0.030 inch) are created. The use of gradually thickening aligners provides more control on tooth movement and reduces the pain caused by orthodontic forces. One set of impressions is used to create two or three different thicknesses of aligners, with the patient being told to wear each one for 10 to 15 days. Every time a patient visits, a fresh impression is taken, which is used to create a new working cast from which the aligners are made, enabling the clinician to adjust the treatment strategy as needed and monitor the advancement of tooth movement [14, 15].

Aligners Produced by CAD-CAM Technologies:

The procedures and appliances used in orthodontics have undergone a transformation by virtue of the introduction of digital technologies. The use of CAD-CAM technologies in orthodontics and aligner therapy is becoming more widespread, akin to in other areas of dentistry.

The Clear Aligners system was initially introduced to the orthodontic market in 1999 to treat only mild malocclusions, but as new attachments and auxiliary devices have been developed, it is now possible to perform significant tooth movements and treat more complex cases, such as those requiring premolar extraction [16–18]. CAD-CAM technology is used in the design and production of the aligners in the Clear Aligners system. The clear aligner system plays a leading role in aligner therapy because of the integration of computerised virtual treatment planning and stereolithographic prototype technology for manufacture [4, 5, 13, 20].

Biomechanics of Aligner Treatment:

Clear aligners' tooth movement process may be understood from two different angles: the displacement-driven system and the force-driven system [10, 19]. The displacement driven system mainly controls simple movements such as tipping or minor rotations. The tooth continues to move until it aligns with the aligner, at which point the aligners are constructed in accordance with the tooth's position in the subsequent staged location. This technique is known to be insufficient for producing root movements and less effective at controlling tooth movement. The force driven system, however, requires biomechanical principles to facilitate tooth movement. The forces applied to the tooth by aligners are intended to be specific. The aligners' shape, which generates these forces, need not be identical to the tooth's shape. Clincheck programme determines the movement necessary for each individual tooth, the mechanical principles to carry out this movement, and the shape of the aligner. The aligner shape is altered via pressure points or power ridges in order to deliver the necessary forces [4, 10, 19]. Power ridges govern axial root motions and torque, whereas pressure points cause more challenging uprighting and intrusion movements [1, 21] (Figure 1, 2).

Figure 1: Power ridges

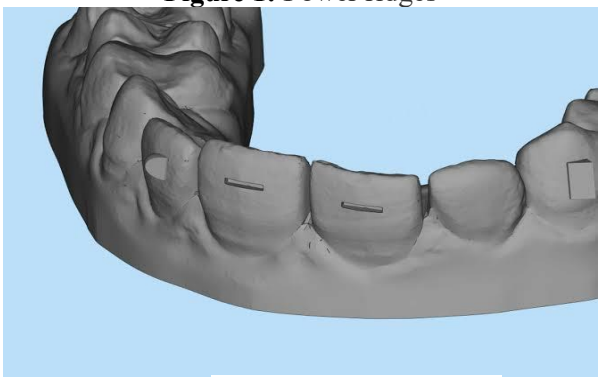
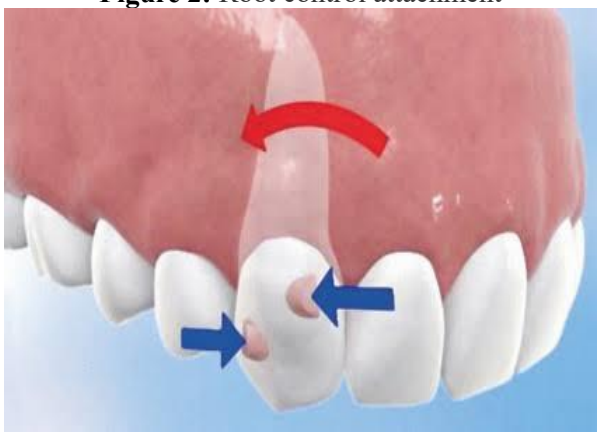


Figure 2: Root control attachment



Before Align Tech invented smart force attachments for the Invisalign system, movements including root paralleling, extrusion, and rotation were still challenging to achieve using aligners, despite changes to the aligner's design. These attachments are small composite bulges that are intended to create a force system that is advantageous for the movement that is desired. Clincheck software is used to determine their position and shape in relation to the desired movement. Currently, attachments for extrusion, rotation, and root control are employed. When compared to fixed-appliance systems, extrusion of a single tooth with transparent aligners is relatively challenging, although several auxiliary devices, including buttons and elastics, can be utilised to help with this movement. Additionally, employing aligners, a set of teeth (i.e., maxillary incisors) can be extruded.

Figure 3: Extrusion of anterior teeth using aligners

The use of temporary anchorage devices in combination with clear aligners further widened the range of treatments possible with aligners [21, 22].

Scope and Limitations of Treatment with Clear Aligners:

Clear aligners are practical for those with fully erupted permanent teeth and people whose growth has little to no bearing on their treatment (late adolescents and adults). Narrow arches that are dental in origin (4-6 mm), Mild spacing (1-3 mm), Moderate spacing (4-6 mm), Mild crowding (1-3 mm), Orthodontic movements that can be performed efficiently in treated instances with recurrence tooth movement after lower incisor extraction, including interproximal reduction, flare, distalization, and space closure.

Certain malocclusion more difficult to treat with clear aligners includes Crowding and spacing over 5mm, 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. [21, 22]

Effectiveness of Clear Aligners:

The first retrospective cohort study on the efficiency of clear aligners was carried out in 2005 by Djeu et al. [23] and compared the Invisible aligner's treatment outcomes. They claimed that while root paralleling, marginal ridge alignment, and space closure are all equally effective with both methods, the Invisible aligners system is behind when it comes to occlusal contacts, posterior torque, and the treatment of anteroposterior discrepancies.

According to Kassas et al. [24] the clear aligner method is effective for correcting buccolingual inclinations and levelling and aligning arches in mild to moderate cases, but it is insufficient to create optimal occlusal contacts. Because aligners' thickness prevents the occlusal plane from settling properly, it hampers occlusal contacts.

Kravitz et al. [20] evaluated the accuracy of tooth movement obtained by the aligners system and reported that only 41% of the predicted tooth movement was achieved. Lingual constriction (47.1%) was the most successful movement, while extrusion (29.6%) was the least accurate. Only 33% of the anticipated rotation correction was also accomplished.

When using clear aligner appliances for orthodontic tooth movement, Yıldırım et al. [25] looked at the effectiveness of their results. In their study, retrusion was found to be the most accurately obtained tooth movement followed by a rotation, fan-type expansion, and protrusion respectively.

Time Efficiency of Clear Aligners:

Private practise orthodontists should take time efficiency into account because it allows them to treat more patients while also satisfying the present patient when they spend less time with them in the clinic and finish their treatment quicker.

Bushang et al. [26] investigated the difference between conventional fixed appliances and clear aligners in terms of total treatment time and chair time in non-extraction patients. The clear aligner group's overall treatment time was determined to be 67% shorter. In contrast, the clear aligner treatment time in extraction instances is 44% longer than it is for fixed-appliance treatment. When using aligners, patients with high compliance must visit the orthodontist every 10 to 12 weeks, whereas fixed appliances must be used every 4-6 weeks. Therefore, more appointments are required in fixed appliances therapies [26]. Additionally, the clear aligner group's chair time was shown to be much shorter, enabling the clinician to serve more patients [26, 27].

Conclusion:

Influence of appearance in personal and professional lives have led to a considerable interest among adult population seeking aligner therapy in past few years. Its transparency enhances its aesthetic appeal for patients who are averse to wearing fixed appliances.

Clear aligner treatment has progressed immensely since its inception. Invisalign innovations based on fundamental biomechanics, biomaterials and orthodontic knowledge and experience have enabled practitioners to treat highly complexed cases with good clinical results.

Educating patients on advantages and disadvantages of clear aligner therapy significantly depends 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 patients desire the benefits of clear aligner therapy, the patient must understand their compliance, responsibility and the need to wear them 20-22 hour per day. one of the benefits of this therapy is the opportunity to see the end result and progression of tooth movement during multitude of stages.

As technology incorporates "orthodontic smartness" into the aligner and improves protocols and tools for treatment planning, aligner therapy moves closer and closer to becoming the true state-of- the- art- treatment.

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