

Comparison of Removable Appliance and Aligner

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ABSTRACT

Teeth position shifting in the jaw arch has been achieved for a long time, using active removable orthodontic appliances. This technique has faced some technological advancement as seen with the creation of Invisalign transparent aligner systems, which features digitally conducted treatment plans. The outcome is, therefore, stored, analyzed, and modified through computer devices, using a 3-dimensional display. Meanwhile, the advantage of transparent aligners is seen in the ease of use, as manual adjustments are not needed during the treatment progression, as observed with the conventional removable appliances. At the initiation of treatment with digital 3-dimension, teeth movement is determined using a computer device, characterized by enhanced aesthetic physical appearance. This increases patients' interest in the subsequent use of appliance to produce the desired results, within the specified time frame. This literature study is, therefore, aimed at creating an insight on technological developments in the use of active orthodontic treatment, alongside conventional removable appliances.

Keywords: orthodontics, removable orthodontic appliances, aligners

INTRODUCTION

It is important to perfectly position tooth in the jaw arch. This is obtainable by adequately planning for a dental procedure, including prosthodontics, restorations, periodontics, and oral surgery.¹ Therefore, the proper execution of this procedure plays an important role in maintaining teeth health, as well as the surrounding soft and hard tissues. Also, minor tooth movements in patients with mild malposition tend to increase treatment effectiveness, which provide long lasting results.

Perfect tooth positioning is an important factor in the maintenance of teeth and oral cavity health. The provision of minimal treatment increases the tendency of losing the tooth in vain, especially if the malposition is not corrected. Furthermore, difficulty in brushing malaligned teeth leads to a pathological state, which is related to the attachment of food debris.

The discovery of removable orthodontic appliances by Victor Hugo Jackson in the early 20th century, has led to wide applications in the movement of teeth into perfect positions.² This device is unable to perform multiple movements at an instance in time, including tipping, expansion, and rotation. Meanwhile, the level of effectiveness has been attributed to patient compliance, despite the numerous advantages supporting the use in daily clinical practice. Furthermore, the proper application is assumed to maintain better oral cavity hygiene at a low cost, alongside the ability to take off the device when the patient is uncomfortable. This limits the tendency of a dentist emergency, and the orthodontic appliance is easily repaired during subsequent visit.

With the evolution of time, patients increasingly realize the importance of face and mouth aesthetics. These needs are possibly fulfilled through the development of devices that resemble a removable orthodontic appliance, paying more attention to the aesthetic aspect. Furthermore, invisalign is a system characterized by the movement of teeth with a tray made from transparent plastic, which is made in the form of a patient's teeth.³ Also, there is a likelihood of personally removing the transparent aligner at any time.

The distinguishing features between Invisalign's transparent aligners and removable orthodontic appliances is based on the absence of a wire and base plate, which sometimes reduces the aesthetic appearance of patients. Despite the numerous deficiencies in the Invisalign system, including a weak power to change the teeth position, there are also some advantages in terms of aesthetics. This makes the device increasingly popular in the world of dentistry. The growing development of therapeutic appliances required to fulfill patients needs, raises interests in this current study, with the aim of comparing the strengths and weaknesses of existing forms. The purpose of this literature, therefore, is to compare the removable orthodontic appliances with Invisalign transparent aligners, in order to enhance the dentists' choice regarding suitability in the handled cases, therefore fitting the patient's situation and producing maximum results.

Removable Orthodontic Appliance

This device was first discovered by Victor Hugo Jackson² at the beginning of the 20th century, as the removable orthodontic appliances are much different from those widely used today. These were initially created with vulcanite as the baseplate and silver-nickel alloy wire, due to the limited availability of material. In addition, further development is sometimes made entirely of precious metals, based on the discovery by George Crozat in the early 1900s.²

At the end of the 20th century, acrylic was adopted as a base plate up to today.⁴ Meanwhile, removable orthodontic appliances are distinguished based on functions, including active and passive appliances, when used to move and maintain a tooth, respectively.⁵ Conversely, the removable forms tend to move a tooth by interrupting the existing natural pressure in a planned manner.⁶

Contemporarily, there has been a decline in the use of removable orthodontic appliances, as the fixed types are better. However, modern dental practices tend to require mixed therapy (correcting crossbite), which is an

indicators of patient compliance prior to the performance of complex procedures.⁷

Removable orthodontic appliances only provide maximum results on continuous use. This is supported by patient motivation and compliance in a series of treatments, as well as the dentist contribution to the design needed for proper and correct use. Thus, the patient ability to tolerate the presence of these devices within the oral cavity is enhanced on a longterm basis. In addition, removable orthodontic appliances have been confirmed to not follow the philosophy of complete treatment, based on the ease of conducting tooth movements through simple tipping. However, some cases tend to be more difficult (rotation and intrusion) and impossible to perform (extrusion, bodily, arch leveling, and general spacing closure).⁸

C. Invisalign Aligner System

In 1945, Dr. H. D. Kesling reported on the teeth movement method using cutting tooth models, which features individual repositioning to the desired point.⁴ In 1964, Nahoum created the first transparent aligner, which was attained by implementing the Kesling method, through the use of 20 plastic sheets with a thermoformed technique, termed Dental Contour Appliance.⁹ This device was developed in 1993 by Sheridan, and marketed as the Essix Appliance (Raintree Essix, New Orleans, La).¹⁰ However, the weakness of this method was observed in the ability to produce tooth movements between 2 mm to 3 mm, while Invisalign (Align Technology, Inc., Santa Clara, CA), in 1997 created a transparent aligner, using CAD / CAM (Computer Aided Design / Computer Aided Manufacturing).³

This development is known as a brand and a system, due to the orthodontic appliance capacity to slowly move teeth to the ideal position using the transparent plastic aligners made individually with a computer.³ This aesthetic device is made up of thin transparent plastic, which covers the buccal, palatal / lingual, and occlusal teeth. In addition, there is also a possibility of removal, as seen with the removable orthodontic appliances, which is more comfortable, as there is no interference with tongue movement in the palatal or lingual. In terms of the dentists, aligners with the CAD / CAM manufacturing process tend to improve result predictability as the design and possible movements are visible on the computer prior to use.¹⁰ Meanwhile, aligners have also been adopted as contemporary treatment for patients.³

Invisalign's Aligner is an orthodontic revolutionary development, due to the combination of scanning techniques and teeth imaging models, which is made from impressions with high accuracy. This replicates the patient's dental model on the computer in three dimensions, subsequently allowing for the virtual manipulation and correction of dental positions in accordance with the dentists treatment plan. ¹⁰ The high-accuracy three-dimensional graphics have been used to manipulate virtual tooth models, where regular and detailed movements are achievable, compared to the manual work of removable orthodontic appliances.¹¹

Complete patient data is needed by the dentist, in order to produce a suitable aligner for specific needs. The details to be collected include:⁴

1. Polyvinylsiloxane dental impression ⁴
2. Bite recording during centric occlusion ⁴
3. Panoramic radiograph⁴
4. Lateral cephalometric radiograph⁴
5. Extra oral and intra oral photographs ⁴

The large paradigm shift of dental molding in the world of orthodontics is conducted by the existing aligner system. Furthermore, the use of alginate for dental impression have been sufficient for the production of study and work models, following the advent of removable appliances, although the existence of an aligner system has demonstrated insufficiency in this technique. Currently, dental molding with two-stage polyvinylsiloxane is the recommended protocol for creating the dental impression needed to produce a good aligner. Despite the longer time required, the results obtained are often more accurate, compared with the use of alginate. The procedure for two-stage molding is initiated with the creation of an individualistic tray from heavybody material. This is followed by the casting of details with light body material, and the resulting dental impression is expected to cover the distal of second molar.¹¹

The accuracy of aligners produced with the shape of the teeth is only as good as the results included in the dental impression, which is often of low-quality as a result of negligence in the following aspects:

1. Inadequacy in dental details, especially for the distal of the last molar. The details of the unmolded last molars lead to a reduction in aligner retention, resulting from improper gripping and placement.³
2. There is a crease effect near the gingival margin, which is due to excessive speed in tray placement on the patient's teeth.³
3. The presence of air bubbles on the impression surface results in error, which often rises when placing the material on tray, as well as the inward and outward piercing of syringes.³
4. Placing the dental impression too close to the tray facilitates material thinness on certain parts, which subsequently leads to difficulty in tooth details reading by the scanner.³ The level of errors occurring in the aligner as a result of imperfect dental impressions is possibly reduced by the use of intra oral light scanners. This enables the dentists to capture images of patients' teeth in the clinic and directly send the data to the aligner maker. Furthermore, the use of currently available digital technology save polyvinylsiloxane, and reduces the potential error levels.³

The use of existing software to transfer collected data and the desired final plan to the aligner maker is followed by the conversion of teeth physical impression result to digital data with high accuracy. This involves the use of scanning technology, as the virtual model is improved in the presence of a slight disability, initiated by segmenting the tooth movement stage according to the aligner requirement. Subsequently, the virtual data of patient treatment is sent back to the dentist for review, and alignments are made using CAD / CAM technology to ensure high degree of accuracy.⁹



Figure 11. iTero; One of the many types of intraoral light scanners that can be used to minimize the use of poly vinyl siloxane.

A treatment plan involving the use of aligner produced using CAD / CAM is not the same as the conventional removable orthodontic appliance. In addition, the dentist is persuaded to imagine the tooth movement process from start to finish when creating a case with the aligner, while appliance adjustments are made in the conventional method as the treatment progresses.¹⁰

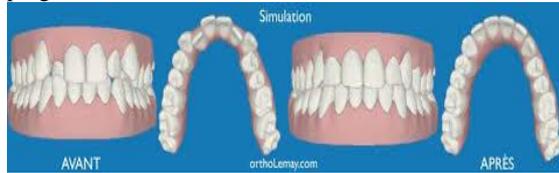


Figure 12: Simulation of treatments with transparent aligners using ClinCheck software.

DISCUSSION

The improvement of masticatory function and aesthetics are the basic goal of orthodontic science. The use of removable appliances have long been adopted to perform minor tooth movements aimed at improving teeth arrangement.¹³ Furthermore, proper diagnosis as well as regular and directed treatment plan, improved masticatory function and aesthetics are maximally achievable through the use of removable orthodontic appliances. This requires a dentist to adjust the components as the treatment progresses, which necessitate an in-depth knowledge on the functions of existing components, as well as the desired hand skills for optimal manipulation. However, ruling out this technique by the dentist has been affiliated with the inability for treatment to achieve the desired results.

The removable appliance is possibly adopted as a tool to correct the tooth position in the hands of an orthodontist. However, this is a source of new problems in the process of improving the patient's teeth position, when handled by dentists, who are less competent and skilled. Furthermore, deeper knowledge and skills are required in the creation and use of removable orthodontic therapy,⁵ as the development have unsuccessfully fulfilled the increasingly diverse treatment needs. This leads to the subsequent abandonment of the orthodontic removable appliances by dentists, as popularity begins to diminish.

Treatments involving a transparent aligner system have been attributed with reduced errors, which occur as a result of diminished dentist competence using removable orthodontic appliances. Furthermore, the aligner system does not require component manipulation as treatment progresses, as the dentist only needs to determine the tooth final position at the initiation of treatment using a software.¹⁰ The transparent aligners are able to eliminate possible treatment errors using removable orthodontic appliances by planning the movement of the desired tooth. Furthermore, designing the aligner through the entire process requires the use of current technological developments, including computer software, where movement precision and accuracy is arranged. Therefore, the use of a transparent aligner provides added value to the procedure.⁹ Meanwhile, the minimization of operator negligence during treatment potentially increases the percentage of success and patient satisfaction with the medical services provided by dentists. This orthodontic therapy is an action where dentists attempt to reposition an individual's teeth,¹³

which requires a sufficient and consistent amount of force to ensure proper and correct movement.¹² In addition, tooth movement is believed to occur as a result of biological changes in the surrounding supporting tissues, especially in the aspect of surrounding bone thickness. This modification results from the experience of bone deposition in the compressed area by osteoblasts, while the opposite area undergoes bone repositioning as a result of osteoclast activity.¹² Furthermore, the biomechanical process used is triggered by the appropriate amount of pressure, which is approximately 20 grams / cm², according to Schwarz (1931).⁶ Therefore, occasions where the compressive force exerted is too low, feature the absence of changes, while the presence of too large exertion is accompanied by imperfect changes, which leads to pathological states.¹³

The basis of tooth movement with removable orthodontic appliances lies in the components, which is estimated by calculating the diameter, wire length, and the contact position between the tooth surface and the wire. This possibly determines the amount of force required to ensure a movement,⁵ hence the creation of improperly calculated devices have a high tendency to provide an undesirable force. Furthermore, good knowledge and skill are required to enhance the working capacity to a removable orthodontic appliance, hence the inability for a dentist to manipulate the components according to the desired style leads to the production of movements that are not aligned with expectations. The transparent aligners tend to overcome the possible disadvantages in terms of component manipulation.

These limitations are weakened by creating a system without the need for manual component manipulation. The system works digitally from the initial patient case determination, up to the achievement of final results. In addition, the amount of force required for the movement of each tooth to the desired position is identified. This is then translated into a transparent tray, which is subsequently divided into stages, in according to the degree of difficulty.¹¹

Using the digital aligner system (Computer Aided Manufacturing), the computer is programmed to produce individualistic trays, which accommodate tooth movements according to the required force.⁹ In addition, dentists no longer need to worry about tooth movement that is too fast or too slow, as a result of the difficulty in predicting the amount of tooth movement that occur from manual manipulations. This is due to the design of the aligner trays, which is fabricated to accommodate tooth movement by covering the surfaces, in order to maintain the teeth position in the planned place. Meanwhile, the high result predictability is a characteristic of the modern removable orthodontic appliance, which is increasingly preferred among dentists in worldwide.¹⁰

The aligner system allows patients and dentists to observe the final results after the dental molding procedure, followed by sending the impression to the manufacturer. This is then converted into a digital form, where the dentists are able to design the desired tooth position with a computer software.³ At this stage, the dentist is able to show the patient the exact process to expect, and ask for opinions related to the planned final results.¹⁴ In addition, the patients tend to reduce the level of trust, as their contribution is required for the determination of tooth shape and appearance. This aligner system allows for the verification of desired tooth movements and process modification in teeth shifting

where needed. After determining the final results at the initiation of treatment and the manufacture of high-precision tray, a very low tendency of failure is expected to occur. Furthermore, the digitally produced tray reduces the dentist input at each control visit, as the manipulation of wires is evaded. Conversely, the reduced patient control time provides psychological comfort as the time to the spent in the clinic or hospital is saved.

With reduced control time, dentists are provided with more time to work on other patients. In addition, the less satisfying aesthetics of removable orthodontic appliances, as well as the limited ability to produce a variety of forces for movement also serve as obstacles during use. Furthermore, the existence of observable wire parts during socialization increases the reluctance to continuously use the appliances.¹⁵ Hence, a near invisible transparent aligner provides additional value, including the aspect of aesthetics, which facilitates the increased use by dentists in minor dental malposition. Using the same treatment results as conventional removable orthodontic appliances, transparent aligners contribute to the further advancements in treatment.¹⁶ Therefore, patient compliance was identified as the main problem faced, as long-term usage is required for optimal results.⁵ However, the absence of routine use and time insufficiency has been affiliated with poor treatment outcomes within the estimated period. The use of a transparent aligner decreases the patient's doubt on the efficiency of removable orthodontic appliances, as the high aesthetic value increases interest in compliance. This modified device alleviates the feeling of shame in daily application while socializing,¹³ and the high aesthetic also provides greater opportunities for treating patients with special jobs and elevated interest in appearance, including athletes, musicians, and celebrities. Meanwhile, the aligner tray functions both as an aid during therapy, as certain cases e.g., public figures, demand aesthetic enhancement. The use in teeth whitening processes does not interfere with teeth position improvement, as treatment time is shortened simultaneously for both procedures. Conversely, the advantages of tray aligners as a multi-functional treatment appliance are the independence from patient compliance. This is not attainable with removable orthodontic appliance and aligner treatments, particularly because the device is to be worn routinely over a long period. Meanwhile, the incidence of non-compliance possibly results from various factors, including comfort and aesthetics, as the transparent aligner increases the number of patient visits without altering personal appearance. This device also enhances the confidence to consistently use the appliance. In terms of comfort, the removable type is capable of providing a less comfortable sensation to users, due to the presence of an acrylic base on the palate as well as the visible wire barrier. These characteristics are absent in the aligner as the fabrication with elastic plastic allows for the ease of use, and also ensure comfort, by eliminating the sensation of a large foreign body inside of the mouth. These aligners have a mechanical retention with characteristic reproducibility according to the shape of the user's teeth, which limits the ease of removal on use, despite the absence of an acrylic base.

CONCLUSION

In this digital era, transparent aligners have been identified as a revolution in the world of dentistry,

particularly in the orthodontic treatment method. This device minimizes operator errors compared to the conventional removable forms that require manual adjustments by a trained dentist.

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