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Composite Attachments with Clear Aligner Therapy – A Review

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Abstract

With more number of patients seeking orthodontic treatment, the advent of removable clear aligners has revolutionized the field of orthodontics. Despite the widespread use of clear aligners, several concerns still remain regarding the efficacy of these appliances in controlling all orthodontic movements. Composite attachments were introduced in aligner therapy to improve predictability of orthodontic treatment in various clinical situations. They can be of two types: conventional attachments and optimized attachments. It is important to understand the importance of these attachments in the aligner systems to achieve predictable results.

Introduction

With increasing number of adults taking orthodontic treatment, the advent of removable clear aligners has undoubtedly revolutionized the field of orthodontics in recent years.**[**1**]** Clear aligners have gained immense popularity and have proven to be the best options for patients demanding aesthetic treatment modality. These materials were used initially as retainers and later were called as „Aligners" because, the typical use was to bring mildly displaced teeth back into alignment.**[**2**]** Even with widespread use of clear aligners, there is a great concern regarding the efficiency of these appliances to bring about predictable tooth movements.

Earlier thermoformed plastic aligner–based orthodontic movement techniques have demonstrated limitations in the configuration of complex force systems, such as extrusion of central incisors and rotation and inclination of the canines4, as well as bodily tooth movement.**[**5**]** Over a period of time there have been controversies over whether moderate to difficult orthodontic treatment could be systematically accomplished with the orthodontic aligner system **[**6**]**.

To increase effectiveness and facilitate controlled tooth movement, composite attachments are bonded on the teeth.**[**7**]** Attachments were introduced in aligner therapy to improve the predictability of orthodontic treatment in various clinical situations.

History

In Orthodontics, thermoplastic appliances have an extensive history. Over the past ten years these appliances have evolved and are useful to bring about complete orthodontic tooth movement with light continuous forces.

In 1946 Kesling devised the concept of using a series of thermoplastic tooth positioners to improve the position of teeth. **[**3**]** Later various authors followed the same concept and devised new techniques. In 1971, Ponitz 2 who made vacuum appliances with transparent material on plaster setups. Further in 1993, Sheridan introduced the Essix system, and a technique which creates reliefs and deformations in the models using special heated pliers to move teeth. In 1997 two Stanford MBA students, applied their knowledge in computing and CAD/CAM technology to develop the Invisalign system of aligners using digital technology **[**8**]**. Since the introduction of Align Technology (Santa Clara, California), The Invisalign system (Align Technology, Santa Clara, California) has gained increased interest as an alternative treatment option for adult patients to simplify the treatment plan.

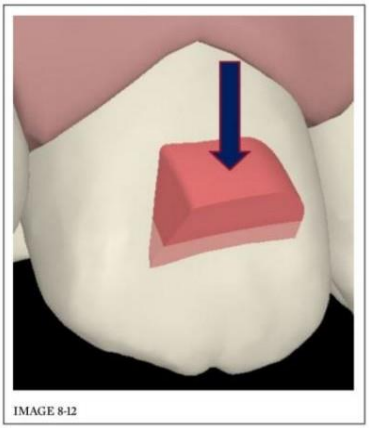
Types of Attachments

The basic principle of any attachment is to provide a surface for proper engagement of the aligner and a point of force application to move the teeth. Can be of two types:

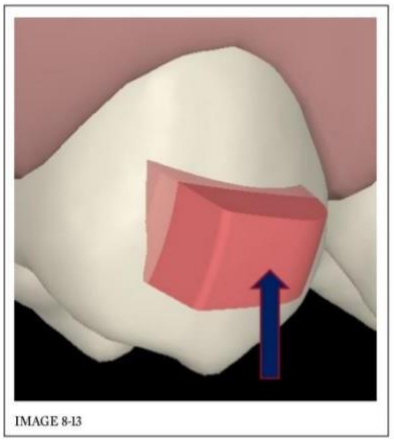
1. Conventional attachments

2. Optimized attachments

Conventional attachments - The most basic function of a conventional attachment is retention. For any movement to be expressed fully the thermoplastic aligner should engage the tooth properly and be completely seated onto the arches. Another important function of an attachment is to provide an active surface which helps the aligner to push the tooth and bring about specific tooth movement. **[**9**]**



Gingivally beveled rectangular attachments **[**10**]**



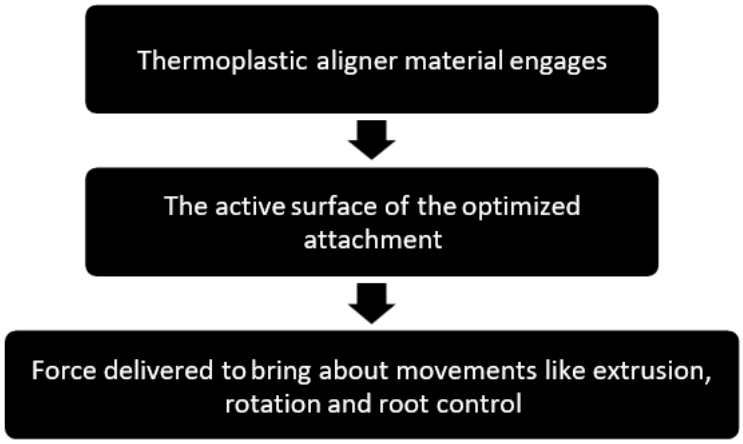
Occlusally beveled rectangular attachments**[**10**]**

Conventional attachments are either gingivally beveled or occlusally beveled with the bevel sloping toward the gingival or occlusal aspect of the tooth.**[**10**]**

Occlusally beveled attachment is mostly used for aligner retention, level the curve of Spee and support absolute extrusion on posterior teeth.**[**10**]**

2. Optimized attachment- As the name implies these attachments are designed based on the type of tooth movement required, and the amount of biologic force needed to accomplish this kind of movement is exerted by the elastic nature of the clear aligner material, based on the root form and morphology of the tooth.

The basic principle is as follows.



The non-active surface is relieved to avoid any interference. **[**9**]**

Optimized attachments **[**10**]**

FEATURE	MOVEMENT	LOCATION	IMAGE
Optimized Rotation Attachment	Rotation	Upper and lower Canines andpremolars	
Optimized Extrusion Attachment	Extrusion	Upper and lower incisors and canines	
Optimized Root Control Attachment	Tipping	• Upper central and lateral incisors • Upper and lower canines andpremolars	
Deep Bite Attachments	During anterior intrusion, Deep Bite Attachments are usedfor anchorage/retention or activated forpremolar extrusion	Upper and lower premolars	
Optimized Retraction Attachment	Canine retraction	Upper and lower canines	
Optimized Anchorage Attachment	Posterior anchorage	Upper and lower second premolars and molars	
Space closure lower incisor extraction	Vertical rectangular 1mm thick conventional attachment	Teeth adjacent to the extraction space	

Table A [11]

Biomechanics of Clear Aligner Therapy

As compared to fixed appliances, moving teeth using aligners is far more complex. Some of the reasons are as follows:

- Force application without specific points
- Tooth anatomy
- Aligner material properties
- Mismatch between aligner and dentition geometries
- Slipping motions between contact shapes
- Other biomechanical factors **[**3,10**]**.

The basic biomechanics involved in aligner treatment is the use of aligner trays. Multiple sets of aligner trays are used successively to move teeth in small increments and achieve the desired position.**[**11**]**

The small successive movements are achieved with by 2 main mechanisms:

1. The shape molding effect-. As the name suggests, this method causes movement of teeth by molding the teeth to their final positions by varying shape of the aligners. The initial aligners generally fit the anatomy of the tooth, and as the aligners progress, shape is changed to achieve what positions they will occupy finally in the oral cavity. **[**12**]**
2. Auxiliary elements-. They are used strategically to deliver forces at specific areas on the tooth surface. These are additional objects placed on the tooth or aligners, like attachments and power ridges respectively, which help in delivering more predictable movements of the teeth.**[**13**]** These auxiliary elements allow forces to be applied in a planned manner on specific sites on the surface of the tooth.**[**14**]**

The basic concept of tooth movement using aligners entails a combination of force and stress produced by the appliance which is translated on to the tooth ‟s biology i: e the PDL fibers along with the bone in which it is encompassed.**[**15**]** So if adequate tooth movement is desired, optimal levels of forces are applied on the tooth throughout the treatment time. This force is applied either through the primary mechanisms of shape molding effect or use of auxiliaries.**[**11**]** Previously published literature suggests that tipping movements of teeth are most predictable **[**14,16,17,18,19,20**]**, whereas root movement involving mechanisms generally have poor prognosis, including controlled tipping **[**21,22,23,24**]**.

Discussion

In the last few years, the need for alternatives to conventional metal braces has been replaced by more esthetic appliances like ceramic braces and aligners. Considering the increasing demand for aligner therapy among patients, it is important for clinicians to be updated with the various research studies on aligners and attachments and there efficacy in treating complex malocclusions. **[**1-4**]** Aligners have hence become extremely in-demand all over the world, and so have orthodontists. **[**5-11**]**

The most important goal in orthodontic treatment is to obtain accurate movements of teeth and remove the aetiology to treat the malocclusion. The success of aligners, although extremely preferred by patients, especially those who do not want conventional braces, lies a lot in the cooperation and working of both the orthodontist as well the patient, to achieve good results **[**25**]**

Aligners are fabricated to cause tooth movement in small increments. These changes are desired to move the teeth until it matches that of the aligner. This moving tooth requires sound backing of biomechanics and its principles. Movement of teeth just by shaping aligners is not sufficient to produce the required change and hence auxiliaries like composite attachments and power ridges are used to exert the desired force. These auxiliaries aid in movements like intruding the tooth, root movements as well as torqueing. The Invisalign® force systems called “smart force attachments” aided by the ClinCheck® software were the pioneers to introduce composite attachments to aligner biomechanics. This has changed the way complex malocclusions being treated with aligners in the past few years**[**26**]**.

One of the main things to keep in mind while planning aligner treatment is the retentive properties of composite attachments. Some specific movements like extruding a tooth, maximum amount of retention is required. Hence attachments are placed more towards the gingiva or directing attachment bevels away from the gingiva or both. If this does not provide adequate retention, other attachment types may need to be used to aid in removing the appliance.**[**27**]**

Drawbacks

There are some cases which make treatment with aligners difficult. They could be: **[**28**]**

- Complex malocclusions where the amount of crowding or spacing >5 mm.
- Skeletal sagittal discrepancies of >2 mm measured by canine relation, centric relation and/or centric occlusion discrepancies.
- Severe rotations of teeth >20 degrees
- Severely extruded teeth

- Tipping of teeth >45 degrees from normal
- Teeth which have short clinical crowns height
- Upper or lower arches having multiple missing teeth.

Other drawbacks include the following:**[**29**]**

- Sheridan in 1993 introduced a new method integrating aligners with inter-proximal reduction (IPR), allowing moderate tooth movement. The biggest drawback in this method is it requires a new alginate/silicone impression at each patient visit.
- One of the biggest constraints in aligner therapy is the lack of efficiency without use of appropriate attachments and proper knowledge of biomechanical aspect.
- The outcome of treatment to treat different types of tooth movement are extremely difficult, for e.g., torque, molar relation, overjet, closing extraction spaces, improving occlusal contacts and maxillary arch expansion when compared to the conventional fixed appliances.

Conclusion

The mechanism used in aligners involves complex science of polymers along with biomechanics in a sequential approach to apply force on teeth either by shape change or with the use of composite attachments. One of the biggest plus point of aligners is obviously the esthetics, albeit it necessitates extractions or stripping in cases where space is needed, or teeth are severely protruded.26 In today‟s time there are lot of untrained dentists practicing aligners without knowledge of the above conditions; this makes treatment outcomes both uncertain as well as risky. A lot of young orthodontists are also diving headlong into converting patients from conventional braces to aligner therapy without complete understanding of the biomechanics and use of attachments with aligner systems.

It is important to understand that any clear aligner therapy is a well-planned, sophisticated planning system, and will deliver predictable results if the clinician makes use of his knowledge efficiently. Sometimes if treatment does not go as planned, the orthodontist should always go back to reconsider treatment steps, even if it means achieving desired results. Careful case selection and treatment planning will help us obtain maximum efficacy and precise treatment results.

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