Auxillaries in Clear Aligners-A Review

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ABSTRACT
Clear aligners have revolutionised the field of Orthodontics over the past few decades. The increasing demand for aligner treatment can be attributed to increasing awareness about tooth alignment and aesthetics among the public. With the era of clear aligners, the discomfort associated with fixed appliances can be eliminated. The techniques and the materials that can improve the aligner biomechanics are being actively researched. It is difficult to achieve certain complex tooth movements with aligners, primarily owing to the contact of the aligners with the tooth. In order to increase the active surface area of contact and to modify the resultant force vector, attachments can be used. Apart from attachments various other auxillaries like bite ramps, elastics, power ridges, mandibular advancement blocks, temporary anchorage devices can also be used in delivering efficient biomechanics. This article will discuss about all the auxillaries that we commonly use with aligner treatment that aid in bringing about effective tooth movement.

1. Introduction:

Invisible appliances were introduced in Orthodontics as early as 1940s in the form of Kesling tooth positioners. Clear aligners have started replacing fixed appliances over a large extent owing to the sudden surge in esthetic concerns. This can be attributed to the social media marketing and advertisements by the aligner companies [1]. There has been a great demand for techniques that can improve the treatment efficiency of these aligners, so that complex tooth movements can be achieved without the need for fixed appliances later. Innovations in clear aligner materials and auxiliaries that can improve the biomechanical efficiency of aligners are being extensively studied. Auxiliaries in clear aligners may include various forms like **attachments, power ridges, mandibular bite blocks, buttons, elastics, precision cuts etc.** They have been extensively used to bring about Orthodontic tooth movements to achieve a good finish and stable results with aligner cases.

2. Attachments

Attachments are complementary composites bonded to teeth, that can provide supplemental force and couple system when the aligners are worn. They have the capacity to modify the resultant force system as a whole, and can thereby bring about complex tooth movements like torque, rotation, and extrusion [2]. The first attachment was a 1x3mm rectangle proposed by Align technology and was given on the lower incisor buccal surface to prevent undesirable incisor tipping following lower incisor extraction.[2] They are placed on the surface of the teeth to increase the contact on the teeth surface, thereby teeth movement are more actively guided, locating the point of force close to centre of resistance and allows more bodily tooth movement. [3] The prime purpose of attachments is to ensure that forces are directed along the desired movement path, reducing unnecessary strain on surrounding tissues. Understanding and manipulating the biomechanics of aligner orthodontics is essential for orthodontists to achieve optimal treatment outcomes. Three important parameters that can determines the resultant force vector are: attachment shape, size and localization.[2] There are various types of attachments based on the shape like ellipsoid, semi ellipsoid, vertical rectangular, horizontal rectangular and a set of bevelled attachments. Each of these shapes are preferred according to the biomechanical needs of a case.[4] The primary functions of the attachments are to aid in retention of the aligner, deliver predetermined force vectors and avoid aligner slippage to achieve proper tracking with aligners [2]. The types of aligner attachments and the area of placement is determined based on the biomechanical needs of the case, for

example if we require anterior extrusion for correction of anterior open bite, optimised gingival bevelled attachments can be given (Figure 1), optimised attachments can also be given for rotation correction (Figure 2), for preventing unwanted tipping of teeth (Figure 3). Similarly, attachments can be given for better torque control and uprighting of the tooth.

Figure 1: Optimised extrusion attachment [2]

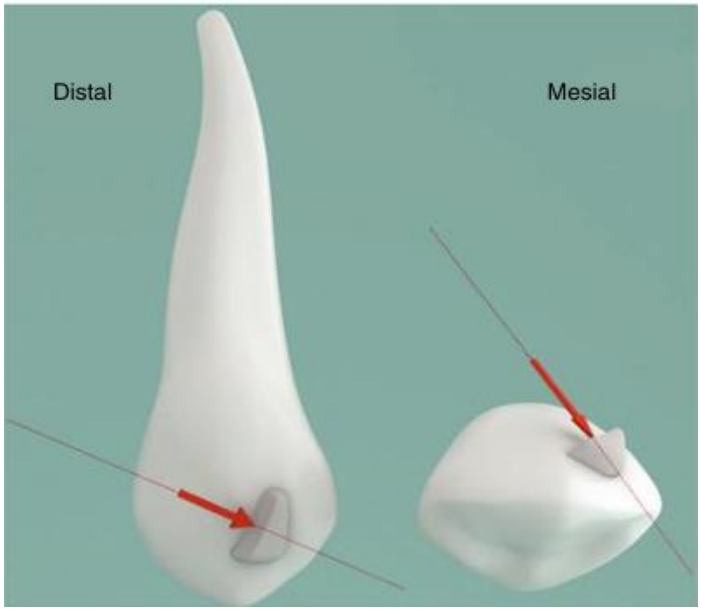


Figure 2: Optimised attachment for correction of rotation [2]

Power Ridges:

Power ridges are small indentations in clear aligners that apply gentle pressure to the teeth to move them into place. They are often used on the upper or lower incisors either on the labial or the lingual side to achieve better torque control.[5] Incorporating power ridges along with the aligner treatment in extraction cases helps eliminate roller coaster effects that occurs due to torque loss and the associated deepening of bite. These pressure areas can either be given as indentations in the 3D models prior to printing it , or by using precision tools like aligner pliers after printing the aligners [6]. There is bound to be a gap between the aligners and the teeth because of these pressure spots and the patient should be advised of pain till they get used to **it** (Figure 3)

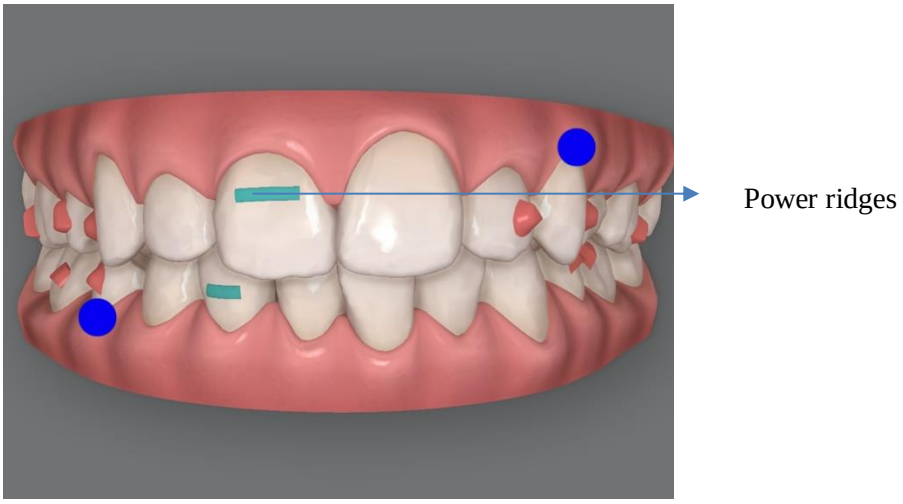


Figure 3: Power ridges

Elastics:

Elastics play an important role in orthodontic treatment by exerting forces on the teeth and jaws to achieve proper alignment. These can be used in combination with clear aligners to help move the teeth into their desired positions. These elastics are typically made of latex or synthetic materials and are available in various sizes, colors and strengths. The biomechanics of the elastics change based on how and where the elastics are applied, degree of vertical opening by the patient with elastics also based on the imbibition of the elastics when the patient **drinks any liquid**.The elastics can be worn in the form of Class II elastics , between upper canines and lower first molars, this can aid in distalisation of the upper dentition and mesialisation of the lower back teeth.[7,8] Class III elastics can be worn between the lower canines and the upper first molar , to aid in distalisation of the lower teeth and mesialisation of the upper dentition.[9] Box elastics can be given in the posterior teeth for correcting posterior open bite.[10] Triangular elastics can also help in extruding teeth and settling.[11] Cross elastics can be given for crossbite correction. Elastics can also be used in correction of rotation of a single tooth by proper planning. **Elastics are engaged between the buttons bonded to the teeth and precison cuts given on the aligners. Proper treatment planning is essential to facilitate the desired tooth movement.**

Buttons

Buttons are bonded to the tooth in specific areas according to the button cutouts that are given on the aligners. These button cutouts are pre planned and can be given on the aligners so that they can allow the space for the buttons to be bonded. [12] They maybe metallic or ceramic ones and can be bonded on the buccal, lingual, mesial or distal side based on the need for placement of elastic that is determined by the biomechanical planning of the case (Figure 4).

Precision cuts

Precision cuts are designed on the aligner for engagement of elastics. Precision cuts are generally given in the area of upper canine region in the case of need of engagement of class II elastics, and are given on lower canine region in case of need of engagement of class III elastics.[13] The precision cuts can also be given after thermoforming the aligner sheets using specialised pliers indicated specifically for this (Figure 4).

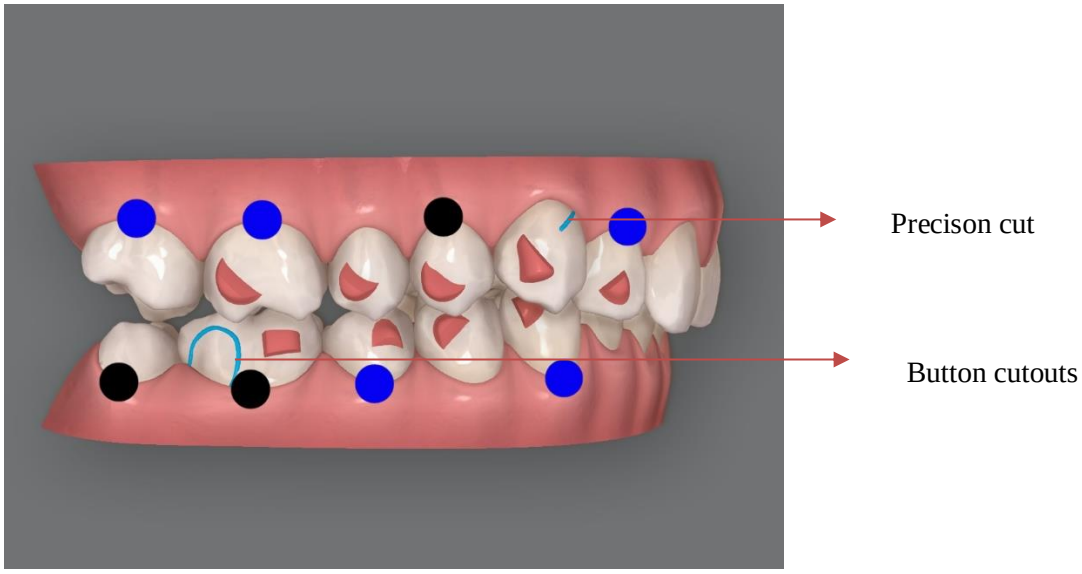


Figure 4: Button cutouts and precision cut

Bite ramps

Bite ramps are **small extensions** attachable to the back of the upper front teeth or, in some cases, to the posterior teeth. In most cases, they are attached directly to the upper incisors on the lingual surface. They can also be affixed directly on the aligners. Once attached, bite ramps prevent patients from biting down completely. Bite ramps can fix various bite issues, but orthodontists commonly employ them to fix deep bites.[14] Initially when the bite ramp **is included**, the posterior teeth disocclude and helps in correction of malocclusion (Figure 5).

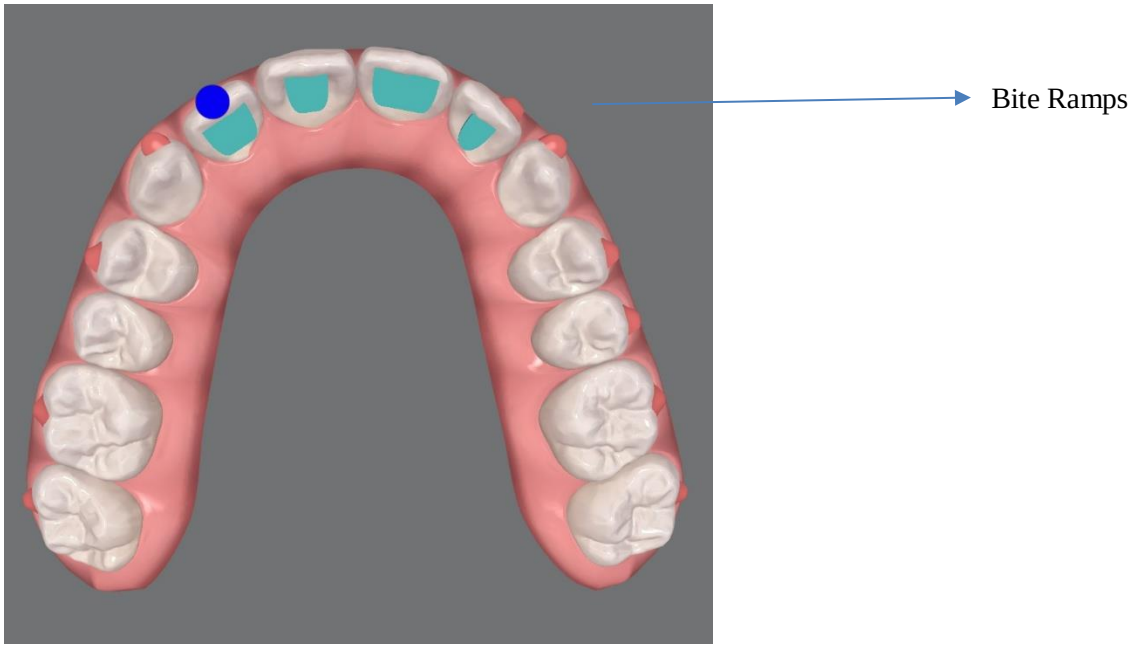


Figure 5: Bite Ramps

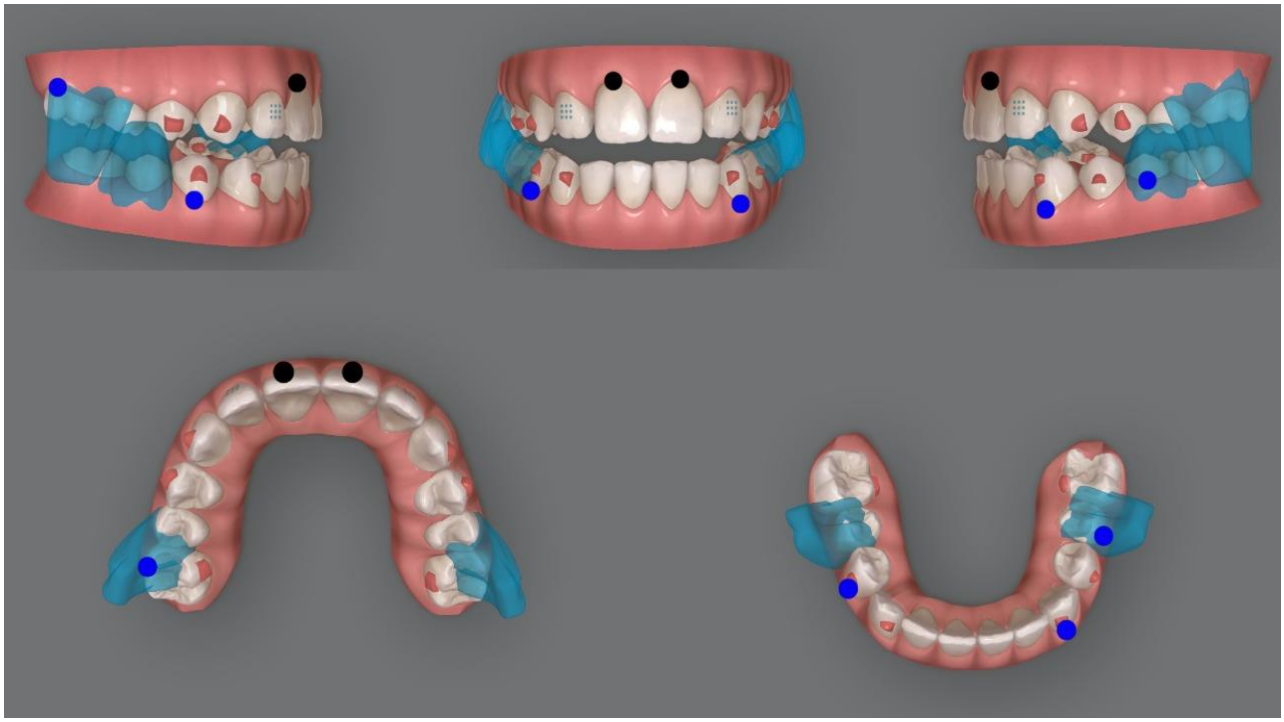
Temporary anchorage devices

Temporary anchorage devices like Mini implants, Infra-zygomatic implants, buccal shelf screws or palatal implants can be used in conjunction with aligners to achieve better biomechanics in skeletal and borderline cases, where using only the aligners, cannot produce satisfactory results. These serve as additional anchorage systems in achieving complex tooth movements .[15,16] This can widen the range of tooth movements that can be achieved with aligners and thereby improve their treatment efficiency

Mandibular advancement

In 2017, Align Technology introduced Invisalign with mandibular advancement appliance (MAA) to aid Class II correction in growing patients. The MAA uses buccally positioned inclined planes (precision wings), which are built into the maxillary and mandibular aligners to posture the mandible forward [17,18]. Various limitations that may be associated include patient compliance with wear protocols, discomfort, and an initial period in which the patient must learn to posture their mandible forward in a correct manner to enable effective engagement with the precision wings.[19]

Evidence indicates the mandibular advancement achieved with Invisalign mandibular advancement appliance was as effective as any other functional appliance with an added advantage of simultaneous achievement of alignment and levelling.[20] (Figure 6)



Aligner activation (Non-specific):

Smart force aligner activation is seen in Invisalign (Align technology), where there a specific area on the aligners that are contoured to deliver specific force. SmartForce aligner activation specifically contours select areas on the aligner's surface to create strategic contact areas on the tooth surface. This provides improved clinical predictability for the challenges doctors encounter most frequently.[21] (Figure 7)

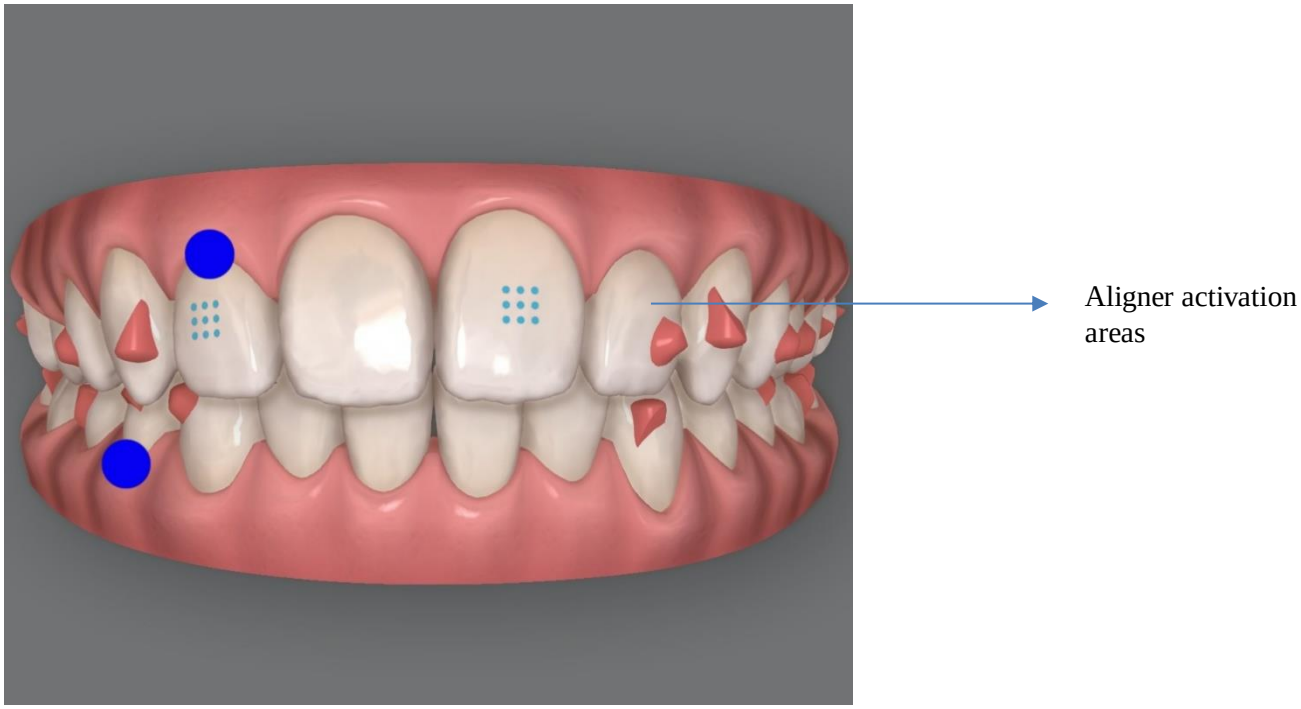


Figure 7: Aligner activation points

Discussion

The popularity of clear aligners has been increasing owing to the increased esthetic demand. With a lot of adult patients resorting to aligners for the correction of their teeth alignment, the need for maximising the treatment efficiency with aligners is also increasing.[2] Newer materials and new techniques are being actively researched in an aim to achieve better treatment mechanics with aligners.[22] The tooth movement with aligners can be achieved by the shape molding effect of the aligner material itself and by the use of auxillary elements.[1,23] It is almost impossible to achieve complex **tooth** movements relying on the shape molding effect of the aligners alone, so incorporating auxillaries is essential to achieve proper correction. **Auxillaries can provide better control for the pull type of force that the aligners and there by aid in achieving complex teeth movements. .**[24] Auxillaries like attachments act as handles for force delivery from the aligners and modify the resultant force vector. [25] Variety of attachments have been studied over the past decades that has helped in improving the treatment efficiency with aligners. The mechanism of attachments differs based on the area of placement, their shape and size. Different shapes have different biomechanics based on the force distribution and the area of aligner contact. Some attachments may also be used for retention of the aligner, especially in case of need of wear of elastics on the aligner.[3] The decision of choosing the aligner auxillary is based on the planning the biomechanics of the case and the tooth movement required.[2] Other auxillaries maybe bite ramps, exclusive for deep overbite correction by allowing posterior eruption. [26] The bite ramps can also help in removing the restrictions present for mandibular growth. Multiple auxillaries can be given to achieve multiplanar **tooth** movement at the same time. **Since different tooth movements can be achieved with a single aligner, the total number of aligners required for the complete correction can be made lesser .**[1]With mandibular advancement incorporated in the Invisalign aligners, the patient is able to achieve simultaneous alignment and levelling alongside mandibular advancement. In this way the treatment time is reduced and hence better compliance can be ensured along with improved treatment efficiency.[17] Similarly other auxillaries have been very beneficial in revolutionising aligner biomechanics. With the use of temporary anchorage devices like Infrazygomatic implants, buccal shelf and palatal implants, better tooth movement can be achieved with aligners. Elastics are another useful adjunct that can be worn by the patients along with the aligners, to achieve the desired tooth movement. Aligner auxillaries have

been truly beneficial and has made it possible to achieve many difficult tooth movements, in a more predictable way.

3. Conclusion

Clear aligners have revolutionised orthodontics with their ability to bring about effective treatment without compromising on the esthetics during treatment. Though aligners provide a successful treatment result, their ability in achieving certain tooth movements that requires more root control is still not comparable to fixed appliances. To maximise the treatment efficiency in these, auxillaries are used to deliver an improved treatment result with a minimal tendency to relapse. With the use of auxillaries like attachments, power ridges, bite ramps, elastics, buttons, mandibular advancement blocks, temporary anchorage devices, pressure areas the aligner biomechanics can be modified for a effective treatment result.

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