Creative adjuncts for clear aligners to improve predictability

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The concept of clear aligners has grown in leaps and bounds internationally since the introduction of Invisalign (Align Technology) in 1999. In the 1940s, Dr Harold Kesling first proposed the original theoretical basis for moving teeth with a series of retainers, but it took more than 50 years before computer technology made the idea workable.

Although some of the initial excitement attending the idea that all patients could be treated without metal-fixed orthodontic appliances wore off quickly, early adopters and innovators have worked diligently to improve and enhance clear aligner methods. Limitations of clear aligner treatment simply required some time and experience to discover, but ultimately resulted in a series of articles quantifying issues often experienced clinically.1–16

As patients’ and practitioners’ desires for aesthetic alternatives to fixed appliances continued to coalesce in the past decade, there have been a number of technological and biomechanical advancements that have led to an ever-increasing number of treatment application possibilities for aligners, including the expansion to treating teenagers.17, 18 In those endeavours, a series of articles were published suggesting innovative treatment options with various adjuncts to clear aligners,19–21 including Hu-Friedy’s Clear Collection instruments (Fig. 1).22–24

Fig. 1: The Hu-Friedy Clear Collection consists of four instruments: the TEAR DROP, HOLE PUNCH, VERTICAL and HORIZONTAL. — Figs. 2a–c: The TEAR DROP is designed to cut a teardrop-shaped notch in the margin of clear aligners to retain orthodontic elastics for various applications. — Fig. 3: Class II clear aligner treatment enhanced with Class II inter-maxillary elastics and Class I intra-maxillary elastics attached to mini-screw anchors to produce the intended vectors of force. — Figs. 4a & b: The HOLE PUNCH is used to cut a half-moon of plastic at the aligner margin to clear the way for bonded buttons or brackets in order to connect orthodontic elastics or elastomeric chains. — Fig. 5: Seating elastics used to improve posterior intercuspation in finishing aligner treatment. The HOLE PUNCH cleared plastic to permit bonding of buttons for the inter-maxillary box elastics.
As understanding of some of the limitations of clear aligner applications came to light, alterations to biomechanics, materials and treatment planning were introduced. The primary aims were to improve the predictability of specific tooth movements and to expand the scope of treatment to a wider variety of presenting malocclusions.

A set of instruments were created specifically for clear aligners in order to enhance, accent and increase the spectrum of applicability and acceptability of this form of aesthetic orthodontic treatment. The Clear Collection consists of four instruments designed to individualise aligners to address specific treatment needs.23–24

The TEAR DROP

The TEAR DROP instrument is used to add a notch or hook in the gingival margin of aligner plastic for the application of typical orthodontic elastics.19–21, 23 The design of this cut-out is in the shape of a teardrop with the intent that the reservoir of the notch will keep an elastic in place on the aligner (Figs. 2a–c). In this manner, the aligner with elastics can be inserted into the mouth, reducing the fumbling and difficulty associated with attempting to put elastics into slits or notches after the aligner tray is already on the teeth. The TEAR DROP cuts can be made anywhere along the aligner tray edges where elastics may be needed, such as inter-maxillary Class II, Class III or delta, or Class I intra-maxillary applications, even involving the use of mini-screw anchors to support the elastic forces (Fig. 3).19, 21, 23

The HOLE PUNCH

The HOLE PUNCH instrument is used to create a half-moon cut-out at the gingival margin of aligner plastic (Figs. 4a & b).19–21, 23 The intention is to relieve the plastic to permit the application of bonded buttons or brackets on specific teeth to support orthodontic elastics or chains. These cuts can be placed wherever needed along the aligners on either buccal or lingual surfaces. A common scenario would be punching holes in the buccal margin of plastic at the maxillary and mandibular first molars and canines to bond buttons to support seating or box elastics (Fig. 5)23 or cutting a half-moon on both the lingual surface of the maxillary first molar and buccal surface of the mandibular first molar to facilitate the use of a through-the-bite cross-bite elastic.

In addition, the HOLE PUNCH may be employed to simply clear plastic away from impinging gingival tissue anywhere along the aligners.23 The incisive papilla is a common location for this type of irritation that can be quickly resolved by clipping the plastic in that area for each tray in a series (Figs. 6a & b).

Individualising aligners with accent pliers

Two accent pliers round out the Clear Collection. These unique instruments were designed to enhance specific types of tooth movement by increasing plastic contact points in precise locations for individual teeth. The intent is to increase the predictability of tooth movements by creating shallow indents in the plastic to augment prescribed mechanical couples. Most importantly, these pliers are not heated. In addition, these indents may be produced to increase the retentiveness of aligners or clear retainers in undercuts and at line angles.
controlled rotations of teeth are often difficult to achieve with aligners, as the computer-generated prescribed movement may not be translated accurately to the tooth. The first of the two accent pliers is called the VERTICAL and it is used to gently impress a vertical indent into the aligners in a specific location in the lingual and/or facial plastic for an individual tooth (Figs. 7a & b). Rotating maxillary lateral incisors and canines are often sites of these types of problems. As an example, the rotated lateral incisors in Class II Division 2 malocclusions are difficult to correct and typically require that overcorrection be designed into the aligners at the outset. If additional rotation is indicated, an indent can be placed in the plastic at the mesial line angle on the facial surface and the distal line angle on the lingual surface to create some extra force in the form of a rotational couple in a series of aligners. This may preclude the necessity of another round of refinement appliances to achieve the intended goal. If a composite attachment is in place on a specific tooth, the VERTICAL can be used at the right-angle contact of the aligner and the composite.

Fig. 11a & b: Chewies Aligner Tray Seaters were developed as a kind of mini-tooth positioner for patients to clench in specific sites to encourage trays to seat and reduce the development of aligner lag.

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Figs. 12a–d: Bootstrap mechanics are designed to extrude individual teeth into clear aligners with orthodontic elastics. (a & b) The HOLE PUNCH is used to cut out a half-moon clearance for a bonded button on the lingual surface of a selected tooth. (c) The TEAR DROP is used to place two elastic notches in the facial margin of the aligner at both the mesial and distal gingival embrasures. An elastic is then stretched from the dual notches, over the aligner, to the lingual button to generate an extrusive force. (d) A second option is to cut a second half-moon in the facial surface, bond a labial button and place the elastic from the labial to lingual surfaces over the aligner. – Fig. 13: A Clear Collection prescription form is completed for each patient to indicate the instruments that will be required to customise each aligner in a series, along with the specific sites where they will be employed on each tooth.
ite to sharpen the contact point in that location for more efficient transmission of force to the tooth (Fig. 8).

The HORIZONTAL

The second accent instrument is the HORIZONTAL 19–21, 24 and it is primarily used to produce an indent to affect a change in tooth root rotation or torque. 18, 24, 28, 29 A horizontal impression into the plastic at the gingival margin of the aligners will emphasise the force applied to torque the roots of individual teeth (Fig. 9a). These horizontal indents can also be placed at the right-angle junction of a composite attachment and the tooth to enhance the contact, thereby increasing the effectiveness of the intended tooth movement and reducing the risk of lag as the plastic may slip away. Another option is to place horizontal indents at the marginal undercuts of the crown of the tooth to increase the retentiveness of aligners or retainers (Fig. 9b).

Common applications: Beating aligner lag and bootstrap mechanics

Besides facilitating the typical addition of inter-maxillary elastics for a variety of anchorage supports for tooth movement or intention to alter dentoalveolar compensation (i.e. Class II, Class III, resolving deep and open bites, extraction space closure, etc. 19–24, 30–34), a common application for the TEAR DROP and the HOLE PUNCH is establishing bootstrap mechanics. 20, 21 For instance, a tooth or teeth may be lagging behind the prescribed movement, especially in terms of extrusion—the tooth may not be following along the projected path (Fig. 10). This may be due to inadequate space created adjacent to each side of the tooth or lack of adequate contact on the tooth or attachment.

Initially, Chewies Aligner Tray Seaters 20, 21, 35 (another of our creations from our private practice; DENTSPLY Raintree Essix) are routinely used at each new aligner to assist in seating them on to the teeth (Fig. 11a), along with instructions to massage the trays into place (use fingers to push the trays on to the teeth as though attempting to stretch them over attachments and undercuts for the first few days). Despite those efforts, an air gap between the incisal edge of the teeth and the plastic may develop (Fig. 11b). It may be that inadequate space has been created prior to extrusion and the interproximal contacts thus cannot pass by each other (consider the widening taper towards the anterior incisal edges) and aligner lag or lack of tracking is the result.

In these instances or in anticipation thereof, a bootstrap set-up is prepared. 20, 21 This consists of placing bonded buttons on the lingual surface of the offending tooth near the gingival margin by creating clearance for the button in the aligner plastic with the HOLE PUNCH (Figs. 12a & b). On the facial surface of the same tooth there are two options: another button and a hole punch (Fig. 12c). The TEAR DROP is used to create two elastic notches at the mesial and distal gingival embrasure spaces (Fig. 12d). A small-diameter orthodontic elastic is then applied to either the teardrop notches or the button on the facial surface of the tooth and stretched over the occlusal surface of the aligner to the lingual button. In this scenario, the elastic is intended to more predictably extrude the tooth into the aligner to the prescribed position.

Future view on aligners

As demand by patients for more comfortable, hygienic and aesthetic treatments increases, the clear aligner market will respond with more advances and alternatives. In addition, orthodontists will learn to better push the envelope of applications by adding adjuncts to improve the effectiveness and ultimately the predictability of treatments with aligners. Much like fixed appliances, the ability to individualise, accent and enhance clear aligner biomechanics reduces the known limitations of aligners and the associated clinical frustrations of the orthodontist. Managing alterations of series of aligner trays in real time (including the use of a Clear Collection prescription form; Fig. 13) provides increased flexibility in the endeavour towards increased predictability of aligner orthodontic outcomes.

More details on the Clear Collection, treatment applications, downloadable publications (including the Clear Collection prescription form) and a series of instructional videos can be found on the Hu-Friedy website.

Editorial note: A list of references is available from the publisher.

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