

Review Article

Self Ligating Brackets: An Evolving System

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ABSTRACT

With the ever evolving orthodontic practices, concept of self ligation is readily accepted by clinicians over the globe. Soon, stainless steel and elastomeric ligatures will become outdated making way for more comfortable and user friendly self ligating appliances. Self ligating system provides an added advantage of reduced ligation time and decreased friction thereby reducing anchorage demand. Considering the advantages of self-ligating brackets for the clinician, staff, and patient, they may well become the “conventional” appliance systems of the 21st century. This article highlights various self ligating systems to aid in proper appliance selection so as to use this system’s features to the best possible extent.

INTRODUCTION

Over the last couple of decades, several types of brackets have evolved with different built-in prescriptions and in different materials. These different brackets had their own limitations. In general, these can be summed up as increased treatment time due to increased friction between bracket and arch wire, increased chair time and increased anchorage demand. Conventional brackets have been found to cause soft-tissue lacerations due to the sharp ends of the brackets as well as due to the tucked ends of the ligatures. There are chances of swallowing and breakage of modules. The increase in mesiodistal width of the brackets decreases interbracket distance and this

creates difficulties in controlling three dimensional movements of the teeth¹

Self-ligating brackets are supposed to be advantageous in that they provide greater patient comfort, reduced friction between bracket and archwire, shortened treatment time and reduced chair time. They offer more precise control of tooth translation, reduced overall anchorage demands, rapid alignment and more certain space closure. There is reduced incidence of soft-tissue lacerations, improved oral hygiene, less chance of cross infection risk and better esthetics²

HISTORICAL PERSPECTIVE

The concept of self-ligating brackets is not new, with the first designs dating back to the 1930s, with the

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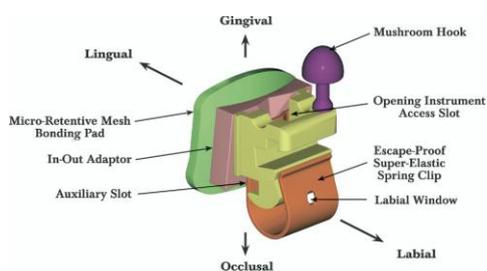


Fig-1: The SPEED appliance

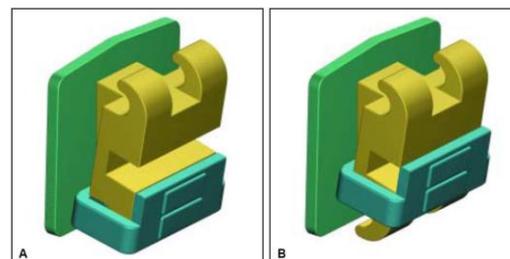


Fig:2 Damon SL bracket in open (A) & closed (B) positions

introduction of The Russell Attachment by Dr. Jacob Stolzenberg. Since 1970 there has been a constant endeavor to perfect self-ligating brackets and several brackets were introduced like Edgelok (Jim Wildman-1971), Mobil-Lock (Franz Sander-1973), SPEED System (Herbert Hanson-1976), Activa (Erwin Pletcher-1986), Time (Wolfgang Heiser-1995), Damon SL (Dwight Damon-1996), Twinlok (Jim Wildman-1998), Damon System II (Dwight Damon-1999), In-Ovation (Michael C. Alpem) and Damon III (Dwight Damon-2004).

EVALUATION OF CURRENTLY AVAILABLE SELF LIGATING BRACKETS

3.1 SPEED System

Hanson in 1975^{3,4} combined Angles edgewise appliance with his own concept of developing both a dynamic & self ligating appliance (fig.1). This resulted in a spring-loaded, self-adjusting ligature less design that possessed the unique quality of retaining & actively influencing control of the arch wire within the arch wire slot.

It has a unique roll-shaped, flexible spring clip. This highly resilient spring clip opens and closes in a vertical manner to permit arch wire removal and insertion and, hence, replaces the steel or elastomeric tie as used on conventional brackets as a means of ligation.

3.2 DAMON Appliance System

The Damon philosophy is based on the principle of using just enough force to initiate tooth movement—the threshold force. The Damon SL bracket design has twin configuration, and a passive slide forming a complete tube (fig. 2)

The preadjusted Damon appliance is available in 0.022- and 0.018-inch slots. The Damon tube is manufactured by metal injection molding, making it possible to manufacture exceedingly small, accurate parts that allow movement of the slide and provide the close tolerances of the arch wire slot. Opening the slide in the latest 03 version is achieved with an opening tool whereas closing only requires finger pressure. Upper tubes open incisally and lower tubes open gingivally to provide the best visibility when checking arch wire placement.^{5,6}

3.3 IN-OVATION Bracket System

In-Ovation brackets were introduced by GAC Company in 2000. It seats the arch wire in the base of the slot for predictable results without the high resistance associated with traditional steel and elastomeric ties. Unlike Passive Brackets, In-Ovation reduces the resistance without sacrificing control by seating the arch wire fully in the base of the slot.⁷

In-Ovation is self-ligating system with complete four dimensional programming which combines Metal Injection Molding (MIM) with Computer Numerated Controlled (CNC) milling. MIM provides a smaller design, with greater strength and full compound-contouring of the base. CNC milling ensures the truest slots available today.⁷

3.4 SMART CLIP Bracket System

Smart Clip Self- Ligating brackets were introduced by 3M Unitek Company in 2005

(fig 3). These are passive self ligating twin brackets which engage the wire using a nickel titanium clip. This nickel- titanium clip has an intrinsic memory for shape and force and therefore secures the arch wire in place, yet is specifically calibrated to release the archwire if force exceeds a predetermined level. This helps assure that force levels recommended for biocompatible tooth movement are not exceeded, therefore promoting efficient tooth movement with less patient discomfort. Because of the true twin design, the clinician has the option of selectively engaging the archwire in only one clip when teeth are severely maloccluded. In addition, the familiar tie-wing design allows for the use of traditional ligation at the option of the clinician. This design also facilitates simple and easy use of chain ligatures when needed for space closure.⁸

3.5 Time: A Self-Ligating Interactive Bracket System

It is a “hybrid” self-ligating bracket, with both integrated passive and active elements (interactive) introduced by American Orthodontics, Sheboygan, WI. It offers the advantage of minimal force and friction (passive) in the early stage of treatment, torque and rotational control (active) in the middle and finishing stages of treatment, Low profile (low in-out



Fig:-3 SmartClip Self ligating Bracket

relationships), simple to open-close clip mechanism for ease of wire changes and the capacity to achieve finishing details in a controlled manner in all three planes of space. Exposure of the bracket slot for archwire insertion or removal is easily accomplished by engaging the hole of the clip with the instrument and rotating the clip in a gingival direction.⁹

3.6 Self Ligating Lingual Brackets

Philippe 2D self-ligating lingual brackets¹⁰ (Forestadent Bernhard Foerster GmbH), providing 2-dimensional control, were suggested for the correction of simple malocclusions, such as minor crowding or spacing with the lingual technique.¹ These brackets have no slot; they include small wings welded to the brackets base. The wings are used to secure the archwire to the brackets base. The wings are closed, or pushed against the base of the brackets with Weingart utility pliers¹ to hold the archwire, and can be opened for archwire replacement, using a thin spatula placed between the wings and the base of the bracket.

The Forestadent 3D Torque-Lingual self-ligating brackets¹¹ have the similar flat design as the Philippe 2D self-ligating brackets, but have a vertical slot for 3-dimensional control. The vertical opening of the slot provides fast and easy archwire insertion. The archwire is secured in the slot by small wings that can be pushed or opened like the wings of the Philippe 2D self-ligating lingual brackets.

The Adenta Evolution lingual bracket (Adenta GmbH) is designed as a one piece bracket with a clip that opens at the incisal edge and allows insertion of the archwire from the occlusal direction. The clip can serve also as a bite plate, and consequently presses the archwire further into the slot when biting.^{12,13,14}

Evolution SLT bracket system (Adenta GmbH) eliminated the disadvantages of the old lingual systems, and produce a lingual technique with individual transfer caps, that can be fabricated easily with-out the use of costly equipment using Smart Jig technology. Smart Jig is used to connect the core and the bracket together. By simply removing the ligature tie, Smart Jig disconnects from the bracket taking the transfer cap with it. This device reduces chair time and simplifies the lingual technique during the bonding stage.¹⁵

CLASSIFICATION OF SELF LIGATING BRACKETS

4.1 Passive:

Passive brackets use a rigid, movable component to entrap the arch wire. Tooth control with passive brackets is determined solely by the fit between bracket slot and arch wire. As a result, tooth control frequently is compromised with undersized wires housed in what is essentially an arch wire tube.¹⁶

Ex: Damon, Mobil-Lock

4.2 Active:

Active brackets use a flexible component to entrap the arch wire. This flexible component constrains the arch wire in the arch wire slot and has the ability to store and subsequently release energy through elastic deflection. This gentle action imparts a light but continuous level of force on the tooth and its supporting structures, resulting in precise and

controlled movement. The homing action of the flexible component may be described as the ability of the bracket to reorient itself and its accompanying tooth in three dimensions until the arch wire is seated fully in the arch wire slot, the “home” position. Any subsequent rotation, tipping or torquing during tooth movement of any kind results in the labial deflection of the flexible component and reactivates this homing behavior.¹⁶

Ex: Speed, In-Ovation

4.3 Active clip or passive slide

The intended benefit of storing some of the force in the clip, as well as in the wire is that, in general terms, a given wire will have its range of labio-lingual action increased and therefore, produce more alignment than a passive slide with the same wire. This needs more detailed consideration. It is perhaps helpful to think of the situation with three different wire sizes¹⁶

4.3.1 With thin aligning wires smaller than 0.018 inch diameter:

The potentially active clip will be passive and irrelevant, unless the tooth (or part of the tooth if it is rotated) is sufficiently lingually placed in relation to a neighboring tooth that the wire touches the active spring clip. In that situation, a higher total force will usually be applied to the tooth in comparison to a passive clip.¹⁶

4.3.2 For wires larger than 0.018 inch diameter:

On teeth that are whole or in part lingual to a neighboring tooth, the active clip will again bring the tooth (or part of the tooth if rotated) slightly more labial than would have been the case with a passive clip at 0.027 inch slot depth. With an active clip, an active lingual force will remain on the wire, even when it is passive.¹⁷

4.3.3 With thick rectangular wires:

An active clip will probably make a labio-lingual difference in tooth position of 0.002 inch or less, which is very small and unlikely to be of clinical significance. The suggestion that continued lingually-directed force on the wire from an active clip (or from a conventional ligature) will cause additional torque from an undersized wire is interesting and probably reflects a degree of misunderstanding about the generation of torque in an edgewise slot. Figure shows that whatever the orientation or shape of the rectangular wire, the clip places a diagonally directed lingual force on the wire, which does not contribute to any third order interaction between the wire corners and the walls of the bracket slot, which is the origin of torquing force. In fact, the need for an active clip to invade the slot reduces the available depth of one side of the slot and this means the rectangular wire is not fully engaged. This increases the slop' between the rectangular wire and the slot, and also reduces the moment arm of the torquing mechanism.¹⁸ These factors probably explain the reported additional difficulty in finishing cases with some examples of this bracket type.

4.4 Overall advantages or disadvantages of an active clip:

It is probable that with an active clip, initial alignment is more complete for a wire of given size to a clinically useful extent. However, with modern low modulus wires it should be possible to insert thicker wires into a bracket with a passive clip and arrive at the working archwire size after the same number of visits, i.e., to store all the force in the wire, rather than dividing it between wire and clip. Once in the thick working archwire, the potential disadvantages of an active clip are increased friction and reduced torquing capacity in

one direction. To put the friction levels in context, these higher friction forces are still much lower than those found with elastomeric 'ligatures on a conventional tie-wing bracket.¹⁹

FRICITION AND SELF LIGATING BRACKETS

Berger (1990)²⁰ concluded that a highly significant reduction was observed in the level of force required to move different arch wires a standard distance through the self ligating SPEED bracket when compared with both the elastomeric and the steel- tie ligated "A" company and American Orthodontics bracket system.

A.P.T Sims (1993)²¹ showed a significant reduction in frictional resistance in the Activa brackets compared with SPEED brackets by a factor of approximately 15. When the SPEED brackets were compared to Minitwin brackets, the reduction in friction was by 50-70 per cent. The placing of 'figure-of-eight' elastomeric ties increased friction by a factor of 70-220 per cent compared to conventional elastomeric ties. The results indicate that self-ligating brackets require less force to produce tooth movement because they apply less frictional contact to the archwire than conventionally tied siamese brackets.

Shivapuja and Berger (1994)²² demonstrated no statistical difference, in the force values to initiate wire movement for the Activa, Edgelok, SPEED and twin bracket with metal tie. However, the variability in the force values was higher for the twin bracket with metal tie. In terms of dynamic frictional resistance, ceramic bracket with the elastomeric tie offered the most resistance to movement with a mean value of 10.84 ounces (308.15 gm). The use of the elastomeric power module revealed a higher level of mean frictional resistance of 3.07 ounces (87.26 gm) with the SPEED

bracket system when compared with either the Activa bracket system, which had a mean value of 12.64 ounces (35.91 gm) or the Edgelok bracket system, with a mean value of 1.42 ounces (40.40 gm).

Pizzoni et al (1998)²³ showed that a linear relationship between frictional forces and increasing angulation seemed to exist with the conventional brackets while the self-ligated behaved differently. With a rectangular wire the frictional forces observed with the self-ligating brackets increased dramatically when the angulation was 9 and 12 degrees. Generally, the self-ligating brackets exhibited less friction than the conventional brackets. At no or small angulations and with round wires these brackets demonstrated a very low friction compared with the conventional brackets loaded with a normal force. At larger angulations between the brackets and the wire the Speed bracket exhibited a significantly greater increase in friction than the other brackets.

Thorstenson and Kusy (2002)²⁴ demonstrated that when clearance exists, the resistance to sliding is negligible for self-ligating brackets with slides coupled to any size of wire as well as for those with clips when coupled to wires that do not contact the clip. Once the wire attains a certain size and contacts the clip, the resistance to sliding depends on the archwire size, the bracket design, and the materials of the couple.

Cacciafesta et al (2003)²⁵ showed that stainless steel self ligating brackets generated significantly lower static and kinetic frictional forces than both conventional stainless steel and polycarbonate self-ligating brackets, which showed no significant differences between them.

Franchi et al (2008)²⁶ found that passive stainless steel self-ligating brackets and nonconventional elastomeric ligatures are valid alternatives for low

friction during sliding mechanics when compared to conventional elastomeric ligatures.

Tae-Kyung Kim & associates (2008)²⁷ suggested that combinations of the passive SLB and A-Ni-Ti archwire during the initial leveling stage can produce lower frictional force than other combinations of self-ligating bracket and arch wire in vitro.

Ehsani et al (2009) summarized self ligating brackets maintain lower friction when coupled with small round archwires in the absence of tipping and/or torque in an ideally aligned arch as compared to conventional brackets. There is not enough evidence to claim that with large rectangular wires, in the presence of tipping and/or torque and in arches with considerable malocclusion, self ligating brackets produce lower friction compared with conventional brackets. Most of the evaluated studies agreed that friction of both self-ligated and conventional brackets increased as the archwire size increased.²⁸

CONCLUSION

Every self-ligating bracket, whether active or passive, uses the movable fourth wall of the bracket to convert the slot into a tube offering the advantage of more certain full archwire engagement, low friction between bracket and archwire, less chair side assistance, faster archwire removal and ligation.²⁹

Percutaneous injury³⁰ to the index finger or thumb during archwire changes accounts for 57.9% of all clinical injuries sustained by orthodontists, with a similar incidence reported by orthodontic assistants and hygienists. Self-ligation reduces the risk of such injuries and potential transmission of HBV, HCV, or HIV for both the orthodontist and the staff. It also protects the patient from soft-tissue lacerations and possible infections from the cut ends of steel ligatures.

Elastomeric ligatures not only show a rapid rate of decay and deformation, but they are often associated with poor oral hygiene. With the elimination of ligatures (as well as tie wings and other types of food traps in some designs), self ligating appliances can significantly improve the hygiene of all patients.

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