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Review Article

# Self-ligating brackets from the past to the last- A complete over-view part I

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ABSTRACT

The introduction of the self-ligating brackets proved to be a revolutionary change in the history of brackets. The benefits of orthodontic appliances and techniques revolve around efficiency, allowing the patient to expect more efficient and timely treatment. The popularity and USP of self-ligating brackets have been for the ability of SL bracket systems to reduce chair time and overall treatment time. Until the early 1970s, the concept of self-ligating brackets fell more or less into oblivion. There has been a continuous endeavor to perfect self-ligating brackets, and several brackets were introduced Since 1970. Within the past decade, substantial developments, new designs, and numerous proposed advantages of SL brackets have caused them to gain significant popularity among practicing orthodontists. At present, the orthodontic market is flooded with the promotion of different SL brackets. This review aims to provide a complete overview of the evolution of self-ligating brackets from the first to the latest available.



## 1. Introduction

*"Good, better, best. Never let it rest. 'Til your good is better, and your better is best."* **-St. Jerome**

Webster's dictionary defines efficiency as 'the ability to do or produce something without wasting time, materials, or energy: the quality or degree of being efficient.[1]

The benefits of orthodontic appliances and techniques revolve around efficiency, allowing the patient to expect more efficient and timely treatment.

Efficiency in the field of Orthodontics is said to be influenced by three key factors:

1. Efficiency of mechanics
2. Decreased chair time per office visit
3. Fewer appointments to complete treatment.

The popularity and USP of self-ligating brackets have been for the ability of SL bracket systems to reduce chair time and overall treatment time.[2,3]

A self-ligating bracket is defined as a bracket, which utilizes a permanently installed, movable component to entrap the archwire'- Graber and Vanarsdall.[4] "Self-ligating bracket" is the term used for brackets that incorporate a locking mechanism (such as a ring, spring, or door mechanism) that hold the archwire in the bracket slot.[2]

The introduction of the self-ligating brackets proved to be a revolutionary change in the history of brackets. Self-ligating (SL) brackets were initially introduced in the early 20th century. In the early 1930s,[5] the Russell attachment, the first self-ligating bracket, was developed by a New York orthodontic pioneer, Dr Jacob Stolzenberg. The mechanism of this innovative bracket was in direct contrast to the traditional approach of ligating steel ligatures tightly around

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each bracket until recently, which did not receive much attention in the profession of orthodontic because perhaps Dr Stolzenberg was ahead of his time. Until the early 1970s, the concept of self-ligating brackets fell more or less into oblivion. There has been a continuous endeavour to perfect self-ligating brackets, and several brackets were introduced Since 1970.[6] (Table 1).

Safe, timely, efficient, effective, equitable, and patient-centred health care should be present. Self-ligating bracket systems have purported advantages in efficiency, effectiveness, and patient-centeredness.[7]

Self-ligating brackets have advantages such that they provide greater patient comfort, reduced friction between bracket and archwire, shortened treatment time, and reduced chair time.[8] They offer more accurate control of tooth translation, reduced overall anchorage demands, rapid alignment, and more certain space closure.[9] There is a reduced incidence of soft-tissue lacerations, improved oral hygiene, less chance of cross-infection risk, and better esthetics.[10]

The art manufacturing techniques and improved designs have produced various robust, reliable, effective, and easy-to-use brackets. It is believed that SL systems produce a better quality of results in terms of finish and stability. Within the past decade, substantial developments, new designs, and numerous proposed advantages of SL brackets have caused them to gain substantial popularity among practising orthodontists. At present, the orthodontic market is flooded with the promotion of different SL brackets.

## 2. Classification

According to Woodside DG, Berger JL;

Two main types of Self-ligating brackets, depending on the design of the locking mechanism, the dimensions of the slot, and the dimensions of the archwires:[4]

1. Passive brackets
2. Active brackets

### 2.1. Passive

To entrap the archwire, passive brackets use a rigid, movable component. Tooth control with passive brackets is determined by the fit between the bracket slot and archwire. Tooth control usually is compromised with undersized wires housed in what is essentially an archwire tube. The advent of nickel-titanium wires has lessened the impact of this reduction on the level of tooth control early in treatment, but this can create problems later in treatment when stiffer wires are difficult to engage.

The passive self-ligating brackets had two designs: -

Ones with a rigid slide that passively held the wire

E.g., Edgelok, Mobil lock, Activa, Damon brackets.

Ones with integral "C " clips mechanism that ensures consistent full

E.g., Kesling, Smartclip

Ex: Damon, Mobil-Lock, Ormco Corporation Damon System, California; and Discovery SL, Orange, Ispringen, Dentaurum Ltd., Germany.

### 2.2. Active

Active brackets use a flexible to entrap the archwire. This flexible component constrains the archwire in the archwire slot and can store and subsequently release energy through elastic deflection. This gentle action imparts a light but constant force on the tooth and its supporting structures, resulting in an accurate and controlled movement. The capability of the bracket to reorient itself and its accompanying tooth in three dimensions till the archwire is seated fully in the archwire slot, the "home" position is known as the homing action of the flexible component. Any subsequent tipping, or torqueing, rotation during tooth movement results in the labial deflection of the flexible component and reactivates this homing behaviour.

Ex: Speed, In-Ovation, Quick, SPEED, Forestadent Ltd., Pforzheim, Germany; Strite Industries, Cambridge, Ontario, Canada.[11,12]

### 2.3. Active clip or passive slide?

This issue has interesting, intense debate and, as is seen in the articles of this issue, continues to be stressed by many advocates and producers of particular brackets as a significant feature of importance.

### 2.4. Thin aligning wires smaller than 0.018-inch diameter

The potentially active clip will be passive and irrelevant except the tooth (or part of the tooth if it is rotated) is sufficiently lingual placed to an adjacent tooth that the wire touches the active spring clip. A higher total force will usually be applied to the tooth compared to a passive clip in this situation. Even though there is no notable clip deflection, still a force on the wire which would not exist with a passive clip will be there because the active clip effectively reduces the slot depth from 0.027 inches (the depth of a Damon 2 slot) to near about 0.018 inches, either instantly as the wire becomes passive if it is initially deflected or the clip is not deflected or. This extra force is unlikely to be detrimental with modem low modulus wires. Still, it should be borne in mind since several studies have indicated that only large deflections allow a super-elastic wire to show a plateau of force for a range of deflection. For teeth that are initially positioned lingual to their neighbours, the active clip can bring that tooth more labial or facial (up to a maximum of 0.027 -0.018 = 0.009 inch) with a given wire.[13,14] These figures are slightly complicated because the active clip does not minimize the depth of the slot to the same extent over the full slot height - the clips on Time, Speed, and In-Ovation brackets impinge into the slot more gingivally than at the occlusal end. Depending on adjacent teeth' relative vertical positions, this asymmetry would make a difference with small diameter wires. The effect of an active clip at the initial stage of treatment can be thought of as having a potentially shallower bracket slot.

### 2.5. Wires larger than 0.018-inch diameter

An active clip will give a continuous lingual force on the wire even though the wire has gone passive. On teeth that are wholly or in part lingual to an adjacent tooth, the active clip brings again the tooth (or part of the tooth if rotated) slightly more labial than having a case with a passive clip at a 0.027-inch slot depth. The most significant difference will be the variation between the labio-lingual dimension of the wire and 0.027 inches. For a 0.016 x 0.022-inch intermediate wire, this would give a maximum difference of 0.005 inches. 0.016 x 0.025-inch nickel-titanium wires are advocated wire for intermediate aligning for Damon 2, and this wire decreases this potential difference to 0.002 inches. Lingually placed teeth would have a little higher initial force with an active clip and wires of intermediate size. Even when the wire is passive with an active clip, an active force will remain.[11]

### 2.6. Thick rectangular wires

An active clip will make a labio-lingual change in tooth position of 0.002 inches or less, which is very small and not likely to be clinically significant. Additional torque from an undersized wire causes continued lingual directed force on the wire from an active clip (or from a conventional ligature) is interesting and probably reflects a degree of misunderstanding about the torque generation in an edgewise slot. The diagonally directed lingual force on wire exerted by the clip, whatever the orientation or shape of the rectangular wire, does not contribute to any third-order interaction between the walls of the bracket slot and wire corners - the origin of torquing force. The requirement for an active clip to invade the slot decreases the available depth of one side of the slot, which means the rectangular wire is not fully engaged. This increases the 'slop' between the rectangular r wire and the slot and reduces the torquing mechanism's moment arm. Errors in torque can appear as labiolingual contact point errors or errors in height. Speed brackets have newly addressed this problem on upper incisors by extending the gingival walls of the slot on either side of the clip as torquing rails.'[15]

### 2.7. Advantages or disadvantages of an active clip

The clinical consequences of having a potentially active clip impinging into the slot are harder to assess than a first thought suggests. It is predictable that with an active clip, initial alignment is more complete for a wire of a given size to a clinically helpful extent. However, after the same number of visits, it should be feasible to place thicker wires into a bracket with a passive clip and arrive at the working archwire size, with modern low modulus wires, i.e., rather than dividing it between wire and clip, to store all the force in the wire.[16,17] Once in the thick working wire, the potential disadvantages of an active clip are reduced torquing capacity in one direction and increased friction. These higher friction forces are still much less than those with elastomeric 'ligatures on a conventional tie-wing bracket to put the friction levels in context.[18] All other factors being equal, high friction is a disadvantage, which leads to the loss of clinical performance. Finally, there are questions of robustness, the security of ligation, and ease of use.

### 2.8. Properties of an ideal ligation system

The concept of ligation via tie-wings is so prevalent that it is worth considering the properties of the ligation system. The benefits and difficulties of current self-ligating systems are outlooked in this exercise.

#### 2.8.1. Ligation should be:[10]

1. Be secure and robust;
2. Be quick and easy to use;
3. Ensure full bracket engagement of the archwire;
4. Permit high friction when desired;
5. Permit easy attachment of elastic chain;
6. Assist good oral hygiene;
7. Be comfortable for the patient.

#### 2.8.2. Frequently proposed limitations of conventional ligation

1. Failure maintenance and to provide full engagement of wire resulting in poor control of tooth movement.
2. Friction values are increased.
3. For elastomeric modules owing to force decay, tooth control was not optimal.
4. Oral hygiene was potentially impeded.
5. Wire ligation is time consuming clinical procedure.

### 2.9. Historical perspective and evolution of self ligating brackets

The orthodontic ligatures became an integral part of modern clinical orthodontics, with the introduction of Edward Angle's edgewise appliance. Since that time, orthodontic ligatures have come in many variations in design and materials.

### 2.10. Stainless steel ligatures

They are robust, cheap, and essentially free from degradation and deformation, and to an extent, they can be applied loosely or tightly to the wire. They also allow ligation of the archwire at a distance from the bracket. These wire ligatures have substantial drawbacks, and the most immediately apparent of these is the time required to place and remove the ligatures. According to one study, an additional 11 minutes was needed replace two archwires if wire ligatures were used rather than elastomeric ligatures. Displaced ligature end causing puncture wounds and trauma to the patients' mucosa are the other potential hazard.[19]

### 2.11. Elastomeric ligatures

Elastomeric ligatures became available in the late 1960sand rapidly became the most common means of ligation, almost entirely because of the significantly reduced time required to place and remove them compared with steel wire ligatures. Elastomerics frequently fail to engage an archwire when full engagement is intended tightly. Khambay et al. mentioned the potential seating forces with wire and elastic ligatures and higher archwire seating forces available with tight wire ligatures. A second and well-documented drawback with elastomeric is the substantial degradation of their mechanical properties in the oral environment.[20,21]

In the past, attempts have been made to describe the self-ligating systems and their design, advantages, and drawbacks. In this article, we highlight and elaborate the self-ligating techniques from its introduction to the most recent development in a chronological manner and the frequent use of self-ligating brackets in day-to-day clinical practice, with each bracket claiming better treatment efficiency with their changing designs

### 2.12. Ford lock

J. W. Ford was the first to manufacture Ford Lock self-ligating bracket in 1933. It featured a circular ring to create a rigid wall to entrap the archwire in the slot. As the circular member was incapable of interacting with the archwire for rapid tooth movement, the Ford bracket turned into a passive self-ligating bracket. (Figure 1)

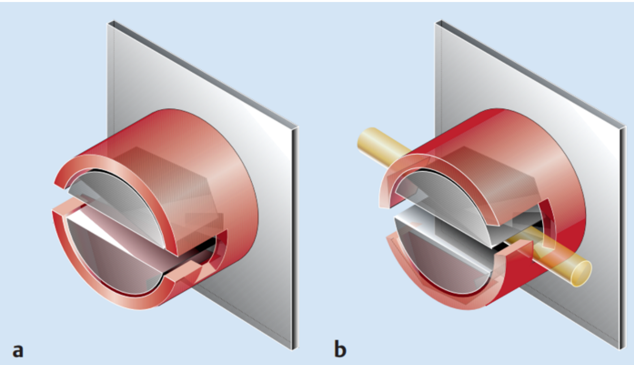


**Fig. 1:** Ford bracket (1933); **a:** Slot open; **b:** Slot closed

### 2.13. Edgelok

In the early 1970's orthodontic pioneer J. Wildman introduced a passive SLB called Edgelok bracket, marketed by the Ormco Corporation. This attachment was unique as it was the 1stself-ligating bracket to receive widespread commercial exposure. It featured a rigid movable cap that served to entrap the archwire. One of the advertised benefits of Edgelok design was that it permitted immediate free movements of the archwire within the archwire slot as with all passive design this free movement combined with a narrow width of the bracket resulted in limited tooth control. Auxillary rotational collars were introduced quickly to address this limitation, but this, combined with a bulky bracket body, contributed to its decline. The bracket was taken off the market in little less than ten years after its introduction.[22] (Figure 2)

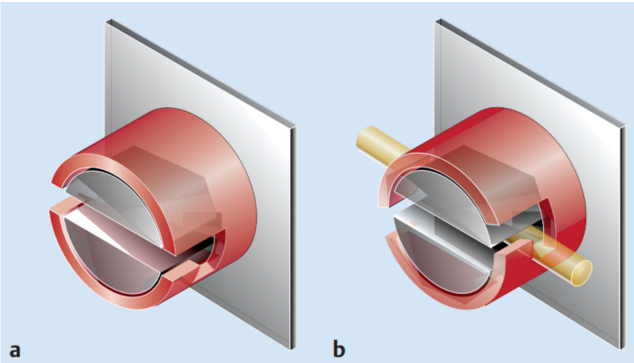


**Fig. 2:** Ford bracket (1933); **a:** Slot open; **b:** Slot closed

### 2.14. Speed

G.H. Hanson, in 1973 began work over this new self-ligating appliance, which is a trademark of Strite Industries Ltd. **SPEED** stands for **s**pring-loaded, **P**recision, **E**dgewise, **E**nergy, and **D**elivery. According to Hanson, the SPEED bracket can save as much as 5 minutes/arch change, and that it permits a high degree of precision in the three-dimensional control of tooth movement, that is well suited for sliding mechanics, and that it can store large amounts of energy release at a slow rate. This active self-ligating design featured a curved flexible spring moving in either of two equilibrium positions. The slot slid open to permit archwire insertion or slot closed to allow entrapment. The SPEED design was unique as its design could interact with archwire in gentle corrective tooth movement.[23,24]

Hanson, in 1999, described various clinical uses of the SPEED appliance. The auxiliary tubes allow the attachment of elastic hooks from either the mesial or distal. He said that it is possible to accomplish various objectives simultaneously, like applying labial root torque to the canines while intruding on the incisors.[25] The passive self-

**Table 1:** Evolution of self ligating brackets over the years

| Manufacturer | Bracket | Year | Type |
|---|---|---|---|
| | Russell Lock | 1935 | Active |
| Ormco | Edgelok | 1972 | Passive |
| Forestadent | Mobil-Lock | 1980 | Passive |
| Forestadent | Begg | 1980 | |
| Strite Industries | SPEED | 1980 | Passive |
| "A" Company | Activa | 1986 | Passive |
| Adenta | Time | 1996 | Passive |
| "A" Company | Damon SL | 1996 | Passive |
| Ormco | TwinLock | 1998 | Passive |
| Ormco/"A" Co. | Damon 2 | 2000 | Passive |
| GAC | In-Ovation | 2000 | |
| Gestenco | Oyster | 2001 | Passive |
| GAC | In-Ovation R | 2002 | |
| Adenta | Evolution LT | 2002 | Passive |
| Ultradent | OPAL | 2004 | Passive |
| Ormco | Damon 3 | 2004 | Passive |
| 3 M Unitek | SmartClip | 2004 | Passive/Active |
| Ormco | Damon 3 MX | 2005 | Passive |
| Forestadent | Quick | 2006 | Passive |
| Lancer | Praxis Glide | 2006 | Passive |
| Class 1/Ortho Organisers | Carrière LX | 2006 | |
| GAC | In-Ovation C | 2006 | Passive |
| 3M Unitek | Clarity SL | 2007 | Passive/Active |
| American Orthodontics | Vision LP | 2007 | Passive |
| Dentaurum | Discovery SLB | 2007 | Passive |
| Ortho Technology | Lotus | 2008 | Passive |
| Ormco | Damon Q, Damon aesthetic | 2009 | Passive |
| Ortho Classic | Axis | 2009 | |
| 3 M Unitek | SmartClip SL3 | 2009 | Passive/Active |
| Ormco | Damon Clear | 2010 | Passive |
| Forestadent | BioQuick, | 2010 | Passive |
| 3 M Unitek | Victory Series$^{TM}$ | 2011 | |
| American Orthodontics | Empower | 2011 | |
| Ortho Technology | Sensation Ceramic | 2012 | Active |
| | Carriere SLX | 2014 | Passive |
| | ProGate I | 2015 | Passive |
| | Empower 2 | 2016 | Passive |
| | In-Ovation X | 2017 | Active |
| | Lotus Plus DS | 2017 | Active/Passive |

ligating designs were brought to the market in the early 1980s. (Figure 3)

## 2.15. Activa

In 1986 Activa bracket was brought into the market by "A" Company of Ormco Corporation. A passive self-ligating bracket featured a circular door that rotates around the cylindrical bracket body, permitting insertion and removal of the archwire. Once closed, the rigid outer wall of the movable arm converted the archwire slot into a passive archwire tube. The inner curvature of the circular door increased the effective slot depth with small-diameter wires, diminishing labiolingual alignment with such wires. The

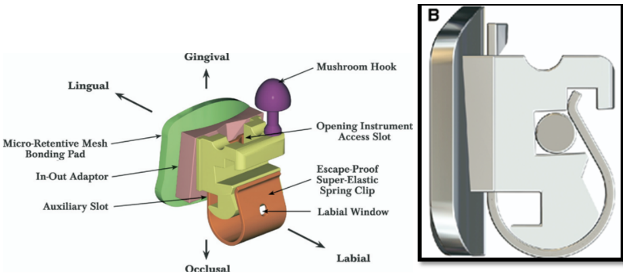


**Fig. 3:** Speed brackets; a: Components of SPEED brackets; b: SPEED brackets with archwire

decreased inter bracket distance and absence of tie wings are the limitations of Activa bracket design.[26] According to Griffics JM et al. (1993), the advantages and disadvantages are as follows. (Figure 4)

### *2.15.1. Advantages of activa brackets*

1. Low friction between bracket and archwire.
2. More certain full archwire engagement.
3. Less chair side assistance.
4. Vertical slot for hooks and auxiliaries.
5. Smoother and more comfortable.
6. Easier oral hygiene.
7. Better esthetics.

### *2.15.2. Disadvantages of activa brackets*

1. Higher bond failure rate.
2. Less convenient with elastomeric chain.
3. Unfamiliarity.
4. Harder to hold and seat when bonding.
5. Partial slot engagement not possible.
6. Breakage of archwire retaining clips.
7. Low friction increases wire displacement.

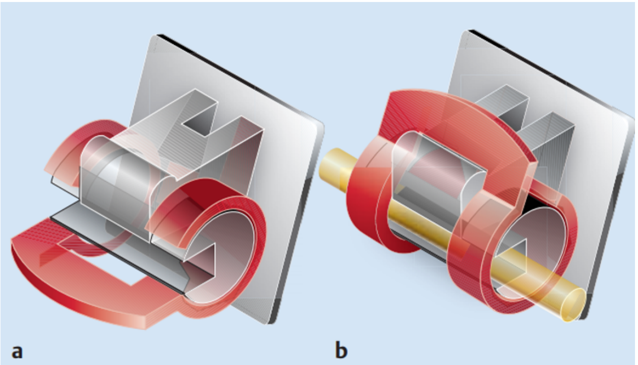


**Fig. 4:** Activa Brackets; **a:** Slot open; **b:** Slot closed

### *2.16. Time*

In 1996 another self-ligating bracket was introduced, the 'Time' bracket by 'Adenta' featured a rigid door pivoted on a small mount, thus preventing archwire insertion or removal. These attachments open the slot by moving the rigid door towards the gingiva and close the slot by moving towards the occlusal side.[27] Although these resemble the SPEED design, its rigid door did not permit active interaction with an archwire. The success of this passive design remains in question. (Figure 5)

**Fig. 5:** Time brackets

### *2.17. Damon SL1*

In 1996 the 1st of several Damon brackets were introduced, which is a trademark of Ormco corp. It featured a rigid slide wrapped around the bracket body that could be moved to permit archwire insertion and returns to its original position to entrap the archwire. The Damon 1 was unique and popularized due to the utilization of tie wings in self-ligating designs. These brackets were a significant step forward but had two significant problems. The slides sometimes opened inadvertently because of the play of the slide around the exterior of the bracket, and they are prone to breakage due to work-hardening on the angles of the slide during manufacture. (Figure 6) This design went several variations and was replaced by Damon 2 design.[28,29]

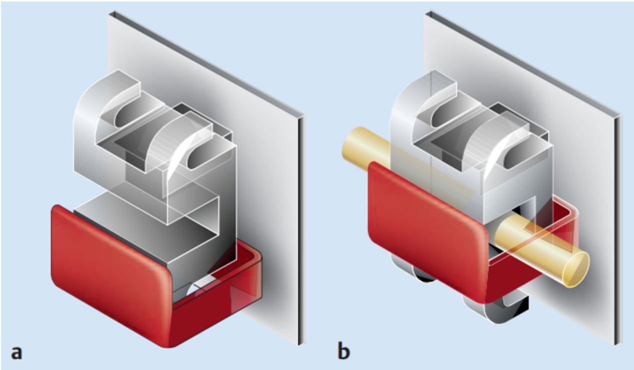


**Fig. 6:** Damon SL; **a:** Open; **b:** Closed

### *2.18. Twin lock*

At the same time, the introduction of Damon 1, J. Wildman, who invented the Edgelok bracket, developed another self-ligating model called the Twin Lock appliance in 1998. It featured a flat rectangular passive slide tied between the tie wings and could occupy the open or closed position. Notable to this design was the very deep archwire slot. One year after its introduction, the TwinLock bracket was modified slightly and introduced as Damon SL 2 bracket.[10]

(Figure 7)

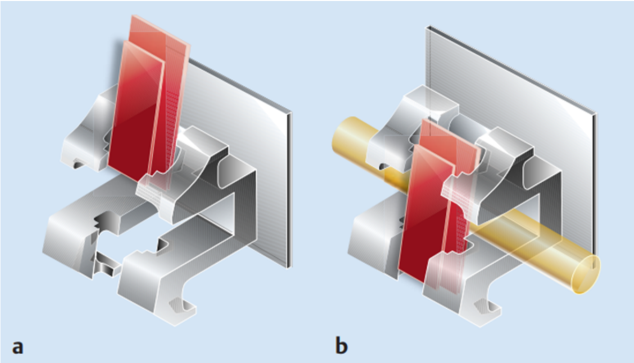


**Fig. 7:** Twinlok brackets; **a:** Open; **b:** Closed

Damon 2 In2000, A passive Damon 2 self-ligating bracket was introduced, which was very similar to that of the Twin Lock design. Like the Twin Lock design, it featured a flat rectangular slide-mounted between its tie wings.1 the rigid slide could be moved up and down, thus permits archwire insertion and removal. This design was also replaced by Damon 3. (Figure 8)

**Fig. 8:** Damon 2 series

### 2.19. Inovation

In 2000 GAC introduced a self-ligating bracket design which resembles G. Hanson's SPEED design, called In-Ovation bracket. It featured a curved flexible clip that could occupy a slot open or closed position. Like the Damon bracket, the emphasis was on incorporating tie wings that could accommodate ligature ties. This resulted in a rather bulky design which later eventually reduced in size and turned into In-Ovation R brackets.[10,12] In 2002, smaller brackets for the anterior teeth became available, In-Ovation R (referred to as the reduced bracket

width), and due to this narrower width bracket design was more effective in terms of greater inter bracket span. Therefore, the bracket subsequently became known as System R. They are a successful design, but some relatively minor disadvantages in bracket handling were initially apparent.[12] (Figure 9)

**Fig. 9:** In-Ovation R brackets

### 2.20. Smart clip

The smart clip is a passive self-ligating bracket introduced in 2004, a 3M Unitek Company trademark. This bracket is similar to the design of Boyd and Brusse's bracket. This design featured two Nickel Titanium C-shaped clips on either side of the bracket slot to retain the wire. The pressure required to remove or insert an archwire is not applied directly to a clip or slide, but it is applied to the archwire, which in turn uses the force to deflect the clips and thus permit archwire removal or insertion.[12] (Figure 10)

### 2.21. Opal brackets

Oyster (2001), Opal (2004) are passive self-ligating brackets entirely made of plastic resin and featured a hinged cap that rotates open for archwire insertion or removal. Good results can certainly be achieved with these brackets, but, as with all resin brackets, rigidity, robustness, and longevity are a challenge. Their success is questionable, but they are still commercially available.[30] (Figure 11)

### 2.22. Damon 3, damon 3 MX and damon Q brackets

Plastic also made its way into Damon brackets. The Damon 3 self-ligating bracket introduced in 2004 features a metal

**Fig. 10:** Smart clip brackets

**Fig. 11:** Opal brackets

archwire slot and rectangular slide housed in a plastic shell. This plastic shell forms a bracket base and tie wings. The rectangular slide functions the same as in previous Damon models. (Figure 12)


**Fig. 12:** Damon brackets; **A:** Damon 3; **B:** Damon 3MX; **C:** Damon Q

## 2.23. *Victory series™ brackets*

The Victory Series™ Active Self-Ligating Bracket has a sturdy ligating mechanism designed for the reliability of use and ease of operation. The full slot-width size door maximizes the available rotational control ability of this system. Rounded slot edges are designed to minimise archwire binding. Doors can be quickly closed and opened by using either the door Unotch or the gingival tab. The vertical groove under the door allows for easy opening from the U-notch.[31] (Figure 13)

**Fig. 13:** Victory series brackets

## 2.24. *Empower brackets*

Empower, a trademark of American Orthodontics is the first to offer versatility in passive and interactive bracket designs in one unified system with coordinated outs/in. Empower two metal brackets to give you the choice of a fully interactive, fully passive, or combination Dual Activation™ system. These brackets provide self-ligating benefits in a comfortable, low-profile design. Empower Clear self-ligating brackets (American Orthodontics, Sheboygan, Wis) consists of ceramic bracket body and rhodium-coated clip deliver patient-pleasing aesthetics. This fully interactive aesthetic bracket gives the versatility and ease of self-ligation while providing the patients with the beautiful smile they deserve both during and after treatment.[32] (Figure 14)

## 2.25. *Self-ligating lingual brackets*

The use of self-ligating brackets in lingual orthodontics was first presented by Neumann and Holtgrave. They suggested using SPEED (Strite Industries Ltd) self-ligating labial brackets for application in the lingual technique. The lingual technique presents particular difficulties when compared with the labial technique. Self-ligating brackets have important benefits that can overcome those difficulties, improve the performance of the lingual appliance,

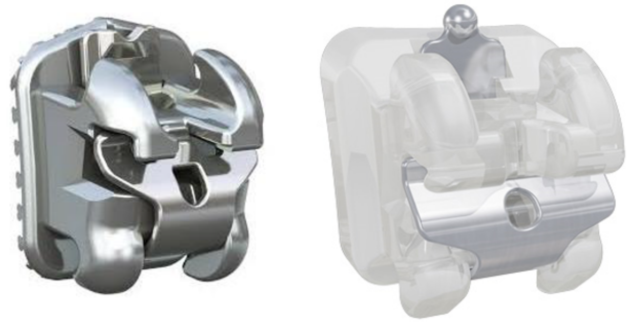

**Fig. 14:** Empower series brackets

and contribute to the efficiency of lingual orthodontic treatment.[33]

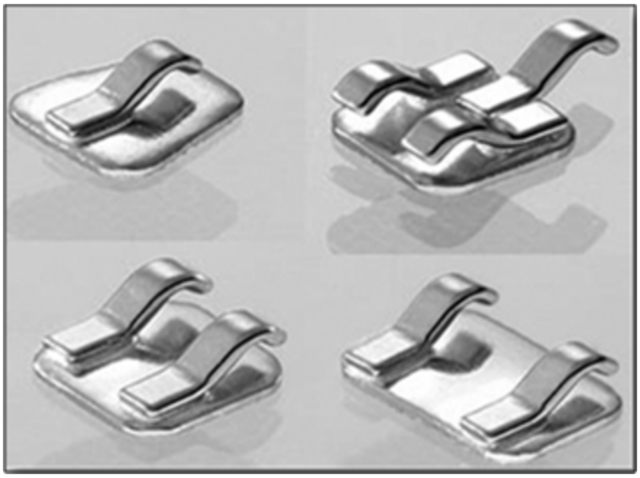

**Fig. 15:** Philippe 2D self-ligating lingual brackets

### 2.26. Philippe 2D self-ligating lingual brackets

(Forestadent Bernhard Foerster GmbH), providing2-dimensional control, was suggested for the correction of simple malocclusions, like minor crowding or spacing with the lingual technique. These brackets have no slot; they include only small wings welded to the base of the bracket. The wings are used to secure the archwire to the base of the bracket. The wings are closed, pushed against the base of the brackets with Weingart utility pliers to hold the archwire, and can be opened for archwire replacement, using a thin spatula between the wings and the base of the bracket.[34] These brackets are comfortable to the patient as they have a low profile. Four types of Philippe brackets are available: a standard medium twin, a narrow single wing bracket for lower incisors, a large twin bracket, and a three-wing bracket for attachment of intermaxillary elastics. Philippe self-ligating brackets can be placed directly intraorally or prepared for indirect bonding on the malocclusion model. The most important advantage of the Philippe brackets is their low profile and comfort to the patients. They are suitable for simple cases which do not require 3-dimensional control since they have no slot.[34](Figure 15)

### 2.27. The forestadent 3D torque-lingual self-ligating

Brackets have a 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 ribbon arch-like archwire is used, with the widest edge of wire lying towards the tooth surface; therefore, the buccolingual slot dimension is smaller than the occlusogingivally slot dimension, and the bracket is nearly flat, with a low profile. 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 archwire is secured in the slot by pushing the wings against the bracket's base and over the archwire with Weingart utility pliers. A thin spatula placed between the wings and the bracket base is used for opening the bracket for archwire replacement.(Figure 16)

**Fig. 16:** Forestadent 3D Torque-Lingual self-ligating

### 2.28. 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 also serve as a bite plate and consequently presses the archwire further into the slot when biting.[32,36][32] Dr Hatto Loidl, an orthodontist from Berlin, Germany, and Mr Claus Schendell, owner and engineer of Adenta mbH, designed a new self-ligating new self lingual bracket and modified HIRO system called the Evolution sit bracket system. Eliminating the old lingual systems disadvantages and producing a lingual technique with individual transfer caps can be fabricated easily without using costly equipment using Smart Jig technology.[32] In a study comparing the 3D Forestadent and Adenta Evolution brackets, it was found that both brackets had some limitations in handling. Both

3D Forestadent and Adenta Evolution brackets are wide mesiodistally, which caused difficulties in handling due to reduced inter bracket distance.(Figure 17)

**Fig. 17:** Adenta Evolution lingual bracket

### 2.29. *In-Ovation-L*

(GAC International) lingual brackets are twin, horizontal slot brackets, with an interactive clip with an effortless opening. The bracket wings and clips have a very low profile, and the base of the incisor brackets is bent to fit the anatomy of the palatal surface of the incisors. Low profile brackets with minimal buccolingual width allow a larger archwire perimeter and an increased inter bracket distance; the latter design of brackets has advantages in lingual orthodontics. The low profile of the brackets also contributes to greater patient comfort.[32,34] (Figure 18)

**Fig. 18:** In-ovation-L brackets

### 2.30. *Phantom*

(Gestenco International) is a poly ceramic self-ligating bracket. These brackets are bonded directly in the mouth after preparation of the lingual surfaces of the teeth by reshaping and filling all irregularities with flowable composite.[34] (Figure 19)

**Fig. 19:** Phantom

## 3. Conclusion

Whether active or passive, every self-ligating bracket uses the movable fourth wall of the bracket to convert the slot into a tube. Numerous studies have demonstrated a dramatic decrease in friction for self-ligating brackets compared to conventional bracket designs. Such a reduction in friction can help shorten overall treatment time, especially in extraction cases where tooth translation is achieved by sliding mechanics. Several authors have indicated that self-ligating brackets can reduce treatment time by about four months and save significant chair time in changing archwires. These factors add up to a considerable cost saving. As more orthodontic practices embrace the concept of self-ligation, it is becoming apparent that stainless steel and elastomeric ligatures will eventually be as outdated as full banding is today. Considering the advantages of self-ligating brackets for the clinician, staff, and patient, they may well become the "conventional" appliance systems.

## 4. Conflict of Interest

None.


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