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SELF-LIGATING BRACKETS - A REVIEW

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ABSTRACT

Self-ligating brackets are ligatureless bracket systems that have a mechanical device built into the bracket to close off the edgewise slot. These brackets secure passive or active ligation mechanism that ensures consistent full bracket engagement. Reduced friction between archwire and bracket allows more rapid tooth movement. This results in good control of tooth position through an adequately dimensioned bracket. A review of self-ligation in general has been highlighted in this article

Keywords: **Self ligating Brackets**, **Lingual Orthodontics** ,**Passive slide, Bracket selection, Damon, SPEED, TIME.**

INTRODUCTION

Self-ligating brackets are ligature less bracket systems that have a mechanical device built into the bracket to close off the edgewise slot[1]. The cap holds the archwire in the bracket slot and replaces the steel/elastomeric ligature. With the self-ligating brackets the moveable fourth wall of the bracket is used to convert the slot into a tube.To overcome the problems of ergonomics *(study of workplace/equipment*), time-consuming procedures, plastic deformation, discoloration, plaque accumulation and friction with steel and elastomeric ligatures, self-ligating brackets have been developed.

History

Self-ligating brackets were first introduced in the mid 1935 in the form of the Russell attachment by Stolzenberg[1,2](Fig.1.)

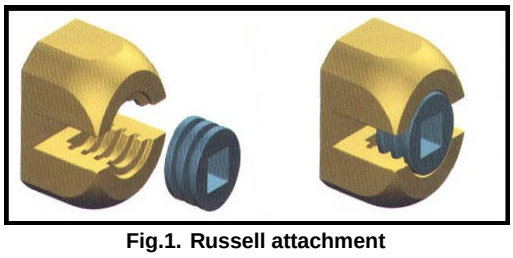

Fig.1. Russell attachment

The chronology of evaluation of the different self ligating bracket sytems is [2]

Bracket	Year
Russell Lock	1935
Ormco Edgelok	1972
Forestadent Mobil-Lock	1980
Orec SPEED	1980
A company Activa	1986
Adenta Time	1994
A company Damon SL	1996
Ormco Twin Lock	1998
Ormco /ACo.Damon 2	2000
Gentenco Oyester	2001
GAC In-Ovation	2002
GAC In-Ovation R	2002
Adenta Evolution LT	2002
Ultradent Opal	2004
SDS Ormco Damon3	2004
3M Unitek SmartClip	2004
SDS Ormco Damon MX	2005
Class One Carriere SLB	2005

Limitations of conventional ligation[1]

1. Failure to provide and maintain full archwire engagement results in poor control of tooth movement.
2. Frictional values are increased.

3. For elastomerics, force decays and so tooth control is not optional.
4. Both wire and elastomeric ligature become displaced.
5. Oral hygiene is impeded.
6. Wire ligation is a time consuming clinical procedure.

Advantages of self ligation[1-3]

1. A secure passive or active ligation mechanism that ensures consistent full bracket engagement.
2. Reduced friction between archwire and bracket that allows more rapid tooth movement.
3. Good control of tooth position through an adequately dimensioned bracket.
4. Less chair side assistance.
5. Faster archwire removal and ligation.

Properties of self ligation [1-3]

1. Secure and robust
2. Ensure full bracket engagement of the archwire
3. Exhibit low friction between bracket and archwire
4. Quick and easy to use
5. Permit easy attachment of elastic chain
6. Assist good oral hygiene
7. Comfortable for patient

Time savings with self-ligating brackets

Rolf and Smith[4] in 1990 revealed how time consuming self ligating brackets are**.** Consider a scheduled appointment of 30 minutes. For the edgewise cases, an average of 10 minutes was required for archwire removal and replacement, and six minutes for the orthodontist's adjustments. Assuming that the average patient takes five minutes to arrive and depart, a total of 21 minutes has been used. On the other hand, the average *self-ligating case would take 14 minutes*. Using the self-ligating brackets therefore frees an additional seven minutes of the appointment for positive reinforcement of proper oral hygiene, discussion of progress, or simply communicating with the patient.

Classification of self ligating brackets

Two types of self-ligating brackets have been developed. They are 1. Active 2. Passive. These terms refer to the mode in which they interact with the archwire.

Active Type(Fig.2)

The Active type has a spring clip that presses against the archwire such as

1. IN-OVATION
2. SPEED
3. TIME BRACKETS

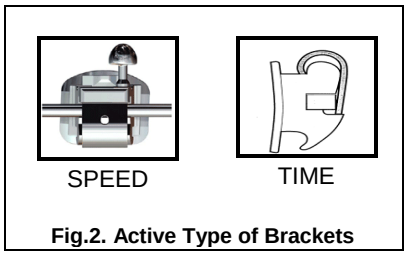

Fig.2. Active Type of Brackets

Passive Type (Fig.3.)

In the passive type of self-ligating bracket, the clip does not press against the archwire - such as

1. ACTIVA
2. DAMON SL II
3. OYSTER ESL

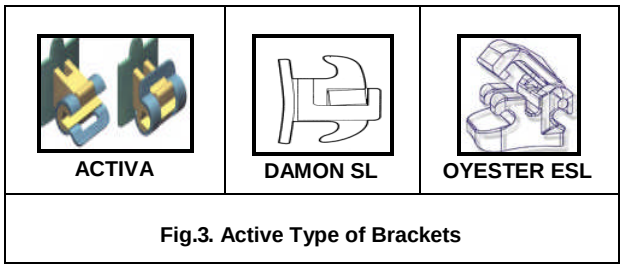

Fig.3. Active Type of Brackets

Active or passive slide

In Active clip**(Fig.4),** the initial alignment is more complete for a wire of a given size. In Passive slide, increased clearance between a given wire and passive slide will generate lower forces and facilitate dissipation of binding forces and ability of teeth to push each other aside as they align. **,(Fig.5)**

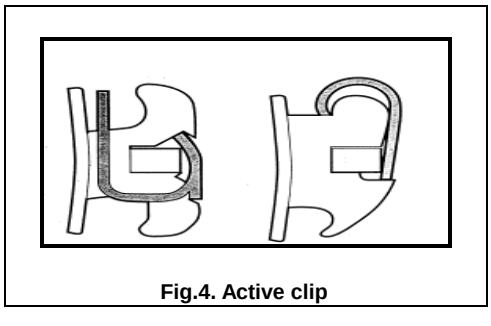

Fig.4. Active clip

Disadvantages of active clip

1. Increased friction
2. Potentially reduced torquing capacity in one direction with some brackets.

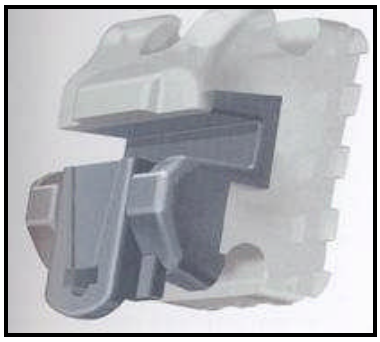

Fig.5. Passive slide

Comparison Of Resistance To Sliding Between Different Self-Ligating Brackets

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Resistance to sliding was investigated by Thorstenson Glenvs and Kusy Robert P[5] for 3 self-ligating brackets having passive slides and 3 self-ligating brackets having active clips with Second-Order angulation In The Dry And Saliva States. Brackets with passive slides exhibited negligible friction; brackets with active clips exhibited frictional forces as great as 50 cN (50 g). Above each critical angle, all brackets had elastic binding forces that increased at similar rates as angulation increased and were independent of bracket design. At second-order angulations that exceeded the critical angle, brackets with active clips that had a low critical angle had more resistance to sliding than did brackets with active clips that had a higher critical angle. Brackets with passive slides that had a high critical angle exhibited the lowest resistance to sliding, but could do so at a cost of some loss of control.

Cost and treatment efficiency of self ligating brackets (Harradine)[1-3]

1. More *expensive* than tie wing brackets.
2. Average time saving from reduction in archwire placement / removal of 24 seconds per arch
3. Mean reduction of 4 months in active treatment time from 23.5-19..4 months
4. Mean reduction of 4 visits during active treatment from 16-12 months.

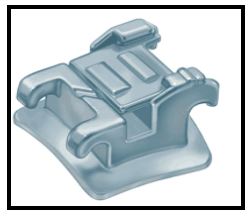
Classification of Self Self Ligating Systems

Basically self ligating systems are classified into four types as :[6-9]

1. DAMON
2. TIME
3. SPEED
4. SMART CLIP

1. Damon Passive Self Ligating System

Introduced in 1994 by Dr. Dwight Damon [6,7] .The Damon bracket utilizes (sliding door) technology known as "self ligation" that allows the wire to slide back and forth within the bracket. Based on principle of using just enough force to initiate tooth movement - *threshold force*. Passive self ligation has lowest frictional resistance - forces transmitted to teeth without absorption by ligature system **(Fig.6).**



Damon 2

Damon 3

Fig.6. Damon Brackets

Three features of passive self ligation

1. Low levels of static and dynamic friction
2. Control of tooth position because there is an edgewise slot of adequate width and depth.
3. Rigid ligation due to positive closure of slot by gate or slide

Bracket selection

1. High torque
2. Standard torque
3. Low torque

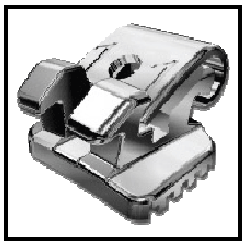
Bracket positioning

1. Midpoint of facial axis of clinical crown with the vertical bracket positioning key parallel to this axis. Exceptions:
2. The lower cuspid brackets are positioned 0.5-1mm mesial to facial axis of clinical crown to prevent mesial edge of cuspid tucking behind distal part of lower lateral incisor.
3. In deep bite cases, cuspid and incisor brackets are placed slightly more incisally in both arches to aid bite opening.
4. In open bite cases, brackets are placed more gingivally.
5. Teeth that have to undergo translation,overangulation of brackets to exaggerate root movement in desired direction. eg:correction of pseudotranspositions, opening spaces for implants, closure of spaces such as moving lateral incisor into central incisor space.

6. In teeth with damaged incisal edges position bracket to obtain correct gingival emergence profile and restore the incisal edge.
7. Brackets are not inverted as gates are more vulnerable to open rarely generate enough torque to correct the problem.

2. Time: A Self Ligating Interactive Bracket System

It is a hybrid self ligating bracket introduced by Wolfgang Heiser[8] in 1998. with both active and passive elements. Incorporation of all features lacking in other systems. There is minimal force and friction in early stages of treatment. Torque and rotational control in middle and finishing stages of treatment.Time has a simple open-close clip mechanism for ease of wire changes. Finishing details is achieved in a controlled manner in all 3 planes of space. **(Fig.7.)**



TIME SL BRACKET
Fig.7. TIME brackets

3. SPEED system

Invented by Dr.G.Herbert Hanson [1,2]in 1970. Miniaturized self ligating bracket with active niti spring clip. Clip has 2 resting positions**(Fig.8.)**

- slot closed: to capture the archwire
- slot open: to release the archwire

Also stores energy which is gently released as corrective tooth movement occurs. As corrective movements are required, archwire engagement results in elastic deflection of clip. Any subsequent movement of tooth from this ideal position results in repeat of corrective process and return of tooth to correct position.

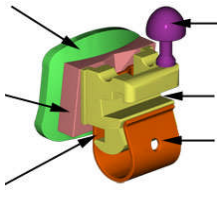


Fig.8.SPEED system

Advantages of SPPED system

1. Highly flexible niti spring clip provides 3D control
2. Minimal friction during sliding mechanics
3. Extended activation due to energy stored in clip
4. Large inter bracket span
5. Spring clip will not fatigue or physically deform under normal treatment conditions.
6. Horizontal slot enhances segmental mechanics
7. Clinically proven for 25 yrs

SPEED supercable[3]

It is a superelastic nickel titanium coaxial archwire consisting of 7 strands of wire wrapped with a long pitch. It is available in 0.016'',0.018'' and 0.020''. It can be fully engaged without plastic deformation due to its unique construction and superelastic property.There is minimal patient discomfort**.(Fig.9)**

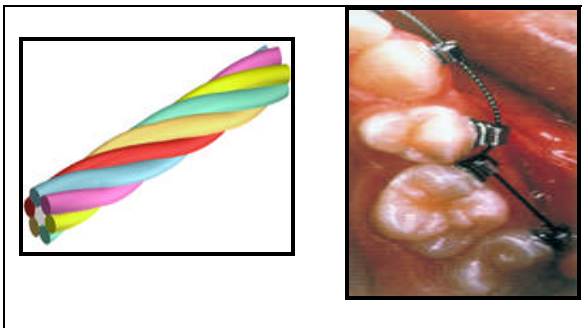


Fig.9. SPEED super cable wires

Supercable and the Speed system(Berger and Byloff-1998)

Titanium alloys such as nickel titanium (Nitinol) and titanium molybdenum (TMA) are more resilient than stainless steel; archwires made of these materials exhibit lighter and more continuous forces and 20-30% of the bending values of stainless steel wires. In 1993, Hanson combined the mechanical advantages of multistranded cables with the material properties of superelastic wires to create a superelastic nickel titanium coaxial wire. This wire, called Supercable, comprises seven individual strands that are woven together in a long, gentle spiral to maximize flexibility and minimize force delivery.

Uses:

1. engaged in even the most crowded cases without patient discomfort.
2. The resilience of Supercable makes it impossible to place distal end bends. Flaming the wire ends only results in fraying. Therefore, specially designed Supercable distal end stops must be

added to secure the wire distal to the terminal brackets or light-cured composite material can be placed over the protruding archwire ends

3. Smart Clip Self Ligating Appliance System

Consists of 2 Niti clips that open and close through deformation of material when archwire exerts a force on clip. Bracket has no moving door or latch (prevents sticking, plaque build up, spontaneous opening). Clip automatically closes and secures archwire in wire slot. Tie wings allows traditional ligation and simple chain ligatures when needed for space closure**(Fig.10)**

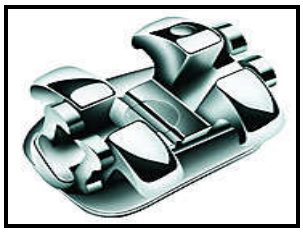
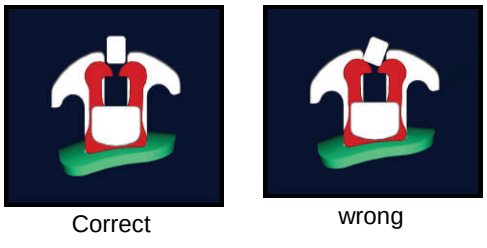


Fig.10. SMART CLIP system

Insertion and disengagement of wires [7-8]

Wire insertion: one end of insertion instrument has a rectangular notch. It allows the clinician to direct wire into slot, applying gentle pressure to pass through clips and engage into bracket slot. The opposite end of insertion instrument is used as torquing key to aid insertion of rectangular wires. Support the tooth from the lingual using fingers to provide comfort to patient. Initiate archwire insertion on upper and lower incisors. Insert wire perpendicular to the base of the slot. This may require torquing of the wire. If the wire does not enter the clip correctly, it can create a positive stop (black arrows) and resist easy wire insertion. Proper alignment to the slot will also assist in wire engagement.**(Fig.11)**



Correct wrong

Fig.11. Inserion of wires

Disengagement; Approach archwire with disengagement instrument from occlusal or gingival side. Place instrument hooks under archwire keeping the bracket between the instrument hooks. Squeeze handles**.(Fig.12)**

Fig.12. Disengagement of the wire

Esthetic self ligating bracket[2]

Opal brackets

Designed by Norbert Abels. Opal is a unique self-ligating bracket designed for patient comfort and efficient clinical performance. Opal brackets have a smooth, rounded surface which open and close easily to access the archwire. The unique cap design ensures consistent opening and closing of the bracket throughout the treatment. In addition it has reduced size, low profile and rounded edges. Cap is robust to withstand sharpness of opening tool and bond strength needs to withstand leverage of initial opening of cap. No tie wings so elastic chain is placed in auxillary slot prior to closing cap**.(Fig.13)**

Fig.13. Opal brackets

A highly polished passive slot ensures that teeth move quickly and efficiently using ultra-light force archwires at the beginning of treatment. Highly accurate slot tolerances ensure full expression of torque and rotation control at the end of the treatment. The Opal bracket is designed with a simple marking and identification system on the face and base of the bracket. Horizontal and vertical cross hairs are printed on the face to assist with visual positioning of the slot over the center of the tooth during bonding. The base of each Opal bracket is imprinted with Palmer Notation to identify the correct tooth just prior to application of bonding adhesive. Mechanical undercuts on the base of the bracket provide reliable bond retention and after treatment

is completed, the debonding procedure is identical to other metal brackets.

Oyster - translucent, self-ligating, bracket system
The Oyster bracket is made from a strong, fiberglass reinforced composite polymer that resists discoloring. The unique snap-on cap allows arch wires to be placed and changed in a fraction of the time normally required for traditional ligation. The absence of traditional ligatures also enhances oral health and hygiene. **.(Fig.14)**

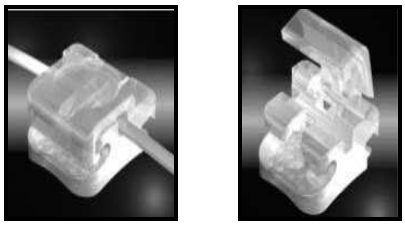


Fig.14. Oyster Brackets

Self ligating brackets in Lingual orthodontics

The benefits of the self ligating brackets in lingual orthodontics

1. Reduced friction and faster alignment
2. Improved oral hygiene
3. Improved clinical efficiency
4. Time saving

Self ligation Bracket systems in lingual orthodontics

1. Philippe 2d lingual bracket
2. Forestadent 3D torque brackets
3. Adenta evolution lingual bracket
4. In –Ovation-L brackets
5. Phantom brackets

Philippe 2d lingual bracket

Correction of minor crowding or spacing. Brackets have no slots; include small wings welded to bracket base. Wings secure archwire to bracket base. Wings are closed or pushed against base of bracket with Weingart utility pliers to hold archwire and can be opened for archwire replacement, using thin spatula placed between wings and base of bracket.

Forestadent 3D torque brackets

Have a vertical slot for 3Dcontrol. Vertical opening of slot provides easy archwire insertion. Archwire is used like a ribbon arch (buccolingual slot dimension smaller than occlusogingival). Archwire is secured in slot by small wings that can be pushed or opened. A thin spatula placed between wings and base is used for opening bracket for archwire placement. Torque of Upper and lower incisors = 45*, Bicuspids and molars = 0*

Adenta evolution lingual bracket

Designed as a one piece bracket with a clip that opens at incisal edge and allows insertion of archwire from occlusal direction. Clip can serve as bite plane and presses archwire into slot when biting.

In –Ovation-L brackets

These are twin ,horizontal slot bracket with an interactive clip with easy effortless opening. Bracket wings and clips have low profile and base of incisor bracket is bent to fit palatal surface. Minimal buccolingual width allows larger inter bracket distance, larger archwire perimeter. Low profile increases patient comfort.

Phantom brackets

It is a polyceramic self ligating bracket. Bonded directly after preparation of lingual surface of teeth by reshaping and filling all irregularities with flowable composite.

Factors that have hindered adoption of self ligation

1. Edgelok brackets - inadequate rotational control, bulkiness,inconvenience with opening and closing slide
2. SPEED brackets - handicapped by clips,which could too easily be displaced or distorted.
3. Mobil-lock brackets - narrowness of labial surface of slot, difficulty of access to open and close premolar brackets with straight screw driver.
4. Activa brackets - absence of tie wings was a nuisance when placing elastomeric chain and unfamiliar shape of early bonding base made bracket position more difficult.
5. Time 2 bracket - displacement of clip
6. Damon SL brackets - slides opened inadvertently and prone to breakage.
7. Damon 2 brackets - brackets were not immediately very easy to open
8. Damon 3 and damon 3 MX brackets - high rate of bond failure, separation of metal from reinforced resin components and fractured tie wings
9. System R brackets - (In Ovation brackets) difficulty to open in lower arch where gingival end of of spring clip is difficult to visualize.
10. Smart clip bracket - force required for insertion and removal of thick SS was uncomfortable.

CONCLUSION

This article reviews some of the self ligating sytems that are going to replace the cumbersome ligating sytems in future. At the same time these are little expensive which can be weighed against the many hours of clinical time they save.

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