Demystifying self-ligating brackets

Renata Sathler*, Renata Gonçalves Silva**, Guilherme Janson***,
Nuria Cabral Castello Branco****, Marcelo Zanda*****

Abstract

Currently self-ligating brackets have been associated to faster and more efficient treatments, which arouse the curiosity to compare them to the conventional system. Unlike traditional appliances, self-ligating brackets do not require elastomeric or metal ligatures. The literature is abundant in concluding that this feature decreases, ostensibly, the friction resistance during sliding mechanics. Moreover, there are reports on minimizing the need of extractions and maxillary expansion using these accessories. Therefore, the purpose of this literature review was to seek the newest studies about self-ligating brackets currently used in orthodontic treatments, confirming or correcting current speculations.

Keywords: Orthodontic brackets. Friction. Treatment outcome.

HISTORY

Introduced in the early 20th century, self-ligation brackets are not new to orthodontics.[22] The concept of a ligatureless Edgewise bracket, first appeared around 1930s, with the Russell Lock appliance, which was an attempt to enhance clinical efficiency, associated to time reduction spent to ligate the brackets. That system had a nut and screw, which created a fourth wall to the archwire slot. The appliance activation ranged according to the tightness force of the system.[1]

The idea of a ligature-free system was refined by Wildman, with the introduction of the Edgelok appliance in 1972 (Ormco, Glendora, California).[1,22,23] The mechanism to ligate the archwire involved a labial sliding cap across the top of the archwire slot. When that vertical device was closed off, the bracket slot was converted into a four wall tube.[1]

In 1975, Hanson[9] developed the self-ligating bracket Speed (Strite Industries Ltd., Ontario, Canada), which consists of a stainless steel flexible spring, that exert pressure over the archwire in the slot, allowing a constant activation upon thicker wires. That bracket, better improved nowadays—its stainless steel spring was replaced by nickel titanium spring—is one of the most employed at present (Fig 1).[1,9,22,23]

* MSc in Orthodontics, School of Dentistry, Bauru - USP. PhD Student in Orthodontics, School of Dentistry Bauru - USP.
** Specialist in Orthodontics, Uningá, unit of Bauru-SP.
*** Post-doctoral studies at the School of Dentistry, University of Toronto - Canada. Member of the Royal College of Dentists of Canada. Professor and Head of Pediatric Dentistry Department, Orthodontics and Public Health, School of Dentistry, Bauru, USP. Coordinator of the Masters Degree in Orthodontics, School of Dentistry, Bauru, USP.
**** MSc in Orthodontics, School of Dentistry, Bauru - USP. PhD Student in Orthodontics, School of Dentistry, Bauru - USP.
***** MSc and PhD in Stomatology, School of Dentistry, Bauru - USP.

Ten years later, the "A" Company (Johnson& Johnson, San Diego, California) launched the brackets Activa.[22,23] Those cylindrical brackets presented a rigid curved wall, which opened and closed off, rotating towards occlusal-gingival direction. However, the commercialization of those brackets was suspended, due to the facility in which patients locked and unlocked the wall.[4]

New models of self-ligating brackets are being manufactured: the brackets Time[11,12] (American Orthodontics, Shebiyan, Wis) were available in 1994. The aspect and activation were very similar to Speed, nevertheless the flexible spring was curved and less rigid, although it was made by stainless steel.[4]

In 1996, the brackets Damon SL[5] (Ormco, Glendora, California) appeared in the market as passive self-ligating brackets presenting low or absence friction. The system was improved and in 1999, Damon 2 was launched (Fig 2)—metallic brackets with a sliding wall, whose unlocking and locking occurred by means of a specific instrumental.[4] The following improvement, Damon 3 (Fig 3) was manufactured from a combination of a resinous composite reinforced by fiber glass and stainless steel.[7] Recently, Damon 3MX was presented (Fig 4) and Damon Q (Fig 5), which are entirely metallic brackets and more curved.

Very similar to Speed in concept and design, the brackets In-Ovation were suggested by GAC®.

FIGURE 1 - Speed bracket (Source: http://www.speedsystem.com/HTML/Speed%20Products/Wire%20Products/hills_wire.html).

FIGURE 2 - Damon 2 bracket (modified from: http://www.ormco.com/index/damon-thesystem-damon2-thebracket).

FIGURE 3 - Damon 3 bracket (modified from: http://www.ormco.com/index/damon-thesystem-damon3-thebracket-01).

FIGURE 4 - Damon 3MX bracket (Source: http://damonbraces-orthodental-philippines.blogspot.com/).

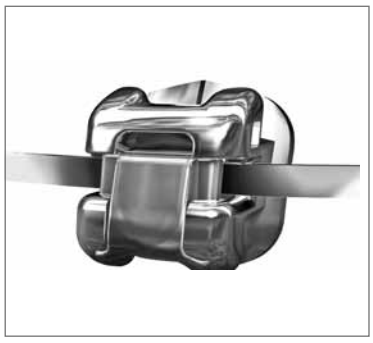

FIGURE 5 - Damon Q bracket (Source: http://www.simonorthodontics.com/Portals/0/DQ_Bracket_Wire.jpg).

FIGURE 6 - In-Ovation R bracket (Source: http://www.forrestortho.com/new_orthodontics_technology_katy_texas.php).

FIGURE 7 - SmartClip bracket (Source: http://www.bracesmd.com/Treatment/TypesofBraces/tabid/107/Default.aspx).

FIGURE 8 - Evolution bracket (Source: http://www.adentausa.com/index.php?article_id=16&clang=0).

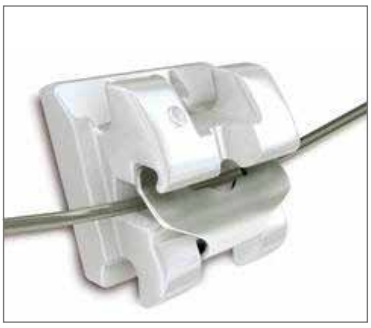

FIGURE 9 - In-Ovation C bracket (Source: www.gacinovation.com/categories/in-ovationsup-sup-systems.cfm).

Some years later, its dimensions were reduced and In-Ovation-R (Fig 6) was launched, whose system keeps the wire passive during alignment and leveling, and as the dimensions of the arch are enhanced, the tight contact of the wire with the spring bracket makes it active.[4]

The SmartClip (Fig 7)[15,22] are self-ligating brackets very similar to the conventional ones. However, they present mesial and distal nickel titanium clips, which keep the wire passively inside the slots during the initial phases of the treatment.[22] If necessary, the bracket becomes active, by the employment of ligatures.

Due to the great acceptance and esthetic demand nowadays, lingual self-ligating brackets and esthetic self-ligating were designed in order to attend the necessities. Since 2001, lingual brackets with self-ligating system as Evolution (Fig 8) were designed.[4] According to esthetical pattern, Oyster brackets were launched and manufactured employing fibreglass reinforced composite polymer. Nowadays, it was launched In-Ovation C (Fig 9), translucent ceramic self-ligating brackets.[7]

CLASSIFICATION

The most traditional classification of self-ligating brackets classifies those accessories in three distinct types, according to the pressure level of the system upon the wire. They can be active, when the system pressures the wire inside the slot; passive, when the system allows movement of the wire in the slot; or interactive, when the self-ligating brackets exert pressure upon thicker wires, but allow some movement of thinner wires. When the active system of brackets is employed, friction is more intense when employing passive brackets system.[5,14,27] Some examples of active brackets system are as follows: In-Ovation R, Speed and Time. Among the examples of passive group brackets are: Damon and SmartClip.[22]

Updated classification separates self-ligating into two groups, according to the type of slot-closure system: self-ligating brackets with active wall (spring clip) and self-ligating with passive wall.[22]

FAVORABLE VIEW

Friction

Several authors have clearly demonstrated and quantified in their studies, very low friction levels with the self-ligating devices.[5,11,14,23,24,28,30] The similar conclusion in literature about the fact that self-ligating produces less friction during orthodontic movement, when compared to conventional brackets, is directly linked to the fact that self-ligating brackets dispense the employment of ligatures. It is acknowledged that metallic ligatures produce around 30% to 50% of friction caused by elastomeric ligatures.[23] The placing of 'figure-of-eight' elastomeric ties increased friction by a factor of 70-220 per cent compared to the

"O" elastomeric ties[24] Consequently, the device which dispenses the employment of these ligatures, certainly causes lower friction levels.

Among several studies, it is important to highlight Voudouris,[30] who measured the friction produced by three types of conventional brackets, and compared them to three types of self-ligating brackets: one active (Sigma) and two passive (Damon SL and Interactwin). When stainless steel arches 0.019 X 0.025-in were placed, a conventional bracket with ligature "O" produced from 371 times to 667,8 times higher friction than self-ligating passive brackets.

In a study comparing self-ligating brackets—Time2, In-Ovation R, Speed, Damon3—Budd, Daskalogiannakis and Tompson[2] pointed out that Damon3 showed the lowest friction value. The outcome is intrinsically linked to the passive design of this system.

Plaque accumulation or plaque cluster

Self-ligating brackets promote less plaque retention when compared to the conventional ones. Most of the patients bonded with self-ligating presented fewer bacteria in plaque. The outcomes are related to the archwire ligating method; in case of conventional ones, to the elastomeric ligatures, which retain higher levels of bacteria in plaque.[21,30]

Root resorption

There are not evidences which support some differences of root resorption employing self-ligating brackets and the conventional ones. In a comparative study, Pandis et al[18] demonstrated a relation between the period of treatment and root resorption, but there were no differences between the groups treated with self-ligating or conventional brackets.

Efficiency

The higher efficiency of self-ligating when compared to the conventional brackets is mainly related to the following topics: quicker treatment time, chairside time savings and possibility of longer appointment intervals.

According to Harradine,[10] self-ligating brackets reduces about 4 months in treatment time, an average time saving of 24 seconds for archwire removal and insertion and a mean reduction of 4 visits per treatment, with the same PAR index reduction.

A decrease in treatment time with the self-ligating is probably due to the dramatic friction reduction.[1,5]

Concerning the chairside time savings, Shivapuja and Berger[23] concludes that when stainless steel wire ligatures are employed, a mean time of 8 minutes is spent for the positioning and removal of the wire. If elastomeric ligatures are employed, 2.3 minutes will be spent. If Speed self-ligating are employed, 0.7 minutes are required.[23] Due to the fact that self-ligating brackets do not require stainless steel wire ligations, they normally do not cause any soft tissue laceration,[26,30] consequently is more comfort to the patient.[11] Furthermore, lower friction levels would reduce the painful symptoms during the alignment phase.[25]

The ability to assure a safe and complete positioning of the arch into the slot of self-ligating brackets, concomitant to the employment of high technology arches, makes possible longer appointment intervals.[5,11] Another benefit of the complete positioning of the arch into the bracket slot, is that the wall, active or passive, promotes total closure of the arch into the slot, allowing greater rotation control.[11]

Besides those topics, there is a discussion about other aspects concerning the treatment efficiency with the use of self-ligating brackets. Reports found on the official page of Damon (http://www.ormco.com/index/damon-aboutthesystem-advantages-fewerextractions-2) suggest that the use of self-ligating brackets, associated to the last generation archwires, allows the orthodontic treatment planning to be modified towards a more conservative aspect. According to this reports, the employment of these

accessories is attributed to the possibility of obtaining an arch expansion, minimizing the necessity of dental extractions and invasive procedures such as rapid maxillary expansion and other surgeries.

THE CRITICAL VIEW

In vivo X in vitro studies

Usually, self-ligating brackets show excellent performance in vitro especially with archwires of smaller calibers. However, when thicker archwires are used, such as 0.016 X 0.022-in or 0.019 X 0.025-in, there are no differences when compared with conventional brackets.[12]

In a laboratory experiment with a simulated periodontal ligament and rotated brackets, Damon SL showed no difference in friction when compared with the conventional brackets tied with elastomeric ligatures.[11] The difference between these results against those of the majority of the studies is given to the fact that research on self-ligating brackets are generally made in vitro, it is limited to initial leveling archwires and to the fact that the brackets are arranged linearly, and not in a irregular manner, as clinically seen.[29]

According to Turpin,[29] editor-in-chief of the American Journal of Orthodontics and Dentofacial Orthopedics, the results of in vitro studies on the self-ligating brackets should be interpreted cautiously. Because these studies were performed mostly in models, the results may not correspond to reality due to the absence of hard and soft tissues.

Friction

Several authors report that either conventional or self-ligating brackets exhibit greater frictional force as the caliber of the archwires increase.[3,26] Some studies have shown that frictional forces may be significantly high and even superior to those displayed by the conventional brackets when a rectangular archwire was in place.[7,26] Furthermore, some studies report that the severity of crowding increases the levels of friction, making conventional brackets comparable to the self-ligating brackets.[2,6]

Torque control

Passive self-ligating brackets produce less frictional resistance. However, this lower friction may result in greater loss of torque control.[2,6] This may be why Miles, Weyant and Rustveld[17] found Damon brackets to be less painful at the initial months of treatment when smaller calibers are used; but considerably more painful than the conventional brackets when the second archwire was inserted, due to a minor freedom inside the slot.

CuNiTi archwires

Somehow, the great difference in treatment time, in the lower number of appointments and in terms of a painless treatment, all shown by self-ligating brackets is closely attached to the use of next-generation archwires such as Copper NiTi. In a in vivo comparative study, when using Damon archwires (0.014-in and 0.016 X 0.025-in CuNiTi), the comparison between Smartclip and the conventional brackets, tied whether with metallic or elastomeric ligatures, presented no significant differences in reducing crowding.[16] In a similar in vitro study, now with Damon brackets, conventional brackets achieved better rates of malocclusion correction and less failure than Damon brackets.[10]

Higher cost

Compared to conventional brackets, the cost of self-ligating brackets is still an obstacle to its increased commercialization. The arguments used by the manufacturers try to counteract this higher price with the fact that there will be no expenses with elastomeric ligatures which are not needed with the self-ligating brackets.[23] However, it must be admitted that this convenience cannot be justified due to the small prices of those ligatures in the market.

Final remarks

According to Dr. Robert Keim, editor of the Journal of Clinical Orthodontics, the future of orthodontics will be focused on three areas: three-dimensional images (3D), mini-implants and self-ligating brackets. However, Keim[13] pointed out the relevance of cautiously evaluate the scientific evidences before accepting the manufacturer's instructions on the self-ligating system because unfortunately strong evidence is lacking in most reports.

There are undeniable questions about the use of self-ligating brackets. In fact, these brackets do not promote greater root resorption when compared to conventional brackets. Another fact is the absence of elastomeric ligatures, reducing plaque retention over the bracket and one more advantage of this system is the complete wire insertion into the slot, allowing good rotational control.

The possibility of a significant reduction in treatment time, reported by several manufacturers, is announced as an advantage of the self-ligating brackets.[1,11,30] However, recent studies have scientifically proven that there is no significant difference on treatment time with the use of the self-ligating system.[15]

About the argument stated by Damon, who claims Damon System can minimize the need for tooth extractions and expansions, Peck[20] affirms that what really happens in this type of treatment is a gross dental arch expansion as Angle advocated more than 100 years ago and Fauchard almost 300 years ago. The difference is the use of Copper NiTi archwires that distribute this expansive force more gently than the archwires used by Angle. According to Peck,[20] Angle used to defend the treatment without extractions and even then two of his best students decided to disagree with that idea because of recurring clinical relapses. Then, how Damon's followers do not observe this strong relapse? Probably because their treatment results are sealed indefinitely with permanent bonded retainers unlike Tweed and Strang's protocol of retainers. Besides these facts, computed tomography (CT) scans used to support this assertion are always presented in a single slice, in a single plane. We know that CT scans should be evaluated in several slices in all different planes, to confirm the absence of problems or to understand the extent of them.[19] Moreover, the absence of CT images prior to treatment does not allow the comparison with the final image, not to mention the lack of long-term data to demonstrate treatment stability. Finally, the CT image displayed on the official Damon site represents an area distant to the critical region of bone dehiscence, which is the cementoenamel junction. Actually, this image represents the apical area of the molars furcation, a region slightly affected in expansive mechanics.

Someone might suggest a selective or rationalized use of self-ligating brackets. If low friction is desired the use of passive self-ligating brackets could the choice.[5,14,27,30] However, if high friction is appropriate in a particular me-

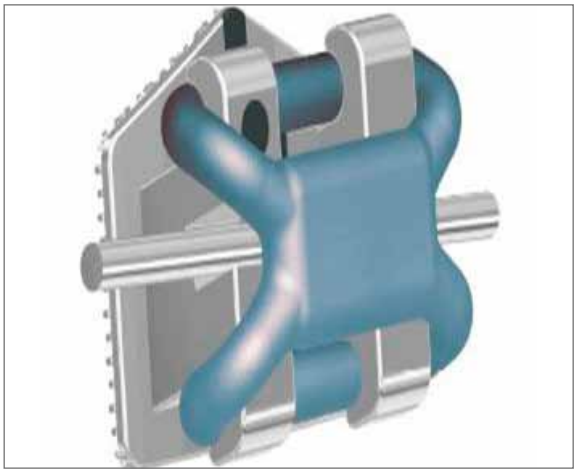

FIGURE 10 - Slide ligatures (Source: www.jco-online.com/files/archive/2005/08/464-jco/figures/464-jco-img-f2.jpg).

chanics then active self-ligating brackets, or even the conventional ones, would be the best alternative.[9,11,22,27,28] Yet, it is necessary to compute the benefit of such usage, considering the higher cost of these accessories. If high friction is demanding, conventional brackets tied with elastomeric ligatures may be used. If low friction is required, it is possible to use low friction ligatures, such as Slide ligatures (Leone, Florence, Italy) (Fig 10). Of significantly lower price, the same result obtained with passive self-ligating brackets can be anticipated with the use of these ligatures in the early stages of treatment.[8]

CONCLUSION

Although self-ligating brackets might have a great impact over orthodontics, it is important to know its real advantages involved in their mechanical performance. Despite the initial euphoria about these brackets, an evidence-based dentistry should always prevail. Further studies are still needed to evaluate the effects of the expansion promoted by this type of treatment, avoiding another chapter of relapse in the orthodontic history. It should be clear that self-ligating brackets are only a new tool which permits one more clinical option for both the clinician and the orthodontic patient.

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Contact address
Renata Sathler
Alameda Octávio Pinheiro Brisolla 9-75
CEP: 17.012-901 - Bauru / SP, Brazil
E-mail: renatasathler@hotmail.com

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Renata Sathler**, Renata Gonçalves Silva***, Guilherme Janson****,
Nuria Cabral Castello Branco*****, Marcelo Zanda******

Abstract

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Keywords: Orthodontic brackets. Friction. Treatment outcome.

Editor´s summary

Self-ligating brackets have been associated with faster and more efficient treatments, which raises the issue of comparing them to conventional systems. Contrary to conventional devices, self-ligating brackets do not require ligatures, and some authors have argued that this characteristic clearly reduces friction and resistance to sliding. Moreover, treatments that use these brackets seem to be more conservative. The purpose of this review of the literature was to evaluate the scientific evidence about the effect of these devices on orthodontic treatments according to the most recent studies about self-ligating brackets currently available in the market.

Some facts about the use of self-ligating brackets are unquestionable. They actually do not promote greater root resorption than conventional brackets, and their use does not require ligatures, which results in less plaque accumulation in both the appliance and the enamel around the bracket. Other aspects have not been defined yet, and results suggest that their application demands less chair time, reduces friction during sliding and shortens total treatment time. Moreover, as their slot closing mechanism is more effective than the one found in conventional devices, some authors suggest that intervals between visits may be longer.

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** MSc in Orthodontics, School of Dentistry, Bauru - USP. PhD Student in Orthodontics, School of Dentistry Bauru - USP.
*** Specialist in Orthodontics, Uningá, unit of Bauru-SP.
**** Post-doctoral studies at the School of Dentistry, University of Toronto - Canada. Member of the Royal College of Dentists of Canada. Professor and Head of Pediatric Dentistry Department, Orthodontics and Public Health, School of Dentistry, Bauru, USP. Coordinator of the Masters Degree in Orthodontics, School of Dentistry, Bauru, USP.
***** MSc in Orthodontics, School of Dentistry, Bauru - USP. PhD Student in Orthodontics, School of Dentistry, Bauru - USP.
****** PhD in Stomatology, School of Dentistry, Bauru - USP.

However, evidence of the excellent performance of self-ligating brackets has been obtained mostly from in vitro studies. Clinical trials have yielded less encouraging results, and studies that evaluated friction are a good example of it. When crowding is taken into consideration, the levels of friction seem to be similar to those found when using conventional brackets. The arguments that support the possibility of adopting a more conservative treatment are assumptions that disregard the individual needs of each patient. Indiscriminate expansion may lead to poor esthetic results, compromise periodontal structures and increase the chances of recurrence. Moreover, expansion mechanics is more closely associated with the shape of the CuNiTi arch wire than with the use of self-ligating brackets. When making decisions about self-ligating brackets, dental healthcare workers should not confuse orthodontic appliances with treatment philosophy. The promise of treating all using the same mechanical and systematic approach seems to ignore the individuality of each case and distort treatment goals that should aim at excellence in orthodontics.

Questions to the authors

1) What are the advantages of the clinical use of self-ligating brackets? And the disadvantages?

The advantages are less plaque around the device and full insertion of the wire in the slot, which provides more effective torque control when using arch wires of a larger size. The disadvantages are the lower rotation correction rate in the first stages of alignment and the consequent increase in pain when the second wire is inserted, as well as the high cost of these devices when compared to conventional brackets.

2) Would the authors suggest that further studies should be conducted to investigate the effect of self-ligating brackets on orthodontic treatment outcomes?

Clinical studies should compare cases with the same type of malocclusion and similar severity based on occlusal indices and divided into groups with conventional or self-ligating brackets. Comparisons should be made of the number of device breaks, pain during treatment, treatment time and final occlusal results. Also, studies should evaluate stability in the long term.

3) Are self-ligating brackets the future of orthodontics?

Self-ligating brackets do not warrant the development of faster treatments or better treatment plans than the ones made when using conventional brackets. They are just an option and should be chosen according to each dentist's skills and experience, rather than on the promises of better or more efficient outcomes.

Contact address
Renata Sathler
Alameda Octávio Pinheiro Brisolla 9-75
CEP: 17.012-901 - Bauru / SP, Brazil
E-mail: renatasathler@hotmail.com