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Research Paper

Treatment efficiency of Self-ligation system vs. Conventional ligation system: a Review

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ABSTRACT:
Self-ligating brackets by definition do not require an elastic or wire ligature but have an inbuilt mechanism a permanently installed labial wall that can be opened and closed to secure the arch wire. In the past two to three decades, a consensus has emerged on the potential core advantages, which can be summarized as low friction between bracket and arch wire, faster arch wire removal and ligation, secure full arch wire engagement, improved infection control, less time or no chair side assistance for ligation, rapid alignment and space closure, faster treatment time and increased treatment efficiency, development of arch form (Arch expansion) and associated with an emphasis on non-extraction which is earlier based on assumption of low friction of brackets and laboratory studies. On the contrary to recent clinical studies and randomized controlled trails binding (elastic and inelastic) not friction, is the major component of resistance to sliding, hence the claim that more rapid alignment and other proposed core advantages that are supported by friction of self-ligating brackets has been shown to be incorrect. Therefore this paper reviews the treatment efficiency and effectiveness of self-ligating brackets in comparison to conventional bracket systems.
KEYWORDS: *Self-ligating brackets, Damon system, SPEED appliance and Smart clip appliance.*

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I. INTRODUCTION:

Self-ligating brackets have been gaining popularity in recent years. However, self-ligation is not a new concept, brackets of this type have existed for a surprisingly long time in orthodontics before elastomeric ligatures the Russell Lock edgewise attachment being described by Stoltenberg in 1935[1]. Self-ligating brackets can be divided into 2 main categories, active and passive, according to their mechanisms of closure. Active self-ligating brackets have a spring clip that stores energy to press against the archwire for rotation and torque control (In-Ovation, SPEED and Time are examples of active self-ligating brackets). On the other hand, passive

self-ligating brackets usually have a slide that can be closed which does not encroach on the slot lumen, thus exerting no active force on the archwire (Damon and SmartClip are 2 popular brands of passive design)[2]. The principle motive when developing the earlier self-ligating brackets was to speed the process of ligation but not for the inherent advantages built in them, the claim of reduced friction with self-ligating brackets is often cited as a primary advantage over conventional brackets and this occurs because the usual steel or elastomeric ligatures exerts force on arch wire leading to friction during tooth movement. With reduced friction and hence less force needed to produce tooth movement, self-ligating brackets are proposed to have the potential advantages of producing more physiologically harmonious tooth movement by not overpowering the musculature and interrupting the periodontal vascular supply[3]. Therefore, more alveolar bone generation, greater amounts of expansion, less proclination of anterior teeth, and less need for extractions are claimed to be possible. Other claimed advantages include full and secure wire ligation anchorage conservation, decreased treatment time with fewer appointments, better infection control, less patient discomfort. Kusy et al[4,5] showed resistance to tooth movement created by contact of the wire with the bracket amount of resistance to sliding. This resistance is determined primarily by two things:

1. Friction as the wire contacts the walls or bottom of the bracket.
2. Binding as the wire contacts the corners of the bracket.

For very early alignment of teeth, resistance to sliding is due to a combination of friction and binding, But almost immediately with minor tooth movement unless the tooth is allowed to tip where binding takes place, the frictional component becomes so low that it is negligible, and resistance to sliding is due almost totally to elastic binding. Hence the claim that more rapid alignment is a major advantage of self-ligating brackets and other proposed advantages has been shown to be incorrect[6]. This article review the orthodontic literature with regard to the efficiency and effectiveness arch dimensions), of treatment with self-ligating brackets compared with conventional brackets.

Handling efficiency (Speed of Archwire removal and ligation):

The principle motive when developing the earlier self-ligating brackets was to speed the process of ligation. Maijer and Smith[7] demonstrated a four-fold reduction in ligation time with Speed brackets compared with wire ligation of conventional brackets. Voudouris[8] also reported a four-fold reduction in arch wire removal and ligation time with prototype Edge wise brackets. Turnbull et al[9] shown self-ligating brackets saved up to 9 minutes per visit compared with stainless steel wire ligation and approximately 2 minutes compared with elastomeric ligation. A Systematic review of Chen et al[10] has shown that shortened chair time as significant advantage of self-ligating systems over conventional systems. Hence it is clear that Self-ligation does appear to have a significant advantage with regard to chair time and probably that many of the more recent bracket types would show greater time savings for archwire changes because the mechanisms have become significantly easier to use.

Number of visits with Self-ligation system vs. Conventional ligation:

Harradine et al[11] retrospective study found that treatment times were 4 months shorter and required 4 fewer visits on average in the first generation Damon group when compared with conventional brackets ligated with either stainless steel or elastomeric ligatures. Hamliton et al[12] study with 387 patients were treated using a conventional pre-adjusted bracket system and 379 patients were treated with active self-ligating brackets concluded that active self-ligating brackets appear to offer no measurable advantages in orthodontic treatment time, number of treatment visits and time spent in initial alignment over conventional pre-adjusted orthodontic brackets. Johansson et al[13] conduct a prospective and randomized study of the efficiency of orthodontic treatment with self-ligating edgewise brackets and conventional edgewise twin brackets Orthodontic treatment with SL brackets does not reduce treatment time or number of appointments.

Treatment duration of Self-ligation system vs. Conventional ligation:

One of the earlier proposed advantage of self-ligation was efficiency of treatment with self-ligating brackets was superior to conventional ligation system. The hypothesis is that lower friction enables more effective relative movement between arch wire and bracket and hence more rapid tooth movement.Hence, faster alignment and retraction of teeth with self-ligation system when compared to conventional ligation system. Miles et al[14] compared Smart Clip self-ligating bracket and the Victory edgewise bracket in fifty-eight patients for correction of crowding and found no difference in irregularity index at initial stage of treatment to 10 weeks and 20 weeks interval. Pandis et al[15] in a prospective study of 54 patients, evaluated mandibular incisor alignment efficiency with Damon2 and conventional ligation brackets, the results of this study suggest that Damon2 brackets are not more efficient in terms of treatment time (Damon2 114 days, conventional 125 days) required to resolve severe anterior mandibular crowding relative to conventional appliances which are statistically insignificant. Scott et al[16] compared efficiency of tooth alignment and clinical effectiveness of the

Damon3 and a conventional bracket system using identical wire sequences. This randomized clinical trial included 62 patients with lower incisor irregularity between 5 and 12 mm, fully ligated 0.014″ nickel–titanium archwires were used as the initial archwire in both groups, followed by a sequence of 0.014″ × 0.025″ and 0.018″ × 0.025″ nickel–titanium and 0.019″ × 0.025″ stainless steel. The Damon3 cases took an average of 253 days and the conventional cases 243 days in order to reach the stage at which the final 0.019″ × 0.025″ stainless steel wire was inserted suggesting that no difference in treatment tine was observed between conventional bracket system and self-ligation systems in terms of alignment and levelling.

Space closure with self-ligation Vs. Conventional ligation brackets:

Some self-ligating brackets are labelled as passive and promoted on the premise that elimination of ligatures reduces friction and allows for faster sliding mechanics. So earlier proposed advantage is that, self-ligating brackets could reduce overall treatment time.But we have seen that friction is not a major factor binding is a major factor for resistance to movement in alignment or sliding mechanics. Miles et al[17] evaluated the rate of en masse retraction with sliding mechanics between passive self-ligating Smart Clip brackets and conventional twin brackets ligated with stainless steel ligatures. The median rates of tooth movement were similar, with the Smart Clip bracket side being 1.1 mm per month and the conventional twin bracket side 1.2 mm per month were not significantly different. Burrow[18] compared the rates of retraction down an archwire of maxillary canine teeth when bracketed with a self-ligating bracket (Damon3) was used on one side and a conventional bracket on the other side. The teeth were retracted down a 0.018-inch stainless steel archwire, using a medium Sentalloy retraction spring (150 g).The retraction rate is faster with the conventional bracket, probably because of the narrower bracket width of the self-ligating brackets which causes binding faster than conventional brackets. Mezomo et al[19] measured space closure during the retraction of upper permanent canines with self-ligating on one side and conventional brackets on other side and showed that distal movement of the upper canines and anchorage loss of the first molars were similar with both conventional and self-ligating brackets.

Secure archwire engagement with self-ligation Vs. Conventional ligation brackets:

An inbuilt metal face to the bracket slot has the potential to ensure full arch wire engagement and provide reliably secure ligation. Some early self-ligating brackets did not deliver the secure engagement but today most self-ligating brackets have mechanisms to deliver this advantage and ensure full engagement of all arch wires and eliminate the need to regain control of the teeth when full engagement is lost. Mezomo et al[19] studied of canine retraction with 0.018-in stainless steel wires and showed self-ligating brackets were found to give better rotational control of the canine than conventionally ligated brackets. Furthermore, 80% of the canines rotated more than 10^0 with conventional brackets, as opposed to 33% with self-ligating brackets, over the 12-week period, so that rotational control of the canine being retracted was better on the canines with a self-ligating bracket than conventional bracket side.

Arch width changes with self-ligation Vs. Conventional ligation brackets:

According to Damon[20] treatment with Self-ligation brackets lead to development of the dental arches and posterior expansion distal to the canine which make non-extraction treatment more feasible have been proposed. Pandis et al[21] investigated the duration of mandibular crowding alleviation with self-ligating brackets compared with conventional appliances and the accompanying dental effects which involve lower incisor proclination and slight expansion of the dental arches. Increases in intercanine and intermolar widths associated with crowding correction in both groups. The self-ligating group showed a greater intermolar width increase than the conventional group. However they concluded that Damon archwire has a broader arch form compared to the archwire used with the conventional brackets hence difference in posterior expansion may be solely attributed to the differences in the archwire forms not as a treatment effect. Franchi et al[22] found that 1.7 mm increase in intermolar width with self-ligation when compared with conventional module ligation, this increase in intermolar width is attributed to the molars tipped buccally 4º suggesting that molar expansion observed with self-ligating brackets is related to rolling or tipping of the molars rather than bodily movement or basal maxillary expansion. Fleming et al[23] compared the effects of the Smart Clip self-ligating brackets and conventional pre-adjusted edgewise brackets two pre-adjusted appliances on transverse mandibular arch changes over a minimum period of 30 weeks. To overcome the bias 0.016″ round; 0.017″ × 0.025″; 0.019″ × 0.025″ NiTi and 0.019″ × 0.025″ stainless steel archwire were used. However, the self-ligating appliance produced slightly more expansion in the molar region although this was only small (0.9 mm) and also clinically insignificant.

Torque control with self-ligation Vs. Conventional ligation brackets:

Torque expression is a key element to obtain good results in clinical orthodontics. Accurate torque is essential to establish proper occlusion and esthetic for orthodontic treatment. Torque control seems more difficult with self-ligating brackets and perhaps particularly with passive brackets, Badawi et al[24] conclude that

active self-ligating brackets are more effective in torque expression than passive self-ligating brackets which can be a direct result of their active clip forcing the wire into the bracket slot. Major et al [25] and Brauchli et al[26] found that the additional force from the active clips of Speed and In-Ovation brackets did not provide any effective additional torque force and found only minor differences with regards to torque expression of active and passive ligating brackets. Al Fakir et al[27] found that if tight wire ligatures brackets were added and twisted to self-ligation brackets produce torque equal to conventional brackets base of the bracket and a ligature system are a significant additional source of force couple to the bracket system. Yousef Al-Thomali et al[28] in their systematic review concluded that conventionally ligated brackets presented with highest torque expression compared to SL brackets with minor difference was recorded in torque expression of active and passive self-ligating brackets.

Pain and discomfort with self-ligation Vs. Conventional ligation brackets:

Scott et al[29] compared the degree of discomfort experienced during the period of initial orthodontic tooth movement using self-ligating brackets and conventional brackets at 4 hours, 24 hours, 3 days, and 1 week no statistically significant differences in perceived discomfort levels between the two appliances. Pringle et al[30] reported lower mean maximum pain intensity with self-ligating brackets than conventional bracket systems but unlikely to be clinically relevant. However, a systematic review of Čelar et al[31] concluded that the evidence to date did not support a reduced level of pain with self-ligation and discomfort depend not only on type of bracket but also due to ligation process and experience of the operator influence this result.

Root resorption with self-ligation Vs. Conventional ligation brackets:

Pandis et al [32], Scott et al[16] using panoramic radiographs, reported no mean difference in the amount of apical root resorption of the maxillary incisors with conventional and self-ligation bracket systems. Leite et al[33] evaluated root resorption using CBCT and concluded that the design of the brackets either self-ligating or conventional preadjusted did not seem to influence the degree of root resorption. Jianru Yi[34] in their systematic review suggested that self-ligating brackets do not outperform conventional brackets in reducing external apical root resorption.

II. CONCLUSION:

Self-ligating brackets are a highly active area of technical development, thought-provoking clinical practice, and research. 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, although claims regarding the clinical superiority of self-ligating brackets, clinical evidence is generally lacking. Self-ligation does appear to have a significant advantage with regard to chair time (yet, it is necessary to compute the benefit of such usage, considering the higher cost of these accessories) but no other significant differences in treatment time, arch width changes, torque control, root resorption was found. Hence orthodontic treatment efficiency and effectiveness of self-ligating brackets is almost comparable to conventional bracket systems.

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