



Possible Advantages of Self-Ligating Brackets: From Claims to Evidence, a Literature Review

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Abstract

Self-ligating brackets are ligature-less brackets with the mechanical device built into them to close edgewise slot. It was claimed that self-ligating brackets (SLBs) have advantages over conventional-ligating brackets (CLBs). The most claimed advantageous feature is reduced friction between the archwire and the bracket and full archwire engagement, resulting in faster alignment and space closure. Greater arch expansion with less incisor proclination, also faster ligation, reduced number of visits and less pain is mentioned as the beneficial features of SLBs in different articles. In this review article, we compared SLBs with CBs in aspect of resistance to sliding, speed of archwire ligation, quality of alignment and amount of pain during treatment base on the most recent articles published in literature. We concluded that although self-ligating brackets are proved to have some advantages over conventional brackets, but more studies are needed to discard doubts about using them, routinely.

Keywords: Self-Ligating Brackets, Review, Friction, Alignment, Pain, Ligation, Engagement

1. Context

Traditionally wire or elastomeric ligatures are used to engage the archwire in the bracket slot. These conventional ligation systems have limitations with respect to ergonomics, efficacy, discoloration, plaque accumulation, and friction. Self-ligation has been developed to overcome these deficits. Self-ligating brackets (SLBs) are ligature-less brackets with the mechanical device built into them to close edgewise slot (1).

Self-ligation is not a new concept. The first self-ligating bracket, the Russell attachment, was introduced by Stoltenberg in the early 1930s and during the past several decades, interest in SLBs has been remarked (2). SLBs are divided into 2 groups according to their mechanisms of closure: active and passive. Active SLBs like in-ovation, SPEED, and time, have a spring clip that stores energy to press against the arch-wire for rotation and torque control. Passive SLBs usually have a slide that can be closed to the slot lumen, so they exert no active force on the archwire (Damon and Smart Clip) (3). It was claimed that SLBs have advantages over conventional brackets (CB). The most advantageous feature is reduced friction between the archwire and the bracket and full archwire engagement, result-

ing in faster alignment and space closure. Greater arch expansion with less incisor proclination (4). Also, faster ligation with reduced number of visits and less pain are mentioned as the benefits of SLBs (5).

2. Evidence Acquisition

In order to compare different allegations around these kind of brackets we searched databases including: PubMed, Google Scholar, Scopus and Medline. Two orthodontic experts reviewed articles in English language only and those published from 2010 to 2018. Our keywords were: "self-ligate AND orthodontic" - "ligation method AND orthodontic" - "active self-ligated AND brackets" - "passive self-ligated AND brackets". Clinical trials (randomized or non-randomized), systematic reviews and meta-analysis on patients with no anomalies like syndrome or lip and palate cleft and experimental in vitro studies were chosen

3. Results

In this review we compared SLBs with CBs in aspect of resistance to sliding, speed of archwire ligation, quality

of alignment (arch expansion and incisor pro-inclination) and amount of pain during treatment by using newest papers according to the criteria mentioned earlier.

3.1. Resistance to Sliding

Friction is defined as resistance to motion when one surface attempts to slide over another, which has contact with (6). It has been proposed that approximately 50% of the force applied to slide a tooth through an archwire is used up to overcome friction (7). There is lots of assertions considering this factor in self ligating and conventional brackets and sometimes contradicting conclusions (8). Ehsani et al. reported that SLBs maintain lower friction than CBs when engaged with small round archwires in the absence of tipping and/or torque in an ideally aligned arch. Also, they announced that as the archwire size increased, friction of both self-ligated and conventional brackets increased (1). Harradine concluded that for self-ligation, lower resistance to sliding is one of 3 main features that are increasingly supported by valid studies (9). Thapa and Wu reported that major portion of the resistance is because of the ligation forces applied to the archwire and self-ligation decreases the amount of friction due to binding but only when thin archwires are used along with it (10). Rinchuse and Miles reported that SLBs showed good performance in vitro with smaller wires that are used during early stages of treatment. But when larger wires are used (like 0.016×0.022 and 0.019×0.025 nickel-titanium), no differences were found between SLBs and CBs (11). Pillai et al. by evaluating frictional resistance generated by conventional stainless steel, radiance ceramic, self-ligating and composite brackets concluded that SLB has the least friction among these four types of brackets (12). Leite et al. also confirmed this finding in his research in 2014. According to him, SLBs had lesser frictional resistance than steel or elastomeric-tied conventional brackets (13). Other studies also found the same conclusion (8, 14-18). In an in-vitro study by Vinay K which assessed friction in different combinations of wire, bracket and ligation method, it was concluded that self-ligating brackets offered least friction followed by conventional stainless steel brackets, ceramic with metal insert bracket and ceramic brackets (19). In spite of these articles, Pliska et al. found that with the exception of CL monocrystalline bracket, CBs & SLBs displayed comparable amounts of resistance to sliding regardless of ligation method or bracket slot material (20).

Saporito et al. compared the effectiveness of space closure of CBs & SLBs. No significant difference was seen in the efficiency of space closure between the self-ligating bracket and conventional bracket tied with stainless steel ligatures (21).

Karim Soltani et al. compared the resistance to sliding in 4 subgroups of brackets including: metallic and clear Damon brackets and metallic and clear conventional brackets in a wet condition resembling oral cavity environment. Statistically, there was no significant difference observed between either of the subgroups in resistance to sliding and static frictional forces meaning that neither the type of bracket materials (clear and metal) nor their type of ligation made any difference in resistance to sliding and static friction (22).

Muguruma et al. investigated the effects of torque on frictional properties of SLBs. He founded that in most situations, increasing the torque produced a significant increase in static friction but most SLB-wire combinations at all torques produced less friction than that of the conventional bracket. Active-type SLB-wire combinations showed higher friction than passive-type SLB-wire combinations in most conditions (23). Huang et al. (24) and Oliver et al. (25) also confirmed this finding.

3.2. Pain During the Treatment

The belief that treatment with SLBs is less painful may be because of the lighter archwires that can be used with equal effectiveness with these brackets; so forces on the teeth are lower and also the teeth move more readily in response to the applied forces because of decreased resistance to sliding (25, 26). Celar et al. in their meta-analysis announced that there were no significant differences in perceived pain between self-ligating and conventional brackets during the first week of treatment (27, 28). Fleming and Johal declared that analysis of the effect of bracket type on pain experience confirmed that SLBs do not have a clinically significant stance on pain experience (29). Othman et al. found the same conclusion in their randomized clinical trial (30). Zhou et al. found that Patients with self-ligating brackets were associated with less pain and discomfort at any intervals compared with conventional brackets but no significant difference of overall oral health-related quality of life (OHRQoL) scores could be found between two groups (31).

Bertl et al. in their study declared that engagement and disengagement of rigid rectangular archwires caused more pain with Smart Clip self-ligating brackets than conventional ones (32). In a randomized clinical trial by Rahman et al. with the aim of comparing pain perception between self-ligating and conventional preadjusted edge-wise brackets, it was concluded that patients treated with self-ligating brackets reported more pain perception but statistically it was not significant and was higher in day 1 compared to day 3 and 5 after bonding brackets (33) which is confirmed by the work of Scott et al. who did not report

any significant differences in pain perception during initial alignment between patients who randomly were prescribed by self-ligating and conventional brackets (34). Discussing active or passive self-ligating brackets Kohli and his colleagues in 2012 stated that patients with active self-ligating brackets experienced more pain in the first 2 days after bonding which was significant (35).

3.3. Quality of Alignment

It is believed that with self-ligation mechanics, lesser incisor proclination and greater arch expansion is achieved, and so fewer extractions are required to provide space to do aligning of teeth (3). Chen et al. stated that there was no significant difference between the SLB and CB for intercanine and intermolar widths. For incisor proclination, their meta-analysis indicated that self-ligating brackets resulted in slightly lesser incisor proclination (1.5° lesser proclination with SLBs versus CBs) (3). Prettyman et al. declared that the use of SLB and CB does not cause differences in incisor proclination and intercanine expansion (4). Songra et al. concluded that the time of initial alignment was significantly shorter in the conventional bracket than for either the active or passive self-ligating brackets. There was no statistically significant difference in passive, active, or total space-closure times among the 3 brackets under investigation (36). Pandis et al. found that use of conventional or self-ligating brackets did not seem to be a significant indicator of mandibular intermolar width in non-extraction patients when the same wire sequence is used (37). Celikoglu et al. found that bracket type has little influence on improvement in anterior ambiguity during initial mandibular alignment (38). Wahab and his colleagues compared the aligning efficacy of damon self-ligating brackets and mini-diamond conventional brackets at each appointment and showed that in the first month of therapy CLB group lead to significantly faster alignment compared with SLB group but there were no significant differences in the alignment speed between the second and third month and third and fourth month. After four month of alignment, CLB group showed 98 percent of alignment which was significantly more than 67 percent of SLB group (39).

3.4. Speed of Archwire Ligation

The initial motivation of developing self-ligating brackets was to speed up the process of archwire ligation. Several authors have reported that self-ligating brackets save of up to nine minutes per visit compared with wire ligation and approximately two minutes compared with elastomeric ligation (9). In the study of Chen et al. results showed a mean saving of 20 seconds per arch for opening

the slides of SLB compared with removing the ligatures of CB, but there was no significant differences between the time needed for closing the slides of SLBs and replacing the ligatures of CBs and self-ligation does appear to have a significant advantage in aspect of chair time (5). Paduano et al. revealed that SLB had significantly shorter ligation time compared with elastomeric or stainless steel ligations in both arches. He also claimed that speed of arch wire ligation in SLB was dependent to self-ligating bracket type (40).

4. Conclusions

As shown in a recent systematic review by Dehbi and colleagues which evaluated the tooth alignment, space closure, treatment duration, arch expansion and patient discomfort in SLB and CB systems, and found no significant differences (41). Evidence shows that self-ligating brackets can have little advantages over conventional ones. But as the results of articles are contradictory, more studies are needed to survey different aspects of these brackets, more precisely.

Footnotes

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