

Review

Passive Self-Ligating Bracket Systems: A Scoping Review of Their Claims Regarding Efficiency and Effectiveness in Orthodontic Treatment

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Abstract: Passive self-ligating bracket systems (PSLBs), such as the Damon[®] system (Ormco, US) and SmartClip (3M Unitek[®], US) claim advantages over other types of brackets regarding efficiency and effectiveness. However, some studies have questioned their qualities, particularly during the alignment stage, in arch development, and regarding stability of results. This article aims to conduct a scoping review from the past decade's literature (2013–2023) regarding these assertions about PSLBs. A comprehensive search was performed on several databases. With at least one comparison between PSLBs and the other two bracket types, the inclusion criteria were restricted to English-written randomized controlled trials and split-mouth design studies involving patients receiving orthodontic treatment using PSLB, active self-ligating bracket systems (ASLBs), or conventional/traditional bracket systems (CBs). After screening and manual analysis of the selected studies, only 39 were chosen for the review. Most of the efficiency and effectiveness results from research conducted in the past ten years did not indicate any appreciable differences between the three different types of brackets; therefore, the evidence on whether PSLB is better than CBs and ASLBs is equivocal. Further research is necessary to understand the distinctions between passive self-ligating and other bracket systems and establish the optimal utilization of each system in clinical settings.

Keywords: self-ligating brackets; passive self-ligating; active self-ligating; conventional brackets; the Damon system; SmartClip; PSLB



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1. Introduction

Self-ligating brackets (SLBs) have gained popularity in recent years due to claims of improved orthodontic efficiency and effectiveness compared to the traditional/classical bracket system (CB). However, their superiority over other bracket types has not yet been fully established. The first SLB design was introduced in 1935 by Stolzenberg, known as the "Russell lock" edgewise attachment [1]. Self-ligating brackets can be categorized into two main types, active (ASLBs) and passive (PSLBs), depending on their closure mechanism. Active self-ligating brackets use a spring clip that stores energy to apply pressure on the archwire for torque and rotation control. In-Ovation[®] (Dentsply GAC International), SPEED[™] (Hespeler Orthodontics Limited), and Bioquick[®] (Forestadent[®]—Bernhard Foerster GmbH) are some examples of ASLBs. Passive self-ligating brackets use a slide that does not exert active force on the archwire and does not infringe on the slot lumen when closed. Damon (Ormco[™]) and SmartClip (3M[™]) are popular passive brackets, with Damon braces having a low-profile design that eliminates the need for auxiliary elastics or steel ligatures. While the SmartClip resembles conventional brackets and lacks a slide, it falls under the passive design category.

The passive self-ligation technique is claimed to have the least frictional resistance compared to other types of ligation systems [2]. This technique allows for the direct transmission of force from the archwires to the teeth and their supporting structures without the dissipation of force by the ligature system, resulting in reduced friction [3]. It has been stated that passive self-ligating brackets, especially the Damon system, offer several advantages over other types of bracket systems, such as faster alignment of teeth [4–6], greater efficiency in chairside time [6], less need for extraction [7], improved control of tooth position [3], reduced patient discomfort [7,8], decreased demand for anchorage devices [9], and limited use of intraoral expansion appliances [3,7,8]. PSLB systems are also claimed to significantly increase the posterior region of the arches and improve the stability of the transverse dental arch dimension over time [10,11]. Additionally, some studies conclude that it promotes periodontal health and infection control due to the reduced need for elastic ties, plaque accumulation, and plaque clusters [12,13].

However, PSLBs have also their drawbacks. The primary disadvantage is their cost, as they are typically more expensive than conventional metal braces and may not be covered by insurance. Moreover, repair and treatment delays may result from a broken or stuck locking mechanism. The effectiveness of smaller brackets may diminish when rotating larger teeth. Some studies question the effectiveness and efficiency of PSLB systems compared to other types of bracket systems in terms of alignment stage [14–16], space closure [15–18], patient comfort [19–21], arch development [14–16,20–23], stability of the results [11,24], periodontal health [25–27], and apical root resorption (APP) [3].

Because of this debate, this article aims to conduct a scoping review from the past decade's (2013–2023) literature concerning the assertions made about PSLB systems, in comparison with other types of bracket systems (ASLB, CB).

2. Materials and Method

2.1. The Research Question

The literature research question was formulated with sufficient specificity to enable the review team to pinpoint pertinent studies while also being comprehensive enough to encompass the entire breadth of the topic under examination. *Does the passive self-ligating bracket system provide several advantages over other types of bracket systems?*

2.2. Protocol

Starting from the main question, the PRISMA-ScR statement protocol [28] was used as the basis for this scoping review, with the PICO (population, intervention, comparison, and outcomes) strategy focusing on orthodontic patients as the population, and the intervention involving orthodontic treatment with different types of bracket systems. The comparison was made between PSLBs and one of the other two bracket types (ASLB and CB), while the outcomes measured were efficiency outcomes (patient comfort with pain perception, tooth movement alignment rate, rate of space closing, canine retraction, periodontal health, bracket bond failure, chair time, treatment duration, number of visits) and effectiveness outcomes (occlusal outcomes, incisor position modification with torque control, transverse arch dimensional changes, apical root resorption and stability of treatment results).

2.3. The Research Strategy

The objective of the search strategy was to locate all pertinent studies related to the topic being scrutinized. We searched the PubMed Central electronic library, Cochrane database, Scopus, and Web of Science to obtain a more comprehensive understanding of the topic. The search query was created collaboratively with AI ChatGPT 3.5 (Open-AI Inc., San Francisco, CA, USA). On 15 February 2022, the databases were searched using the query listed below: (passive self-ligating brackets OR self-ligating brackets) AND (traditional brackets OR conventional brackets OR ligature brackets OR elastomeric brackets OR active self-ligating brackets).

2.4. Inclusion Criteria

Our search criteria were confined to scientific articles written in English that were published between January 2013 and January 2023, including split-mouth design studies (SMDs) and randomized controlled trials (RCTs). The clinical studies included patients undergoing fixed orthodontic treatment with either ASLBs, PSLBs, or CBs, with at least one comparison between PSLBs and one of the other two bracket types.

2.5. Exclusion Criteria

The exclusion criteria were as follows: studies published before 1 January 2013 and after 1 January 2023; studies that do not contain answers to our research question and that do not relate to our topic; studies with an absence of a control group; in vitro studies; finite element analysis studies; non-full-text studies; studies with an absence of randomization; studies with a lack of statistical data; case reports; case series; systematic reviews; and meta-analyses.

2.6. Review Process

Using a comprehensive search of online journals, 814 records were located, but after removing similar or duplicate publications (using EndNote X9 software (Clarivate Analytics, Philadelphia, PA, USA)), only 272 unique studies remained. Further screening based on abstracts and titles resulted in the disqualification of an additional 198 articles. Two experienced researchers (E.R.C., D.N.O.) manually analyzed the remaining studies and excluded any studies that did not meet the predetermined exclusion criteria. The same two authors then examined the selected studies in full text and excluded any that lacked relevant information for the review. Any disagreements were resolved with the assistance of a third experienced reviewer (I.N.Z.) selected from among the authors. Ultimately, 39 RCTs and SMDs that met the necessary inclusion and exclusion criteria were chosen for the review (Figure 1).

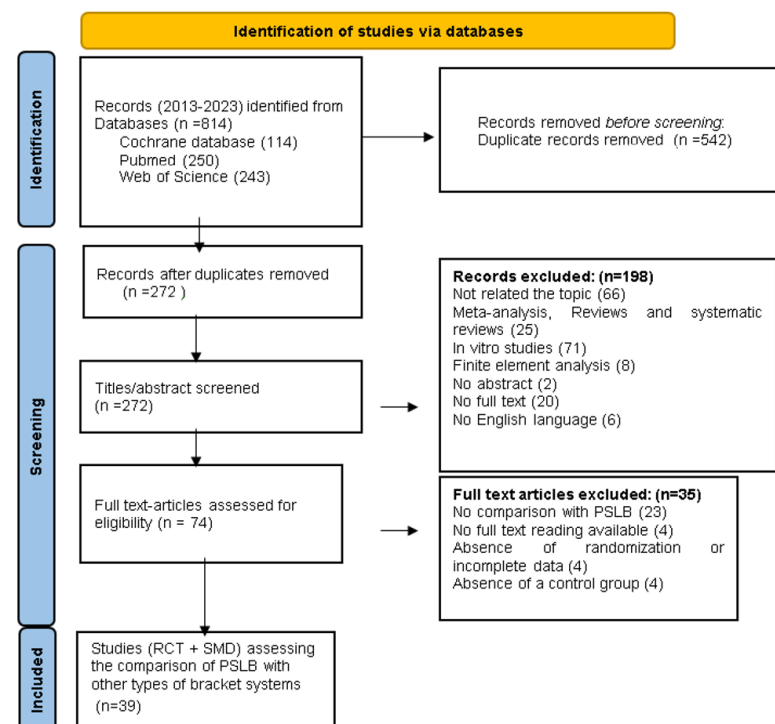


Figure 1. PRISMA flowchart of the methodology for the conducted study.

3. Results

Of the 39 studies analyzed, only part of the proposed outcomes was identified because this review was limited to scientific English-language articles published from January 2013 to January 2023. No studies were identified regarding the following parameters: number of visits and occlusal outcomes. The analyzed studies included the following outcomes: patient comfort and pain perception; alignment and space closure; periodontal health; chair time and treatment duration; bracket bond failure; incisor position modification with torque control; transversal arch dimensional changes; apical root resorption; and stability of the results (Table 1).

Table 1. The number of studies identified in the review according to the outcomes.

Efficiency Outcomes	Number of Studies Addressing	Effectiveness Outcomes	Number of Studies Addressing
Patient comfort and pain perception	8 [16,19,20,29–33]	Incisor position modification with torque control	5 [34–38]
Alignment and space closure	8 [15,16,18,33,39–42]	Transversal arch dimensional changes	10 [20,23,36–38,43–47]
Periodontal health	9 [26,27,48–53]	Apical root resorption	3 [33,54,55]
Bracket bond failure	1 [56]	Stability of the results	2 [24,57]
Chair time, treatment duration	1 [33]		

3.1. Efficiency Outcomes

3.1.1. Patient Comfort and Pain Perception

Eight studies (Table 2) were found that specifically examined patients' pain experience with PSLBs and compared them with CBs or other types of SLBs. In an SMD study, rigid rectangular archwire introduced and removed using SmartClip (PSLB) appliances resulted in higher pain than with conventional ones (Bertl et al., 2013) [29]. However, another randomized controlled clinical trial concluded that no bracket system offered superior oral health-related quality of life (OHRQoL) (Othman et al., 2014) [19]. Moreover, a study found that the CB and Damon systems were similar concerning clinical periodontal parameters and pain intensity (Atik and Cığer, 2014) [20]. However, a multicenter randomized controlled clinical trial revealed no statistically significant difference in the level of pain experienced by patients treated using an SLB system compared to those treated using a conventional ligation system. (Rahman et al., 2016) [30]. In another two-arm parallel trial, there was no evidence that the pain intensity differed between conventional and passive self-ligating brackets at different time intervals (Lai et al., 2020) [31]. Finally, a randomized clinical trial found that CBs caused more pain and had a negative impact on quality of life than PSLBs (González-Sáez et al., 2021) [32].

Table 2. Summary of the studies analyzing patient comfort and pain perception.

Studies with Some Differences between PSLB and ASLB/CB in Terms of Patient Comfort and Pain Perception	Studies with No Differences between PSLB and ASLB/CB in Terms of Patient Comfort and Pain Perception
Bertl et al. (2013) [29] González-Sáez et al. (2021) [32] Maurya et al. (2022) [33]	Othman et al. (2014) [19] Atik and Cığer (2014) [20] Rahman et al. (2016) [30] Lai et al. (2020) [31] Jahanbin et al. (2019) [16]

In terms of apical root resorption, patient pain perception and extraction space closure, Maurya et al. (2022) [33] compared CBs and PSLBs. They discovered that PSLBs had

shorter chairside times, less pain, and improved patient comfort. Although the study discovered that passive self-ligating brackets lengthened treatment times, the difference was not statistically significant, and the results must be interpreted.

Jahanbin et al. (2019) [16] compared the alignment efficiency and pain experience of Damon's self-ligating and MBT prescription preadjusted brackets during the initial alignment stage of orthodontic treatment. They found that PSLBs resulted in significantly more improvement in upper dental irregularity than CBs, but there was no significant difference in pain experience between the two types of brackets.

3.1.2. Alignment and Space Closure

Several studies (Table 3) have been conducted to compare the efficiency of PSLBs with CBs in orthodontic treatments regarding alignment and space closure. Wong et al. (2013) [18] investigated the effect of bracket–ligature combinations on the amount of orthodontic space closure over three months. They found no differences in the amount of space closure between three different bracket/archwire combinations (PSLBs vs. CBs vs. CBs with low friction ligatures). The individual patient response to any applied force was the largest factor in determining the rate at which teeth move. Celikoglu and colleagues (2015) [39] conducted prospective randomized controlled clinical research to investigate the effectiveness of SmartClips (PSLBs) for initial mandibular alignment in comparison to CBs. The results showed that both bracket types significantly improved incisor inclination and intercanine and intermolar width at 8 and 16 weeks, with no significant intergroup differences. Songra et al. (2014) [15] compared the time to initial alignment and extraction space closure using CBs and both types of SLB systems. They found that the time to initial alignment was significantly shorter for CBs than for self-ligating brackets (ASLBs and PSLBs). Still, there was no statistically significant difference in space closure times among the three types of brackets.

Table 3. Summary of the studies analyzing alignment and space closure.

Studies with Some Differences between PSLB and ASLB/CB in Terms of Alignment and Space Closure	Studies with No Differences between PSLB and ASLB/CB in Terms of Alignment and Space Closure
Jahanbin et al. (2019) [16] Hassan et al. (2016) [40] Al-Ibrahim et al. (2022) [42]	Songra et al. (2014) [15] Wong et al. (2013) [18] Maurya et al. (2022) [33] Mittal et al. (2020) [41] Celikoglu et al. (2015) [39]

On the other hand, Hassan et al. (2016) [40] compared the effects of using passive self-ligating brackets on maxillary canine retraction with sliding mechanics versus conventional ligating brackets tied with metal ligatures. They found that the amount and rate of canine retraction were greater with PSLBs, while canine rotation and anchorage loss were less. Using PSLBs or CBs, Mittal et al. (2020) [41] examined the impact of micro-osteoperforation (MOP) on the space closure rate. When compared to MOP used with traditional brackets, they discovered that MOP combined with passive self-ligation did not speed up the closure of orthodontic spaces. In patients with severe upper crowding treated using corticotomy-assisted PSLBs as opposed to CBs or PSLBs, Al-Ibrahim et al. (2022) [42] compared leveling and alignment time and periodontal health. They concluded that using PSLBs along with flapless corticotomies could potentially result in a 50% decrease in regular treatment duration compared to using traditional brackets alone. In contrast, the use of PSLBs alone was only able to reduce the treatment time by 25%.

3.1.3. Periodontal Health

Several research articles (Table 4) have studied the effect of different types of orthodontic brackets on periodontal health and microbial flora. In one study, Pejda et al. (2013) [48] found that bracket design did not have a strong influence on periodontal clinical parameters

and periodontal pathogens in subgingival plaque. Similarly, Baka et al. (2013) [49] found that SLBs and CBs ligated with stainless steel ligatures did not differ significantly in dental plaque retention. Folco et al. (2014) [50] compared gingival response in patients wearing PSLBs or CBs and found that Damon self-ligating brackets and Synthesis conventional brackets produced similar results regarding bacterial plaque indices and gingival clinical responses. Nalçacı et al. (2014) [51] concluded that PSLBs might be advised to prevent patients from developing halitosis and to increase the likelihood of good oral hygiene during orthodontic treatment. However, Kaygisiz et al. (2015) [25] found that PSLBs did not have an advantage over conventional brackets concerning the periodontal status and halitosis. Cardoso et al. (2015) [26] found no significant differences concerning periodontal response to orthodontic treatment between subjects receiving PSLBs and conventional brackets. Bergamo et al. (2019) [52] evaluated the levels of microorganisms associated with dental caries among different types of brackets. They found that orthodontic appliances break the salivary homeostasis of microorganisms involved in dental caries and that the contamination pattern differed between PSLBs and CBs. In a study conducted by Wang et al. (2021) [53], the objective was to examine the effect of PSLBs on periodontal tissues and inflammatory factors in patients with chronic periodontitis undergoing orthodontic treatment. The results indicated that using PSLBs in such patients can significantly reduce inflammatory reactions, improve the periodontal status, and have overall favorable effects on teeth. Finally, Chhibber et al. conducted a randomized clinical trial to investigate the effectiveness of different orthodontic appliances in maintaining oral hygiene during active treatment. The study compared the effects of clear aligners, PSLBs, and conventional elastomeric-ligated brackets on oral hygiene. The trial concluded that clear aligners and PSLBs were potentially better for oral hygiene than traditional fixed appliances. The study found no significant differences in oral hygiene levels among the three types of appliances after 18 months of active treatment [27].

Table 4. Summary of the studies analyzing periodontal health.

Studies with Some Differences between PSLB and ASLB/CB in Terms of Periodontal Health	Studies with No Differences between PSLB and ASLB/CB in Terms of Periodontal Health
Nalçacı et al. (2014) [51]	Pejda et al. (2013) [48]
Bergamo et al. (2019) [52]	Baka et al. (2013) [49]
Wang et al. (2021) [53]	Folco et al. (2014) [50]
Chhibber et al. (2018) [27]	Kaygisiz et al. (2015) [25]
	Cardoso et al. (2015) [26]

3.1.4. Bracket Bond Failure

A two-arm parallel trial was used in O'Dwyer et al.'s study [56] to compare the effectiveness of therapy between PSLBs and CBs systems. In three orthodontic hospital departments in the UK, a prospective multicenter randomized controlled clinical trial was carried out. An edgewise appliance bracket system with either a PSLB (3M SmartClip) or a CB (3M Victory) preadjusted system was used to treat participants. According to the study, there were no appreciable variations in treatment effectiveness between the SmartClip (PSLB) and Victory (CB) appliance systems, and the total bond failure rates for both systems were comparable. No serious harm was observed with either bracket system. The study concluded that there was no clinically significant difference in treatment efficiency between the two bracket systems.

3.2. Effectiveness Outcomes

3.2.1. Incisor Position Modification with Torque Control

The effectiveness of PSLBs in controlling tooth movement has been studied in several research articles (Table 5). Cattaneo et al. (2013) [34] found that both PSLBs and ASLBs did not demonstrate third-order torque control, suggesting there is plenty of play between the

brackets and wire. Ren et al. (2020) [35] reported that ASLBs achieved more proclined maxillary incisors, while PSLBs achieved proclined mandibular incisors. Atik et al. (2016) [36] found no notable differences in incisor inclination changes between the use of CBs, ASLBs, and PSLBs with broad archwires. Palone et al. (2021) [37] observed that PSLBs tend to increase torque values during treatment, which helps resolve misalignment and crowding. Alabdullah et al. (2022) [38] concluded that there were no significant differences in the buccolingual inclination of the incisors between ASLBs, PSLBs, and CBs.

Table 5. Summary of the studies analyzing periodontal health.

Studies with Some Differences between PSLB and ASLB/CB in Terms of Incisor Position Modification with Torque Control	Studies with No Differences between PSLB and ASLB/CB in Terms of Incisor Position Modification with Torque Control
Ren et al. (2020) [35] Palone et al. (2021) [37]	Cattaneo et al. (2013) [34] Atik et al. (2016) [36] Alabdullah et al. (2022) [38]

3.2.2. Transverse Arch Dimensional Changes

This review includes ten studies (Table 6) that compared the effectiveness of PSLBs with that of CBs and ASLBs in terms of transverse arch development.

Table 6. Summary of the studies analyzing transverse arch dimensional changes.

Studies with Some Differences between PSLB and ASLB/CB in Terms of Transverse Arch Dimensional Changes	Studies with No Differences between PSLB and ASLB/CB in Terms of Transverse Arch Dimensional Changes
Esteves et al. (2019) [43] Mateu et al. (2018) [23]	Atik and Cığır (2014) [20] Almeida et al. (2015) [44] Shook et al. (2016) [45] Palone et al. (2021) [37] Fleming et al. (2013) [46] Atik et al. (2016) [36] Alabdullah MM et al. [38]
Bashir et al. (2019) [47]	

Esteves et al. (2019) [43] evaluated how the proportions of the mandibular dental arch and WALA ridge changed in orthodontic patients treated using a PSLB system and conventional appliances. In comparison to the conventional appliance, they discovered that treatment with a PSLB system considerably enhanced the width of the WALA ridge and the dimensions of the mandibular arch.

However, some studies have concluded that the same results would also appear with conventional orthodontic bracket systems. Atik and Cığır (2014) [20] evaluated the transverse dimension changes in the maxillary arch and changes in maxillary molar inclinations in patients with class I malocclusion. They found that the conventional and Damon systems (PSLBs) were similar regarding transverse dimension changes in the maxillary arch. Still, the Damon system inclined the maxillary molars more buccally than the conventional group. Almeida et al. (2015) [44] compared dentoalveolar changes in the mandibular arch, regarding transversal width and buccal bone thickness, in patients undergoing the initial phase of orthodontic treatment with PSLB or CB systems. They found no significant differences between the two systems regarding mandibular arch expansion or changes in buccal bone thickness or transversal width of the buccal bone. Shook et al. (2016) [45] evaluated the effect of Damon self-ligating (PSLBs) and conventional bracket systems on buccal corridor widths and areas. They concluded that there was no significant difference in buccal corridor width or area in patients treated using the Damon self-ligating system or a conventional bracket system. Comparing transverse measures before and after the alignment stage was the objective of Mateu et al.'s (2018) [23] study. They discovered that, by enlarging the transverse diameter, both conventional and PSLB

procedures made it possible to align the teeth. Both procedures primarily produced transverse development in the premolar region, but PSLBs produced substantially more of it. For both jaws, the intercanine distance increased noticeably more with traditional than with PSLB orthodontic treatment.

Palone et al. (2021) [37] conducted a retrospective study to compare the effects of conventional appliances and PSLB in patients with class I malocclusion on dental arches. The study found no significant differences between the two groups intermolar and inter-premolar width measures. However, transverse linear measures tended to increase during orthodontic treatment, resolving misalignment and crowding in non-extractive treatments. The only detectable difference between the two groups was in mandibular intermolar width, where conventional appliances showed a minor expansive tendency compared to PSLB appliances.

Comparing PSLB with both ASLB and CB, the results of the studies are also similar regarding the development of dental arches. According to a multicenter, randomized controlled research, there is no discernible difference between CBs and ASLBs or PSLBs in the permanent dentition with regard to changes in molar buccal inclination during alignment or arch transversal dimension (Fleming et al., 2013) [46]. There were no variations in the maxillary arch dimensional changes between ASLBs, PSLBs, and CBs, according to an analysis of the inclination and dimension changes of the maxillary arch using these orthodontic appliances. However, the maxillary intercanine, interpremolar, and intermolar widths were significantly greater after treatment in each bracket group (Atik et al., 2016) [36]. In a study published in 2022, Alabdullah MM et al. [38] conducted a randomized clinical trial to compare the dimensions of dental and basal arches in PSLBs and ASLBs with conventional appliances. The study again revealed that there were no significant differences in maxillary intermolar width, basal arch dimensions, depth of arches, buccolingual inclination, and alignment duration among ASLBs, PSLBs, and conventional brackets. However, the study did find a significant difference in the width of the dental arch in the canine and premolar regions. Self-ligating passive or active brackets resulted in increased dental arch width compared to conventional brackets.

Only one study suggested that the choice of PSLB can have an impact on transverse maxillary arch width changes in patients undergoing premolar extractions. The objective of the randomized clinical trial, as reported in the article by Bashir et al. (2019) [47], was to compare the changes in transverse maxillary arch dimensions in first premolar extraction patients treated using ASLBs and PSLBs versus CBs. The study discovered a substantial difference between SLBs and the traditional bracket method in the dimensions of the maxillary arch width. The passive self-ligating bracket SmartClip, in particular, demonstrated the greatest increase in intermolar width.

3.2.3. External Apical Root Resorption

The emergence of PSLB systems, which utilize wires that passively engage in a tube without active springs and offer more flexibility and less friction, has reignited concerns about their impact on apical resorption. Handem et al. (2016) [54] conducted a retrospective study on periapical radiographs. They concluded that there was no significant difference in external apical root resorption between patients treated using the self-ligating Damon system or with conventional ligating appliances. According to Aras et al. (2018) [55], the comparison of external root resorption (ERR) volumetrically in maxillary incisors induced by orthodontic treatment using PSLBs (Damon Q, DQ) or conventional brackets (Titanium Orthos, TO) with the help of cone-beam computed tomography (CBCT) showed that it is not possible to claim the superiority of one bracket system over the other based only on root resorption pattern or amount. However, the study found a higher incidence of slanted ERR in patients treated using the conventional system, which requires further research to identify the possible specific causes (Table 7).

Table 7. Summary of the studies analyzing transverse arch dimensional changes.

Studies with Some Differences between PSLB and ASLB/CB in Terms of External Apical Root Resorption	Studies with No Differences between PSLB and ASLB/CB in Terms of External Apical Root Resorption
	Handem et al. (2016) [54] Aras et al. (2018) [55] Maurya et al. (2022) [33]

3.2.4. Stability of the Results

Atik and Taner (2017) [57] found that both conventional and Damon systems result in similar long-term stability of incisor position and maxillary arch transverse dimension changes, with some significant relapse in intercanine and interpremolar width, but no relapse in incisor position. In a RCT by Ab Rahman et al. (2017) [24], both PSLBs and conventional systems showed similar stability in the treatment outcomes for mild-to-moderate crowding malocclusions during the first 6 months of retention, with a decrease in mandibular arch length in the conventional system group but not in the self-ligating system group (Table 8).

Table 8. Summary of the studies analyzing stability of the results.

Studies with Some Differences between PSLB and ASLB/CB in Terms of Stability of the Results	Studies with No Differences between PSLB and ASLB/CB in Terms of Stability of the Results
	Atik and Taner (2017) [57] Ab Rahman et al. (2017) [24]

4. Discussion

4.1. Patient Comfort and Pain Perception

Most older studies showed that PSLBs are more comfortable than conventional braces. According to Berger (2000) [12], PSLBs offer a decreased risk of injury and protect patients from soft tissue lacerations and infections compared to steel ligatures.

In a comparative study by Tagawa (2006) [58], Damon patients experienced an average of 60% less discomfort than those treated using conventional braces. The Damon bracket was initially less painful than the conventional twin bracket, but tying in the second archwire was more painful (Miles, 2007) [17]. The Damon appliance resulted in lower pain intensity than the CBs appliance (Pringle et al., 2009) [59]. On the other hand, Scott et al. (2008) [60] found no difference in discomfort experienced during initial tooth alignment with a Damon self-ligating bracket system or the Synthesis conventional preadjusted edgewise appliance system. Lastly, Fleming et al. (2009) [61] found that bracket type did not affect subjective pain experience during the first week after the initial placement of two preadjusted orthodontic appliances. Still, significantly greater discomfort was experienced during 19 × 25 NITI archwire insertion and removal with the SmartClip™ appliance (PSLB system) compared to a conventional appliance (Victory 3M Unitek, Monrovia, Calif).

In our review, the results are similar to those of older studies regarding patient comfort and pain perception. While some studies have found differences in pain experience between PSLBs and conventional brackets [29,32], others have found no significant differences [16,19,20,30,31,33]. Factors such as archwire manipulation, friction, and patient perception may play a role in the pain experience of orthodontic patients. Overall, more research is needed to fully understand the pain experience associated with different types of brackets and to develop strategies to minimize pain and discomfort for patients undergoing orthodontic treatment.

4.2. Alignment and Space Closure

Regarding alignment and space closure, studies older than ten years have shown no advantage to using the PSLB system at the expense of CBs. According to a prospective clinical trial by Pandis et al. in 2007 [14], when treating mandibular crowding, there was no appreciable difference in the treatment duration time between PSLBs and CBs approach. However, the PSLB group showed 2.7 times faster correction for moderate crowding. In another study by Miles in the same year [17], there was no significant difference in the en masse space closure rate between passive Smart-Clip self-ligating brackets and conventional twin brackets tied with stainless steel ligatures. Additionally, the time for initial alignment was substantially quicker for conventional brackets than for active or passive self-ligating brackets in a randomized controlled trial by Songra et al. in 2014 [15]. However, there was no statistically significant difference in the passive, active, or overall space-closure times across the three groups examined.

In a 2010 study by Burrow [62], it was found that the retraction rate was faster with the conventional bracket than with PSLBs. Last but not least, distal retraction of the upper cuspids and anchoring loss of the first molars were comparable with CBs and PSLBs in a 2011 study by Mezomo et al. [63]. With self-ligating brackets (SmartClip), the rotation of the upper canines during sliding mechanics was nevertheless reduced.

In our review, studies suggest that PSLBs may offer some advantages over CBs in terms of alignment, space closure, and improved patient comfort [3,16,40]. However, there are also studies that suggest no significant differences between the types of bracket systems (PSLBs, ASLBs, and CBs) [15,18,33,39,41]. The choice of bracket type may depend on individual patient needs and preferences and the clinician's experience and training.

4.3. Periodontal Health

Several studies from more than 10 years ago have stated that self-ligating braces promote less plaque retention compared to conventional braces. According to Voudouris (1997) [64], using self-ligating appliances instead of elastomeric ligatures can significantly improve patient hygiene by eliminating the need for plaque-retentive materials. This is supported by Forsberg et al. (1991) [65], who found that using elastomeric rings for ligation can significantly increase microbial accumulation on tooth surfaces adjacent to the brackets, potentially leading to the development of dental caries and gingivitis. Similarly, Alves de Souza et al. (2008) [13] observed adverse gingival conditions associated with elastomeric rings, including a higher plaque index and bleeding score compared to steel ligatures. In contrast, self-ligating appliances have been demonstrated to decrease the number of microorganisms in plaque and prevent periodontal tissue destruction (Hassan et al., 2010) [66]. Therefore, self-ligating appliances are recommended to improve patient hygiene and prevent oral health problems. Most of the patients who bonded with themselves by self-ligating presented fewer bacteria in plaque. The outcomes are related to the archwire ligating method, in the case of conventional ones, and to the elastomeric ligatures, which retain higher levels of bacteria in plaque [41–43]. However, recent studies from our review suggest no strong evidence supports the superiority of one bracket type over the other in terms of periodontal clinical parameters and periodontal pathogens in subgingival plaque [25–27,38–40]. Controlling bacterial plaque in orthodontic patients is important to maintain gingival/periodontal health status, regardless of the bracket type used.

4.4. Chair Time, Treatment Duration

Various old studies have stated that the Damon system (PSLB) could treat patients more quickly and with fewer appointments compared to traditional braces. According to a study by Turnbull and Birnie (2007) [8], the type of bracket and the wire size statistically impact the speed of ligation and chairside time. The Damon system was stated to offer faster and more efficient wire removal and placement for most orthodontic treatment stages. The study also revealed that the Damon method greatly reduced the mean archwire ligation time compared to the traditional elastomeric system when inserting and removing wires.

In fact, the self-ligating mechanism made ligating an archwire about twice as quick, and opening a Damon slide and closing one took around one second less time per bracket on average than removing an elastic from a mini-twin bracket. For bigger wire sizes used in later treatment stages, the difference in ligation time between the Damon and traditional mini-twin brackets became more pronounced. Several studies, including one by Berger (2000) [12], have reported that PSLBs provide greater patient comfort, shorter treatment times, reduced chair time, and more precise control of tooth translation. The reduction in friction demonstrated by self-ligating brackets can help shorten overall treatment time, especially in extraction cases.

According to Eberting, Straja, and Tuncay's study [4], the Damon system produced significantly faster, better, and more consistent treatment results, with higher patient satisfaction than conventional braces. Damon patients experienced an average treatment time 6.33 months shorter than those treated using conventional twin brackets and required seven appointments less. Similarly, Harradine's [5] study found that the Damon treatment was faster, required fewer appointments, and was more comfortable than conventionally ligated straight-wire appliances. Patients treated using Damon brackets required 30% fewer appointments and experienced significantly faster slide opening and closing than conventional ligation. In Tagawa's [58] comparative study, Damon treatment was found to be faster, requiring an average of 7.2 months less time than conventional braces and resulting in an average of 47.8% fewer appointments. The time required for leveling and aligning with conventional braces was 6.0 months versus just 3.2 months for Damon, representing a difference of 46.7%.

The study conducted by Fleming et al. (2010) [67] compared the effectiveness of two different kinds of orthodontic appliances for treatment: self-ligating (SmartClip) and conventional fixed (Victory) appliances. The study found that there was no significant difference between the two types of appliances in terms of treatment duration or the number of visits required. However, the duration of treatment was slightly longer (by three months) in the group treated using SmartClip compared to the group treated using Victory. In another study by O'Dwyer et al. (2016) [56], a multicenter randomized controlled trial was conducted in the UK population, research showed no clinically meaningful difference between a self-ligating bracket system (3M SmartClip) and a traditional ligation method (3M Victory) in terms of how effectively patients were treated.

However, studies of this nature are invariably compromised by the compelling possibility of selection bias, observer bias, and confounding, including susceptibility to uncontrolled factors, varying operator experience and preference, differing archwires and sequences, and inconsistent appointment intervals. These studies were more notable for the large discrepancy in treatment duration between conventional brackets and PSLB. The discrepancy suggests that any advantage attributable to bracket type is likely to be dwarfed by extraneous factors, including the operator's skills, standards, and ability.

4.5. Incisor Position Modification with Torque Control

Our review studies concluded some differences in the clinical outcomes achieved with different types of self-ligating brackets and conventional brackets [34–38].

The conclusions of older studies regarding torque control in passive self-ligating brackets compared to conventional and active self-ligating brackets are varied. In a prospective clinical trial by Pandis et al. (2006) [68], it was found that passive self-ligating brackets were equally efficient as conventional brackets in delivering torque to maxillary incisors in both extraction and non-extraction cases. Badawi et al. (2008) [69] concluded that active self-ligating brackets were more effective in torque expression than passive self-ligating brackets, while Brauchli et al. (2012) [70] found that the impact of the active or passive self-ligating mechanism or the ligature on torque control was minimal compared to slot dimensions.

However, the differences are not always significant, and it appears that the choice of a bracket system may depend on the specific needs of the patient and the treatment goals.

Further research is needed to fully understand the differences between passive self-ligating and conventional brackets or active self-ligating and to determine the most appropriate use of each system in clinical practice.

4.6. Transverse Arch Dimensional Changes

The distinctive expansion of the arches in passive self-ligating bracket (PSLB) appliances, particularly Damon, is associated with a uniform arch shape in both arches. This arch shape is typically widened in the premolar region to minimize the appearance of “black lateral corridors” when smiling. It is stated that the PSLB technique’s treatment causes a greater expansion of the dental arches compared to other bracket systems [2,3]. Lineberger MB et al. [10] conducted a study to analyze the effects of a PSLB system using three-dimensional digital casting analysis. The study found that the largest increases in arch dimensions occurred at the premolar level in both the maxillary and mandibular arches, ranging from 2.0 to 2.2 mm. This was associated with significant increases in maxillary and mandibular arch perimeters (2.3 and 2.5 mm, respectively) and buccal crown torque of the upper premolars with appropriate torque control of other teeth. The study concluded that the PSLB system resulted in a modest yet statistically significant widening of both maxillary and mandibular dental arches, accompanied by significant net gains in maxillary and mandibular arch perimeters.

However, older studies also reached similar conclusions to the newer ones regarding arch development in PSLBs and CBs. In both the Damon self-ligating and conventional orthodontic bracket systems, there was an increase in inter canine width, a reduction in arch length, and proclination of mandibular incisors associated with alignment, but the differences between the two appliances were not significant, according to a randomized clinical trial (Scott et al., 2008) [60]. A study comparing two preadjusted edgewise appliances found little overall difference in the arch alignment and leveling pattern. Still, the group treated using the passive self-ligating appliance showed a statistically greater increase in intermolar width, although the difference was small at 0.91 mm (Fleming et al., 2009) [61]. According to a single-center randomized controlled research (Pandis et al., 2011) [71], the use of conventional or passive self-ligating brackets did not seem to be a significant predictor of mandibular intermolar width in non-extraction patients when the same wire sequence was utilized. A study evaluating the Damon system found that both maxillary and mandibular intercanine, interpremolar, and intermolar widths increased significantly after treatment, while mandibular incisors were significantly advanced and proclined, contradicting the lip bumper theory of Damon. However, there was no significant difference in posttreatment incisor inclinations between the Damon group and the control group (conventional bracket systems) (Vajaria et al., 2011) [21].

4.7. External Apical Root Resorption

The emergence of passive self-ligating systems, which utilize wires that passively engage in a tube without the use of active springs and offer more flexibility and less friction, has reignited concerns about their impact on apical resorption.

In our review, the results are similar to those of older studies on external apical root resorption. A study by Pandis et al. in 2008 [72] utilized panoramic radiographs and found no discernible difference between the Damon systems and CBs in the amount of apical root resorption in the maxillary incisors. Similarly, Scott et al. (2008) [60] conducted a retrospective study on periapical radiographs and concluded that there was no significant difference in external apical root resorption between patients treated using the self-ligating Damon system or conventional ligating appliances. According to a CBCT study by Leite et al. (2012) [73], there was also no significant difference in the amount of root shortening between PSLBs and conventional preadjusted brackets during the first 6 months of orthodontic treatment.

4.8. Stability of the Results

Some experts have suggested that PSLB treatments may be more stable due to the reduced force required for orthodontic movement. This may result in more natural tooth movements without overburdening the muscles or damaging the periodontal blood vessels [2,3]. Maintaining arch form and preventing relapse are crucial aspects of orthodontic treatment. However, in non-extraction orthodontic treatment, increasing the arch perimeter leads to transverse expansion of the arches and incisor proclination. This approach is known to affect prolonged stability since changes in arch dimensions can significantly impact posttreatment results. Unstable outcomes may be produced by widening the inter-cuspid dimension and labially tilting the incisors.

Recent studies evaluated the long-term effects of PSLBs on the transverse dimensions of the maxillary and mandibular arches. According to Basciftci et al. (2014) [74], PSLBs can effectively correct crowding by proclining and protruding incisors and expanding dental arches, while maintaining stable transverse dimensions of the arches for up to two years after treatment without significant changes to the face's hard and soft tissues. Lucchese et al. (2019) [75] reported significant increases in transverse arch dimensions and torque values following passive self-ligating fixed therapy, with a tendency towards transverse diameter restriction in the maxillary and mandibular premolars in the first 2 years after treatment, while torque values remained mostly unchanged. Lastly, a 6-year follow-up study by Willeit et al. (2022) [11] found that PSLB treatment resulted in significant increases in intermolar and intercanine width, with no significant relapse in expansion achieved with the therapy, except for upper and lower premolars. The study also observed that most of the relapse occurred in the first year after debonding and that the type of retainer could influence the amount and timing of relapse after PSLB treatment.

Recent studies comparing PSLB to conventional and Damon systems [24,57] found similar long-term stability of incisor position and maxillary arch transverse dimension changes, with some significant relapse in intercanine and interpremolar width but no relapse in incisor position. PSLB treatment resulted in significant increases in intermolar and intercanine width, with most of the relapse occurring in the first year after debonding and the type of retainer influencing the amount and timing of relapse after PSLB treatment.

4.9. Limitations of this Review

The present review has some limitations, including the small number of studies (39 studies) and outcomes analyzed, which may affect the generalizability of the findings. However, this review provides valuable information for future research in this area and adds to the existing literature on the topic.

5. Conclusions

There is mixed evidence regarding the superiority of PSLBs over CBs and ASLBs in terms of efficiency and effectiveness. Still, most of the variables examined did not exhibit any notable variations among the three bracket types. Overall, more research is needed to fully understand the differences between PSLBs and other types of bracket systems and determine the most appropriate use in clinical practice.

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