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Review Article

Efficacy of self-ligating vs conventional fixed orthodontic appliance system: An update

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Abstract

The conventional fixed orthodontic appliances have been used to treat number of patients effectively for a long time. However, the popularity of using self-ligating brackets has increased considerably over the last few years. Many advantages of using self-ligating brackets have proposed. These include minimized applied force from the appliance with reduced friction, favorable physiologic tooth movement, less treatment time, longer treatment intervals with fewer appointments, chair time saving, less patient discomfort, improved oral hygiene, etc. However, self-ligating brackets cost higher than conventional appliances. They also have more bulky profile due to their complicated mechanical design and their clip or slide possibly susceptible to breakage during the treatment. This review summarizes and discusses current evidences on the efficacy of self-ligating versus conventional orthodontic fixed appliances that has been claimed and published in various aspects including friction, active vs passive self-ligating brackets, treatment time, rate of alignment and space closure, chair time, arch dimension and lower incisor inclination, bracket failure rate, treatment stability, patient discomfort, oral hygiene and apical root resorption.

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Keywords: *active self-ligating brackets, conventional brackets, ligation, passive self-ligating brackets, treatment efficacy*

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1. Introduction

Self-ligating brackets have become very popular over the last decade under the claims of better orthodontic effectiveness and efficiency. However, their clinical advantages over the conventional brackets have not been strongly proven yet. The focus of the present review is therefore to summarize and discusses current evidences on the efficacy of self-ligating versus conventional orthodontic fixed appliances that has been claimed and published in various aspects.

The self-ligating brackets are ligatureless bracket systems that have a mechanical device built into the bracket to close off the archwire slot. So far, the developments of a self-ligating bracket have revolved around an opening and closing mechanism that turns the slot of the bracket into a tube that either acts passively or actively against the wire.

Self-ligating brackets can be divided into two main types, active and passive, according to mechanisms of closure.

Active self-ligating brackets

Active self-ligating brackets have a spring clip that stores energy to press against the archwire for rotation and torque control (Chen, et al., 2010). The purposed advantages of active self-ligating brackets are the dual advantage of low friction and precise control. Low friction is ensured by the "metal to metal" contact between the bracket components and the archwire. The precise control in all three planes of space is ensured by the unique interaction between archwire and the active component of the bracket. The examples of active self-ligating brackets include In-Ovation (GAC International, Central Islip, NY), SPEED (Strite Industries, Cambridge, Ontario, Canada), and Time (Adenta, Gilching/Munich, Germany).

Passive self-ligating brackets

Passive self-ligating brackets usually contain a slide that can be closed which does not encroach on the slot lumen which results in no active force on the archwire (Chen, et al., 2010). Tooth control is ultimately determined by the difference in dimensions between archwire and archwire slot. The Damon (Ormco, Glendora, Calif) and SmartClip (3M Unitek, Monvoria, Calif) are examples of the passive self-ligating brackets.

The examples of conventional and self-ligating brackets are shown in Figure 1

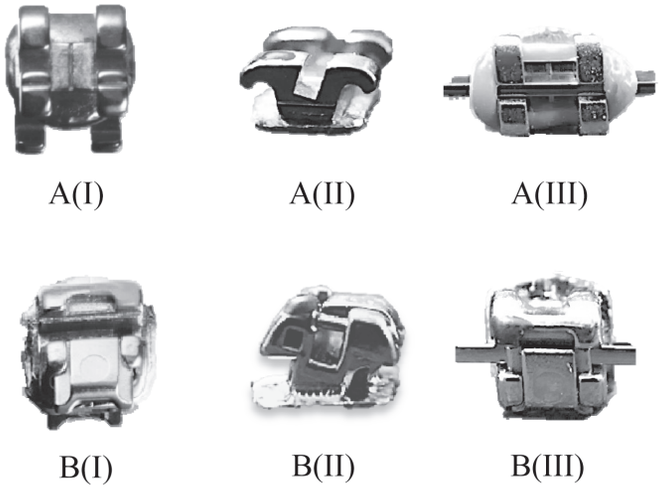

Figure 1: shows the examples of conventional and self-ligating brackets

A(I)-(III): Conventional bracket (the Victory Series™ miniature metal bracket, 3M Unitek)
B(I)-(III): Self-ligating bracket (Damon Q, Ormco)

2. The Advantages and Disadvantages of self-ligating brackets

The purpose for ligation is to engage the archwire as fully as possible into the bracket slot. Harradine (2003) described the ideal properties for ligation which included:

- Secure and robust
- Ensure full bracket engagement of the arch wire
- Exhibit low friction between bracket and arch wire
- Be quick and easy to use
- Permit high friction when desired
- Permit easy attachment of elastic chain
- Assist in good oral hygiene
- Be comfortable for the patient

Harradine (2003) saw the problems with conventional (elastomeric or wire) ligation to be

- Failure to provide and to maintain full arch wire engagement
- High friction
- For elastomerics, the force decays and is sometimes lost
- Potential impediment to oral hygiene
- Wire ligation is slow

2.1 *The proposed advantages of self-ligating brackets*

- Reduction in frictional forces (Damon,1998a, Griffiths, et al., 2005, Khambay, et al., 2004, Kim, et al., 2008). Therefore, less force is required to produce tooth movement.
- Producing more physiologically harmonious tooth movement by not overpowering the musculature and interrupting the periodontal vascular supply (Damon, 1998a). Hence, generate more alveolar bone, greater amounts of expansion, less proclination of anterior teeth, and less need for extractions are claimed.
- Full and secure wire ligation (Harradine, 2003)
- Better sliding mechanics and possible anchorage conservation (Berger, 2008, Damon, 1998b)
- Decreased treatment time, longer treatment intervals with fewer appointments (Damon,1998b, Eberting, et al., 2001, Harradine, 2001).
- Chair time savings, less chair-side assistance and improved ergonomics (Berger and Byloff, 2001, Harradine, 2001, Maijer and Smith, 1990, Sergio, et al., 2008, Shivapuja and Berger, 1994)
- Better infection control (Maijer and Smith, 1990)
- Less patient discomfort (Berger, 2008, Damon, 1998b)
- Improved oral hygiene (Forsberg, et al., 1991, Shivapuja and Berger, 1994)

2.2 The disadvantages of self-ligating brackets

- Higher cost
- Possible breakage of the clip or the slide
- Higher profile because of the complicated mechanical design
- Potentially more occlusal interferences and lip discomfort
- Difficulty in finishing due to incomplete expression of the archwires (Chen, et al., 2010)

3. The efficacy of self-ligating brackets

3.1 *Do self-ligating brackets create friction free environment?*

In order to move a tooth along an archwire the applied force needs to overcome the RS within the system, which was estimated (Kusy and Whitley, 1997) at approximately 50% of the total force applied to a tooth. This is especially critical in situations in which large, slot-filling archwires are used (Ehsani, et al., 2009).

The resistance to sliding (RS) is the sum of 3 components (Thorstenson and Kusy, 2001)

1. Frictional resistance (Classic friction) = between the archwire and bracket slot floor as the bracket slides along the archwire

2. Elastic binding = occurs as the archwire contacts the edge of the slot as the bracket is angulated relative to the archwire

3. Physical notching = occurs at greater bracket angulations such that the bracket may physically deform the archwire

There are several factors affect friction of orthodontic appliances include

- Bracket
- Archwire: size & material
- Method of ligation

Number of studies found exceptionally low levels of friction to sliding in self-ligating brackets (Chotiwannaporn, et al., Pizzoni, et al., 1998, Thomas, et al., 1998). However, there have been frequently and sometimes controversially debated in the current literature. Many of the discrepancies in the results can be attributed to the different testing designs (Brauchli, et al., 2011). The evidence for less friction of self-ligating brackets comes from the results found under laboratory conditions, which do not fully emulate a clinical situation. At the present, there is no in vivo studies evaluation friction between bracket and archwire and also no studies have measured the forces in vivo to confirm this claim (Marshall, et al., 2010).

3.2 *Active or Passive?*

Hamilton et al., (2008) with a long-term in-vivo study comparing active self-ligating brackets and conventional preadjusted brackets. The study was a retrospective case analysis of 800 patients treated by an orthodontist with experience more than 20 years. Group I consisted of 400 patients treated with conventional, preadjusted single-wing brackets (3M Unitek), with treatment starting in 1995. Group II consisted of 400 patients treated with active self-ligating brackets (InOvation), starting in 2002 by the same practitioner. Total treatment time, number of appointments, appointment intervals, breakage, and number of unscheduled appointments were recorded. The authors concluded that the active self-ligating appliance offered no measurable advantage in treatment time. Patients spent comparable amounts of time in rectangular and round archwires. The number of debonded brackets and other emergency visits was significantly higher in patients treated with self-ligating brackets. Brauchli (2011) compared the frictional behaviour of self-ligating brackets with normal both with and without tipping force-moments and in combination with different archwire dimensions. They concluded that active and passive self-ligating brackets showed different behaviour with regard to their resistance to sliding. The influence of the experimental setup, however, was paramount. As soon as the brackets were not passively aligned to the archwire, the differences were minimal between active and passive self-ligating brackets or brackets ligated with elastomeric ligatures, as were the differences related to archwire size. Pandis (2010) conducted RCT to compare the time required to complete the alignment of crowded maxillary anterior teeth (canine to canine) between Damon MX (Ormco, Glendora, Calif) and In-Ovation R (GAC, Central Islip, NY) self-ligating brackets. They found no difference in crowding alleviation was found between the 2 bracket systems. They concluded that the use of passive or active self-ligating brackets does not seem to affect treatment duration for alleviating initial crowding, although the degree of crowding did.

However, Yang et al., (2017a) performed a systemic review and meta-analysis based on randomised clinical trials to investigate the differences in the effectiveness and efficiency between the passive and active self-ligating brackets and concluded that the active self-ligating brackets seems to be more efficient for the alignment than the passive self-ligating while none of the them had any favors for the arch width change.

3.3 *The total treatment time*

The treatment time of using self-ligating has been reported to have shortened from 4-6 months and 4-7 fewer visits (Eberting, et al., 2001, Harradine, 2001). However, Hamilton et al., (2008) and Miles et al., (2009) found no significant difference between self-ligating and conventional brackets. DiBiase (2011) concluded

that bracket type did not influence the duration of treatment or the number of appointments needed. Moreover, The systematic review by Chen et al also found no significant difference in total treatment time and occlusal quality at the end of treatment between self-ligating and conventional brackets (Chen, et al., 2010).

The current prospective evidence regarding duration of treatment indicates that no clinically significant difference exists between conventional brackets and self-ligating brackets. Some studies claim that self-ligating systems deliver a better clinical post-treatment result whereas others have shown no significant difference. Again, the results from these clinical studies are highly dependent on type of self-ligating bracket system being used and the operator experience with the bracket system. Currently, the evidence is limited and more prospective clinical trials using identical wire sequences and mechanics are required. The reasonable conclusion to draw would be that any possible time savings is dependent on each individual.

3.4 Rate of alignment and space closure

Pandis et al., (2007) investigated the time that took to align lower incisors in 54 patients. Patients were randomly assigned to treated with either the Damon2 self-ligating bracket or a conventional edgewise bracket. All patients had an irregularity index score greater than 2 mm in the lower arch and were treated non-extraction. They found there was no difference in the time required to correct mandibular crowding. However, when moderate (< 5 mm) and severe (> 5 mm) crowding were examined separately, self-ligating brackets corrected moderate crowding 2.5 times faster than conventional appliances. This difference was insignificant for patients with the more severe crowding. There was increased proclination of the lower incisors associated with the correction of crowding for both groups. Turpin reviewed the articles of self-ligating brackets and said this article is one of the well-designed study of the self-ligating brackets (Turpin, 2009). Scott et al., (2008a), RCT, compared alignment efficiency of Damon3 brackets and Synthesis conventional bracket systems to treat patients with 5 to 12 mm of mandibular incisor irregularity with pattern of extraction of the first premolars. Sixty two patients were randomly assigned to treated with self-ligating and conventional brackets systems. They found that there is no significant difference in initial rate of alignment. The initial irregularity influenced the rate of movement, but sex, age, and appliance type were not statistically significant. The authors concluded that Damon3 self-ligating brackets were not more efficient than conventional preadjusted brackets to achieve tooth alignment. Chen et al., (2010) found no significant difference in efficiency of alignment in the lower arch. The efficiency of alignment was found to be associated with initial irregularity only.

In term of rate of space closure, study by Miles et al., (2009) showed no significant difference in rate of en-masse space closure between SmartClip and conventional brackets but the sample size in this study was small. Another quantitative systematic review by Yang et al., (2018) also showed no clinical superiority between the conventional and self-ligating brackets in term of space closure and the orthodontic efficiency.

The current evidence does not support the claim that lower friction in a self-ligating system provides faster alignment or space closure in a clinical situation. On the other hand, Megat et al., (2011) found conventional ligating brackets aligned the teeth faster than self-ligating during the first month and there was no difference in efficacy between the two groups in the later 3 weeks. They concluded that the alleviation of crowding was faster with conventional ligating than with self-ligating brackets. However, individual perception of certain orthodontists would support the more efficient role of self-ligating brackets over the conventional system. Further studies would undoubt-

edly be required to confirm this.

3.5 Chair time

Study by Turnbull et al., (2007) compared the efficiency of changing archwires in 131 treated patients. They measured the time that took to change the archwire in patients who treated with Damon2 self-ligating brackets and compared to those who treated with conventional twin brackets and Alastiks. They found The Damon2 self-ligating system had a significantly shorter mean archwire ligation time for both placing and removing wires compared with the conventional elastomeric system. The ligation of an archwire was twice as quick with the self-ligating system. Opening a Damon slide was on average 1 second quicker per bracket than removing an elastic from the mini-twin brackets, and closing a slide was 2 seconds faster per bracket. The systematic review by Chen et al., (2010) found mean saving of 20 seconds per arch for opening the slides of Damon brackets compare with removing the ligatures (modules) of conventional brackets. However, there was no significant difference between the time used for closing the slides of Damon brackets and replacing the ligatures of conventional brackets.

3.6 Arch dimension and lower incisor inclination

The Damon philosophy is that biologically friendly light forces do not overpower the musculature. Instead, the arch form aligns by taking the path of least resistance, which is posterior expansion (Damon, 1998b, Pandis, et al., 2007). The perioral muscles, like the orbicularis oris and the mentalis muscle, act as a ''lip bumper,'' which minimizes the anterior movement of the incisors (Damon, 1998b). Damon also believes that the mandibular intercanine width does not change significantly with his system, and his lateral cephalometric tracings show minimal labial movement of incisors in his published articles.

However, Fleming et al., (2009) compared the effects of a self-ligating bracket system (SmartClip) and a conventional edgewise bracket (Victory) to align incisors and improve transverse mandibular arch dimension changes over 30 weeks. Sixty six patients were randomly assigned to treatment groups. They found that over the period of studied, bracket type had little effect on incisor inclination, positional changes, intercanine widths, or other arch dimensions. The authors concluded that there was little difference overall in the pattern of arch alignment and leveling from the 2 appliance systems. The efficiency of alignment in the mandibular arch in non-extraction patients is independent of bracket type and the alignment efficiency is mainly influenced by initial irregularity. Chen et al., (2010) also suggested that the self-ligating and conventional resolve crowding with a similar mechanism as the only significant difference was the 1.5 degree difference in incisor proclination (less proclination in self-ligating system). Therefore, the claims that self-ligating brackets facilitate greater and more physiologic arch expansion to allow more non-extraction treatment require more evidence. Cattaneo et al., (2011) investigated the transversal maxillary dento-alveolar changes in patients treated with active and passive self-ligating brackets by using randomized clinical trial using CBCT-scan and digital models. They concluded that the anticipated translation and buccal bone modelling using active or passive self-ligating brackets could not be confirmed. Due to the large inter-individual variation, they also suggested a patient-specific as individual factors like pre-treament teeth inclination and occlusion influenced the treatment outcome of the individual patients. Vajaria et al., (2011) evaluated the incisor position and dental transverse dimensional changes using the Damon system by comparing the subjects treated with the Damon system and subjects treated with a conventionally ligated edgewise brackets system. The results did not support the claimed lip bumper effect of the Damon system and showed similar patterns of crowding alleviation, including transverse expansion and incisor advancement in both groups. Maxillary and mandibular

intercanine, interpremolar, and intermolar widths increased significantly after treatment with the Damon system. The mandibular incisors were significantly advanced and proclined after treatment with the Damon system, contradicting the lip bumper theory of Damon. Posttreatment incisor inclinations did not differ significantly between the Damon group and the control group. Yang et al., (2018) also conducted a quantitative systemic review which a total of 976 patients from 17 RCTs were included in this study. They found that the conventional brackets provided better intercanine width expansion whereas the passive self-ligating brackets were better in the posterior expansion. However, there was no significant difference in the transverse arch expansion between the conventional and self-ligating brackets.

3.7 Bracket failure rate

Self-ligating brackets usually have a smaller base and a thicker profile than do conventional brackets. Therefore, it was postulated that the increased failure rate with self-ligating brackets might have been due to the smaller base and the higher profile, especially in the mandibular posterior teeth (Harradine and Birnie, 1996). However, the research found no significant difference of failure rate between the self-ligating and conventional system (Chen, et al., 2010, Pandis, et al., 2006).

3.8 Stability

Yu at al (2014) conducted a long-term follow-up retrospective study to compare the stability of the treatment with conventional and self-ligating brackets in adolescents. There were two groups with 30 patients each. Subjects in group which treated with conventional brackets and self-ligating brackets had a mean pretreatment age of 13.48 and 13.56 years respectively. A mean follow-up period for conventional brackets group was 7.68 years and the self-ligating brackets group was 7.24 years. The study casts were examined using the Peer Assessment Rating (PAR) index and the Little irregularity index to evaluate the relapse. The study found no significant difference changed in PAR and Little irregularity index between these two groups. They concluded that the long-term treatment stability did not affect by the type of the brackets used.

3.9 Subjective pain experience

Using self-ligating system claimed to have less patient discomfort (Berger, 2008, Damon, 1998b). However, Scott et al., (2008b) found no difference in discomfort perceiving during initial tooth alignment when using self-ligating and conventional brackets. Fleming et al., (2010) also found that self-ligating bracket do not confer particular advantage in regard to subjective pain experience. Rahman et al., (2015) conducted a RCT to compare the pain perception of the patients treated with the conventional and self-ligating brackets using a Verbal Rating Scale to assess the discomfort. They found no significant difference in the pain perception between these two groups. Same as the finding from Yang et al., (2017b) which found that there was no significant difference in the reduction of discomfort between the conventional and passive self-ligating brackets.

3.10 Oral hygiene

It is claimed that using self-ligating system improve the oral hygiene (Forsberg, et al., 1991, Shivapuja and Berger, 1994). However, the evidence does not support the claim that self-ligating brackets are more hygienic than conventional brackets (Marshall, et al., 2010). Pellegrini et al., (2009) found mean streptococcal and total bacterial levels harvested from tooth surfaces were lower with the self-ligating brackets but they failed the show to association between bracket type and bacterial load. Pandis et al., (2008) also failed to demonstrate an association between bracket type and periodontal health following removal of orthodontic appliances. Furthermore, the systemic review by Yang et al., (2017b) also found no significant difference in plaque control between the convention and passive self-ligating brackets.

3.11 *Apical root resorption*

The systematic review by Fleming et al., (2010) showed no significant difference in apical root resorption compared between self-ligating and conventional brackets. Another systemic review by Yi et al., (2016) found that for the maxillary lateral incisors, mandible central incisors and mandible lateral incisors, there was no significant difference in external apical root resorption between conventional and self-ligating brackets. For the maxillary central incisors, the study showed that the external apical root resorption in self-ligating bracket was significantly less than the conventional bracket. However, more studies still needed to be done to confirm this finding.

A summary of the results from and conclusion from previous studies is shown in Table 1.

4. Conclusion

There have been claims that self-ligating brackets are superior to the conventional brackets in many aspects. More often, this information comes from the marketing materials and non-scientific/non-refereed sources. Hence, all the information must be interpreted carefully. The direct conclusion applied from in vitro studies to the clinical situation should not be drawn, as many factors except the materials will influence the overall treatment progression.

However, the prospective clinical trials and systematic reviews have failed to demonstrate any advantage in terms of initial alignment, overall treatment time, or discomfort (Chen, et al., 2010, Dehbi, et al., 2017, Fleming, et al., 2009, Fleming and Johal, 2010, Goonewarden, 2010, Miles, 2009, Yang, et al., 2017b). The systematic review by Chen et al., (2010) found that from the current evidence, the only shortened chair time and slightly less incisor proclination seem to be the only significant advantages of self-ligating brackets over conventional brackets.

The current evidence does not support that the self-ligating bracket systems are more efficient or more effective in treating malocclusion (Chen, et al., 2010, Fleming and Johal, 2010, Miles, 2009, Yang, et al., 2017b, Yang, et al., 2018). However, the further studies are required to confirm the results.

5. Discussion

Many of the discrepancies in the results from previous studies may attribute to the different testing designs, uncontrolled factors which possibly influence orthodontic treatment such as mode of action (active or passive), differences in treatment procedures, clinical and statistical methods, the variations in the individual response and oral health habits of the patients, and the small sample size. The further high-quality studies with well-designed set up, for example, clinical trials/in vivo studies with larger sample sizes and lower heterogeneity, using identical wire sequences and mechanics are needed for more conclusive results.

Table 1 : summary of the results from previous studies and the conclusion

The efficacy of self-ligating brackets	Results from previous studies		Conclusion
	Author, year	Results	
3.1 Do self-ligating brackets create friction free environment?	Chotiwannaporn, et al., Pizzoni, et al., 1998. Thomas, et al., 1998.	Found exceptionally low friction to sliding in self-ligating brackets.	There is still no in vivo studies evaluation friction between bracket and archwire and also no studies have measured the forces in vivo to confirm this claim at the present.
3.2 Active or Passive?	Hamilton, et al., 2008	The active self-ligating appliance offered no measurable advantage in treatment time.	Active self-ligating brackets shows superior result for the alignment than the passive self-ligating brackets. However, there is no significant difference between active and passive self-ligating brackets in transverse dimensional change, tooth inclination, life quality, and space closure rate.
	Brauchli, 2011	Active and passive self-ligating brackets showed different behaviour with regard to their resistance to sliding. The influence of the experimental setup, however, was paramount. As soon as the brackets were not passively aligned to the archwire, the differences were minimal between active and passive self-ligating brackets or brackets ligated with elastomeric ligatures, as were the differences related to archwire size	
	Pandis, 2010	The use of passive or active self-ligating brackets does not seem to affect treatment duration for alleviating initial crowding, although the degree of crowding did.	
	Yang, et al., 2017 systemic review	The active self-ligating brackets seems to be more efficient for the alignment than the passive self-ligating while none of the them had any favors for the arch width change.	
3.3 Total treatment time	Eberting, et al., 2001	Treatment time shortened from 4-6 months and	The current evidence

	Harradine, 2001 Hamilton, et al., 2008 Miles, et al., 2009 DiBiase, 2011 Chen, et al., 2010: systematic review	4.7 fewer visits. Found no significant difference between self-ligating and conventional brackets.	regarding duration of treatment indicates no clinically significant difference between conventional and self-ligating brackets. Any time saving for the use of self-ligating brackets is dependent on each individual.
3.4 Rate of alignment and space closure	Pandis, et al., 2007	Found no difference in the time required to correct mandibular crowding. Increased proclination of the lower incisors associated with the correction of crowding for both conventional and self-ligating brackets	The current evidence does not support the claim that lower friction in a self-ligating system provides faster alignment or space closure in a clinical situation.
	Scott, et al.,2008	Found no significant difference in initial rate of alignment between conventional and self-ligating brackets. The initial irregularity influenced the rate of movement, but sex, age, and appliance type were not statistically significant.	
	Chen, et al., 2010	Found no significant difference in efficiency of alignment in the lower arch. The efficiency of alignment was found to be associated with initial irregularity only.	
	Miles, et al.,2009	Showed no significant difference in rate of en-masse space closure between SmartClip and conventional brackets (small sample size).	
	Yang, et al., 2018: Systematic review	Showed no clinical superiority between the conventional and self-ligating brackets in term of space closure and the orthodontic efficiency.	
3.5 Chair time	Turnbull, et al.,2007	Self-ligating system had a significantly shorter mean	From the current evidences

		archwire ligation time for both placing and removing wires compared with the conventional elastomeric system.	available, the self-ligating brackets seem to have shorter chair time than the conventional brackets.
	Chen, et al., 2010: systematic review	Found mean saving of 20 seconds per arch for opening the slides of Damon brackets compare with removing the ligatures (modules) of conventional brackets. However, there was no significant difference between the time used for closing the slides of Damon brackets and replacing the ligatures of conventional brackets.	
3.6 Arch dimension and lower incisor inclination	Fleming, et al., 2009	Bracket type had little effect on incisor inclination, positional changes, intercanine widths, or other arch dimensions.	The evidences from previous studies showed no significant difference in arch dimension change between the conventional and self-ligating brackets. However, slightly less incisor proclination found in self-ligating brackets.
	Chen, et al., 2010	Self-ligating and conventional resolve crowding with a similar mechanism as the only significant difference was the 1.5 degrees difference in incisor proclination (less proclination in self-ligating system).	
	Cattaneo, et al., 2011	The anticipated translation and buccal bone modelling using active or passive self-ligating brackets could not be confirmed. Authors suggested a patient-specific as individual factors like pre-treament teeth inclination and occlusion influenced the treatment outcome of the individual patients.	
	Vajaria, et al., 2011	Damon system and conventional brackets showed similar patterns of crowding alleviation, including transverse expansion and incisor advancement.	
	Yang, et al., 2018: systematic review from RCTs	There was no significant difference in the transverse arch expansion between the conventional and self-ligating brackets.	

3.7 Bracket failure rate	Chen, et al., 2010, Pandis, et al., 2006	Found no significant difference of failure rate between the self-ligating and conventional brackets.	There is no statistically significant difference of the bracket failure rate between the conventional and self-ligating brackets.
3.8 Stability	Yu, at al., 2014	Found no significant difference changed in PAR and Little irregularity index between conventional and self-ligating brackets.	Type of the brackets does not affect the long-term treatment stability.
3.9 Subjective pain experience	Scott, et al., 2008	Found no difference in discomfort perceiving during initial tooth alignment when using self-ligating and conventional brackets.	There is no significant difference in pain perception/discomfort between conventional and self-ligating brackets.
	Fleming, et al., 2010: systematic review Rahman, et al., 2015 Yang, et al., 2017: systematic review	Found no significant difference in the pain perception/reduction of discomfort between conventional and self-ligating brackets.	
3.10 Oral hygiene	Pellegrini, et al., 2009	Found mean streptococcal and total bacterial levels harvested from tooth surfaces were lower with the self-ligating brackets but they failed to show to association between bracket type and bacterial load.	The current finding from previous studies does not support the claim that self-ligating brackets are more hygienic than conventional brackets.
	Pandis, et al., 2008	The result failed to demonstrate an association between bracket type and periodontal health following removal of orthodontic appliances	
	Yang, et al., 2017: systematic review	Found no significant difference in plaque control between the convention and passive self-ligating brackets.	

3.11 Apical root resorption	Fleming, et al., 2010: systematic review	Showed no significant difference in apical root resorption compared between self-ligating and conventional brackets.	From the current data available, the apical root resorption of conventional and self-ligating brackets is not significantly different.
	Yi, et al., 2016: systematic review	There was no significant difference in external apical root resorption between conventional and self-ligating brackets for the maxillary lateral incisors, mandible central incisors and mandible lateral incisors. For the maxillary central incisors, the study showed that the external apical root resorption in self-ligating bracket was significantly less than the conventional bracket. However, the authors suggested to have further studies to confirm this finding.	

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