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Self Ligating Vs Convention Bracket System: A Comparative Review

Sonia Prakash[1], Santosh Kumar[2], Tarun Kumar[3]
[1] *Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics,SGT University, Gurugram, Haryana,India .*
[2]*Professor, Department of Orthodontics and Dentofacial Orthopaedics,Faculty of dental sciences,SGT University, Gurugram, Haryana,India.*
[3]*Professor, Head of Department of Orthodontics and Dentofacial Orthopaedics.*
**Corresponding Author: Dr. Sonia Prakash*

ABSTRACT
Self-ligating brackets firstly introduced in middle of 1930s with the Russell attachment, are orthodontic systems that eliminate the need for traditional wire ligatures. These brackets feature a built-in mechanical device to close the bracket slot, offering potential advantages like improved comfort and ease of cleaning. The two main types: active self-ligating brackets exert force on the arch wire and passive self-ligating brackets do not apply force on arch wire but allow the arch wire to move freely. These systems are believed to reduce friction during tooth movement, facilitating smoother movement and enabling the use of lower forces. This low-friction mechanism is thought to promote biologically compatible tooth movement, reducing the risk of tissue damage while enhancing efficiency.

In self ligating brackets proponent contend that by enabling teeth to follow the path of least resistance, the treatment procedure is improved overall. While there is a theoretical benefit to these systems, clinical studies comparing self- ligating brackets to conventional ones have yielded mixed results. Some studies suggest that self-ligating brackets result in shorter treatment times, better patient comfort, and more efficient tooth movement. However, other studies indicate no significant differences in treatment outcomes or patient comfort between self-ligating and conventional brackets.

Given these conflicting findings, further research is needed to definitively determine the advantages of self-ligating brackets. Understanding their true clinical benefits requires more comprehensive studies that account for various factors, including treatment stage, bracket design, and patient-specific considerations.

I. INTRODUCTION

"Self-ligating brackets firstly introduced in the middle of 1930s with the development of the Russell attachment, marks the beginning of this innovative approach to orthodontic appliance design."Self-ligating brackets are a type of orthodontic appliance that eliminates the need for external ligatures by incorporating a self built mechanism to secure the archwire within the bracket slot. From the patient's viewpoint, these brackets tend to offer greater comfort and improved oral hygiene due to the absence of wire or elastic ties.".[1]

Self-ligating brackets are generally categorized into two primary types based on their closure mechanism: active and passive. Active self-ligating brackets feature a spring clip that engages the archwire and can apply pressure to it, while passive self-ligating brackets utilize a gate that secures the wire without exerting active force or occupying space within the bracket slot.[2]In recent decades, various self-ligating systems have been introduced, with their developers asserting that these designs offer greater efficiency compared to conventional orthodontic techniques.[3]

Various criteria have been outlined for an effective ligation system. According to Harradine, such a system should provide secure and stable engagement of the archwire within the bracket, minimize friction during sliding mechanics while allowing for increased friction when necessary, be time-efficient in clinical use, facilitate the attachment of auxiliary components, promote good oral hygiene, and offer patient comfort. A key benefit of self-ligating brackets lies in their ability to reduce friction between the bracket and archwire, enabling smoother tooth movement and the

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application of lighter orthodontic forces.

PHILOSOPHYOFSELFLIGATING BRACKET PROPONENTS

Self-ligating orthodontic systems operate on the principle that gentle, consistent forces promote healthier and more effective tooth movement. Advocates claim that using light

pressure and low-friction mechanics allows teeth to shift into alignment more naturally, without overpowering the surrounding muscles or harming periodontal tissues. Because the forces exerted by modern, small- diameter archwires are minimal, they do not block blood flow in the periodontal structures, thus preventing tissue ischemia.

In contrast, strong orthodontic forces can lead to areas of hyalinization within the periodontal ligament, temporarily halting tooth movement. Self-ligating brackets, however, apply just enough pressure to initiate tooth movement while preserving blood circulation in the surrounding tissues, making the process more biologically appropriate and efficient. As a result, the final alignment of the teeth is influenced more by natural factors like muscle balance and periodontal support rather than by excessive mechanical force.

Furthermore, passive self-ligating brackets are featured to allow teeth to move along the path of least resistance. When the bracket gate is closed, it functions similarly to a tube, enabling flexible nickel-titanium archwires to slide with little friction. This design reduces mechanical resistance, allowing the archwire to work more effectively and guide the teeth in a way that aligns with natural biological [5] processes. Teeth movement is also more efficient when they are allowed to move individually, and passive self-ligating brackets offer more freedom for teeth to move to their natural position even though they are still interconnected because the archwire is never tightly engaged with the bracket slot (Damon, 1998).[6]

TYPES OF SELF LIGATING BRACKET SYSTEM

Two types of self-ligating brackets have been developed, active and passive. The active type has a spring clip that encroaches on the slot from the labial/ buccal aspect and presses against the archwire providing an active seating force on the archwire and ensuring engagement such as In-Ovation (GAC International,Bohemia,NY, USA),SPEED (Strite Industries, Cambridge, Ontario, Canada), and Time brackets (Adenta, Gilching/Munich, Germany).

In the passive type, the clip does not press against the archwire. Instead, these brackets use a rigid door or latch to entrap the archwire providing more room for the archwire such as Damon (Ormco/"A"Company), SmartClip (3M Unitek, USA), and Oyster ESL (Gestenco International, Gothenburg, Sweden).[5]

A recent meta-analysis compared conventional and self-ligating brackets without making a distinction between active and passive self-ligating brackets.Researchers concluded that the primary distinction between self- ligating and conventional brackets lies in the quicker process of opening and securing self-ligating systems. However, no statistically significant differences were found between the two types in respect of overall treatment duration, number of appointments, alignment effectiveness, extraction space closure, changes in arch width, periodontal outcomes, root resorption, or final [6]occlusal results.

DIFFERENCE BETWEEN SELF AND CONVENTIONAL BRACKET SYSTEM

The Difference between self and conventional can be organized under the following treatment elements:

Torque:

With the use of active self-ligating brackets , torque expression may be improved by pressing the archwire into the bracket slot more firmly. Nonetheless, research suggests that there is little difference in torque control between active and passive self-ligating brackets .

More important influences on torque expression than the type of ligation mechanism are slot size, wire dimensions, and manufacturing tolerances. As a result, both bracket system can be useful in clinical settings, with bracket and wire dimensions having a greater impact on torque control than the ligation technique alone.[7].

Friction

The amount of friction generated in passive self ligating bracket is very low as compared to the active self ligating brackets.This results in better sliding mechanism associated with bracket system.[8]However, bracket design must also be considered.

Experimental studies have yielded varying results, with some showing a significant reduction in friction and others indicating an increase. In an in vitro study by Henao and Robert, three dissimilar arch wires helped compare the active and passive bracket system with conventional brackets. They found a notably lower friction in passive self-ligating brackets when using 0.014-inch archwires[9]. 0.014-inch arch wires yielded lower friction values with passive self ligating brackets.Similar findings were observed by Costa et.al about reduced friction in passive bracket .Hempel souper G et.al also carried out a systematic review that both systems of brackets reduced lower friction levels with lower dimension arch

wires(round) specifically in well aligned dental arches.However, in cases of complex malocclusion, there is insufficient evidence to confirm that rectangular archwires result in lower friction in self-
ligating systems.[10]

Levelling and Alignment:

Self-ligating brackets are commonly thought to improve tooth movement speed because to decreased friction, although data is inconsistent. Self-ligating devices improve efficiency, although other studies show that conventional brackets with moderate-strength metal ligatures can produce equal outcomes. Ong et al. observed that the ligation method is only one element impacting treatment progression, however conventional brackets being more effective in early few months of treatment was noted by Scott and Abdul et.al in 2024. Pandis et al. found that passive self-ligating brackets are more successful in moderate crowding, although traditional brackets excel at rotation control. These findings emphasise the need of choosing the right bracket system based on clinical parameters including crowding intensity and treatment stage.[11].

Systematic reviews highlight ongoing debate regarding the primary alignment phase of extraction orthodontics. Whereas the time and alignment of alignment phase , incisor repositioning and their inclination were quiet similar in cases that did not require extractions between patients treated with both self-ligating and conventional systems. Overall, the effectiveness of orthodontic alignment has shown minimal differences between various types of fixed appliances.

Anchorage loss

No significant differences found between the two groups comparing self- ligating brackets with conventional brackets. Systematic reviews conclude that both bracket types exhibit similar levels of anchorage loss, with no evidence based a significant difference between conventional and self ligating systems..

Space closure

No significant differences were found in the rate of space closure when comparison between passive self-ligating brackets and conventional brackets with metal ligatures. However, Burrow's study showed different results, as conventional brackets achieved better space closure. Another clinical study found no statistically significant difference found in canine retraction between conventional and self-ligating brackets[11].

Systematic reviews on this topic reveal no significant differences in performance. When it comes to en-masse retraction of incisors and canines, it is concluded that self-ligating brackets do not offer any advantage over conventional braces in terms of space closure. The efficiency of space closure has shown minimal variation across different types of fixed appliances.

Transverse Effects:

Although it has been observed that self-ligating brackets may have a greater effect on transverse changes than conventional brackets.Other studies have shown no significant differences in the maxillary arch length, in the inclination of incisors or molars while using wider, transversed archwires. Also there is no difference in buccal bone remodeling with passive or active self-ligating brackets. Therefore, the results of this study do not support the idea that passive self-ligating systems facilitate alveolar bone remodeling during arch expansion with controlled[12] tipping. On other hand some studies suggest that conventional and passive self-ligating brackets found notable difference in greater buccal inclination of the upper molars in passive self-ligating brackets compared to conventional brackets. Studies may vary results when comparing transverse movement occurred in the premolar region in both techniques showing a significantly greater movement in passive self-ligating brackets. Some studies found greater inter-canine distance in conventional when compared to self-ligating brackets. Increase in both intermolar and inter-canine width found in passive self-ligating bracket. Therefore, similar dimensional changes observed in both self-ligating and conventional brackets with comparable inter-canine expansion outcomes[13].

Root resorption:

Active self-ligating brackets exert less force than conventional brackets with metal or elastomeric ligatures, according to in vitro research. This could potentially lessen negative effects such root resorption that are linked to high force levels. However, the type of brackets employed has little effect on root resorption, according to randomized clinical investigations. On comparing the two, self ligating brackets are not superior to conventional brackets in reducing external apical root resorption in the mandibular central and lateral incisors or upper lateral incisors. Self-ligating brackets might, however, provide some protection for the upper

central incisor, however reliable research has not yet verified this. Another review emphasizes the lack of clarity surrounding the clinical treatment of root resorption.

Clinical time:
Greater reduction in timing are found to position and remove ligatures in conventional metal and active and passive self-ligating brackets ,an average of 6 minutes per arch reduced. In comparison, self-ligating brackets only take about
0.7 minutes.Also reduction in chair side time in passive self-ligating appliances give approximately 1.5 minutes per patient. According to Harradine reduction in time had limited clinical significance. Therefore, both active and passive self- ligating brackets had considerable benefits in respect of chairside time efficiency.

Routine Checkups:
Due to longer checkup durations self-ligating brackets is not prone to biological degradation. While other studies showed benefits of reduction of four to seven[8] weeks in total treatment duration and less appointment recalls.

Total treatment time
Studies observed that Cases are finished on an average of 4 to 6 months earlier[7] compared conventional brackets. On the other hand , both active and passive self- ligating brackets had no considerable benefits in respect of reduced treatment time compared to conventional appliances. Studies suggested that result may vary due to due to the limited number of cases involved.

Patient comfort
"Although minimum patient pain discomfort in the first seven days o n inserting the 0.014-inch Cu NiTi archwire with passive self-ligating brackets and conventional brackets. Rahman et al.study also found the same.Similar studies done with 0.016-inch NiTi archwire studies comparing pain, again no
differences were found between the two groups.[7] However, pain noticed in the self-ligating group on removal of NiTi 0.019x0.025-inch archwires and insertion of SS 0.019x0.025-inch archwires. Similar s t u d i e s d o n e w i t h insertion or removal of rectangular archwires greater degree of pain observed.. Although no significant differences in pain intensity found on comparing self- ligating and conventional brackets at different time intervals between 4 hours to 1month. Aesthetically patients prefer for conventional brackets.Also, patients reported more discomfort with self-ligating brackets while contact between the brackets and lips.Therefore no significant results were found although Systematic reviews indicate greater discomfort with self-ligating brackets,.[11]

Hygiene and halitosis
More accumulation of pathogens found in self-ligating appliances in some studies. Some studies shows no significant differences because of bracket design .Although biofilm accumulation or the presence of periodontal pathogens accumulates due to subgingival plaque or gingival inflammation. Consequently, self-ligating brackets do not appear to differ from conventional braces in terms of colonization by *Streptococcus mutans*or *Lactobacillus* and do not offer any distinct advantage in terms of periodontal health or halitosis. Other studies concluded that less *Streptococcus mutans* biofilm accumulate on self-ligating metal brackets than conventional metal brackets. However, these findings should be considered alongside individual patient factors, such as oral hygiene and dietary habits. Other studies have found that self-ligating brackets do not outperform conventional brackets in promoting better oral health, and some found no evidence to suggest that bracket design (whether conventional or self-ligating) influences the formation and adhesion of *Streptococcus mutans* colonies. Some studies on Halitosis indicate that self-ligating brackets cause
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less malodor compared to conventional brackets.

II. DISCUSSION:

The results and conclusions presents a wide range concerning passive and active self-ligating brackets, also the conventional brackets. Due to this variety of findings, it is difficult to suggest the available evidence to guide clinical decision-making effectively.

When concluding studies on self-ligating brackets, their decisions may vary. Several factors need to be considered when reviewing this type of research. Additionally, some studies focus only on certain aspects of the treatment process. Furthermore, the range of tooth movement observed in these studies is often much[12] greater than what is seen in clinical practice .Moreover, brackets come in a variety of sizes, which complicates direct comparisons with conventional brackets.

Many studies also focus on different archwire sizes, making it challenging to draw[14] definitive conclusions or standardize the criteria for comparison.

When comparing the efficiency of passive and active self ligating bracket in alignment and levelling clinical research yield contradictory findings.Active self ligating brackets might be more effective during alignment phase ,according to single systemic review that was examined. However, the changes found were not statistically significant[2,15].With respect to friction, findings suggest that passive self-ligating brackets may offer certain advantages. Because these studies are done in-vitro the results may vary.[16,17] Results should be interpreted with caution based on previous discussed limitations.The same caution applies when evaluating torque expression in these studies. One systematic review reported only a slight difference in torque expression between bracket types.[18]

When comparing data across studies involving active and passive self-ligating brackets versus conventional brackets, conflicting results emerge at various treatment stages and under different clinical conditions. It was found under systemic review that on using round archwirers less friction produced in self- ligating brackets in a well-aligned dental arches. However, such ideal clinical conditions are relatively uncommon in everyday orthodontic practice[19,20]

On going through different stages of orthodontic treatment, alignment and leveling between different types of fixed appliances showed no significant differences[21]. Similarly, there is no strong evidence to suggest differences in anchorage loss or space closure among bracket types. In terms of torque
expression, conventional brackets tend to perform better than self-ligating systems. Lastly, when assessing transverse expansion, current evidence does not support the superiority of self-ligating brackets[22,23].Additional conflicting findings arise in clinical studies assessing other aspects of self- ligating versus conventional brackets. In the case of root resorption, only one in vitro study suggests that self-ligating appliances may offer a protective effect due to the lower forces they apply compared to conventional brackets. However, clinical studies generally report similar levels of root volume loss between both systems, and systematic reviews conclude that neither bracket type can be considered superior in this regard.[24,25]

One of the study reported a decreased chair side time in self-ligating brackets, although it had limited clinical relevance. While some systematic reviews suggest that self-ligating appliances offer notable benefit in reducing chair time, it is uncertain whether this translates into meaningful clinical benefit. One proposed advantage of self-ligating systems is that their locking mechanisms are resistant to biological degradation, potentially allowing for extended intervals between check- ups. However, the literature on appointment frequency presents mixed findings, with most systematic reviews concluding that there is no significant reduction in the number of visits compared to conventional brackets.

Regarding total treatment duration, some studies report a shorter treatment time with self-ligating brackets, while others find the reduction statistically insignificant. In fact, one study even found that self-ligating appliances required more time to complete treatment. Overall, when compare to traditional fixed appliances, thorough evaluations show no discernible reduction in treatment (26-28) time In terms of comfort, patients tend to report slightly more discomfort with (29,30) selfligating brackets; however, the difference is not statistically significant Finally, both reviews and clinical studies present conflicting results regarding oral hygiene. While some report no significant differences between bracket types, others suggest that self-ligating brackets are associated with reduced accumulation of *Streptococcus mutans* biofilm. As a result, the impact of bracket design on hygiene remains inconclusive[20,31-34]

III. CONCLUSION:

Based on the current literature, the following conclusions can be drawn regarding self-ligating brackets:

The alignment ,levelling, friction, space closure, anchoring loss, transfers alterations, root resorption ,check-up frequency, overall treatment time, patient comfort, cleanliness and halitosis do not significantly differ between self ligating and traditional brackets. Existing evidence does not support a clear clinical advantage of one system over the other, and further high-quality research is necessary to confirm these findings.

Regarding chair time, while some studies suggest a minor reduction with self- ligating brackets, the overall evidence does not indicate a clinically meaningful decrease in time compared to conventional systems.

The most consistent drawback of self-ligating brackets appears to be reduced torque expression compared to conventional brackets.

It is also important to acknowledge that many external factors influencing tooth movement such as patient compliance, oral hygiene, and

biological variability cannot be fully controlled, complicating direct comparisons between bracket types. Additionally, results from in vitro studies often differ from those observed in clinical settings, further emphasizing the need for cautious interpretation and more robust clinical trials.

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