ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 11| Issue: 3| March 2025|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2025: 8.691 || ISI Value: 1.188

SELF-LIGATING BRACKETS: A REVIEW

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Article DOI: https://doi.org/10.36713/epra20468
DOI No: 10.36713/epra20468

ABSTRACT
Since its inception, orthodontics has undergone remarkable advancements, driven by innovative treatment philosophies, technological integration, and improved appliance designs. This review explores the progression of orthodontics, emphasizing the development of ligation systems, mainly the introduction of self-ligating brackets and their properties.
KEYWORDS: *Self Ligating, Bracket, Orthodontics*

INTRODUCTION
Orthodontics, as a specialized field of dentistry, has continually evolved to address the complexities of malocclusion and craniofacial anomalies. The concept of self-ligation is not new, it has been pioneerd since the 1930s and has undergone a revival over the past years.

Definition
A self-ligating bracket is characterized by a permanently affixed, moveable element that secures the archwire.[1]
Initially, steel ligatures were employed to secure archwires, offering durability but requiring a labor-intensive application. The 1970s saw the advent of elastomeric ligatures, which simplified the process but introduced challenges such as force decay, permanent staining, and increased friction.[1]

The evolution of SLB systems involves a variety of design changes, from passive systems allowing natural engagement between brackets and archwires to active systems allowing controlled and personalized adjustments. The main goals of these designs are to improve force delivery, minimize friction, and potentially minimize treatment time, thereby making them a popular choice for both patients and orthodontists.[2] By critically examining the distinctive attributes and clinical implications of these systems, orthodontic clinicians can gain a broad understanding of their role in modern orthodontic treatment procedures.[3]

Classification of Self-Ligating Brackets
Self-ligating brackets may be classified into 2 categories Passive & Active[4] :

Passive Brackets incorporate a rigid, adjustable element to secure the archwire. The alignment of teeth using passive brackets relies entirely on the compatibility between the bracket slot and the archwire. Consequently, tooth control often suffers when wire with smaller dimension are placed into archwire tube. The introduction of nickel titanium wires has mitigated the effects of this limitation on tooth control during the initial stages of treatment; however, this can lead to challenges later on when engaging stiffer wires becomes problematic.
Examples include Damon and Mobil-Lock.

Active Brackets incorporate a flexible component designed to secure the archwire. This flexible element holds the archwire in place within the bracket slot and is capable of storing and releasing energy through elastic deflection. This gentle mechanism applies a light yet continuous force on the tooth and its supporting structures, facilitating precise and controlled movement.

Examples include Speed, In-Ovation, Quick, SPEED, Forestadent Ltd. (Pforzheim, Germany), and Strite Industries (Cambridge, Ontario, Canada).

An ideal orthodontic ligation system should: [5]
- Be **secure and robust** to prevent accidental loss.

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- Ensure **full engagement of the archwire** with the bracket.
- Be **quick and easy to use** for efficiency.
- Exhibit **low friction** for optimal tooth movement while allowing **high friction** when necessary to lock tooth positions.
- Permit **easy attachment of elastic chains**.
- Assist in **maintaining good oral hygiene** and be **comfortable for the patient**.

The efficiency of self-ligating (SL) brackets compared to conventional brackets has been investigated in various studies, yielding mixed results.[5,6] Key findings include:

- Ligation, Chairside and Efficiency
- Alignment
- Subjective Pain Experience
- Bond Failure Rate
- Plaque Retention and Periodontal Health
- Dental Arch Changes and Torque Expression
- Space Closure
- Apical Root Resorption
- Total Treatment Time and Occlusal Indices

Recent studies, including a large retrospective comparison and a randomized clinical trial, concluded that SL brackets did not significantly reduce treatment duration, total visits, or time for initial alignment when compared to conventional brackets. While SL brackets may reduce chair-side time and simplify procedures, their overall impact on treatment duration and efficiency remains debatable, with results varying across studies. [7,8]

A study by Eberting et al. (2001) comparing Damon 2 brackets to conventional brackets showed SL brackets completed alignment faster in cases of moderate crowding (2.7 times faster), with less pronounced differences in severe crowding (1.37 times faster). However, differences in archwire sequences used in the study might explain these results, reducing reliability [5,6]

Randomized controlled trials (RCTs) consistently concluded no significant difference between SL and conventional brackets in alleviating crowding during the alignment phase. This included studies examining mild to moderate mandibular irregularities and maxillary anterior alignment. [9]

SL brackets may provide efficiency benefits in later treatment stages, such as space closure in extraction cases, where reduced friction could facilitate faster sliding mechanics

Subjective Pain Experience

Discomfort is a common side effect of fixed orthodontic treatment, potentially affecting patient compliance and outcomes. Pain levels are influenced by factors such as the force applied by orthodontic archwires and the friction between the archwire and brackets. [10] Light forces, as suggested by histological studies, are more biologically efficient and less traumatic, while higher forces can lead to increased discomfort. [11]

Self-ligating (SL) brackets are marketed as having reduced frictional resistance, which is theorized to allow for lower force levels during alignment and sliding mechanics. This reduction in force may lead to a more biologically compatible treatment process and less pain during tooth movement.[12]

However, studies on pain associated with SL brackets have yielded mixed results:

- Some studies reported greater pain during chairside manipulation of SL brackets compared to conventional systems.[13,14]
- Direct statistical comparisons of these studies are challenging due to differences in the mechanisms of archwire engagement and disengagement across various SL systems.

Overall, while SL brackets may offer potential advantages in reducing treatment forces, their impact on subjective pain experience remains inconclusive, requiring further investigation.

Bond Failure Rate

Bracket failure impacts treatment efficiency by increasing patient visits and clinical time for repairs.

While some studies suggest higher failure rates for SL brackets(Miles et al. 2006))[15,] others indicate no significant differences when proper bonding techniques are used (Pandis et al. 2006)[16]. Operator familiarity with SL systems and bracket design characteristics may play crucial roles in mitigating bond failures.

Plaque Retention and Periodontal Health

Fixed orthodontic therapy, while effective for malocclusion correction, increases the risk of plaque accumulation and subsequent issues like white spot lesions, caries, and periodontal inflammation due to microbial imbalances caused by the appliance architecture A randomized clinical study by **Pellegrini et al. (2009)** revealed that the impact on the overall microbial ecosystem compared between self ligating and conventional brackets and long-term benefits remains unclear. [17,18,19]

- SLBs may reduce bacterial colonization in the short term compared to CBs with elastomeric ligatures.
- No consistent periodontal advantage of SLBs over CBs has been demonstrated in terms of plaque index, gingival health, or calculus accumulation.
- Pre-treatment microbial levels significantly influence post-treatment outcomes, highlighting the importance of maintaining good oral hygiene regardless of the bracket type.

Dental Arch Changes and Torque Expression

The debate surrounding extraction versus non-extraction and expansion versus non-expansion treatments has long persisted in orthodontics. The role of self-ligating brackets (SLBs) in influencing dental arch changes, torque expression, and non-extraction approaches is explored through various studies.

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Arch Development and Expansion

- **Expansion Feasibility**
  SLBs have been proposed to facilitate non-extraction treatments by enabling dental arch development, especially posterior expansion distal to the canines.
  - Expansion typically occurs through transverse widening and incisor proclination, both of which increase the arch perimeter.
  - Excessive proclination or marked intercanine expansion can be unstable, leading to relapse post-treatment.

Stability and Long-term Considerations

- Excessive proclination and intercanine expansion during treatment are associated with instability and relapse. Stability requires controlled expansion across premolars and molars with minimal incisor proclination. [20]

SLBs vs CBs: Both systems provide similar outcomes in torque delivery and arch alignment. Claims of greater physiologic expansion with SLBs require stronger evidence.

1. **Arch Expansion Mechanisms:** SLBs facilitate modest intermolar expansion but often through tipping rather than true basal movement.
2. **Stability Concerns:** Long-term retention issues persist, especially in cases of excessive expansion or proclination.
3. **Operator Control:** Preformed nickel-titanium archwires limit precise operator control over arch dimensions, influencing outcomes for both SLBs and CBs. [21,22]

While SLBs may offer slight mechanical differences, their long-term clinical advantages over CBs remain inconclusive. Controlled treatment planning and individualized approaches are essential for optimal outcomes.

Space Closure

The efficiency of self-ligating brackets (SLBs) compared to conventional brackets (CBs) in space closure during orthodontic treatment has been extensively investigated. Despite theoretical claims of SLBs' superiority, most high-level evidence shows no significant differences between the two systems in terms of space closure rates or treatment efficiency.

Treatment Efficiency and Chair Time

- SLBs potentially save time in **archwire ligation and untying**, which can reduce chair time.
- However, chair time savings do not equate to significant differences in overall treatment time or space closure rates. [23,24]

Apical Root Resorption (ARR) in Orthodontic Treatment

Apical root resorption (ARR), characterized by the blunting or shortening of the root apex, is a common side effect of orthodontic treatment. The maxillary and mandibular incisors, particularly the maxillary lateral incisors, are most susceptible to ARR. The role of self-ligating brackets (SLBs) in influencing ARR has been investigated, with varying findings and several potential influencing factors.[25]

Limitations of Self-Ligating Brackets

Self-ligating brackets are known for features such as full archwire engagement, low friction between the bracket and archwire, and quicker archwire removal and ligation. These benefits have been demonstrated and quantified in various studies.[26] However, there are some drawbacks to self-ligating brackets that may limit their widespread use.

Firstly, the clip design, which is intended to flex, may be more susceptible to breakage, permanent deformation, or unintentional opening or closing. This concern has not been formally investigated yet. Future studies comparing different self-ligating brackets within the same patient or randomly assigned to different patients are necessary to test these hypotheses.

Secondly, the higher profile of self-ligating brackets, resulting from their complex mechanical design, may lead to increased occlusal interferences and lip discomfort. Additionally, currently, available self-ligating brackets tend to be more expensive than high-quality tie-wing brackets. However, this extra cost needs to be weighed against time savings, which is a valuable commodity. If self-ligating brackets do indeed save a noticeable amount of chairside time, as some studies suggest, this could justify the additional expense

CONCLUSION

In summary, while SLBs may offer some mechanical efficiencies, their impact on treatment time and occlusal outcomes remains inconclusive and dependent on case-specific factors and study designs.

SLBs offer some mechanical advantages, their impact on ARR remains inconclusive. High-quality, prospective studies are needed to clarify their role in minimizing ARR.

Current evidence does not conclusively demonstrate superior occlusal outcomes with SLBs compared to CBs.

Current high-level evidence supports that **self-ligating brackets are not superior to conventional brackets** in terms of space closure rates or treatment efficiency. Their benefits may primarily lie in reducing chair-side procedures rather than improving clinical outcomes.

SL bracket systems are only a tool that we use today; therefore, Orthodontists should prioritize biologically friendly treatment protocols, focusing on optimizing force magnitude, treatment duration, and regular monitoring of root integrity.

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