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Beyond Elastics: A Dive into the Innovations of Self-Ligating Bracket Design

Zainab Alkhayat[1], Rasha Y Al-darzi[2]* and Niam Riyadh Saleem[3]

[1,2,3] College of Dentistry, University of Mosul, Mosul, 41002, IRAQ

*Corresponding Author: Rasha Y Al-darzi

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ABSTRACT: By eliminating ligatures and decreasing friction, self-ligating brackets provide a novel alternative to conventional orthodontic brackets. They are classified as active (e.g., SPEED) or passive (e.g., Damon), utilize clamps or slides to secure archwires, thereby improving patient comfort and efficiency. Since the 1930s, current designs have evolved to emphasize reduced friction, convenience for users, and enhanced cleanliness. Advantages encompass reduced chairside duration, fewer visits, and enhanced periodontal health, however disadvantages entail elevated expenditures and mechanical vulnerability. Their design concept prioritizes minimal pressures and physiological tooth movement, reinforced by characteristics such as accurate slot engagement. Nevertheless, issues such clip breakage and de-bonding concerns remain. The recycling of self-ligating brackets is impractical because of material deterioration. Notwithstanding their limitations, self-ligating brackets are increasingly favored for their therapeutic efficacy, but their cost-effectiveness is still a subject of contention. This study delineates their history, advantages, and obstacles, emphasizing their capacity to transform orthodontic practice.

Keywords: orthodontic brackets, self-ligating bracket, Damon system

1. INTRODUCTION

E.H. Angle invented Edgewise brackets in 1925, and the first ligature-free method was established by Stolzenberg in Brooklyn 10 years later, due to mistrust among the orthodontic community at that time and insufficient promotion, the technique did not become widely accepted, however, Self-Ligating Brackets (SLBs) were projected on a significant scale in the 1980s and afterwards adopted worldwide. These unique brackets are classified into two main types based on the approach of archwire retention where the bracket slot is located [1]. Active SLBs utilize a spring clip to exert force and secure the archwire in place. In-Ovation (GAC International, Central Islip, NY), SPEED (Strite Industries, Cambridge, Ontario, Canada), and Time (Adenta, Gilching/Munich, Germany) exemplify an active SLBs. While passive SLBs have a slide that does not impact the slot or apply force to the wire, Damon (Ormco, Glendora, Calif) and SmartClip (3M Unitek, Monvoria, Calif) are two well-known brands of passive form. SmartClip, unlike Damon, has a traditional bracket look and lacks a slide mechanism [2].

The contemporary orthodontic research state that SLBs offer numerous benefits, such as decreased friction, quicker archwire changes, complete engagement of the archwire within the slot, enhanced patient acceptance, comfort and hygiene, fewer emergencies, reduced emergency, diminished root resorption, lowered necessity for extractions due to arch extension, accelerated treatments, fewer appointments, enhanced outcomes, and improved efficiency [3].

SLBs possess disadvantages including heightened expense, risk for clip or slide fracture, higher profile resulting from intricate mechanical design, possible occlusal interferences and lip pain, as well as difficulties in achieving a refined finish due to inadequate arch-wire expression. Several (in-vitro) investigations have examined factors like frictional resistance and torque expression in self-ligating systems.19 Studies have demonstrated that SLBs cause less friction than traditional brackets in laboratory settings, resulting in the need for less force to move teeth [4] [5] [6] [7].

*Corresponding author: rasha-darzi@uomosul.edu.iq

Recently an advanced meta-analysis compared traditional brackets with SLBs, without differentiating between the major properties whether being active or passive SLBs. The authors revealed that self-ligated brackets as quicker to un-tie and ligate compared to traditional brackets.

No significant differences were observed in factors such as treatment duration, frequency of visits, alignment efficiency, closure of extraction sites, alterations in periodontal ligament conditions, root resorption, transverse dimensions, or occlusal results [8].

2. REVIEW OF LITERATURE

2.1 HISTORICAL BACKGROUND OF THE SELF-LIGATING SYSTEM, EVOLUTION OF SELF-LIGATING BRACKETS

The theory of a ligature less Edgewise bracket emerged in the 1930s when Dr. Jacob Stoltenberg, an orthodontic pioneer, created the first SLBs, Russell attachment, in1935 (Fig 1). In New York, this bracket features a screw with flat head structure located in a circular, threading aperture design its surface. Subsequently this arch wire change may aids orthodontists in a rapid and easy process. A screw driver resembling watch repair driver may be used to adjust the horizontal screw to achieve the significant tooth movement. Due to a lack of recognition, this design was practically totally vanished from the markets [9].

In 1972, Dr. Jim Wildman of Eugene, Oregon, created the Edge-Lok brackets, including a spherical form and more stiff labial sliding top (Fig. 2), the bracket slot became a four-wall tube once that vertical device was sealed up [10].

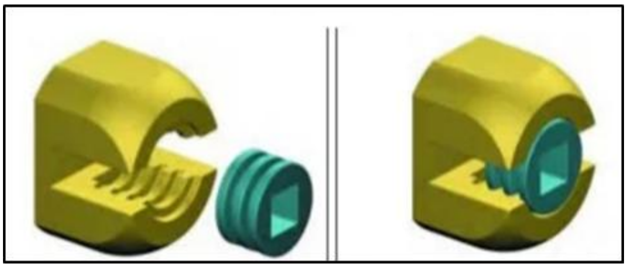

FIGURE 1. - Russell attachment

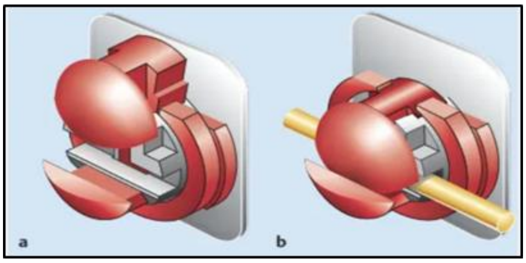

FIGURE 2. - Edge-Lok brackets

A comparable bracket discovered by Dr. Franz Sanders of Ulm, Germany, was subsequently existing within 2 years. A specialized tool was needed to spin the semi-circular labial disk far from any obstruction in the 1980 Mobil-lock. Similar to Edge-Lok, the passive type of bracket transforms the slot into a cylindrical shape which partially encapsulated the orthodontic arch wire. The Edge-lok and Mobil-lock (Fig. 3), did not acquire popularity, possibly due to the simultaneous appearance of elastomeric ligatures [11].

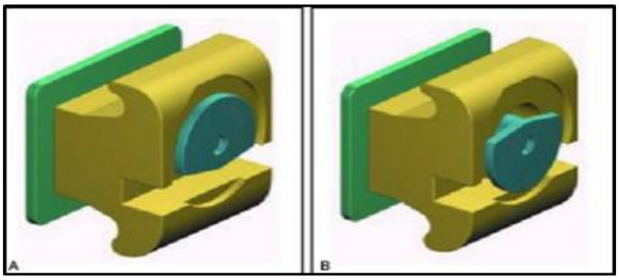

FIGURE 3. - Mobil-lock

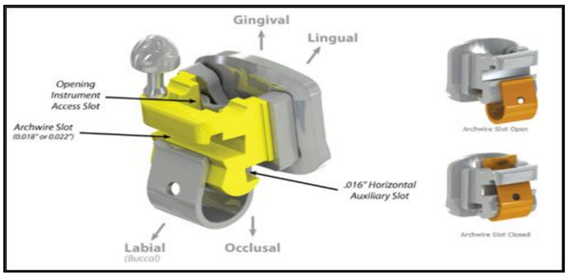

FIGURE 4. - Speed Bracket.

The Speed self-ligating bracket, invented by Hanson in 1975 [12] and manufactured by Strite Industries Ltd. in Ontario, Canada, a flexible stainless-steel spring is encountered, that constantly activates larger wires by pressing down on them in the slot. These days, a nickel titanium spring has mostly supplanted the stainless steel one in that bracket, making it one of the most popular options (Fig. 4). The "A" Company (Johnson & Johnson, San Diego, California) introduced the Activa brackets ten years later in 1986 designed by Dr. Erwin Pletcher. The curved, inflexible wall of those cylindrical brackets rotated in an occlusal-gingival direction, opening and closing the brackets, the passive structure of the Activa bracket, like the Edge-lok bracket, limits its interaction with the archwire (Fig. 5). Due to some drawbacks involving patient ease of opening and high mesio-distal bracket width, the bracket was subsequently discontinued commercially [13]. The Time brackets (made by American Orthodontics in Sheboygan, Wisconsin) were on the market in 1994 and these were conceived by Dr. Wolfgang Heiser of Innsbruck, Austria (Fig. 6). Although resembling the SPEED bracket, its construction and operation differ dramatically. A unique tool pivots the arm into the gingival direction to secure the open or closed position. The bracket's stiff arm prevents considerable contact with the orthodontic arch wire, making a passive bracket [14]. In 1998, Dr. Jim Wildman unveiled the Twin Lock bracket, his second venture. The slide is held in place between the tie wings of an Edgewise twin bracket after being occlusally pushed into the slot-open position with the help of a universal scaler and the archwire is ensnared in a passive position when it moves gingivally with finger pressure[11] [14].

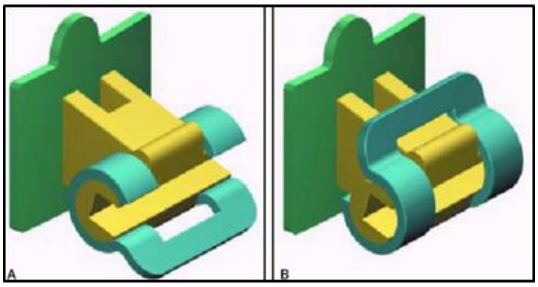

FIGURE 5. - Activa bracket

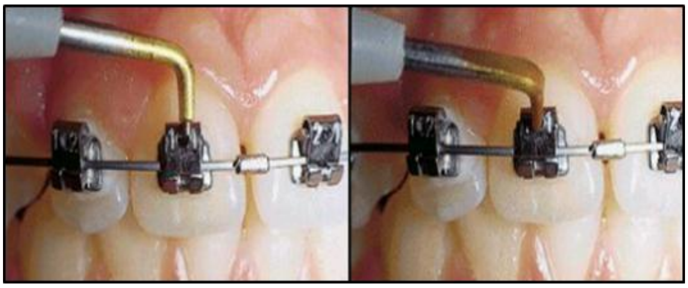

FIGURE 6. - Time brackets with the special tool

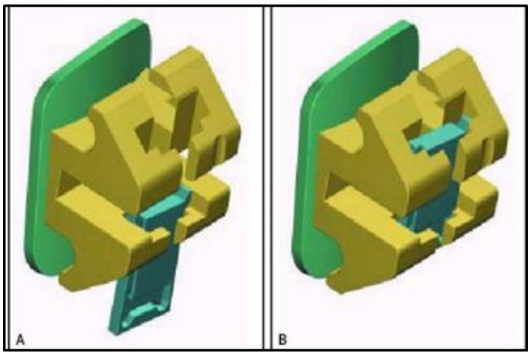

FIGURE 7. - Twin-Lock bracket

In the mid-1990s, another type of bracket with a wraparound slide across the labial face was introduced: Damon SL brackets. These brackets were made by the "A" Company in San Diego, CA. Underneath the slide, there was a little U-shaped wire spring that could be snapped into place at the two labial "bulges" to create open and close positions (Fig. 8). While these brackets were an improvement over their predecessors, they did have two major drawbacks: the slides may open accidentally and they were easily broken. Still, the admiration for self-ligation's potential skyrocketed once these brackets were installed [15].

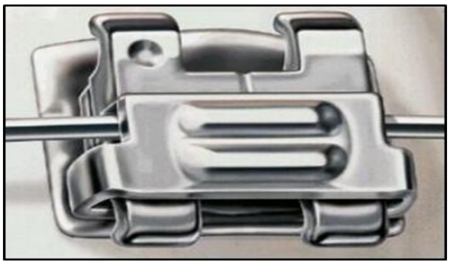

FIGURE 8. - Damon SL brackets

FIGURE9. - Damon 2 brackets

The Ormco Corp. released Damon 2 brackets in 2000, to fix the issues with Damon SL. Although they moved the slide to a protected location within the tie wings, The vertical sliding action and the U-shape spring that control the open and closing movement were preserved (Fig. 9).

These advancements nearly entirely eradicated accidental slide opening or slide breaking and accelerated the usage of self-ligation, especially when coupled by using metal injection molding production, so that it allows for finer tolerances. Nevertheless, the new user valued the ease of opening the brackets, and it was not instantly and consistently easy [15].

The Damon 3 (Fig. 10) and Damon 3 MX brackets, manufactured by Ormco Corp. in 2004, include a different area and activity of the holding spring, resulting in a straightforward design and a robust method for accessing and storing items. Furthermore, the Damon 3 brackets possess a semi-esthetic quality. However, it should be noted that the initial development of Damon 3 brackets faced three remarkable challenges: a notable occurrence of bonding failure, the dislodgement of metal site from the bonding resin components, and the occurrence of breakage of the wing tie.

The recently introduced Damon D3 MX bracket, equipped with all metal components, has evidently derived advantages from the manufacturing and clinical expertise gained from earlier Damon brackets.

FIGURE 10. - Damon 3 brackets

The GAC In-Ovation brackets are conceptually and operationally identical to the SPEED brackets, but they are designed in a twin configuration (Fig. 11). The design is commendable and strong, with no incidents of clip breaking either personally encountered or reported [16]. However, some minor drawbacks in brackets manipulation have been reported, Firstly, certain brackets are highly resistant to being opened. Because the gingival location of the spring clip is difficult to discern precisely in the mandibular arch, this phenomenon is characterized by its unpredictability.

The presence of an excessive amount of composite on the gingival surface of the lower brackets might may impede the closing process. Secondly, these brackets may inadvertently shut prior to positioning the archwire is in the right place. The downward path of closure increases the likelihood of this happening in the mandibular arch. Furthermore, the integrity of the flexible closing clips can be compromised by the usage of rectangular nickel-titanium wires, which may result in the clip opening spontaneously [17]. Lastly, if you find it difficult to remove a thicker archwire, you may find that you need to open the clip halfway before you realize you need to open it fully.

The In-Ovation R (Reduced) in 2002, smaller brackets were created for the front teeth. Their compact breadth greatly improved the space between the brackets. There is an active clip-on In-Ovation brackets. In-Ovation C (Ceramic) is often offered with a partly ceramic face that aims to enhance its aesthetic qualities [18].

FIGURE 11. - GAC In-Ovation brackets both R and C.

Oyster SLBs, introduced for the first time in 2003, transparent SLBs were made with a high-strength glass reinforced material (Fig. 12). polymer associated with the cap that can be emptied and reinserted plus a special mushroom hook designed for supplementary attachments [17] [18].

FIGURE 12. - Oyster SLBs

The Smart Clip™ SLBs (Fig. 13), introduced by 3M Unitek in 2004, these devices differ from its predecessors by lacking a slide or clip mechanism for wire retention [19]. The alternative is a specially designed tool from 3M Unitek-TM that allows the arch wire to pass through a NiTi slit on each side of the twin brackets that attach inside the wire. This process of implanting the arch wire requires the use of finger pressure.

FIGURE 13. - The Smart Clip™ SLBs

The polychromic self-ligating bracket Phantom was unveiled in June 2006 at the ESLO convention in Venice. After reshaping and filling any imperfections with flowable composite material, the brackets are attached directly within the mouth after the lingual surfaces of the teeth are aligned . Opal (Ultradent)- The Opal bracket is a passive bracket that came out in 2004. The gadget has a self-ligating lid mechanism and a single-piece, curved shape. A specialized tool is used to open the tooth from the incisal side.

As a result of their extraordinary elegance and gentleness on the soft tissues, the Opal brackets are highly visually pleasant. It can be positioned with reasonable ease and features very legible, well-defined markings. The phenomenon of bracket loss is frequently observed. Furthermore, accessing this bracket might be challenging and positioning elastomeric chains can be difficult, Because the bracket is susceptible to discoloration, it is important that a dental hygiene professional or another oral healthcare practitioner do the necessary cleaning procedures on the brackets [20].

Bio Quick LP, metal inoculation molding is used in its construction, which results in a one-piece architecture (Fig. 14). Either the gingival or the labial surface can be used to adjust this bracket using a device that has been precisely created. The challenges with these brackets are aesthetic; similarly, all metal bracket may not satisfy patients' most requirements [21].

FIGURE 14. - Bio Quick LP

Clarity SL (3M Unitek) (Fig. 15), the Clarity SL brackets, which were developed in 2007, are a ceramic-based inactive system. To improve its frictional qualities, this features a metal groove embedded into its ceramic base.

Self-ligating mechanism of the Smart Clip brackets consists mainly of a Ni-Ti groove that is affixed to mesial segment and distal segments. Specialized instruments are available for the insertion and taking out the archwires [22]. The ALIAS lingual straight wire appliance bracket system, which was developed by Takeyomoto and Scuzzu, is a recent advancement in SLBs (Fig. 16).

FIGURE 15. - Clarity SL (3M Unitek)

FIGURE 16. - ALIAS

This system includes the first in-active self-ligating lingual brackets with square holes, enabling improved mobility and increased inter-bracket distances thereby simplifying the alignment phase [23].

2.2 PHILOSOPHY OF THE SELF-LIGATING BRACKET SYSTEM

Usually, given the situation of crowded teeth in both upper and lower arches, numerous orthodontists would schedule extractions without hesitancy. Today, many orthodontists globally are recognizing the significant influence of the self-ligating bracket designing system that can exert on such cases. The self-ligating system philosophy comprises three principal fundamentals [24]:

•According to this theory, the major goal of face-based treatment planning should be to make use of the face's naturally adaptable mechanisms. The treatment plan is established by assessing the long-term effects on profile breadth and dental arch breadth, in addition to facial support. The therapeutic mechanisms must be engineered to avoid overwhelming the biological system. The teeth are positioned physiologically according to the orofacial structural skeleton and orofacial musculature .

• Light forces with utmost care, created pressures as a result of treatment that are sufficiently robust to stimulate cellular function without compromising the periodontium or orofacial muscle complex have been utilized. This approach aligns therapeutic mechanisms with the body's inherent low-force systems, signifying a change in thinking for several orthodontists. The Copper Niti wires have variable degrees of excellent reshape memory and flexibility. A distinctive feature of this wire is that its unloading trajectory diverges from its loading trajectory. This signifies that the exerted force diverges from the applied force required to begin it [25].

• The SLBs possess a four-walled construction, unlike the three-walled shape of a conventional readapted edgewise bracket. This minimizes friction, hence enhancing tooth movement [26].

2.3 ESSENTIAL FEATURES OF A SLBS

• An optimal self-ligation process must offer a scheme which is both efficient and protected while keeping the teeth's resistance to orthodontic movement in relation to the arch wire as low as possible. It needs to be strong and able to make sure that the bracket fully engages with the arch wire [27].

• The self-ligating bracket system must demonstrate low frictional resistance across the wire and the bracket hole, while simultaneously enabling a rapid and uncomplicated operational procedure [28].

• An elastic chain should be easily attachable, thereby facilitating good oral cleaning while ensuring patient comfort .

• It should facilitate the process of opening and closing brackets while applying the least amount of stress on the teeth possible, irrespective of the size or substance of the arch wire. It must not open inadvertently, that ended in an absence of dental integrity .

• It features an open clip or sliding position secured to avert interference of view or access to the bracket slot and the installation of the arch wire.

• It has to tolerate a significant quantity of composite material so that the clip and/or sliding technique does not become blocked .

• It must not to be substantially affected by the buildup of calculus .

• It should make it easy to fasten and remove appliance accessories like E-chains, tie-backs, and lace-back ligatures without damaging the self-ligating slide or clip .

• The performance should meet the expected standards regarding the precision of slot proportions, bond strength and contour smoothness [29] [30].

2.4 THE BENEFITS OF USING SLBS [31], [32]

• A reduction in sliding resistance results in a reduction in the total treatment time.

• With less time-consuming archwire modifications, chair side time is minimized.

• A precise control over the translation of the teeth.

• Because of its wingless shape, it is quite easy to clean patient-friendly in terms of both appearance and comfort

2.5 DRAWBACKS OF SLBS [31], [32]

1. Exorbitant expense.
2. The possibility of clip breakage.
3. Moreover, SLBs typically have reduced bases and horizontal dimensions that potentially leading to frequent debonding, especially posterior teeth.

2.6 RECYCLING OF SLBS

Spring clips may carbonize, causes brittle cracks. Normally, it is not prescribed.

3. CONCLUSION

This assessment shows a feature common to certain self-ligating systems that are likely to supplant conventional ligating systems in the near future. Concurrently, they are quite expensive, which might be juxtaposed with the considerable clinical time they conserve.

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Acknowledgements and Reference heading should be left justified, bold, with the first letter capitalized but have no numbers. Text below continues as normal.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

REFERENCES

[1] J. Stolzenberg, "The Russell attachment and its improved advantages," Int. J. Orthod. Dent. Child., vol. 21, no. 9, pp. 837–840, 1935.
[2] D. H. Damon, "The rationale, evolution, and clinical application of the self-ligating bracket," Clin. Orthod. Res., vol. 1, pp. 52–61, 1998.
[3] M. Balteau, F. Lefebvre, D. Kanter, D. Wagner, and Y. Bolender, "Diagnosis and treatment procedures in French orthodontic practices," J. Clin. Orthod., vol. 55, pp. 83–100, 2021.
[4] H. S. Griffiths, M. Sherriff, and A. J. Ireland, "Resistance to sliding with three types of elastomeric modules," Am. J. Orthod. Dentofacial Orthop., vol. 127, pp. 670–675, 2005.
[5] T. K. Kim, K. D. Kim, and S. H. Baek, "Comparison of frictional forces during initial leveling using various self-ligating brackets and archwires," Am. J. Orthod. Dentofacial Orthop., vol. 133, p. 187, 2008.
[6] T. T. Lai et al., "Perceived pain in orthodontic patients with conventional or self-ligating brackets," J. Formos. Med. Assoc., vol. 119, pp. 282–289, 2020.
[7] L. Pizzoni, G. Ravnholt, and B. Melsen, "Frictional forces related to self-ligating brackets," Eur. J. Orthod., vol. 20, pp. 283–291, 1998.
[8] D. Wagner et al., "Are self-ligating brackets more efficient than conventional brackets? A meta-analysis," Orthod. Fr., vol. 91, pp. 303–321, 2020.
[9] N. Harradine, "The history and development of self-ligating brackets," Semin. Orthod., vol. 14, no. 1, pp. 5–18, 2008.
[10] D. J. Rinchuse and P. G. Miles, "Self-ligating brackets: Present and future," Am. J. Orthod. Dentofacial Orthop., vol. 132, no. 2, pp. 216–222, 2007.
[11] N. W. T. Harradine and D. J. Birnie, "The clinical use of the Activa self-ligating bracket," Am. J. Orthod. Dentofacial Orthop., vol. 109, pp. 319–328, 1996.
[12] G. H. Hanson, "The SPEED system: Development of a new edgewise appliance," Am. J. Orthod., vol. 78, no. 3, pp. 243–265, 1980.
[13] L. Q. Closs et al., "Self-ligating brackets: Literature review," Rev. Clín. Ortod. Dental Press, vol. 4, no. 2, pp. 60–66, 2005.
[14] W. Heiser, "A new orthodontic philosophy," J. Clin. Orthod., vol. 35, pp. 44–53, 1998.
[15] Y. Mao, J. Mu, and H. Dai, "Classification, characteristics, and clinical applications of self-ligating brackets," Med. Aesthetics Beauty, vol. 5, p. 676, 2014.
[16] D. H. Damon, "The Damon low-friction bracket," J. Clin. Orthod., vol. 32, pp. 670–680, 1998.
[17] S. Geron, "Self-ligating brackets in lingual orthodontics," Semin. Orthod., vol. 14, no. 1, pp. 64–72, 2008.
[18] H. Trevisi and F. Bergstrand, "The SmartClip self-ligating appliance system," Semin. Orthod., vol. 14, pp. 87–100, 2008.
[19] F. K. Byloff and J. Berger, "The clinical efficiency of self-ligated brackets," J. Clin. Orthod., vol. 35, pp. 304–308, 2001.
[20] X. Ren et al., "Torque expression by active and passive self-ligating brackets," Orthod. Craniofacial Res., vol. 23, pp. 509–516, 2020.
[21] M. F. Sfondrini et al., "Reconditioning of self-ligating brackets," Angle Orthod., vol. 82, no. 1, pp. 158–164, 2012.
[22] G. Scuzzo et al., "A new self-ligating lingual bracket with square slots," J. Clin. Orthod., vol. 45, pp. 682–690, 2011.
[23] P. Nambiar, R. Kamble, and K. Nambiar, "An elaborate review on self-ligating bracket systems," J. Res. Med. Dent. Sci., vol. 10, no. 8, pp. 197–202, 2022.
[24] A. Verulkar et al., "Awareness of orthodontic treatment appliances," J. Datta Meghe Inst. Med. Sci. Univ., vol. 15, p. 347, 2020.

[25] W. R. Proffit, H. W. Fields Jr., and D. M. Sarver, Contemporary Orthodontics, 5th ed. India: Elsevier, 2012.
[26] F. J. Willeit et al., "Stability of transverse dental arch dimension with passive self-ligating brackets," Prog. Orthod., vol. 23, p. 19, 2022.
[27] L. W. Graber, R. L. Vanarsdall, and K. W. Vig, Orthodontics: Current Principles and Techniques. St. Louis, MO, USA: Elsevier, 2022.
[28] H. M. Al-Ibrahim et al., "Leveling and alignment time using corticotomy-assisted self-ligating brackets," J. World Fed. Orthod., vol. 11, pp. 3–11, 2022.
[29] B. Khambay, D. Millett, and S. McHugh, "Evaluation of archwire ligation methods," Eur. J. Orthod., vol. 26, pp. 327–332, 2004.
[30] R. Maijer and D. C. Smith, "Time saving with self-ligating brackets," J. Clin. Orthod., vol. 24, pp. 29–33, 1990.
[31] H. Türkkahraman et al., "Archwire ligation techniques and periodontal status," Angle Orthod., vol. 75, pp. 231–236, 2005.
[32] P. S. Fleming, A. T. DiBiase, and R. T. Lee, "Self-ligating appliances: Evolution or revolution?" Aust. Orthod. J., vol. 24, p. 41, 2008.