Self-ligating brackets are not a new concept in orthodontics – they were invented in the early 1930s by Stolzenberg [1, 2] as Russel’s attachments. Their main advantage was supposed to be a more efficient archwire insertion and therefore chair-side time reduction. Due to skepticism by orthodontists and lack of promotion, self-ligating brackets did not become popular and were overshadowed by traditional brackets. Nevertheless, over the last few decades it has once again become believed that self-ligating brackets have advantages over traditional ones. Due to this fact, many companies had tried to introduce their brackets, but only some of them have become commercially available [3].

The revival of interest in self-ligating brackets came in the early 2000s, when Keim said that the key ideas for the future development of orthodontics were 3D imaging, self-ligating systems and temporary skeletal anchorage. Since that time, the development of self-ligating brackets has gained steam, which has resulted in the invention of thirteen types of brackets, which in turn have improved their sales [3]. The commercial effect has undoubtedly been supported by clinical theories regarding not only the reduction of friction in the slot, but also shorter chair-side time or total treatment time. Other theories have spoken of the widening effect of the appliance, a smaller tendency for root resorption, easier hygiene maintenance and wider acceptance by patients [2]. The goal of this study is an analysis of the articles which will allow for an objective verification of the potential benefits of self-ligating systems.
Evaluating Features

Friction

The goal of inventing self-ligating brackets was to eliminate ligating ties, which would create a friction-free background. Uninhibited movement of the archwire in the inflexible slot allowed for more effective sliding, which resulted in biologically accepted reduction of forces and their momentum [4, 5]. This idea aroused the interest of clinicians and intense research comparing self-ligating and traditional brackets had begun – the point of which was the reduction of friction. A systematic review by Chen et al. [1] proved that such a reduction is often observed in the case of self-ligating brackets. Furthermore, many authors [3, 6] stated significantly lower friction in self-ligating brackets when using either NiTi or steel wires. Based on these results, Damon [7] determined that thanks to the reduction in friction, the orthodontic forces on the arch are lower, which allows for more physiological movement of teeth without straining the muscles or periodontal vessels. Damon [7] found opponents to his statement. According to Franchi et al. [8] as well as Petersen et al. [9], the lower friction from self-ligating brackets causes greater force on the archwire in comparison to conventional brackets.

They came to this conclusion by measuring forces at the tooth leveling stage. Furthermore, Lotfus et al. [10], who compared friction in Damon brackets to conventional brackets in vivo, didn’t find any significant difference, therefore contradicting Damon as well, but in a different way.

The theoretical reduction of friction in self-ligating brackets allows for faster space closure in cases required extraction. This theory was debunked by research conducted by Scott et al. [11] and Miles et al. [12] who did not observe any advantage of self-ligating brackets over traditional ones. They observed similar tooth movement times regardless of which of the two bracket systems were used.

Further studies regarding friction required more accurate analysis of the behavior of the archwire in self-ligating bracket slots which contained 4 walls: two horizontal – occlusal and gum, one vertical, and one buccal. The latter of these walls can have different forms – a movable flap or a clip. Depending on the construction of the bracket, self-ligating brackets can be divided into two groups – active and passive, the key determining division being the construction of the slot and the buccal wall [13].

One of the characteristics of self-ligating brackets is the slot, which becomes shallower on the vertical plane from the occlusal edge towards the gingival edge. This is caused by the difference in the horizontal bracket’s walls: the gingival wall is shallower than the occlusal wall. For example, the In-Ovation® bracket’s horizontal gingival wall is 0.195 inches and the occlusal wall is 0.285 inches.

Active brackets are equipped with a spring based clip which, pushing on the archwire, allows for all the values built in the bracket to be expressed; it helps to control rotation and torque.

All values built into the bracket may be expressed without the necessity of applying a full-sized archwire [2]. Pushing the clap on the archwire generates friction and forces action of the archwire toward the buccal or labial directions, which helps in leveling the teeth. According to Chen et al. [1] and Harradine et al. [14] active brackets have an advantage over passive ones due to the presence of friction at the early stages of leveling the teeth, especially when tooth rotation is supposed to occur. Examples of active brackets are: In-Ovation® (GAC International, Central Islip, NY), SPEED® (Strite Industries, Cambridge, Ontario, Canada), Time® (Adenta, Gilching/Munich, Germany) and Quick® (Forestadent) [2, 14].

In passive brackets, the horizontal walls (gingival and occlusal) have the same dimensions. The buccal wall is usually equipped with a slide clip, which doesn’t enter inside the slot and doesn’t decrease it’s diameter after closure. The slide clip doesn’t push the archwire in the slot – thus allowing for it’s uninhibited movement which results in lesser friction in comparison to active brackets [15]. This is however, controversial. It cannot be said that the bracket is passive from the beginning of treatment. The slot can be passive only when the teeth are properly aligned in all three dimensions, so that they express correct angulation and torque, and the full-sized archwire doesn’t have contact with the walls of the slot [2]. This has been evidenced by Brauchlia et al. [16] who compared the in vitro action of passive and active self-ligating brackets, as well as conventional brackets. The authors didn’t notice any significant difference in the action of non full-sized archwires in active and passive brackets until the teeth had been fully leveled. Friction decreased in the passive brackets in later stages. On the other hand, according to Henao et al. [17], the friction in passive brackets is minor in the early stages of treatment, which allows for more effective tooth movement along the archwire. Nevertheless, the price that must be paid for this free movement of the teeth is worse movement control in the palato-labial direction as well as rotation in comparison to active brackets. Examples of brackets with active slots are: Damon® (Ormco, Glendora, Calif), SmartClip® (3M Unitek, Monvoria, Calif) and Carriere® (Class One).
Shorter Chair-side Time and Treatment Time

Voudouris [18] had approximately four times shorter chair-side time when using self-ligating brackets in comparison with conventional ones. In cross-sectional studies [19, 20] it has been observed that in the case of one archwire, it takes approximately 20 seconds less time to perform ligature removal on tradition brackets, but this difference is not statistically significant. Nevertheless, a systematic review performed by Fleming and Joshi [21] has proved clearly that the advantage of self-ligating brackets is shorter chair-side time thanks to an opening and closing mechanism allowing for quicker archwire removal and insertion. Since the shorter chair-side time had been proven, many authors have tried to compare total treatment times depending on bracket type: conventional and self-ligating. Researchers have conveyed total treatment time abridgment of about 4–7 months, based on the assumption that less friction, lesser forces and more physiological tooth movement provide shorter treatment time. The number of appointments could be limited to 4 to 7 [4, 19, 22] as well as their frequency reduced [5]. The authors also emphasized that archwire removal and insertion does not require the help of an assistant, which results in a more ergonomic work environment [4]. Nevertheless, assessment of real total treatment abridgement with the usage of self-ligating brackets has not been accomplished with a systematic review.

Dental Arch Expansion

Another feature of self-ligating brackets is better action during crowded leveling. They help to expand dental arches in cases that are on the border between extraction and non-extraction treatment [4]. On the basis of the comparison of the actions of passive and active slots, it is known that it is possible not due to free archwire movement in the slot, but due to pressure of the clip toward the archwire in the slot of an active bracket. Moreover, in contrast to most traditional brackets, self-ligating brackets have narrower bases, so the spans of the archwire between brackets are longer and the contact between the bracket and the archwire in the slot is shorter. Due to the fact that the force released by an archwire is inversely proportionate to its length, a smaller contact between the slot and the archwire generates lesser forces, [4] and a longer span between adjacent brackets makes the archwire more flexible and gives it more scope of work [23]. Both of these physical qualities can be the reason for better tooth leveling at the early stages of treatment [4]. Unfortunately, this concept has not been proven in in vivo studies. Miles [24] and Ong et al. [25] compared the rate of tooth leveling in self-ligating and traditional brackets and were unable to prove any advantages in one type over another in elimination of crowding or expansion of the dental arch. The effectiveness of traditional brackets, regardless of the type of ligatures (elastic or wire), was similar after 20 weeks of treatment. It has been rightly observed by the authors that most of the studies about friction of self-ligating brackets are performed in vitro, and the oral background and muscles are not considered despite the fact that they can increase the friction.

Expansion of the dental arches generates better conditions for minor tooth proclination; therefore indicators for extraction may be restricted. This has not been proven in studies by Pandis et al. [26] and Fleming et al. [27], who achieved the same proclination of the upper and lower teeth and same inter-canine dimension regardless of the appliance used. However, randomized research [11] and a systematic review performed by Chen et al. [1] have proven that proclination of the incisors was about 1.5 mm less in self-ligating brackets in comparison to traditional ones due to the advantage of transverse forces over sagittal ones. Space on an alveolar may be created by the widening of the circuit of the dental arch rather than by its elongation. This theory has been proven by Fleming et al. [27] and Pandis et al. [28], who reported greater dental arch expansion of the level of molars in self-ligating bracket in comparison to traditional ones.

Minor Tendency for Root Resorption

Contrary to expectations, there is no unequivocal evidence confirming minor root resorption after treatment with self-ligating brackets. Pandis et al. [29] found no statistical significance in root resorption in comparative studies. Moreover, Scott et al. [11] reported larger root resorption when using Damon’s brackets than in conventional brackets – 2.26 in the former versus 1.21 in the latter.

Easier Intra-oral Hygiene

In theory, smaller brackets dimensions and less retention spaces (such as the ends of metal ligatures and elastic ligatures) may provide easier hygiene maintenance. Pellegrini et al. [30] proved in retrospective studies a lower level of Streptococcus in the presence of self-ligating brackets, however Pandis et al. [31] did not find any correlation between
the type of brackets and the level of the bacteria – the evaluation of the accumulation of plaque, calculus and gingivitis in 50 patients wearing conventional brackets and 50 patients wearing self-ligating brackets during an 18-month treatment period showed no difference in the mentioned indexes in either groups. In turn, Fortini et al. [32] claim that the hygiene around the brackets is impeded regardless of its type and it should be conceded that controversy about this is still ongoing.

Better Patient Tolerance

There are reports about better toleration of self-ligating brackets by patients. However, there is no systematic review confirming this, which may lead to mistaken conclusions [2, 25]. The feeling of less discomfort should be considered as subjective and not an evidence-based symptom [19, 22, 33].

Conclusions

The disadvantages of self-ligating brackets, such as the high cost, the possibility of clap damage, and higher vestibule dimensions causing the possibility of mucosa irritation or occlusal obstruction are obvious [13]. In addition, self-ligating brackets usually have smaller bases and transverse dimensions, what may be the reason for frequent debonding – in particular on premolars and molars [34]. Moreover, self-ligating brackets with passive slots may be an impediment in the finishing stage [1, 32, 35, 36].

Lower friction, bio-compatible forces, and better tooth leveling in the early stages are features unduly attributed to self-ligating brackets.

According to the reports cited in the above-presented literary review, forces when using self-ligating brackets at early stages of treatment may be larger than in traditional brackets. Moreover, leveling of the teeth proceeds at the same rate regardless of the type of brackets.

If the only indisputable and evidence-based advantages of self-ligating brackets are shorter chair-side time and proclination control of the lower incisors, then Stolzenberg's original suggestions, which were reduction of chair-side time and the possibility of decreasing the proclination of the lower incisors by 1.5 degrees, should be used as a guide when deciding whether to use self-ligating brackets or traditional ones. Any other advantages of these brackets should be considered as marketing hype and requiring further evidence.

References


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