Self-Ligating Brackets in Orthodontics

Current Concepts and Techniques

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Thieme

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Foreword

Since the early beginning of orthodontics, clinicians have progressively produced modifications and enhancements to improve force delivery of the appliances and clinician's efficiency. Major advances since the last century included the development by Dr. Angle of the Edgewise appliance, the introduction of enamel direct and indirect bonding techniques, the advent of the Preadjusted Straight Wire appliances and the development of fully customized Lingual Appliances (IBraces or Incognito). In the last 10 years, self-ligating appliances have captured the imagination of many clinicians and are increasing in popularity. Those brackets have been developed to overcome the limitations of stainless steel and elastomeric ligatures in terms of ergonomics, efficiency, plastic deformation, discoloration, plaque accumulation, and friction.

A self-ligating bracket is a ligature-less system with a mechanical device built in to close off the edgewise slot. Secure engagement may be produced by a built-in clip mechanism replacing the stainless steel or elastomeric ligature. Both active and passive self-ligating brackets have been manufactured, referring to the bracket/archwire interaction. The active type has a spring clip that presses against the archwire. In the passive type, the clip or rigid door does not actively press against the archwire. Active self-ligating appliances may allow better torque control with undersize archwires than can be achieved with passive appliances; a spring clip might also enhance the potential for bucco-lingual alignment. The resistance to sliding is thought to be lower for passive appliances, however, which may improve the aligning capability of these systems. Self-ligating systems outperform conventional brackets in the in-vitro situation, producing considerably less friction within the appliance systems, but this effect is less marked in-vivo. Clinical data documenting the efficiency of rotational correction and space closure with self-ligating systems remain limited. Use of self-ligating brackets results in a marginal reduction in chairtime required for appliance manipulation. Also, there is limited, retrospective evidence pointing to reduced overall treatment time with fewer scheduled appointments with the use of self-ligating systems.

While many clinicians recommend selected self-ligating appliances to facilitate expansion in non-extraction treatment, there are no published long-term follow-up studies on the stability of this approach.

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Preface

Self-ligating brackets—in recent years these words have taken on almost unbelievable magic powers. It is now almost impossible to envisage orthodontic treatment without such brackets. Keywords supporting this idea are: greater user comfort; better differentiation from competitors; more marketing possibilities, economical, shorter chair times, easy-to-use, patient comfort, perfect for your patients, and so on. The conclusion is: everything works easier and quicker. Sometimes the phrase "intelligent system" is used. Somewhat exaggerated, it seems as if the bracket at last can inform the tooth who is now in charge of moving from the false to the correct position. And the tooth? It follows the new brackets obediently, friction-free, and at a breathtaking pace.

By putting this rather ironic text at the front of a specialist book, the authors attempt to make it clear that they are attempting to replace suggestive remarks with facts and to be critical about advertising slogans. All the authors have been working with self-ligating brackets for a long time and will be presenting their investigations and experiences accordingly in this book.

Sometimes it may seem that self-ligating (SL) brackets are a recent invention. This is not the case. The first experiments with brackets that fixed the wire into the slot date back to the 1930s. The era of modern SL brackets began with Speed Brackets around 1980. For almost two further decades the SL brackets existed in the background. The growing number of systems and concepts from recent years is difficult to explain. The explosive growth in popularity became quite uncontrolled, and this book will try to clear the undergrowth as it were.

There have been many publications on this topic during recent years. A lot of experience has been gained regarding friction and treatment times as well as the requirements for clinical use and treatment possibilities. The aim of the authors is to summarize existing knowledge and to complement it with their own experiences and study results, in order to provide readers with an overview of SL brackets that is as comprehensive as can be. Following a chapter on the history of SL brackets, the first part of the book presents aspects dealing with material and techniques, including the evaluation of selected systems. The second part of the book is dedicated to clinical practice. Here also the authors have tried to demonstrate the complexity of the topic from the first to the final treatment steps. Statements are illustrated using numerous case studies. The conclusion drawn from this section could be: SL brackets are and will remain interesting tools, if they are properly used. They are just one of the many therapeutic choices in the hands of a doctor, and not a "magic pill."

This book is intended to be both a guide and a compendium, teaching beginners how to use this method, helping advanced users to detect sources of errors, and encouraging readers to go in a new, creative direction.

The authors thank everyone who played a part in completing the manuscript by giving advice and help, whether directly or indirectly, and those who motivated us to invest a great amount of work to reach our goal. Without this help the project would not have been realized so quickly. Our special thanks go to the Editorial Department of Thieme Publishers in Stuttgart for their excellent cooperation and the way in which they were able to turn our not always simple ideas into reality.

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I Basics

The Development and History of Fixed Appliances

Franziska Bock

1

For many centuries, in many regions and cultures of the world, attempts have been made to correct malocclusions caused by malaligned teeth, skeletal discrepancies of the jaws, or a combination of the two. The Habsburg dynasty, for example—one of Europe's most powerful reigning families—shaped Europe politically, but there was one thing that, despite all their wealth and influence, they were powerless against: the male Habsburgs, regardless of whether they had been crowned or not, were unable to overcome their class III malocclusion. Throughout the history of dentistry, the profession was well aware of malocclusions and sought ways to treat them. Pierre Fauchard, for example, dedicated an entire chapter of his 1728 textbook—the first dental textbook ever written—to the correction of malocclusions.

Fauchard's text is the first description in the literature of the use of fixed appliances. The fixed appliance he described was quite simple by today's standards and consisted of gold bands and either silk ties or metal wires that were attached to a misaligned tooth and the neighboring teeth.[29] Many other authors have since described a large number of fixed appliances that used bands. Other appliances featuring very varied designs and adjuncts, such as wooden wedges, special ligatures, as well as "caps" or crowns, were also used to treat poorly aligned teeth.[22] Further refining treatment mechanics, some orthodontists also used developments that were originally described by engineers; Carabelli (1842) developed a number of appliances in this way. He is also known as the first orthodontist who fitted appliances not directly on the patient but used plaster models of fixed appliances, which allowed him to manufacture the fixed appliances in the laboratory.[22] Whilst most of the above-mentioned appliances were only suitable for treating specific malocclusions, Edward H. Angle was the first orthodontist to develop a 'standardized' fixed appliance. Angle not only established orthodontics as the first dental specialty, but also developed and categorized malocclusions, and his classification is still in use today. The appliances he developed were intended to be suitable for treating the types of malocclusion he identified. The expansion arch (E-arch, 1887) consisted of a band that was activated with a screw and an arch with a threaded end, which was fitted into a tube and tightened using a screw nut. The arch itself was then connected by ligatures to the individual teeth in order to align them.

NOTE

The ribbon arch developed by Angle in 1916 was the starting point for the development of bracket systems whicht are still in use today.

In 1910, Angle developed the 'pin-and-tube' appliance in which small pins were soldered to the arch and then inserted into vertical tubes. Further development of the appliance utilising bands with vertical slots, also known as the ribbon arch appliance (Angle 1916), allowed three-dimensional control of tooth movement. This was the first fixed appliance that used a rectangular slot in a bracket, which was then soldered to a band. The ribbon arch appliance marked the birth of modern orthodontics; all of today's fixed appliances are derived from it.[23] Subsequent improvements on the concept by Angle led to the invention of the 'Edgewise' appliance in 1928. This was another milestone, as a change in the archwire dimensions (turning the wire on its 'edge') allowed controlled expression of torque, tip, and rotation.[23,24] All later developments of fixed appliances copied these early developments in bracket design, eventually leading to contemporary fixed appliance designs in terms of slot shape, size, and position, the number of slots, the contour of the bracket and its base, as well as the mechanism for ligating the archwire to the bracket.[18] Advances in the manufacture of brackets were another (often underestimated) factor involved in further developments. With the invention of metal injection molding, it became possible to produce very complex bracket shapes of an extremely high level of precision and in large quantities, making it easy to incorporate precise values for torque, tip, and angulation in the bracket.[16] In addition, the manufacturing technique allows smaller and flatter bracket designs.

Development of Self-Ligating Bracket Systems

The technique today uses metal or elastomeric ligatures to attach an archwire to a bracket. Ligating the archwire to the bracket slot in this way can be quite time-consuming, particularly when metal ligatures are used, and this is why self-ligating brackets were first developed. The earliest examples (all developed in the United States) date back to the 1930s.

NOTE

The term "self-ligating bracket" (SL bracket) is used for brackets that incorporate a locking mechanism (such as a ring, spring, or door mechanism) that holds the archwire in the bracket slot.

There are essentially two main types of self-ligating bracket, depending on the design of the locking mechanism, the dimensions of the slot, and the dimensions of the archwires: active brackets and passive brackets. In passive systems (such as the Damon System, Ormco Corporation, Orange, California; and Discovery SL, Dentaurum Ltd., Ispringen, Germany), the slot is locked or shut with a rigid locking mechanism. Once it is engaged, the bracket is effectively turned into a tube, ideally allowing archwires to slide freely within the tube. In active systems (such as Quick, Forestadent Ltd., Pforzheim, Germany; and

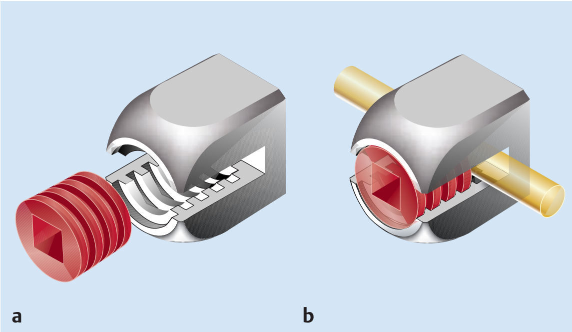

Fig. 1.1 a, b Russell attachment (1935)
a Open.
b Closed.

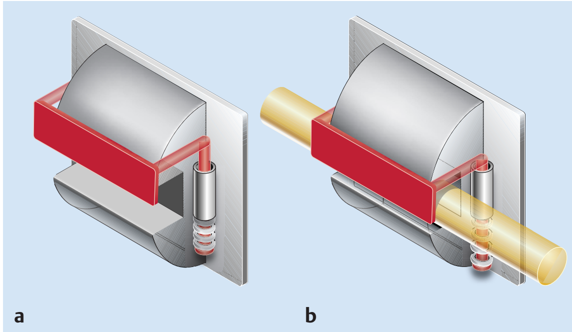

Fig. 1.2 a, b Boyd bracket (1933)
a Archwire slot open.
b Archwire slot closed.

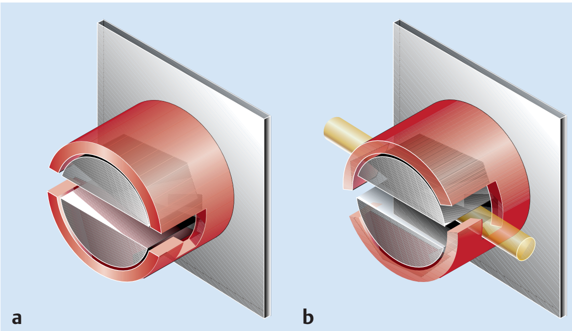

Fig. 1.3 a, b Ford bracket (1933)
a Slot open.
b Slot closed.

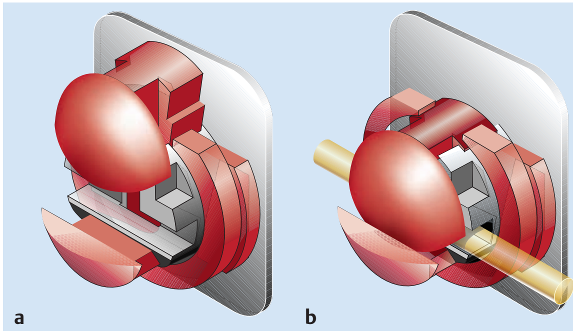

Fig. 1.4 a, b EdgeLok bracket (**a**). The bracket slot is closed with a sliding mechanism (**b**)

SPEED, Strite Industries, Cambridge, Ontario, Canada), the locking mechanism generally consists of a flexible but resilient clip that can actively engage wire into the bracket slot once the archwire reaches a certain size or deflection.[26]

Stolzenberg invented the Russell attachment in 1935 and is one of the pioneers of self-ligating brackets (**Fig. 1.1**).[5,12,25] Although Boyd (1933) (**Fig. 1.2**) and Ford (1933) (**Fig. 1.3**) developed passive, ligature-free systems earlier, these were never widely used.[10] Other designs were patented, but only very few of them eventually became commercially available.

It was not until the 1970s that interest in the development of self-ligating brackets resurfaced. In 1972, Wildman introduced the passive EdgeLok bracket,[10,12,30] which in its earlier incarnations had a round bracket body as well as a labial sliding door (**Figs. 1.4** and **1.5**). This was the first self-ligating bracket to become widely available commercially, but it was eventually taken out of production as more advanced systems appeared. At about the same time (1973), the Mobil-Lock bracket (**Fig. 1.6**) was introduced by Sander.[27] This was the first self-ligating twin bracket that had a variable slot. Due to the eccentric movement of the locking system, the wire could either be locked tightly into the bracket or, with proper adjustment, achieve partial ligation, which was designed to allow the wire to glide freely through the slot.[20] These were all passive systems, and none of them are still in use today, as they have been superseded by newer and improved designs.

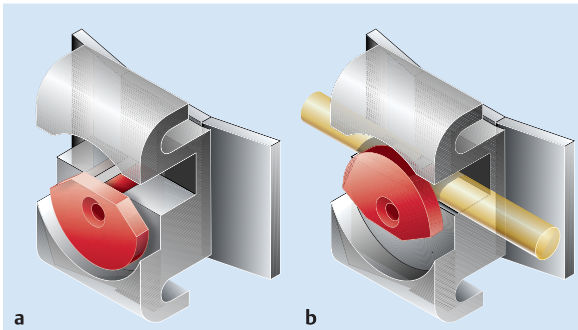

Fig. 1.5 a, b EdgeLok bracket
a Slot open.
b Slot closed.

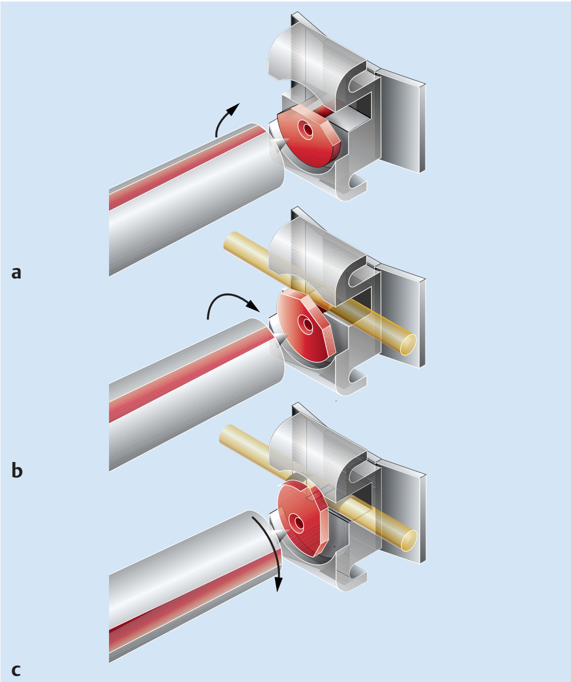

Fig. 1.6a–c Mobil-Lock bracket
a Open.
b Closed—sliding.
c Closed—locked.

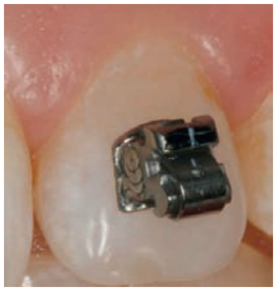

Fig. 1.7 The Speed bracket was the first active self-ligating bracket. (Reproduced with permission from Bock et al.[2])

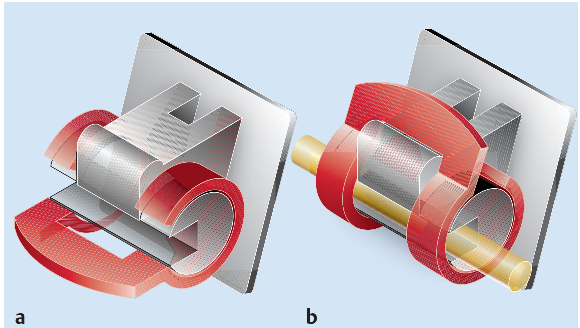

Fig. 1.8a, b Activa bracket
a Slot open.
b Slot closed.

The 1980s

In the 1980s, Hanson developed a completely new approach to self-ligation: the SPEED bracket (**Fig. 1.7**). This was the first active self-ligating bracket. The locking mechanism is formed by a flexible clip.[5,9,12] This bracket is still in use today, but has undergone significant modifications during the past 20 years of clinical experience. As mentioned earlier in the text, changes in bracket manufacture techniques have had a significant impact on the bracket design. For example, the locking mechanism, the resilient spring had originally been made from stainless steel, but this has recently been replaced with nickel–titanium (NiTi).

NOTE

The SPEED bracket was quickly accepted in clinical practice and is still in use today.

Following the clinical acceptance and commercial success of the SPEED bracket, further self-ligating systems were developed in quick succession. Since the 1980s, a number of very different designs for self-ligating brackets have entered the market and Plechtner introduced the Activa bracket in 1986 (**Fig. 1.8**).[5,12] This passive system consisted of a mechanism that rotated around the body of the bracket and locked in an occlusogingival direction; this rotating “door” closes and opens the slot.[10]

The 1990s

In the 1990s, Heiser developed the Time bracket (**Fig. 1.9**), which is also an active system.[12] A hinging movement opens the locking mechanism in the direction of the gingiva. The Flair bracket (**Fig. 1.10**), which has been commercially available since 2005, is a further development of the Time bracket. It is significantly smaller than the Time bracket and has different in–out values and an improved locking mechanism.

Wildman also carried out further development of the EdgeLok bracket. Maintaining the concept of the vertical sliding door on the labial side, he introduced the TwinLock bracket in 1998 (**Fig. 1.11**). In this twin bracket, the flat, rectangular door sits between the two tie-wings.[12]

Another self-ligating bracket with a vertical mechanism was developed by Dwight Damon and first introduced in 1999 (**Fig. 1.12**). The Damon 2 bracket was developed later using a different locking mechanism.[5,12] Like the TwinLock bracket, it uses a rectangular sliding door mechanism between the wings of the bracket (**Fig. 1.13**). The Damon system was marketed very successfully in combination with a treatment philosophy that is mainly based on a nonextraction approach. Particular archwire sizes, shapes, dimensions, and materials are all part of the concept. To further develop and satisfy the demand for an esthetic self-ligating bracket, the Damon 3 bracket was introduced in 2004. The bracket consists of a tooth-colored acrylic base material (**Fig. 1.14**) but the locking mechanism remained.

A hybrid between a conventional twin bracket and a SPEED bracket, known as the In-Ovation bracket, was developed by Voudouris in 1997.[5,12,19] An improved design has been available since 2002, marketed as In-Ovation R (**Fig. 1.15**). An esthetic version of this system (In-Ovation C) was introduced in 2007 in the form of a ceramic bracket, in which the metal clip has been produced in such a way that it is matt in appearance and thus does not reflect light as much as a polished surface would (**Fig. 1.16**).

Fig. 1.9 The Time bracket. (Reproduced with permission from Bock et al.[2])

Fig. 1.10 The Flair bracket was a further development of the Time bracket.

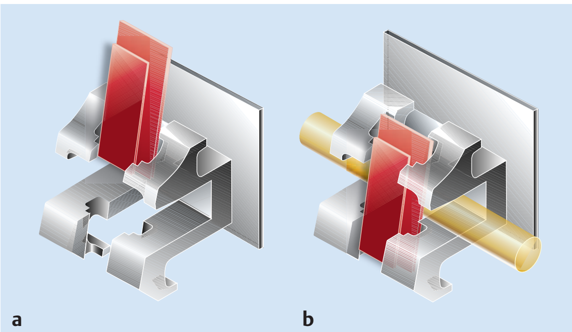

Fig. 1.11 a, b The TwinLock bracket is based on the same locking concept used in the EdgeLok bracket.
a Open.
b Closed.

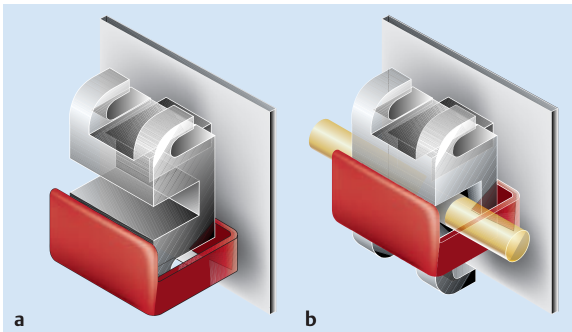

Fig. 1.12 a, b The first-generation Damon self-ligating bracket.
a Open.
b Closed.

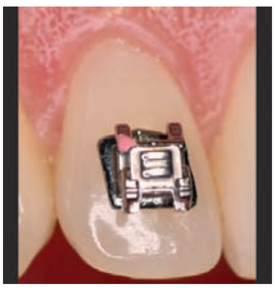

Fig. 1.13 The second-generation Damon bracket.

Fig. 1.14 The third-generation Damon bracket. (Reproduced with permission from Bock et al.[2])

Fig. 1.15 The In-Ovation R bracket. (Reproduced with permission from Bock et al.[2])

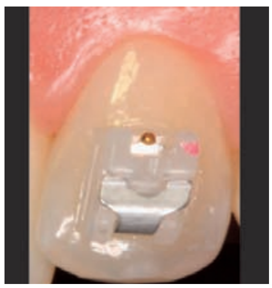

Fig. 1.16 The In-Ovation C bracket.

The 21st Century

The Opal bracket, marketed as the "most comfortable bracket in the world," was introduced by Abels in 2004 (**Fig. 1.17**). It was made completely of translucent acrylic. However, due to its mechanical properties with regard to force translation, abrasion resistance, the locking mechanism, as well as frequent discoloration it did not meet the high expectations raised for it.[2] All of the above characteristics were due to the use of acrylic as the bracket material.
In 2007 a metal bracket based on the same principle, the Opal M (**Fig. 1.18**) was introduced but it has also disappeared from the market since.
The design of the passive SmartClip bracket (2004) (**Fig. 1.19**) is based on a completely different approach to ligature-free ligation. It does not have any movable locks or doors. The archwire is held in place with two NiTi clips that are mounted on the outside of the tie-wings. Ligation and removal of the archwires is achieved by elastic deformation of the clips. This bracket has also been available in an esthetic version (Clarity SL) since 2007 (**Fig. 1.20**). The body of the bracket is ceramic, but it has a stainless steel slot to reduce friction. It is also engineered with a predetermined fracture line point to facilitate debonding.
In 2005, another self-ligating active twin bracket, the Quick bracket, was introduced (**Fig. 1.21**). An esthetically improved version (QuicKlear) has been available since 2008 (**Fig. 1.22**).

The Vision LP bracket (**Fig. 1.23**), a relatively small metal twin bracket, was also introduced in 2005. The NiTi clip is opened with a rotational movement towards the gingiva. It has been available in Europe since 2007.
An alternative locking mechanism was introduced in 2008 in the Discovery SL bracket (**Fig. 1.24**). This is a passive metal bracket in which the locking mechanism is hinged open towards the gingiva. The bracket is very small and comparatively flat. It has been promoted as the smallest self-ligating bracket available today.
A number of other systems are also commercially available, but are beyond the scope of this book. More than 14 different types of self-ligating bracket were developed during the 70-year history of self-ligating brackets in 2003.[27]

NOTE

There have been numerous recent developments, demonstrating that there is growing interest in self-ligation: Self-ligating brackets are available today even for lingual orthodontics.

Fig. 1.17 The Opal bracket. (Reproduced with permission from Bock et al.[2])

Fig. 1.18 The Opal M bracket.

Fig. 1.19 The Smart clip bracket. (Reproduced with permission from Bock et al.[2])

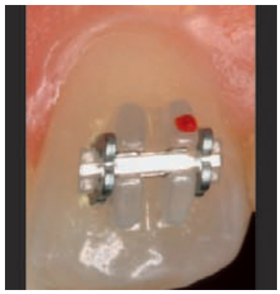

Fig. 1.20 The Clarity SL bracket.

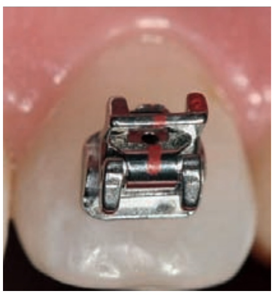

Fig. 1.21 The Quick bracket. (Reproduced with permission from Bock et al.[2])

Fig. 1.22 The Quick C bracket.

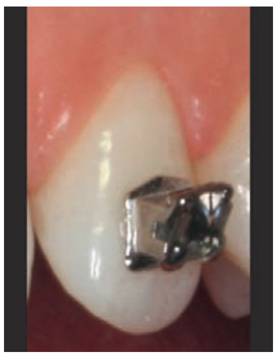

Fig. 1.23 The Vision LP bracket.

Fig. 1.24 The Discovery SL bracket.

Expectations and Reality

NOTE

The most important advantages that self-ligating brackets are expected to provide are:
1. Reduced friction
2. Shorter overall treatment time
3. Longer intervals between visits
4. Reduced chairside time[14,17,21,26]

More and more 'ligature-free' bracket systems have been introduced that claim to offer improved and more efficient treatment, particularly during leveling and alignment (**Table 1.1**). Another proposed advantage is the ability to reduce the forces acting on the teeth, which supposedly improve patient safety by reducing adverse effects such as root resorption resulting from high force levels. Other advantages claimed include reduced patient discomfort.[1] Previous in-vitro studies have shown that active systems are associated with slightly greater friction than passive ones. However, active self-ligating brackets are slightly better at dealing with rotation and torque.[7,26,27] Further details comparing active and passive self-ligation brackets are provided in Chapter 2. The effectiveness of distalization for class II treatment due to reduced friction is another advantage that has been claimed for self-ligating systems.[8,28] However, scientific proof that self-ligating brackets have improved friction characteristics in comparison with standard brackets is still lacking.[3,4] An investigation by Fuck et al.[7] showed on the contrary that conven-

Table 1.1 A selection of self-ligating brackets developed between 1935 and 2008

Year	Developer/company	Name	Ligation principle	Design
1935	Stolzenberg	Russell	Passive	Metal
1972	Wildman/Ormco	EdgeLok	Passive	Metal
1973	Sander/Forestadent	Mobil-Lock	Passive	Metal
1980	Hanson/Strite Industries	SPEED	Active	Metal
1986	Plechtner/A-Company	Activa	Passive	Metal
1994	Heiser/Adenta	Time	Active	Metal
1996	Damon/A-Company	Damon	Passive	Metal
1997	Voudouris/GAC	In-Ovation	Active	Metal
1998	Wildman/Ormco	TwinLock	Passive	Metal
1999	Damon/A-Company/Ormco	Damon 2	Passive	Metal
2002	Voudouris/GAC	In-Ovation R	Active	Metal
2004	Abels/Ultradent	Opal	Passive	Aesthetic
2004	3 M Unitek	SmartClip	Passive	Metal
2004	Damon/Ormco	Damon 3	Passive	Aesthetic
2005	Adenta	Flair	Active	Metal
2005	Forestadent	Quick	Active	Metal
2005	American Orthodontics	Vision LP	Passive	Metal
2007	Abels/Ultradent	Opal M	Passive	Metal
2007	GAC	In-Ovation C	Active	Aesthetic
2007	3 M Unitek	Clarity SL	Passive	Aesthetic
2008	Dentaurum	Discovery SL	Passive	Metal
2008	Forestadent	QuicKlear	Active	Aesthetic

tional twin brackets with “loose” steel ligatures are associated with the least friction in comparison to self-ligation. However, elastic elements and tight steel ligatures are routinely used for treatment with twin brackets, so that the friction characteristics of self-ligation can be expected to be beneficial for this type of treatment. Some clinical studies have shown that the overall treatment time is significantly shorter with self-ligating brackets.[6,11,15] The locking mechanisms of self-ligating brackets are not subject to biological degradation, as elastomeric ligatures are, and in this case intervals between routine checkups can sometimes be increased. Most self-ligating brackets are very small, and this should make cleaning easier and hence reduce the risk of demineralization. Avoiding elastomeric ligatures may also further reduce the risk of plaque retention.[21] Some authors have also claimed that patient comfort is improved, as there are fewer hooks and ligatures that irritate the lips or cheeks.

NOTE

Small self-ligating brackets and completely tooth-colored brackets are now also commercially available that may be able to satisfy patients’ esthetic requirements.

It is difficult to provide a comprehensive and balanced overview of the advantages of self-ligation systems compared to conventional ligation, due to the complexity and sheer numbers of self-ligating systems that are on the market today (**Table 1.1**). It is also often difficult to scientifically verify the advantages that bracket manufacturers claim for their products. The following two chapters therefore focus on the science behind self-ligation and self-ligating brackets.

REFERENCES

1. Berger JL. The influence of the SPEED bracket’s self-ligating design on force levels in tooth movement: a comparative in vitro study. Am J Orthod Dentofacial Orthop 1990;97(3):219–228
2. Bock F, Goldbecher H, Stolze A. Klinische Erfahrungen mit verschiedenen selbstligierenden Bracketsystemen. Kieferorthopädie 2007;21(3):157–167
3. Bourauel C, Höse N, Keilig L, et al. Friktionsverhalten und Nivellierungseffektivität selbstligierender Bracketsysteme. Kieferorthopädie 2007;21(3):169–179
4. Bourauel C, Husmann P, Höse N, Keilig L, Jäger A. Die Friktion bei der bogengeführten Zahnbewegung. Inf Orthod Kieferorthop 2007;39:18–26
5. Byloff FK. Das Speed-System – Eine Behandlungsphilosophie mit selbstligierenden Brackets. Inf Orthod Kieferorthop 2003;35:45–53
6. Eberting JJ, Straja SR, Tuncay OC. Treatment time, outcome, and patient satisfaction comparisons of Damon and conventional brackets. Clin Orthod Res 2001;4:228–234
7. Fuck LM, Wilmes B, Gürler G, Hönscheid R, Drescher D. Friktionsverhalten selbstligierender und konventioneller Bracketsysteme. Inf Orthod Kieferorthop 2007;39:6–17
8. Garino F, Garino GB. Distalization of maxillary molars using the speed system: a clinical and radiological evaluation. World J Orthod 2004;5(4):317–323
9. Hanson GH. The SPEED system: a report on the development of a new edgewise appliance. Am J Orthod 1980;78(3):243–265
10. Hanson GH, Berger JL. Commonly Asked Questions About Self-ligation and the Speed Appliance. Cambridge, Ontario: Strite Industries Ltd.; 2005
11. Harradine NW, Birnie DJ. The clinical use of Activa self-ligating brackets. Am J Orthod Dentofacial Orthop 1996;109(3):319–328
12. Harradine NWT. Self-ligating brackets and treatment efficiency. Clin Orthod Res 2001;4:220–227
13. Henao SP, Kusy RP. Evaluation of the frictional resistance of conventional and self-ligating bracket designs using standardized archwires and dental typodonts. Angle Orthod 2004;74(2):202–211
14. Kapur R, Sinha PK, Nanda RS. Frictional resistance of the Damon SL bracket. J Clin Orthod 1998;32(8):485–489
15. Maijer R, Smith DC. Time savings with self-ligating brackets. J Clin Orthod 1990;24(1):29–31
16. Matasa CG. Moderne Klebebrackets und die Probleme, die sie verursachen können. Inf Orthod Kieferorthop 1997;29:193–207
17. Pizzoni L, Ravnholt G, Melsen B. Frictional forces related to self-ligating brackets. Eur J Orthod 1998;20(3):283–291
18. Renfroe EW. Edgewise. Philadelphia: Lea & Febiger; 1975
19. Schoebel H, Thedens K. Das Damon-System. Darstellung der Technik in Verbindung mit einem Patientenbericht. Kieferorthopädie 2007;21(3):191–202
20. Sergl HG. Festsitzende Apparaturen in der Kieferorthopädie. Munich: Hanser Verlag; 1990:73–75
21. Shivapuja PK, Berger J. A comparative study of conventional ligation and self-ligation bracket systems. Am J Orthod Dentofacial Orthop 1994;106(5):472–480
22. Sonnenberg B, Göz G. Die Entwicklung der festsitzenden Apparatur. Teil 1 – Historischer Überblick 1728–1878. zm 2002;92(12):80–82
23. Sonnenberg B, Göz G. Die Entwicklung der festsitzenden Apparatur. Teil 2 – Historischer Überblick 1906–1980. zm 2002;92(13):84–86
24. Sonnenberg B, Göz G. Die Entwicklung der festsitzenden Apparatur. Teil 3 – Bracketentwicklung. zm 2002;92(14):82–84
25. Stolzenberg J. The Russell attachment and its improved advantages. Int J Orthod Dent Children 1935;9:837–840
26. Thorstenson GA, Kusy RP. Comparison of resistance to sliding between different self-ligating brackets with second-order angulation in the dry and saliva states. Am J Orthod Dentofacial Orthop 2002;121(5):472–482
27. Voudouris JC, Kuftinec MM, Bantleon H-P, et al. Selbstligierende Twin-Brackets (Teil I) – Ist weniger mehr? Inf Orthod Kieferorthop 2003;35:13–18
28. Voudouris JC, Kuftinec MM, Bantleon H-P, et al. Selbstligierende Twin-Brackets (Teil II) – Klinische Anwendung. Inf Orthod Kieferorthop 2003;35:19–26
29. Ward G. Fauchard’s influence on orthodontic technics. J Am Dent Assoc 1964;69:695–696
30. Gottlieb EL, Wildman AJ, Hice TL, Lang HM, Lee IF, Strauch EC Jr. The Edgelok bracket. J Clin Orthod 1972;6(11):613–623, passim

Materials

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