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An Overview of Orthodontic Brackets and Their Use in Clinical Orthodontics

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ABSTRACT
Orthodontic brackets are small devices that are attached to teeth to help guide them into the correct position. They are typically part of braces and are made from materials like metal, ceramic, or plastic. The brackets are glued to the surface of each tooth and connected by a wire, which applies pressure to move the teeth over time. Brackets come in different designs, including traditional metal, clear ceramic, and self-ligating types, each offering different aesthetic or functional benefits. The goal of orthodontic brackets is to straighten teeth, correct bite issues, and improve overall dental alignment.
KEYWORDS: Brackets ,self-ligating

INTRODUCTION

The field of orthodontics has provided significant advantages to humanity. Beginning in the early 18th century, orthodontics has evolved into a specialized area of study. To grasp those techniques, contemporary orthodontists look back to the practices of their predecessors. The pace of innovation in orthodontic treatment is remarkable. Thanks to recent breakthroughs and advancements, orthodontists can offer enhanced experiences to their patients with greater ease. It is essential that we stay informed about developments in the field if we wish to continue providing our patients with timely and effective care. Since the time of Edward Hartley Angle, recognized as the father of modern orthodontics since 1899, there has been significant progression in orthodontic brackets, transitioning from the McLaughlin, Bennett, Trevisi bracket system to lingual braces. These advancements in brackets have greatly streamlined the work of orthodontists. Patients pursuing orthodontic care—including a growing number of adults—now require not only a better smile but also improved aesthetics. Different strategies that have been explored to address this requirement include changing the appearance of stainless steel brackets, reducing their dimensions, repositioning the appliance towards the tongue side of the teeth, and altering the materials used for making the brackets. Smaller stainless steel brackets are increasingly prevalent; however, while they generally meet the orthodontist's criteria for effectiveness, they offer limited aesthetic benefits compared to equipment of similar size [1,2].

Following the introduction of stainless steel brackets, the lingual bracket system emerged. While lingual orthodontic brackets are visually appealing, there is an argument that they lead to a decline in appliance performance along with increased practical challenges and time requirements for orthodontists [3]. In late 1986, the first ceramic-based bracket became available on the market, offering a more aesthetically pleasing option. Patients have embraced ceramic brackets because they represent the most effective attempt so far to create an orthodontic appliance that meets both aesthetic desires and the performance standards of orthodontists [1]. Although ceramic brackets boast superior aesthetics compared to stainless steel ones, this advantage is primarily limited to their appearance, as they present mechanical difficulties when utilized in clinical practice [4]. A variety of new generations of brackets is

continuously appearing in the market. It is essential to stay informed about the latest innovations, including 3D imaging, digital impressions, and advancements in bracket design, in order to provide patients with optimal functional and aesthetic outcomes.

HISTORY

Pierre Fauchard, recognized as the pioneer of Modern Dentistry, is often credited with the first thorough exploration of 'Regulating Teeth'. In his 1728 dentistry treatise, he discusses what is now referred to as the expansion appliance, originally called the "Bandelette."

William E Magill (1823-1896) was the first individual to band teeth for the purpose of active tooth movement in 18712. The period from 1855 to 1930 marked a significant advancement in orthodontics with the introduction of brackets. In orthodontic terminology, a bracket is an attachment bonded to enamel that facilitates the transfer of force from the arch wire to the tooth in an accurate and effective way. The development of this appliance, initially made from stainless steel, has shown a distinctive progression pattern characterized by prolonged periods of stability punctuated by notable bursts of activity.

The initial treatment method employed a slot that was attached to a stainless steel band cemented to the tooth, and early modifications to this attachment resulted in wide base surfaces onto which a slot was soldered. This appliance was then secured to the tooth using epoxy resin. In the late 1970s, the practice of directly bonding to enamel was broadly embraced as a standard technique, moving away from banding. In orthodontics, any devices that extend horizontally to support arch wires can be classified as brackets.

The term "Bracket" entered orthodontic vernacular when Dr. Edward H. Angle unveiled the Ribbon Arch appliance in 1916. This bracket was affixed to the band near its gingival margin and featured a vertical slot oriented occlusally.

Following Angle's death, rather than signaling an end, it heralded a new era, leading to the development of various bracket systems. Some significant contributions during this time came from Steiner, Holdaway, Jarabark, Fizell, Ricketts, Tweed, and many other orthodontic pioneers. Throughout the last

century and a half, the orthodontic field was significantly influenced by Dr. P.R. Begg's theories and innovative techniques originating from Adelaide, South Australia. In his differential force technique, he employed a modified ribbon arch type bracket with the slot oriented gingivally, using light round wires.

Occasionally, various practitioners proposed the use of different bracket angulations to achieve built-in tooth movement. In 1970, Andrews took the concept of slot angulation to its ultimate development with the introduction of the completely preadjusted straight wire appliance (SWA). In 1979, Dr. Ronald Roth presented a bracket configuration incorporating adjustments to the tip, torque, rotations, and in-out movements of Andrews' standard bracket setup. Subsequently, numerous modifications to bracket prescriptions emerged in the following years, along with the introduction of self-ligating and combination brackets aimed at enhancing treatment mechanics.

The subsequent phase in the evolution of brackets included alterations to base designs to enhance bond strength with adhesives, while simultaneously attempting to reduce the base surface areas, which had previously covered nearly the entire labial mesiodistal tooth surface. Beyond these design variations, brackets are also made from different materials. They can be constructed from stainless steel, gold, titanium, cobalt-chromium, polycarbonate, fiberglass, ceramic, magnetic, and metal-reinforced plastic. These different materials exhibit variability in terms of bond strength, friction, and fracture resistance. Additionally, brackets differ in size and slot dimensions, which greatly influence treatment mechanics.

CLASSIFICATION

Orthodontic brackets can be classified based on various factors such as the material they are made of, their design, and their method of attachment. Here’s a breakdown of the common classifications:

1. By Material

- **Metal Brackets**: Made of stainless steel, these are the most traditional and durable type. They are strong, reliable, and cost-effective.
- **Ceramic Brackets**: These are made from clear or tooth-colored materials, making them more aesthetically pleasing as they blend with the natural color of teeth. However, they are more fragile than metal brackets.

- **Plastic Brackets**: These are often used in more affordable options, but they may not be as durable or aesthetic as ceramic.
- **Self-Ligating Brackets**: These can be metal or ceramic but are characterized by a built-in mechanism (a clip or door) that holds the wire in place, eliminating the need for elastic ligatures.

2. By Design

- **Conventional Brackets**: These require elastic or steel ligatures to hold the archwire in place. They are commonly used and very effective.
- **Self-Ligating Brackets**: These brackets have a built-in clip that holds the wire, reducing friction and making the treatment process potentially quicker and more comfortable. They come in two types: passive (for less force) and active (for more force).
- **Lingual Brackets**: These are placed on the inside (lingual side) of the teeth, making them completely hidden from view. They are more challenging to adjust but offer a very aesthetic solution.
- **Mini Brackets**: These are smaller than traditional brackets and are typically used for less visible areas or for more comfort and reduced visibility.

3. By Method of Attachment

- **Direct Bonding**: The bracket is directly bonded to the tooth with an adhesive.
- **Indirect Bonding**: The brackets are first attached to a model of the patient's teeth, then transferred to the mouth using a special tray.

Each type of bracket offers unique advantages depending on the treatment goals, patient preferences, and specific dental needs.

CERAMIC BRACKETS

Ceramic brackets were introduced in the 1970s and offer several advantages over traditional cosmetic options. These ceramics are made from elements that are formed and then heated to harden them. Initially, they can be hard to detect, as they may gradually develop a slight yellow tint. If you dislike the idea of metal braces, these might be the ideal choice for you. Ceramic braces come in various designs, such as solid, Lewis/Lang, true Siamese, and semi-Siamese variations, as well as multiple appliance systems, including Begg brackets and ligation brackets with adjustable force [1]. Also known as aesthetic brackets, ceramic brackets are preferred due to their clear appearance. Ceramic braces offer numerous advantages, including greater strength, enhanced durability,

better color stability, and improved aesthetic qualities compared to stainless steel brackets. However, they have some drawbacks, such as limited ductility, higher cost, fragility, susceptibility to staining, bulkiness, and a complex, costly manufacturing process**.**

METAL BRACKETS

These brackets stand out for their cost-effectiveness and durability, making them the most popular type of metal brackets used today. Additional benefits include their high stiffness, yield strength, resilience, biocompatibility, and resistance to corrosion. Orthodontists have utilized these stainless steel (SS) brackets since the beginning. The majority of metal brackets are constructed from stainless steel (SS) [5]. In Figure 2, SS brackets are depicted. However, they come with some downsides: they require soldering, lack aesthetic appeal, possess a high modulus of elasticity, necessitate more frequent activations, and exhibit less springback compared to NiTi alloy. Furthermore, heating them to temperatures ranging from 400 to 900 degrees can lead to the release of nickel and chromium, which reduces their corrosion resistance. There have been efforts to recycle brackets. Smith [5] found that both bond strength and corrosion resistance were notably diminished. Super SS is specifically identified as SS with a pitting resistance equivalent (PRE) value exceeding 40. The super SS (SR-50A) utilized in 2023 Mundhada et al. Cureus 15(10): e46615. DOI 10.7759/cureus.46615 has localized corrosion resistance comparable to that of titanium alloys (6.77%), due to the combined effects of high concentrations of nitrogen (0.331%) and molybdenum (0.904%). It is also believed to have strong mechanical properties attributed to a "solution-strengthening effect" [6].

SELF LIGATING BRACKETS

In the first decade of the 1930s, Stolzenberg created the Russell attachment, the pioneering self-ligating bracket. In comparison to traditional edgewise brackets, these self-ligating brackets are said to have many benefits [14-16]. There are various materials available for these brackets. Patients have the option of choosing a metallic as well as ceramic one, but this is not their specialty. Regular adhesive or elastic bands are not required for these brackets. Their unique shape provides the necessary mobility and tension simultaneously. They can be divided into active and passive types based on how they close. Active self ligating brackets exert an active force through a spring clip onto the arch wire in order to maintain it in the slot, whereas passive self-ligating brackets present an additional slide that once closed does not affect the slot lumen, nor exert an active force on the wire. The passive self-ligating brackets generate significantly larger torquing moments, giving better performance. They are said to have less friction than traditional brackets, which is frequently highlighted as

one of their main advantages, making them increasingly popular [15,17-20]. This happens because the typical ligatures made of steel or elastomer are not required, and it has been asserted that the passive design produces significantly lesser friction compared to the active one [20,21]. They have minimal friction and consequently require less force to move teeth [22]. They are thought of as having the ability to generate tooth movement that is more physiologically harmonious by preventing the musculature from being overworked and the periodontal vascular supply from being cut off [15].

CONCLUSION

Orthodontic brackets are a crucial element of modern orthodontic treatment. While metal brackets are still the most common and cost-effective choice, innovations in design and material, such as ceramic and self-ligating brackets, offer more options tailored to patients' preferences. Ultimately, the choice of bracket depends on factors like appearance, comfort, and budget, with orthodontists helping to guide patients toward the most effective solution for their individual needs.

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