Shear Bond Strength Between Two Different Passive Metal Self Ligating System

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ABSTRACT:

Introduction: Nowadays, both conventional and self-ligating brackets are commonly used in orthodontics. Their differences in design, however, makes them withstand different forces during orthodontic treatment. Advantages of self ligating system are reducing friction and treatment time in orthodontic mechanotherapy. Self-ligating brackets have been clinically tested in various studies, evaluating periodontal indices, bonding with self-etching primers and also in trifocal distraction–compression osteosynthesis. **Materials & Method:** 6 premolars and 6 self ligating brackets taken. Each tooth was mounted in resin. Etching and bracket placement was done. Material was placed on instron and shear bond strength was evaluated. **Results:** Maximum force used in Damon system was 25.23N and their bond strength was found to be 6.31 MPa, whereas, in Orana system, the maximum force was 138.33N and their bond strength was found to be 34.58 MPa. **Conclusion:** The shear bond strength of the Orana bracket system were significantly higher than the Damon bracket system.

Keywords: Passive Metal Self Ligating System, conventional and self-ligating brackets, orthodontic treatment

INTRODUCTION:

Orthodontics is a specialized field of dentistry that focuses on correcting misaligned teeth and jaws. One common method for straightening teeth is the use of orthodontic brackets, which are attached to the teeth with adhesive materials (1). Self-ligating orthodontic systems have gained popularity in recent years due to their advantages over traditional ligated systems. Unlike conventional brackets, self-ligating brackets have a built-in mechanism that secures the archwire without the need for elastic or metal ligatures. This design reduces friction, allows for better tooth movement, and potentially reduces treatment time.

Adhesion is still a crucial factor to be considered in the large field of bracket characteristics. Dental clinical success is significantly influenced by adhesive interfaces, and in vitro experiments can measure interface durability. Orthodontic materials that are bonded to enamel should be tested for shear bond strength. The various elements affecting the binding strength of orthodontic brackets have been examined in more than 1000 investigations (2).

Self ligating brackets come in active and passive varieties. Through a spring clip that keeps the archwire in the slot, active self ligating brackets exert an active force on the archwire. When locked, an additional slide on passive self ligating brackets has no effect on the slot and exerts no active forces on the archwire, turning the bracket into a tube (3). The archwire is kept in place by interchangeable stainless steel or elastomeric ligatures in conventional brackets. Self-ligating brackets are larger than traditional brackets, and this, together with the structure of the bracket base, may have an impact on how well they adhere to the enamel (4).

Research has assessed various bond strength variables, such as the type of bracket base examination, the placement force, the surface pretreatment, and the enamel's contamination with blood or saliva. Other variables that have been evaluated include the surface (enamel, metal, and ceramic), adhesive system (glass ionomer and composite), bracket material (stainless steel), and type (self-ligating, conventional, and lingual) (5).

Typically, a shear force is delivered in a testing machine at a specific crosshead speed until the adhesive system fails in order to assess the bond strength. Interface stress units, or newtons/megapascals, are used to measure the debonding force. The literature is unclear on the appropriate limits for bond strength; however, the material should allow good adhesion to withstand masticatory forces (5–10 MPa minimum shear bond strength) (6) and not apply excessively high adhesion forces (40–50 MPa), which can cause enamel loss during debonding (7).

There are also a limited number of clinical investigations that evaluate the aspect of utilizing in vivo debonding devices and compare those outcomes with in vitro research (8). Furthermore, when evaluating adhesion, it is important to take into account the complex nature of clinical bond failure. The bracket material, implantation site, anomaly types (overjet, overbite, and dental classification), patient age, oral hygiene, and stage of treatment are among the risk factors (9).

The bond strength between these brackets and the tooth surface is crucial for the effectiveness and stability of orthodontic treatment. The aim of the study is to assess the shear bond strength between two different passive metal self ligating bracket systems.

MATERIALS AND METHOD:

6 extracted premolar teeth were taken for the study. The extracted teeth were acquired from the department of oral and maxillofacial surgery, Saveetha dental college, Chennai. Included were only teeth with complete enamel and anatomically appropriate buccal surfaces for gluing bicuspid brackets. Excluded teeth included fillings, cavities, scale, big lesions on white spots, cracks on the buccal surfaces, and less than two thirds of the roots remaining. Once all organic substances were

eliminated, they were carefully washed with saline solution. All the teeth were individually mounted to resin material. 6 bicuspid self ligating brackets were used (3 Damon bracket system and 3 Orana bracket system). The teeth were brushed without toothpaste, and was etched with 37% orthophosphoric acid and was bonded with stainless steel bicuspid brackets using composite. Once the extra material was eliminated, they were each given a separate light cure. The teeth were once more preserved in synthetic saliva for a duration of one month, up until the time of the measurements. In order to assess the shear bond strength, the finished model was put on an intron. Each tooth with the bonded bracket was securely positioned in a load cell that was secured in a repeatable position and locked into the bottom hydraulic grip. At the chosen crosshead speed, the top hydraulic grip with a metal pin in situ would press perpendicularly against the bracket between the wings and the base. The same operator carried out all of the measurements and operations. Tensile strength is the highest tension a material can withstand before breaking when it is pushed or stretched. Tensile strength is determined by performing a tensile test and recording the stress–strain curve, with the tensile strength being at the top of the curve. Force per unit of area is used to quantify it. The PA, or pascal, or the MPa, or megapascal, is the unit of measurement. It is expressed similarly in N/m2. The obtained data were assessed.

RESULTS:

From this study, we infer the maximum force used in Damon system was 25.23N and their bond strength was found to be 6.31 MPa, whereas, in Orana system, the maximum force was 138.33N and their bond strength was found to be 34.58 MPa.

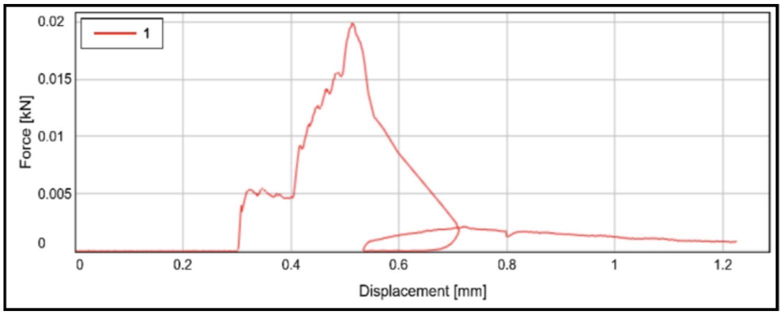

Figure 1: Shear bond strength of Damon bracket system - D1

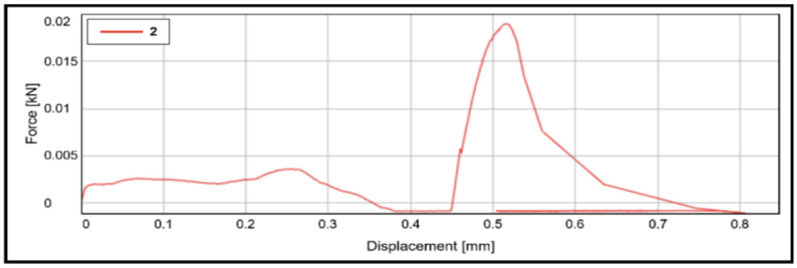

Figure 2: Shear bond strength of Damon bracket system - D2

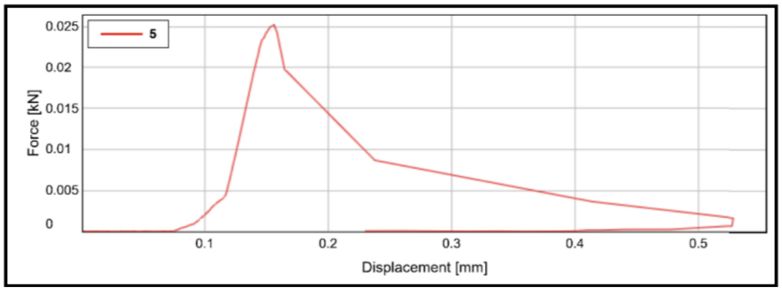

Figure 3: Shear bond strength of Damon bracket system - D3

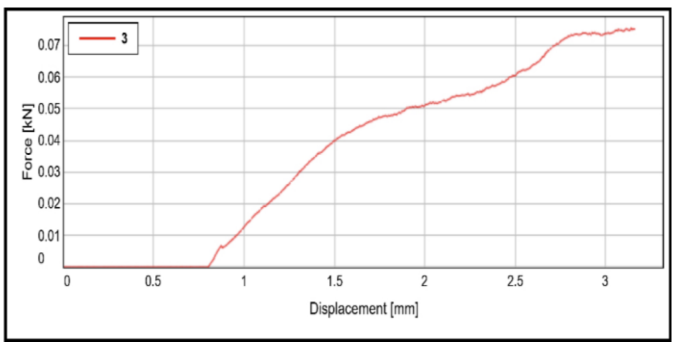

Figure 4: Shear bond strength of Orana bracket system - O1

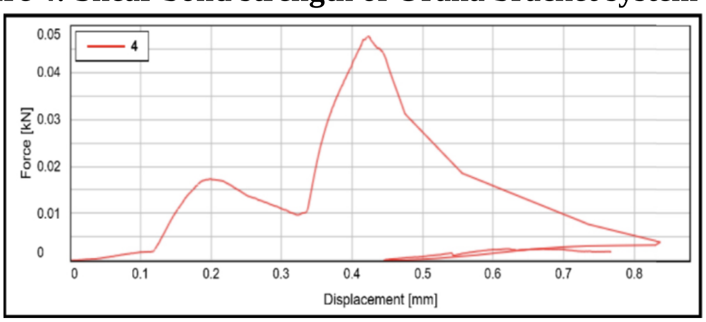

Figure 5: Shear bond strength of Orana bracket system - O2

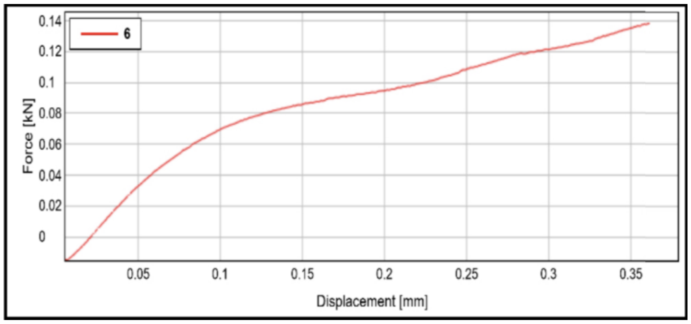

Figure 6: Shear bond strength of Damon bracket system - O3

DISCUSSION:

Self-ligating brackets do not require the use of traditional ligatures (elastics or metal ties) to hold the archwire in place. Instead, they have built-in mechanisms to secure the wire, making them more convenient and potentially offering advantages in terms of reduced friction and potentially faster treatment times. Several factors can influence the shear bond strength of orthodontic brackets such as bracket design, adhesive system, tooth surface preparation, curing process and environmental factors. A bracket with insufficient bond strength may lead to bracket failure during treatment, which can result in treatment delays and additional visits to the orthodontist. It can also affect the overall effectiveness of orthodontic treatment.

Compared to stainless-steel brackets, ceramic brackets have a noticeably weaker bond (10). Another study found that in order to achieve a bond strength comparable to a silica-rich ceramic treated with hydrofluoric acid and silane, ceramics made primarily of zirconia needed to be treated with at least three coats of methacryloyloxy-decyl dihydrogen phosphate primer. Orthodontic tubes were the subject of the investigation (11). Clinical challenges persist in bonding orthodontic brackets to zirconia restorations. RelyX or Clearfill ceramic primer applied after pretreatment with silica-coated alumina produced high enough shear bond strength values (12). It is highly desirable to increase the shear bond strength of brackets. Glass ionomer cement's bond strength rose to Transbond XT-like levels after the enamel surface was deproteinized with sodium hypochlorite prior to etching, possibly lowering the frequency of white spot lesions (13). The bond strength is not weakened by pretreating enamel with an Er,Cr:YSGG laser and CPP-ACP as a preventive measure prior to bonding brackets (14). Nonetheless, Contreras-Bulnes et al. state that Er:YAG laser irradiation is not a viable option for enamel conditioning (15).

Compared to poly-acrylic acid and self-etching primers, phosphoric acid produced a more aggressive etching pattern; however, neither the adhesive system nor the etching pattern had a significant effect on the shear bond strength (16). The bond strength in metal brackets was strengthened by enamel deproteinization using sodium hypochlorite, although there was no statistically significant difference between the groups that received this treatment and those that did not (17). Shear bond strength is reduced when eroded enamel is treated with fluoride prior to bracket bonding; however, bonding to eroded surfaces can be strengthened by using a fluoride-releasing adhesive (18). Furthermore, erythritol pretreatment of enamel may be a workable way to lower the failure rate in brackets (19). Comparing self-ligating brackets to conventional or alternative self-ligating brackets, similar studies discovered higher shear bond strength values in self-ligating brackets [7]. In another study, Northrup et al. compared two adhesives with conventional and self-ligating brackets and found that, when using both adhesives (Transbond and Blugoo), the Damon self-ligating system demonstrated a satisfactory shear bond strength (20). Additionally, Basaran and Ozer discovered no appreciable variations in the clinically acceptable mean bond strength between two self-ligating systems and a conventional one (21).

It is optimal if clinical trials are used to validate the findings of this study and other studies of a similar nature. The intricate interactions that are dynamic and occur in the intra-oral three-dimensional environment cannot be replicated in a linear experiment. Our research's finding of statistically significant differences between the two sparked debates about their origin. Given that the debonding pressure was applied at the level of the tested materials, the closing mechanism's resistance may have played a role in the results. Some bracket systems might have stiffer clips, but more research needs to be done on this point.

CONCLUSION:

From the above study, it can be concluded that, Passive self ligating brackets presented the highest shear bond strength and Orana bracket system showed significantly higher shear bond strength than Damon bracket system. Future clinical trials are required to support the findings of this research.

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CONFLICT OF INTEREST:

The study's author states that there were no conflicts of interest.

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