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İSTANBUL YENİ YÜZYIL UNIVERSITY

HEALTH SCIENCES INSTITUTE

DEPARTMENT OF ORHODONTHICS

COMPARISON IN SHEAR BOND STRENGTH OF ORTHODONTIC CERAMIC BRACKETS BETWEEN BIOFIX AND CONVENTIONAL BONDING SYSTEM

MASTER OF THESIS

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ACCEPTANCE AND APPROVAL

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DEDICATION

This thesis is dedicated to:

My husband Mohamed,

He was always encouraged and supported me to achieve my goals.

My lovely children, my parents, my sisters and brothers they always share with me all of my moments during my study.

And all of my friends who wishes to me bright future.

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ABSTRACT

COMPARISON IN SHEAR BOND STRENGTH OF ORTHODONTIC CERAMIC BRACKETS BETWEEN BIOFIX AND CONVENTIONAL BONDING SYSTEM.

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Purpose: The purpose of this in vitro study is to compare the shear bond strength of orthodontic ceramic brackets between single component bonding system (Biofix) and orthodontic conventional bonding system (Transbond XT).

Materials and Methods: Forty intact human premolars (N =40, n = 20 per group) were selected and randomly divided into two groups. Group1: orthodontic conventional bonding system (Transbond XT), Group 2: single component bonding system (Biofix) adhesive bonded ceramic brackets . the teeth were prepared then the brackets placed in the ideal position. Shear bond strength (SBS) for each sample was measured. The shear bond strength of each group were statistically compared using t-test $p<0.05$.

Result: The shear bond strength was greater in conventional adhesive 3M group (13.34 ± 5.38) Mpa than Biofix adhesive (8.40 ± 5.05) Mpa, a statistically significant difference of 4.94 Mpa (95% CI, 1.60 to 8.28), $t = 2.994$, $p = .005$.

Conclusions: The results of the present investigation showed that single component bonding system—Biofix adhesive had shear bond strength lower than conventional adhesive Transbond XT but clinically acceptable. Decreasing the number of steps during bonding, as the clinicians can reduce the potential for mistakes and contamination during the bonding procedure, in addition to save the time, less effort and less cost .

Key words: Biofix adhesive, conventional adhesive, Shear bond strength, ceramic brackets.

ÖZET

Ortodontik Seramik Braketlerin Biofix ile Konvansiyonel Yapıştırma Sistemleri Arasındaki Kayma Dayanımı Karşılaştırılması

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Amaç: Bu in vitro çalışmanın amacı, ortodontik seramik braketlerin tek bileşenli yapıştırma sistemi (Biofix) ve Ortodontik konvansiyonel yapıştırma sistemi (Transbond XT) arasındaki makaslama gücünün karşılaştırılmasıdır.

Gereç ve Yöntem: 40 bozulmamış insan azı dişi (N = 40, n = 20 grup başına) seçildi ve rasgele iki gruba ayrılmıştır. Gruv: ortodontik konvansiyonel yapıştırma sistemi (Transbond XT), Grup 2: tek bileşenli yapıştırma sistemi (Biofix) yapıştırıcı bağlı seramik braketler. Dişler hazırlanıp daha sonra braketler ideal pozisyonda yerleştirildi. Her örnek için makaslama direnci (SBS) ölçüldü. Her grubun makaslama direnci, t-testi $p<0.05$ kullanılarak istatistiksel olarak karşılaştırılmıştır.

Sonuç: Makaslama direnci 3M konvansiyonel yapıştırıcı grubunda (13,34 ± 5,38) MPa 'dan Biofix yapıştırıcı (8,40 ± 5,05) MPa 'dan istatistiksel olarak belirgin düzeyde bir farkla daha büyüktür 4,94 MPa (% 95 CI, 1,60-8,28), t = 2,994, p =. 005.

Tartışma: Araştırma sonuçları gösterdi ki tek aşamalı yapıştırma sistemi biofix'in makaslama kuvvetlerine karşı direnci konvansiyonel yapıştırma sistemi transbond xt'ye kıyasla daha düşüktür fakat klinik olarak Kabul edilebilir düzeydedir, yapıştırma aşamalarının sayısının azaltılması klinikçilerin hata şansını azalttığı ve kontaminasyonu engellediği gibi çalışma süresini de kısaltır.

Anahtar Kelimeler: Biofix yapıştırıcı, konvansiyonel yapıştırıcı, makaslama direnci, seramik braketler.

ABBREVIATIONS

GIC: Glass ionomer cement.

RBC: Resin bonded cement.

SBS: Shear Bond Strength.

RBCs: Resin based composites.

MPa: Mega Pascal.

N : Newton.

μM: Micrometer

mm: Millimeter.

Sec: Second.

n : Number.

1. LITERATURE REVIEW

1.1 Introduction

Orthodontics typically involves the use of braces for aligning teeth. Bonding of orthodontic brackets to the tooth has been an important issue, since many new bonding agents have been developed with its own success and drawbacks (1).

As a success of fixed orthodontic appliance has a significant correlation with bracket _adhesive_enamel junction in which they have to be in high facility to resist failure. Orthodontic adhesives should be enabling the bracket to stay bonded to the enamel for a total duration of treatment and to allowing easy removal of brackets, when needed without impairment to enamel surface. It should be easy applied and cured, have potential of fluoride_release and un irritant to soft tissues (2, 3) .

In the second half of the 20th century the direct bonding of orthodontic attachments was probably the most significant development in clinical orthodontics. In 1955, Buonocore, borrowing the techniques of industrial bonding, enhanced the adhesion with phosphoric acid (4).Traditional system of orthodontic bracket bonding need to use of a three-step procedure includes (enamel conditioner) etching of enamel by acid , increase of surface area by roughening the out layer this irregularities is important to remove the smear layer , the micromechanical process between enamel pores and adhesive component help in retention after polymerization. then a layer of priming agent and adhesive resin (5).

Reynold (1975) attributed that optimal bond strength value ranged between 6 to 8 MPa which is adequate to withstand the applied forces during treatment (6).

Many materials and methods have been developed for bonding procedures, but still some disturbances of decalcification (7).Low PH environment, increase chance of food particles accumulation and growth of bacteria (8, 9).

Where the quality and design of brackets have been developed by the manufacturers to improve treatment capacity, meanwhile try to limit the three steps into two steps, effectively reduce chair time, increased comfort and reducing costs.

The main objective is to achieve a sufficient marginal seal to avoid caries or white spot lesion under the arch and these obtained on ideal three main components these are the dental surface and individual orthodontic base attachment and, bonding of material itself (shear bond strength)

In this study, the composite used is Biofix for which the manufacturer claim that there is no need for applying the primer separately. Biofix light cured is a single component bonding system for plastic, metal and ceramic orthodontic brackets to be fixed on dental enamel. The composite and primer are combined together reducing a step in chair side and thereby reducing the time and cost needed for bonding ,as acoupling the two in one step may affect the bond strength either advantageously or adversely. This study proposes to evaluate the shear bond strength of orthodontic brackets and evaluating the efficiency of the new bonding system.

1.2. Enamel developments, features and composition.

1.2.1 Enamel development:

Tooth development stages are identified as (bud stage ,cap stage ,bell stage and crown stage) the last stage known as calcification stage in which the enamel formed. After origination of the first dentine the ameloblasts, start to form enamel in a process called an amylogenesis which is a complicated and including two phases .These two phases depending on the cells which sustain great morphological changes throughout amylogenesis. In the first phase proteins and organic matrix secreted, create the shape of crystals make it wider and thicker and 30% of mineralized enamel established, further mineralization occurs during the second phase and mature enamel formed (10).

1.2.2 Enamel features:

The basic enamel unit is called an enamel rod. Formally known as enamel prisms, measuring 4-8 microns in diameter,).the rods as amass formed from compact crystals of hydroxyapatite in a structured pattern. Enamel rods appears in a cross section like a keyhole with its head pointed toward the crown of the tooth, and its bottom pointed toward root of the tooth (10).

Since the enamel has to be supported by underlying dentine, the enamel crystals are oriented parallel to the long axis of the rods which are oriented at right angle to the dentin with slight divergence toward the root at cervical third of permanent teeth. The area where the crystals on both enamel rods and interrods engage tighter known as the rod sheath (10).

The area that surrounds the enamel rod is termed as interrod enamel. Both the rods and inter rode enamel has similar composition, but only verify in the orientation of their crystals. These crystals measured from 60 to 70 nm in width and 25 to 30 nm in thickness (10).

1.2.3 Enamel Composition:

Enamel after full formation is greatly mineralized tissue contains the highest proportion of minerals, 96% in the form of hydroxyapatite and 4% water and organic matrix although enamel is the hardest substance in the human body, the enamel is a fragile and the underlying layer of more flexible dentin is important to protect its integrity. also Enamel does not contain collagen fibers, as found in other hard tissues like dentine and bones, but the enamel contain two unique classes of proteins: amelogenins and enamelins, enamel varies in the thickness according to the surface of the teeth, the highest thickness over the cusps about 2.5 mm, and to a fine edge at cement enamel junction (CEJ) (10)

The normal color of enamel differs from light yellow to Gray (bluish) white. As the enamel is semi-transparent it is strongly affected by the underlying dentin but on the edges of the teeth where there is no dentine underlying the enamel, color sometimes has white or slightly transparent tone, clearly visible on the upper incisors (10).

In transverse section a series of dark lines called striae of Retzius extending from dentino-enamel junction toward the outer surface of enamel, where they end in shallow furrows known as perikymata .after maturation of enamel and before its eruption into the mouth the ameloblast cells are destroyed which cause the enamel to be non-generative tissue (10).

1.3 Preparation of tooth surface:

1.3.1 Prophylaxis

Cleaning of enamel before acid etching is essential in order to receive either direct or indirect bonded restorations. The tooth surface is covered by protein film known as pellicle acquired which is shapeless, organic flake and sham, without cells, covers cleaned tooth surfaces in a few minutes (11),so even in patients with good oral hygiene, it is necessary to remove the invisible acquired pellicle with dental prophylaxis. Acquired pellicle is important, especially in the enamel demineralization / reminelization process. In clinical terms, it has been exposed that The effectiveness ability of acquired pellicle to protect the tooth surface is unknown as well as acid exposure respect (12-14).

Removing the discoloration and plaque accumulation before enamel etching could be done by using dental prophylaxis with pumice powder or paste and rotating brush or rubber cup in low speed which is the most common technique. However many other faster and more efficient prevention techniques, such as airflow and bicarbonate jet polishers could be used, but they can hurt tissue and contaminate surfaces (15-17).

1.3.2 Acid etching technique:

In 1955,Bounocore introduced the first enamel surface etching technique by using weak acid such as phosphoric acid (H_3PO_4) 85% concentration and 30 seconds to obtain better adhesion between enamel and acrylic resins(4).

Bonding of resin material to the tooth surface is based on mechanical changes on enamel surface after adding of acid which cause roughness, removing smear layer, micoporosity and increase permeability . these irregularities form mechanical resin tags that play a major role in interlocking between enamel and adhesive .

Acid etching technique form one of these patterns : type I where the enamel rods are predominantly dissolved ; type II in which just the area around the enamel rod is dissolved and type III where no evidence left of enamel rods .type I is the optimum while type III is the least the differences in enamel crystals orientation could be the reason of different pattern types(18)

The procedure was introduced in dentistry ahead of its time and after 10 years the bonding mechanism was described Bis-GMA- (19). changing of enamel surface from a low-reactivity surface to a surface more susceptible to adhesion, where many studies have terminated that resin tags penetration depth ordered from 8 _15 microns reach to maximum length up to 50μm, about 10 _30 mm of enamel surface lost also another 55.6 mm of enamel lost occurring as a result of cleaning procedure after deboning (20).

1.3.3 Etchant Concentration and etching time:

The optimum duration of acid application and concentration still remain highly dispute among the researches (4). in 1955 Buonocor suggested that use of 85% phosphoric acid solution for 30 sec but at the time of its first clinical use, the etching time was extended to 60 seconds. Silverstone and Retief in (1974) found the most retentive condition by using acid with concentration of 20 -50% for1 to 2 minutes (19, 21).

In 1984 the etching time was decreased to 30 seconds the application stayed until today (22, 23). Some writers recommend reducing the etching time to15 seconds when 32% to 40% phosphoric acid is used(24), in 1989 Legler et al evaluated that phosphoric acid concentration did not expressively affect on the shear bond strength whereas the duration of etching had a significant effect on SBS .

In 1991 Wang and Lu they obtained from their study that the best time for good retention when using 15 sec with 37 % phosphoric acid ,and they found that over 30 sec of etching cuased enamel loss and the lost enamel fragments was proportionally increased by increasing of etching time, also the amount of adhesive remaining on the tooth surface was greater as well (25).

So by adapt the etching time at 15 sec advant decreasing of enamel loss decreasing of chair time, it was enough for orthodontic adhesion procedures produce clean etch site after debonding.

Hermsen and Vrijhoef in (1993) compared between 10% aleic acid and 35% phosphoric acid and they found that less enamel loss to phosphoric acid by etching time (15-120 sec) (24).

Some evidence indicted that different types of teeth show biological differences in etching which may affect bond strengths ,the shear bond strengths of upper anterior teeth higher than the upper posterior teeth while vice versa at lower teeth , when the teeth examined under the scanning electron microscope there were statistically significant differences in the mean SBS were found as the canine and premolar teeth had higher strength than incisors (26).

In general the application of 32% to 50% phosphoric acid concentration for 15-30 seconds achieve proper bond strength value and still the best option extensivelly used in dentistry (25, 27).

1.4 Adhesion and Adhesives

1.4.1 Orthodontic cements and Adhesives:

For direct bonding of orthodontic braces to tooth surface numerous of bonding agents have been developed and used with a differet polymerization mechanism such as chemically, light or dual treatment (28). the resin and hybrid resin are the most clinical user beacuse of improved physical and clinical features.

Composite resin is one of the most popular used adhesives in orthodontic bonding as its adequate qualities ,it provide qualified bonding strength and its simple to handling , furthermore attaches of resin to the tooth surface occures just by mechanical interlock so keep dry field during practice and because of restricted amount of fluoride release so anticaries effect is very low.

Resin modified glass ionomer cements are the most recent generation of GIC . their effortless during practice make them exceed the composite resins in some titles as their ability to provide sufficient bonding in a moist field , fluoride release properties , as well as the ability to provide satisfactory bond strength to the enamel either chemical bonding or by micromechanical lock with enamel surface irregularities (28).

1.4.2 Ideal Requirements Of Orthodontic Adhesive:

The adhesives should persistent bonded to enamel until complete period of treatment and with effortless during removal of the brackets without damaging the tooth structure and minimal patient discomfort (29, 30).

The adhesive should be non-ulcerated to soft tissues of the mouth, while positioning of the brackets working time should be long enough, as well as short setting time for more patient comfort, simply applied , conveniently cured and able to fluoride release(2).

1.4.3 Glass ionomer cement:

In 1972 Wilson and Kent were introduced Glass ionomer cements as material for restorative treatment, and later became available as cement (31). GICs firstly generated by a composition of aluminosilicate glass powder and an alkenoate acid liquied, setting reaction of GICs theorize acid base reaction, The second generation of GICs consist of a freeze dried acid powder mixed with glass and distilled water (32).Original glass ionomer cement (GICs) were water based substances advanced by acid base reaction between a poly alkenoic acid and afluroaluminosilicate glass materials. to promote their physical properties by adding metal particles (silver or gold), and also (ceramic, metal)were fused resulting acement or by addition of amalgam alloy particles (admix) (33).

However,beacuse it was difficult during handling and to make accurate dispensing of the liquid component leads to inaccurate powder: fluid / water ratios which are tend to be affected by moisture pollution during the setting reaction. To overcome this negative effect the encapsulated cements could be a better option but they are high cost and wastage of material is prospective (32).

1.4.4 Resin modified cement:

following the introduction of high powder input: ratio of liquid products The use of "metal reniforced" GICs appeares to be declined.

In early 1990s conventional GICs arranged to be blend with water-solvent resin monomers and watery poly-acrylic corrosive to produce soluble “resin modified GICs” (RM-GICs), which is exhibit improvment of physical properties over the conventional material, it has the advantage of good adhesion to the tooth structure, minimize sensitivity of water balance, fluoride release and fast setting by visible light (31).

Further more the chemical bonding of (RMGICs), resin monomers penetrate surface irregularities to produce micro-mechanical interlock after polymerization (34)

1.4.5 Zinc poly-carboxylate cement:

In the quest for a adhesive luting specialist that unequivocally clinging to the structure of teeth, zinc polycarbxylate and curve concrete as cement attach to the dental structure. Polycarboxylate cement is a product reaction of zinc oxide and a polycarboxylate acid solution. a chemical bond between cement and tooth come from chelation of The carboxylic group to the calcium in enamel and dentin, integration of zinc oxide powder in the viscous relatively poly carboxylate acid is hard (34). Although its advantage of chemical adherence to enamel but the usage was flawed, due to short working time , poor bonding strenght, high viscosity and solubility (32).

1.4.6 Zinc-phosphate cement:

Zinc phosphate cement is the product reaction of zinc oxide and phosphoric acid solution, it is one of the oldest cement sealers and has been widely used as band cement in the last century (35). The tecnique of mixing powder / liquid cement product is sensitive so the components must be mixed properly and zinc phosphate cement during mixing should be kept cool to ensure an optimum acidic base, resulting in sufficient physical properties including the relatively dimensions stable and low solubility in oral fluids (34).

Zinc phosphate cement has high compressive strength, but low tensile strength and high solubility which leads to micro leakage and demineralization (32).

1.4.7 Resins:

In (1965) Newman was the first person who use epoxy resin for bonding stainless steel brackets to the enamel(36). Resin cement is mainly low viscosity, insoluble in oral liquid, do not contain any water gel and do not have any fluoride release potentials.

It consists of resin monomers and inert fillers. Polymerized either light or chemically activated, or by dual activation. Single component are light activated material stored in opaque packages, more suitable used as do not need to mix (34).The systems which are chemically cured available as powder and liquid or as two pastes. Dual treatment systems use both chemical and light cure mechanisms .the bonding to tooth surface occurs by interlock mechanism, however this bonding affected by several factors including enamel conditioners used, acid concentrations and etching duration and bonding agent (primer), bracket type, base design and oral environment (35).

1.4.8 Compomers:

Compomers also known as poly acid –modified composite resin, are a single component systems composed of aluminosilicate glass , carboxyl modified resin monomers and light cure traditional resin monomers. The reaction does not occur inside the package because the water is absent from compostion, this material is moisture sensitive and packed in moisture proof (34).

The material is not self-adhesive as the setting happen after light curing of acidic monomers to become rigid material, bonding to the tooth surface is by mechanical interlock so prior to bonding tooth surface must be dry and surface treatments are desired (35).

The fluorides and other remineralizing ions are released from aluminosilicate glass when absorbs water from the saliva as a result of acid base reaction.

1.4.9 Three-step adhesive (total etching system):

Before putting composite these systems require acid etching of enamel and dentin, rinse, dry, and then use of priming agent and adhesive . Once the tissue are demineralization, primers must transform the hydrophilic dental surface into hydrophobic surface (previosuly wetted) in which complete tissue infiltration by the adhesive can be achieved, since adhesive systems containing volatile organic compounds such as ethanol and acetone remove the remaining water, this enables the penetration micropores of etched enamel and inside the open dentinal tube reach the nano-spaces in the collagen network of dentin (37).

Hydroxyethyle methacrylate (HEMA) and Polyalkenoic acid are the main components of water-soluble primers, water has a much higher steam pressure than HEMA so it is retained above the applied surface , as solvent, water, evaporates in the drying phase, The mechanism of action is based on the fact that water evaporates after application and the surface is air- dried, thus increasing thehydroxyethyle methacrylate concentration, in the last step, the hydrophobic bonding agent is applied, which bond chemically with composite resin.

The great advantage of a three-step system is the ability to achieve the accurate bond strength for enamel and dentin. The main disadvantages is that the technique has many clinical steps which makes it very sensitive , and the risk of over-wetting or over drying the dentin after the etching acid step ,the bond strength value of these adhesives have reached approximatly 31 Mpa (38, 39).

1.4.10 Two-step adhesive:

The adhesion mechanism of this system is the same as that of their three steps, but in this technique a priming step does not occur independently, so wet tissue should be kept in the dentin case to prevent the demineralization collagen from collapse, thus preventing the infiltration of incomplete adhesive. However, it is very difficult for the doctor to reach the optimum degree of moisture, because of that it is considered as a sensitive technique system (40).

The clinical techniqe of system is simple , procedures are described into two steps so reduced the working time.the primer and adhesive come together in one package and comes separately. after etching the acid rinse with water and then dry but the dentin must remain wet after etching, the main drawback is difficult to standardize clinically given the lack of stability of the demineralized matrix (41).

As the primer now has monomers acid etching agent, therefore preparing dental tissues for adhesion. The main advantage of this system is elimination of rinse phase also surface of the dentin is already ready to receive adhesive agent (40).

1.4.11 One Step All-in-One Adhesives:

This system combine three functions of acid etching, priming and adhesion in one stage , Technology of adhesive system is simple ,as it could maintain acidic water monomers, organic solvents and water in one solution.

The components necessary to activate the process of dentin demineralize and running the system (41).Solvents such as acetone or alcohol are retained in solution, but once dispensed solvent evaporation begins this leads to separation phase with forming multiple drops and inhibition of oxygen. There is also a lower degree of conversion, which enhances the hydrolytic dig bond regeneration systems in restorative dentistry, affecting the ability of bonding in the adhesive interface (42, 43).The main advantage is that they are easy to apply and they are no need to surface rinse, only drying is necessary for uniform spread product before polymerization (40).

1.5 Orthodontic Bracket type and Design

1.5.1 Metal brackets:

Maijer and Smith (1981) mentioned that the orthodontic brackets available in three types (plastic, ceramic and metal).

The earliest metal bracket were milled from cold drawn from stainless steel and had perforated bases into which the adhesive could flow (44).Stainless steel brackets holded at the base adhesive interface by mechanical interlocking, they did not have any chemically connection (45). One of disadvantages of using metal brackets is the corrosion and collection of black and green stains.

The primary metal pads was with limited retention thus to provide better bond strength the design was changed from just one row of holes along the outer margin of the smooth inner surface to the foil mesh strong base .

The foil mesh welded to a solid metal backing into a points known as gobbets, these cause stress concentrations leads to broken of adhesive in areas adjacent to these sites, however this design produced the largest bond strength and less tissue irritation and plaque accumulation (6).

1.5.2 Ceramic bracket:

In 1980s ceramic brackets introduced, depending on the method of fabrication it constructed from aluminium oxide in either polycrystalline or monocrystalline shape, from a single crystal of sapphire, the earliest brackets was milled by diamond tools. The latest monocrystalline alumina (MCA) brackets were formed by extrusion of synthetic sapphire.

Because of their inert aluminium oxide composition they cannot chemically bond with acrylic and diacrylate bonding adhesives so to increase chemical retention a silane coupling agent used to act as chemical intermediary between the ceramic bracket base and the adhesive resins resulted in very high bond strength that initiated the enamel / adhesive interface to strained during debonding which leads to irreparable enamel damage. To avoid that widely available ceramic brackets based on mechanical retention just by using standard adhesives or chemically treated materails without adding special bonding agents (46).

The polycrystalline alumina brackets (PCA) are made by molding of submicron-sized particles of alumina suspended in resin and fusing them to combine the alumina and produce the bracket which is machined to shape, characterized by their roughness and porosity so have greater friction coefficient than stainless steel brackets.

Ceramic brackets propose steel bracket in their color stability and superior aesthetics, thet get high resistance to wear and deformation and great strength but the most drawbacks their fragility that could cause proplem during debonding also could cause dental abrasion (46).

1.5.3 Metal-reinforced ceramic brackets:

Metal-reinforced slots introduced by the manufactures (Clarity© brackets, 3M Unitek) to overcome high friction of polycrystalline ceramic brackets, however increase strength and get smooth sliding mechanics.

Now metal lined polycrystalline brackets inserted with 18 carat of gold which reported as better in friction resistance than stainless steel.

1.5.4 Bracket base morphology:

The effect of bracket base morphology and orthodontic bonding agent together had a suggestive impact on bond strength so that certain base designs may evolve penetration of adhesive promote bonding process, also during removal of bracket, bracket base effected on the enamel surface destruction (47).

The base can provide mechanical retention, most common metal brackets with welded mesh base but this type during deboning easily deformed of the components of network-based brackets so leaving mesh wire attached to the teeth (48).Thus restore the solder as a technique to connect the foil mesh to the bracket base to overcome staying of fine network branches on the enamel surface (49).

However the bond strength of the foil mesh brackets is affected by diameter of wire mesh, also number and size of opening per unit area, also the free size available affects resin penetration, which also depends on the filler size (6).The microscope expose the air blanks in the adhesive / base interface, probably caused by polymerization shrinkage or by air intra pigmentation during bracket placement. Although the literatures provide inconsistent reports on the influence of using different designs bracket base on shear bond strength, Study of two metal brackets, one with a single – mesh bracket base and the other with double - mesh bracket using Trans bond XT Adhesive St ©. The results were showed that both single and double mesh bracket base have the same comparable shear bond strengths and bracket failure modes (50).

For more aesthetic consideration ceramic brackets used, in (1997) Wang et al found no statistical difference in bonds strengths between ceramic and metal bracket just on enamel detachment which happen only when ceramic base chemically coated with consequently higher bond strengths. Some ceramic brackets use a silane coupler as a chemical mediator, Silane treatment of a smooth ceramic bracket base integrate the silica component of bracket with the composite resin to produce a chemical bond (51).

The ongoing challenge is to develop a relationship between orthodontic attachments and enamel that are strong enough for survival treatment but can be broken for deboning without damage to the surface of enamel (50). And in Comparison between metals and ceramic brackets concluded that during deboning mechanically-ceramic brackets have a risk of enamel damage while no greater risk when deboning metal bracket (52).

1.6 Bond strength testing

Van Noort et al (1989) and Rueggeberg (1991) both have suggested the procedures for the measurement of bond strengths need for standardization of test to allow usable comparisons to be made between different bonding agents (53, 54). Also Fox and Mc Cabe (1994) approved standardization of bond strength testing (55).

Hobson and McCabe (2002) investigated the relationship between distinction enamel etch and resin-enamel bond strength 28 patients had the buccal surfaces of teeth for 28 patients had etched and replicated for examination under the scanning electron microscope. No statistical difference was found in etch patterns between upper and lower teeth. However mean bond strength various significantly between different tooth types, with the lowest bond strength found on the upper first molar and the highest on the lower first molar (56).

Bishara et al(2002) Aljubouri et al (2003) were found Brackets bonded with the SEP have a considerably lower mean shear bond strength compared with those bonded with a conventional two-stage adhesive system (50, 57).

Universal testing machine (Instron) was used for measuring shear bond strength since it give precise value and popularly used, this machine is capable of delivering a controlled and measured force to the bonded bracket via its moving crosshead.

Compressive fracture resistance test by universal testing machine is an important method used for measure the shear bond strengths of different types of orthodontic brackets bonded to extracted teeth, although it has a lot of advantages but the major disadvantage is that because in vitro shear bond strength test so does not accurately proliferate the clinical situation. While in the mouth there are multiple forces shear, tensile and torsion applied onto orthodontic brackets, whereas in vitro studies the universal testing machine is able to producing only pure debonding forces (shear, tensile or torsion) not the combination of them. More over the rate of loading for the machine is stander while in vivo studies are not constant (11, 58).

In spite of limitation of shear bond strength test to represent the real bond strength still continue as clinically relevant method used for comparison of bonding with different protocols and give significant awareness on bracket debonding clinically (59).

Reynolds reported that the clinically optimal bond strength is about 6 to 8MPa, while Retief mentioned that the enamel could fractured with bond strength as low as 13.5 MPa (6).

The bracket bond must be capable to withstand forces from orthodontic mechanics and by mastication, on the other hand the bond strength of adhesive system (bracket, adhesive, enamel) affected by several factors such as bracket base design, type of adhesive and bracket, storage media, enamel morphology, clinicians technique and the system of appliance force (60).

2. MATERIALS AND METHODS

2.1 Specimens collection and storage:

Forty upper and lower premolar teeth were used in this study, which were extracted for orthodontic reasons, mainly in severe crowding orthodontic cases, consequently achieved easly. All of the teeth were collected from the Orthodontic Department of Istanbul Yeni Yüzyil University, Dental Faculty. All teeth samples were selected carefully and examined by normal light conditions to assessment suitability of inclusion criteria. The samples were normally distributed, as assessed by Shapiro-Wilk's test and as showed in the table 1 below:

Table 1: Distribution of samples

Tests of Normality			
Group	Shapiro-Wilk		
	Statistic	df	Sig.
3M group (1)	.950	20	.363
BİOFİX group (2)	.913	20	.072

After extraction of the teeth, the teeth samples were placed in glass bottle filled with distilled water and the water changed every a week to inhibit bacterial growth, Samples were placed within dark place at 37°C (fox et al, 1994) (55). Then randomly separated into 2 groups each group contain 20 teeth.

The criteria for teeth samples were as following:

- Labial surface of enamel is intact.
- All samples were place in distilled water immediately after extraction
- No caries, no cracks, no any enamel defect.
- No restoration over the crown.

Figure 1 : Teeth were placed in glass bottle.

2.2 Material used in this study:

2.2.1 Bracket type

Forty premolar Elegan l .018 roth ceramic brackets manufactured by (Fairfield Orthodontics 410 Surf Ave.Stratford. CT 066 15 USA) were used to be bond to both two groups, the base of the bracket is characterized by rank design in which they have three groove base super good bonding and to ensure that all specimens have the same bracket base criteria all the brackets used in this study were bought from the same company.

2.2.2 Bonding system

Group 1 the orthodontic Transbond XT bonding system was used in this group described according to 3M Unitek, Monrovia, California as a light cure adhesive system available in both syringe and capsule bond metal and ceramic brackets to tooth surfaces . the properties of product are quick metal/ceramic bracket cure, extended working time which allows accurate bracket placement, immediate bond strength, efficient bonding of ceramic and metal brackets, excellent handling properties where no bracket drift and easy flash clean-up, no waste of materials. The syringe type was used in our research which easy to applied and more convenience to the clinician.

Figure 2: Materials of group (1).

Group 2 brackets fixing adhesive BIOFIX light curing was used in this group described according to BDP Biodynamic Dental Products LDA, Parana – Brasil as a single component bonding system to fix plastic, metal and ceramic orthodontic brackets to the dental surface, no need to using primer which mean one step adhesive technique, available in shape of 4g syringe which used in our research, it composed of Bisphenol A Glicidilmethacrylate, Dymethacrylate Groups, Inorganic filler, Titanium Dioxide, Sodium Fluoride and Catalyst.

Figure 3: Materials of group (2).

2.3 Experimental Procedures

2.3.1 Specimen embedding:

The teeth were placed in self-curing orthodontic acrylic resin by using of silicone mold available in square shape to be suitable and proper adapted with the square jig of Instron machine that used in our research, the tooth placed perpendicular in the medial of the mold with about 1mm down to cement enamel junction to facilitate placement of bracket. Afterwards, the specimens were placed in distilled water to avoid enamel dehydration.

Figure 4: Embedding of specimen in self-curing acrylic resin**.**

2.3.2 Enamel surface preparation and bracket placement:

Preparation of enamel surface for bracket bonding submitted in distinct steps. The labial surfaces of enamel were polished by pumice slurry by using rubber cup for 10 seconds, then washed by air/water sparing for 15 second then dehydrated by compressed air for 10 seconds, furthermore the labial surface of both experimental groups were prepared by using traditional etching protocol.

Group 1 – phosphoric acid etch, Transbond XT primer, Transbond XT composite

The labial surface of enamel was etched for 30 second with 37% ortho-phosphoric acid by using a syringe, then the etching surface washed for 15 second with water and dried by oil-free compressed air until the etched enamel surface had a frosty appearance. Transbond XT primer (3M Unite, Monrovia, California) was applied to etched enamel surface followed by a stream of oil-free compressed air to confirm that tinny layer of primer stayed before light curing for 20 seconds. Transbond XT composite was applied on the base of ceramic bracket, then applied directly to the primed enamel surface and placed in ideal position (mesio-distal and occluso-gingival) with a consistent force. The excess adhesive was removed from around the bracket by right angle probe and bonding material polymerized by ortholux luminous curing for 6 seconds mesial and 6 seconds distal to the brackets.

Group 2 –phosphoric Acid Etch, Biofix adhesive

The labial surface of enamel was dried without humidity or oil, then was etched with 37% ortho-phosphoric acid (attaque gel) during 30 seconds, the conditioned area was washed thoroughly by water for 30 seconds, after that dried by air and carefully applied thin layer of BIOFIX light curing on the bracket base, immediately the bracket was putted on tooth surface and adjusted to the correct position, pressed slightly to remain a thin layer of approximately 0.5mm and remove the excess, then light curing for a ceramic brackets during 10 seconds as described by the manufacture .

Table 2: **Test groups**

GROUP	DESIGNATED ETCH	PRIMER	ADHESIVE	BRACKET TYPE
1	Phosphoric acid (37%)	Trans bond XT	Trans bond XT	Ceramic bracket
2	Phosphoric acid (37%)	Nill	Biofix adhesive	Ceramic bracket

Figure 5: Polishing buccal surface of tooth

Figure 6: Etching of prepared tooth surfaces with 37% phosphoric acid .

Figure 7 : Washing surface of tooth from acid and dry it.

Figure 8 : Apply Transbond XT primer on etched surface.

Figure 9 : Curing primer for 20 second.

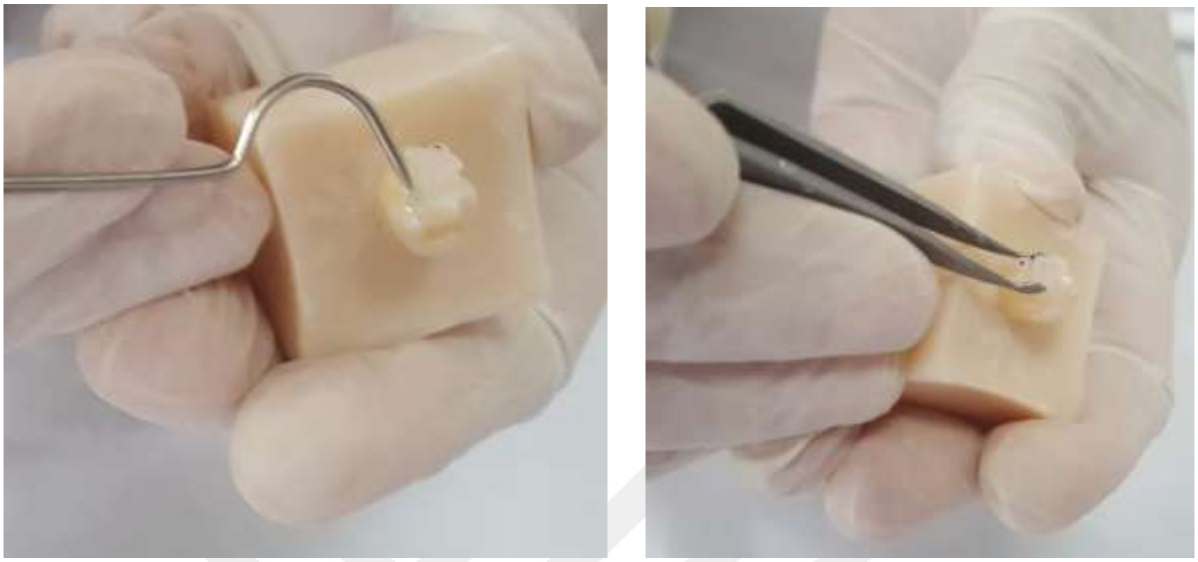


Figure 10: Placing the bracket in ideal position after Transbond XT composite was applied on the bracket base and then excessive composite was removed.

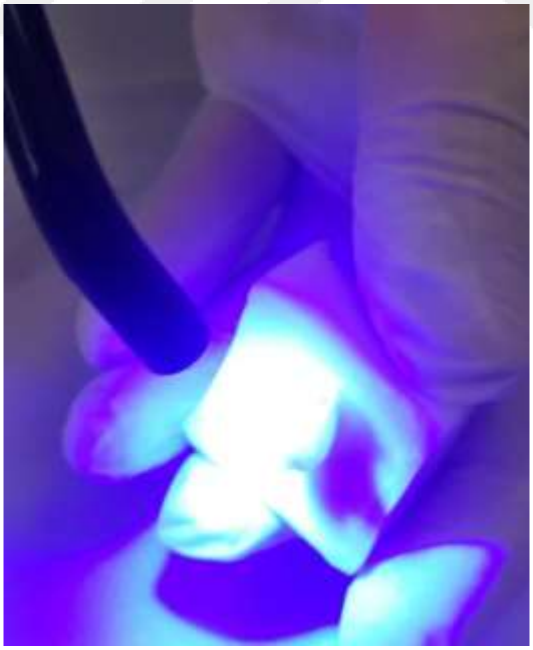


Figure 11: Polymerizing adhesive for 6 seconds mesial and 6 seconds distal of the bracket.

Figure 12: Bracket placement on the tooth surface

Figure 13 : Polishing buccal surface of tooth.

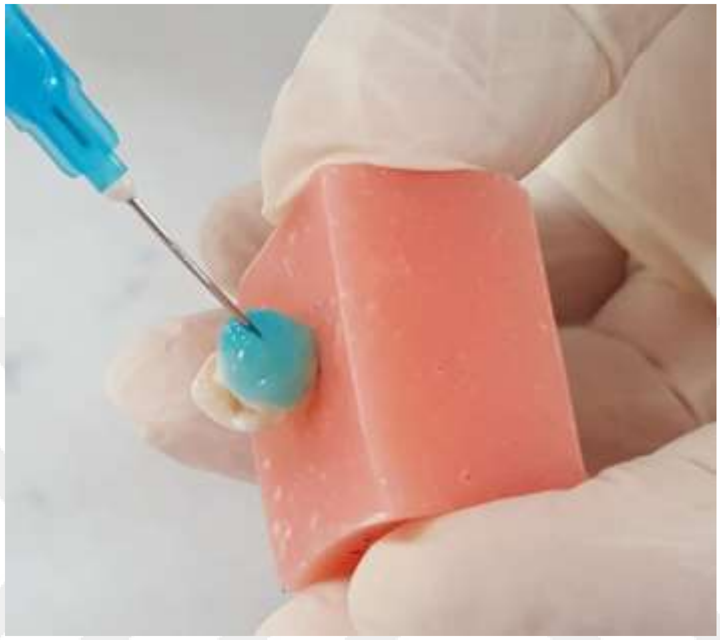


Figure 14: Etching of prepared tooth surfaces with 37% phosphoric acid.

Figure 15 : Washing surface of tooth from acid and dry it.

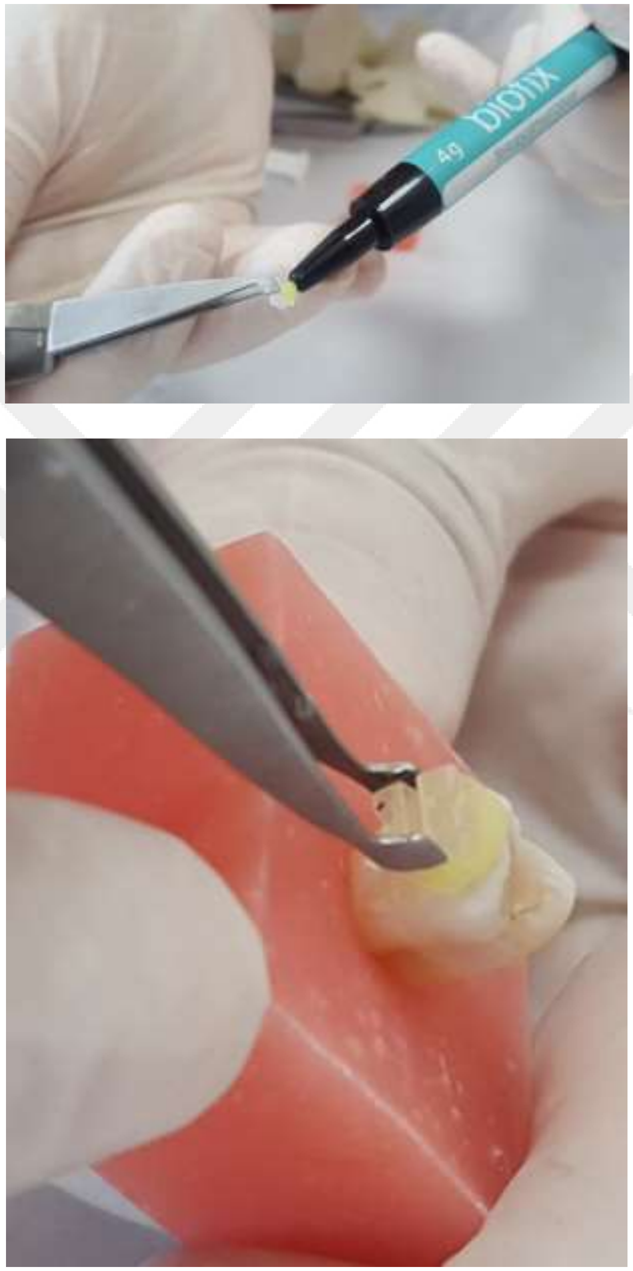


Figure 16: placement of adhesive on the bracket base and positioned at tooth surface directaly after etching.

Figure 17 : Excessive composite was removed.

Figure 18 : Curing for 10 seconds.

Figure 19 : Placing the bracket in ideal position.

2.4 Shear Bond strength testing

Before starting the test permission was signed by the researcher, the supervisor and the director of the laboratory .the test of shear bond strength of our research was done in the laboratory of hard tissue at Bazmialem Vakif University, for evaluation of shear bond strength Instron Universal Testing Machine had used (The Shimadzu Autograph AGS-X series model 3655, Japan) with capacity of 5000 Newton, it provides superior performance and practical testing solutions for a wide array of applications. Offering high-level control and intuitive operation, the AGS-X series sets a new standard for strength evaluations while providing the utmost in safety considerations in a modern stylish design.

Each embedded specimen was gathered in customized jig in the lower cross head of the Instron Universal testing machine The jig had a square hole into which each brass mold was fixed. The brass mold could be adapted, allowing shear forces to be directed at right angles to the long axis of the bracket body. Specimens were mounted purposely to direct the applied force occluso - gingivally and parallel to the labial tooth surface. The blade was perpendicularly oriented on the bracket base and an occluso-gingival force was practical at a crosshead speed of 1mm/min. Keep the distance fixed for each specimen because any increase in distance from the tooth would increase the bond strength (Katona, 1997)(59). During testing procedures the Instron had a 2 KN load cell and cross-head speed of 1.0mm / min (Sunna and Rock, 1999) (2). The Instron machine connected to electronica reader that records the value of maximum lading applied at failure in Kg and Newton and this data were consequently altered to megapascals (MPa) as a ratio of Newton to surface area of the bracket using the following equation:

$$MPa = \frac{\text{Load (mass) (kg)}}{Bracket\ base\ area}\ X\ gravitational\ acceleration\ \ constant\ (9.81)$$

1 Kg = 9.81 N

1 MPa = N / mm2

The bracket base size was established by taking the average sum of the widths and lengths of the bracket measured by using digital calipers. The applied force creates tensile stress that tends to peel the bracket away from the tooth surface, because of that the term ‘shear–peel’ is more accurate to use in the texts to concede this phenomenon than ‘shear–bond’ (Katona, 1997) (59). In vivo, various forces are applied onto the brackets and stress distributions created within the adhesive are complex (combination of shear, tensile and compressive force systems).therefore the Instron machine is more likely to produce shear-peel forces that imitate the clinical status even though never truly represent it (Tavas and Watts, 1979).

igure 20: Testing the shear bond strength by universal testing machine.

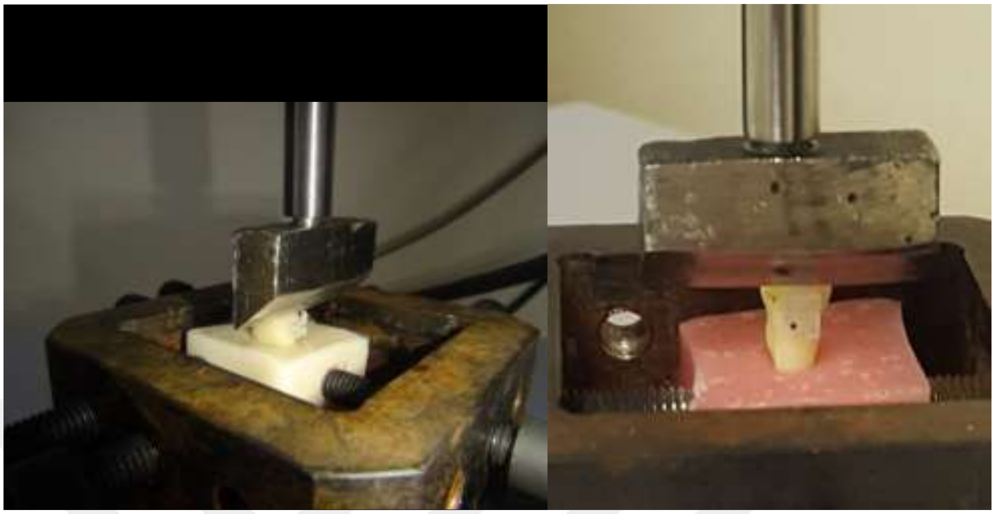


Figure 21 : The teeth during the test inside the machine.

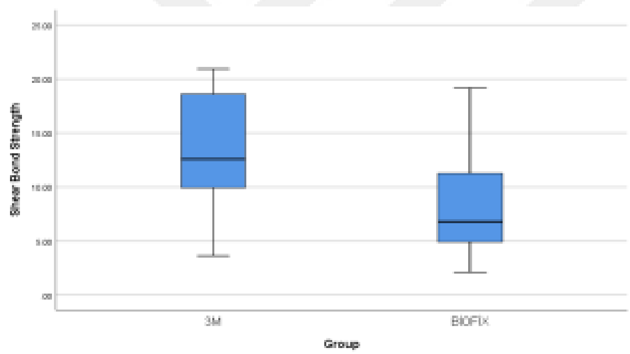
Figure 22: Instruments used during the preparation

2.5 Statistical analysis

Statistical analysis was performed with SPSS (statistical package for the social sciences) v.25 (IBM, New York, NY). Statistical significance level was established at $p < 0.05$.

3. RESULTS

The shear bond strength of Transbond XT adhesive (Group1) was significantly higher than the Biofix adhesive (group 2) by average (13.34) and (8.40) respectively, as showed in the Bar chart below.



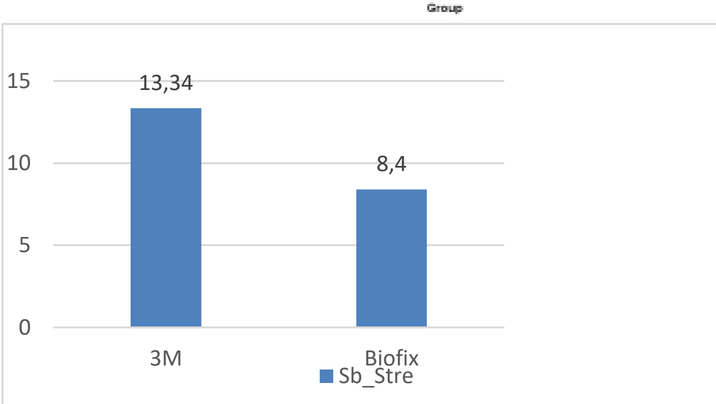


Figure 23: Bar-chart of shear bond strength in MPa between two study groups.

The Bar-chart show the mean shear bond strength of **group 1** was significantly higher than the **group 2 .**

Table 3: Mean shear bond strengths (MPa) of the 3M and Biofix groups.

Group	N.	mean	Standard Deviation	Minimum	Maximum	95.0% CI for Mean	
						Lower	Upper
3M (1)	20	13.34	5.38	3.65	20.96	10.82	15.85
BİOFİX (2)	20	8.40	5.05	2.13	19.18	6.04	10.76

Table 4: Comparison of shear bond strength between groups one and two:

	T	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Shear Bond Strength	2.994	0.005	4.94	1.60	8.28

Data are mean ± standard deviation, unless otherwise stated. There were 20 ceramic brackets luted with 3M and 20 others luted with BİOFİX. An independent-samples t-test was run to determine if there was a difference in shear bond strength between the two groups. There were no outliers in the data, as assessed by inspection of a boxplot. Shear bond strength scores for each group were normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$). The shear bond strength was greater in 3M group (13.34 ± 5.38) Mpa than Biofix (8.40 ± 5.05) Mpa, a statistically significant difference of 4.94 Mpa (95% CI, 1.60 to 8.28), $t = 2.994$, $p = .005$

4. DISCUSSION

Accomplish efficient and durable shear bonding between enamel, adhesive and orthodontic brackets is necessary in orthodontic practice. The mechanical bond to be qualified requires a dry environment, therefore any contamination during bonding procedure concession the bond strength completely and is supposed the most common reason for bond failure. To reduce the probability of contamination and defeat this problem is by do the bonding faster and reducing the chair side time (61, 62).

Conventional adhesive system uses three different agents (enamel conditioner, primer solution and adhesive system). The reduction in the number of steps for bonding procedures reduces the chance of contamination during bonding and decrease the chair side time for orthodontic treatment.

To facilitate orthodontic clinical bonding steps and to preserve chair time, modern materials have been constructed, which decrease the steps of bonding as introduction of self-etching primers, because they combine the etching and priming steps. And another utilized material no need to using primer which mean one step adhesive technique as here in our study by using Biofix adhesive. According to studies, the conventional multi-step adhesives showed the highest bond strength, the self-etching primers simplified bonding procedures which give an undesirable decrease in bond strength value but acceptable, many disruption and doubt enclosed the use of sealants and primers in orthodontic bonding (28, 63).

Research has been consecrated to define the accurate function of the intermediate resin in acid etch procedure. The findings are forked. Some investigators conclude that an intermediate resin is necessary to achieve proper bond strength: some indicate that intermediate resin is essential to improve resistance to microleakage, others appear intermediate resin is required for both reasons, still others do not think that intermediate resin is necessary at all. Here in our study no intermediate resin had been used and shear bond strength value decreased but accepted (64, 65).

The bonded brackets should be able to withstand forces generated by treatment mechanics and occlusion, and permit easy debonding without damage to the enamel, researches informed that maximum tensile bond strength of 5.9 to 7.9 MPa would be sufficient to resist treatment forces but in vitro tensile strength level of 4.9 MPa have confirmed clinically acceptable. In 1975, Reynolds24 reported that shear bond strengths in the range of 5.9 to 7.8 MPa were needed to substantiate normal oral and orthodontic forces (6). The mean bond strengths in this study were in an acceptable range, between (8 and 13) MPa. In this study, an in vitro bond strength characterization was chosen due to the relative simplicity, increased reliability of simulating debonding techniques and mode of load application by shear force. Shear bond strength was tested, because most masticatory forces are of a shearing nature.

The test result shows that the shear bond strength values of the single component bonding system Biofix and the Transbond XT are comparable. Although, the shear bond strength values of different adhesive systems were varying in the current study, they are still in the clinically acceptable range between 8 and 13 MPa.

Visible light-cured composites may have some clinical advantages over the chemically cured composites. They give more working time which is helpful in definite bracket adaptation, including their relative ease of use, improved bracket placement possibilities, and faster setting of the composite. In orthodontics, brackets and attachments are bonded for a limited time. The requirements of sufficient bond strength, ease of debonding, and limited risk of permanent damage to the enamel surface are thus critical in orthodontics (66, 67).

By attaining an optimum marginal integrity in the interface between the tooth surface and bracket base this is the perfect solution for minimizing bracket loss . Besides, the tighter the seal between the bracket-adhesive-enamel, the less micro leakage of plaque bacteria is possible also demineralization and white spot lesions less occurred (68, 69).

The reduction of steps during the new bonding procedure lessens the probability of contamination, the orthodontist has to decide whether the time and steps saved during the bonding procedure as well as decreasing the risks of contamination equilibriums the additional cost incurred when using the new bonding systems. To reduce chair time both for the patient and the practitioner, varied alterations have been brought to the orthodontic community. Respecting to the bonding process of conventional brackets, not only orthodontic adhesive and self-etching priming systems but also high-quality light-curing devices have to be noticed (70).

By escape of contamination and make the bonding fast and accurately could be a key point for the current scenario. By using the new composite system Biofix, the chair side time can be reduced and will also be cost effective. The current study is in conformity with the manufacturer’s assume, that by using Biofix we can have sufficient bond strength, reduce the chair side time and cost by avoiding the primer application step.

Bond strength of orthodontic brackets has been studied largely, with wide range of data and publications. The typical orthodontic bond should ensure that the bracket rested bonded to the teeth surface during duration of treatment, withstanding orthodontic and orthopedic forces. In addition the attachment should be easily removed without causing any injury to teeth surface when treatment finished (6).

Ceramic brackets were introduced because of most of orthodontic patients ask for aesthetic, since their introduction, design and performance has greatly improved and with superior aesthetics and the resistance to discolorations are quite accepted, but some clinicians attentive about their bond strength.

Ceramic brackets are available in many forms, the brackets made of monocrystalline which are the expensive one and have excellent aesthetics, while brackets composed of polycrystalline that are less expensive with comparatively poorer aesthetics. However the most important requirements of the ceramic brackets are to be able to provide adequate bond strength during the orthodontic treatment in addition to easy debonding and subsequently minimal damage to the enamel surface, the majority of ceramic brackets based on the mechanical retention to form an acceptable bond, ceramic brackets allows more transmission of light onto the bracket base resulting in high polymeriazation of the adhesive and thus providing a high SBS.

In previous studies designate that ceramic brackets produce stronger bonds than the metallic orthodontic brackets. Arhun et al (71). Informed that the high strength and difficult debonding for ceramic brackets may be assigned to the tight adhesion of the ceramic bracket to the adhesive in the absence of microleakage. Similar to the opinion of Arhun et al we thought incomplete polymerization of the adhesives under metallic brackets may clarify this difference, some investigators illustrated a number of reasons that affect the final degree of cure of a resin, These included the chemical structure of the dimethacrylate monomer and the polymerization conditions including, atmosphere, temperature, light intensity, photo-initiator concentration, filler type, shade of adhesive resin, and the reflective features of adhesive resin (72).

In our study, we aimed to evaluate and compare the SBS of Ceramic orthodontic brackets bonded with two bonding systems under laboratory conditions. We used natural human teeth, so we have increased the variability of the bond strength moreover, to be closely approximates the clinical condition human teeth had been used with respect to tooth morphology. The teeth of similar sizes and shapes were selected to decrease the possible variations and errors. All extracted teeth were stored in storage media until further processing; the storage medium maintains the chemical, physical and mechanical properties of extracted teeth and to prevent dehydration of the teeth. The major storage media used for natural human teeth are formaldehyde, ethanol, chloramine, freezing, water, distilled water, saline solution and thymol.

In our study, we used distilled water as a storage media for extracted teeth, which believed as one of the best storage medium able of establish adequate results related to enamel and dentine characteristics. Silva et al. (2006) compared the effect of the storage time and type of storage on bond strength of extracted tooth. They reported that extracted teeth stored in distilled water provided less variation in bond strength values (73).

In our study specimens embedded in self-polymerizing acrylic resin; silicon mold had been used as model for resin. The teeth have been embedded in acrylic resin blocks to imagine cortical bone, the cemento-enamel junction of teeth should be situated approximately 2 mm above the level acrylic resin to assume bone crest.

Before performing mechanical tests the enamel surface should be polished, then rinsed with air/water and dried with a steam of oil free compressed air. Kimura et al (2004) had reported that cleaned tooth surfaces have a high surface energy that is more able to bonding (74). In our study, the labial surface of enamel was polished with no fluoride of pumice because application of fluoride on the surface can reduce the surface energy of the adherent and loss the ability of the adhesive to spread.

Garcia-godoy et al.1991, had reported that the topical application of fluoride can interfere with etching effect of phosphoric acid on enamel surface resulting in reduced bond strength of dental resins (75). Also Aasenden et al (1972) had reported that the bond strength might affect by fluoride deposits in hydroxyapatite to form fluor-apatite (76).

In this study, we used the same etching protocol for enamel preparation at two groups, and the same polymerization technique by using an ortholux luminous curing system (3M unitek) with instant of 1600 mm/cm. The ortholux luminous light with a combination of high intensity LED lamp and 8 mm light guide optimized for orthodontic bonding and efficient curing time.

The serious method used to measure the shear bond strength of several orthodontic braces which were attached to extracted teeth, is the compressive fracture resistance test by universal testing machine. There are good quality and drawbacks to such testing and its importance to clinical practice is doubtful. In vitro shear bond strength testing does not precisely express the clinical condition, though; it does give suggestion of potential or expecting bond strength in vivo. In fact, potential loading would be complex with the following acting as stresses on the (enamel adhesive) and (adhesive bracket) interfaces: Multi-directional loading during function such as mastication and pressure introduced by application of orthodontic force, (ligature of an arch wire). Recommendation for standardization of bond strength testing was introduced by Fox et al (1994). However a problem would appear in vitro investigation: Enamel surface structures of extracted teeth may differ from in vivo due to dehydration during storage and bracket removal by using shear force only (55).

In our study, the mounted specimen were placed inside an adjustable vice for shear bond strength (SBS) testing in push pull instron Universal testing machine. Test was carried out by using a chisel edge mounted on crosshead of the testing machine. Each tooth was pointed such that the chisel was parallel to the bracket base and at equal distances to both incisal tie-wings. The chisel-type working tip was placed in the occluso-gingival direction in contact with the bracket-enamel junction, producing a shear force at the bracket-tooth interface until the bracket deboned.

In our study, the speed of the cross head was set at 1 mm/min, load was determined using 2 KN load cell and recorded by the attached computer. The same de-bonding procedure was performed for all of the study samples. Katone et al (1997) reported that increase in distance from cross head of the instron universal testing machine to occlusal tie wing of bracket would increase the bond strength according to that axial loading that we did in our study may represent pointed occlusal forces which applicated at the same distance from the bracket/ resin interface in all samples, assisting to make the method of testing more precision (59).

Instron Universal machine was used for measuring shear bond strength since it is accurate and widespread. This machine is capable of transmitting a controlled and measured force to the bonded bracket via its moving crosshead. As was suggested, testing to failure in shear was quoted in Newtons and converted to MPa by dividing the value in Newton by the surface area of the bracket base.

SBS should be within an optimum range between 5.8 MPa-13.5 MPa to be supposedly “clinically acceptable” as recommended by Rossouw (Rossouw, 2010) about 10 MPa as mean value (77). Bracket failure at either of the two interfaces, bracket-adhesive interface or enamel-adhesive interface, has its own advantages and disadvantages (Bishara et al., 2007) (78). Failure at the bracket adhesive interface is advantageous as it indicates good adhesion to the enamel and is safer to deboned (Berk et al., 2008) (79). However, more chair time (Khoroushi et al., 2007) (58) is needed to remove the residual adhesive, with possibility of damaging the enamel surface during the cleaning process (Justus et al., 2010) (11). Also more enamel loss during cleaning is reported (Bishara et al., 2000) (60). In contrast, when failure occurs at the enamel-adhesive interface, less residual adhesive remains on the enamel and less chair-side time is needed for cleaning.However failure at this interface may cause enamel fracture while de-bonding (Berk et al., 2008) (79).

In our study, SBS of two step technique Transbond XT adhesive group was significantly greater than that one step technique Biofix adhesive group.

Mean shear bond strength different between test groups. the mean shear bond strength value 8.4 Mpa for (group 2) Biofix, and (group 1) Transbond XT bracket bonded with etch and primer had the highest mean bond strength of 13.33Mpa.

The bond strength of two study groups ranged between (8.4 and 13.33) Mpa which is sufficient for orthodontic purposes.

We have to mention that our study was an in vitro and the results are not essentially as those that would be realized in the oral environmental, future studies could use dyes to help measure the adhesive around the bracket base and clinically measure and assess decalcifications or white spot lesions around brackets bonded with Biofix, also investigate the extent of microleakage at gingival and occlusal sides of the orthodontic brackets bonded with Biofix.

5. CONCLUSION

1. The results of the present investigation showed that single component bonding system—Biofix adhesive had shear bond strength lower than Transbond XT adhesive but clinically acceptable.

2. Decreasing the number of steps during bonding, as the clinicians can reduce the potential for faults and contamination during the bonding procedure, in addition to save the time, less effort and less cost.

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