T.C

ISTANBUL YENİ YÜZYIL UNIVERSITY

HEALTH SCIENCES INSTITUTE

DEPARTMENT OF ORTHODONTICS

EVALUATION OF SHEAR STRENGTH OF THE BRACEPASTE ADHESIVE IN COMPARISON WITH 3M TRANSBOND XT ADHESIVE MATERIAL

MASTER THESIS

AYHAM HASAN HIJAZI

Supervisor

Prof. Dr. İlter UZEL

ISTANBUL

August 2019

ACCEPTANCE AND APPROVAL

T.C.

İSTANBUL YENİ YÜZYIL UNIVERSITY

HEALTH SCIENCES INSTITUTE

This study which was conducted within the framework of the Orthodontic Department was accepted by the jury as a Master`s thesis

Thesis Presentation Date: 2/8/2019

Prof. Dr. İlter UZEL
Istanbul Yeni Yüzyil University

Prof. Dr. Gökmen KURT
Bezmialem Vakıf University

Dr. Öğr. Üyesi Hüseyin Özkan
Istanbul Yeni Yüzyil University

DEDICATION

This thesis is dedicated to:

Thanks for God have blessed me in so many ways.

I dedicate my efforts to my parents (Hasan and Amal) for raising me so perfectly with all love and kindliness in world.

I would like to thanks to my lovely wife (Lamia) and my daughter (Amal), and my sister(Hadil) , brothers who supporting me during my education(Mohammed,Qutaiba,Sa

mi,Ghaith).

Fainlly warm thanks for all my teachers and friends who did not only teach me but also inspired me and contribution to building my knowledye thanks for everythings.

ACKNOWLEDGEMENT

The completion of this thesis could not have been possible without the participation and assistance of so many people whose names may not all be enumerated. Their contributions are sincerely appreciated and gratefully acknowledged. However, I would like to express my deep appreciation and indebtedness particularly to the following:

Prof. Dr. İlter UZEL, **Prof. Dr.M. Haluk İŞERI**, **Prof. Dr. Gökmen KURT**, **Dr. Göksu Trakyalı**, **Dr. Ayşe BAHAT**, **Dr. Huseyin ÖZKAN** and **Dr. Hale SAKA**. For their endless support, kind and understanding spirit during my study.

To my family and friends who shared their support, either morally and physically, thank you.

All of above, to the Great Almighty, the author of knowledge and wisdom, for his countless love.

I thank you

TABLES OF CONTENTS

DEDICATION iii

ACKNOWLEDGEMENT vi

TABLES OF CONTENTS vii

LIST OF TABLES ix

LIST OF FIGURES ix

ABSTRACT xi

ÖZET xii

ABBREVIATIONS xiii

1. LITERATURE REVIEW 1

1.1. Introduction 1

1.2. Enamel composition and properties 2

1.2.1. Enamel structure 2

1.3.1. Prophylaxis 3

1.3.2. Acid etch technique 3

1.3.4. Duration of etching 5

1.3.5. Etch pattern 5

1.4.1. Resin based composites (RBCs) 6

1.4.2. Glass ionomer cements (GIC) 6

1.4.3. Resin modified glass ionomer cements 7

1.4.4. Self-etch primer 8

1.5.1. Metal brackets 9

1.5.2. Plastic brackets 10

1.5.3. Ceramic brackets....10
1.5.4. Ceramic brackets strengthened by stainless steel....11
1.5.5. Design of bracket base....12
1.5.6. Adhesive pre-coated brackets....14
1.6.1. Bond strength testing....15
1.6.2. Unit measure the bond strength....15
1.6.3. Debonding direction and approach....16
1.7Visible light-cured (VLC) adhesives and use of high-speed curing devices....16
1.8Bracepaste® Medium Viscosity Adhesive....18
2. MATERIALS AND METHODS....19
2.1. Tooth specimens....19
2.2. Tooth preparation....20
2.3. Preparation of tooth surface....20
2.4. Power calculation....20
2.5. Bracket selection....21
2.7. Bond strength testing....29
3. Statistical analysis....31
4. RESULTS....32
5. DISCUSSION....35
6. CONCLUSION....40
7. REFERENCES....41

LIST OF TABLES

Table 1: Test groups.....21

Table 2: Test of normality: 32

Table 3: Comparison of SBS between two groups (MPa) :.....32

Table 4: Mean difference of shear bond strength in (MPa) between two study groups: 34

LIST OF FIGURES

Figure 1:3M Unitek Victory© series orthodontic bracket 10

Figure 2: 3M Unitek Transcend© ceramic orthodontic bracket.....11

Figure 3: 3M Unitek Clarity© series orthodontic bracket.....12

Figure 4: Used material 22

Figure 5: Polishing buccal surface of tooth. 22

Figure 6 : Etching of prepared tooth surfaces with 37 % phosphoric acid. 23

Figure 7: Washing surface of tooth from acid and dry it. 23

Figure 8 : Apply Transbond XT primer on etched surface. 24

Figure 9: Curing primer for 20 sec. 24

Figure 10 : Placing ceramic bracket with 3M adhesive 25

Figure 11 : Placing the bracket in ideal position after 3mTransbond XT composite was placed on the base and then excess composite was removed.....25

Figure 12 : curing for 6 seconds mesial and 6 seconds distal to the brackets. 26

Figure 13 : Apply MTP Light Curable Moisture Tolerant Primer on etched surface 26

Figure 14 : were bonded with the same bracket system but bonded by Bracepaste® Medium Viscosity Adhesive (AO). 27

Figure 15 : light curing for a ceramic bracket during 10 seconds as described by the manufacture. 27
Figure 16 : Laboratory set-up: Instron Universal Testing Machine. 30
Figure 17 : Intact premolar teeth. 31
Figure 18 : Instruments used during the preparation. 31
Figure 19 : Bar-chart of Shear bond strength in MPa between two study groups. 33

ABSTRACT

Evaluation of shear strength of the Bracepaste adhesive in comparison with 3 M Transbond XT adhesive materials.

A.HIJAZI

Department of Orthodontics, Yeni Yüzyıl Üniversitesi.

Purpose: The aim of this study is to measure shear bond strength of the Bracepaste adhesive and compare it with 3M Transbond XT adhesive material using cosmetic ceramic brackets.

Materials and Method: 40 extracted intact bicuspid, will be divided into two groups of 20 teeth each. Each group will be bonded with one type of bonding systems namely, the conventional component bonding system 'Bracepaste' and conventional light cured bonding system 3M Transbond XT. The shear bond strength in each group will be tested using (Instron) testing machine.

Conclusions: 1. The SBS of 3M Transbond XT on ceramic brackets bonded by using conventional acid etching technique is higher than Bracepaste adhesive on ceramic brackets bonded by the same etching technique.

2. Both 3M Transbond XT and Bracepaste adhesive have SBS which are clinically acceptable.

Key words: Shear bond strength , 3M Transbond adhesive , Bracepaste adhesive , ceramic brackets.

ÖZET

Bracepaste Yapıştırıcının Kayma Dayanımının 3M ile Karşılaştırılması Transbond XT Yapıştırıcının Malzemeleri.

A.HIJAZI

Ortodonti Anabilim Dali, Yeni Yüzyıl Üniversitesi.

Bu: çalışmanın amacı, Bracepaste yapıştırıcı ile 3M yapıştırıcının kayma dayanımlarının kozmetik seramik braketler yardımıyl kullanılarak karşılaştırmasıdır.

Materyaller ve metod: 40 çekilmiş sağlam insan premolar dişi, her biri 20 diş olmak üzere iki gruba ayrılmıstır. Her grup bir tipte bonding sistemi ile birleştirilmistir, Geleneksel bonding sistemi 'Bracepaste' ve geleneksel ışıkla sertleşen bonding sistemi 3M Transbond XT. Her gruptaki kesme bağ kuvveti (Instron) test makinesi kullanılarak test edilmiştir.

Sonuç: 1. Geleneksel asitle aşındırma tekniği kullanılarak bağlanmış seramik braketlerdeki 3M transbond XT'nin SBS'si, aynı aşındırma tekniğiyle yapıştırılan seramik braketlerdeki Bracepaste yapıştırıcısından daha yüksektir.

2. Hem 3M Transbond XT; hem de Bracepaste yapıştırıcısı, klinik olarak kabul edilebilir olan SBS'ye sahiptir.

Anahtar Kelimeler: Barcepaste yapıştırıcı , 3M transbond XT yapıştırıcı , makaslama direnci, kozmetik seramik braketler.

ABBREVIATIONS

GIC: Glass ionomer cement.
RBC: Resin bonded cement.
SBS: Shear Bond Strength.
RBCs: Resin based composites.
APC: Adhesive pre-coated.
MPa: Mega Pascal.
N : Newton.
µM: Micrometer
mm: Millimeter.
Sec: Second.
n : Number.
MTP: Moisture Tolerant Primer
AO: American orthodontics

1. LITERATURE REVIEW

1.1. Introduction

As fixed therapy relies on fixing brackets on teeth by bonding them of approximately two years. When choosing the adhesive that will bond the brackets to teeth we should keep in mind that it should have low failure rate, and it should not harm the tooth surface at debonding phase. despite the efficiency of an adhesive technique and any side impact on the tooth surface perhaps surveyed by carrying out in-vivo surveys, it is almost out of the question to separately examine various factors that affect a special adhesive material in the mouth(1). In-vitro surveys may standardize procedures for examining various adhesive techniques and products obtainable. A methodical review and meta-analysis(2). Had thoroughly mentioned the variables impacting in-vitro orthodontic bond properties examining and concluded that the empirical situations that extremely affect in-vitro bond strength were stored in water, photo polymerization time and crosshead speed. Moreover, the writers also assured that the test circumstances were not described rightly in many researches, which could have excessively affected the findings. However, surveys examining the influence of dental fluorosis on the shear bond properties of fixed appliances were not taken into account in their methodical review. The present review is a try to explain material-related, teeth-related (fluorotic vs non-fluorotic teeth) and other diverse variables that affect the shear bond strength (SBS) of fixed appliances.

The acid-etching approach was primarily developed in dentistry in(3). There has been some concern about the possible damage by acid-etching to enamel. In In 1955 Buonocore started using 85 % 30 seconds ortho-phosphoric acid and found that failure rate of acrylic restorations was reduced by etching the enamel surface(3).

The reduction in the failure rate is arised from degeneration of hydroxyapatite crystals in the enamel to make micro-voids into where the low viscous bonding agent can run(4).

- Material-related factors:

a. Kind of etching product.

b. Kind of brackets.

c. Bracket base dimension and shape.

d. Bonding materials.

e. Bonding to restorative materials.

1.2. Enamel composition and properties

1.2.1. Enamel structure

The enamel forms upon two stage of formation. In the primary stage the enamel is minimally calcified (30 % minerals). When enamel reaches the second stage water and minerals are fully included in the full width enamel (96%) mineral content thus enamel becomes the most calcified part of the human body. Enamel formation is a very complicated process which is ruled by the cellular control.

The main units of human enamel are prisms (rods) and interprismatic material. The enamel is built up by hydroxyapatite crystals measuring (60 – 70) nm.in width; the thickness of enamel is 25 nm. The enamel crystals of an adult are not perfectly hexagonal the can come with different outlines because of friction that happens between the prisms during the final stage of enamel maturation.

The rods are cylindrical packets of crystals with long axes. Around the rods we can figure out inter-rod region which contains crystals in different orientation than the intra-rods ones. The rod sheath is the region around and between the rods and it is known by the organic substance in it.

1.3. Tooth surface preparation

1.3.1. Prophylaxis

On the surface of the tooth there is a pellicle of protein thin layer that receives glycoprotein and bind it to the surface of the enamel. The literature advice to clean the surfaces before applying chemical etching in order to make the surface able to receive the etchant.

In common a brush or rubber bur is used to do the cleaning process. The prophylaxis agent should be abrasive as much as required to remove all the obstracles in front of adhesive material but without causing abrasion or any kind of damage to the surface. Silica and zirconium silicate are the most popular abrasives. In fact, it is reported that 10 μm from the enamel is lost when using abrasives and apply it by a low-speed brush bur.

1.3.2. Acid etch technique

In 1955, Buonocore's study on acid etching of tooth surfaces create from manufacture, where phosphoric acid putting together were utilized to gain proper retention of the coat to treated metal surfaces. This process raised the adhesion of acrylic filling when doing conservative treatments. Supported by investigations done by Silverstone (1974) and Retief, it has been found that etching by using acid solution of 20% to 50% concentration for 1 to 2 minutes result in high retentive capacity and advised for practical application(4, 5).

Phosphoric acid as an etching agent alters the enamel surface of in two methods:

- Dissolving a thin enamel layer.
- Producing the micro voids by melting the enamel rod limits.

In 1955, Buonocore submitted etching the tooth surfaces by applying 85 % phosphoric acid for 30 sec(3). In 1971 the enamel was etched with 50 % phosphoric acid for 2 minutes and approximated the damage of tooth surface to be between 5 and 25 µm in depth. Etching for 90 sec with 30 % phosphoric acid Fitzpatrick and Way in 1977 concluded a usual enamel loss of 9.9 µm (6).

In 1980, Pus and Way managed 50 bicuspids by applying 43 % phosphoric acid gel and another pool of 50 with 37 % phosphoric acid, and all for 90 sec. The enamel tissue findings were losses of average by 7.5 and 6.5 µm respectively. Wickwire and Rentz (1973) find that enamel damage increased with time when applied the etching on bicuspids so the time is another factor(7).

1.3.3. Concentration of etching

In 1978, measurements of tensile bond strengths with various concentrations of phosphoric acid (2-60 %), showed that with 16 % created the raised bond strength, but the results for 2 % acid were the same to those for 40 %. In 1986, after 1 minute application of 2 %, 5 % and 35 % phosphoric acid found no specific difference in tensile bond strength while the damage of tooth surface was extremely greater with 35 % acid than with 2 % acid.

The most proportionately convenient and regular etching fashion was depicted following applying of 30 to 40 % phosphoric acid.

1974, Rock indicated dentition managed with 30 % phosphoric acid have exceedingly more bond strengths than 50 % phosphoric acid(8).

So concentrations of Phosphoric acid with 37 % provides high bond strengths, clinically most popular used and also less harmful to tooth surface.

1.3.4. Duration of etching

In 1990, raising the bond strengths following reduction in etching time when bicuspids were etched for 15 and 60 sec by using 37 % phosphoric acid. In 1985, Barkmeier *et al.* in 1985, used 15 and 60 sec etching time, while in 1980 and Beech and Jalaly examined 5, 15, 60 and 120 sec intervals(9, 10).

All of them concluded no reduction in bond strength due to reduced etch times. In 1999, Osorio *et al* reported increase in shear bond strength when tooth surface was etched for 60 second the size of bonding agents remaining on the dentition was greater as well(11). Though a 15 sec etch still created a bond stronger than that needed for proper bracket bonding. They also mentioned that 15 sec etch time created a clean etch site following bracket removal.

In 1986, Carstensen surveyed 1134 incisors to measure the clinical failure rate of mesh-based metal brackets, following etching for 30-35 sec with 37 % phosphoric acid. During the 16 month of study period only 10 brackets were failed. In a 2th study between the effects of etching for 15-20 and 30-35 sec, concluded that 15 sec etch was enough for bracket bonding on incisors teeth(12).

1.3.5. Etch pattern

The bond strength studies have been done on extracted premolars. A big difference was observed in SBS between tooth structures, types and dental arch. For example, upper anterior have more SBS values than posteriors, the opposite income was observed in the mandibular teeth.

Different types of teeth have biological differences in patterns of etch which in turn affects bond strength. In 1974, Marshall *et al.* evaluated the etched enamel under the scanning electron microscope and mentioned an increased level of variation in etching system from tooth to tooth and in

different spots of the same tooth, following the same process of etching. Some regions in the enamel have thicker adhering prism less layer that immersed melting of the enamel and this was observed in premolars more than in molars. This lead the researchers to assume that premolars need less time of etching when compared to molars.

1.4. Adhesion and Adhesives

1.4.1. Resin based composites (RBCs)

The composite material is made of organic binder and filler. The monomer is used for bis-glycidyl methacrylate or Bowen's resin. The resin is dejected to free-radical adding. It has a reduced shrinkage rate of thermal expansion than methyl=methacrylate based adhesives. Anyway, it is a viscous material and it should be used with low viscosity dimethacrylate monomers in order to use it in clinic.

The up to date RBCs are filled with particles from 0.1 to 1 micrometre. The resins can be chemically cured or light cured.

1.4.2. Glass ionomer cements (GIC)

The first generations of GICs are luting cements, they are used in orthodontics. It is a fine-grain material which is not thick when set. The well-known ones are used for cementing bands. Type II GICs are restorative materials and Type III are lining materials.

The material subjected to hygroscopic influences during setting. To small amount of water causes dehydration and increases the excitability of the reaction, and damages the cement surface. Wilson and McLean (1988) reported possible issues in testing the bond strength by putting new mixed traditional GIC in water for 1 day before the test, causing elution the ions required theoretically for the formation of the cross linked polyacrylate chains(13).

The GIC fix directly to the enamel. The basic adhesion mechanism is derived from the acid's ability for cleaning, penetrating and roughening the enamel that reduces the surface energy and facilitating both mechanical and

chemical bonding. The carboxylic group in the polymer acid forms ionic bonds with metal ions.

In 50-75 % of orthodontic patients, the demineralization is happens on no less than one labial tooth surface at debonding. Indication of demineralization was accounted for as an imperative clinical issue following five long periods of dynamic orthodontic treatment at the point when GICs discharges fluoride, this will impact the lessening of demineralization and back off progression of caries, however the protection from caries just fractional. The counter microbial impact of the fluoride is affirmed. Notwithstanding, in Mill operator's examination 1999 made sense of that there is no distinction in decalcification esteems between patients encountering settled machine treatment with apparatuses that were reinforced with each glass-ionomer or composite adhesive.

1.4.3. Resin modified glass ionomer cements

GICs arranged to be blend with water-solvent resin monomers and watery poly-acrylic corrosive. Called (RMGICs), which known as materials that subjected to polymerization and acid-base response, which support the setting response in the dark.

Acid-base response is starts when powder and fluid are blended just like with any ordinary GICs. The response continues moderately gradually and creates a low pH(3). Cross-interface is started by an oxidation response or by free radicals discharged by the photograph polymerization impetus. A hard blend frames inside which the corrosive base response precedes. The advantage of RMGIC is that the photograph polymerize improves the setting all the more rapidly and diminishes the affectability of the materials to water. The concoction response proceeds after the light response that has started is finished. Extra favorable position of RMGICs over customary GICs is the near speed in the improvement of mechanical quality. The hydrogel stage isn't generally seen with regular concrete after light treatment on the grounds that the polymerization response in the monomer gives incredible quality to the

material. The polymerization reaction in the monomer gives great strength to the material.

1.4.4. Self-etch primer

The SEPs made from the chemistry under dentine bonding which contain meth acrylic acid would fix to dentine. Buonocore (1955) concluded that glycerophosphoric acid-methacrylate containing resin would fasten to acid etching dentine(3).

As an alternative to phosphoric acid, polyacrylic acids have been used because of it has less harm effect compared to phosphoric acid that leads to demineralization of enamel cover resulting. However, the bond properties were reduced as the result.

Recently, methods of mixing the priming and conditioning in a single container have been developed, the aim was to have effects on both enamel and dentin which enhance the cost effectiveness as well.

Methacrylate phosphoric acid in the SEPs is the element capable of generating the desirable effect. Phosphate Group on Phosphoric Acid Ester Methacrylate breaks down calcium and drives out it from the hydroxyapatite lattice. Instead of rinsing calcium, it is bind with the phosphate and integrated with the network when polymerization is polymerized. The profiling steps and the monomer in uncovered enamel bars are synchronized.

Transbond Plus© 3M Unitek is a primer used in orthodontic bonding. Developers assure this joined etch and primer can be useful in terms of time consuming for the gluing of fixed braces and White in (2001) mentioned the general time that we can reduced during orthodontic appliance gluing to be 65 %(14). Although there is doubtful about having less time, where pumicing and priming stages are omitted and SEPs must be blended on the tooth surface for 3 and 20 seconds. The product works efficiently in conditions with a less saliva control as developers guarantee. In this way, the disengagement of the enamel surface to expect salivary contamination may not be apparent when SEP is to be used. SEP is less critical technique on the grounds that the

materials withstand the saliva contamination. Fundamentally the properties are diminished in the test group that did not utilize air drying after applying SEP than the other two test groups, SEP with air drying and regular two-organize cement framework.

Utilizing of SEP depends on polishing of the surface of enamel prior to gluing. This step can be omitted in traditional procedures.

There are conflicting studies on the clinical fulfillment of SEPs and traditional etch and bond techniques.

The rate of attachments failure when we use one-step method is the same or more than the traditional two-steps technique and the procedure time are minimized, it is advisable to apply one-step adhesive approach routinely. Bond failure rates of brackets bonded with a SEP (Transbond Plus©) and a traditional acid-etched technique with control adhesive was examined by Manning *et al.* (2005) in his a prospective clinical trial. He concluded that the statistical difference was negligted. In 6 months, the bond failure rate for both groups (1.8 %) was low compared with other published data(15).

Significantly, more remnants were seen on tooth surfaces in case of using SEP. Also, the material property was higher in two-stage adhesive than the one-stage self-etching approach. However both products fulfilled well, indicating that insignificant differences in the material properties.

Hirani and Sherriff in (2006) examined glue strengths, failure spots of adhesive pre-coated brackets and traditional appliances when a SEP (Transbond Plus©) and conventional acid etching and conditioning were used. No difference was found and majority of deboning occurred at the adhesive-enamel interface(16).

1.5. Orthodontic bracket design

1.5.1. Metal brackets

The first metal appliance were developed by milling from cold drawn stainless steel, the base was developed to be cribriform to permit the glue to stream for mechanical interlocking.

The base design had a smooth surface and with cribriform in line. This design was altered into mesh bracket base-design which is favorable in terms of bonding and cleanliness.

Figure 1:3M Unitek Victory© series orthodontic bracket

1.5.2. Plastic brackets

They were made in 1970s. They were developed from of acrylic and polycarbonate and were presented as an esthetic option to metal one. Later on, there were a lot of problems with these brackets especially the color change and the bad odor. The great issue was their weak properties especially when metal ties were applied, and torque prescription cannot be expressed well.

Some edits were offered to overcome these problems such as adding a metal slots or even changing the whole composing materials (ceramics of fiber glass).

1.5.3. Ceramic brackets

Ceramic brackets have better appearance than metal brackets. They were firstly produced in 1980s. They are stronger than metal brackets as well as they are resistant to deformation and wear; they have better color stability when compared to acrylic brackets. Ceramic brackets have the superior aesthetics all over other kinds of brackets. They are made of aluminum oxide.

From one sapphire crystal, the first brackets were each milled using diamond tools. The latest (MCA) appliances are formed from defamation of artificial sapphire. Ceramic appliances do not make chemical attachment with acrylic and acrylate adhesives caused by inactive aluminum oxide structure. Consequently, the saline material was utilized in the former ceramic appliance

between the ceramic base and the bonding resins resulting in irreversible damage to the enamel.

In 1988, The American Association of Orthodontists conducted a study of members' skills with chemically-bonded ceramic brackets. The findings have led to recommendations on possible health issues with ceramic arches as well as they recommended orthodontists to explain possible hazard to cases as part of the informed consent step. The biggest amounts of ceramic braces depend upon mechanically retained method only applying standard adhesion and they do not need specific bonding agent.

The poly-crystalline alumina attachments (PCA) are developed by injecting casting of very small crystalls of alumina hanging in the resin and fusing them to combine the alumina to make an attachment and then machined to their ultimate shape. Polycrystalline ceramics have a high coefficient of friction due to their rough and more porous surface. Machined ceramic attachments cause more friction than metal ones.

In 1995, Birnie encouraged the use of non-sliding approaches with ceramic appliances, and recommended stainless steel appliances to the bicuspids in sliding approach(17).

Ceramic brackets can break when debonded. They are very hard and can cause serious abrasion to the enamel of opposing teeth.

Figure 2: 3M Unitek Transcend© ceramic orthodontic bracket

1.5.4. Ceramic brackets strengthened by stainless steel

They were produced to enhance the frictional specifications of poly-crystalline ceramic attachments, the manufacturing companies produced

reinforced metal slots to offer smooth friction method and extra properties (Clarity© brackets, 3M Unitek). Various metals are used in this production such as 18 carat gold which is reported to be much better than SS in relation to frictional resistance.

Figure 3: 3M Unitek Clarity© series orthodontic bracket

1.5.5. Design of bracket base

The design of the base of the bracket is assumed to influence the rate failure and an influence on the damage to tooth surface during bracket removal. The porous and undercuts on the surface of brackets guarantee mechanical interlock. Especially in stainless steel attachments, a network is fused into the bases. In clinical use the mesh must be thin and easy to remove from the teeth. Anyway, when removing the brackets the mesh can separate and stay attached to the tooth. Thus welded mesh was found to be weak.

The mechanical characteristic of foil-net brackets is affected via the size, thickness and width of the arch net and the number and volume of spaces per unit area. The standard size available influence the flow of the resin, that depends on the size of the filler as well.

There were bubbles of air at the bond / base side when tested under microscope may be because of contraction or due to retention of air during attachments bonding. Knox *et al.* (2000) evaluated the effect of base design and adhesive on bond property and found out that bonding agent had a significant impact on the property of the bond and that special base

morphology upgraded bonding agent flow or enhanced breakthrough of a light polymerization(18).

The research presents inconsistent findings on the infuence of thermo cycling utilizing various ceramic bracket types on SBS. The SBS of two stainless steel attachments was tested with a one net base and the other with a twin -net base using Transbond XT© bonding agent. The shear bond properties of each test groups were the same and the Adhesive Remnant Index (ARI) compares both kinds of bracket, the result was that there were the same bracket failure patterns. Those findings point out that the one and twin net bases have similar SBS and bracket failure.

Ceramic brackets provide better aesthetics, but it was concerning that they have harm on tooth surface on bracket removal. Statistically, there was no difference in bond strengths between ceramic and metal brackets. Tooth surface fractures have seen only in case of utilizing the ceramic bracket with chemically covered base. Silane treated ceramic base bonds to the silica component of the bracket with the composite resin to produce a chemical bond. Those brackets show unexpected and bond strengths considerably increased causing an increase in the tooth damage.

Producers sometimes put a notched base to ceramic brackets e.g. Transcend© 1000 (3M Unitek). The shear bond properties is less than silane treated brackets but more than metal. It has been recommended that the memory of microcrystalline material of ceramic attachment gives chances for harder connecting between brackets and bonding material than the stainless steel brackets. Habibi *et al.* (2007) examined the properties of debonding of metal and ceramic brackets and it showed that the percentage of damage of tooth surface in removal of ceramic bracket was higher than removal of metal bracket (19).

The stream now is to make orthodontic attachments that can bond to the tooth strongly enough to stand still till the end of treatment without having the disadvantage of damaging the dental material.

1.5.6. Adhesive pre-coated brackets

The pre-coated adhesive is a copy of Transbond© XT (3M Unitek), altered to give a high percentage of stickiness. It can combined with Transbond© Plus Self-Etching Primer (TPSEP). APC brackets are intended to reduce time and easy bracket placement.

The APC have a lot of advantages in front of conventional methods:

- Consistent quality and quantity of light-cured adhesive
- Easy to clean.
- Decrease excess material.
- Utilize infection-control.
- Control of supplies.

Moreover, better handling of the bracket and bonding material with the use of APC is showed better shear bond properties and the result is decrease the percentage of fail in clinic. The advantage of light-cured bonding material is that it helps the orthodontist to have more time to put the bracket on the tooth surface properly before light curing. The disadvantage of the polymerization process is that it takes more time to penetrate each placed bracket to light.

Increasing the stickiness of the bonding material used on APC brackets, in addition to the retention of the net imbedded in the base of stainless steel bracket, may expressively decrease the SBS. In response to this data, the company altered the bonding material used in the pre-coating (APC1 to APC2).

Reynolds (1975) suggested the clinically accepted SBS of 6-8 MPa (20). Sfondrini *et al.* (2002) announced higher bond strengths than this despite of the sort of light or bracket used (21). Light-curing for 2 seconds in micro-xenon light provide clinically acceptable bond strengths for the uncoated and pre-coated brackets. The patient and doctor benefit from time saving using micro-xenon light.

1.6. Bracket removal

1.6.1. Bond strength testing

Shear bond strength test is done to evaluate the adhesion potential force of bonding agent Barkmeier and Cooley (1992). In vitro bond strength tests are beneficial and necessary for foretelling the performance of bonding agents and potential association with problems in practice.

The researches have a huge number of subjects on the testing of bond strength of materials, the findings of which were coded by developers to uphold their materials. However, the studies have paid little interest to the specifics of the test process utilized and we need to standardize testing steps to evaluate bond strengths, to permit for comparisons without errors between various adhesive materials.

Hobson and McCabe (2002) examined the relation between the properties of etching agent of enamel and resin-enamel bond strength. Twenty-eight cases had the facial sides of dentition etched and replicated for evaluation under the scanning electron microscope. Statistically, there was neglected values between etch patterns in maxillary and mandibular dentition. However, the median adhesive properties varied considerably between various dentition kinds, with less bond strength found on the maxillary first molar and the major value on the mandibular first molar. A super etch pattern was not essential a good way to produce a robust bond (22).

1.6.2. Unit measure the bond strength

There has been disruption in the studies over the unit to measure bond strength appropriately. Units such as Pascal, Mega Pascal, and Newton per millimeter squared or Mega Newton per meter squared have been utilized. In a well-controlled area, the use of force as an indicator of bond strength is only suitable way, but it is complicated to record. As long as the proportions of the bracket base are determined, the use of Newton or Mega Pascal is convenient in determining bond strength.

1.6.3. Debonding direction and approach

Fox and McCabe (1994) examined an (Instron) or a similar testing tool was utilized in 58 out of 66 surveys. Instrument like pair of specially designed opening pliers and different other testing instrument was used. 44 of the surveys measured tested the samples in shear mode, 16 in tensile and 6 utilized a combination of directions.

Extra surveys evaluation that reported using an Instron testing machine manifests more variations in the technique and direction of bracket removal. Issues arise with the precise relation of the bracket and its link with the testing machine. The major parts of researches utilize a wire loop around the bracket to connect it to the device.

Unilateral forces to the test sample is major part of study into SBS with a universal testing machine was applied. The findings cannot be exercised to bracket removal. Debonding with sharp-edged pliers that apply a two-sided force at the bracket base-adhesive interface has been found to be an efficient approach of removal of ceramic appliance and its use *in vitro* mimics more neatly the removing forces exercised in a real clinical cases.

1.7Visible light-cured (VLC) adhesives and use of high-speed curing devices

Visible light-cured adhesives are very common for gluing brackets, this a normal phenomenon because they have a lot of advantages over the chemical treated adhesive materials, neither the less, they are easier to use and can provide well extended working time, it is also possible to move the bracket all over the tooth and also provides the ability to clean the tooth from the excess adhesive. Also, they have better physical properties because air is not impeded as it does not require mixing (23-25).

On the other hand, they have disadvantages the main one is the required time of exposure to curing device. The most used initiator is camphoroquinone, this material is sensitive to the blue light (450 to 500nm) wave length the peak of activity is at 480 nm (26).

The polymerization times of composite materials are decreased by argon lasers and plasma. The increased focus of the of light that are centered on the wave length of 480 nm is the most ideal activation to dental composite. The polymerization period that decreased by the plasma light will give highly light form the halogen light (27).

Argon laser plasma light and other height speed curing are used in orthodontic to enhance effectiveness, the effective of all this way is not completely know. The polymerization of composite material in restorative density that has been activated with laser and height in intensity light triggered the increase of shrinkage and microlekage (28-33).

When the percent of filler is decreased it will shrink the polymerization as Miyazaki mentioned.

The composite that had been cure with laser had shown that its bond strength is similar to halogen light (34, 35).

These light are save time for doctor and the patient by speeding up the curing (34).

The argon laser and plasma light have shown few surveys and provides bond strength that traditional halogen light (21, 27, 36-39).

The argon laser and plasma give increase microlekage around orthodontic bracket may raise the patient risk of demineralization of caries (40, 41).

1.8Bracepaste® Medium Viscosity Adhesive

Bracepaste is a medium viscosity, light-curable bonding agents that offers perfect bonding of stainless steel and ceramic appliances. The bonding agents are developed to reduce bracket drift and offer easy flash clean up. It permits arch wire to tie-in immediately after light curing, and fluoresces under UV light to help in clean up. BracePaste is stored at 25; and is appropriate with most light cure orthodontic sealants and bond enhancers.

2. MATERIALS AND METHODS

Measurement of SBS two adhesive techniques. SBS was measured using an Instron universal testing machine.

2.1. Tooth specimens

In this study we used 40 extracted teeth. Samples composed from upper and lower bicuspid teeth, already extracted for orthodontic treatment. The teeth had been extracted from patients presenting T.C Istanbul Yeni Yüzyıl University Dental Hospital. It is possible that all or the generality of the extracted teeth were taken from patients living in Istanbul.

The Human Tissue Act (2004) give a legal support for issue relating to body donation and the removal, use and storage of human body part and tissue. The storage and use of extracted teeth for study comes under these guidelines. In conformity with the Human Tissue Authority (HTA) guidelines, approval is not required from giver when anonym zed tissue is used for studies. This study was restricted and approved by the University of T.C Istanbul Yeni Yüzyıl Research and Ethics Committee.

Following extraction, the teeth were stored in sample jars containing distilled water (0.1 % weight / volume) to stop bacterial growth. Samples were thereafter stored in the dark at 10° +/- 5°. Testing time from extraction to nearly up to 12 months.

Inclusion principles for tooth samples were as followings:

- Undamaged labial tooth surface.
- Sample properly stored after tooth removal.

Exclusion principles were:

- Decays.
- Dental restorations.
- Gross enamel hypoplasia.

- Tooth surface disturbance.
- Fracture of tooth surface.
- Sample stored improperly after tooth removal.

A thorough dentition examination with applying a light surgery situation to measure suitability for inclusion. Apparent cracks was specified as those dentition with cracks discovered by direct visual inspection.

Jars having the stored dentition were put into a box and assigned in rotation to each of the three test pools by a procedure of materialistic randomization.

2.2. Tooth preparation

The teeth were occluded horizontally in an orthodontic acrylic resin contained within elastic boxes (cube) at cemento-enamel junction. The teeth were immersed so the facial surface of crowns was projected above the surface of the acryl. Samples were then put in 25 degree in filtered water, to protect the enamel from dryness.

2.3. Preparation of tooth surface

Preparation of tooth surface and bracket bonding was in a standard way as follows:

1. Cleaning and polishing with fluoride free pumice slurry using a rubber prophylaxis cup in a slow handpiece for 10 sec.
2. Washing with air / water spray for 15 sec and drying with a stream of oil-free compressed air for 10 sec.
3. Two test pools, each has 20 dentition, were prepared.

2.4. Power calculation

In our study, power analysis was carried out to determine the sample size. The specimen number was 17 for every pool in the analysis of the power analysis done with G * power 3.1 program and in the sample width analysis performed by taking 0.80 power value in 2 study groups (alpha

error probability = 0.05). A total of 40 samples was included in this study and categorized into 2 pools with 20 samples in each.

2.5. Bracket selection

Group A: were bonded with Elegan I Ceramic brackets (Fairfield). This is a ceramic twin bracket mimicking one's natural tooth color, and they sustain the change in color during the duration of the patient's therapy. The base matching have 3 grooves for retention purpose and bonded by transbond XT (3M Unitek).

Group B: were bonded with the same bracket system but bonded by Bracepaste® Medium Viscosity Adhesive (AO).

Table 1: Test groups

GROUP	Number of samples	Specified ETCH	PRIME MATERIAL	ADHESIVE	BRACKET TYPE
A	20	Phosphoric acid (37%)	Transbond ™ XT Primer	Transbond™ XT Light Cure Adhesive	Elegan I Ceramic brackets (Fairfield)
B	20	Phosphoric acid (37%)	MTP Moisture Tolerant Primer	Bracepaste® Medium Viscosity Adhesive (AO).	Elegan I Ceramic brackets (Fairfield)

Figure 4: Used material

Group A – phosphoric acid etch, Transbond XT primer, Transbond XT Composite.

Figure 5: Polishing buccal surface of tooth.

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

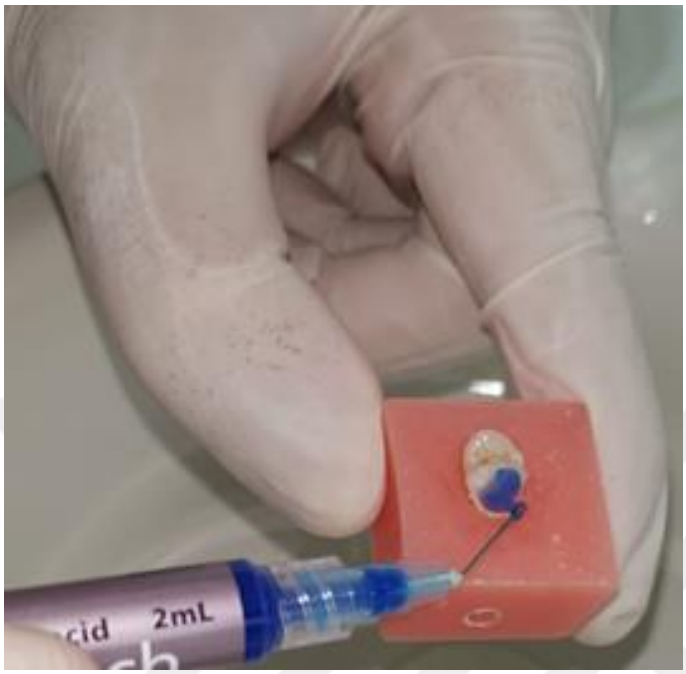


Figure 7: Washing surface of tooth from acid and dry it.

Figure 8 : **Apply Transbond XT primer on etched surface.**

Figure 9: Curing primer for 20 sec.

Figure 10 : Placing ceramic bracket with 3M adhesive

Figure 11 : Placing the bracket in ideal position after 3mTransbond XT composite was placed on the base and then excess composite was removed.

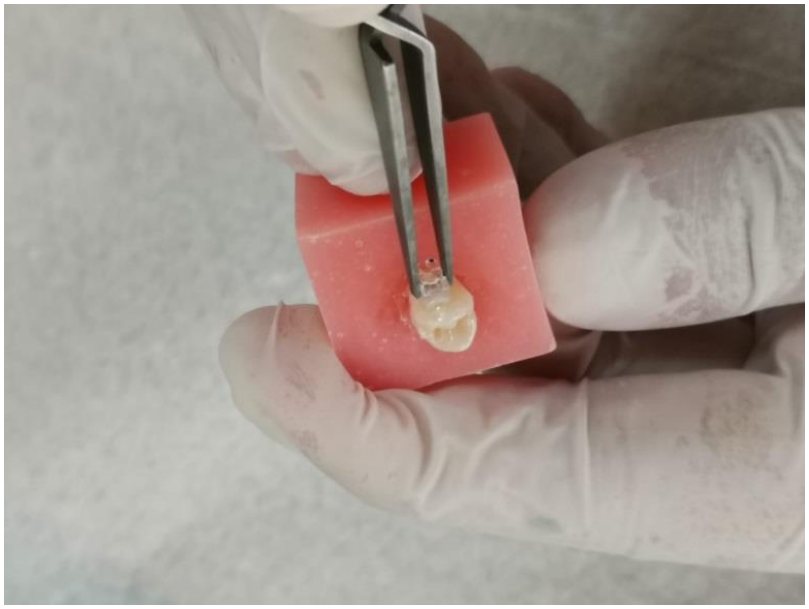
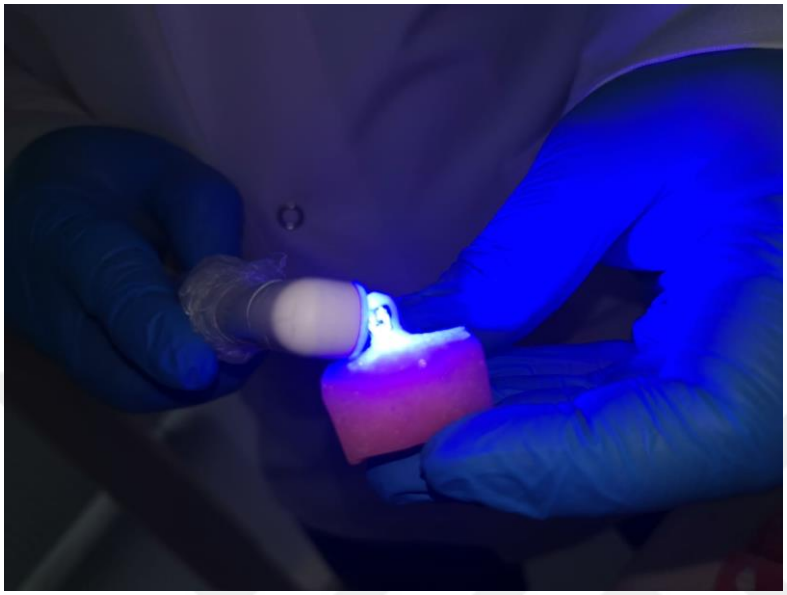


Figure 12 : curing for 6 seconds mesial and 6 seconds distal to the brackets.



Group B –phosphoric acid etch, MTP Light Curable Moisture Tolerant Primer , BracePaste adhesive :

Figure 13 : Apply MTP Light Curable Moisture Tolerant Primer on etched surface

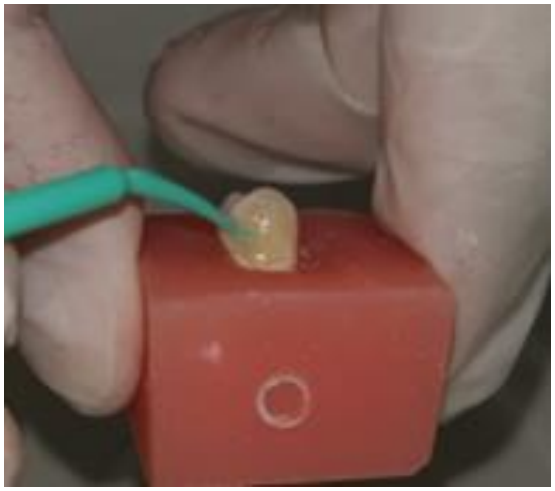
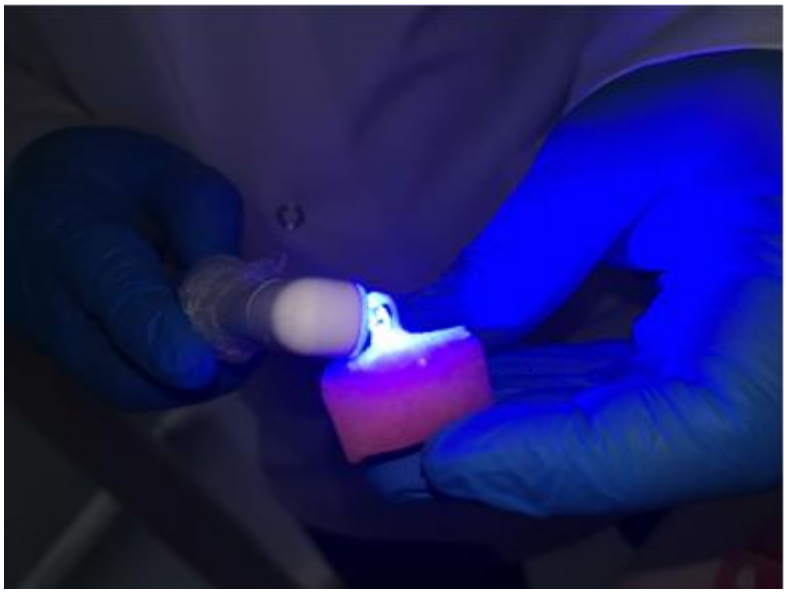


Figure 14 : were bonded with the same bracket system but bonded by Bracepaste® Medium Viscosity Adhesive (AO).

Figure 15 : light curing for a ceramic bracket during 10 seconds as described by the manufacture.



2.6. Bracket placement

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

The tooth surface on labial side was etched for 30 second using 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 till the white choky appearance abtained. Transbond XT primer (3M Unite, Monrovia, California) was put to etched tooth surface followed by a current of compressed air (oil-free) to guarantee that tiny coat of prim material remained before light curing for 20 seconds. Transbond XT composite was applied on the bracket base, then applied directly to the primed enamel surface and placed in ideal position (mesio-distal and occluso-gingival) with a consistent force. flash cleanup and 6 seconds polymerization adhesive material by ortholux luminous

Group B –phosphoric acid etch, MTP Light Curable Moisture Tolerant Primer, BracePaste adhesive

The labial surface of enamel was dried without humidity or oil, then was etched with 37% ortho-phosphoric acid during 30 seconds, the conditioned area was rinsed thoroughly by water for 30 seconds, after that dried by air , carefully applied MTP Primer then light curing and gently applied thin layer of BRACEPASTE Adhesive then light curing on the ceramic base, immediately the bracket was put on dental surface and adjusted to the correct spot, pressed slightly to remain a thin layer of approximately 0.5mm and remove the

Excess, then light curing for a ceramic bracket during 10 seconds as described by the manufacture.

2.7. Bond strength testing

Before starting the test permission was signed by the researcher, the supervisor and the director of the laboratory .the shear bond strength measurement of our research was done in the laboratory of hard tissue at Bezmialem Vakif University. The shear bond strength was examined by using Instron Universal Testing Machine, (The Shimadzu Autograph AGS-X series model 3655, Japan) with capacity of 5000 Newton, it offers ideal fulfillment and practical testing solutions for a broad range of uses. Providing high-level monitoring and intuitive procedures, the AGS-X series standardize strength measurement while offering the maximum in integrity vision in a modernistic, elegant way.

Each immersed sample was grouped in customized jig in the lower cross head of the Instron Universal testing device, each brass mold was fitted into a square hole in the jig. The brass mold could be set, allowing shear forces to be directed at right angles to the long axis of the bracket body. Samples were occluded intentionally to direct the applied force occluso - gingivally and parallel to the facial tooth surface. The blade was perpendicularly oriented to the bracket base and an occluso-gingival force was applied at a crosshead speed of 1mm/min. This dimension was constant for every sample; the bond strength is raised by rising in dimension from the tooth would increase the bond strength (Katona, 1997).

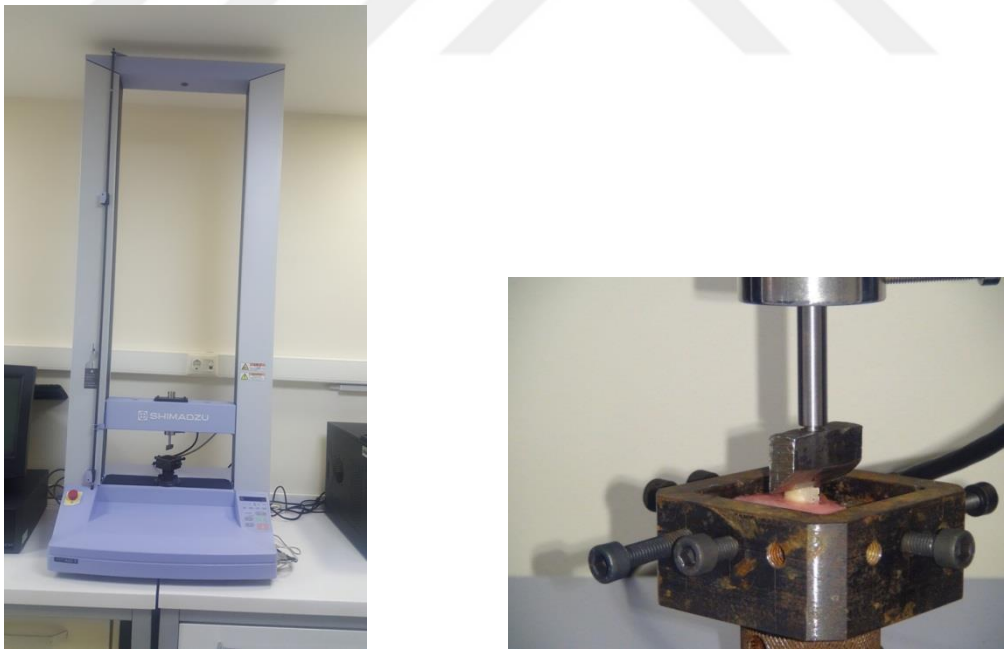
Through measuring procedures the Instron had a 2 KN load cell and cross-head speed of 1.0mm / min (Sunna and Rock, 1999). The Instron machine connected to electronica reader that records the value of maximum load applied at failure in Kg and Newton and this data were subsequently converted to megapascals (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 size of bracket base for every bracket kind was defined by taking the medium sum of the widths and lengths of 10 brackets gauged using digital devices. 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 study to confess this phenomenon than ‘shear–bond’ In vivo, different forces are applied onto the brackets and stress scatterings created within the bonding agents are complicated (combination of shear, tensile and compressive force systems). Therefore the Instron device is more likely to create shear-peel forces that imitate the clinical conditions despite it is never really representative of it (Tavas and Watts, 1979).

Figure 16 : Laboratory set-up: Instron Universal Testing Machine.



3. Statistical analysis

Statistical calculations were carried out with SPSS (statistical package for the social sciences) (2008) statistical software program for windows. Independent t-test was used to assess for a statistically significant difference in mean values between test groups for SBS. Equal variance t-test was done during the examination qualitative data. Statistical significance level was established at $p<0.05$.

Figure 17 : Intact premolar teeth.

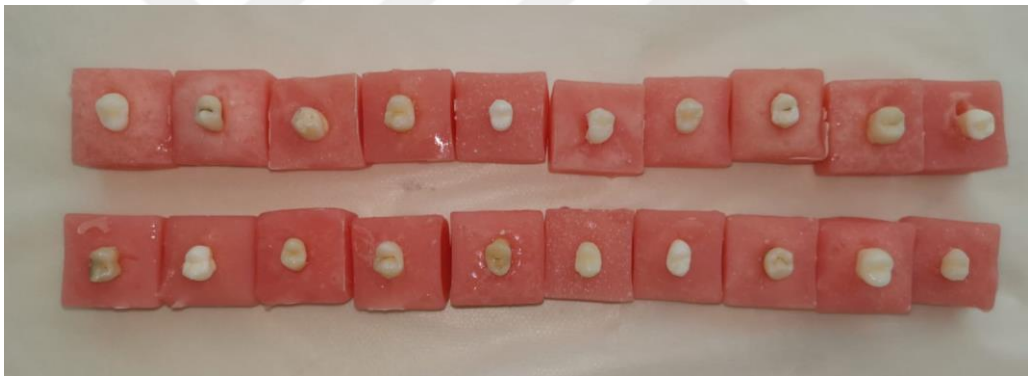


Figure 18 : Instruments used during the preparation.

4. RESULTS

The highest mean of SBS was for 3M transbond XT ceramic brackets bonded with etch and primer which was 12.8669 MPa. The lowest second mean SBS was for bracepaste adhesive for ceramic brackets bonded with etch and MTP primer was10.225.

(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).

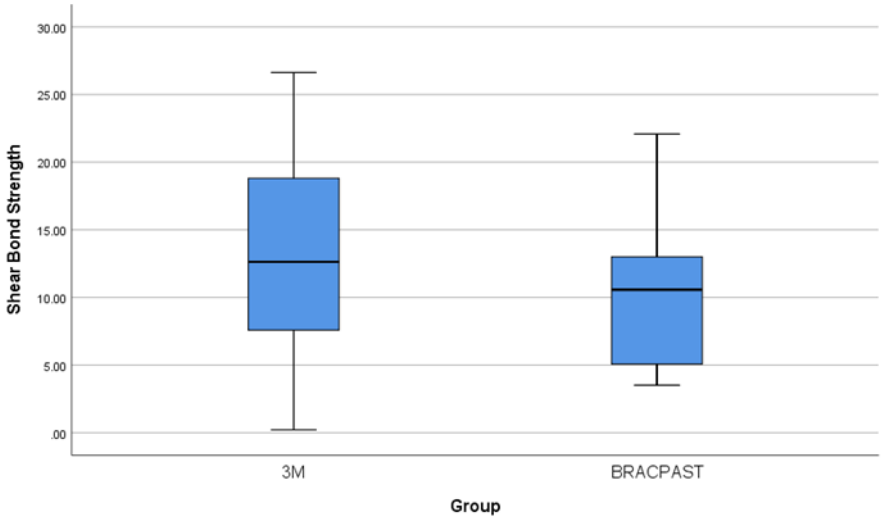
Table 2: Test of normality:

Group	Shapiro-Wilk		
	Statistic	df	Sig.
3M	.975	20	.850
BRACPAST	.914	20	.076

Table 3: Comparison of SBS between two groups (MPa) :

Group	N.	mean	Standard Deviation	Minimum	Maximum	95.0% CL for Mean	
						Lower	Upper
3M	20	12.87	6.70	.22	26.62	9.73	16.00
BRACPAST	20	10.22	5.49	3.51	22.08	7.66	12.79

Figure 19 : Bar-chart of Shear bond strength in MPa between two study groups.



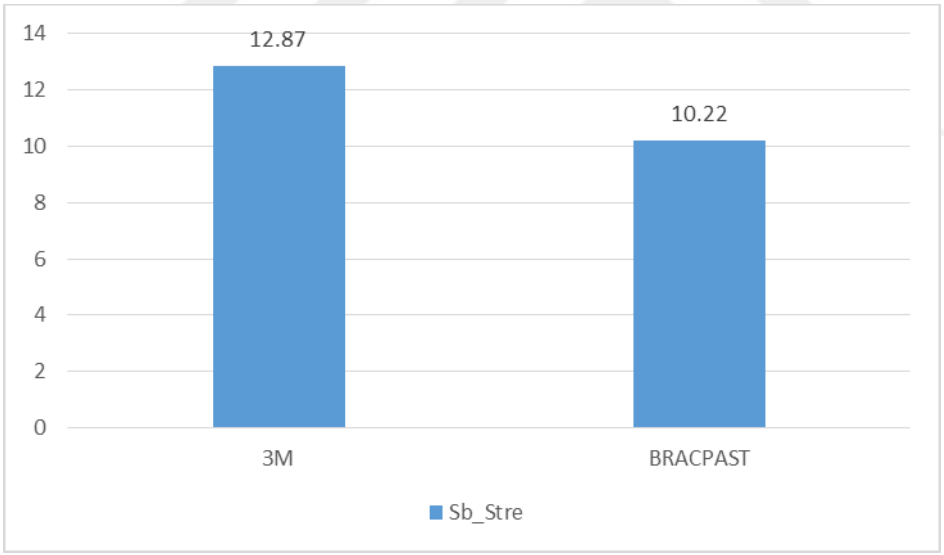


Table 4: Mean difference of shear bond strength in (MPa) between two study groups:

	t	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Shear Bond Strength	1.365	0.180	2.64	-1.28	6.56

Data are mean ± standard deviation, unless otherwise stated. There were 20 ceramic brackets luted with 3m resin cement and 20 other brackets luted with BRACPAST resin cement. An independent-samples t-test was run to determine if there was a difference in shear bond strength between the two resin cements. 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 with 3m resin cements (12.87 ± 6.70) than BRACPAST (10.22 ± 5.49), however statistically significant difference was found, $p = .180$.

5. DISCUSSION

Ceramic brackets are available in market in mainly two forms. The monocrystalline form is considered expensive but has excellent aesthetics. alline form, on contrary, is less expensive but has less aesthetics. One of the challenging and substantial requirements of ceramic brackets is to provide sufficient shear bond strength (SBS) for orthodontic treatment in addition to keep debonding procedure easy and damage-free to the enamel surface.

Most of the available ceramic brackets rely on mechanical retention to achieve an acceptable bond. Ceramic brackets has higher affinity to incident light in comparison of metal brackets; thus, it permits more transmission of light to the bracket base which results in better polymerization of the orthodontic adhesive and therefore, providing a higher SBS.

Numerous factors such as enamel conditioning procedure, adhesive composition, bracket retention mechanism and debonding technique affect the level of forces applied while debonding the brackets. In the mean study, the variables which affect debonding characteristics were minimized by performing identical debonding conditions in all the three groups. The results showed that different enamel conditioning procedures have different effects on SBS.

In the mean study, we aimed to evaluate shear bond strength and remaining composite index of the Bracepaste adhesive and compare it with 3M transbond XT adhesive material using cosmetic ceramic brackets We used natural human teeth, so we have increased the variability of the bond strength; in addition, the use of human teeth approximates the real life situation with respect to teeth morphology. The teeth of similar shapes and sizes were choosed 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 considered as one of the best storage medium which is capable of reassuring adequate results concerning to both the 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 showed that extracted teeth stored in distilled water provided less variation in bond strength values (42).

The enamel surface should be polished, then rinsed with air/water and dried with an oil free compressed air stream. Kimura et al (2004) had reported that cleaning the tooth surfaces increases the surface energy that interferes to bonding (43). In our study, the labial surface of enamel was polished with no fluoride of pumice because the use fluoride in polishing procedure can decrease the surface energy of the tooth surface and minimize the ability of the orthodontic adhesive to spread over the tooth surface.

Garcia-godoy et al.1991, had also concluded that the use topical application of fluoride prior to bracket placement can negatively interfere with acid etching procedure; thus, it results in reduced bond strength of orthodontic adhesive (44). Also Aasenden et al. (1972) had reported that the fluor-apatite crystals which results may affect negatively the bond strength (45).

In this study, we used the same etching protocols for enamel preparation. The materials used for surface preparation and adhesive were Transbond XT and Bracepaste adhesive. These materials have been widely used in orthodontic clinics.

The adhesive resin of the samples was polymerized by using an ortholux luminous curing system (3M unitek) with High intensity 1600

mW/cm2 blue LED for 10 sec mesial and 10 sec distal sides of Elegan I ceramic brackets curing time.

The method used to measure the shear bond strength of orthodontic brackets that bonded to the extracted teeth, is the compressive fracture resistance test by using a universal testing machine. It is important to mention that such testing methodology has advantages and shortcomings; moreover, its relevance to orthodontic clinical practice is still questionable, because the in vitro shear bond strength testing procedure does not represent the clinical situation; yet, it gives an overview of anticipated bond strength in vivo. In fact, potential loading in oral cavity is extremely complex due to the sequential acting stresses on the enamel-adhesive and adhesive-bracket interfaces.

In 1994, Fox et al. introduced standardization and repot several recommendations for bond strength testing (40). However, the following problem would arise an in vitro investigation: enamel surface structures of extracted teeth may differ from in vivo due to desiccation during storage and bracket removal by using shear force only.

In our study, the mounted specimen were placed inside an adjustable vice for SBS testing in a push-pull instron universal testing machine (Model 3382; Instron Corp., Canton, Massachusetts, USA) at a cross head speed of 1 mm/minute connected to a PC that recorded the results of each test. The test was done by using a chisel edge mounted on crosshead of the testing machine. Each tooth was orientated such that the chisel was parallel to the bracket base and equidistant to both incisal tie-wings. The chisel-type working tip was positioned 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 crosshead moved in a speed of 1 mm/minute, the maximum load which was necessary to debond bracket was recorded in

Newtons (N) and then converted into Mega-pascals (Mpa) as a ratio of Newton's to surface area of the bracket.

Bond strength (MPa) is equal to Force (N) devided by surface area of bracket (in square mm). After shear mode testing procedure, enamel surfaces of teeth were assessed independently by the same evaluator.

Axial loading that was performed in the present study may represent occlusal forces with the point of application at the same distance from the bracket resin interface in all cases, helping to make the method of testing more reproducible. 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 (46).

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 (47).

Brackets failure at either of the two interfaces, bracket-adhesive interface or enamel-adhesive interface, has its own advantages and shortcomings (48). The failure at the bracket adhesive interface indicates good adhesion to the enamel and is considered safer for deboneding procedure (Berk et al., 2008) (49). However, there are two shortcomings. First, considerable chair time is needed to remove the residual orthodontic adhesive material (50). Second, there is an added chance of damaging the enamel surface while cleaning the enamel surface (Justus et al., 2010) (50). Also more enamel loss during cleaning is reported (51).

On the other hand, when failure does occur 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 (49).

Before performing mechanical tests, after removing from the solution, the teeth were thoroughly rinsed and put in self-polymerizing acrylic resin. The teeth have been put in acrylic resin blocks to simulate cortical bone and the

cemento-enamel junction of teeth should be situated approximately 2 mm above the level acrylic resin to simulate bone crest.

Orthodontic brackets are subjected to either shear, tensile or torsion forces during function; moreover, they are subjected to a combination of previously mentioned forces. The brackets in vivo are also will be under the effect of heat change in the mouth, therefore in our study all teeth bonded with brackets were thermo cycled for 5000 cycles between 5 C^o and 50 C^o with a dwell time of 30 sec, which simulated 6 months of intraoral environment.

In the mean study, when evaluating the mean SBS of different adhesive material, it was realized that the mean SBS of 3M transbond XT was the highest (12.8669 MPa) , While the bracepaste adhesive with the least mean SBS was Ceramic bracts (10.225 MPa).

6. CONCLUSION

1. The SBS of 3M transbond XT of ceramic brackets which were bonded by using conventional acid etching technique is higher than Bracepaste adhesive on ceramic brackets bonded by the same etching technique.

2. Both 3M transbond XT and Bracepaste adhesive have SBS which are clinically acceptable.

7. REFERENCES

1.Leloup G, D'Hoore W, Bouter D, Degrange M, Vreven J. Meta-analytical review of factors involved in dentin adherence. J Dent Res. 2001;80(7):1605-14.

2.Finnema KJ, Ozcan M PW, Ren Y, PU. D, . In-vitro orthodontic bond strength testing: a systematic review and meta-analysis. Am J Orthod Dentofacial Orthop. 2010.

3.Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res. 1955;34(6):849-53.

4.Retief DH. The mechanical bond. Int Dent J. 1978;28(1):18-27.

5.Silverstone LM. Fissure sealants. Laboratory studies. Caries Res. 1974;8(1):2-26.

6.Fitzpatrick DA, Way DC. The effects of wear, acid etching, and bond removal on human enamel. Am J Orthod. 1977;72(6):671-81.

7.Wickwire NA, Rentz D. Enamel pretreatment: a critical variable in direct bonding systems. Am J Orthod. 1973;64(5):499-512.

8.Rock WP. The effect of etching of human enamel upon bond strengths with fissure sealant resins. Arch Oral Biol. 1974;19(10):873-7.

9.Barkmeier WW, Gwinnett AJ, Shaffer SE. Effects of enamel etching time on bond strength and morphology. J Clin Orthod. 1985;19(1):36-8.

10.Beech DR, Jalaly T. Bonding of polymers to enamel: influence of deposits formed during etching, etching time and period of water immersion. J Dent Res. 1980;59(7):1156-62.

11.Osorio R, Toledano M, Garcia-Godoy F. Bracket bonding with 15- or 60-second etching and adhesive remaining on enamel after debonding. Angle Orthod. 1999;69(1):45-8.

12.Carstensen W. Clinical results after direct bonding of brackets using shorter etching times. Am J Orthod. 1986;89(1):70-2.

13.Wilson AD, JW). M. Glass Ionomer Cement. first edition ed. Chicago (US): Quintessence Publishing Company, ; 1988.

14.White LW, Soetopo PL, Beech DR, JL. H. An expedited bonding technique. Mechanism of adhesion of polymers to acid etched enamel. Journal of Clinical15,Journal of Oral Rehabilitation. 2001.

15.Manning N, Chadwick SM, Plunkett D, Macfarlane TV. A randomized clinical trial comparing 'one-step' and 'two-step' orthodontic bonding systems. J Orthod. 2006;33(4):276-83; discussion 56-7.

16.Hirani S, M S. Bonding characteristics of a self-etching primer and precoated brackets: an in vitro study. European Journal of Orthodontics,. 2006.

17.Birnie D. Comment on ceramic bracket bonding. Am J Orthod Dentofacial Orthop. 1995;108(3):18A.

18.Knox J, Hubsch P, Jones ML, Middleton J. The influence of bracket base design on the strength of the bracket-cement interface. J Orthod. 2000;27(3):249-54.
19.Habibi M, Nik TH, Hooshmand T. Comparison of debonding characteristics of metal and ceramic orthodontic brackets to enamel: an in-vitro study. Am J Orthod Dentofacial Orthop. 2007;132(5):675-9.
20.IR R. A review of direct orthodontic bonding. . British Journal of Orthodontics,. 1975.
21.Sfondrini MF, Cacciafesta V, Pistorio A, Sfondrini G. Effects of conventional and high-intensity light-curing on enamel shear bond strength of composite resin and resin-modified glass-ionomer. Am J Orthod Dentofacial Orthop. 2001;119(1):30-5.
22.Hobson RS, McCabe JF. Relationship between enamel etch characteristics and resin-enamel bond strength. Br Dent J. 2002;192(8):463-8.
23.Pollack BF, Blitzer MH. The advantages of visible light curing resins. N Y State Dent J. 1982;48(4):228-30.
24.Tavas MA, Watts DC. A visible light-activated direct bonding material: an in vitro comparative study. Br J Orthod. 1984;11(1):33-7.
25.Greenlaw R, Way DC, Galil KA. An in vitro evaluation of a visible light-cured resin as an alternative to conventional resin bonding systems. Am J Orthod Dentofacial Orthop. 1989;96(3):214-20.
26.Cook WD. Spectral distributions of dental photopolymerization sources. J Dent Res. 1982;61(12):1436-8.
27.Oesterle LJ, Newman SM, Shellhart WC. Rapid curing of bonding composite with a xenon plasma arc light. Am J Orthod Dentofacial Orthop. 2001;119(6):610-6.
28.Burgess JO, DeGoes M, Walker R, Ripps AH. An evaluation of four light-curing units comparing soft and hard curing. Pract Periodontics Aesthet Dent. 1999;11(1):125-32; quiz 34.
29.Davidson-Kaban SS, Davidson CL, Feilzer AJ, deGee AJ, N. E. The effect of curing light variations on bulk curing and wall-to-wall quality of two types and various shades of resin composites. . Dent Mater 1997.
30.Mehl A, Hickel R, Kunzelmann KH. Physical properties and gap formation of light-cured composites with and without 'softstart-polymerization'. J Dent. 1997;25(3-4):321-30.
31.Feilzer AJ, Dooren LH, deGee AJ, CL D. Influence of light intensity on polymerization shrinkage and integrity of restoration-cavity interface. . Eur J Oral Sci 1995.
32.Unterbrink GL, Muessner R. Influence of light intensity on two restorative systems. J Dent. 1995;23(3):183-9.
33.Uno S, Asmussen E. Marginal adaptation of a restorative resin polymerized at reduced rate. Scand J Dent Res. 1991;99(5):440-4.
34.Shanthala BM, Munshi AK. Laser vs visible-light cured composite resin: an in vitro shear bond study. J Clin Pediatr Dent. 1995;19(2):121-5.
35.Hinoura K, Miyazaki M, Onose H. Influence of argon laser curing on resin bond strength. Am J Dent. 1993;6(2):69-71.

36.Lalani N, Foley TF, Voth R, D B, A M. Polymerization shrinkage with the argon laser: curing time and shear bond strength. Angle Orthod. 2000.
37.Talbot TQ, Blankenau RJ, Zobitz ME, Weaver AL, Lohse CM, Rebellato J. Effect of argon laser irradiation on shear bond strength of orthodontic brackets: an in vitro study. Am J Orthod Dentofacial Orthop. 2000;118(3):274-9.
38.Weinberger SJ, Foley TF, McConnell RJ, Wright GZ. Bond strengths of two ceramic brackets using argon laser, light, and chemically cured resin systems. Angle Orthod. 1997;67(3):173-8.
39.Kurchak M, DeSantos B, Powers J, Turner D. Argon laser for light-curing adhesives. J Clin Orthod. 1997;31(6):371-4.
40.Fox NA, McCabe JF, Buckley JG. A critique of bond strength testing in orthodontics. Br J Orthod. 1994;21(1):33-43.
41.Eliades T, Brantley WA. The inappropriateness of conventional orthodontic bond strength assessment protocols. Eur J Orthod. 2000;22(1):13-23.
42.Silva. The influence of storage and sterilization methods more used in tests of adhesive resistance with extracted teeth,. Revista de Odontologia da Universidade Cidade de São Paulo. 2006.
43.Kimura T, Dunn WJ, Taloumis LJ. Effect of fluoride varnish on the in vitro bond strength of orthodontic brackets using a self-etching primer system. Am J Orthod Dentofacial Orthop. 2004;125(3):351-6.
44.Garcia-Godoy F, Hubbard GW, Storey AT. Effect of a fluoridated etching gel on enamel morphology and shear bond strength of orthodontic brackets. Am J Orthod Dentofacial Orthop. 1991;100(2):163-70.
45.Aasenden R, DePaola PF, Brudevold F. Effects of daily rinsing and ingestion of fluoride solutions upon dental caries and enamel fluoride. Arch Oral Biol. 1972;17(12):1705-14.
46.Katona TR. A comparison of the stresses developed in tension, shear peel, and torsion strength testing of direct bonded orthodontic brackets. Am J Orthod Dentofacial Orthop. 1997;112(3):244-51.
47.Rossouw. Shear bond strength of ceramic orthodontic brackets to enamel. . American Journal of Orthodontics and Dentofacial Orthopedics,. 2010;138.
48.Bishara SE, Ostby AW, Laffoon JF, Warren JJ. The effect of modifying the self-etchant bonding protocol on the shear bond strength of orthodontic brackets. Angle Orthod. 2007;77(3):504-8.
49.Berk N, Basaran G, Ozer T. Comparison of sandblasting, laser irradiation, and conventional acid etching for orthodontic bonding of molar tubes. Eur J Orthod. 2008;30(2):183-9.
50.Justus. Comparing Shear Bond Strength of Two Adhesive Systems with enamel surface deproteinization before etchin. 2010.
51.Bishara SE, Vonwald L, Laffoon JF, Jakobsen JR. Effect of altering the type of enamel conditioner on the shear bond strength of a resin-reinforced glass ionomer adhesive. Am J Orthod Dentofacial Orthop. 2000;118(3):288-94.