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# INVESTIGATION THE EFFECT OF RELATION BETWEEN CEMENT TYPE AND SURFACE TREATMENTS OF DIFFERENT CERAMIC TYPES ON THEIR SHEAR BOND STRENGTH WITH TOOTH STRUCTURE

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## *ABSTRACT*

**Statement of problem**: The clinical success of the ceramic restoration system that is strongly bonded to the tooth structure in order to prevent microleakage, marginal fracture, discoloration, and secondary caries. Which do types of cements and surface treatment considerably influence. **Purpose**: This study investigated the shear bond strength between three all ceramic systems (CAD-CAM CEREC type, The VM7( VITADURVEST) powder, and IPS Empress II) treated by air abrasion and hydrofluoric acid, then cemented to tooth structure by two types of adhesive resin cements. **Material and methods**: Ninety freshly extracted human lower third molar teeth were used. Each tooth was free of caries or restorations. Teeth were embedded into autopolymerizing resin limited to their cervical line using dental surveyor. The occlusal third of the molars was grounded using diamond stones under water coolant to make dentin discs with smooth and flat surface. Ceramic discs with 5mm diameter and 3mm thickness of three types of all ceramics and two types of chemically cured resin cements were used.All specimens were randomly divided into three groups of 30 teeth each according to the ceramic used. Each group are divided into three subgroup(n=10). The bonding surfaces of each ceramic discs of each subgroup are treated with one of the following: 9% hydrofluoric acid, Airborne particle abrasion with 50 µm grain sized aluminum oxide particles and Air abraded with 50 µm grain sized aluminum oxide particles and etched in 9% hydrofluoric acid .The ceramic disks were bonded to the flattened molars using one of the two types of the resin cement used in this study. All samples were mounted on a computer controlled materials testing machine with a load cell of 5 KN and their data were recorded using computer software. **Results**: The results of the present study showed the following mean loads at fracture: the Cerec type (7.56+1.96 N), VM7 (6.21+0.99 N) and Empress II (6.96+1.72 N) .ANOVA and *Tukey's post-hoc test* showed that the differences between these all ceramics types were statistically non-significant ($p>0.05$). However the CAD-CAM Cerec blocs gave the highest mean of


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shear bond strength .on the other hand, Statically analysis of the results showed that the differences between the three types of surface treatment were statistically significant ($p<0.05$). Hydrofluoric acid etching produced the highest mean shear bond strength. Panavia dental adhesive is better than Dyract cem plus as it produced higher mean shear bond strength values in all cases of this study. **Conclusions**: The three types of All ceramic used in this study have no clear effect in the Shear bond strength of ceramic to tooth structure, Hydrofluoric acid etching produced the higher mean shear bond strength than air abrasion (AA) with aluminum oxides, and according to this study Panavia dental adhesive is better than Dyract cem plus in Shear bond strength.

## INTRODUCTION

Increasing demand for esthetic restoration has leading to the greater use of all ceramic materials because of their improved biocompatibility,optical properties compared with metal ceramic restorations(1).

There are many advantages of a ceramic restorations lead to the development of new high-strength dental ceramic restorations dominated the latter part of the 20th century: The increase in depth of translucency and light transmission (2). In addition, when a metal substrate with a tooth-colored framework is not required, more translucent ceramics can be used with tooth-colored resin cements to enhance esthetics at the cervical area and achieve superior blending between the restoration and surrounding tissues (3). allows the restorative dentist to place the finish line of the prepared tooth either at the free gingival margin or slightly below it (0.5 mm) without compromising the esthetic results and reducing the biologic sequences of subgingival location (4), ceramic systems have a reduced thermal conductivity, resulting in less thermal sensitivity and potential pulpal irritation (5), a small percentage of the population is hypersensitive to dental alloys containing both noble and base metals such as palladium and nickel. Metal-free ceramic systems eliminate this problem (6).and finally, the development of a number of new fabrication techniques. Among the available ceramic restoration systems, computer assisted design–computer integrated manufacturing (CAD -CAM) allows rapid production of tooth- colored restoration(7). In spite of the inherent brittleness and limited flexural strength related to the first all ceramic, but the dispersion of ceramic crystals of high strength and elastic modulus within the glassy matrix can strengthen dental porcelain. As long as the glassy matrix has a thermal expansion similar to that of the crystals, both overall strength and elastic modulus may be increased. Due to this continuous technical improvements, An increasing number of all-ceramic materials and systems are currently available for clinical use. Multiple clinical studies document excellent long-term success of resin-bonded restorations, such as porcelain laminate veneers, ceramic inlays and onlays, resin-bonded fixed partial dentures, and all-ceramic crowns. A strong, durable resin bond provides high retention, improves marginal adaptation and prevents microleakage, and increases fracture resistance of the restored tooth and the restoration(8,9).

Silica-based ceramics, such as feldspathic porcelain and glass ceramic are frequently used to veneer metal frameworks (commonly referred to as *metal ceramic restorations* or *PFMs*) or high-strength ceramic copings for all-ceramic restorations. Their excellent esthetic properties make them the material of choice for ceramic laminate veneers and inlays/onlays also, Leucite-reinforced feldspathic porcelain (for example: IPS Empress; Ivoclar-Vivadent) achieves significantly higher fracture strength that has been suggested to be high enough for the fabrication of short-span anterior fixed partial dentures (FPDs)(10).

It is important for the clinical success of the restoration system that the ceramic material is three types of surface treatment were statistically significant ($p<0.05$). Hydrofluoric acid etching produced the highest mean shear bond strength. Panavia dental adhesive is better than Dyract cem plus as it produced higher mean shear bond strength values in all cases of this study.

The three types of All ceramic used in this study have no clear effect in the Shear bond strength of ceramic to tooth structure, Hydrofluoric acid etching produced the higher mean shear bond strength than air abrasion (AA) with aluminum oxides, and according to this study Panavia dental adhesive is better than Dyract cem plus in Shear bond strength. Strongly bonded to the tooth structure in order to prevent microleakage, marginal fracture, discoloration, and secondary caries. The marginal integrity of a ceramic restoration is considerably influenced by cement type and thickness and by types of surface treatment[11]

The use of adhesive resin cement has been encouraged for all-ceramic restorations because of it has no solubility in oral fluids, good esthetics and high bond strength; however, longitudinal studies have shown marginal degradation over time due to wearing of the resin cement. Cements with greater amounts of filler had less wear, a factor that may facilitate the clinician's choice of resin cement [12].

The shear bond strength of three different types of adhesive resin cements to the ceramic material and the effect of 4 Silane coupling agents on the bond strength were evaluated by some authors. They found that the surface treatment by silane coupling agents improved the shear bond strength when compared with non treated samples [13].

New adhesive resin cement used in conjunction with a dentin bonding agent to attach crowns to teeth with short clinical crowns achieved approximately 3 times the attachment effected by phosphate cement. For teeth with crown preparations with less-than-ideal angle of convergence, the attachment of crowns bonded with one resin cement was more than 6 times higher than the attachment achieved with zinc phosphate cement [14].

The longevity and prognosis for prosthetic restorations is largely a function of cementing agent choice, cement durability, the content of adhesive bond[15,16], and the Modification of dentin and enamel surfaces by conditioning, priming or etching is a necessary step for most adhesive restorative procedures [17]

To create a reliable bond between the ceramic material and adhesive resins, Several researches have description for various surface treatment procedures to allow adhesion of all-ceramic restorations. According to the majority of the studies creating a microretentive surface texture and silane priming are essential for such restorations. Surface texture can be prepared by the help of either chemical or mechanical methods [18,19].

The chemical etching of dental ceramic was first reported in 1983. Since then, several ceramic etchants, such as orthophosphoric (OP), sulphuric, nitric, hydrofluoric acids (HF), acidulate phosphate fluoride and ammonium hydrogen difluoride have been recommended for surface treatment of the ceramic restoration. The most commonly accepted chemical etchant is HF [20].

Kato et al [21] compared airborne particle abrasion with different acid-etching agents. They found that HF acid and sulfuric acid-hydrofluoric acid provided the highest and most durable bond strengths.

Furthermore, The bond strengths of some resin luting cements of two different all ceramic materials (In-Ceram, IPS Empress) also was evaluated by some authors. Composite cylinders were prepared on the ceramic surfaces for a shear test. Four ceramic surface treatments were performed: (i) as received, (ii) grinding with diamond bur,(iii) sandblasting with 50 μm alumina grit and (iv) HF acid treatment and sandblasting with 50 μm alumina grit. Ceramic specimens were treated with one of the four methods and then cemented together with each of the two luting agents. The tested luting cements were Panavia F and Clearfil Se Bond (CSeB). They concluded that the CSeB demonstrated higher bond strength than Ceramic specimens luted with Panavia F. Acid etching of the surfaces with HF acid demonstrated a weak tendency to improve bond strength [22].

But, Some authors evaluated the effect of surface treatment using 9.5% hydrofluoric acid, 50µm or 250µm air born particles abrasion for 10 seconds on surface roughness and bond strength to dentin and enamel of a commercially available heat-pressed dental ceramic (IPS Empress). They found that the greatest bond strength between the ceramic and tooth dentin and enamel in case of hydrofluric acid treatment (that produced pores & grooves) [23,24].

Regarding to ceramic surface treatment, the acid reacts with the glassy matrix that contains silica and forms hexafluorosilicates. This glassy matrix is selectively removed and the crystalline structure is exposed. As a result, the surface of the ceramic becomes rough, which is expected for micromechanical retention on the ceramic surface [25]. This roughly etched surface also helps to provide more surface energy prior to combining with the silane solution [26].

The subsequent use of the alumina oxide-particle abrasion on ceramic surfaces prior to acid etching may substantially increase the surface area and enhance the potential for micromechanical retention, and increases the bond strength of the ceramic veneer on the tooth [27]. also, Numerous in vitro studies has reported the positive effect of acid etching and the application of silane on the ceramic veneer, most of the veneering ceramics used in these studies were either conventional veneering ceramics or heat-pressed ceramics [28]. HF solutions between 2.5% and 10% applied to the fitting surface of the ceramic restoration for 2 to 3 minutes seem to be most successful. Because it creating micropores that enhance bonding [29].

Some authors studied that the shear bond strengths of 2 dual-cured resin luting agents to a CAD/CAM composite material and the effect of silane coupling agent and bonding resin on the bond strength. Rectangular and disk-shaped CAD/CAM composite materials were untreated or treated with 1 of the 2 silane coupling agents or bonding resin and then cemented together with 1 of the 2 dual-cured resin luting agents. They concluded that the application of a silane coupling agent to the CAD/CAM composite surface provided the highest bond strength between the resin luting agent and composite after long-term thermal cycling [30].

Some silane agents that contained carboxylic acid provided sufficient bond strengths even without HF acid etching, and others were successful after acid etching with phosphoric acid [31]. Also, Sorensen et al [32] showed that ceramic etching and silanization significantly decreased microleakage, which was not achieved by exclusive silane treatment.

More recently, one-step self-adhesive composite cements have been proposed as a more suitable alternative for ceramic bonding, thanks to their lower technique sensitivity and user-friendliness.[33]

The purpose of the study is to test the null hypothesis that support the positive relation between the type of resin cement and ceramic surface treatment on the bond strength of recent ceramic to tooth dentin structure

## MATERIALS AND METHODS

Ninety freshly extracted human lower third molar teeth were used. Each tooth was free of caries or restorations. The teeth were cleaned and stored in saline solution at room temperature [37] during the study. Teeth were embedded into autopolymerizing resin limited at the cervical line using surveyor.

Fig. (1) A photograph showing the tooth after removal of its occlusal third. The occlusal third of the molars was grounded using diamond stones under water coolant to make a smooth and flat dentin surface for cementation

**Preparation of Cerec samples**

Firstly the ceramic blocks are grounded using diamond stones into a rods with a diameter of five mm. Then the discs were made by slicing the rods using diamond discs to produce discs of three mm in thickness Fig (2). The correct thickness of the discs achieved using caliper.

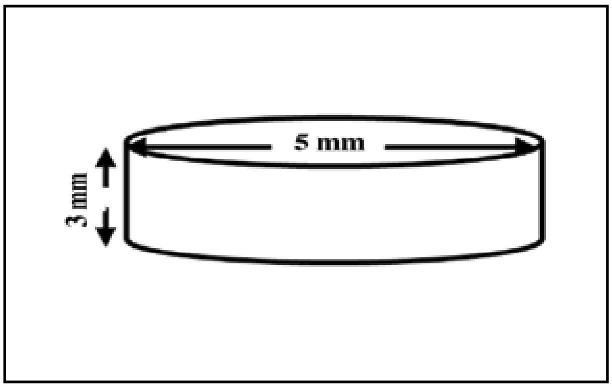


Fig. (2) Diagram showing the diminutions of moist ceramic disc

**Preparation of I.P.S Empress samples**

Thirty wax pattern of 3mm thickness and 5mm diameter was constructed using splitted brass mould. Each wax pattern was directly connected with a 3 mm round wax sprue to the base of the sprue former and invested with a phosphate-bonded investment for a rapid burn out technique with its special mixing liquid Expansor-B

The inner part of the metal ring was covered with a (1 layer) of quartz band which was moistened slightly with water to prevent absorption of the investment.

The powder were added to the liquid in the ratio of 60 gm powder: 15.6 ml liquid (according to the manufacturer instruction), and mixed vigorously by hand for 15-20 seconds to obtain moist uniform mass then passed to mechanical vacuum mixing for 60 seconds. Then the ring was filled over the pattern surfaces and vibrated gently for 10-15 seconds. The invested ring was bench set for 20 minutes, after which, the upper surface of the ring was scrapped with a knife before placing in the furnace. The ring was placed in the oven with the spouts downwards at temperature of 850 c maximum.

**Preparation of porcelain (Vita VM7) samples**

***Preparation of Model:***

To ensure maximum results two extra hard stone models (Fuji rock; GC Corp, Tokyo, Japan) (LOT NR. 0701081) were produced according to the manufacturer's recommendations. The first was used as the master model to check the final work and the second was used as working model.

The mould was duplicated using Dubliermasse (VITA Zahnfabrik, bad sackingen, Germany) (Batch NR. 4307) the contents of one bag were poured into a plastic cup in the ratio of 30g duplicating paste:

7g duplicating paste liquid: 1g catalyst.

Then, the contents were mixed together for 2.5 minutes and allowed to set for 30 minutes inside the mould. The mould was opened and the duplicating material was bench cooled for another 20 minutes to return to its original shape.

***Treatment of VITADURVEST burnt gypsum:***

The VITADURVEST powder was added to the liquid (VITA Zahnfabrik, Bad Sacking, Germany) (LOT NR. 14540) in the ratio of 30g powder: 6ml liquid, and mixed vigorously by hand for 15seconds to obtain a totally moist and uniform mass, then passed to mechanical vacuum mixing for 30 seconds, then the mix was poured over the silicon duplicating material.

The VITADURVEST was allowed to set for 3 minutes and then removed from the silicon. Duplicating material. The VITADURVEST was hardened in a porcelain furnace, and fired according to the manufacture's recommendations (10 min 600 C /5 min 1050 C 5 min (in air). After firing. The VITADURVEST was bench cooled for 20 min.

**Sealing the surface of the refractory die:**

In order to seal the surface of the refractory die material and prevent the dentine powder drying too rapidly during building-up, a mixture of VITA Akzent Glaze - No.25 (LOT NR. 27970) and VITA Akzent fluid with a thin consistency was prepared and then fires according to the manufacturers recommendations (5 min 600 C/6 min 970C 2 min (in air)

To ensure an even uniform thickness of the dentin porcelain build up a brass split counter die was constructed to provide 5x3 mm mold space. The dentine powder (LOT NR. 10830) was mixed with modeling fluid (LOT NR. 19580) for the first dentine firing.

Standard technique was used to complete building-up and then fired according to the manufacturers recommendations (pre-drying 6 min, raise the temperature from 500 C to 910 C in 7 min. under vacuum for a 1 min holding time. The firing shrinkage was compensated by applying a second layer of body porcelain, yielding a final total thickness of 3 mm verified with a digital caliper (Dial Caliper D. Germany).

***Removing of the die material:***

The bulk of the Vitadurvest was removed using no 8 round head bur, and the reminder was air abraded with 110 um aluminum oxide (AL2O3) particles (Protechno, Girona, Spain) ( Lot.No.06-9513) in a sandblasting unit - (Eurocem s.r.l. ,Milanese, Italy). The pressure during air-abrasion was 2 bars for a period of 15 seconds. Then, the samples were steam cleaned for 15 seconds using a steam cleaner - (EGV 18; Eurocem Srl, Milanese, Italy and left to dry 10 minutes prior to final adjustments.

**Procedures of cementation**

Two resin cements were tested for their bond strength to ceramic and dentin C1 for panavia dental adhesive and C2 for dyract cem plus. All specimens were randomly divided into three groups of thirty teeth each (Group P1, P2, and P3) according to the ceramic used group P1 for the cerec ,group P2 for empress, and group P3 for Vita VM7. Each group are divided into three subgroup (Subgroup S1, S2, and S3) of ten teeth each according to the surface treatment used (S1) for air abrasion AA (S2) for hydrofluoric acid HF (S3) for combination AA and HF.

The bonding surface of each ceramic discs of each subgroup are treated with one of the following:

1. 9% hydrofluoric acid for 4 minutes.
2. Airborne particle abrasion with 50 µm grain sized aluminum oxide particles at a pressure of 200 kPa from a distance of approximately 10 mm nozzle-to-porcelain surface distance for 14 sec.
3. Air abraded with 50 µm grain sized aluminum oxide particles at a pressure of 200 kPa from a distance of approximately 10 mm nozzle-to-porcelain surface distance for 14 sec. and etched in 9% hydrofluoric acid for 4 min.

The treated samples were then rinsed with water from a dental unit syringe for 10 sec. silanated, and air thinned.

The prepared tooth surfaces were etched for 20 seconds with 35% phosphoric acid gel, rinsed for 10 seconds, and lightly dried with gentle air (free oil) to ensure that the dentin remained moist. The prepared dentin surfaces of the specimen teeth were then primed with primer (dentin conditioning)

The silanated ceramic discs were bonded to the flattened molars using one of the two type of the resin cement used in this study. A small amount of the autopolymerizing resin cement (wither Panavia) dental adhesive or Dyract cem plus) was placed on the ceramic and the tooth. The ceramic was placed on the center of the dentin substrate (when using Panavia dental adhesive oxyguard was applied at the periphery of the ceramic disk) and a fixed vertical static load (5 kg) was applied to the ceramic surface using cementing device to create an approximately uniform cement layer. The excess cement overhangs were removed with a sharp hand instrument after initial sitting of the cement. The shear bond test was done after 24 hours.

**Shear Bond Strength Test procedure**

A circular interface shear test was designed to evaluate the bond strength. All samples were mounted on a computer controlled materials testing machine (Model LRX-*P*lus; Lloyd Instruments Ltd., Fareham, UK) with a load cell of 5 kN and data were recorded using computer software (Nexygen-MT; Lloyd Instruments). Samples were secured to the lower fixed compartment of testing machine by tightening screws (fig.3).

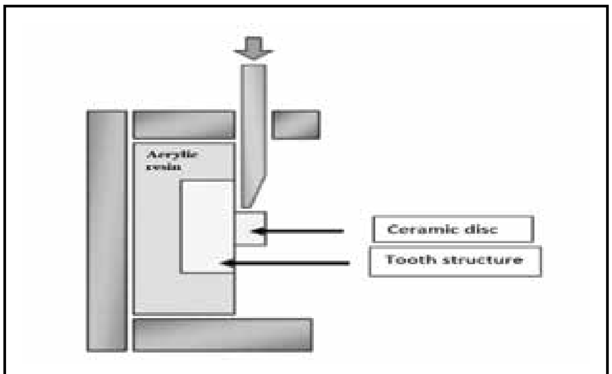


Fig. (3) Schematic representation for samples testing

Shear bond strength was determined by compressive mode of force applied at ceramic-strength (8.10±1.70Mpa). This was followed by air abrasion + Hydrofluoric acid (7.28±1.32Mpa). Air abrasion showed the lowest statistically significantly mean shear bond strength (5.47±0.94Mpa).

**Effect of cement**

Panavia cement showed statistically significantly higher mean shear bond strength(7.72±1.86Mpa) than Dyract Cem Plus cement(6.17±1016Mpa) with p-value(0.001).

The statistically significantly highest mean shear bond strength was found with (Cerec x HF x Panavia cement) P1S2C1 group. This was followed by (Empresss was followed by dmean shear bond strength.

c acid. Air abrasion showed the statistially x HF x Panavia cement) P2S2C1 group and (Empresss was followed by dmean shear bond strength.

c acid. Air abrasion showed the statistially x AA and HF x Panavia cement) P2S3C1 group with no statistically significant difference between the two groups.The statistically significantly lowest mean shear bond strength was found with (Cerec x AA x Cem Plus cement) P1S1C2 group.

**TABLE (1)** *Descriptive statistics for shear bond strength values Ceramic*

| Ceramic | Surface treatment | Cement | Mean | SD |
|---|---|---|---|---|
| Cerec | Air abrasion (AA) | Panavia | 6.97 | 1.20 |
| | | Cem Plus | 4.33 | 0.61 |
| | Hydrofluoric acid (HF) | Panavia | 10.98 | 1.52 |
| | | Cem Plus | 8.01 | 1.62 |
| | AA and HF | Panavia | 8.32 | 1.77 |
| | | Cem Plus | 7.43 | 0.98 |
| Empress | Air abrasion (AA) | Panavia | 5.66 | 1.05 |
| | | Cem Plus | 4.93 | 0.76 |
| | Hydrofluoric acid (HF) | Panavia | 8.96 | 0.79 |
| | | Cem Plus | 6.64 | 1.00 |
| | AA and HF | Panavia | 9.12 | 1.28 |
| | | Cem Plus | 6.45 | 0.54 |
| VM7 | Air abrasion (AA) | Panavia | 4.93 | 0.81 |
| | | Cem Plus | 6.00 | 0.42 |
| | Hydrofluoric acid (HF) | Panavia | 7.64 | 0.75 |
| | | Cem Plus | 6.34 | 0.92 |
| | AA and HF | Panavia | 6.94 | 0.57 |
| | | Cem Plus | 5.43 | 0.77 |

**TABLE (2)** *Regression model results for the effect of different variables on shear bond strength:*

| Source | Type III Sum of Squares | Df | Mean Square | *F*-value | *P-value* |
|---|---|---|---|---|---|
| Ceramic | 10.3 | 2 | 5.1 | 1.7 | 0.061 |
| Surface treatment | 23.6 | 2 | 11.8 | 6.3 | 0.013* |
| Cement | 8.3 | 1 | 8.3 | 10.2 | 0.001* |
| Ceramic x Surface treatment x Cement | 36.8 | 4 | 9.2 | 22.7 | < 0.001* |

***df : degrees of freedom,*** ** : Significant at $P \leq 0.05$*

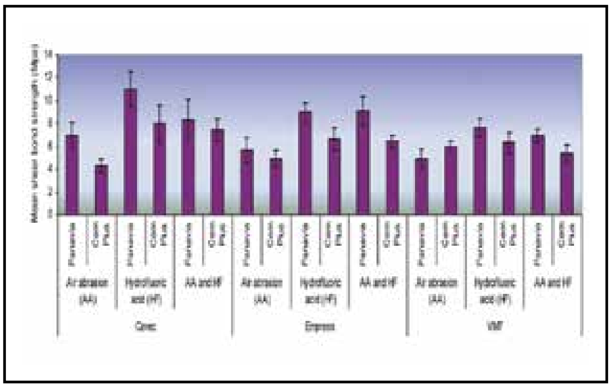

Fig. (4) Bar chart representing means and SD values for comparison between shear bond strength of the different interaction

## DISCUSSION

In this study, IPS-Empress, Cerec, and VITA-VM7 were examined and the shear bond strengths were measured. The ceramic surfaces exposed a moderately rough surfaces primarily treated with silane, which implies surface treatment of the ceramics. Two different resin cements were used and the results showed that Panavia Dental adhesive was superior to Dyract Cem plus. However, two cements together have demonstrated good bonding properties.

The results support the null hypothesis that shear bond strength values differ with different surface treatment that appeared most conductive to the development of high bond strengths as a function of the number of porosities contained within its amorphous surface. The majority of researchers agree on the importance of the ceramic etch to the dentin-ceramic-resin bond [34-36].

Etching porcelain surfaces with hydrofluoric acid is well known as a method to increase bond strength between ceramic and luting cements. Airborne particle abrasion with aluminium oxide is another method of surface roughening. Silane treatment together with etching improves bonding of composites to conventional feldspathic porcelains. Sandblasting and etching with hydrofluoric acid have often been used to increase bonding strength to ceramic. Some studies have demonstrated that these treatments, followed by the application of silane coupling agents, have been able to increase adhesion strength to feldspathic ceramic. When a silane agent is used to improve the bond between composite and ceramic surfaces, the silanol groups of the silane agent condense with the silanol groups on the ceramic surface to form siloxane bonds that bind silane to the ceramic surface [37].

The present study found that hydrofluoric acid traetemnt produced higher shear bond strength than air-borne-particles abrasion surface treatment this confirmed by Thurmond et al [34] that compared the bond strength of composite resin bonded to ceramic surfaces treated with aluminum-oxide air-borne particles abrasion ,aluminum-oxide air-borne particles abrasion followed by hydrofluoric acid,and they found that the bond strength produced by the ceramic surfaces treated with aluminum-oxide air-borne particles abrasion followed by hydrofluoric acid to be significantly greater than that of the ceramic surfaces treated with aluminum-oxide air-borne particles abrasion.

In regarding to the effect of the composition of resin luting cements and different surface treatments on both dentin and ceramic, they influence the bond strength of the specific ceramic material. This is confirmed by Stewart et al [37] that tested the bond strength values of the resin cements between all-ceramic materials and dentin and found that the shear bond strength increased by conditioning the dentin from one side and roughening the ceramic surface from the other side, And this may be due to the presence of a hybrid layer between adhesive resin and dentin seems to adequately seal the dentinal tubules and allows a good bond strength[38].

Because the accurate and meticulous procedures during the cementation phase may play an essential clinical role in achieving a valuable connection between the dentin and the ceramic restoration, this confirmed by the results of this study. Air abrasion and etching with hydrofluoric acid increased the bond strength to ceramic. These treatments, followed by the application of silane coupling agents, have been able to increase the adhesion strength to the feldspathic ceramic in accordance with previous studies [39].

The results of this study showed that bond strengths for Dyract Cem Plus were quite low but suitable for bonding Cerec, VITA-VM7 and IPS-Empress material and stressed the importance of the selection of appropriate surface treatments for optimal bonding. The Panavia dental adhesive showed abond strength reasonably acceptable for clinical use. Surface treatments such as acid etching or air abrasion had major influence on bond strengths. The use of hydrofluoric acid in the present study gave an improvement of retention of resin cements to ceramic restorations this results was in agreement with Özcan et al [40] who assumed that hydrofluoric acid should improve microretention, but rather that it might possibly change the adhesive capacity of the ceramic surface or change its potential of free energy. Also It is known that HF selectively dissolves glassy or crystalline components of the ceramic and produces a porous irregular surface that increases the surface area and facilitates the penetration of the resin into the micro-retentions of the etched ceramic surfaces [41].

Furthermore, Acid etching of the ceramic surface with hydrofluoric acid are shown to provide the high and most durable bond strengths by Kato et al. [21.42]. Their study compared airborne particle abrasion with different acid etching agents. In this study, higher bond strengths of adhesive resin cements to ceramic substrate were obtained with the two resin cement systems used, which involved HF acid etching when compared with the same cement systems with air abrasion.

Application of a silane coupling agent to the pretreated ceramic surface provides a chemical covalent and hydrogen bond of resin systems to ceramic and is a significant factor for a sufficient resin bond to silica-based ceramics. A combination of airborne particle abrasion (50 µm aluminum oxide), HF acid etching and application of a silane coupling agent is recommended by some researchers [43].in addition, Paul and Scharer[42] modified the luting procedure and applied the dentin bonding agent to freshly prepared dentin. This technique resulted in a considerable increase in the bond strength values. This in agreement to a study by Piwowarczyk et al [44] about the shear bond strengths of cements to lithium disilicate ceramics, bond strength values achieved with the adhesive resin cements RelyX Unicem (8.4 MPa) and Panavia (10.3 MPa) are considerably the same results of this study. This may be attributed to the similarity in the surface conditioning methods.

Simulation of periodontal ligament was unnecessary in this study because the progressive load applied to the coronal portion of the embedded teeth would not have mitigated by interposition of a softer medium between the root of the tooth and surrounding epoxy resin un interposed soft medium would have been meaningful during an impact fracture test when blow was delivered to a specimen[45].

Relating to the effects of the types of resin cements, In this study the difference between the two types of resin cement was significant,(Panavia cement showed statistically significantly higher mean shear bond strength than Dyract Cem Plus cement). This may be due to the difference of chemical ingredients of the two agents.Panavia dental adhesive and Dyract cem plus provided more bond strength with Cerec system and IPS Empress than VITA VM7 this may be due to the amount of silica in Cerec and Empress is more than that in VITA VM7. The hydrofluoric acid reacts with the glassy matrix of the ceramic surface that contains silica and forms hexafluorosilicates. This glassy matrix is selectively removed and the crystalline structure is exposed. As a result, the surface of the ceramic becomes rough, which is expected for micromechanical retention on the ceramic surface[25].

It can be concluded that there were significant differences in the bond strengths between composite resin cements and silica-based ceramic. There was a trend that application of HF acid etching provided better bond strength values although differences in chemical composition of cements might also have an influence.

## CONCLUSION

Within the limitation of this study and Based upon the findings of the present study it could be concluded that:

1. The three types of modern ceramic used in this study have no clear effect in the SBS of the resin cements used in the study.
2. Hydrofluoric acid etching produced the higher mean shear bond strength than air abrasion (AA) with aluminum oxides.
3. According to this study Panavia dental adhesive is better than Dyract cem plus in SBS.

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