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The Effect Of Saliva Contamination And Cleaning Technique On Bond Strength Of Zirconia To Dentin : An Invitro Study

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ABSTRACT
This study aimed to evaluation of the effect of saliva contamination and different cleaning techniques on bond strength of zirconia ceramics to dentin using two resin cements.
This study was carried-out on 64 specimens were copy milled from Yttrium-stabilized zirconia plates to produce zirconia specimens with the required dimensions (8 mm diameter,3 mm thickness). The specimens were randomly divided into four groups, (n=8 specimens/gp), according to cleaning procedures. **Group 1 (control):** After saliva contamination, the surfaces of the specimens were rinsed with distilled water spray and air dried for 10sec. **Group 2:** After saliva contamination, the surfaces of the specimens were rinsed with distilled water spray, air dried for 10sec and cleaned with isopropanol %95. **Group 3 :** After saliva contamination, the surface of specimens was treated with steam cleaning, rinsed with distilled water spray, and air dried for 10 sec. **Group 4:** After saliva contamination, the surfaces of the specimens were rinsed with distilled water spray and air dried for 10sec and treated with Ivoclean for 20sec using micro brush, rinsed with distilled water spray and air dried for 10 sec. Each group was subdivided into 2 subgroups (n=8) according to the type of resin cement used (Multilink Auto mix and Gc cement).
The results of this study indicated that, the degree of cleaning in GC self –adhesive higher than its level in Multilink adhesive. The best cleaning material observed in Ivoclean, Isopropanol, steam and all of them higher than its affinity for cleaning than water. Also, the shear bond strength differ according to the type of surface area and the materials of the surface area. The higher shear bond strength observed in group-4 (Ivoclean - GC Self-Adhesive), followed by group 2 (Isopropanol - GC Self-Adhesive).
The study concluded that, saliva contamination significantly affected resin bonds to zirconia ceramic and its durability. Ivoclean, Isopropanol and steam was the most effective cleaning method and the Ivoclean - GC Self-Adhesive, Isopropanol - GC Self-Adhesive and Steam - Multilink Adhesive of a higher shear bond strength, respectively.
Key words: Saliva contamination - Cleaning technique - Bond strength - Zirconia - Dentin

I. INTRODUCTION

In the field of dentistry, ceramic has been widely used because it provided a restoration without metallic component, good esthetics, stability of shade, biocompatibility, high resistance to attrition and low thermo-conductibility. (1)

Among ceramics, zirconia has properties such as high strength, transformation toughening, chemical and structural stability, and biocompatibility; and these properties enabled zirconia prosthesis possible in posterior teeth area. But the zirconia ceramic has inert surface without glassy component, so it difficult to create durable bond to resin cement. (2)

Therefore, selection of an appropriate adhesive system to obtain good adhesion between the zirconia ceramic and the abutment is recognized to play a crucial role in the success of restorations. However, bonding to zirconia ceramic is influenced by different factors; surface treatment of zirconia, the wettability of ceramic by adhesive resins, the composition of adhesive resins and a possible contamination during bonding. (3)

On the other hand, any alteration of the surface topography of zirconia results in changes on the surface area and on the wettability of the substrate, which are related to the surface energy and the adhesive potential. Wettability is the result of molecular interactions between the adhesive and the substrate, as well as the cohesion forces of the adhesive, particularly it surface tension. The wetting of the adherent surface by an adhesive could be indicated by the contact angle. (4)

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In-vitro studies and systematic reviews are in strong agreement that a combined micromechanical and chemical pretreatment is necessary for long-term durable resin bonding to zirconia. (5)

So, to achieve high and long-term durable bond strengths to high-strength ceramics three practical steps are mandatory: (A) air-particle abrasion, (P) primer application, and (C) adhesive resin cement and this called APC zirconia-bonding concept. (6)

Different roughening methods are applied to promote adequate adhesion between the resin cement and zirconia. The most common method used is sandblasting with aluminum oxide (Ah03) particles with different particles shape and size and different abrasive time and pressure. cs.9) It increases the zirconia surface roughness, surface area of bonding, and wettability for micromechanical retention. (7)

Also, chemical bonding between resin cement and ceramic surface could be achieved by using primer and resin cement based on adhesive monomer containing 10-methacryloyloxy decyl dihydrogen phosphate (MDP) acting as coupling agent. (8)

The combination of a mechanical and chemical treatment is essential for good adhesion. However, resin-ceramic bonding might be compromised in clinical situations when compared with clean laboratory situations. (9)

After the try-in of all-ceramic restoration, the ceramic surface might be contaminated by saliva, blood, or silicone fit-indicators. Among them, saliva contamination is reported the main cause of decreased resin bond strength. (10)

Saliva, biofilm, and other organic debris are always present on the tooth surface. All of these contaminants reduce the surface energy of the bonding substrate and, consequently, its wettability. Therefore, it is very important for the surface that will contact the adhesive to be thoroughly clean to produce proper bonding strength to substrate. (11)

The problems of saliva-protein contamination are still main problems during bonding of ceramic restorations. It is recommended to use different organic solution to remove the saliva contamination on luting surface of restoration before cementation. (12)

The composition of the cleaning agent should not cause any damages to the restoration surface and provide adhesive securing of dental restorative materials. In addition, it should be applied simply, washed off easily, non-toxic chemicals and has no negative effects on the fit of restoration. (13 While, previous studies have reported on different cleansing protocols, such as water , alcohol (70%-96% isopropanol) , phosphoric acid (37%) and additional airborne particle abrasion (Al2 O3). (14)

On the other hand, any alteration of the surface topography of zirconia results in changes on the surface area and on the wettability of the substrate, which are related to the surface energy and the adhesive potential. Wettability is the result of molecular interactions between the adhesive and the substrate, as well as the cohesion forces of the adhesive, particularly it surface tension. The wetting of the adherent surface by an adhesive could be indicated by the contact angle. (15)

A clean and dry surface ensures that the adhesive has the best possible chance of creating a proper bond with the adhered. (10) Saliva, biofilm, and other organic debris are always present on the tooth surface. All of these contaminants reduce the surface energy of the bonding substrate and, consequently, its wettability. Therefore, it is very important for the surface that will contact the adhesive to be thoroughly clean to produce proper bonding strength to substrate. (16)

The problems of saliva-protein contamination are still main problems during bonding of ceramic restorations. It is recommended to use different organic solution to remove the saliva contamination on luting surface of restoration before cementation. (14)

Alkaline cleaning agent is suitable for optimize the adhesive bond. (15) While, previous studies have reported on different cleansing protocols, such as water (16) , alcohol (70%-96% isopropanol) (16, 17) , phosphoric acid (37%) (16-18) , and additional airborne particle abrasion (Al2 O3). (19)

Strength and durability of resin bonds to zirconia and that air-abrasion was the most useful cleaning method. Therefore, in order to overcome these potential clinical problems, the ceramic surface should be cleaned from any contaminants prior to adhesive cementation. It was shown that saliva contamination could not be removed with water rinsing. Various cleaning methods of the saliva-contaminated ceramic surface were recommended, including cleaning with tap or distilled water, 0.5% or 5% sodium hypochlorite solution, 2% chlorhexidine, 96% ethanol, 70% isopropanol, ultrasonic cleaning, phosphoric (H3P04) or hydrofluoric (HF) acid etching, or cleaning paste. (18)

Realizing safe and standardized adhesive cementation protocols of zirconia is necessary in order to adequately complete the

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conservative/prosthetic treatment plan, especially when the preparation is not retentive, (due to the characteristics of the abutment or of the prosthesis design), or when it is necessary to improve the mechanical characteristics of the tooth-prosthesis complex. [19]

Over the last few years, many adhesion techniques have been studied. Different treatments of the zirconia surface, application of primers or adhesives, and various types of resin cements have been tested. However, a standardized adhesive cementation protocol, that provides univocal and reliable results, could be used for cementation of zirconia ceramic full-coverage restorations. However adhesive cementation is preferred in case of compromised retention and resin-bonded fixed dental prosthesis. [20]

Universal adhesives (UAs) are the latest category of dental adhesives. The majority of commercial UAs contain I 0-methacryloyloxydecyl dihydrogen phosphate (MDP), however a few contain both MDP and silane. UAs are claimed to promote bonding to dental substrates including various ceramics. UAs enhanced the bonding to polycrystalline ceramics such as zirconia because of the presence of MDP. [21]. Currently, self-etch modalities using monomers with mild acidity and water insoluble salt formation capacity with dentin, such as I0-methacryloyloxydecyl dihydrogen phosphate (10-MDP), have been considered as the most reliable treatment for dentin. [22]

So this study aimed to evaluate the effect of saliva contamination and different cleaning techniques on bond strength of zirconia ceramics to dentin using two resin cements. The null hypothesis was that saliva contamination would not affect neither the surface free energy zirconia ceramics, nor the shear bond strength of resin cement to zirconia surface.

II. MATERIALS AND METHODS

1.Teeth: Sixty-four extracted human molars free of caries and cracks were chosen for this study, cleaned by hand scaling and stored in 0.1 chloramine solution through the course of the study.

2.Acrylic blocks fabrication: After preparation teeth were fixed in acrylic resin blocks surrounded by thermoplastic rings as follow:

A specially designed Teflon mold with 2 central concentric holes was used for the fixation of teeth. After placement of the thermoplastic rings, powder and monomer of self-cure acrylic resin (Acrostone, Egypt) were mixed following the manufacturer's instructions then poured into the thermoplastic rings

3.Preparation of specimens: the teeth specimens were copy milled from Yttrium-stabilized zirconia plates to produce zirconia specimens with the required dimensions (8 mm diameter,3 mm thickness). The zirconia specimens were milled 20% larger than the desired dimensions to take into consideration shrinkage, and then the specimens were placed into furnace (Programat S1, Ivoclar Vivadent) to be sintered at 1500°C for 90 min according to the manufacturer’s instructions to complete the crystallization process. All specimens were sandblasted with 50-µm alumina for 15 seconds under 2.5 bars pressure and at a distance of 10 mm between the nozzle and the surface. The specimens were then cleaned in an ultrasonic bath with distilled water for 5 min and air dried

4. Saliva contamination: Each specimen was subjected for saliva contamination using artificial saliva solution before the bonding procedure. The artificial saliva was placed on the surface of zirconia specimens using micro brush at 37°C for 60 sec. Then the specimens were rinsed with distilled water spray for 15 sec and dried with oil free air dryer spray for 30 sec.

The specimens were randomly divided into four groups, (n=8 specimens/gp), according to cleaning procedures.

Group 1 (control): After saliva contamination, the surfaces of the specimens were rinsed with distilled water spray and air dried for 10sec.

Group 2: After saliva contamination, the surfaces of the specimens were rinsed with distilled water spray, air dried for 10sec and cleaned with isopropanol %95.

Group 3 : After saliva contamination, the surface of specimens was treated with steam cleaning, rinsed with distilled water spray, and air dried for 10 sec.

Group 4: After saliva contamination, the surfaces of the specimens were rinsed with distilled water spray and air dried for 10sec and treated with Ivoclean for 20sec using micro brush, rinsed with distilled water spray and air dried for 10 sec.

Each group was subdivided into 2 subgroups (n=8) according to the type of resin cement used (Multilink Auto mix and Gc cement).

5.Bonding: The zirconia specimens were bonded to the prepared dentin surfaces after each group

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treatment according to the manufacture instructions of each luting cement.

Zirconia discs were secured to a specially designed device with lever system to deliver a constant load of 5 Kg on the composite/zirconia discs assembly during cementation. Excess resin cement was removed with a micro brush then curing was done using (Dr`s Light Clever, korea) from four directions for 40s. The bonded assembly was kept for 5 minutes under the static load.
Bonded specimens were stored in water bath at 37° C for 6 months followed by thermal cycling for 2000 cycles. Eight specimens from each subgroup were stored in water bath at 37^0 C for 6 months followed by thermocycling for 2000 cycles using thermocycling device (Julabo®FT200, Germany) then air dried prior to shear bond strength testing. Each thermal cycle consisted of 5^0 C cold bath for 1 min and 55^0 C hot bath for 1 min with a dwell time of 30s.

6.Bond strength measurement: Shear bond strength test was used to determine the strength of the bond obtained between zirconia/composite discs interfaces. Shear bond strength test was performed using Bluehill Lite Software from Instron(R). All specimens were mounted horizontally and individually on a computer-controlled testing machine (Model 3345; Instron Industrial products, Norwood, USA) with 5 KN loadcell. Computer software (Bluehill Lite; Instron Instruments) was used for data recording.

7.Failure analysis: The debonded specimens were examined using Binocular optical microscope to determine the mode of failure. The recorded failure patterns belonged to one of the three following types: 1) Adhesive failure pattern at zirconia/resin cement interface. 2) Cohesive failure pattern within composite resin or resin cement. 3) Mixed failure pattern (adhesive at zirconia/resin cement interface and cohesive within composite resin). Further evaluation of representative specimens of each failure pattern was done under high magnification (×1000 magnification) using Scanning Electron Microscope (SEM) (Quanta 250-FEG, FEI, Netherlands) at faculty of science Mansoura university.

8.Scanning Electron Microscope (SEM): SEM was used for the examination of surface topography of a representative specimen from each test group. Each examined specimen was sputter coated with gold using (K550X Sputter Coater, England) followed by examination under different magnifications using SEM (Quanta 250-FEG, FEI, Netherlands). at faculty of science Mansoura university.

9. Statistical analysis: Statistical analysis of data was conducted using the International Business Machine (IBM) Social Package for Statistical Sciences (SPSS) software package version 24.0. Because the data were found not to be normally distributed, nonparametric methods, Kruskal-Wallis test and Mann-WhitneyUtests were used for statistical analysis. The Kruskal-Wallis test was used first to detect overall significance and Mann-WhitneyU tests followed to identify which pairs of groups demonstrated a significant difference (a=.05).

III. RESULTS

1- Results on the acceptance or rejection of null hypothesis according to the categories of cleaning:

a- GC self-adhesive resin cement:

Our results observed in Table (3) cleared that, the distribution of shear Bond Strength differ significantly ($P < 0.05$) across the categories of cleaning of GC self-adhesive resin cement so, we reject the null hypothesis and accept the alternative hypothesis of the distribution of Shear bond strength is differ according to the categories of cleaning of GC self-adhesive resin cement.

Table (3): Kruskal-Wallis's Test for cleaning at GC self-adhesive resin cement.

Null Hypothesis	Decision	p
The distribution of Shear Bond Strength is the same across categories of Cleaning.	Reject null hypothesis	**0.002***

* Significant difference ($p < 0.05$).

b- Multilink adhesive resin cement:

Our results observed in Table (4) cleared that, the distribution of shear Bond Strength differ significantly ($P < 0.01$) across the categories of cleaning at Multilink adhesive resin cement resin cement so, we reject the null hypothesis and accept the alternative hypothesis of the distribution of Shear bond strength is differ according to the categories of cleaning of at Multilink adhesive resin cement.

Table (4):. Kruskal-Wallis's Test for cleaning at Multilink adhesive resin cement.

Null Hypothesis	Decision	p
The distribution of Shear Bond Strength is the same across categories of Cleaning.	Reject null hypothesis	**0.001***

* Significant difference ($p < 0.05$).

c- Cleaning among adhesive resin cement:

Our results observed in Table (5) cleared that, the distribution of shear Bond Strength differ significantly ($P < 0.01$) across the categories of cleaning resin cement so, we reject the null hypothesis and accept the alternative hypothesis of the distribution of Shear bond strength is differ according to the categories of cleaning at GC self-adhesive resin cement and Multilink adhesive resin cement.

Table (5): Kruskal-Wallis's Test for cleaning.

Null Hypothesis	Decision	p
The distribution of Shear Bond Strength is the same across categories of Cleaning.	Reject null hypothesis	**0.005***

* Significant difference ($p < 0.05$).

2- Results on the acceptance or rejection of null hypothesis according to the for adhesive resin cement:

Our results observed in Table (6) cleared that, the distribution of shear Bond Strength differ significantly ($P < 0.01$) across the categories of for adhesive resin cement. So, we reject the null hypothesis and accept the alternative hypothesis of the distribution of Shear bond strength is differ according to the adhesive resin cement.

Table (6): Kruskal-Wallis's Test for adhesive resin cement.

Null Hypothesis	Decision	p
The distribution of Shear Bond Strength is the same across categories of Adhesive Resin Cement.	Reject null hypothesis	**0.000***

* Significant difference ($p < 0.05$).

3-Comparisons of cleaning at GC self-adhesive/Multilink adhesive resin cement:-

The results observed in table (7) indicated that, the degree of cleaning differ significantly among adhesive resin cement type of either GC self-adgesive or Multilink adhesive. The results indicated that, the degree of cleaning in GC self –adhesive higher than its level in Multilink adhesive.

The best cleaner in GC self-adhesive observed in Ivoclean that was 1.64 with average rank 21.50, Isopropanol that was 0.38 with average rank 11.14, steam that was 0.22 with average rank of 10.50 and all of them higher than its affinity for cleaning than water that was 0.15 with average rank of 6. While, the best cleaner in Multilink adhesive observed in steam that was 0.23 with average rank 22.57, Isopropanol that was 0.09 with average rank of 12, Ivoclean that was 0.08 with average rank 11.67, and all of them higher than its affinity for cleaning than water that was 0.04 with average rank of 5.50.

Table (7): Kruskal-Wallis's Tests pairwise comparisons of cleaning at GC self-adhesive/Multilink adhesive resin cement.

Cleaning	Adhesive Resin Cement							
	GC Self-Adhesive				Multilink Adhesive			
	N	Mean ± SD	Average Rank	p	N	Mean ± SD	Average Rank	p
Water	5	0.15 ± 0.07D	6.00	0.214	6	0.04 ± 0.02C	5.50	0.127

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Isopropanol	7	0.38 ± 0.33B	11.14		7	0.09 ± 0.06B	12.00	
Water	5	0.15 ± 0.07D	6.00	0.293	6	0.04 ± 0.02C	5.50	**0.000***
Steam	6	0.22 ± 0.11C	10.50		7	0.23 ± 0.06A	**22.57**	
Water	5	0.15 ± 0.07D	6.00	**0.000***	6	0.04 ± 0.02C	5.50	0.105
Ivoclean	6	1.64 ± 0.38A	**21.50**		6	0.08 ± 0.04B	11.67	
Isopropanol	7	0.38 ± 0.33B	11.14	0.870	7	0.09 ± 0.06B	12.00	**0.010***
Steam	6	0.22 ± 0.11C	10.50		7	0.23 ± 0.06A	**22.57**	
Isopropanol	7	0.38 ± 0.33B	11.14	**0.008***	7	0.09 ± 0.06B	12.00	0.876
Ivoclean	6	1.64 ± 0.38A	**21.50**		6	0.08 ± 0.04B	11.67	
Steam	6	0.22 ± 0.11C	10.50	**0.007***	7	0.23 ± 0.06A	**22.57**	**0.020***
Ivoclean	6	1.64 ± 0.38A	**21.50**		6	0.08 ± 0.04B	11.67	
* Significant difference ($p < 0.05$).								

Means within the same column of different litters are significantly different at ($P < 0.05$)

4-Comparisons between the different cleaner:

In general the best cleaning material observed in Ivoclean that was 0.86 with average rank 31.42, Isopropanol that was 0.24 with average rank 23.21, steam that was 0.22 with average rank of 32.62 and all of them higher than its affinity for cleaning than water that was 0.09 with average rank of 13.55.

Table (8): Kruskal-Wallis's Tests pairwise comparisons of cleaning.

Cleaning	N	Mean ± SD	Average Rank	p
Water	11	0.09 ± 0.07	13.55	0.100
Isopropanol	14	0.24 ± 0.27	23.21	
Water	11	0.09 ± 0.07	13.55	0.001*
Steam	13	0.22 ± 0.08	32.62	
Water	11	0.09 ± 0.07	13.55	0.003*
Ivoclean	12	0.86 ± 0.85	31.42	
Isopropanol	14	0.24 ± 0.27	23.21	0.094
Steam	13	0.22 ± 0.08	32.62	
Isopropanol	14	0.24 ± 0.27	23.21	0.153
Ivoclean	12	0.86 ± 0.85	31.42	
Steam	13	0.22 ± 0.08	32.62	0.837
Ivoclean	12	0.86 ± 0.85	31.42	
* Significant difference ($p < 0.05$).				

5-Shear Bond strength among different groups:

a-Estimation of null hypothesis among different groups:-

The results observed in Table (9) indicated the significant differences ($P < 0.01$) of shear bond strength among the different groups. Thus we reject the null hypothesis of no differences of shear bond strength among different groups and accept the alternative hypothesis of there is a significant differences across the different studied groups in their shear bond strength.

Table (9): Median's Test of Groups

Null Hypothesis	**Decision**	**p**
Medians of Shear Bond Strength are the same across categories of Group	Reject null hypothesis	**0.000***

* Significant difference ($p < 0.01$).

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b-Comparison between the different groups in its shear bond strength:

The results observed in Table (10) indicated the significant differences (P < 0.01) of shear bond strength among the different groups. The results indicated that the higher shear bond strength observed in group-4 (Ivoclean - GC Self-Adhesive) that was 1.64, followed by group 2 (Isopropanol - GC Self-Adhesive) that was 0.38, group 7 (Steam - Multilink Adhesive) that was 0.23 and group 3 (Steam - GC Self-Adhesive) that was 0.22.

While, the lower shear bond strength level observed in the group 1 (Water - GC Self-Adhesive) that was 0.15, group 6 (Isopropanol - Multilink Adhesive) that was 0.09, group 5 (Water - Multilink Adhesive) that was 0.04, group 8 (Ivoclean - Multilink Adhesive) that was 0.08.

Table (10): Median's Test pairwise comparisons of Groups.

Group	Group-1	Group-2	Group-3	Group-4	Group-5	Group-6	Group-7	Group-8	**Median**	**N**	**Mean ± SD**
Group-1	—	0.079	0.122	**0.006***	**0.036***	**0.558**	**0.079**	**0.036***	0.14	5	0.15 ± 0.07
Group-2		—	0.797	**0.000***	**0.002***	**0.008***	**0.593**	**0.002***	0.20	7	0.38 ± 0.33
Group-3			—	**0.001***	**0.001***	**0.013***	**0.391**	**0.021***	0.20	6	0.22 ± 0.11
Group-4				—	**0.001***	**0.000***	**0.000***	**0.001***	**1.68**	6	1.64 ± 0.38
Group-5					—	**0.048***	**0.002***	**0.021***	0.04	6	0.04 ± 0.02
Group-6						—	**0.008***	**0.797**	0.06	7	0.09 ± 0.06
Group-7							—	**0.002***	0.22	7	0.23 ± 0.06
Group-8								—	0.07	6	0.08 ± 0.04

* Significant mean difference (p < 0.05). (A cell represents a pairwise p-value.)
Grand Median = 0.16.
Note: Group-4 (GC Self-Adhesive at Ivoclean) is the best group.
Note: Group-5 vs Group-6 is checked using Mann-Whitney test that gives p = 0.06. Thus, it is critical.

IV. DISCUSSION

The challenge in promoting a strong, reliable bond between the intaglios (ie, the internal surface of zirconia restorations to resin luting agents) lies in achieving a surface free of the contaminants that often result during intraoral try-in procedures. Therefore, surface cleaning procedures should be done before bonding, several cleaning solutions have been used for cleaning restorative surfaces such as water, Ivoclean, steam and Isopropanol.

Saliva contains more than 99% water, combined with small amounts of proteins, glycoprotein sugars, amylase, and inorganic particles. After saliva contamination, non-covalent adsorption of salivary proteins occurs on the surfaces of restorative materials, creating an organic coating that cannot be removed by rinsing with water [(28)].

The purpose of this in-vitro study is to evaluate the effect of saliva contamination and different cleaning techniques on bond strength of zirconia ceramics to dentin using two resin cements. The null hypothesis of this study was that saliva contamination would not affect neither the surface free energy zirconia ceramics, nor the shear bond strength of resin cement to zirconia surface.

The results on the acceptance or rejection of null hypothesis according to the categories of cleaning cleared that, the distribution of shear Bond Strength differ significantly (P < 0.05) across the categories of cleaning of GC self-adhesive resin and Multilink adhesive resin cement so, the null hypothesis was rejected and accept the alternative hypothesis of the distribution of Shear bond strength is differ according to the categories of cleaning of either GC self-adhesive or multilink adhesive resin cement.

This results agreed with the results of **[(23)]** where they reported that, an optimum resin–ceramic bond obtained in a strictly controlled clean condition in vitro could be negatively affected by many situations, which lead to a significant decrease in bonding strength. During the try-in procedure of a restoration inside he mouth, the inner surface contamination is challenging to avoid **[(23)]**.

This results indicated that, for obtaining good adhesion between the zirconia ceramic and the abutment is recognized to play a crucial role in the success of restorations. However, bonding to zirconia ceramic is influenced by different factors; surface treatment of zirconia, the wettability of ceramic by adhesive resins, the composition of adhesive resins and a possible contamination during bonding. [(3)]

While, our results on the comparisons of cleaning at GC self-adhesive/Multilink adhesive resin cement, indicated that, the degree of cleaning in GC self –adhesive higher than its level in Multilink adhesive.

This results agreed with those of, **Ghuman et al.** [(26)] where they compared bond strengths of 7 self-adhesive cements to Zr and found that G-Cem achieved bond strength similar to that of Unicem and Panavia, and a considerably greater compared with others.

Also, the results cleared that, the best cleaner in GC self-adhesive observed in Ivoclean that was 1.64 with average rank 21.50, Isopropanol that was 0.38 with average rank 11.14, steam that was 0.22 with average rank of 10.50 and all of them higher than its affinity for cleaning than water that was 0.15 with average rank of 6.

This results agreed with those of [(25)] where they reported that, the Self-adhesive cements simplified bonding techniques, saved time and most importantly shortened the "window of contamination" since cementation is achieved in one step. As total-etch cements necessitate many steps, each step can associated with a likely contamination. The contamination risk is less and better adhesion could be attained by self-adhesive cements compared to total-etch cements.

While, the best cleaner in Multilink adhesive observed in steam that was 0.23 with average rank 22.57, Isopropanol that was 0.09 with average rank of 12, Ivoclean that was 0.08 with average rank 11.67, and all of them higher than its affinity for cleaning than water that was 0.04 with average rank of 5.50.

The results on the comparisons between the different cleaner indicated that, in general the best cleaning material observed in Ivoclean that was 0.86 with average rank 31.42, Isopropanol that was 0.24 with average rank 23.21, steam that was 0.22 with average rank of 32.62 and all of them higher than its affinity for cleaning than water that was 0.09 with average rank of 13.55.

This results attributed to Ivoclean is formed of of a hyper-saturated solution of Zr particles. Its efficacy depends upon the chemical affinity between its components and contaminants in saliva. In other words, contaminants are attracted to Ivoclean, and then, it is removed from the restoration surface [(27)].

This results agreed with the results of [(28)] where they **commercially available product (Ivoclean [IC], Ivoclar Vivadent, Schaan, Leichtenstein)** can also remove contaminants. The manufacturer as well as the initial evaluations assert that water-washing and air-drying following its application efficiently removes contaminants from Zr restorations**.**

The results of the shear Bond strength among different groups indicated that, the null hypothesis of no differences of shear bond strength among different groups was rejected and accepted the alternative hypothesis of there is a significant differences across the different studied groups in their shear bond strength.

This results agreed with the results of **(Cakir et al.,)** [(29)] where they reported that the shear bond strength differ according to the materials used for surface treatments. **Also, the results of the comparison between the different groups in its shear bond strength,** indicated that the higher shear bond strength observed in group-4 (Ivoclean - GC Self-Adhesive) that was 1.64, followed by group 2 (Isopropanol - GC Self-Adhesive) that was 0.38, group 7 (Steam - Multilink Adhesive) that was 0.23 and group 3 (Steam - GC Self-Adhesive) that was 0.22.

While, the lower shear bond strength level observed in the group 1 (Water - GC Self-Adhesive) that was 0.15, group 6 (Isopropanol - Multilink Adhesive) that was 0.09, group 5 (Water - Multilink Adhesive) that was 0.04, group 8 (Ivoclean - Multilink Adhesive) that was 0.08.

This results attributed to the Self-adhesive cement decreases possible problems caused by improper application of the bonding method. They have the ability to bond to the untreated teeth surfaces which were not micro-abraded or pre-treated with an etchant, primer, or bonding substances [(25)]**.**

Also, Self-adhesive cement doesn't necessitate pretreatment of teeth and restoration surface and application of bonding agents prior to cement application, so it has less technical sensitivity compared to the conventional cement. In other words, self-adhesive resin cements may combine the advantages of both adhesive and conventional luting agents [(24)]**.**

The study concluded that, saliva contamination significantly affected resin bonds to zirconia ceramic and its durability. Ivoclean, Isopropanol and steam was the most effective cleaning method and the Ivoclean - GC Self-Adhesive, Isopropanol - GC Self-Adhesive and Steam - Multilink Adhesive of a higher shear bond strength, respectively.

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