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An In Vitro Comparative Evaluation of Shear Bond Strength of Zirconia Restorations using Various Cleansing Protocol

Research Article

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Abstract

The aim of this study to the leverage of Ivoclean on saliva-contaminated zirconia in comparison to air abrasion regarding of resin bonding strength.

Materials and Methods: A total of 30 partially-stabilized translucent zirconia disk-specimens with a thickness of 2 mm and a diameter of 4 mm were turned out, the specimens were classified into three experimental groups according to the surfaces cleaning methods: "CO" 1st group no contaminated (control group), "AB" 2nd group immersion in saliva then rinsed with water spray for 15s, air drying for 15s with compressed air free oil afterwards alumina blasting with 50 mm particles of Al2O3 at 0.3 MPa for 15 seconds at a distance of 10 mm, using a blasting machine, "IC" 3th group : immersion in saliva for 1 min then water rinsing and air drying protocol, Ivoclean was applied for 20 s without rubbing motion, then water rinsing and air drying protocol was applied. The pretreated specimens were bonded using one self-adhesive resin cement(Multilink N) , and shear bond strength (SBS) were examined using a universal testing machine at a crosshead speed of 0.5 kg/min.

Results: The data so obtained was tabulated and statistically analyzed . The results showed after analyzing no significantly difference between (IC) and (AB) ($P>0.05$), and no significantly difference between (IC) and (CO) in improving of (SBS) ($P<0.05$).

Conclusion: Within the limitations of this in-vitro study, it can be concluded that Ivoclean is effective for removing saliva contaminants, and can improve the resin bond strength to saliva-contaminated zirconia surfaces.

Keywords: Zirconia; Adhesion; Shear Bond Strength; Ivoclean; Saliva Contamination.

Introduction

Partially stabilized tetragonal zirconia polycrystalline restorations have gained widespread use in dentistry mainly because of its enhanced esthetics and increased fracture resistance. Recently, the use of zirconia ceramic restorations has also increased due to their high translucent, the reducedlaboratory costs for ceramic fabrication, and the ease of milling zirconia. However, bonding of resin to zirconia can be affected by a wide range of factors such as contamination of the restorative surface by saliva, the type of resin cements, and the bonding procedure employed during cementation.

To increase bond strengths between resin cements and zirconia, studies on various surface treatments have been conducted [1]. Acid-etching on zirconia surface have been attempted to enhance micromechanical retentivity, but hydrofluoric acid etching was unsuccessful because zirconia is a polycrystalline structure [2]. Micromechanical retention can be achieved by increasing the surface area of the substrate so Sandblasting was used to enhance the mechanical bond strengths, and was reported to have contributed to the improvement of the bond strength.

Recently, a commercial cleaning solution (Ivoclean [IC], Ivoclar Vivadent, Schaan, Liechtenstein) has been introduced to the dental market. The manufacturer claims that a simple application of

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the solution, followed by water rinsing. and air-drying, effectively cleans the saliva-contaminated bonding surfaces of various dental restorations including zirconia ceramic [16].

In this in vitro study, we tested the cleaning leverage of cleaning method in enhancing resin-zirconia bonding following simulation of try-in with saliva exposure and compared itto that of control and air abrasion group . The hypothesis tested was that the cleaning method are notbeneficial in removing saliva contaminants from zirconia surfaces with respect to zirconia bonding with a 10-MDP-containing ceramic primer.

Materials and Methods

For salivary contamination, Fresh human saliva collection was done from one healthy nonalcoholic, nonsmoking individual who had refrained from eating and drinking 2h before saliva collection, and with the informed consent of the donor.

Thirty no carious , human maxillary first premolars extracted for orthodontic purpose were collected and stored in distilled water and ultrasonically cleansed using a scaler (woodpecker Ultrasonics) to remove hard and soft tissue debris , teeth's surfaces were then evaluated for any defects or visible cracks under magnification (×2.5). then we were rejected the defective teeth. All the samples were placed in 0.1% thymol solution until testing for a maximum period of 4 months. The teeth were sliced along the cement-enamel junction using a diamond disc perpendicular to the long axis of the tooth. The buccal surfaces of the tooth were straightened with a diamond disc to uncoveradequate amount of at least 10 mm 2 of dentin available for bonding procedures. Specimens were then embedded in a clear acrylic block of diameter 7 mm and height 7.5 mm. The samples were then finished and polished with silicon grit carbide papers in the order (200, 400, and 600.

A total of 30 completely sintered disk-shaped specimens with a thickness of 2 mm and diameter of 4 mm were used. At first, bonding surfaces of all specimens were polished with 600 grit silicon carbide (SiC) paper, air abraded with 50 µm Al2O3 at0.3 MPa for 15 seconds at a distance of 10 mm,ultrasonicallycleaned in isopropyl alcohol for 3 minutes, rinsed with water, and finally air-dried.The specimens were classified into three study groups. Protest for the control group (group CO, no saliva contamination), all specimens were immersed in saliva for 1 minute and rinsed with water-spray for 15 seconds and air-dried for 15 seconds, After saliva immersion, the specimens were cleaned with 1 of the following 2 cleaning methods:

AB: Additional AB at 0.3 MPa for 15 seconds at a distance of 10 mm, then drying with oil-free air for 10 seconds.

IC: Application of IC for 20 seconds, followed by rinsing with water-spray for 30 seconds, and drying with oil-free air for 10 seconds.

The zirconia plates were bonded to specimens with 1 resin cements (Multilink N+) with the corresponding ceramic primer (Monobond-S.Ivoclar Vivadent). The resin cements were mixed and thenapplied in accordance with the manufacturer's instruction. Mononbond-S was applied on the zirconia surface with aspecial Bruch and dried with oil-free air for 5 seconds before cementation.Excess cement was removed from the bonding margin using small disposablebrushes. Light irradiation was performed by placing the tip ofthe light-emitting diode unit (power density of 1000 mW/cm2; Pencure;J. Morita Mfg. Corp.) on the surface of the resin composite from4 sides for a total of 40 seconds. The bonded specimens were left standing for 30 minutes at room temperature.

The samples were subjected to shear bond strength test after 24 h using universal testing machine (Testometric, Instron) with a crosshead speed of 0.5 mm/min. The values obtained in Newton were converted to stress in Megapascals (Mpa)

Results

Statistical methods of work

To achieve the goals of the research, the researchers used the Social Sciences Statistical Package (SPSS V20), the Social Sciences Statistical Package, to carry out the analysis process and achieve the goals set within the framework of this research, and a level of significance (5%) was used, at an acceptable level in the social sciences in general , And it is matched by a confidence level equal to (95%) to interpret the results of the study to be conducted by the researcher, and enable the following statistical methods:

- Testing the normal distribution using (Kolmogorov-Smirnov, K-S), to see if the data distribution was a normal distribution or not.
- Mathematical averages and standard deviations, as well as areas of confidence.
- Anova monitors and accompanying tests Bonferroni and Dun-

Table 1.

Results	Moral of sig	Value of KS	Bond strength	Groups
normal	0.999	0.365	newton	Control
normal	0.999	0.365	MPa	
normal	0.983	0.463	newton	Air abrasion
normal	0.983	0.463	MPa	
normal	0.809	0.639	newton	IvoClean
normal	0.809	0.639	MPa	

Where we note that p-value> 0.05 for all groups represented in the normal distribution, which causes us to use normal tests (parameter tests)

can.

The researcher used the normal distribution test using (Kolmogorov-Smirnov, K-S) To find out the normal of the results of the research sample tests. The table shows a summary of the results of the normal distribution test (K-S) of the results of the tests, where if the value of (Alpha) statistically significant more than (5%), this indicates that the data follow the normal distribution.

First: The control Group: The following table shows descriptive statistics of bond strength outcomes in the control group:

From the previous table, we note that the average strength of the newton's binding force which occurred at failure in the control group 262.75 with a standard deviation of 39.98 and that the lowest strength at which it failed 192.20 while the highest strength at which it failed 334.10 and the confidence field with a 95% probability of the average strength of the newton's connection ranged from 234.15 as a minimum And 291.35 as a maximum, so if we pull the sampleIts size is 10 hundred times the average bonding force to the newton, at which failure occurs in the observed group in the field [234.15,291.35] 95 times and five times, will fall outside it.

Second: IvoClean group: The following table shows descriptive statistics of bond strength outcomes in the IvoClean group:

From the previous table, we notice that the average strength of the newton's binding force that occurred at EvoClean group failed 227.39 with a standard deviation 41.83 and that the lowest strength at which it failed failed 131.10 while the highest strength had a failure of 272.40 and the confidence field with a 95% probability of the average binding force of the newton has ranged from 197.47 as a minimum It is 257.31 as a maximum, so if we pull the sample 100 times the average newton's binding force at which the failure occurs in the EvoClean group in the field [197.47,257.31] 95 times and five times it will fall outside it.

Third: Air abrasion group: The following table shows descriptive statistics of correlation strength outcomes in the Air abrasion group:

From the previous table, we notice that the average strength of the newton's binding force which failed in the Sandblasting group 253.64 has a standard deviation of 42.11 and that the lowest strength at which it failed fails 183.10 while the highest strength has had a failure of 325.20 and the confidence field with a 95% probability of the average binding force of the newton has ranged from 223.51 as a minimum It is 283.77 as a maximum, so if we pull the sample 100 times the average binding force to Newton at which failure occurs in the Sandblasting group in the field [223.51,283.77] 95 times and five times outside it.

The comparison of the three groups with a measured bond strength with Newton:

To perform the test, one way Anova test was used and its results are shown in the following table.

Discussion

The method of comparing materials performance is used in vitro to assess its clinical performance and its tolerance to the conditions of the oral environment [10], and considering that adequate correlation with the age structure is one of the most important requirements for functional success of compensation over the years, and the strengths of this association are affected by several factors, such as scratching, its concentration, as well as type The resin adhesive used, the bonding of porcelain with the tooth structure, and the bonding system of the resin adhesive with the tooth structure of the enamel and dentine.

Table 2.

strength	max	min	mean ± SD	significance levelat 95%
newton	234.1	192.2	262.75 ± 39.98	[234.15,291.35]
MPa	26.59	15.29	20.91 ± 3.18	[18.63,23.18]

Table 3.

strength	max	min	mean ± SD	significance level at 95%
newton	272.4	131.1	227.39 ± 41.83	[197.47,257.31]
MPa	21.68	10.43	18.09 ± 3.33	[15.71,20.48]

Table 4.

strength	max	min	mean ± SD	significance level at 95%
newton	325.20	183.1	253.64 ± 42.11	[223.51,283.77]
MPa	25.88	14.57	20.18 ± 3.35	[17.79,22.58]

Table 5.

Groups	p-value	F	Mse	mean ± sd	Results
Control	0**	27.07	1853.85	262.75 ± 39.98	Significant Differences
EvoClean				227.39 ± 41.83	
Sandblasting				253.64 ± 42.11	

The sample of the laboratory section of the research was designed to study the test of resistance to shear stress from transparent zirconia, as it is a type of versatile porcelain in dental clinics and because of its cosmetic properties and tablets were selected with a thickness of 2 mmand a diameter of 4 mm for possibility of applying the head of the shear stress meter.

The tablets are manufactured in cad/cam technology, the size of the laboratory sample in the study was 30 tablets of transparent zirconia divided into three groups, each group 10 tablets, and the sample size is close to the sizes of the samples that study resistance to shear stress as in a study [11] in which the size of each group reached 10 tablets. The study relied on extracted human teeth to attach zirconium discs, as they give results closer to the clinical state in terms of dental resonance bonding, and in terms of mechanical properties of natural teeth [12], while a study [13] used village teeth.

Cloramine T solution 0.5% was adopted to preserve the extracted teeth, which were collected for the study, as it is the recommended solution according to the ISO standards for the disinfection of the extracted teeth prior to their use in the studies on adhesion, as it preserves the dental composition, as well as securing a tooth-resin bonding of the extracted teeth similar to the non-extracted teeth [10] Note that other materials such as the Formol may affect the structure of the teeth and glue fibers and thus the nature of the adhesive.

Teeth are fixed in acrylic molds, because the acrylic elastic modulus is close to the elasticity factor of the alveolar bone, as well as for making easy-to-install molds on the shear stress-fighting device, as the surfaces of the teeth on which the discs were affixed within the dentin are settled, as many prosthodontics, inlays or full coverage crown, are Paste it into the dentine.

The study adopted the test of resistance to shear stress, since most laboratory tests are commonly used in examining the forces of bonding to the adhesion systems with dental tissues is the test of resistance to shear stress and tensile strength [14] and it is one of the most important stresses that prosthodontics is exposed to in the oral cavity during chewing, so it is possible to test the resistance to stress Shear is a study of the distribution of efforts on the adhesion surface, as it is an easy test in terms of sample preparation, and the speed of obtaining results, while the tensile test needs greater accuracy in terms of difficulty in ensuring the integrity of the samples, which results in a heterogeneous distribution of efforts in the adhesion area [15], therefore Use a mechanical test device General study of shear stress resistance, by applying force parallel to the adhesion surface.The study did not show a statistically significant difference in shear stress resistance between the use of Ivocline with the control sample, as the shear stress resistance to the use of Ivocline reached 18.09 MPa compared to the control sample which had resistance to shear stress 20.90 MPa.

Ivoclean group showed a clear increase in resistance to bonding forces, as it improved its application against resistance to shear stress, in accordance with the Yoshida study [16]. The results of this study also agree with both Sankar and Kondas to evaluate the effectiveness of cleaning in improving the binding forces. Ivoclean and airway were used to clean saliva pollution. The results showed that Ivoclean could be considered an effective alternative to airway in cleaning surfaces and improving resistance to shear forces. In a 2018 study of Yoshida, its aim was to study the efficacy of several cleaning methods on the shear strength resistance of two types of resin adhesive containing MDP compound affixed to the zirconia surfaces exposed to saliva contamination. The results of this study showed that saliva has a significant effect in reducing the binding forces, and the aerobic and ADG compound superiority of the Ivoclean suspension in improving the resistance of shear forces and improving the binding forces between zirconium and resin cement [16] We agree with this study on the importance of the effect of saliva on reducing resistance Strong link, but the researcher in this study used other cleaning methods

Conclusion

Within the limits of this study, we conclude that Ivocline has an effective role in removing pollution from zirconia surfaces, and has improved resistance to bonding forces with its surfaces, and this is consistent with many studies.

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