Effect Of Air-Borne Abrasion Protocol on Micro-Tensile Bond Strength to Dentin of Different CAD\ CAM Blocks (In-Vitro Study)

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Abstract

Aim: This study evaluated the effect of different air abrasion protocols as a dentin pretreatment with different types of CAD/ CAM blocks on micro-tensile bond strength to dentin.

Methodology: 48 freshly extracted human molars were collected for this study. They were embedded into acrylic resin blocks and a flat uniform mid dentin surface was exposed occlusally. The specimens were then randomly and equally divided into 3 main groups according to the dentin pretreatment protocol whether it is *Control group* (no air abrasion), and *Group* A_1(dentin was air abraded with aluminum oxide particles of 29 µm), and *Group* A_2 (dentin was air abraded with bio-active glass particles). These groups were further divided according to the CAD-CAM blocks whether *Subgroup* C_1 (specimens restored with Lithium disilicate blocks) and *Subgroup* C_2 (specimens restored with composite blocks). then the CAD-CAM blocks were cemented using resin cement. The teeth were sectioned into bar shaped specimens for micro tensile bond strength testing, half of them were tested after 24 hours while the other half was tested after 6 months of storage in distilled water. Then the results were collected and analyzed statistically. One-Way ANOVA followed by Tukey's post hoc test and the pooled error term of the three-way model was performed to compare the effect of study variables and their interaction on µTBS.

Results: Regarding Effect of dentin pre-treatment on mean micro tensile bond strength after 24h, the results of this study showed that there was a statistically significant difference between groups that subjected to dentine surface pretreatment. Immediate CAD\ CAM lithium disilicate: groups with the Al2O3 group (11.44±1.57) showed the highest statistically significant value followed by Slyc group (11.03±1.16), while the lowest value was found in the control group (9.16±0.99). Likewise, the results of immediate CAD\ CAM resin composite groups showed that there was a statistically significant difference between groups that subjected to dentine surface pretreatment. The highest significant value was found in the control group (33.40±3.99), followed sylc group (27.76±5.26), while the lowest significant value was found with Al2O3 group (25.89±3.47). Concerning after 6 months storage all groups showed a significant decrease in the µTBS values except for the groups pre-treated with Sylc.

Conclusions: Dentin surface pre-treatment with air-borne abrasion with Al_2O_3 or sylc powder has fair effect on bonding of CAD/CAM blocks to dentin after 24h but Air-borne abrasion with bioactive glass powder showed stable and durable bonding of CAD/CAM blocks to dentin after six months storage.

Keywords: CAD/CAM Composite Blocks, Surface Treatment Protocols, lithium disilicate blocks, sylc

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Introduction:

In modern dentistry, the minimally invasive concept aims to apply the least invasive surgical approach using the recent available treatment modalities in order to remove minimal dental tissues. Unfortunately, direct resin-composite restorations have many drawbacks which make difficulty in replicating proper proximal contour and contact, reduced mechanical properties and color instability. (1) Recently, indirect esthetic restorations have been extensively used in a challenge to overcome the drawbacks of direct composite resin restorations specially in restoring large cavities, such as inlays, onlays and overlays. This line of treatment considered as the best treatment modality in terms of less polymerization stresses and less chair-side time. (2)

Indirect restorations produced by computer-aided design and computer aided manufacturing (CAD/CAM) are broadly utilized in daily dental practice, due to the marked advances in intra-oral imaging and manufacturing technologies. (3) So new classes of CAD/CAM materials such as lithium disilicate blocks are gaining attention over conventional ceramics. due to its favorable mechanical and optical properties. (4) Moreover, CAD/CAM resin composites material are widely used nowadays because their physical properties closer to tooth structure and their favorable polymerization shrinkage (5)

However, the success of indirect restorations does not depend only on the material nature, but on proper bonding as well. Creating a strong bond between the resin composite and dentin is a challenging pursuit, due to the dentin complex composition. (6) Therefore, several attempts have been made to improve and stabilize the resin dentin bond strength, such as Airborne Particle Abrasion (APA). Literature have stated that Airborne particle abrasion with aluminum oxide is an effective mechanical pretreatment technique used for surface roughening in order to provide an extra ultrafine mechanical retention.

Biomimetic materials such as bioactive glass (silica coating) is a therapeutic ion releasing approach, that can create a bioactive smear layer which in turn can interact with body fluids encouraging mineral deposition through the formation of hydroxy apatite. (7) so, it is an important advancement in improving the adhesive bonding of indirect restorations independent of the alloy used. Although it is very interesting, this strategy is not yet applicable in everyday clinical practice since there is not enough evidence in literature to support the idea. (8)

Materials and Methodology:

The following materials were used in this study

I.1. Abrasive powder Aluminium Oxide 29 μm powder, Bioactive glass (Aquacare, Velopex, UK)

I.2. Two types of CAD\ CAM restorative blocks

Advanced lithium dislicate(Cerec Tessera ™) (Dentsply Sirona , York, PA, USA) **Nano hybrid composite blocks (Brilliant)** (Coltène Whaledent, Switzerland)

I.3. 37% Acid etching gel (Fine Etch, SPIDENT, KOREA).

I.4. 5% HF acid (**IPS Ceramic** (Ivoclar vivadent, AG, Schaan /liechtenstein)

I.5.Porcelain Primer (Bis-Silane™ Bisco, Bisco, Schaumburg, USA)

I.6. Universal adhesive (Prime & Bond, Dentsply Sirona, USA)

I.7. Dual-cure Cement (Calibra Universal, Dentsply Sirona, USA)

The following devices were used in this study

1- **Aqua Care twin air abrasion and polishing Unit** (Aquacare, Velopex, UK).

2- **EliparTM Deep Cure** LED curing light (3M ESPE, Germany).

1) Sample size calculation:

Sample size calculation was conducted using G*Power 3.1.9.4 Software based on data obtained from a previous study Kara and Ozturk, 2017 [9]. The power of t-test was set at 80% using a two-tailed significance level of 5%. A sample size of 6 extracted molars per group was estimated. Sample size was increased by 30% to 8 extracted molars per group, for a total of 48 extracted molars per 6 groups, in order to compensate for pre-test failures.

2) Collection and standardization of human molar teeth:

A total of 48 freshly extracted human molars were collected. the teeth were examined for any previously mentioned defects using 2.5 X magnification (Univet loupes, Italy) and teeth with any structural defects were excluded. [10,11,12]

3) Teeth Storage:

Selected extracted teeth were thoroughly washed and cleaned under running water and then stored for one month in 0.5% chloramine T solution at 4 °C. [13,14,15,16] The teeth were then removed from the disinfectant solution, washed thoroughly, stored in distilled water at room temperature, and used within three months, to avoid their dehydration.

4) Specimens Grouping:

A total number of 48 specimens were used in this study. Specimens were randomly divided into three main groups (16 each) according to the dentin pretreatment protocol (**A**) as follows:

Control group A_0: no air abrasion treatment to dentin.

Group A_1: dentin was air abraded with **AquaAbrasion ™** aluminum oxide particles of 29 µm.

Group A_2: dentin was air abraded with Sylc **™** bio-active glass particles.

Each group were further sub-divided into two sub-groups (8 each) according to the CAD-CAM blocks (**C**) as follows:

Subgroup C_1: specimens restored with Lithium disilicate blocks, Cerec Tessera.

Subgroup C_2: specimens restored with composite blocks, Brilliant Crios.

Each subgroup was divided into two classes (4 each) according to the storage time (**S**) as follows:

Class S_1: specimens tested after 24 hours

Class S_2: specimens stored for 6 months.

5) Sample preparation:

Dental classic wet model trimmer machine was used to remove the occlusal enamel of all samples. Cuts were done occlusally in a mesiodistal direction and perpendicular to the long axis of the tooth, followed by removal of both the occlusal enamel and superficial dentin using a trimmer machine, in order to exposing the midcoronal dentine. This was done in a way to obtain a flat and uniform dentin surface while maintaining the integrity of the pulp chamber. [15,17,18]

6) Mounting of teeth:

Each molar was placed in self-cure acrylic resin (Cold Cure Base Material, Acrostone, Egypt) that was placed in especially fabricated rounded block with dimensions of (1.5 cm X 2cm) using a specially designed centralization guide device. This specially designed device was used during placing to ensure that each molar was placed in such a way that its long axis was perpendicular to the base of the cylinder. Each molar was placed vertically till 2mm below the cemento-enamel margin in acrylic resin. (14)

7) CAD-CAM blocks preparation:

A total of 48 blocks were obtained from the CAD/ CAM blocks with dimensions (8 x 10 x 15 mm) in the study. Twenty-four blocks were obtained from Cerec Tessera lithium dislicate Blocks while the other 24 blocks were obtained from Brilliant Crios (Coltène) reinforced composite blocks. All the blocks were cut using a low speed isomet saw (Isomet 1000, Buehler Ltd., Lake Bluff, IL, USA) into 3 mm blocks to provide adequate thickness. The cut blocks were then checked with hand held digital caliper to standardize the thickness. (10,18) They were then checked for defects such as cracks and chipping if any defect was found, they were excluded.

8) Dentin surface pretreatment:

The dentin specimens were treated according to their assigned groups.

8.1) Control group

Control group (specimens received no pre-treatment): A total of 16 dentin specimens were etched for 10 second using Fine Etch phosphoric acid etchant gel then were rinsed with air-water spray for 10 seconds using the triple syringe followed by gentle air drying for 5 seconds. According to the manufacturer's instructions the Prime & Bond Universal adhesive were actively applied with the microbrush and agitated for 20 seconds, then air thinned and dried gently with oil-free compressed air for 10 seconds. The adhesive was then cured for 20 seconds using LED light curing unit Elipar™ Deep Cure- L LED curing light with a light intensity > 800 mW/cm².

Then specimens were randomly and equally assigned to the following sub-groups (n=8):

Sub-group C1 were cemented to Cerec Tessera , lithium dislicate blocks .

Sub-group C2 were cemented to Brilliant Crios, Resin Composite blocks**.**

8.2) Dentin Pre-treatment groups

Aquacare twin (Velopex International, London, UK) air abrasion unit was used to deliver air-abrasion powder with different powers in all the dentin specimens.

A total of 32 Dentin specimens were divided into 2 main groups (n=16) as follows.

Group A1: In this group, the dentin specimens were pre-treated with AquaAbrasion **™ Aluminium Oxide** 29 µm powder as follows:

Aquacare twin (Velopex International, London, UK) air abrasion unit was used to deliver the Aluminium Oxide**,** this was carried out with a standard tip to ensure that the nozzle is on equal distance and at 90º from the specimen all times. The silver coded hand-piece nozzle with a diameter of 0.6 mm working at 1 cm distance from the dentin surface for 1 minute under continuous water shroud and at an air pressure of 5 bar (500 MPa), then was rinsed with water for 20 seconds and dried. (18,19) To ensure standardized distance and angulation, a premeasured micro-brush was fixed to the nozzle tip by duct tape.

Group A2: In this group, the dentin specimens were pre-treated with **Sylc ™** Bioactive **glass powder as** follows: Aquacare twin (Velopex International, London, UK) air abrasion unit was used to deliver the Sylc™ powder. It was equipped with a standard tip and used in the same way described before with the Aluminium Oxide powder.

A total of 16 dentin specimens of each main groups were etched for 10 seconds using Fine Etch phosphoric acid etchant gel then were rinsed with air-water spray for 10 seconds using the triple syringe followed by gentle air drying for 5 seconds. The Prime & Bond Universal adhesive were applied according to the manufacturer's instructions. It was actively agitated with the microbrush for 20 seconds and then air thinned and dried gently with oil-free compressed air for 10 seconds and using Elipar™ Deep Cure- L LED curing light with a light intensity > 800 mW/cm² to cure for 20 seconds.

Then specimens of each main group were randomly and equally assigned to two sub-groups (n=8) as follows:

Sub-group C1 were cemented to CAD\ CAM lithium disilicate blocks **Cerec Tessera**

Sub-group C2 were cemented to CAD\ CAM resin composite blocks **Brilliant Crios**

9) Pretreatment of CAD/CAM Blocks:

Regarding the **ceramic blocks**, Cerec Tessera (Dentsply Sirona, York, PA, USA) were pretreated according to manufacturer's instructions as follows: the fitting surface was etched with IPS Ceramic Porcelain etchant (HF acid 5%) for 30 seconds, rinsed for 20 seconds, air dried for 10 seconds. Bis-Silane**™** Bisco silane coupling agent was then applied and left for 2-minutes then air dried followed by active application of a thin coat of the Prime & Bond Universal adhesive for 20 seconds then air thinned for 5 seconds and light cured for 20 seconds. [20]

On the other hand, regarding the **composite** blocks, Brilliant Crios (Coltène) were pretreated according to manufacturer's instructions as follows: the fitting surface was subjected to sandblasting for 20 seconds using 29 µm AquaAbrasion ™ aluminum oxide at 1.5 bar, then the sandblasted surfaces were cleaned using an ultrasonic cleaner, dried then rinsed for 20 seconds, air dried for 10 seconds. Thin coat of the Prime and Bond universal adhesive were then actively applied and rubbed for 20 seconds, air thinned for 10 seconds and light cured for 20 seconds. [21]

10) Cementation procedure:

The base and catalyst paste of the Calibra Universal (Dentsply Sirona, York, PA, USA) self-adhesive dual cure resin cement was mixed with the auto-mixing tips provided with the cement tube in a ratio of 1:1 to form a homogenous mix. A thin layer of resin cement was applied to the dentin surface and to the block. All restorations were placed under vertical loading device with 1kg load. The load was applied over the block for 5 mins during cementation. The excess cement was removed immediately with the micro-brush. The cement was cured using Elipar™ Deep Cure- LED light cure (light output ≥ 800 mW/cm2) for 20 seconds and then another 10 seconds after load removal. [20] After complete polymerization, the specimens of each sub-group were randomly and equally assigned to two classes (n=8) as follows:

Class S1: specimens were tested 24 hours after cementation

Class S2: specimens were stored in distilled water for 6 months before testing.

11) Storage of specimens

For the immediate groups (S1), specimens were stored in distilled water at room temperature for only 24 hours before micro-tensile bond testing. On the other hand, regarding the delayed groups (S2), specimens were stored in distilled water at room temperature for 6 months and the water was changed every 3 days, while during the hot days water was changed every day for storage standardization.

12) Microtensile bond strength testing:

The specimens were sectioned along the buccolingual and mesiodistal planes using a diamond disk (MTI Corporation, Richmond, CA, USA) in a low-speed micro-slicing machine (Isomet, Buehler, Lake Bluff, IL, USA) under water-cooling, to produce beam-shaped specimens (bonding areas approximately with cross-sectional areas 1 mm^2). Half of each rod consists of CAD/CAM block and the other half of dentin. Centralized 3 to 4 beams were taken from each specimen**.** [10,22] The bond strength test was performed immediately after cutting. For the micro tensile testing, the beam specimens were attached with cyanoacrylate gel (Zapit; Dental Ventures of America, Corona, CA, USA) to the testing customized microtensile jig. The Jig M consists of two flat, stainless steel sliding plates that function as a fixating device, it attaches to the electromechanical universal testing machine (Instron, USA) ensuring that the motion is uniaxial and that the rod tested is aligned with the direction of the force applied. The jig plates slide away from each other when the apparatus is subjected to tensile force, thus pulling the specimen apart. The test was performed using a micro-tensile bond strength testing device with a stroke length of 50 mm, peak force of 500 N and a displacement resolution of 0.5 mm. The values were expressed in MPa.

13) Statistical analysis:

Categorical data were presented as frequency and percentage values and were analyzed using chi-square test. Numerical data were presented as mean and standard deviation (SD) values. They were explored for normality by checking the data distribution, and using Shapiro-Wilk test. Data showed parametric distribution and were analyzed using three-way ANOVA followed by Tukey's post hoc test. Comparison of main and simple effects were done utilizing one-way ANOVA followed by Tukey's post hoc test and the pooled error term of the three-way model. P-values were adjusted for multiple comparisons utilizing Bonferroni correction. The significance level was set at $p < 0.05$. Statistical analysis was performed with R statistical analysis software version 4.3.0 for Windows. [1]

[1] R Core Team (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Results:

1- Effect of different variables and their interaction:

Effect of different variables and their interaction on surface micro-tensile bond strength (MPa), There was a significant interaction between the three tested variables (p=0.002).

Table (1): Effect of different variables and their interactions on surface micro-tensile bond strength (MPa)

Source	Sum of Squares	df	Mean Square	f-value	p-value
Surface treatment	48.69	2	24.35	2.47	**0.091ns**
Material	8242.81	1	8242.81	837.50	**<0.001***
Storage time	708.86	1	708.86	72.02	**<0.001***
Surface treatment * Material	92.19	2	46.10	4.68	**0.012***
Surface treatment* Storage time	90.73	2	45.36	4.61	**0.013***
Material*storage time	15.54	1	15.54	1.58	**0.213ns**
Surface treatment * material*storage time	133.27	2	66.63	6.77	**0.002***

df =degree of freedom*; significant ($p \leq 0.05$) ns; non-significant (p>0.05)

2- Effect of surface treatment:

Mean, Standard deviation (SD) values of surface micro-tensile bond strength (MPa) for different surface treatments

1- **Lithium disilicate blocks.:**

- **Immediate:**

There was a significant difference between different groups (p=0.004). The highest value was found in Al2O3 (11.44±1.57), followed by Sylc (11.03±1.16), while the lowest value was found in the control group (9.16±0.99). Post hoc pairwise comparisons showed the control group to have significantly lower value than other groups (p<0.001).

- **6 months:**

There was a significant difference between different groups (p<0.001). The highest value was found in Sylc (6.32±0.97), followed by control group (2.92±0.36), while the lowest value was found at Al2O3 (2.60±0.51). Post hoc pairwise comparisons showed Slyc to have significantly higher value than other groups (p<0.001).

2- **Composite blocks.:**

- **Immediate:**

There was a significant difference between different groups (p=0.009). The highest value was found in the control group (33.40±3.99), followed by Sylc (27.76±5.26), while the lowest value was found at Al2O3

(25.89±3.47). Post hoc pairwise comparisons showed the control group to have significantly higher value than Al2O3 ($p<0.001$).

- **6 months:**

There was no significant difference between different groups ($p=0.448$). The highest value was found in Sylc (26.20±3.07), followed by Al2O3 (24.10±3.40), while the lowest value was found in the control group (21.97±7.56).

Table (2): Mean, Standard deviation (SD) values of surface micro-tensile bond strength (MPa) for different surface treatments

Material	Storage time	Surface micro-tensile bond strength (MPa) (mean±SD)			p-value
		Control	Al2O3	Sylc	
Lith.	Immediate	9.16±0.99^{B}	11.44±1.57^{A}	11.03±1.16^{A}	0.004*
	6 months	2.92±0.36^{B}	2.60±0.51^{B}	6.32±0.97^{A}	<0.001*
Comp.	Immediate	33.40±3.99^{A}	25.89±3.47^{B}	27.76±5.26^{AB}	0.009*
	6 months	21.97±7.56^{A}	24.10±3.40^{A}	26.20±3.07^{A}	0.448ns

Means with different superscript letters within the row are significantly different *; significant ($p \leq 0.05$) ns; non-significant ($p>0.05$)

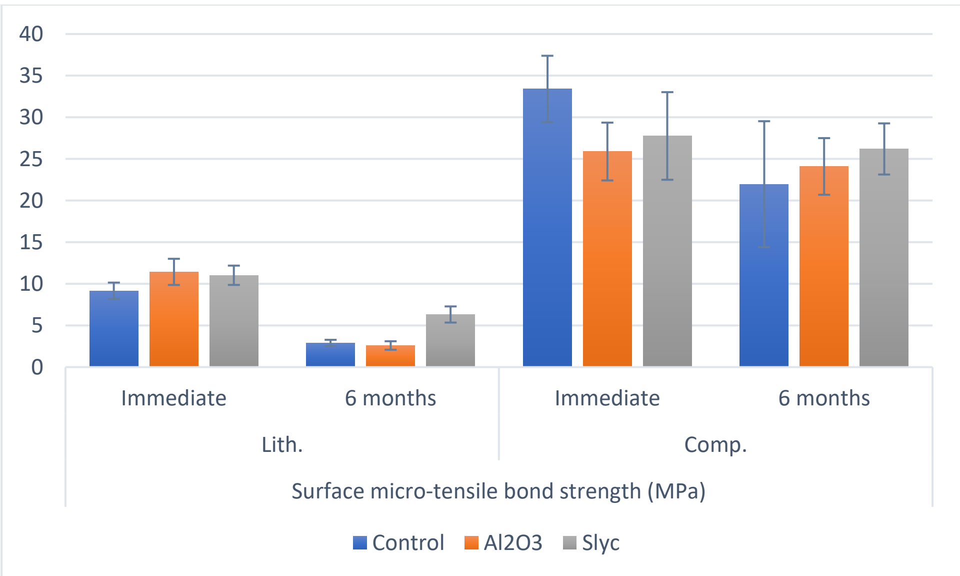

Figure (1): Bar chart showing average surface micro-tensile bond strength (MPa) for different surface treatments

3- Effect of material:

Mean, Standard deviation (SD) values of surface micro-tensile bond strength (MPa) for different materials are presented in table (6) and figure (33)

1- Control:

- **Immediate:**

Composite. (33.40±3.99) had a significantly higher value than Lith. (9.16±0.99) ($p<0.001$).

- **6 months:**

Composite. (21.97±7.56) had a significantly higher value than Lith. (2.92±0.36) ($p<0.001$).

2- Al2O3:

- **Immediate:**

Composite. (25.89±3.47) had a significantly higher value than Lith. (11.44±1.57) ($p<0.001$).

- **6 months:**

Composite. (24.10±3.40) had a significantly higher value than Lith. (2.60±0.51) ($p<0.001$).

3- Sylc:

- **Immediate:**

Composite. (27.76±5.26) had a significantly higher value than Lith. (11.03±1.16) ($p<0.001$).

- **6 months:**

Composite. (26.20±3.07) had a significantly higher value than Lith. (6.32±0.97) ($p<0.001$).

Table (3): Mean, Standard deviation (SD) values of surface micro-tensile bond strength (MPa) for different materials

Surface treatment	Storage time	Surface micro-tensile bond strength (MPa) (mean±SD)		p-value
		Lith.	Comp.	
Control	Immediate	9.16±0.99	33.40±3.99	<0.001*
	6 months	2.92±0.36	21.97±7.56	<0.001*
Al2O3	Immediate	11.44±1.57	25.89±3.47	<0.001*
	6 months	2.60±0.51	24.10±3.40	<0.001*
Sylc	Immediate	11.03±1.16	27.76±5.26	<0.001*
	6 months	6.32±0.97	26.20±3.07	<0.001*

*;significant($p\leq0.05$)…..ns ;non-significant($p>0.05$)

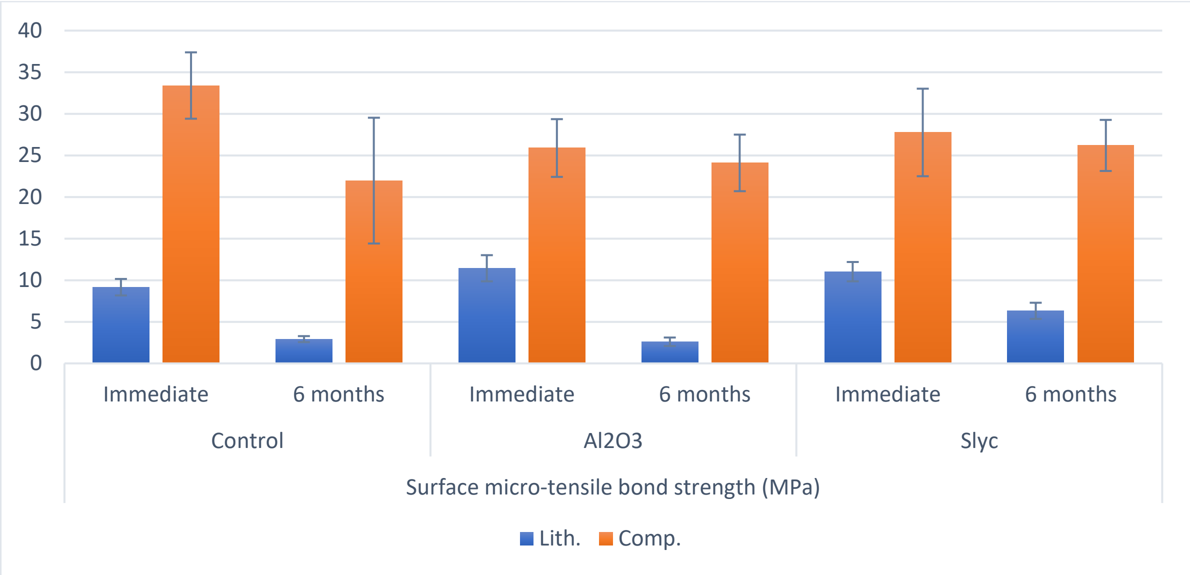

Figure (2): Bar chart showing average surface micro-tensile bond strength (MPa) for different materials

4- <u>Effect of storage time:</u>

Mean, Standard deviation (SD) values of surface micro-tensile bond strength (MPa) for storage time effect

<u>1- Control:</u>

- **<u>Lith.:</u>**

Samples measured immediately (9.16±0.99) had a significantly higher value than samples measured after 6 months (2.92±0.36) ($p<0.001$).

- **<u>Composite.:</u>**

Samples measured immediately (33.40±3.99) had a significantly higher value than samples measured after 6 months (21.97±7.56) ($p=0.006$).

<u>2- Al2O3:</u>

- **<u>Lith.:</u>**

Samples measured immediately (11.44±1.57) had a significantly higher value than samples measured after 6 months (2.60±0.51) ($p<0.001$).

- **<u>Composite.:</u>**

Samples measured immediately (25.89±3.47) had a higher value than samples measured after 6 months (24.10±3.40) yet the difference was not statistically significant ($p=0.379$)

<u>3- Sylc:</u>

- **<u>Lith.:</u>**

Samples measured immediately (11.03±1.16) had a significantly higher value than samples measured after 6 months (6.32±0.97) ($p<0.001$).

- **<u>Composite.:</u>**

Samples measured immediately (27.76±5.26) had a higher value than samples measured after 6 months (26.20±3.07) yet the difference was not statistically significant ($p=0.562$).

Table (4): Mean, Standard deviation (SD) values of surface micro-tensile bond strength (MPa) for storage time effect

Surface treatment	Material	Surface micro-tensile bond strength (MPa) (mean±SD)		p-value
		Immediate	6 months	
Control	Lith.	9.16±0.99	2.92±0.36	<0.001*
	Comp.	33.40±3.99	21.97±7.56	0.006*
Al2O3	Lith.	11.44±1.57	2.60±0.51	<0.001*
	Comp.	25.89±3.47	24.10±3.40	0.379ns
Sylc	Lith.	11.03±1.16	6.32±0.97	<0.001*
	Comp.	27.76±5.26	26.20±3.07	0.562ns

*; significant ($p \leq 0.05$) ns; non-significant ($p>0.05$)

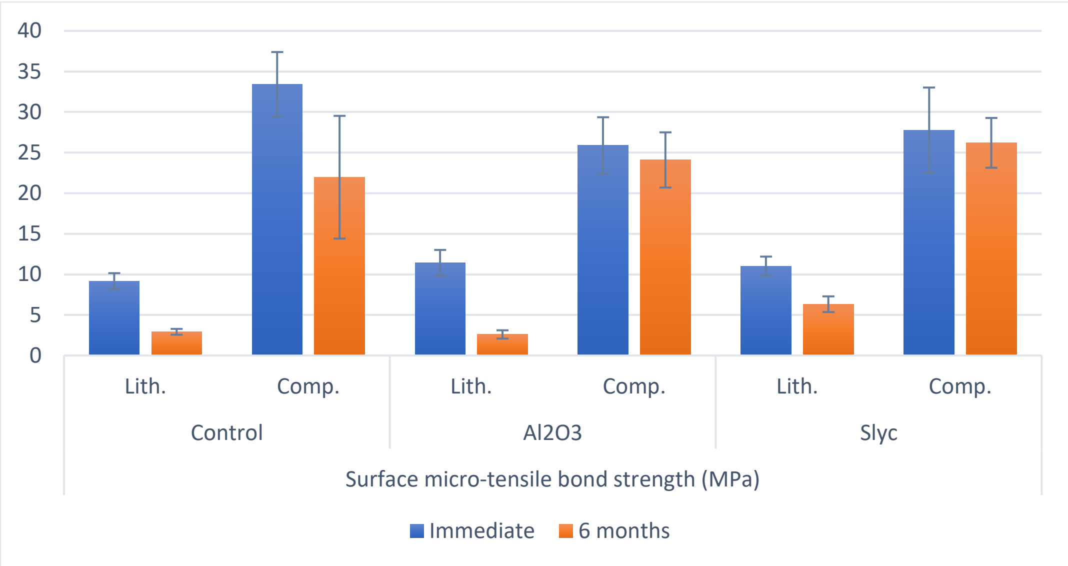

Figure (3): Bar chart showing average surface micro-tensile bond strength (MPa) for storage time effect

Discussion:

In the field of restorative dentistry, the use of indirect adhesive restorations has improved the retention of the restorations, improved the aesthetic results, as well as reduced the invasiveness to tooth structure. However, several factors can influence the long-term performance of indirect adhesive restorations such as different adhesion protocols, restorative materials used and protocols for substrate pretreatment that can improve the bond strength of restoration. [23] Creating a strong bond between the resin adhesive and dentin is a challenging chase. Therefore, different techniques can be applied to dentin and to make the dentin surface approachable for bonding. [24] Recently ***air abrasion***, despite being a relatively old technique, has become the subject of renewed attention. It can be regarded as version of sandblasting, Simply, the abrasive particles strike the tooth surface, removing small amounts of tooth structure producing surfaces that are compatible with the needs of adhesive dentistry. Hence, weighing the benefits versus harms of pre-treatment techniques remains debatable, and adequate knowledge about the influence of pre-treatment techniques and the aging on bond strength of indirect materials to tooth hard tissues is still lacking. [25]

Aluminum oxide powder was the first studied material. Studies claimed that aluminum oxide powder increases the surface area available for adhesion, enhances resin tag formation, and improves bond strength to dentin. [23]

Sylc bioactive glass powder (BAG), was the second studied material. It is an innovative product that is composed of Novamin (Calcium Sodium Phospho-silicate compound). Literature reported that the use of BAG in air-abrasion devices, allows for their embedment in dentin surface and within the dentinal tubules, to create a "bioactive smear layer" within the interface, which can be incorporated within the self-etch adhesive during the bonding procedure and remain "therapeutically" available at the bonding interface. [27] The ion-releasing capacity of the bioactive glass favours remineralization and protection of the adhering interface. [18,26]

Since Shrinkage stresses in composite restorations generated during setting are still one of the major problems in adhesive dentistry. ***The indirect aesthetic bonded*** restorations can overcome these problems by limiting the contraction stresses of the polymerization reaction to the thin resin-cement layer. [27] Therefore, in this study we used indirect aesthetic restorations so that to avoid some of the drawbacks associated with direct composite restorations.

In order to establish a strong and durable bond, which is necessary for the biomechanical aspect of the tooth-restoration system, appropriate treatment of the respective surfaces is crucial. [27] Accordingly, this present study was planned to evaluate the effect of dentin pre-treatment, and aging on the bond strength of two different types indirect restoration to dentin, in terms of micro-tensile bond strength.

In this study, ***Human molars*** were chosen specifically to ensure a large surface area of dentin, where the exposed flat and uniform mid-coronal dentin can be easily polished to standardize the smear layer thickness. [28]

Aluminium Oxide powder and ***Bioactive glass powder*** were delivered using Aquacare twin air abrasion unit with a standard parameter as tip nozzle was on equal distance from the specimen at all times [18,19]

In this study, the ***micro-tensile bond strength*** test was adopted for measuring bond strength due to its accuracy compared to shear bond strength. This related to the applied tensile stresses that are vertical to the bonded area, thus failure becomes directly a function of the tested bond strength. [24,29]

Worth mentioning here that when the conditions of the study simulate the clinical condition, results will be more clinically valuable. Accordingly, this study considered the ***aging*** variable and specimens were tested after 24h and after storage for 6 months to mimic the clinical situation and achieve relevant conditions.

Regarding Effect of dentin-pre-treatment on mean micro tensile bond strength after 24h, the results of this study showed that there was a statistically significant difference between groups that subjected to dentine surface pretreatment.

Immediate ***CAD\ CAM lithium disilicate***: (Cerec Tessera ™) groups with the Al2O3 group (11.44±1.57) showed the highest statistically significant value followed by Sylc group (11.03±1.16), while the lowest value was found in the control group (9.16±0.99). This means that the use of air abrasions as pretreatment have a positive effect on the micro-tensile bond strength of CAD/CAM restoration to dentin. This may be related to the application of air abrasion with aluminum oxide that increase both surface roughness and irregularities of dentin surface which may be more conducive to bonding due to increasing bonding surface area, enhancing hybrid layer and resin tag formation, thus improved bond strength. (23,30,31) Worth mentioning here that the chemical composition of the dentin surface together with surface roughness and capillary action may be the decisive factor for dentin surface-free energy (32), consequently diffusion of the self-adhesive luting cement into the dentin surface (14) hence, increasing bond strength.

The present results are in accordance with **Chaiyabutr et al** (14). which reported an increase in the bond strength of self-adhesive luting cement to dentine used after sandblasting with AL2O3 compared to hand instrument excavation. Similarly, **Mujdeci et al**. (30) in another study showed how the shear bond strength to enamel and dentin significantly increased after airborne-particle abrasion with Al2o3 treatment compared to the control groups. Moreover, **Coli et al**. (33) stated that besides surface roughness, there are many other elements that have significant effect on bond strength, including the chemical composition of the dentin surface, orientation of the dentinal tubules and the formation of resin tags.

Similarly, the manner of Bioactive glass (sylc) application by air abrasion technique under pressure and high velocity as well as the particle size of the powder, might produce micro-irregularities especially in the inorganic part of dentin creating supplementary micro-spaces for the adhesive infiltration with consequent high bond strength. This result came in agreement to **Sutil et al, 2017,** (34) regarding the idea of dentin pre-treatment explaining that the air abrasion unit used is capable of superficial removal of the smear layer and increasing the surface roughness which in turn leads to an increase in the resin infiltration into the dentin thereby improving the adhesion.

Likewise, the results of ***immediate CAD\ CAM resin composite*** (Brilliant Crios) groups showed that there was a statistically significant difference between groups that subjected to dentine surface pretreatment. The highest significant value was found in the control group (33.40±3.99), followed sylc group (27.76±5.26), while the lowest significant value was found with Al2O3 group (25.89±3.47). This means that using air abrasion as pretreatment did not have a positive effect on the bond strength of CAD/CAM composite restoration to dentin. As the bond strength of the CAD/CAM composite blocks was high in control group without air abrasion, the insignificant decrease in bond strength values with both air abrasion powders might be due to their effect on the homogeneity of the resin-dentin interface and formation of pure hybrid layer due to remnants of the powder used on dentin surface and in between collagen fibrils that act as impurities within the formed hybrid layer that adversely affect the bond strength of the composite blocks to the underlying dentin even with phosphoric acid application to clean these remnants. This could be explained by the deep embedding of the particles in dentin surface due to high air pressure used with air abrasion. Additionally, the bioactivity of the bioactive glass powder counteracts its removal from dentin even with etching step.

In **Souza-Zaroni et al.** (35), **Mujdeci et al**. (30) and **D'Amario et al** (36), the authors reported a positive effect of air abrasion on adhesive bonding. On the contrary, among others studies, **Borsatto et al**. (37) and **Huang et al**. (38) did not find a statistically significant positive effect of this type of pretreatment.

Moreover, in this study, results showed the influence of bioactive glass air abrasion (sylc) has no statistically significant difference in the micro-tensile bond strength values of dentine to indirect CAD\ CAM materials. This came in agreement with **Carvalho et al**, (39) findings, who stated that the pre-treatment of dentin using experimental bioactive glass showed no significant difference on the μTBS of resin cements after 24 hours. These results are also in agreement with previous studies **Morais et al,** (40) and **sinhoretti et al,** (41) stated that dentin pretreatment showing no significant difference tested after 24 hours.

Concerning the effect of dentin-pre-treatment on mean micro tensile bond strength after 6 months, there was no statistically significant difference in μTBS mean values between dentin pretreatment groups. Significantly higher μTBS mean values were reported in **ceramics blocks** the highest value was found in Sylc (6.32±0.97), followed by control group (2.92±0.36), while the lowest value was found at Al2O3 (2.60±0.51). While in **composite blocks** the highest value was found in Sylc (26.20±3.07), followed by Al2O3 (24.10±3.40), while the lowest value was found in the control group (21.97±7.56).

After 6 months of aqueous media storage all groups showed a significant decrease in the μTBS values except for the groups pre-treated with ***bioactive glass*** in comparison to those tested after 24 hours. This may be attributed to the use of universal adhesives that could be used with self-etch mode and characterized by high hydrophilicity. Literature has reported that self-etching adhesives are considered the most susceptible to degradation when stored in water due to the increased hydrophilicity of the interface. (42,43,44) Moreover, it is well known that bond deterioration is a common sequela after long term aqueous storage. This might be because of water sorption of the adhesive especially the self-etch approach which is characterized by its high hydrophilicity to facilitate its infiltration into the wet dentin. (54)

Contradictory, all groups pre-treated with **Sylc** air-abrasion powder showed no statistically significant difference in the μTBS mean values; this means that Sylc powder application improved the bond durability even after aqueous media storage. This longevity can be attributed to many reasons: First, the presence of BAG within the resin–dentine interface can lead to the release of a silicic acid, such as Si $(OH)_4$, and a subsequent polycondensation reaction between the silanols compounds and the demineralized collagen through electrostatic, ionic, and/or hydrogen bonds [37,38] which prevented the MMPs from enacting their collagenolytic and gelatinolytic activities. Second, the immediate reaction between Ca^{2+} and PO_4 from BAG which may have also favoured the formation of a high-molecular-weight complex (Ca/P–MMPs), which inhibited the activities of MMP-2 and MMP-9 within the hybrid layer. [14]

Moreover, the bioactive particles with its small size (25-29μ) may be introduced in-between the collagen fibrils to act as cross-link and a scaffold for these fibrils. Thus, improving the infiltration of the adhesive at application time and improve the bond durability by inhibiting the biodegradation of the formed hybrid layer.

Regarding effect of restoration material on mean micro tensile bond strength, the current study showed that groups cemented to ***CAD\ CAM resin composite blocks*** (Brilliant Crios) have a higher significant different micro-tensile bond strength value compared to those cemented to ***CAD\ CAM lithium disilicate discs*** (Cerec Tessera) at 24 hours and after storage for 6 months. This could be due to chemical homogeneity between composite blocks, resin adhesives and resin cement that provide monoblock and complete integration between all these components with maximum bond strength. Another attribution might be related to the mechanical differences between both the CAD\ CAM resin-composite and ceramic blocks. Mainly, the differences in the elastic modules between the two materials could play a significant role, as Literature reported that CAD\ CAM ceramic blocks have higher modulus of elasticity compared to those of resin-composite. A material with a higher modulus of resilience is capable of absorbing more energy before permanently deforming and/or failing. [45] This study also confirmed by a study conducted by **El Zohairy et al** [46], This study reported that CAD/CAM restorations fabricated from processed composite blocks may have the advantage of a higher bond strength values compared to the ceramic blocks. Study reported that the more brittle the ceramic material is, the more the tendency to fail at the adhesive interface at lower values than the more resilient resin-composite. Moreover, **Kavut et al** [47] concluded that Brilliant Crios reinforced composite block showed higher shear bond strength values with Self etch/adhesive resin cements when compared to IPS e.max CAD ceramic blocks, this could be from the strong carbon-carbon bonds on the surface strengthened the adhesion between resin cement and composite block.

CONCLUSIONS:

Under the limitations of the current study the following conclusions werederived:

1. The bond strength of CAD/CAM resin composite and ceramic blocks to dentin is affected by the dentin surface pre-treatment protocol.

2. Dentin surface pre-treatment with air-borne abrasion with Al_2O_3 powder has fair effect on bonding of CAD/CAM resin composite blocks to dentin.

3. Air-borne abrasion with bioactive glass powder as dentin surface pre-treatment showed stable and durable bonding of CAD/CAM resin composite

blocks to dentin even after six months storage.

4. Air-borne abrasion either with Al_2O_3 powder or bioactive glass powder as dentin surface pre-treatment had a modest effect on bonding of CAD/CAM lithium disilicate ceramic blocks to dentin.

5. The resilient CAD/CAM resin composite blocks could be considered as a perfect alternative to CAD/CAM ceramic blocks in restorations of posterior teeth regarding bond stability and durability.

6. Both resin composite and ceramic CAD/CAM blocks restoration were affected by storage time.

RECOMMENDATION:

We recommended to:

1. Randomized controlled clinical trials (RCTs) should be carried out to confirm our findings.
2. Further Long-term evaluation must be done to confirm the bond stability.
3. Using different adhesive techniques, cements, abrasive particle sizes and CAD-CAM blocks, to reach a standardized methodology for the cementation protocol of indirect restorations.

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