WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 7.523
Volume 6, Issue 15, 1-23. Research Article ISSN 2277– 7105

EVALUATION THE EFFECT OF HYDROFLUORIC ACID AND GRINDING TREATMENT ON SHEAR BOND STRENGTH OF IPS E.MAX PRESS WITH CERAMIC VENEER MATERIAL (AN IN VITRO STUDY)

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Article Received on
24 Sept. 2017,

Revised on 15 Oct. 2017,
Accepted on 06 Nov. 2017

DOI: 10.20959/wjpr201715-10040

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ABSTRACT

Back ground: The bond strength is the most common factor success in layer all-ceramic crowns and delaminating is the most common failure reason in the core-veneer interface The core/veneer interface is one of the weakest aspects of layered all-ceramic crowns[1] and plays a significant role in their long-term success.[2,1] **Objective:** the objective of this study to investigate the effect of etching with hydrofluoric acid and grinding on roughness of heat press (lithium di-silicate) core and shear bond strength between lithium di-silicate core and veneering ceramic. **Materials and Methods**: thirty discs specimens (10mm in diameter and 3mm in thickness) were prepared according to the manufacturer's recommendations. polishing was done for all the samples using silicon carbide abrasive paper 600 grit and then 1200 grit and the surface roughness was measured by Atomic Force Microscope(AFM) for all the polished surface of the samples (Ra) which ranged between (**66.063 - 69.66** nm) then in a random way the samples were divided in to three groups as follows: Group 1: no surface treatment (control group), Group 2: etching with 4.5%HF, Group 3: grinding with wet silicon carbide abrasive paper under water cooling first with wet 100 grit, then with 220 grit. grinding performed on

metallurgical polishing machine. After that, the surface roughness measured by AFM for group 2 and 3. later, randomly selected one sample from each group and prepared for scanning electron microscope to analyze the surface morphology characteristic. Followed by the application of veneer ceramic (IPS e.maxceram, Ivoclar vivadent schaan, leichtenstein). Shear bond strength(SBS) was determined by a universal testing machine at a 1mm/min crosshead speed. The fractured specimens were examined with stereomicroscope to detect the mode of bond failure. Data were analyzed with one way ANOVA test and multi comparison least significant difference (LSD Test), and ROC validity test. **Results:** the statistical analysis revealed that, the superior roughness value was for group grinding followed by 4.5%HF and the lowest roughness value was related to the control group and the result of shear bond strength indicate that group grinding was higher than the control and HF groups which showed the similar mean value in shear bond strength.

KEYWORDS: Lithium Di-Silicate, Surface Roughness, Shear Bond, Grinding.

INTRODUCTION

The dental ceramics are used and studied widely in dentistry, and considered the most esthetically pleasing materials existed for the purpose of prosthetic dentistry due to their biocompatibility, chemical stability, acceptable translucence, fluorescence properties, and their high resistance to abrasion.[3] In order to improve the mechanical properties, pressed ceramics reinforced with leucite or lithium di-silicate were introduced.[4]

Because of its excellent mechanical characteristics, pressed ceramic is considered one of the most popular dental materials.[5] IPS e. max was put into the market so as to increase the fracture resistance of IPS Empress II introduced by Ivoclar.[6,7] The IPS e. max press is characterized by its microstructure which is represented as needle-like lithium di-silicate crystals embedded in a glassy matrix. It should be mentioned that IPS e. max press is a dental ceramic that mimics the esthetics and strength of natural tooth structure.[8,9] The strength of layered all-ceramic structure is determined by its weakest component, which will be usually the core/veneer bond strength or the veneering material itself.[10] Thus, there can be clinical failures when there is not an adequate bond, leading to the fracture of ceramic restoration or failure of the bond.[11] Core/veneer bond strength may be affected by mechanical retention which is, by turn, affected by the surface treatment, different surface treatment methods grinding, acid etching, polishing and combination of any of those methods, have been proposed to provide roughness and promote micromechanical retention.[12,13] The shear bond

strength (SBS) test has been used most commonly in studies[14] and become an accepted evaluation method which is a simple and reliable test[15] The use of shear bond strength test can help to determine substructure-veneer bond strength with more standardized information because the applied forces are perpendicular to the bonding area.[1,16]

MATERIALS AND METHODS

Thirty discs specimens of wax patterns were fabricated from 2sheats of modeling base plate wax (3mm in thickness), they were punched with a copper ring (NO.15, Lot no.15039, Germany), 10mm in diameter to obtain the core ceramic specimens that have 3mm in thickness and 10mm in diameter. Then the discs wax pattern are sprued with a wire wax 2.5mm diameter (Lot no.03344, BeGo, Germany) then three samples of wax patterns with sprues attached at the edge of IPS muffle later, investing was done using phosphate bonded investment material (Bella vest SH, Lot no.02068390916, BeGo, Germany) and the special liquid Begosol Lot no.01616HF0816, Germany) were mixed according to the manufacturer's instructions. After that, the mixture is poured inside the silicon ring 100g (Lot no.v28508, Ivoclarvivadent, Liechtenstein) the ring gauge put on the silicone ring with a hinged movement, and allowed the investment to set according the manufacturer's instructions. after complete setting of investment material, the ring base and ring gauge are removed with a turning movement. Carefully push the investment ring out of IPS silicon ring. then, the investment ring prepared for preheating in the preheating furnace(Maxwell, MTA-96) the position of investment ring in the preheated furnace is toward the rear wall, tipped with the opening facing down and preheated for temperature at (900c/1,650f)after the preheating cycle for the investment ring has been completed, the investment ring was removed from the preheating furnace immediately this step may take max-30s to prevent investment ring from cooling down too much and the lithium disilicate ingot (IPS e.max press LTA1,Lot no.S17693,Ivoclarvivadent,Liechtenstien) is placed into the hot investment ring and placed the cold IPS Aloxplunger (Lot no. U38027, Ivoclarvivadent, Liechtenstien) which has been coated with IPS Aloxplunger separator (Lot no.U31466, Ivoclarvivadent, Liechtenstien) then the hot investment ring is placed in the center of press furnace. The Ep3010 press furnace (Ivoclarvivadent, Germany) was used for pressing and select the press program for (LT). At the end of the press cycle, the investment ring was placed on a cooling grid to cool. Then the specimens were divested according to the manufacturing. The sprues were cutting by diamond disc and the stumps of the sprues were adjusted by stone bur the core ceramic specimens that have been obtained would be 3mm in thickness and 10mm in diameter. In

order to obtain flat surface for standardization only one surface of the specimen was polished first with wet 600 then with wet 1200 grit silicon carbide abrasive paper this procedure done with 500rpm in Grinder-Polisher device(Mapao 160E,China) under running water. After that, cleaning the samples in an ultrasonic cleaning device for 10 min and air dried **fig (1).**

Fig. (1): three groups of 30 ceramic discs.

The Atomic Force Microscope(AFM) was used to determine the surface roughness.in this study the average roughness(Ra) range between(66.063 - 69.66 nm) and any sample higher than this range repolished and the surface roughness reevaluated again. when the surface roughness measurement are finished, the samples divided randomly into three groups (n=10 for each group) as fallow:

Group 1: the specimens in this group remain without treatment(control group),

Group 2: etching with 4.5%HF acid each sample of this group treated by etching with one drop of 4.5%hydroflueic acid gel (Lot no.T47018, Ivoclarvivadent, Liechtenstein) by using a fine brush the drop of HF can be applied on the polished surface of the specimen **Fig(2).**

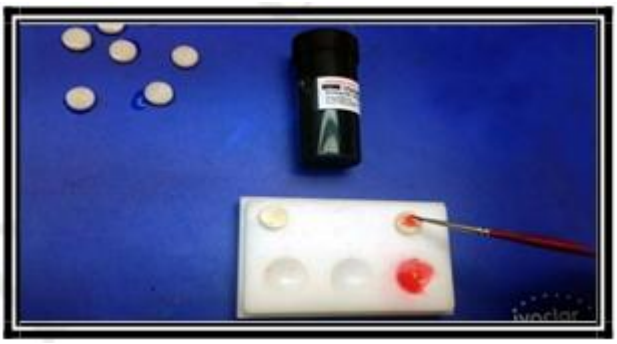


Fig. (2): applying HF acid on the surface of the sample.

And leave it for 20s and rinse with distilled water for 1min then cleaned in ultrasonic device for 10 min and air dried.

Group 3: in this group the samples ground by 100 grit then by 220 grit aluminum oxide

abrasive paper. This is equivalent 75 µm diamond bur grinding was done under abundant of cooling water on metallurgical polisher device(Struers, Denmark) **fig(3).**

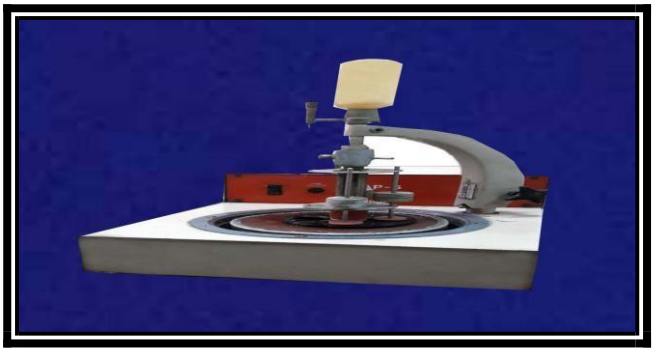


Fig. (3): specimens in metallurgical polishing device.

At speed 200 rpm with a constant force 20 N. to perform the grinding the samples were embedded in mold of self-curing resin after finishing the grinding, this mold of acrylic was put in cut-off machine to remove the core ceramic specimens after that, Cleaning the samples in an ultrasonic cleaning device and the surface roughness is measured by AFM for 2 and 3 treated groups.

Randomly selected one sample from control group and each treated group and coated with pure gold in plasma gold coating device(Ashford, Kent, England) and scanned in scanning electron microscope(Czech republic, Netherlands) at different magnification x500 and x1000 to observe the topography characteristic.

The wash layer (IPS e.maxceram dentin, Ivoclarvivadent, Liechtenstein) was mixed with the respective liquid (IPS e.maxceram buildup liquid, all round Ivoclarvivadent, Liechtenstein) according to manufacturer's instructions using layering technique. after that the applied wash layer was fired, firing was accomplished in a programmable vacuum ceramic oven (Ivoclarvivadent, Liechtenstein) according to the manufacturing directions. followed that the veneering ceramic was applied using an separable Plexiglas mold. ceramic powder (IPS e.maxceram dentin, Ivoclarvivadent, Liechtenstien) was mixed with an appropriate amount of the corresponding liquid (IPS e.maxceram build up liquid, allround Ivoclarvivadent, Liechtenstien) the obtained slurry was sucked off with absorbent tissue paper to draw excess liquid. the veneer ceramic would be 3mm in height and 5mm in diameter firing was performed in programmable vacuum ceramic oven according to the manufacturer's recommendations.

Shear bond strength test: after the veneering steps were finished its ready for bond strength testing. the testing was done in a universal testing machine(LaryeeWDW-50,China). as the test specimen was small for the universal testing machine to hold so silicone mold was made for this purpose and pured by self-curing resin after complete solidification remove this block of acrylic **fig(4).**

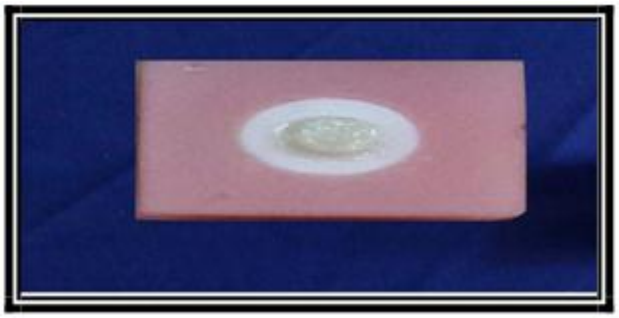


Fig. (4): sample embedded in self-curing resin.

The stainless steel semicircular chisel shaped was positioned at the core veneer bonded area at a crosshead speed of 1mm/min **fig(5).**

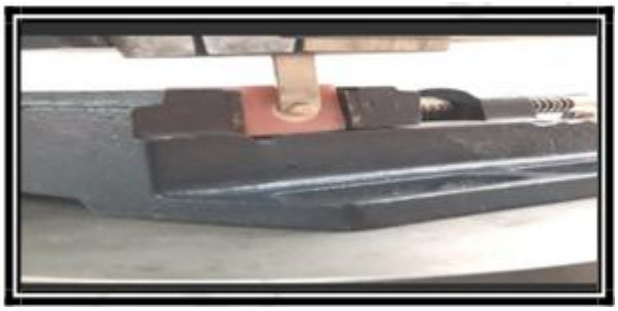


Fig. (5): sample under testing in universal testing machine.

The applied load was recorded in Newton and shear stress calculated in mega Pascal by dividing the surface area of core veneer bonded area according to the following equation: SBS(mpa)=(N)/SA

N=maximum force that caused failure. SA=surface area of bonding area(mm^2)

After the shear testing procedure was completed, the samples were examined under the stereomicroscope(x20) to determine the mode of bonding failure.

RESULTS

Thirty ceramic samples divided into3 Types of surface treatments groups; 10without treatment (Control), 10 HF, 10 grinding, participated in this study, estimation the

roughness(nm) before and after were treated with the above mentioned. As well as, shear bond strength (MPa) & mode of failure test performed to control & another groups after treatments.

Surface roughness test result (nm) before treatment

Table (1), identified that there were a statistically non-significant difference(analysis of variation ANOVA test: p=o.975, p>o.o5) between the mean roughness before treatment(nm) of studied groups, control (66.o63+ 2.977) nm, HF (65.111+3.099) nm, grinding (65.091+2.983) nm.

LSD test (least significant difference test) was followed to estimate the source of difference in surface roughness among all studied groups are presented in table(2);that showed a statistically non-significant difference LSD test, p>o.o5) again with similar mean levels for all groups.

Table (1): mean distributions of roughness before treatment (nm) among studied groups.

Roughness before treatment (nm)		N	Mean	Std. Deviation	Std. Error	Range		ANOVA test (P-value)
						Mini.	Maxi.	
Studied groups	Control	10	66.063	2.977	0.941	60.06	69.66	P=0.975 Non sign. (P>0.05)
	HF	10	65.111	3.099	0.980	60.10	69.48	
	Grinding	10	65.091	2.983	0.943	60.23	69.33	
	Total	30						

Table (2): least significant difference (LSD test) for surface roughness before treatment.

Roughness before Treatment (nm)			Multiple Comparisons LSD test (P-value)
Studied groups	Control	HF	P=0.471 Non sign.(P>0.05)
		Grinding	P=0.462 Non sign.(P>0.05)
	HF	Grinding	P=0.988 Non sign.(P>0.05)

Surface roughness test result (nm) after treatment

Mean surface roughness value (nm) after treatment are presented in table (3) and graphically illustrated in fig(6).One-way ANOVA test revealed that there were a variation between the mean of studied groups control (without treatment) (66.063+2.977),grinding (180.562 +13.557) was elevated followed by HF(159.062+30.995),with a highly significant difference(ANOVA test :p=o.oo , p<0.01).

Table. (3): mean distributions of roughness after treatment (nm) according to studied groups.

Roughness after Treatment (nm)		N	Mean	Std. Deviation	Std. Error	ANOVA test (P-value)
Studied groups	Control	10	66.0630	2.97713	.94145	P=0.00 Highly sign. (P<0.01)
	HF	10	159.062	30.995	9.802	
	Grinding	10	180.562	13.557	4.287	
	Total	30				

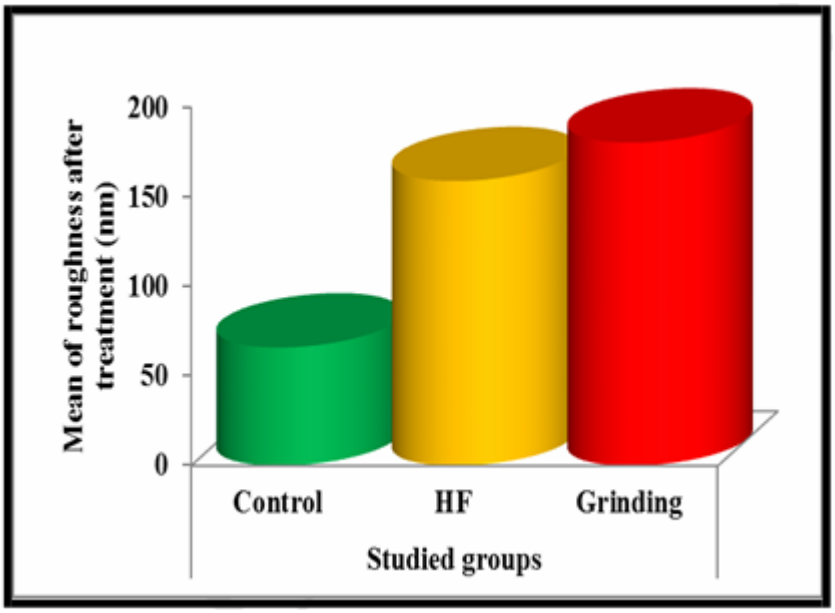


Figure (6): mean distributions of roughness after treatment (nm) according to studied groups.

The multiple comparisons less significant difference test (LSD) was done for estimation the source of difference between the groups, table (4) showed highly significant difference in (control Vs. HF, control Vs. grinding, p=o.oo,p<o.o1);and significant difference in (HF Vs. grinding, p=0.028,p<0.05).

Table (4): least significant difference (LSD test) for surface roughness after treatment.

Roughness after Treatment (nm)			Multiple Comparisons LSD test (P-value)
Studied groups	Control	HF	P=0.00 Highly sign.(P<0.01)
		Grinding	P=0.00 Highly sign.(P<0.01)
	HF	Grinding	P=0.028 Sign.(P<0.05)

The table (5) and fig(7), showed in detail the intervals of mean surface roughness before and after surface treatment (nm) increased between studied groups, highly significant difference (p=o.oo, p<o.o1) as grinding with greater interval {before(65.091+2.983)- after(180.562+ 13.557)},HF{before (65.111+ 3.099)-after (159.062 + 30.995)}

Table (5): mean comparison between roughness before & after treatment (nm) among studied groups.

Roughness (nm) – Treatment / Studied groups	N			Mean	Std. Deviation	Std. Error	t-test (P-value)
	HF	Before	10	65.111	3.099	0.980	P=0.00 Highly sign. (P<0.01)
		After	10	159.062	30.995	9.802	
		Total	20				
	Grinding	Before	10	65.091	2.983	0.943	P=0.00 Highly sign. (P<0.01)
		After	10	180.562	13.557	4.287	
		Total	20				

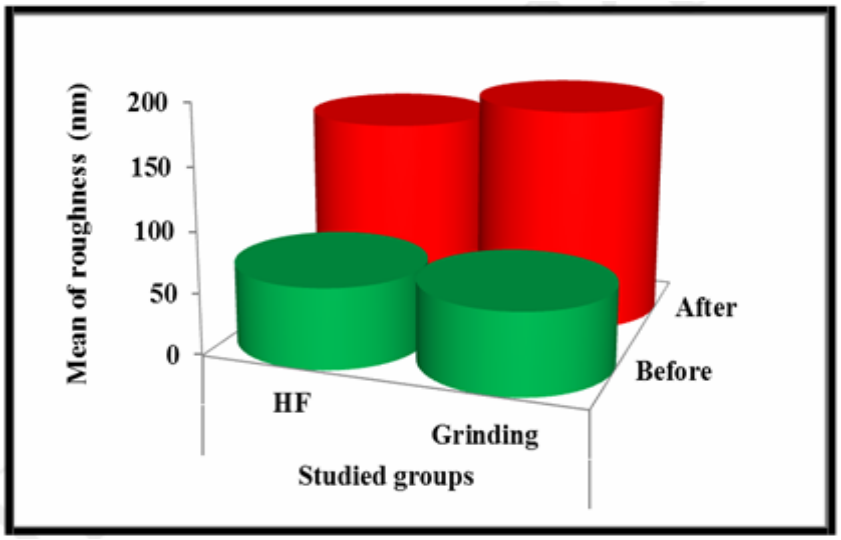
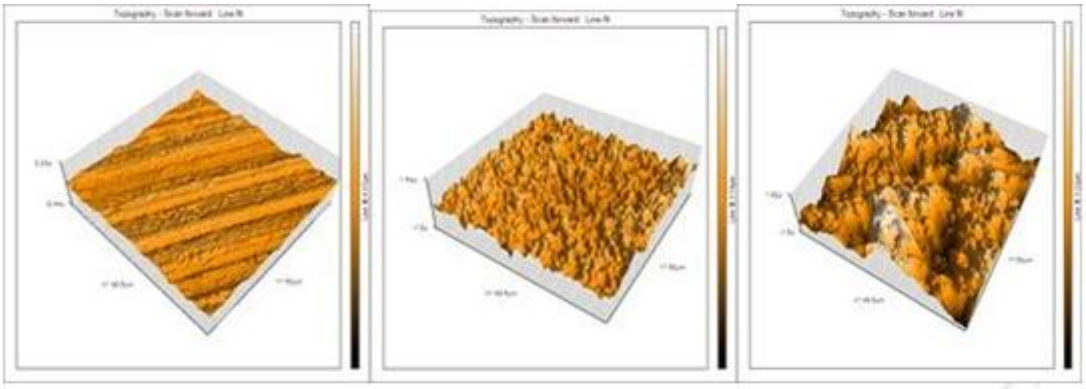


Figure (7): mean comparison between roughness before & after treatment (nm) among studied groups.

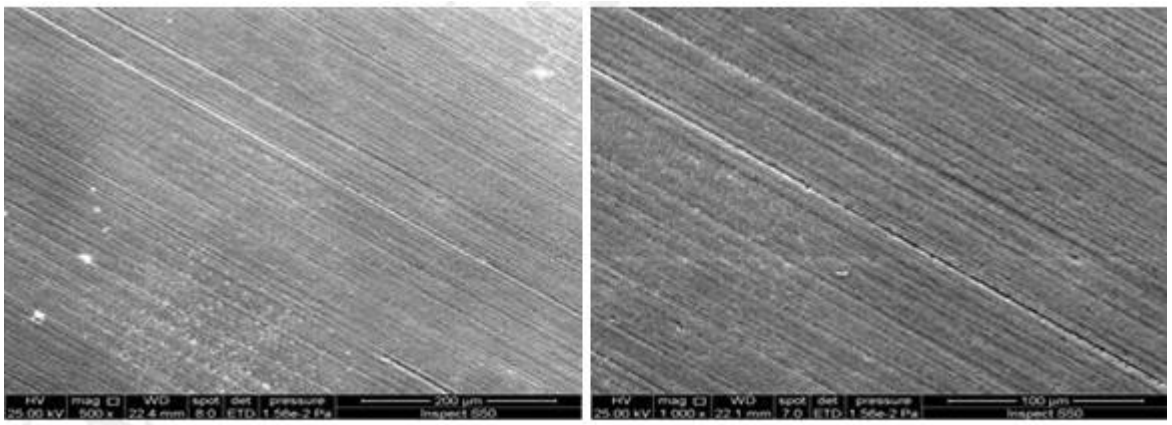
Fig (8 A,B,C) AFM images, for the control group fig(A) showed uniform pattern without any sharp projections. The irregular surface projections with peaks and valleys was seen in HF group image(B). in the AFM image (C) for grinding group showed roughly surface with distinct wide projection and very deep peaks, rougher than (A) and (B) groups.



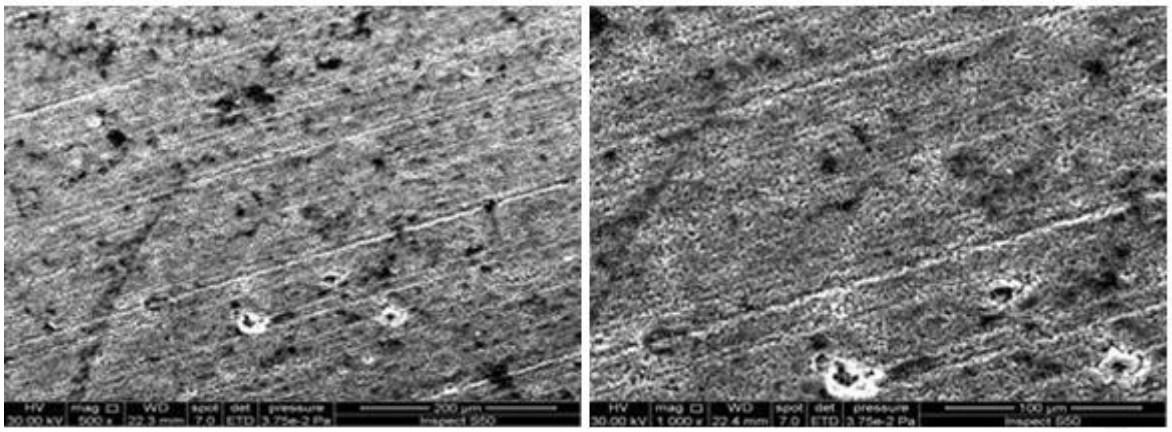
A **B** **C**

Fig. (8) AFM images: A(control group),B:(HF acid 4.5% group),C:(grinding group).

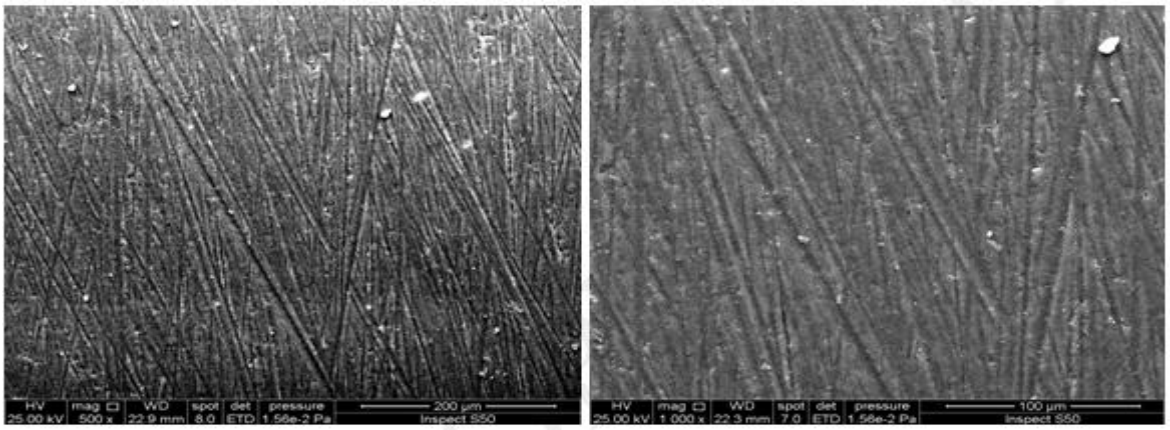
Fig (9 A,B,C) SEM images for the specimen of the control group fig (A) revealed that homogeneous smooth surface without any characteristic as a result of the polish obtained when the ceramic disc was prepared. From the SEM images for the HF group figure (B) showed clearly the dissolution of the glassy phase exposing the lithium disilicate crystals lead to the formation of micro-porous structure with numerous micro- porosities. (C) SEM images for the grinding group in this photograph we can observed numerous scratches at different direction and fine grooves related to the scratches lines.



(A) Control Group



(B) HF Group.



(C) Grinding Group.

Fig. 5: SEM images for studied groups.

Shear bond strength results (mpa)

Data documented in table (6) noted a highly significant difference (ANOVA test: p=0.00, p<0.01) control (13.59+3.79), HF (14.72 +3.15), and the grinding (18.34+3.63) and graphically illustrated in fig (10).followed that the least significant difference test(LSD test) to estimate the source of difference between the groups table (7) showed a non –significant difference when compare between control Vs. HF (p=0.581,p >0.05), HF Vs. grinding(p=0.076, p>0.05), and significant difference when compare between control Vs. grinding (p=0.022, p<0.05).

Table. (6): mean distributions of Shear bond strength test (MPa) among studied groups.

Shear bond strength test (MPa)		N	Mean	Std. Deviation	Std. Error	ANOVA test (P-value)
Studied groups	Control	10	13.59	3.79	1.20	P=0.001 Highly sign. (P<0.01)
	HF	10	14.72	3.15	0.99	
	Grinding	10	18.34	3.63	1.147	
	Total	30				

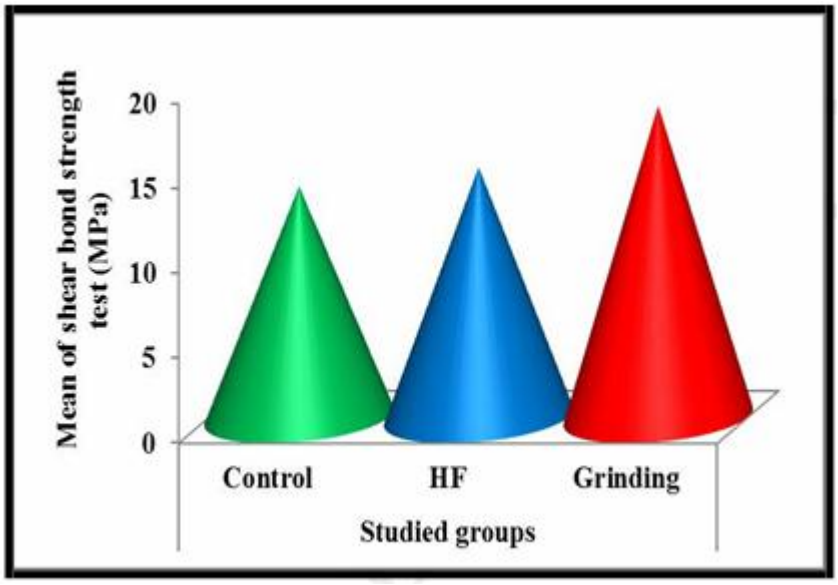


Figure (10): mean distributions of Shear bond strength test (MPa) among studied groups.

Table (7): least significant difference LSD test between studied groups for shear bond strength.

Shear bond strength test (MPa)			Multiple Comparisons LSD test (P-value)
Studied groups	Control	HF	P=0.581 Non sign.(P>0.05)
		Grinding	P=0.022 Sign.(P<0.05)
	HF	Grinding	P=0.076 Non sign.(P>0.05)

ROC(Validity test)

ROC, HF 4.5% before & after treatment

Level of shear bond strength cut-off value (14 MPa**)** stated in study (8) and (11) ROC curve; validity tests for shear bond strength of ceramic sample before & after treated with **HF4.5%**.Moderate sensitivity **60%** (true positive %) and specificity **60%** (true negative%); the positive predictive value (PPV) was **60%**,negative predictive value (NPV) was **60%**and the test accuracy **60%**, with reduced area under the curve (AUC) was **0.581**. Overall, there was a statistically non-significant difference **(P=0.545, P>0.05)**.Ultimately, intermediate validity test evidenced by data of shear bond strength (MPa) treated with **HF 4.5%.**

Table (8): ROC curve; Shear bond strength test (MPa) Validity tests for HF.

Shear bond strength test (MPa) Validity tests {HF}	
Sensitivity	**60%**
Specificity	**60%**
Positive predictive value (PPV)	**60%**
Negative predictive value (NPV)	**60%**
Accuracy	**60%**
Area Under the curve (AUC)	**0.581**
Cutoff value	**14MPa**
P-value	**0.545 NS**

NS=Non significant difference (P>0.05).

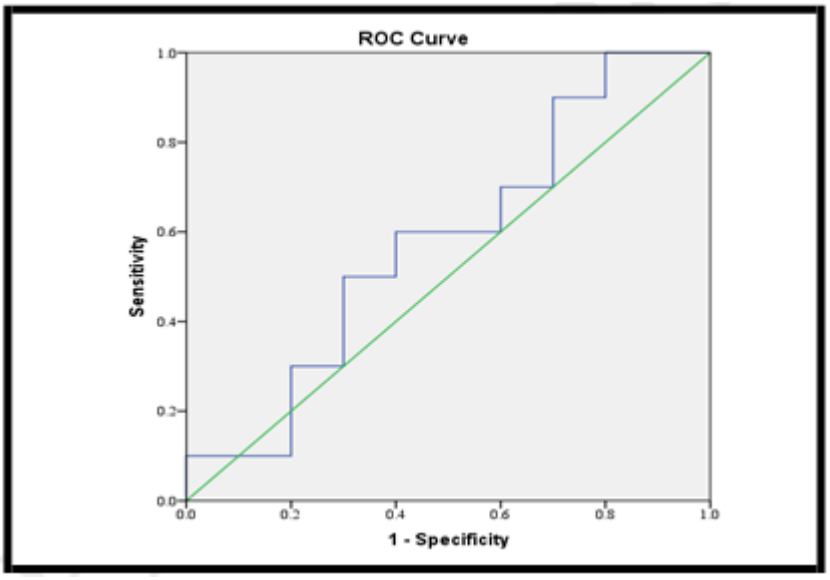


Figure (11): ROC curve; Shear bond strength test (MPa) Validity tests for HF.

ROC, grinding before & after treatment

Table (9) & figure **(12),** shear bond strength cut-off value was (**14.4 MPa),** in ROC curve;

validity tests for shear bond strength of ceramic samples before & after treated with grinding.The best sensitivity **90%** (true positive %) and specificity **60%** (true negative %); the positive predictive value (PPV) **69.2%**,negative predictive value (NPV) was **85.7%**and the test accuracy was **75%**,largearea under the curve (AUC) was **0.821**, with a statistically significant difference **(P=0.016, P<0.05)**.Eventually, better validity test evidenced by data of ceramic samples, with elevated shear bond strength (MPa) after treated with grinding.

Table (9): ROC curve; Shear bond strength test (MPa) Validity tests for grinding.

Shear bond strength test (MPa) Validity tests {Grinding}	
Sensitivity	**90%**
Specificity	**60%**
Positive predictive value (PPV)	**69.2%**
Negative predictive value (NPV)	**85.7%**
Accuracy	**75%**
Area Under the curve (AUC)	**0.821**
Cutoff value	**14.4MPa**
P-value	**0.016 S**

S= Significant difference (P<0.05).

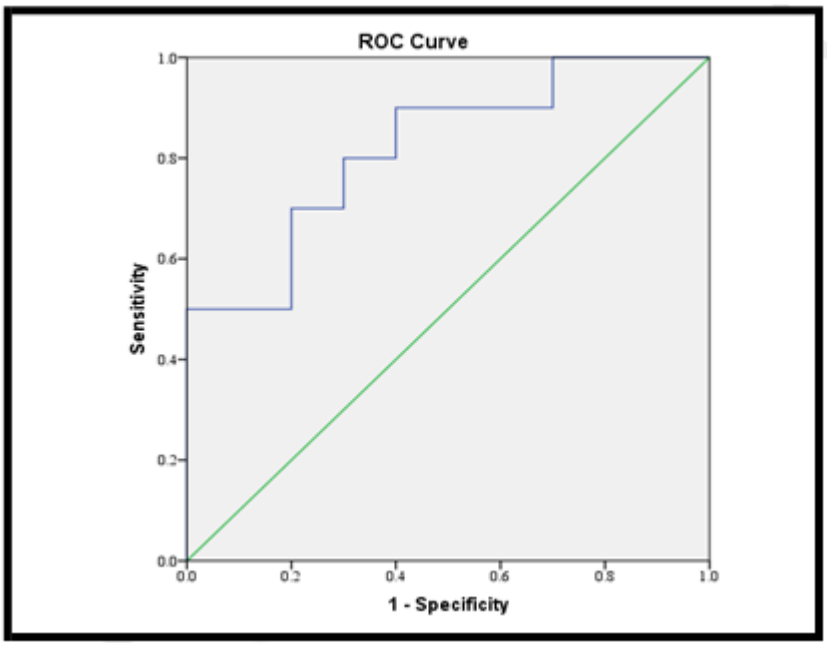


Figure (12): ROC curve; Shear bond strength test (MPa) Validity tests for grinding.

Bond failure analysis: Distinct distribution of failure modes among the groups were found, as is shown in table (10),fig(13), revealed that the best groups were **grinding {**Adhesive (**2, 20%**), Cohesive in core (**6, 60%**), Cohesive in veneer (**1, 10%**) & Mixed - Adhesive & Cohesive (**1, 10%**). While, and the vice versa in control **{**Adhesive (**9, 90%**), Cohesive in

core (**0%**), Cohesive in veneer (**0%**) & Mixed - Adhesive & Cohesive (**1, 10%**)} & Finally, **HF {**Adhesive (**8, 80%**), Cohesive in core (**0%**), Cohesive in veneer (**0%**) & Mixed - Adhesive & Cohesive (**2, 20%**)}**.**

Table (10): Distribution of mode of failure test according to studied groups.

Mode of failure		Studied groups		
		Control	HF	Grinding
Adhesive	N	9	8	2
	%	90%	80%	20%
Cohesive in core	N	0	0	6
	%	0%	0%	60%
Cohesive In veneer	N	0	0	1
	%	0%	0%	10%
Adhesive & cohesive (Mixed)	N	1	2	1

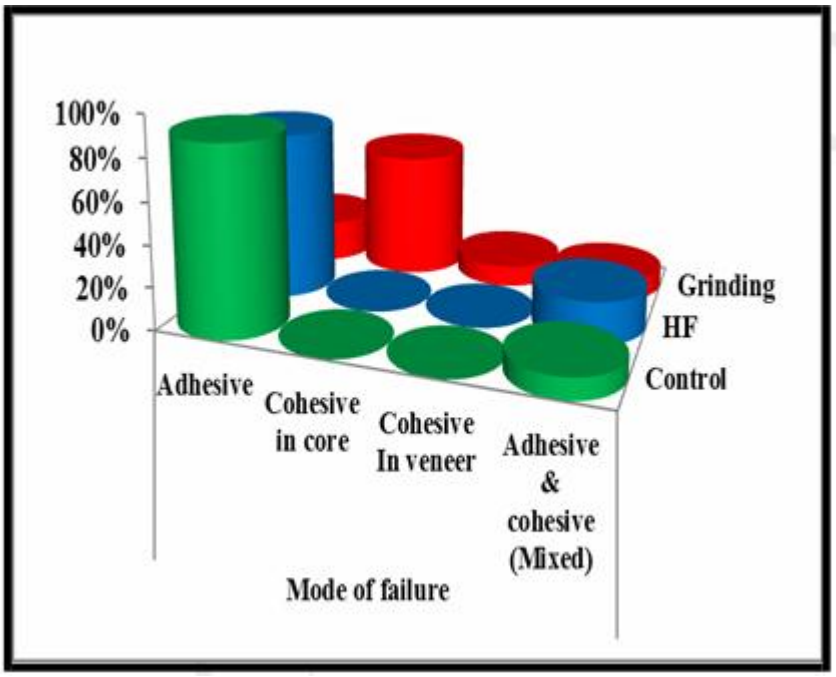


Figure (13): Distribution of mode of failure test according to studied groups.

DISCUSSION

The demand for dental restoration with more esthetic and biocompatible properties has increased. as a result, various ceramics have been widely studied and applied as dental material.[17,18] Lithium di-silicate-reinforced glassy matrix ceramics, are widely used in dentistry.[19]

The majority of all-ceramic restorations have a two-layer structure that is comprised of a weak ceramic veneer laid over a strong supporting core.[20,21] Core veneered all-ceramic

restorations are possible substitute for strong but less esthetic metal core sub-structures.[22] Core veneer interface is regarded as the weakest link in the design of bi-layered ceramic structures crucial to the life time of restoration.[23,24] Delamination can be the result of the use of the weak veneer ceramic or due to a weak bond between the core and veneer.[1] bonding mean connecting and establishing stable adhesive contact between two materials.[25]

Bond strength measurement of all ceramic restorations has not been standardized.to estimate bond strength different testing methods had been used such as macro and micro-shear bond strength test, three-point, four –point bending tests and micro-tensile test.one of the common tests used for evaluating the bond strength is the shear bond test was used most frequently in studies and reported to be relatively simple and easy performed also used to evaluate the bond strength between core and veneer in different all-ceramic system.[14,26-28]

Shear strength is the maximum stress that material can withstand before failure in ashear mode of loading and is particularly valuable in the study of interface between materials.[29] The quality of the strong bond is, in one hand strongly depends on the composition of the ceramic material and its ability to surface treatments.[30] Modification of the lithium di-silicate ceramic surfaces affected shear bond strength.[31] An adequate bond in metal ceramic restorations occurred when the fracture stress was greater than 25mpa.an adequate bond strength of all ceramic materials had not yet been determined.[32,33] although several authors have described various surface treatment procedures to allow adhesion of all-ceramic restorations, little has been reported on surface topography that results from these treatments.[34,35]

Effect of HF4.5%

The present study **table (3),(4),(5) and AFM images fig(8,B**) proved that after treatment with 4.5%HF for 20s, the roughness value of HF group higher than the control group. Which agree with previous studies as shown in[36] used 4.9% HF &[37] used 5%HF, studied the effect of hydrofluoric acid etching duration on roughness and flexural strength of lithium di-silicate-based glass ceramic; elevated ceramic roughness even for period as short as 20s, which is etching time recommended by the manufacturer. Also, agree with,[31] documented that etching with hydrofluoric acid (HF)was recommended before bonding lithium di-silicate crowns and with[36,38] and[39] noted, that the acid reacts with the glass matrix that contains silica and forms hexa-fluorosilicates this glass matrix is selectively removed and the crystalline structure is uncovered, the outcome surface of the ceramic becomes rough, which

is expected for micromechanical retention on the ceramic surface, surface roughness is a result of the formation of numerous porosities and grooves due to the acid action on the matrix and the crystal structure; initiating the extreme bond strength, the absolute amount of roughness required for ideal bonding is actually not known. Furthermore, etching also cleans the surface by eliminating debris and impurities, and alters surface topography, and increases the surface area for micromechanical bonding (interlocking,retention)with resin composite.[40,41] In another hand, **in table(6) & figure(10), and table (7)** reduced shear bond strength and that disagree with following authors:[31] shear bond strength was(8.42mpa) and indicated that, HF acid etching increased the shear bond strength between resin cement and ceramic surfaces more effectively than any laser treatment. Shear bond strength in our study, higher value (14.72mpa) than (8.42mpa)in spite of previous study[31] used 9.5% HF for 60s;the difference may be attributed to the material used which is the resin cement. Correspondingly,[42] studied the effect of hydrofluoric acid etching on the bond strength of resin composites to lithium di- silicate ceramics and stated enhanced bond strength; the study attributed the improved bond strength to the roughened surface after etching. and[43] revealed that micro-morphological changes after the etching of ceramic samples which improved bond strength.

Effect of grinding

The largest roughness value showed after treatment by grinding within **study (3), (4),(5),** and as clearly visible by AFM images fig (8,C), these fact agree with researchers revealed that, dental ceramic restoration were subjected to a set of fabrication procedures in the laboratory, and grinding of lithium di-silicate ceramic is a standardized procedure used to improve fit after divesting and finishing, additionally, in the cutback veneering technique, dental technicians need to reduce the shape of the core ceramic to create space for additional veneer application.[44]

Grinding with diamond bur is closer to the clinical situation, nevertheless it is hard to form a comparable flat surface by this non uniform abrasion procedure leading to substantial differences between samples.[45] Whereas, disagree with[46] noted that group grinding had the second highest surface roughness values with irregular and rough surfaces. This difference may be due to the hand grinding with diamond bur in that study while in this study was used silicon carbide paper in automatic machine. In spite of the results showed highest surface roughness for grinding group but the shear bond strength(SBS) showed no significant

difference between HF and grinding group; these finding agree with the result of[46] who stated that the bond strength surprisingly showed no significant enhancement by surface roughness, this could be attributed to the fact that the grinding created macro-surface irregularities without undercuts and pores for micromechanical retention, and hence no strong bond adhesion was obtained.[46] Disagree with[47] who reported that grinding had negative effect on the SBS, as it showed significantly lower SBS value when compared to the control group, this is may be due to hand grinding is more effective than machine grinding. The ground surface is characterized by deformed and displaced material at the edge of the scratches.[47] SEM image **fig (9,C)** gave emphasis to that, which shown morphological surface without under cut and pores for micromechanical retention only scratches on the surface could be seen that result from grinding. In addition to, non-significant difference in shear bond strength between control group (untreated) and (HF4.5%) the above data mentioned agree with[48] that showed, non-significant differences between a ceramic surface etched with 10% HFAlso, agree with[49] who found non-significant difference in SBS between the control and HF groups between zirconia framework and indirect composite material. In another side & in spite of a significant differences in roughness but there were non-significant difference in shear bond strength when compared between groups (control, HF)), (HF, grinding), and significant between (control, grinding), may be elucidate this phenomenon as follows; the relation between surface roughness and shear bond strength may not be linear relationship[50] and excessive rough surface may lead to stress concentration which may consequently weaken the interfacial bonding.[51] Moreover, agrees with;[18] who was found different surface roughness did not influence bonding strength. & Also agree with,[46] high roughness value for ceramic surfaces do not always mean that good bond strength would be obtained and,[43] surface roughness non-effective on the shear bond strength of core-veneer structures.[46] the geometric characteristics of the surface rather than the surface roughness should be one of the most important factors. Nonetheless, the surface roughness found in the ceramic surfaces, but surface morphology plays important role in gentrification the shear bond strength.

Type of bond failure

The mode of failure **table (10), fig (13)** should be considered in studying the quality of bond and should not depend on the bond strength data alone.

Group (C) displayed that adhesive, cohesive failure in core and mixed failure (combination of

adhesive and cohesive failure), cohesive failure in veneer occurred only in one sample from grinding group.

Although, this group exposed higher bond strength the adhesive failure found but in a lower percentage, the cohesive failure in core higher (%), these facts was agree with,[52] who established that mixed fracture pattern or cohesive fracture within lithium di-silicate core had higher shear stress value. Also, agree with[53] who noted that cohesive fracture in the infrastructure for the IPS e. max press indicated a good bonding between the veneering porcelain and the lithium di-silicate infrastructure. The results of failure mode analysis support the shear bond strength data, agree with[54,55] stated that poorer bond strength caused delamination fracture pattern in zircad/ceram. And disagree with[56] who revealed that the mode of failure not correlated directly with the bond strength results. The results of validity test & mode of failure parallel with the above data mentioned for roughness and or shear bond strength which proved that grinding was the best treatment than 4.5% HF treatment.

CONCLUSION

1. Surface roughness elevated after surface treatment especially in grinding followed by 4.5% HF.
2. S.B.S was influenced by surface roughness result but not in all treating groups which grinding presented with largest S.B.S.
3. Roughness of 4.5% HF treatment group was increased while decrease S.B.S approximately equal to control level.
4. Mode of failure & validity test for S.B.S results parallel with the above notes mention.

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