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Effect of Different Surface Treatments and Repair Materials on Bond Strength to Aged Restorative Materials

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ABSTRACT:

Objectives: This study compared the effects of different surface treatments and repair materials on the shear bond strength of different restorative materials after accelerated artificial aging.

Methods: Eighty specimens from each resin composite (Tetric N Ceram) and the two resin-modified glass-ionomer (GC Fuji II LC/Photac Fil) were prepared and aged in distilled water for 90 days and thermocycled 5000 times. The 80 specimens prepared from each material were mounted and randomly assigned into eight groups with 10 specimens per group. Every twenty specimens of each materials were roughened with a diamond bur, sandblasted, green silicon carbide bur, or left without roughening as control. According to each group, the specimens were repaired using the same original material or flowable resin composite/Filtek Z350 XT. Shear bond strength was measured at a crosshead speed of 0.5 mm/min using a universal testing machine.

Results: The highest repair shear bond strength (Mean±SD) in MPa was 70.68±1.10 for sandblasted resin composite repaired withflowable resin composite. While the lowest repaired shear bond strength was30.52±1.96 for resin-modified glass-ionomer (Photac Fil),treated with silicon carbide bur and repaired withflowable resin composite. The repair shear bond strength was 49.16±1.66 for sandblasted resin-modified glass-ionomer repaired withflowable resin composite. While the repair shear bond strengthwas, 45.38±1.41 for resin-modified glass-ionomer treated with silicon carbide and repaired with the same resin-modified glass-ionomer. A statistically significant difference(p=0.0001) was observed between all surface treatment methods: diamond bur, sandblasting, green silicon carbide bur, and control. While no significant difference between the three restorative materials.

Conclusion: Different surface treatments and repair materials affects the repair bond strength of tested materials after accelerated artificial aging. Surface treatment of resin composite with sandblasting and repair withflowable resin composite was more effective than the other surface treatments and repair materials.

KEYWORDS: Repair, Surface Treatments, Shear Bond Strength, Accelerated Artificial Aging, Adhesive Systems, Bonding, Resin Composite, Resin-Modified Glass-Ionmomer

I. INTRODUCTION

Developments in the arena of adhesive technologies have had a notable impact on the way in which concepts in the field of restorative dentistry have been influenced with the objective to maintain healthy dental tissues whilst decreasing the interventions deemed necessary.[1,2] Nonetheless, within the oral setting, dynamic conditions, including diet, could be responsible for degrading the resin composite.[3,4] A number of other environmental situations come to deal with restorative materials intra-orally, such as pH changes, rapid changes in temperature, and occlusal interactions.[5,6]Theseenvironmental situations could impact and ultimately cause the materials to degrade, eventually inducing various phenomena, such as marginal ditching, delamination, discoloration, wear, microleakage or fracture warranting replacement and/or other clinical correction.[5-9]

A significant proportion of dentists' time is spend correcting and replacing inadequate restorations, which is far more time-consuming than that required in the case of filling primary carious lesions. Furthermore, such care causes significant costs for both the health system and for patients.[10,11] In the past, a restoration would be entirely replaced; this is one of the most widely carried out procedures in the day-to-day work of a clinical practice.[7] Nonetheless, such an approach could be considered as going beyond what is necessary due to the fact that, in the majority of instances, a significant portion of the restoration remains intact, whether radiographically, clinically or both.[5] Should the restoration be removed in its entirety, this could subsequently result in the tooth structure being weakened, with dental tissue unnecessarily grinded, cavity size increased, and

the pulp facing continuous injury.[12,13] Accordingly, restorations should be repaired through re-layering, which is an approach known as an alternative in thesecases.[7] Accordingly, a number of advantages can be garnered due to the lesser degree of invasiveness, including less pulp injury, cost-effectiveness, greater efficiency, and tooth structure conservation.[5,6] Importantly, when there is a failure in existing resin composite restoration, predominantly as a result of fracture, color change, caries or unsuitable contour, for example, the choice of treatment may comprise either the complete repair of an existing restoration or otherwise its total replacement.[14,15] Different restorative materials notably have their own repair success, which rests on different factors.[16] As an example, composite–composite bonding success in repair, notably through re-layering, ultimately depends on the resin composite surface and the condition of such, including its composition,[16] roughness,[17] wettability,[18] and the surface conditioning approaches implemented.[16,19-21]

A number of different resin composite and resin-modified glass-ionomer restorative materials can be used when restoring the teeth of children,through direct restorative approaches.[22-24]It is common for the repair of resin composite restorations to be achieved through positioning new composite over the old;[14,15] such an approach is recognised as potentially problematic owing to there being only a select fewif any at allreactive double bonds in the old composite to facilitate bonding to the new composite.[15] Despite the recognised importance of a good bond between new and old resin materials, it remains that, as shown through various studies, there is much variation and unpredictability in terms of repair bond strengths.[25-27] A number of different mechanical, chemical bonding agents and surface treatments have been the focus of assessment in mind of enhancing resin composites' repair strength,[14,28,29] with the majority of studies suggesting that resin composite surface roughness has a notable influence in terms of repair strength, particularly when compared with the use of a bonding agent.[30] When adopting a surface treatment process through sandblasting or diamond bur, the greatest bond strength was achieved.[31] Moreover, bonding was significantly enhanced through sandblasting[30] and the adoption of multistep adhesive primers.[32] When drawing a contrast between the repair bond strength and the original strength, the former was found to decline by as much as 25–80% through the surface exposure to dynamic oral environment.[33] As a result, a number of different works have emphasised that, in consideration to old restorative treatment, surface treatment affects the overall bond strength of the repair.

As far as the researchersare aware, very few studies have been carried out in mind of drawing a contrast between various repair methods of the new restorative materials. Thus far, there has been a lack of agreement pertaining to the most suitable way via which the surface can be prepared prior to repair in order to achieve the very best bond strength. Therefore, the present study is centred on drawing a contrast between the effects of various surface treatments and repair materials on different restorative materials and their individual shear bond strength, notably one resin composite/Tetric N Ceram and two resin- modified glass-ionomer/GC Fuji II LC/Photac Fil following accelerated artificial aging. The null hypothesis underpinning the testing in this regard emphasises no difference of the restorative materials' shear bond strength and the various repair materials and surface treatments applied in the present work.

II. MATERIALS AND METHODS

A total of 80 specimens (6 mm diameter, 2 mm thickness) were prepared from one resin composite restorative material (Tetric N Ceram, Ivoclar Vivadent AG, Liechtenstein) and two resin-modified glass-ionomer; GC Fuji II LC (GC Corporation, Tokyo, Japan) and Photac Fil (3M, ESPE, St. Paul, MN, USA), in line with the manufacturers' guidelines in regards cylindrical silicon mould use.

With the sequential use of 240, 320, 400, and 600 silicon carbide paper (JEANWIRTZ GmbH & Co. Charlottestrabe Dusseldorf W. Germany), all of the individual specimens were polished under running water, and subsequently underwent storing in distilled water, at room temperature, i.e. 25^{o}C, for a period of 90 days. Subsequently, thermocycling was carried out across all specimens a total of 5,000 cycle times (SD Mechatronik GmbH Dental Research Equipment, W. Germany) in baths between 5°C and 55°C.Transfer time equated to 5 seconds whilst dwell times were 30 seconds before completing surface treatment. All of the specimens underwent roughening on the unused surface; this was done in order to achieve retention through the adoption of an inverted cone bur prior to completing mounting in acrylic resin through the adoption of PVC (polyvinyl chloride) cylinders.

All of the specimens from all materials underwent random distribution into four subgroups, 20 specimens each. In the first group, Group 1, specimens underwent roughening with the use of a medium grit disk shape diamond bur, D.909.040.FG (Frank Dental, Gmund, Germany) with the application of a slow-speed handpiece (MF- TECTORQUE type 9908, W&H DENTALWERK Bürmoos, Austria), amounting to 50,000 cycles per minute for five strokes. In Group 2, specimens underwent sandblasting with the use of a sandblasting machine (DUOSTAR,BEGO, Bremen, Germany) for a period spanning five seconds. This was done with the use of sandblasting powder, 25 microns, Alpha – corundum, white, 99.7% Aluminiumoxid (SHERA Aluminiumoxid, Werkstoff-Technologie, Lemförde, Germany). In Group 3, specimens underwent roughening with a disk shape green silicon carbide bur (Dura Green Stones, SHOFU INC., Kyoto, Japan) with the use of a

slow-speed straight-hand piece (KAVO EWL type 4415, Germany), equating to 50,000 cycles per minute for five strokes. Group 4 specimens were accordingly utilised as a control group, without being exposed to any degree of surface treatment.

All specimens in different groups underwent random categorisation into different subgroups, each of which encompassed 10 specimens. As can be seen in Table 1, group distribution in line with restorative materials and surface treatment was carried out. Specimens in one subgroup underwent repair with the use of new similar restorative materials, whilst the other subgroup underwent repair with the use of the Filtek Z350 XT flowable resin composite (3M, ESPE, St. Paul, MN, USA) with the adoption of a standard PVC tube, the dimensions of which are recognised as an internal diameter of 3 mm and a height of 2 mm. This then was placed perpendicular to each of the specimen's surface. All applications pertaining to bonding, repair material and surface preparation was carried out in line with the manufacturer's instructions with the use of Scotchbond universal etchant (3M, ESPE, St. Paul, MN),Prime and Bond NT adhesive (DENTSPLY Ltd - Surrey, United Kingdom), with polyacrylic acid (3M ESPE, Seefeld, Germany) applied as a conditioner for the resin-modified glass-ionomer materials (GC Corporation, Tokyo, Japan).

In terms of storing, specimens were stored at room temperature (approximately 25^{o}C) in distilled water for a period spanning 48 hours, before then being exposed to thermocycling 1,500 times before testing was carried out in terms of shear bond strength. The measurement of shear bond strength was carried out at a crosshead speed of 0.5 mm/min with the use of a universal testing machine (Instron, Illinois Tool Works Inc., Norwood, MA, USA).

When completing the analysis of data, the methods of one- and two-way analysis of variance (ANOVA) and Tukey's post hoc and t-test were utilised, with SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). All statistical analyses significance level determined as being at $p<0.05$.

III. RESULTS

Independent t-test indicated a significance difference in the shear bond strength between the three main restorative materials treated with different surface treatment and repaired with different restorative materials(p=0.0001) (Table 2). Except for repaired Photac fil restoration (with either flowable resin composite or Photac Fil) that treated with diamond bur(p=0.119).

Two-way ANOVA showed an interaction between shear bond strength of different restorative materialsregardless the surface treatment and the repair materials. Tukey Post Hoc test revealed a significant difference between the Photac Fil in comparison to resin composite and Fuji II LC (p=0.0001). However, there was no significant difference between resin composite and Fuji II LC(p=0.129). For the repair materials' bond strength (regardless the surface treatment and the restorative materials), two-way ANOVA and Post-Hoc test showed a significant difference between the different repair materials(p=0.0001), except resin composite with flowable resin composite(p=0.251), Photac Fil(p=0.276)with Photac Fil and flowable resin composite(p=0.985). Two-way ANOVA showed an interaction between the different surface treatments groups regardless of the restorative and repair material. Tukey Post Hoc test for multiple comparison showed a significance difference(p=0.0001) of the shear bond strength except between the diamond bur and the control group(p=0.292). Furthermore, sandblasted surface treatment showed the highest shear bond strength magnitude regardless of the restorative and repair materials while silicon carbide bur surface treatment showed the lowest shear bond strength.

Figure 1 shows the mean and standard deviation of different subgroups of resin composite restorative material. The highest repair shear bond strength(Mean$\pm$SD) in MPawas 70.68$\pm$1.10 for sandblasted specimens repaired with flowable resin composite. While the lowest shear bond strength was, 32.99$\pm$1.50 for specimens treated by silicon carbide bur and repaired with resin composite. Figure 2 shows the mean and standard deviation of shear bond strength of different subgroups of Fuji II LC restorative material. The highest repair shear bond strength was 58.16$\pm$1.25 for sandblasted specimens repaired with Fuji II LC. While the lowest shear bond strengthwas, 36.99$\pm$1.22 for specimens treated by silicon carbide bur and repaired with flowable resin composite. Figure 3 shows the mean and standard deviation of different subgroups of Photac Fil. The highest repair shear bond strength was 50.82$\pm$2.07 for sandblasted specimens repaired with Photac Fil. While the lowest shear bond strength was, 30.52$\pm$1.95 for specimens treated by silicon carbide bur and repaired with flowable resin composite.

IV. DISCUSSION

The null hypothesis of the present studywas rejected, as there were several differences in regards the tested materials' repair bond strength following the use of the various repair materials and surface treatment. Improved bond strength between old and new restorative materials commonly warrants changes being made to the surface of the old material in an effort to ensure the new material's bonding can be improved.[14] Furthermore, in consideration to aged resin composites, these are more restricted in terms of the number of carbon–carbon

double bonds being affixed to a new resin layer.[34]Importantly, a suitable repair approach ultimately rests on there being the presence of high bond strength between the old restorative material and the new repair material, with optimal surface treatment known as a critical consideration when performing repairs to failed restorations.[34]

As a result of the dynamic oral environment, resin composite surface demonstrating ageing, a composite–composite restoration's adhesive strength is seen to decline by as much as 80% when contrasted with its original strength.[35]With this in mind, there has been the introduction of a number of different surface-conditioning approaches in an attempt toenhance adhesion between old and new restorative materials. The application of an intermediate adhesive resin is documented as being well positioned to achieve significant improvements in repair bond strength,[34] with chairside air-borne particles abrasion with small silica-coated alumina particles followed by silanization also known as having demonstrated a notable improvement in terms of composite-composite bonding,[36] although thus far there remains a lack of agreement pertaining to the potential advantages of the use of silica coating over the adoption of intermediate adhesive resins for aged composite resins.

When completing laboratory-based investigations, the simulation of composite resin aging has been achieved through water storage,[37] immersion in citric acid,[38] or otherwise by subjecting specimens to thermocycling.[39]In the case of the current research, the approaches of thermocycling and water storage were utilised, with the latter known as having negative impacts on the restorative resin surface notably as a result of hydrolysis and filler particles release, in addition to resin matrix water uptake.[40,41]Importantly, a number of stresses are incurred as a result of thermocycling, notably between different materials' expansion when involved in a restoration that could potentially result in tooth-restoration bond failure, or otherwise failure at the filler-matrix interface.[42]Following aging, composite-composite aging has been examined in a number of different works,[43,44]without achieving any significant agreement in terms of which aging approach is most appropriate or valuable. In an effort to achieve aging of restoration simulation in the context of the oral cavity, in the present investigation, specimens underwent storage in distilled water at room temperature for a period spanning 90 days. Beyond this point, thermocycling was carried out at a rate of 5,000 times per cycle, utilising temperatures of 5^{o}C and 55^{o}C with 5 seconds transfer time and 30 seconds dwell time before surface treatment was carried out. Restoration surface conditioning effects in the case of immediate repair have been the focus of much discussion, with studies identifying greater bond strengths following surface conditioning. Additionally, it was found that, following aging, there were lower repair shear bond strengths when contrasted alongside the repair bond strengths of non-aged composites. Nonetheless, it is valuable to mention that water storage, completing after surface conditioning, provided a combination that was able to demonstrate bond strength increases with regard non-aged controls. This could be seen as a result of the greater capture of silica particles achieved through the softened resin matrix.[5] Upon those specimens that have been subjected to thermocycling are further subjected to temperature fluctuations, thermal stresses are caused, ultimately resulting in failure at the interface of the filter/matrix or microcracks in the matrix.[39] In other studies, it has been stated that, when aging impacts are identified as a result of thermocycling and immersion in citric acid, the repair bond strengths are negatively affected when contrasted alongside those resin composites that are non-aged, irrespective of the resin composite type or the conditioning utilised. It was further recognised that intermediate adhesive resin utilisation following water storage negatively affects the repair bond strength as a whole.

When carrying out composite-composite repair bonding, durability is known as resting on the adhesion between the resin composite and the polymerized substrate, where the aging of the latter could influence the adhesive joint's exhibited strength.[5]Importantly, completing new resin composite adhesion in relation to an old one is problematic as a result of reductions in unsaturated C=C bonds and the lack of an oxygen-inhibited layer.[45]In the present study, the findings showed that repair bond strength is influenced by various factors, including repair material, restorative material type, and surface treatment.[5] Moreover, three different surface treatment methods were applied in an effort to enhance the aged restorations' repair shear bond strength, with the inclusion of green silicon carbide bur, sandblasting and diamond bur. When considering the greatest repair shear bond strength (Mean$\pm$SD) in MPa, this was identified as 70.68$\pm$1.10 for sandblasted resin composite repaired withflowable resin composite. On the other hand, the lowest repaired shear bond strength was found to be 30.52$\pm$1.96 for resin-modified glass-ionomer treated with silicon carbide bur and repaired withflowable resin composite. For sandblasted resin-modified glass-ionomer repaired withflowable resin composite, the repair shear bond strength was 49.16$\pm$1.66, whereas for resin-modified glass-ionomer treated with silicon carbide and repaired with the same resin-modified glass-ionomer, the repair shear bond strength was 45.38$\pm$1.41. When considering all surface treatment methods, namely green silicon carbide bur, control, diamond bur and sandblasting, a statistically significant difference (p=0.0001) was identified, although no significant difference could be established between the three restorative materials. The results garnered throughout this work emphasise sandblasting with aluminium oxide particles as providing the highest repair shear bond strength when compared across all of the subgroups and in line with all three restorative materials considered. It was reported

that after completing sandblasting, removal of some of the resin matrix along with the exposure of surface fillers, causing a greater degree of resin surface roughness was evident.[45,46]A number of other works have gathered comparable results in regards the positive effects centred on repair bond strength as a result of sandblasting.[35,36,45] Conversely, however, few investigations have shown repair strength declines following abrasion.[25,46]It was reported that the application of silane as an adhesion promoter may be considered simplistic and as not warranting any additional tools or resources when contrasted alongside sandblasting.[47]Furthermore, there have been some statements made to suggest that the surface characteristics following air abrasion ultimately rests on a material's own composition and microstructure. As an example, in the case of nano-filled composites, abrasion can cause clusters to break off.[48]accordingly; filler loss could mean silane interaction is decreased when contrasted to the diamond bur group. It is valuable to note that this was not the situation in the present research, with the second highest place, second only to sandblasting, achieved by diamond bur. It was also stated that, following air abrasion, there is no removal of the smear debris, which could affect the surface area for bonding, with this factor decreased.[48]Importantly, however, the above cannot be generalised to the present study's findings due to the fact that, in the present research, surface etching was carried out following each treatment, in line with the instructions provided by the manufacturers.

When completing restorative material repairs, it is suggested in some studies that the bond strength should range between 15 MPa and 25 MPa.[45]It is common for such values to be viewed as typical of resin composite to dentin bond strength.[49,50]Since the bond strength necessary for repairing restorations in vivo has not yet been determined, the surface treatment that produces the highest possible repair bond strength should be considered the most promising repair technique.[34]In the present study, all of the individual groups, with the inclusion of that conducting no treatment (control group), achieved even greater values than those detailed in the literature as an acceptable strength, with the lowest found to be in the case of the Photac Fil treated with silicone carbide bur and repaired with flowable resin composite at 30 MPa. It may be considered that acceptable or high repair bond strengths can be achieved through the application of any of the suggested surface treatment modalities. This has been further described in another study when considering that Filtek resin composite comprises nano-sized silica particles and clusters of Si/Zr. Small filler particles are known as exposing a larger surface area whilst also enhancing bonding substrate.[51] Furthermore, there is the view that a reinforcing mechanism may be prevented as a result of nano-clusters, with silane infiltration within the intimacy of the nano-clusters changing the response to loading stress, ultimately providing enhanced clinical performance.[51]In the present study, testing shear bond strength was carried out due to the fact it is seen as providing a common approach to achieving the very best stress possible at the bonding interface.[34] There is a lack of agreement concerning whether or not composite-composite bonding strength needs to undergo assessment in the case of a shear or micro tensile mode, despite the fact that the point may be laboured that, from a clinical perspective, when completing composite restoration repairs, applied forces are, in the main, in the shear mode, as adopted in this investigation.[5]

In reviewing, chemical and/or mechanical treatments centred on surface roughening of restorative materials such ascarbide bur, green carborundum stone, diamond bur, air abrasion with 50 microns aluminum oxide particles, etching with 37% phosphoric acid gel, hydrofluoric acid and 1.23% acidulated phosphate fluoride gel,[14] there is a preference for diamond bur amongst the majority of clinicians when it comes to preparing enamel and composite surface before completing any form of acid etching.[33]Importantly, sandblasting is recognised as an older option that is identifying a new position in modern science-based dentistry,[14] where the objective of surface treatment is centred on surface energy and/or surface roughness increases.[47]In the current study, sandblasting and diamond bur, alongside green silicon carbide bur, were utilised in mind of achieving mechanical surface roughening. Such an approach is recognised as comparable to approaches applied in other investigations.Bonding agent is used to enhance the strength of repair bonds,[19] with the majority of clinicians showing a preference for adhesive systems adoption that have previously been adopted in practice as opposed to garnering a special bonding system for repair procedures. Accordingly, in the current study, the manufacturers' guidelines have been followed.

The current investigation has generated findings to emphasise the value of micromechanical retention and surface abrasion in repair, with such findings believed to be as comparable to those garnered in another study.[52]When it comes to the restorative materials tested in this research, a general repair approach cannot be suggested owing to the fact that all of the surface treatments succeeded in demonstrating a range of repair shear bond strength that falls within an acceptable suggested range in the literature, with this also seen amongst those specimens that were not exposed to treatment (control). This study has some limitations including *in vitro* setting as the nature of shear force used may not reflect the more complex forces produced *in vitro*.[53]*In vitro* studies are unable to simulate the oral environment and other factors that could have an influence on the shear bond strength such as tooth brushing technique, bad oral habits, age and sex of the patient, kind of food and drinks consumed and type of saliva. However, *in vitro* studies provide us with valuable information about the amount of controlled force lead to bond failure and which protocol possibly gives the clinically desired bond

strength. Therefore, results of *in vitro* setting to the clinical situation must be through with caution. In addition, the Instron universal testing mechanic gives a constant load, which is not the case in oral cavity.[54]

V. CONCLUSION

In line with the present research's limitations, the conclusion can be drawn that the repair bond strength of the materials tested in this study, following accelerated artificial aging, differs in line with the surface treatment and repair materials adopted. Resin composite surface treatment with sandblasting and repair withflowable resin composite was recognized as being preferable in terms of effectiveness when compared with other repair materials and surface treatments.

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Table 1. Distribution of groups according to surface treatments and restorative materials

	A	B	C	D
Surface treatment	Diamond bur	Sandblasting	Silicon Carbide bur	Control group
Group I	Specimens prepared from resin composite (Tetric N Ceram)			
Group II	Specimens prepared from resin modified glass ionmer (Fuji II LC)			
Group III	Specimens prepared from resin modified glass ionmer (Photac Fil)			

Table 2. Mean and standard deviation of shear bond strength (MPa) of the three restorative materials treated with different surface treatment and repaired restorative materials and the significance level

Restorative Material	Surface Treatment	Repair Material	N	Mean	Std. Deviation	*p*-Value
Tetric N Ceram	Diamond bur	Tetric N Ceram	10	48.295	1.431	0.0001*
		Filtek Z350 XT	10	52.870	1.890	
	Sandblasting	Tetric N Ceram	10	56.928	1.358	0.0001*
		Filtek Z350 XT	10	70.679	1.100	
	Silicon carbide bur	Tetric N Ceram	10	32.986	1.504	0.0001*
		Filtek Z350 XT	10	43.148	0.930	
	No surface treatment	Tetric N Ceram	10	41.960	1.765	0.0001*
		Filtek Z350 XT	10	47.125	1.262	
Fuji II LC	Diamond bur	Fuji II LC	10	53.536	1.452	0.0001*
		Filtek Z350 XT	10	45.690	1.503	
	Sandblasting	Fuji II LC	10	58.164	1.255	0.0001*
		Filtek Z350 XT	10	49.162	1.669	
	Silicon carbide bur	Fuji II LC	10	45.386	1.411	0.0001*
		Filtek Z350 XT	10	36.994	1.218	
	No surface treatment	Fuji II LC	10	55.006	1.478	0.0001*
		Filtek Z350 XT	10	46.174	1.203	
Photac Fil	Diamond bur	Photac Fil	10	42.610	1.952	0.119**
		Filtek Z350 XT	10	41.179	1.961	
	Sandblasting	Photac Fil	10	50.821	2.079	0.0001*
		Filtek Z350 XT	10	42.746	1.929	
	Silicon carbide bur	Photac Fil	10	39.035	1.577	0.0001*
		Filtek Z350 XT	10	30.521	1.960	
	No surface treatment	Photac Fil	10	50.241	1.564	0.0001*
		Flowable Resin Composite	10	40.625	1.666	

* Significant
** Non-significant

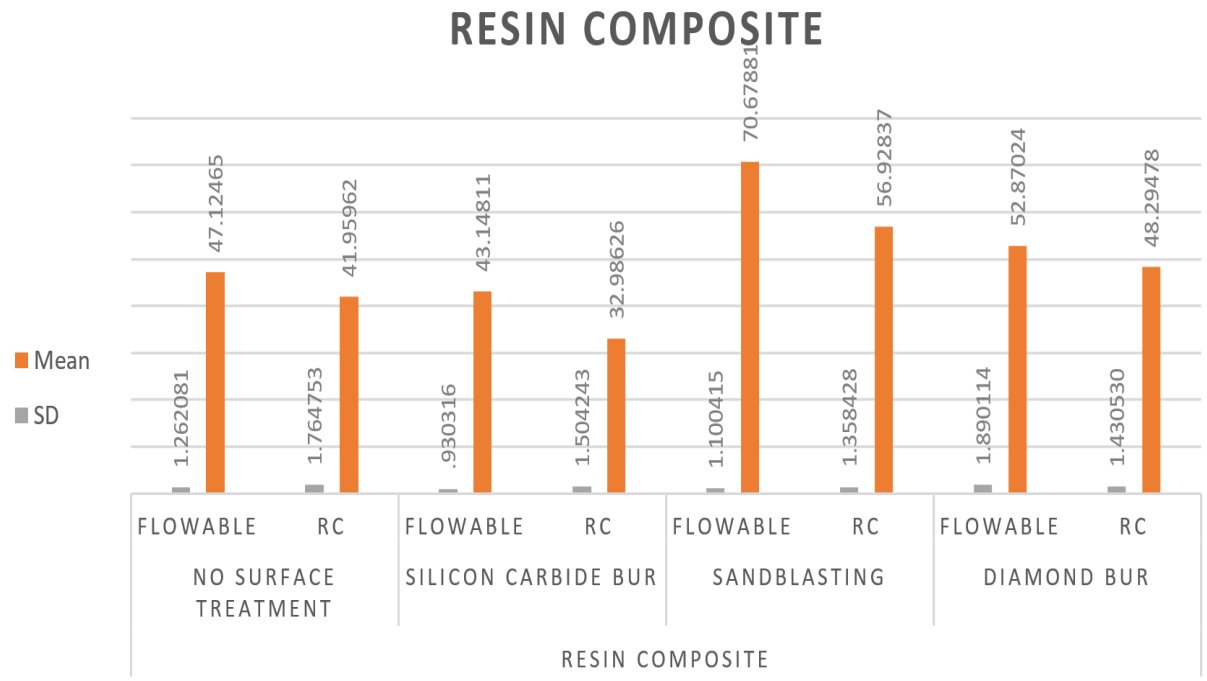

Figure 1. Comparison of the mean and standard deviation of shear bond strength (MPa) of different subgroups of resin composite

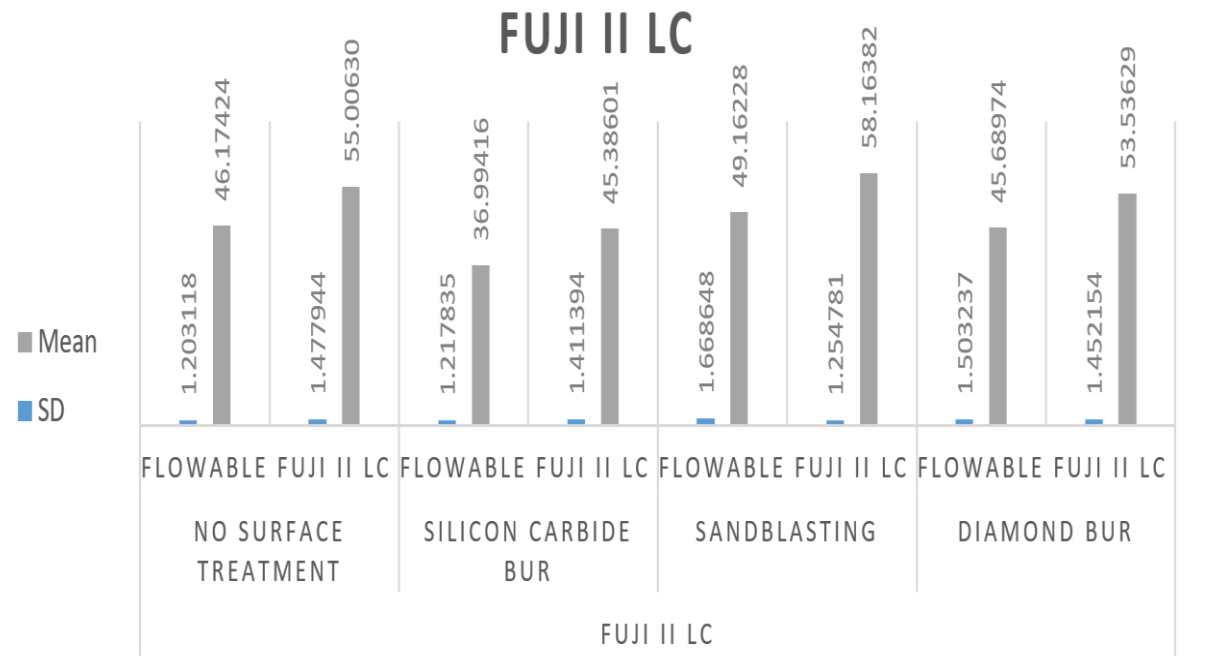

Figure 2. Comparison of the mean and standard deviation of shear bond strength (MPa) of different subgroups of Fuji II LC

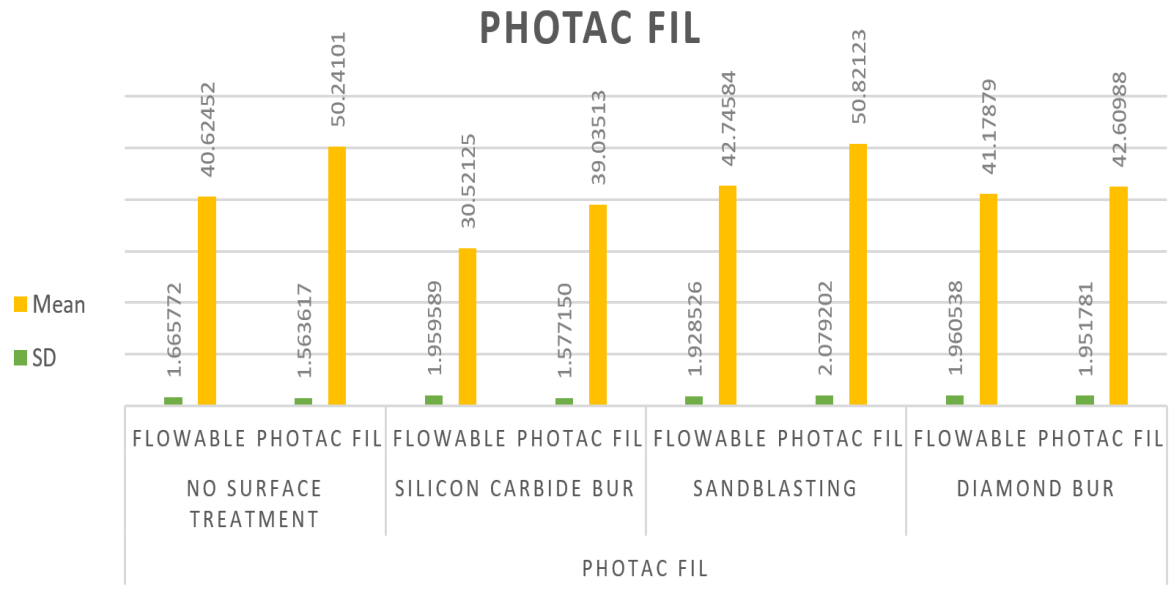

Figure 3. Comparison of the mean and standard deviation of shear bond strength (MPa) of different subgroups of Photac Fil

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