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"To Evaluate the Effect of Bleaching on Shear Bond Strength of Laminate Veneers- An in-Vitro Study".

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ABSTRACT:

Background: The SBS is always affected by the bleaching procedures which can alter the effectiveness of bonding protocols of the restoration**.** *Objective*: This study evaluates the SBS of porcelain laminate veneers bonded to bleached enamel using two different resin cements under various conditions. *Study Design:* Forty maxillary central incisors were separated from their roots and attached to acrylic blocks. Specimens were assigned to four groups after bleaching: Group A (control), Group B (immediate bonding), Group C (delayed bonding), and Group D (antioxidant treatment). Each group was divided into two subgroups based on the resin cement used: Group VL (Variolink) and Group RX (Rely X). Lithium disilicate glass-ceramic discs were bonded to each group, and shear bond testing was conducted using a universal testing machine. *Results:* In Group A, Subgroup AVL showed a SBS of 2.95 MPa, significantly higher than Subgroup ARX, which showed 1.09 MPa (p=0.014). Subgroups BVL and BRX showed no significant difference. In Group C, Subgroup CVL exhibited a SBS of 2.87 MPa, significantly higher than Subgroup CRX, which showed 0.97 MPa (p=0.035). Subgroups DVL and DRX showed no significant difference.

Conclusion: The bond strength of bleached enamel returns to normal after one week. Surface treatment with 10% sodium ascorbate is an effective alternative to delayed bonding. Variolink resin cement resulted in higher SBS compared to RelyX U200.

Keywords: Veneers, Esthetic, Bleaching

1. Introduction

Orofacial appearance is integral to a pleasant and harmonic smile. Because of this, the practice of esthetics has become an essential part of dentistry. These esthetics are affected by number of reasons and tooth discoloration is a major reason behind it.[1]

This discoloration can be either intrinsic or extrinsic based on the etiology and localization.[2]Extrinsic tooth staining is caused by the deposition of chromogens from external sources like poor oral hygiene, chromogenic foods and drinks, and tobacco use. In contrast, intrinsic staining results from structural or compositional changes or thickening of dentinal hard tissues.[3]

Treatment for this discoloration includes full coverage crowns, laminate veneers or minimally invasive therapies such as microabrasion, macroabrasion and oral prophylaxis and bleaching.4]

Restorative dentistry has evolved with improved physical, mechanical, and biological properties, allowing for more conservative treatment options.[5] Porcelain laminate veneers are a popular choice, especially for the anterior region, as a conservative alternative to full coverage crowns. Lithium disilicate is the most common material used for veneers due to its chameleon effect and lifelike fluorescence, which closely mimic the natural tooth structure with excellent light-optical properties.[6] They are generally used for extreme discolorations of anterior teeth, diastemas, and multiple tooth spaces. However, in cases of severe discoloration, veneers may need to be combined with bleaching, which is a conservative, non-invasive, and inexpensive treatment. Bleaching has shown promising results for counteracting tooth discoloration and is a popular treatment choice.[7]

Clinicians should be aware that bleaching can reduce the bond strength of adhesive restorations. Recent literaturehasdemonstrated a reduction in bond strength following tooth bleaching. In a study conducted by Bittencourt et al., application of bleaching agent (35% hydrogen peroxide) was examinedat various time intervals and the results of this study suggested the reduction of resin based composite bond strength to enamel and dentin.[4] Its possible explanation could be the presence of residual peroxide which hinders the attachment of resin which in turn inhibits resin polymerization.However, the general approach is to wait after bleaching before proceeding with further restorative treatment as the depletion of bond strength istemporary. This waiting period can vary from one to two weeks. But it is not always possible for the clinician or the patient to wait for such a long time. So, different surface treatments can be done on bleached enamel in order to restore its bond strength.[7]

Cementation, the final stage in fabricating indirect restorations, is crucial. Composite resin-based luting cements are preferred for their superior mechanical properties, excellent adhesive bond with enamel, dentin and restoration, ease of handling, and satisfactory aesthetics. They are primarily used with glass ceramics, low-filled glass ceramics, some intermediate-filled glass ceramics, and intra-canal fiber posts.[8]

Evaluation of bond strength of composite restorations to the bleached enamel has been analysed in many studies but there is a scarcity of investigations into the adhesion of indirect ceramic veneers to bleached enamel, that too when bonding is done straight away after bleaching.

Hence, this study aims to evaluate the porcelain laminate veneers in terms of shear bond strength (SBS) bonded to bleached enamel using two different resin cements under various conditions.

2. Materials and Methods

Forty well-preserved extracted maxillary central incisors were collectedfrom the Department of Oral & Maxillofacial Surgery. Inclusion criteria required undamaged labial enamel surfaces, while exclusion criteria included deep caries, hypoplasia, hypocalcification, or caries on the labial surface.

Lithium Disilicate discs of 6 mm diameter and 4 mm height were manufactured. A slow speed diamond disc was used to separate crowns from their respective roots at the level of cemento-enamel junction. Separated crowns were embedded in self-cure acrylic blocks of diameter 15mm and depth 1 cmwith labial surface facing upwards. To regulate the surface, the labial surfaces were prepared to be flat with a low-speed sandpaper disc under running water to ensure parallelism with the applied force during shear bond testing. Specimens were randomly assigned to four groups—three test groups and one control group—and further subdivided into two subgroups based on the bonding cements used: Variolink N (VL) and RelyX (RX).The specimens were randomly distributedinto four groups, with ten teeth per group:

Group A: Ceramic discs were fixed to unbleached and untreated specimens and acted as control group.
Group B: After bleaching the teeth with a 35% carbamide peroxide solution, ceramic discs were promptly bonded to the enamel.
Group C: The extracted teeth were bleached using 35% Carbamide peroxide and stored in artificial saliva for 7 days followed by bonding of ceramic discs.
Group D: Similar bleaching protocol was carried out as in previous test groups and then, 10% sodium ascorbate antioxidant agent was applied with an applicator tip and left for a durationof 10 minutes followed by cleansing for 40seconds with waterand dried. The bleached and surface treated specimens were then bonded to the ceramic discs.
Depending upon the cement used all the four groups were distributed into four groups:
Subgroup VL: In this subgroup, the bonding between the specimens and ceramic discs was done using Variolink N. The etching of the specimenswere done with phosphoric acid for 20 seconds and rinsedunder running water. Then, abonding agent was applied and cured for 10 seconds. 5% hydrofluoric acid was used as etchant for ceramic discs for 20 seconds which washed with tap water, and treated with Monobond N for 60 seconds. Excess was removed with a vigorous air stream. The base and catalyst pastes were mixed, applied to the ceramic disc, which was then placed on the specimen and cured for 20 seconds.
Subgroup RX: In this subgroup, lithium disilicate discs were bonded to the specimens using RelyX U200. Both the discs and the enamel surfaces were cleaned and dried. One click of RelyX U200 was dispensed and applied to the ceramic disc, which was then seated on the enamel surface. The cement was tack-cured for one second, excess cement was removed, and the bond was light-cured for 20 seconds.
Thermocycling of the specimens was done between 5-55°C for 600 cycles in order to replicatea clinical service of 1 year. SBS of all prepared specimens were evaluated using a Universal testing machine. Specimens were subjected to a load at crosshead speed of 0.5 mm/minparallel to the long axis of the surface near the bonded area until the ceramic discs debonded.Force applied was recorded and the resultant SBS was interpretedusing the formula:

$B = F \times S^{-1}$

Where:
B: SBS(MPa)
F: load (N) at break
S: bonded area of the cylinder in mm2

$S = \pi r^2$

After collection of data, results were analysed with various statistical tools and compared.

3. Results

Table 1, FIG.1 compared the SBS of specimens using independent t test within each Group. In Group A, Subgroup AVL demonstrated the SBS of 2.95 MPa which was significantly higher than Subgroup ARX which had a SBS of 1.09 MPa with p value being 0.014. The SBS of BVL and BRX sub-Groups did not differ significantly in Group B. In Group C, Subgroup CVL showed a SBS of 2.87 MPa which was significantly higher than Subgroup CRX which had aSBS of 0.97 MPa with p value being 0.035. SBS of DVL and DRX sub-groups did not differ significantly in Group D.
Table 2, FIG.2 presented the difference in SBS of specimens fixed with Variolink (VL) between the four Groups using One way ANOVA test. Maximum SBS was seen in Group A followed by Group C, Group D and Group B respectively.

Table 3 and FIG.3 compared the SBS of specimens luted with RelyX (RX) between the four Groups. Maximum SBS was seen in Group A followed by Group D, Group B and Group C respectively. Group D shows SBS similar to that of Group A.

Table 4 shows pair wise comparison of SBS for specimens luted with Variolink (VL) among the four groups which revealed no significant differences. Table 5 shows pairwise comparison for SBS of specimens luted with RelyX (RX) among the four groups. Group A when compared to Group B, Group C and Group D showed no statistically different values. Also Group B when compared with Group C and Group D showed no statistically different values. Group C when compared to Group D, showed a statistical difference with the p value of 0.028.

4. Discussion

Before bonding any restoration on bleached enamel, one should carefully investigate the initial bond strength to the enamel surface.[9]Bonding restorations to bleached teeth can be challenging, as bleaching changes the enamel surface and chemical composition, potentially reducing adhesive effectiveness.[10]Residual peroxides from bleaching can reduce SBS by interfering with resin tag formation and the bond between resin and tooth, hindering the polymerization of resin monomers. This residual peroxide typically disperses over a period of up to 4 weeks. To restore normal bond strengths to enamel after bleaching, it is generally recommended to delay bonding procedures for a period of two weeks to one month. This waiting period, however, can be seen as a drawback for some patients who desire immediate restoration of their teeth after bleaching.[11]A study done by Svizero et al, concluded that bleaching enamel with 35% hydrogen peroxide gel reduces the immediate SBS of both bleached and unbleached enamel.[12]

This in-vitro study was undertaken to analyse the effect of bleaching on the SBS of porcelain laminate veneers to enamel using two different resin cement under various conditions.
The most effective method for restoring bond strength was delayed bonding, with 10% sodium ascorbate application as the second most successful approach. Similar outcomes were observed in a study done by Egala et al who investigated application of antioxidant and the time interval between bleaching & bonding on the SBS of laminate veneers concluded that bleaching the enamel drastically reduced the bond strength of enamel when bonding procedure was performed immediately after bleaching and a delay of one week in bonding procedure after bleaching was sufficient to reverse the reduced bond strength.[13] Also, done by Jung *et. al.* analysed the effects of sodium ascorbate application on the bond strength of dentinafter bleaching for different time duration and concluded that application of sodium ascorbate for five minutes to forty-eight hours or for thirty minutes to twenty-four hours is suggested in order to restore bond strength after bleaching.[14]

Also, when all the groups were compared in terms of resin cement used, it was found that specimens bonded with Variolink N which is a dual cure, etch and rinse resin cement showed maximum SBS. The reason for this could be the etching of the inner side of the restoration which is done with hydrofluoric acid as it dissolves the glass matrix, and achieves micromechanical retention with the help of remaining porous structure. A study done by Skierczynski et al. evaluated different resin cements for their the SBS with that of human enamel and dentin and concluded that highest bond strength was seen in dual cured etch and rinse cements.[15]

TABLE 1. Comparison of SBS within each Group

Group	Sub-Group	Mean	SD	Difference	p-value
Group A	AVL	2.95	1.31	1.86	0.014*
	ARX	1.09	0.26		
Group B	BVL	1.20	0.50	-0.06	0.859
	BRX	1.26	0.43		
Group C	CVL	2.87	1.67	1.90	0.035*
	CRX	0.97	0.30		
Group D	DVL	1.95	1.30	0.02	0.972
	DRX	1.93	0.76		

Independent t test; * indicates a significant difference at p≤0.05

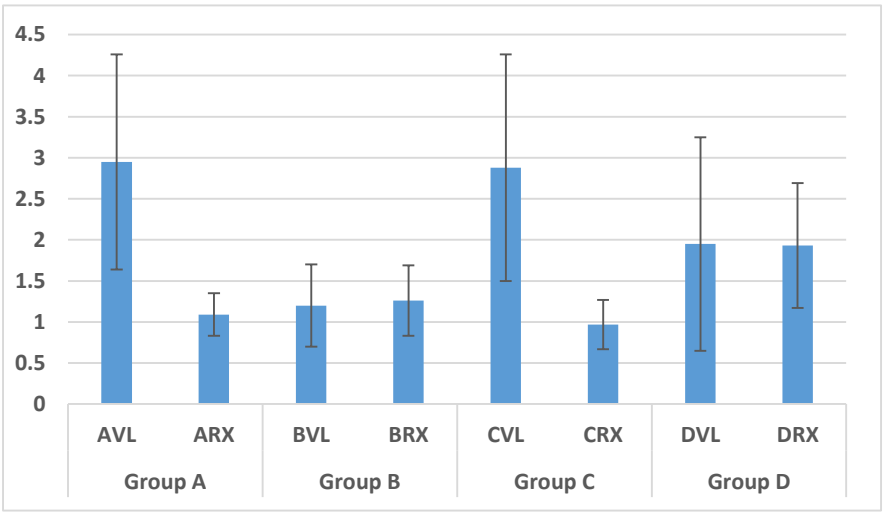

FIG. 1. Comparison of SBS within each Group

TABLE 2. Comparison of SBS for VL between four Groups

Group	Mean	SD	p-value
Group A (AVL)	2.95	1.31	0.098
Group B (BVL)	1.20	0.50	
Group C (CVL)	2.87	1.38	
Group D (DVL)	1.95	1.30	

One-way ANOVA test; * indicates a significant difference at p≤0.05

FIG. 2. Comparison of SBS for VL between four Groups

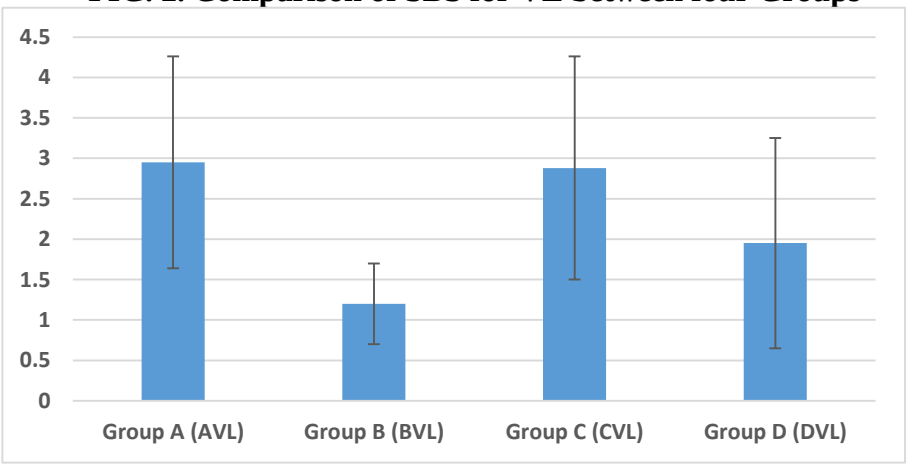

TABLE 3. Comparison of SBS for RX between four Groups

Group	Mean	SD	p-value
Group A (ARX)	1.95	0.26	0.027*
Group B (BRX)	1.26	0.43	
Group C (CRX)	0.97	0.30	
Group D (DRX)	1.93	0.76	

One-way ANOVA test; * indicates a significant difference at p≤0.05

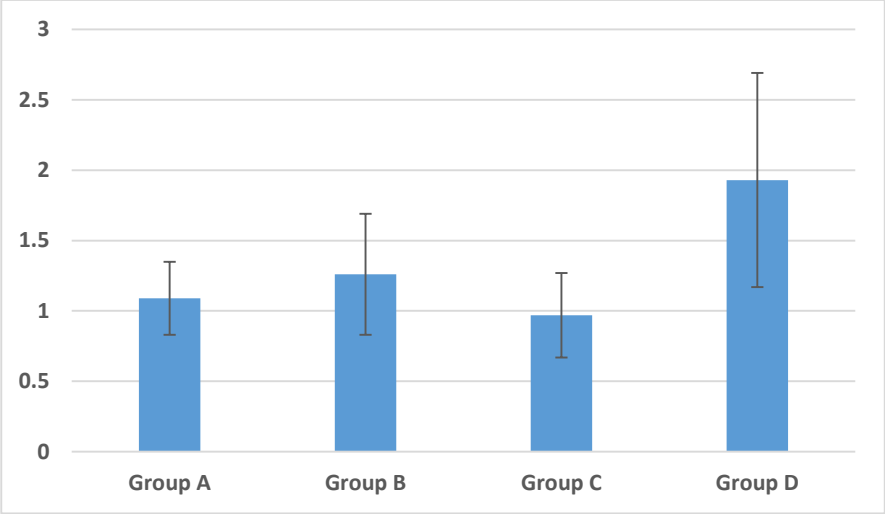

FIG. 3Comparison of SBS for RX between four groups

TABLE 4. Pairwise comparison of SBS for VL between four Groups

Group	**Mean difference**	**p-value**
Group A vs Group B	1.75	0.128
GroupA vs Group C	0.07	1.000
GroupA vs Group D	1.00	0.551
GroupB vs Group C	-1.68	0.153
Group B vs Group D	-0.75	0.749
Group C vs Group D	0.93	0.611

Post hoc Tukey test; * indicates a significant difference at p≤0.05

TABLE 5. Pairwise comparison of SBS for RX between four Groups

Group	**Mean difference**	**p-value**
Group A vs Group B	-0.17	0.942
GroupA vs Group C	-0.12	0.981
GroupA vs Group D	-0.84	0.058
GroupB vs Group C	0.29	0.785
Group B vs Group D	-0.67	0.160
Group C vs Group D	-0.96	0.028*

Post hoc Tukey test; * indicates a significant difference at p≤0.05

5. Conclusion

According to the resultsandconfines of this study, it can be concluded that:
1 Bleaching reduces enamel bond strength by altering its surface and chemical composition due to residual peroxides.
2 Bond strength returns to normal after a one-week waiting period.
3 Treatment with 10% sodium ascorbate can restore bond strength immediately, offering an alternative to delayed bonding.
4 Specimens luted with Variolink resin cement have higher SBS compared to those luted with RelyX U200.

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