Original Research Paper

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Influence of bleaching and remineralizing agents on shear bond strength of ceramics: an in vitro study

Dental Science

KEYWORDS: Bleaching, Hydrogen peroxide, Calcium Sucrose Phosphate

Ananya Maity — Post Graduate Student, Department of Conservative Dentistry & Endodontics, Manipal College of Dental Sciences, Manipal, Karnataka

Shashi Rashmi Acharya — Professor, Department of Conservative Dentistry & Endodontics, Manipal College of Dental Sciences, Manipal, Karnataka

ABSTRACT

Bleaching of teeth is recommended as a treatment option to reduce the intensity of discolouration before bonding thin laminates. Bleaching affects adhesion owing to inorganic & organic changes in teeth. Thus, aim of the study was to evaluate and compare the effect of 5% & 40% calcium sucrose phosphate(CaSP) remineralizing agents after bleaching on enamel with 35% Hydrogen Peroxide(H_2O_2) and its influence on shear bond strength of ceramics. 40 maxillary incisors were divided as: GroupA: control, GroupB: 35% H_2O_2 and 5% CaSP, GroupC: 35% H_2O_2 and 40% CaSP, GroupD: only 35% H_2O_2. Ceramic discs were fabricated and luted with dual cure resin cement. Shear bond strength was evaluated with universal testing machine. Increase in mean values showed no statistically significant difference between GroupB & GroupC. Hence, we can conclude that higher concentration of CaSP before cementation of laminates to bleached enamel may be a better option.

INTRODUCTION:

Everyone, in recent era, wants beautiful smile. But, discoloration of teeth, especially the anteriors, can result in considerable cosmetic impairment in a person. Thus, restoration of such discolored teeth is utmost important. Various treatment options are available to treat such conditions include bleaching, micro & macro- abrasion, direct composite veneer, ceramic laminates and full coverage restorations. Among all these treatment options, bleaching is the most conservative approach.

By definition bleaching is "Lightening of the color of tooth through application of a chemical agent to oxidise the organic pigmentation in the tooth" **(Grossman)**. The goal of bleaching is the restoration of normal color of tooth by decolorizing the stain with a powerful oxidizing agent known as bleaching agent**.** But, sometimes bleaching does not give satisfactory results. In such conditions, we as clinicians have to opt for alternative treatment option such as ceramic laminates. Among various indications of laminates such as correction or alteration in tooth shape or position, diastema closure, one most important indication is to change the colour of tooth **(Sadaqah NR 2014)**. Sometimes, combinations of bleaching & laminate are recommended as treatment option to reduce the intensity of discolouration before bonding thin laminates.

Bleaching may affect both the inorganic & organic phases of teeth. Because of these changes there is difficulty in bonding adhesive restoration **(Dilber E *et al.* 2015)**. Thus, reversal of this structural alteration is required. Application of remineralizing agents has been proven to be beneficial to restore such alteration.

Calcium sucrose phosphate (CaSP) is a calcium–phosphate based remineralizing agent that contains calcium sucrose mono and diphosphate, disucrose monophosphate inorganic calcium phosphate. It quickly breaks down & releases Calcium, phosphate & sucrose ions. These ions are rapidly adsorbed on enamel surface. Sucrose phosphate ions decrease acid dissolution of hydroxyapatite and inhibit demineralization. Calcium & phosphate ions increases rate of remineralization by common ion effect **(Kaur G *et al.* 2015).**

The **aim** of the study was thus to evaluate and compare the effect of 5% & 40% calcium sucrose phosphate remineralizing agents after bleaching on enamel with 35% Hydrogen Peroxide and its influence on shear bond strength of ceramics.

The objectives were to evaluate and compare shear bond strength of ceramics after application of 5% & 40% calcium sucrose phosphate remineralising agent on bleached teeth.

MATERIALS & METHODOLOGY:

SPECIMEN COLLECTION AND STORAGE:

40 extracted human maxillary incisors were taken after surface debridement with scaler and stored in normal saline at room temperature until used. Inclusion criteria were teeth without caries, teeth that were not subjected to bleaching before & preferably extracted for periodontal purpose. Exclusion criteria were fluorosis, surface defects and cracks. After initial debridement with the help of scaler, teeth were stored in normal saline.

SPECIMEN PREPARATION:

All teeth were mounted in self-cure acrylic block & randomly divided into 4 groups as follows:

- Gp A: control (n=10)
- Gp B: treated with 35% hydrogen peroxide (Pola office, SDI, Australia) and 5% calcium sucrose phosphate (Enafix, Group Pharmaceutical Ltd., India) remineralizing agent (n=10)
- Gp C: treated with 35% hydrogen peroxide and 40% calcium sucrose phosphate (Group Pharmaceutical Ltd., India) remineralizing agent (n=10)
- Gp D: treated with 35% hydrogen peroxide. (n = 10)

APPLICATION OF HYDROGEN PEROXIDE:

Hydrogen peroxide gel was applied on the labial surface of enamel as follows:

GpA: No treatment was done

Gp B, C & D**:** 0.5-1 mm thick bleaching agent containing 35% hydrogen peroxide was applied on the specimen and kept for 10 min. After 10 min, gel was removed with the help of suction. Same procedure was followed for second application of bleaching gel and the specimens were rinsed with water after second application of bleaching agent. Whole procedure was repeated again after 1 wk.

APPLICATION OF REMINERALISING AGENTS:

Gp B & C: After 24 hrs of completion of bleaching procedure 5% / 40 % calcium sucrose phosphate remineralizing agent was applied with microbrush on the enamel surface of bleached teeth and kept for 2 min respectively. Remineralizing agents were applied twice daily for 15 days. Specimens were kept in artificial saliva throughout the treatment procedure.

PORCELAIN DISCS FABRICATION:

4mm diameter and 2.5mm thick porcelain discs (Fig 1) were fabricated from IPS e.max press (Ivoclar Vivadent) with lost wax technique.

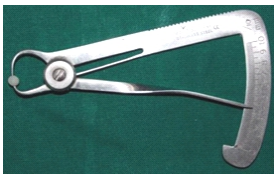

Fig 1: porcelain disc (4mm X 2.5mm)

BONDING PROCEDURE:

37% phosphoric acid was applied on selected area of labial surface of all teeth. After rinsing the etchant with water, teeth surfaces were dried with cotton pellet. Bonding agent (Adper single bond 2, 3M ESPE) was then applied and cured. Porcelain discs were etched with hydrofluoric acid. Monobond N (universal primer mediating an adhesive bond between luting composites and all materials used for indirect restorations) was then applied for 60 sec. onto the etched porcelain surfaces. Porcelain discs were bonded to the teeth (Fig 2) of all groups including the control group with the help of dual cure resin cement (Variolink N, Ivoclar Vivadent).

Fiig 2 ; Application of phosphoric acid (right), Application of hydrofluoric acid (middle), bonded porcelain disc to tooth (left)

SHEAR BOND STRENGTH EVALUATION

Shear bond strength was tested in Universal testing machine (Fig 3) at a 0.5 mm/min crosshead speed.

Fig 3: Evaluation of sample in universal testing machine

RESULTS:

Table 1 : shear bond strength values & maximum load applied of all groups

No.	Group A		Group B		Group C		Group D	
n=10/gp	Maximum compressive load (N)	Compressive stress at maximum compressive load (MPa)	(N)	(MPa)	(N)	(Mpa)	(N)	(MPa)
1.	101.79	8.10	151.43	12.05	165.47	13.17	202.05	16.08
2.	196.54	15.64	48.73	3.88	199.58	15.88	138.59	11.03
3.	182.50	14.52	93.89	7.47	143.27	11.40	63.03	5.02
4.	214.81	17.09	145.37	11.57	188.06	14.97	82.06	6.53
5.	182.96	14.56	267.82	21.31	187.00	14.88	135.42	10.78
6.	201.98	16.07	154.88	12.32	155.99	12.41	139.23	11.08
7.	89.44	7.12	129.25	10.29	154.58	12.30	138.19	11.00
8.	329.04	26.18	133.32	10.61	172.73	13.75	122.08	9.72
9.	298.11	23.72	145.40	11.59	177.14	14.10	80.97	6.44
10.	182.54	14.54	154.82	12.30	87.05	6.93	89.75	7.14

In group A (neither bleaching nor remineralizing procedure was done) maximum bond strength is 26.18 MPa and minimum bond strength is 7.12 MPa. Whereas in group D, which were subjected to only bleaching procedure, maximum bond strength is 16.08 MPa and minimum bond strength is 5.02 MPa. For group B these values are 21.31 MPa & 3.88 MPa respectively. For group C maximum & minimum bond strength values are 15.88 MPa & 6.93 MPa respectively (Table 1).

STATISTICAL ANALYSIS:

Statistical analysis is done with ANOVA with post-hoc Tukey's test (Table 2)

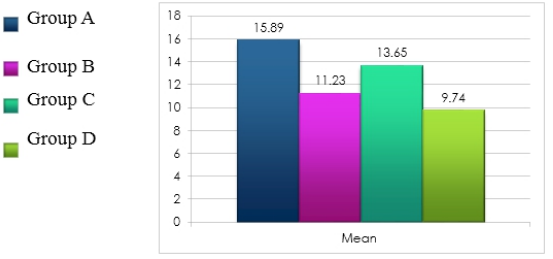

Table 2 : Statistical analysis (intergroup comparison)

	Group A		Group B		Group C		Group D		p-value	Post-hoc test
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
N	199.69	78.24	141.12	58.47	171.54	18.36	122.40	42.10	0.025; Sig	A>D
Mpa	15.89	6.22	11.23	4.65	13.65	1.46	9.74	3.35	0.025; Sig	A>D

There is significant difference in the mean values among the 4 groups. Post-hoc analysis showed that there is significantly higher mean for Group A than group D. No other significant differences are seen.

DISCUSSION:

Due to low molecular weight of hydrogen peroxide, it can diffuse through tooth structure and dissociate to produce unstable free radicals. These free radicals interact with chromophore molecules and oxidize those **(Poorni S *et al.* 2010).** During this procedure carbon ring, responsible for dark brown pigments is converted to carbon chain. Thus, absorb less light & as well as reflect more light appearing lighter in colour.

Although bleaching treatment clearly result in a lighter tooth color, it causes decreased bond strength of resins **(Khoroushi M *et al.* 2013)**. Different Studies have also shown that Ca & P contents of tooth significantly decreases after bleaching **(Son J *et al.* 2012).** Physical alterations after bleaching is the main reason for the decrease in enamel bond strength. SEM analysis of the fractured specimens in shearing test showed that bond failure could be due to adhesive, cohesive or mixed failure (**Kaya AD and Türkün M 2004**). Thus, recommendations have been made from different studies to wait for several days before undertaking any adhesive procedure after bleaching treatment **(Leily MF *et al.* 2013**).

Remineralization can alter structural morphology of bleached enamel. Effective remineralizing action of **calcium sucrose phosphate** is because of its solubility in water providing high concentrations of free calcium and phosphate ions several times higher than normally present in saliva.

According to **ztu¨ rk E *et al.* 2012** preparation for porcelain laminate veneers should be made meticulously to maintain the preparation completely in enamel. Complete polymerization of the luting cement is most important to prevent restoration failure **(Faria-e-Silva A *et al.* 2010).** Dual-cure resin cements have low solubility, high mechanical quality and good adhesive properties **(Da Silva RAT *et al.* 2011**). It possesses good working time and capable of reaching

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high degree of conversion in either the presence or absence of light. Universal testing machine was used for the study as it is most commonly used to evaluate bond strength and also because of its ease of operation & availability.

In the present study both the groups treated with 5% & 40% calcium sucrose phosphate remineralizing agents have shown improved shear bond strength of ceramics to enamel compared to the bleached group. But, probable cause of extreme values in results is patient's age which was not considered during specimen collection. In the present study bond strength of ceramic to enamel decreases after bleaching which is in accordance with previous studies **(Kaya AD *et al.* 2008).** According to the present study 40% CSP gave higher bond strength compared to the group treated with 5% CSP. This could be contributed to the higher Ca & P contents of 40% CSP.

CONCLUSION:

Though groups treated with remineralising agents did not show statistically significant result compared to bleached group, the remineralised groups showed higher mean values.

Use of higher concentration of calcium sucrose phosphate before bonding of laminates to bleached enamel is thus may be a better option.

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