Effects of Different Concentrations of Bleaching Agent on the Shear Bond of Restorative Materials - An In Vitro Study

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ABSTRACT:

BACKGROUND: Bleaching methods had been developed and peroxide compounds at different concentrations are used for tooth whitening procedures.

AIM AND OBJECTIVE: The aim of the present laboratory study was to evaluate the effect of bleaching with carbamide peroxide agents at concentrations 10 and 21% on the shear bond strength of Nano Composites and Nano hybrid Composite restorative materials.

MATERIAL AND METHODS: 60 non carious premolars extracted for orthodontic reasons were selected for the study. The restorative materials were filled in a two layer increment technique, each layer being light cured separately for 40s using light cure unit. For shear bond strength evaluation, samples of both were subdivided into control group (stored in artificial saliva), Experimental groups bleached with 10% carbamide peroxide and those bleached with 21% carbamide peroxide. Following 2 weeks of bleaching treatment, the shear bond test was performed using Instron universal testing machine.

STATISTICAL ANALYSIS: One way Analysis of Variance (ANOVA) was used for multiple group comparisons followed by Tukey's test for pair wise comparison.

RESULTS: Bleaching with carbamide Peroxide at concentrations 10 and 21% caused reduction in bond strength of composite restorative materials.

CONCLUSION: It can be deduced that bleaching caused reduction in bond strength of composite restorative materials.

Key words: Aesthetics, Beauty, bleaching, Carbamide peroxide, Developmental defects, Discoloured enamel, Micro hardness.

INTRODUCTION:

Esthetic dentistry is one among the most dynamic areas of contemporary clinical dentistry. Widespread interest in esthetic dentistry among members of the profession, the dental industry, and

the public had a marked effect on general dental practice.¹ Patients' increased awareness of esthetic outcomes and their desire to look better and to feel better about themselves have led to enormous demands on dentists to perform esthetic procedures.

Tooth discoloration is becoming a greater concern as more emphasis is placed on esthetics. Bleaching systems have been received by the public as a more conservative and economical method of improving the appearance of the Dentition.¹ Dentist's ability to fulfil patients' expectations is directly related to their knowledge and clinical skills in this area.²

Bleaching methods had been developed and peroxide compounds at different concentrations are used for tooth whitening procedures. Peroxide-containing vital tooth whiteners are classified into three categories, according to application mode and peroxide concentration. Oxidizing agents for professional use only contain high concentrations of Carbamide Peroxide (35-37%) and Hydrogen Peroxide (30-35%) solutions, while patient-applied tooth whiteners for at-home bleaching, containing up to 20% Carbamide Peroxide and 10% Hydrogen Peroxide, are dispensed, and monitored by dentist.³

The purposes of the present study were to evaluate the effects of bleaching agents on dental restorative materials-the Nano Composite and Nano Hybrid Composite.

METHODS: The present study was conducted in the Department of Pedodontics and Preventive Dentistry, Rajah Muthiah Dental College and Hospital, Annamalai University in association with Department of Manufacturing Engineering, faculty of Engineering and Technology, Annamalai University.

Restorative materials used were Nano Composite {Te-Econom plus, Ivoclar Vivadent (RO353)} and Nanohybrid Composite {Tetric N Cream, Ivoclar Vivadent (P87103)}. Bleaching agent used were Carbamide peroxide 10% {Opalescence} and Carbamide peroxide 21% (d-tech)⁴

Sampling for Shear bond strength evaluation

60 non carious premolars extracted for orthodontic reasons were used for this study. Each tooth was embedded in acrylic resin exposing the buccal surface. Then the outer enamel surface was ground flat with the help of 320 grit sand paper to obtain a flat dentinal surface. The dentin surface of each specimen was etched with 35% phosphoric acid

for 15 seconds, washed and blotted dry. Two coats of single bond was applied over each of the specimens and light cured for 20 seconds. Cylindrical Teflon mold measuring 2 mm in diameter and 4 mm in height was used to build the Nano Composite and Nano Hybrid Composite cylinders on the dentinal surface. The restorative materials were filled in a two layer increment technique, each layer being light cured separately for 40 seconds using light cure unit. Thirty samples of each restorative material were subdivided into 3 groups of ten each.⁴

The specimens for Shear bond strength evaluation assigned for the bleaching regimes are given in Table 1- Nano Composite group and Table2- Nano Hybrid Composite group.

The bleaching protocol in the present study was designed to simulate treatment of teeth under cycling conditions of bleach and saliva exposure which is encountered under in situ conditions (Kudalkar and Damle, 1997). The control test specimens of restorative materials were stored in artificial saliva throughout and the experimental test specimens while they were not being "bleached" in order to simulate oral conditions as closely as possible.

Artificial saliva comprised of Sodium chloride (NaCl) 0.4 g, Potassium chloride (KCl) 0.4 Calcium chloride ($\text{CaCl}_2 \cdot \text{H}_2\text{O}$) 0.795 g, Sodium-dihydrogen Phosphate ($\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$) 0.69 g, Sodium sulfide ($\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$) 0.005 g and distilled water 1000 ml. The pH was adjusted to 7 (Attin, 1996).⁴

Bleaching regime

The test specimens of the experimental group were bleached with Carbamide peroxide gels at 10% or 21%, for 8 hours daily for a period of 2 weeks.

For Shear bond strength samples, the bleaching gels were applied at the bonded interfaces. After treatment with Carbamide peroxide gel, the test specimens were abundantly washed under running water, dried with absorbent paper, and immersed in artificial saliva for remaining 16 hours of the day.

The test specimens from the control group were kept in artificial saliva all the time, with the saliva being changed daily.⁴

Study of Shear bond strength

After two weeks of treatment, experimental and the control specimens were analyzed in a Micro hardness meter.

The Shear bond test were performed using Universal testing machine at a cross head speed of 0.5 mm min^{-1} in a compression mode using a blade parallel to the dentinal surfaces as the shearing element and the readings were noted.

Measurements were expressed as mean $\pm$ standard deviation and were compared between two groups by student's t test. One-way ANOVA was used for multiple group comparisons followed by Tukey's test for pair wise comparison. P value less than 0.05 was considered for statistical significance.

RESULTS:

The results and observations of shear bond strength are summarized as follows:

SHEAR BOND STRENGTH EVALUATION

The Shear bond strength the specimen were calculated using the formulae

$$\text{FORMULAE: area} = \pi/4 \times r^2 = \pi/4 \times 4^2 = 12.56 \text{ mm}^2$$

Where, R=radius, Stress=load/area.

The values obtained were expressed in Megapascal (Mpa).

The Shear bond strength values have been expressed as mean and standard deviation. 2x3 ANOVA test were used to compare the Shear bond strength by material and group wise. If the groups were significant, Tukey's multiple comparison tests were applied to know which of the group differs. Level of significance has been fixed as 5 % (0.05).

Comparison of Shear Bond Strength between Nanocomposite and Nanohybrid Composite was done which was indicated in Table 3. The Shear bond strength of Nano Composite and Nanohybrid Composite were reduced when it was treated with 10% and 21% bleaching agent. The Shear bond strength of Nanohybrid Composite was better when compared to Nanocomposite. To compare the two materials and the role of bleaching agents, 2x3

ANOVA test has been applied. 2x3 ANOVA test results are shown in Table 4, Graph 1.

Material comparison:

The significant 'p' value of the material comparison infers that the two materials are statistically different. In general the hybrid material is better than the Nano Composite. When the teeth were treated by Nano Composite material and 21% bleaching agent the Shear bond strength were reduced compared to the Nano composite alone and Nano Composite with 10% bleaching agent. When the teeth were treated by Nano hybrid material and 21% bleaching agent the Shear bond strength were reduced compared to the Nano hybrid material alone and Nano hybrid material with 10% bleaching agent (Table 5). In general the Shear bond strength of Nano hybrid material was better than the Nano Composite.

DISCUSSION:

Tooth whitening has a long history and has evolved into one of the most popular aesthetic dental treatments available. From "chew sticks" made from twigs dating back to 3000 B.C. and the ancient Romans' discovery that Ammonia in urine could serve as a bleaching agent to today's use of various forms of peroxide to safely whiten teeth, the quest for "pearly whites" threads throughout the history of oral health. In the 1800s, the discovery of fluoride's teeth protecting capabilities allowed for new oral hygiene opportunities.⁵

The aim of the present laboratory study was to evaluate the effect of bleaching with Carbamide Peroxide agents at concentrations 10% and 21% on the Shear bond strength of Nano composites and Nano hybrid composite restorative materials.

The importance of the present study were that after eruption of the tooth, aging, pulp necrosis, and iatrogenesis are the main causes of intrinsic discoloration. Coffee, tea, red wine, carrots, oranges, and tobacco give rise to extrinsic stain (Khin, 2000). Exposure to high levels of fluoride, tetracycline administration, inherited developmental disorders, and trauma to the developing tooth may result in pre - eruptive discoloration. Bleaching is a

conservative treatment alternative for discolored teeth.⁴

Since enamel and dentin are porous tissues, the scientific basis for bleaching vital teeth is sound (Bastinget al., 2003). Clinicians all over the world had incorporated the vital bleaching into their profession and oxygenating agents like carbamide peroxide or Hydrogen peroxide are used for effective bleaching (Garcia-Godoyet al., 2002).⁴

A 10% Carbamide peroxide bleaching agent is the most commonly used at-home bleaching product.

A range of concentrations of Carbamide peroxide available to the dental professional include 15, 20, 22 and 30% solutions (Khin, 2000). It had been reported that whitening of teeth can be achieved faster with higher concentrations compared with the results for lower concentrations of Carbamide peroxide (White et al., 2003). The bleaching protocol in the present study was designed to simulate treatment of teeth under cycling conditions of bleach and saliva exposure which is encountered under in situ conditions (Kudalkar and Damle., 1997). The control test specimens of restorative materials were

Table 1: Nano Composite group

Group	Shear bond strength
Control	P1(10 Samples)
10% Carbamide Peroxide	P2(10 Samples)
21% Carbamide Peroxide	P3(10 Samples)

Table2: Nano Hybrid Composite group

Group	Shear bond strength
Control	P4(10 Samples)
10% Carbamide Peroxide	P5(10 Samples)
21% Carbamide Peroxide	P6(10 Samples)

Table 3: Comparision of shear bond strength between nanocomposite and nanohybrid composite

S.No.	MATERIAL	GROUP	RANGE (Mpa)	MEAN (Mpa)	SD
1.	NANO	T1	7.96-9.55	8.67	0.58
	COMPOSITE	T 2	7.16-9.55	7.95	0.99
		T3	6.36-7.96	7.16	0.65
2.	NANOHYBRID	T4	9.55-11.14	10.5	0.62
	COMPOSITE	T5	7.96-10.35	9.39	0.90
		T6	7.16-9.55	8.51	0.755

Table 4: ANOVA Test results

No.	SOURCE	F-VALUE	p-VALUE
1	Material	60.31	<0.001
2	Group	26.04	<0.001
3	Material and group	0.558	0.576

One way ANOVA; P < 0.001, Significant (S); P >0.05, not significant (NS).

Table 5: TUKEY'S HONESTLY-SIGNIFICANT-DIFFERENCE TEST

Sample	Material and Group	Mean Difference	P-Value
1	NANOCOMPOSITE (T1) - NANOCOMPOSITE (T2)	0.716	0.311 (NS)
2	NANOCOMPOSITE (T1) - NANOCOMPOSITE (T3)	1.513	0.001 (S)
3	NANOCOMPOSITE (T1) - NANOHYBRID (T4)	-1.833	0.000 (S)
4	NANOCOMPOSITE (T1) - NANOHYBRID (T5)	-0.718	0.308 (NS)
5	NANOCOMPOSITE (T1) - NANOHYBRID (T6)	0.159	0.997 (NS)
6	NANOCOMPOSITE (T2) - NANOCOMPOSITE (T3)	0.797	0.204 (NS)
7	NANOCOMPOSITE (T2) - NANOHYBRID (T4)	-2.549	0.000 (S)
8	NANOCOMPOSITE (T2) - NANOHYBRID (T5)	-1.434	0.001 (S)
9	NANOCOMPOSITE (T2) - NANOHYBRID (T6)	-0.557	0.588 (NS)
10	NANOCOMPOSITE (T3) - NANOHYBRID (T4)	-3.346	0.000 (S)
11	NANOCOMPOSITE (T3) - NANOHYBRID (T5)	-2.231	0.000 (S)
12	NANOCOMPOSITE (T3) - NANOHYBRID (T6)	-1.354	0.003 (S)
13	NANOHYBRID (T4) - NANOHYBRID (T5)	1.115	0.023 (S)
14	NANOHYBRID (T4) - NANOHYBRID (T6)	1.992	0.000 (S)
15	NANOHYBRID (T5) - NANOHYBRID (T6)	0.877	0.127 (NS)

One way ANOVA; $P < 0.001$, Significant (S); $P > 0.05$, not significant (NS).

Graph 1: Comparison of Shear bond strength between Nano-Composite and Nano-Hybrid Composite. Series 1- Control group; Series 2-Bleached with 10 % Carbamide Peroxide; Series 3-Bleached with 21 % Carbamide Peroxide.

stored in artificial saliva throughout and the experimental test specimens while they were not being “bleached” in order to simulate oral conditions as closely as possible.⁴

Carbamide peroxide is an organic white crystalline compound composed of Urea and Hydrogen Peroxide. Carbamide peroxide breaks down in the mouth to form Hydrogen Peroxide. The bleaching gel typically contains between 10% and 44% Carbamide Peroxide, which is roughly equivalent to a 3% to 16% Hydrogen Peroxide concentration. It is supplied as a gel by adding thickening agents like Carbopol, Glycerine, and Glycol etc., to increase its viscosity and prolong its contact with the tooth structure. It is more stable than H_2O_2 having a shelf life of up to 2 years. Its bleaching action is similar to H_2O_2 but it is safer than the latter. Hence it is currently the most popular bleaching agent at home vital bleaching procedures.⁵

Shear stress is considered to be more representative of the clinical situation. Bond strength is the force per unit area that is required to break a bonded assembly with failure occurring in or near the adhesive/ adherend interface. For Shear bond strength evaluation, a total of 60 non carious premolars extracted due to orthodontic reasons were selected and stored in distilled water before and during the study period, since the distilled water does not affect the dentin permeability and bond strength compared to saline. The buccal surfaces of all the 60 teeth were considered in this study, because this surface allowed the shearing force to be exactly perpendicular to the bonded specimen (Shinohara, 2004). The dentin surface was etched with 35% Phosphoric acid for 15 seconds. The single bond multi-purpose etchant is a versatile system which is recommended for bonding all classes of restorations. “Single Bond”, a fifth generation (type 2) adhesive, was used having both primer and adhesive in one bottle. The main reasons to use an adhesive were to facilitate the penetration of Composite into the etched dentin surface to provide a better bond to tooth structure. Single bond

adhesive were found to provide up to 97% retention rate. Few studies have reported that Carbamide peroxide does not interfere in the adhesion of composite resin with dentin. The reaction of Carbamide peroxide is immediate, and it was probable that the residues of hydrogen peroxide leach rapidly. Furthermore, dentin is a porous substrate, and the peroxide residues of Carbamide peroxide may release the oxygen more easily to the dentin tubules than to enamel.

When the tooth were treated by Nano Composite material and 21% bleaching agent the Shear bond strength were reduced compared to the Nano Composite alone and Nano Composite with 10% bleaching agent. When the tooth were treated by Nano Hybrid material and 21% bleaching agent the Shear bond strength were reduced compared to the Nano Hybrid material alone and Nano Hybrid material with 10% bleaching agent.

In the present study, although there were reduction in bond strength of the groups treated with Carbamide peroxide at 10 and 21% for both Nano Hybrid material and Nano Hybrid material restorative materials when compared with the control groups that were stored in artificial saliva, it were statistically in- significant.

The effects of whitening agents on hard dental tissues are tooth sensitivity during bleaching is the most common side effect with the degree of sensitivity varying between patients. Sensitivity, if it occurs during treatment is usually not permanent. Tooth sensitivity, if present, normally persists for up to four days after the cessation of bleaching. Sensitivity can be decreased by decreasing the amount exposure to the bleaching solution per day. Research had shown that toothpastes containing potassium nitrate used for 2 weeks prior to teeth whitening helps to decrease the sensitivity during bleaching.⁵

It had been concluded that the use of dentist-monitored, at-home tooth whitening gels containing 10% Carbamide Peroxide carries no carcinogenic risk and does not cause irreversible damage to enamel.⁵ Gingival irritation is another possible side

effect that occurs when the bleaching solution comes in contact with the gums.⁵ Gastro-intestinal irritation can also occur, mainly with at-home bleaching systems that are worn over night.⁵

Thomas Attin et al (2004) evaluated in some scanning electron microscopic studies and profilometric analysis, it was shown that 10-16% Carbamide Peroxide bleaching gels (i.e. 3.6-5.76% Hydrogen Peroxide) may lead to a slight, but statistically significant increase in surface roughness and amount of porosities of Microfilled and Hybrid Composite resins.⁶

Thomas Attin et al (2004) said that the overwhelming majority of studies utilizing 25-35% Hydrogen Peroxide uniformly showed that both shear bond strength and tensile bond strength of all Composite restorative materials tested were significantly reduced when Composite application (including acid-etching pre-treatment) was performed immediately, i.e. within 1 day, after completion of bleaching regime.⁶

In the present study the Shear bond strength of Nano Hybrid Composite material were better than the Nano Composite material.

CONCLUSION:

Following conclusions were drawn from the study: (1) There was a significant reduction in the Shear bond strength of restorative materials observed after exposure to Carbamide Peroxide agents under a clinically simulated bleaching

regimen. This had clinical implications on post-treatment outcomes. Carbamide peroxide bleaching gel at concentrations 10% and 21% caused a reduction in hardness of Composite. (2) In general the Shear bond strength of Nano Hybrid material was better than the Nano Composite.

Further in-vivo studies are needed to evaluate the other associated effects of bleaching on restorations such as the surface roughness, micro leakage and color changes in tooth colored restorative materials which can significantly enhance the findings of the present study.

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