Original Article

Effects of Different Concentrations of Bleaching Agent on the Micro hardness of Restorative Materials"– An In Vitro Study

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ABSTRACT

Background: Today's society dictates that it is the norm for people to have straight, white teeth. The demand therefore for tooth whitening in dental practice has increased exponentially over the last decade. A common approach to achieving this goal is by bleaching.

Aim: The aim was to evaluate the effect of bleaching with carbamide peroxide agents at concentrations 10%, 21% on the Micro hardness of Nano Composites and Nano hybrid Composite Restorative materials.

Material and Methods: 60 pellets were prepared with both types of composites of 30 each using brass molds of inner diameter 4 mm and a height of 2 mm. For Micro hardness 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, Vickers's hardness number was recorded for each test specimen using a Micro hardness meter.

Results: One way Analysis of Variance (ANOVA) was used for multiple group comparisons followed by Tukey's test for pair wise comparison. Bleaching with carbamide peroxide at concentrations 10% and 21% caused reduction in Micro hardness of Composite Restorative materials.

Conclusion: On the basis of the present findings, it can be suggested that there was a significant reduction in the Micro hardness of restorative materials observed after exposure to Carbamide Peroxide agents under a clinically simulated bleaching regimen.

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

INTRODUCTION

Tooth discoloration is becoming a greater concern as more emphasis is placed on aesthetics. 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].

Tooth discoloration varies in aetiology, appearance, localization, severity, and adherence to tooth structure. It may be classified as intrinsic, extrinsic and a combination of both [3]. Intrinsic discoloration is caused by incorporation of chromogenic material into dentin and enamel during odontogenesis or after eruption. Exposure to high levels of fluoride, tetracycline administration, inherited developmental disorders, and trauma to the developing tooth may result in pre-eruptive discoloration.

Bleaching teeth with 10% Carbamide Peroxide in a custom fitted tray had been popular for more than 10 years. However, primary teeth are seldom considered for bleaching due to the need for compliance by the child and the natural whiteness of the primary teeth [4].

For a long time, the aesthetic treatment of discoloured teeth required invasive procedures such as jackets and crowns. Bleaching techniques offer a conservative treatment alternative for discoloured teeth [5].

The purposes of the present study were to evaluate the effects of bleaching agents on Micro hardness of 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) [6]. Fig 1,2,4.

Fig. 1: Armamentarium

Fig. 2: Bleaching Gel and Restorative Material

Fig. 3: Nano composite and Nano Hybrid Composite in Groups

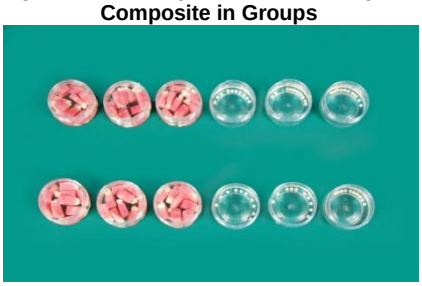
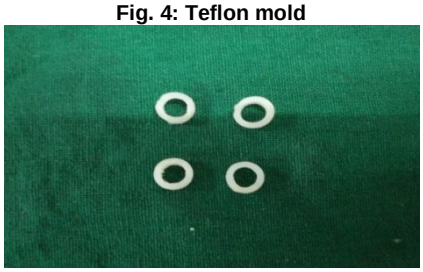


Fig. 4: Teflon mold



Specimen preparation for micro hardness evaluation

60 pellets were prepared with Nano Composite and Nano Hybrid Composite restorative materials of 30 each using brass moulds of inner diameter 4 mm and a height of 2 mm. Brass moulds were positioned on a Matrix strip placed on a glass plate and filled with each restorative material. The materials were held under constant hand pressure using two glass slabs on either side prior to curing. Then the pellets were cured for 40 seconds with visible light curing unit. The pellets of each restorative material were further subdivided into 3 groups containing 10 samples each for the bleaching regime [6]. (Fig 4).

The specimens for Micro hardness evaluation assigned for the bleaching regimes are shown in Table – 1 for Nano Composite group and Table – 2 for Nano Hybrid Composite group. Fig 5

Fig. 5: Composite pellets subjected to bleaching treatment before microhardness evaluation

Fig. 6: Microhardness testing unit

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 [15]. 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) 0.4g, Calcium chloride ($CaCl_2.H_2O$) 0.795 g, Sodium-dihydrogen Phosphate ($NaH_2PO_4.H_2O$) 0.69 g, Sodium sulphide ($Na_2S.9H_2O$) 0.005 g and distilled water 1000 ml. The pH was adjusted to 7 [6].

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 Micro hardness samples, custom made trays were used wherein a drop of bleaching gel was applied in ten areas within the tray and the pellets were placed within the applied area. Fig 3

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 [6].

Study of Micro hardness

After two weeks of treatment, experimental and the control specimens were analyzed in a Micro hardness meter. Fig 6

Measurements were expressed as mean ± 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 micro hardness of the specimen were calculated using the formulae

FORMULAE = 'a' x 0.05 + 'b' x 0.001
Where,
Value of 'a' division = 0.05mm
Value of 'b' division= 0.001mm

The values obtained were expressed in V.H.N (Vickers hardness number).

Table – 3 indicates the comparison of Microhardness between Nanocomposite and Nanohybrid composite

The Microhardness of Nanocomposite and Nanohybrid Composite were reduced when it was treated with 10% and 21% bleaching agent.
To compare the two materials and the role of bleaching agents, 2x3 ANOVA test had been applied. The test results are shown in Table – 4.

Table 1: Nano Composite group

Group	Micro hardness
Control	*T1(10* Samples)
10% Carbamide Peroxide	*T2(10* Samples)
21% Carbamide Peroxide	*T3(10* Samples)

Table 2: Nano Hybrid Composite group

Group	Micro hardness
Control	T4*(10* Samples)
10% Carbamide Peroxide	T5*(10* Samples)
21% Carbamide Peroxide	T6*(10* Samples)

Table 3: comparision of microhardness between nanocomposite and hybrid composite

Sr. No	Material	Group	Range (vhn)	Mean (vhn)	SD
1	Nanocomposite	P1	40.1-46.0	42.800	2.213
		P2	35.3-41.8	37.930	2.098
		P3	33.2-37.6	35.490	1.464
2	Nanohybrid Composite	P4	51.6-59.3	55.100	2.485
		P5	43.5-52.4	47.970	3.047
		P6	37.1-50.1	42.560	4.419

Table 4: (2x3 ANOVA Test results)

No	Source	F-value	P-value
1	Material	186.297	0.000
2	Group	64.577	0.000
3	Material and group	4.446	0.016

The results consist of 3 comparisons.

Comparison 1- deals with material wise comparison (Table – 3)
Comparison 2 -deals with the group wise comparison (Table – 4)
Comparison 3- deals with the interaction effect- material and group wise comparison (Table – 5)
Tukey's Honestly-Significant-Difference Test

Table 5: Tukey's honestly-significant-difference test

Sample	Material and Group	Mean Difference	P-Value
1	Nanocomposite (p1)-nanocomposite (p2)	4.870	0.003**(S)**
2	Nanocomposite (p1)-nanocomposite (p3)	7.310	0.000**(S)**
3	Nanocomposite (p1)-nanohybrid (p4)	-12.300	0.000**(S)**
4	Nanocomposite (p1)-nanohybrid (p5)	-5.170	0.002**(S)**
5	Nanocomposite (p1)-nanohybrid (p6)	0.240	1.000**(NS)**
6	Nanocomposite (p2)-nanocomposite (p3)	2.440	0.378**(NS)**
7	Nanocomposite (p2)-nanonhybrid (p4)	-17.170	0.000**(S)**
8	Nanocomposite (p2)-nanohybrid (p5)	-10.040	0.000**(S)**
9	Nanocomposite (p2)-nanohybrid (p6)	-4.630	0.006**(S)**
10	Nanocomposite (p3)-nanohybrid (p4)	-19.610	0.000**(S)**
11	Nanocomposite (p3)-nanohybrid (p5)	-12.480	0.000**(S)**
12	Nanocomposite (p3)-nanohybrid (p6)	-7.070	0.000**(S)**
13	Nanohybrid (p4)-nanohybrid (p5)	7.130	0.000**(S)**
14	Nanohybrid (p4) -nanohybrid (p6)	12.540	0.000**(S)**
15	Nanohybrid (p5) -nanohybrid (p6)	5.410	0.001**(S)**

Significant (S); P >0.05, Insignificant (NS).

Material comparison:

The significant 'p' value of the material comparison infers that the two materials were statistically different. In general the nano hybrid materials were better than the Nano Composite.

When the pellets were treated by Nano hybrid material and 21% bleaching agent the Micro hardness were reduced compared to the Nano hybrid material alone and Nano hybrid material with 10% bleaching agent.

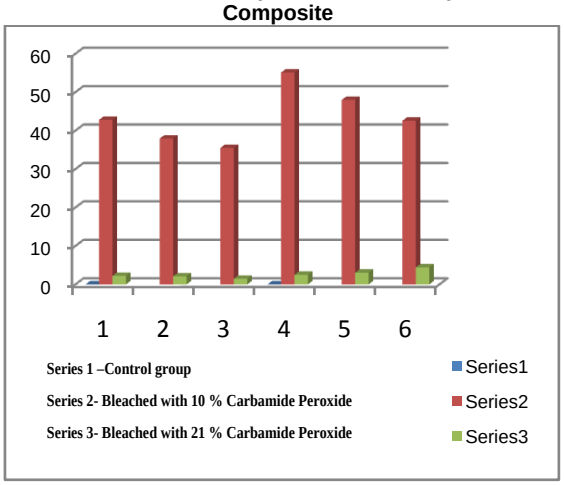
Graph 1.Comparison of Micro hardness strength between Nano-Composite and Nano-Hybrid Composite

DISCUSSION

In a study it was reported the first tooth whitening technique using hydrochloric acid (HCl). Since that time, numerous workers reported tooth whitening with a variety of chemicals, some with the application of heat. In 1895, Garretson used chlorine as part of his treatment [8].

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 Micro hardness of Nano composites and Nano hybrid composite restorative materials.

Graph 1: Comparison of Microhardness strength between Nano-Composite and Nano-Hybrid Composite



The importance of this 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 [9]. Exposure to high levels of fluoride, tetracycline administration, inherited developmental disorders, and trauma to the developing tooth may result in pre - eruptive discoloration. In the past, the demand for Aesthetic Dentistry has dramatically grown and so has the rapid development of new non restorative treatment for dis-coloured teeth. Bleaching is a conservative treatment alternative for discoloured teeth [6].

Since enamel and dentin are porous tissues, the scientific basis for bleaching vital teeth is sound [10]. 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 [6].

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 [9]. 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 [11]. 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 [7]. 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 [6].

Hardness is defined as the resistance of a material to indentation or penetration. As hardness is related to a material’s strength, proportional limit and its ability to abrade or to be abraded by opposing dental structures/materials, any chemical softening resulting from bleaching has implications on the clinical durability of restorations [12]. Surface deterioration of Nano Composite and Nano Hybrid Composite restorative materials bleached with Carbamide peroxide were evaluated. The restorative materials were placed in a brass mold which ensured standardization of the shape and size of each pellet. The setting material were covered with matrix strips on either side to avoid early moisture contamination and was held under constant hand pressure using glass slabs on either side in order to obtain polished surface. This polished flattened surface was essential to prevent distorted indentation for hardness measurement on any material [14]. The VHN for each pellet was evaluated using surface micro hardness tester (Zwick 3212, GERMANY). Vickers hardness measurements fulfill the requirements of the standard test method of materials as defined by American society for testing and materials [13]. The Micro hardness tester was standardized prior to Indentation on each pellet. The testing parameter of 25 gms for 20 seconds initiated no cracks on the surface of the material, thereby providing a size of indentation that allow measurement of surface hardness of these materials. The results of this study showed that the Composite restorative materials when submitted to bleaching with Carbamide peroxide gel at 10% and 21% showed significant reduction in hardness when compared to the control group, which was stored in artificial saliva [6].

In this study when the pellet were treated by Nano composite material and 21% bleaching agent the Micro hardness were reduced compared to the Nano Composite alone and Nano Composite with 10% bleaching agent.
When the pellets were treated by Nano Hybrid material and 21% bleaching agent the Micro hardness were reduced compared to the Nano Hybrid material alone and Nano hybrid material with 10% bleaching agent.

In this study, although there were reduction in microhardness 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 insignificant.

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 [6].

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 [6].

Gingival irritation is another possible side effect that occurs when the bleaching solution comes in contact with the gums [6].

Gastro-intestinal irritation can also occur, mainly with at-home bleaching systems that are worn over night [6].

In a study it was concluded that greater concentrations of Carbamide Peroxide involve lower values of Micro hardness for the materials Charisma, Vitremer, and Permite C. It may be supposed that the increase in the concentration of the gel raises the quantity of Hydrogen Peroxide released, which may lead to greater degradation in the structure of the materials. A reduction of the Micro hardness of the enamel and dentin was reported when treated with hydrogen peroxide at 30%.It was suggested that high concentrations of hydrogen peroxide should be avoided [15].

In a study it was investigated that there had been no consensus on the effect of peroxide bleaches on Composite resin restorative materials. Bailey and Swift reported a significant reduction in hardness, but Burger and Cooley recorded significant increase in hardness. Friend *et al*. reported an elevation in tensile strength that might be expected to parallel Burger’s results [16].

CONCLUSION

Following conclusions were drawn from the study: -
There was a significant reduction in the Micro hardness of restorative materials observed after

exposure to Carbamide Peroxide agents under a clinically simulated bleaching regimen. This had clinical implications on post-treatment out comes Carbamide peroxide bleaching gel at concentrations 10% and 21% caused a reduction in hardness of Composite.

In general the Micro hardness of Nano Hybrid material was better than the Nano Composite.

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

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