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IMPACT OF POLISHING ON THE SURFACE MICROHARDNESS OF A NANOHYBRID COMPOSITE TREATED WITH 22% CARBAMIDE PEROXIDE: AN IN-VITRO STUDY

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ABSTRACT

AIM: To evaluate the in vitro effect of polishing on the surface microhardness of nanohybrid composite resins that were subjected to bleaching procedure with 22% Carbamide peroxide. **Materials and Methods:** Thirty standardized nanohybrid composite resin samples (6 mm × 6 mm) were divided into two groups: Group A (experimental, 15 samples) and Group B (control, 15 samples). A celluloid matrix and a 1 mm microscope slide were used to ensure surface parallelism before light-curing the resin. After being stored at 37°C for 24 hours, the samples were treated with a 22% carbamide peroxide bleaching agent for 4-5 applications of 60 minutes each, followed by rinsing and drying. After 24 hours, Group A was polished using A.S.A.P All Surface Access Polishers, while Group B remained unpolished. The samples were then stored in distilled water at 37°C for another 24 hours. Surface microhardness was tested using a Vickers Hardness tester with five indentations per sample under a 100 g-f load for 10 seconds. Data were recorded in Excel and analyzed with SPSS. **Results:** After bleaching with 22% carbamide peroxide gel in both groups, the nanohybrid composite resin group with polishing (experimental) presented significantly higher surface microhardness than the nanohybrid composite resin group without polishing (control) (P<0.001) **Conclusion:** Nanohybrid composite resins pre-treated with 35% hydrogen peroxide gel demonstrated a significant enhancement in surface microhardness following polishing, in comparison to unpolished nanohybrid composite resins.

KEYWORDS : Carbamide peroxide, Nanohybrid composite resins, Surface microhardness, Polishing.

INTRODUCTION

In the early 1960s, Dr. Rafael Bowen developed and introduced composite resin into dentistry.[1] The bonding ability of composite resin to tooth structure was first researched and reported by Oskar Hagger[2] and then by Michael Buonocore.[3] The increased demand for nanohybrid composite resins is attributed to their exceptional biocompatibility and physical characteristics, including enhanced wear resistance and surface microhardness, which contribute to achieving aesthetic perfection[4,5].

Surface microhardness is defined as resistance of a material to indentation or penetration and plays a key role in clinical success of dental restorations. The polishing aims to improve surface microhardness by eliminating rough surfaces, suppressing pigment retention and formation of secondary caries[6-8].

Tooth bleaching has become one of the most successful and well-accepted aesthetic dental treatments over the past decades with success rate of 79%. 22% carbamide peroxide (CP) is relatively highly concentrated bleaching gel which provides effective teeth whitening results in short amount of time. Various studies reported that bleaching agents might change the properties of restorative materials, such as color, surface and subsurface microhardness, surface roughness, and surface topography[9,10].

Considering the lack of evidence regarding effect of exposure of enamel to 22% carbamide peroxide gel, this study aimed to evaluate the effectiveness of polishing on the surface microhardness of nanohybrid composite resin treated with bleaching agent.

Aim Of The Study

To evaluate the in vitro effect of polishing on the surface microhardness of nanohybrid composite resins that were subjected to bleaching procedure with 22% Carbamide peroxide.

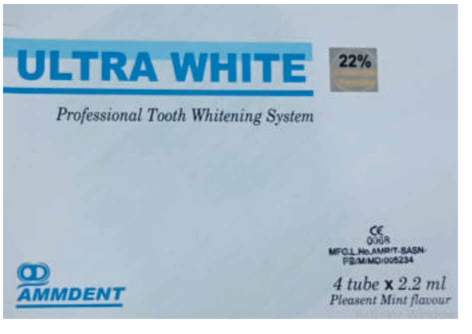
Objectives Of The Study

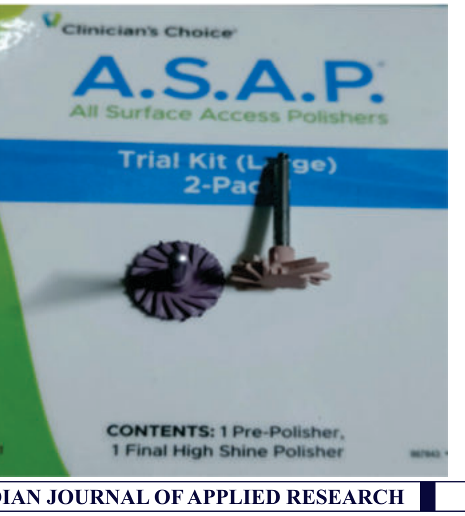
- To examine and compare the microhardness of polished nanohybrid composite resins that were previously treated with 22% Carbamide peroxide bleaching gel.
- To examine and compare the microhardness of unpolished nanohybrid composite resins that were previously treated with 22% Carbamide peroxide bleaching gel.

MATERIALS AND METHOD

Armamentarium and Material

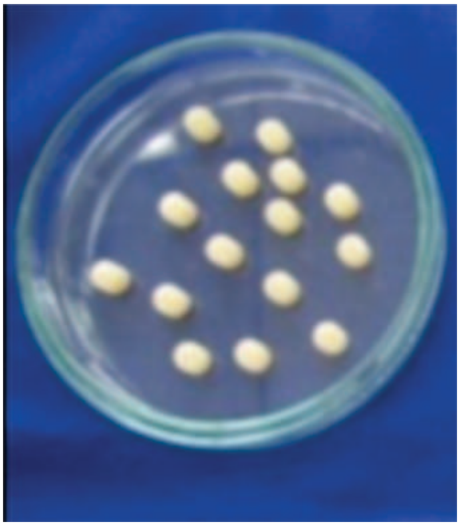
- Nanohybrid Composite Resin (Tetric N-Ceram, Ivoclair vivadent), Shade A2
- Standardized molds (6 mm*6 mm)
- Microscope slide
- Celluloid matrix
- 22% Carbamide peroxide gel (Ultra White, Ammdent)
- A.S.A.P All Surface Access Polishers (Clinicians choice)
- Light cure
- Micromotor





METHODOLOGY

Thirty standardized nanohybrid composite resin samples (6 mm height × 6 mm diameter) were prepared and divided into two groups: Group A (experimental group, n=15) and Group B (control group, n=15). A celluloid matrix was positioned over each mold, and a 1 mm thick microscope slide was placed on top to ensure parallelism between the upper and lower surfaces. The resin layers were then light-cured from the top. Following polymerization, the samples were stored at 37°C in an oven for 24 hours.



The next day, all specimens were subjected to surface treatment with a 22% carbamide peroxide bleaching agent, applied 4-5 times for 60 minutes per application, as per the manufacturer's instructions. After each application, the samples were rinsed with distilled water and dried with sterile gauze. After an additional 24 hours, Group A underwent polishing using the A.S.A.P All Surface Access Polishing system, progressing from the pre-polisher to the final high-shine polisher, whereas Group B remained unpolished.

Subsequently, all samples were stored in distilled water at 37°C for another 24 hours. Surface microhardness testing was performed using a Vickers Hardness tester, with each sample subjected to five indentations under a load of 100 g-f for 10 seconds. The resulting data were recorded in an Excel 2016 spreadsheet and then imported into SPSS software for statistical analysis.

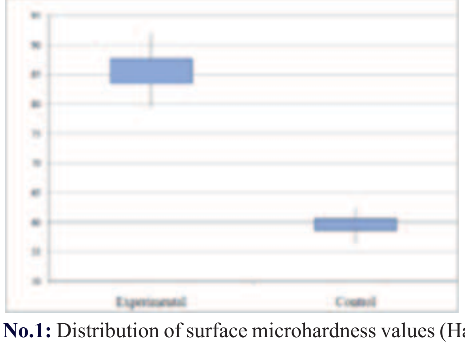
RESULTS:

Table No.1: Descriptive values of surface microhardness of the nanohybrid composite according to the study groups

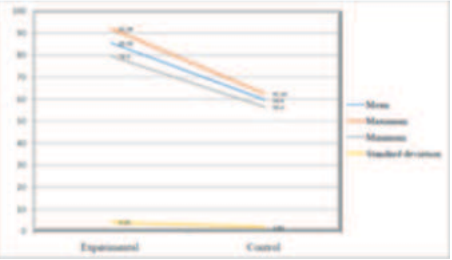
Groups	N	Mean	Standard deviation	95% Confidence Interval of the Mean		Maxi-mum	Mini-mum	*p value
Experi-mental	15	85.58	4.16	83.47	87.68	92.06	79.50	<0.01 **
Control	15	59.60	1.92	58.62	60.57	62.44	56.40	

* Student's t-test for independent samples.

**p value <0.01 was considered statistically very significant.



Graph No.1: Distribution of surface microhardness values (Hardness Vickers) of the nanohybrid composite after bleaching with and without polishing



Graph No.2: Analysis of surface microhardness values (Hardness Vickers) of the nanohybrid composite after bleaching with polishing (Experimental group) and without polishing (Control group)

The results indicate a significant difference in surface microhardness between the experimental and control groups. The experimental group, which was polished after bleaching, exhibited a considerably higher mean surface microhardness (85.58) compared to the control group (59.60), which was not polished. The difference in microhardness between the two groups was statistically very significant, as demonstrated by the p-value of <0.01. This suggests that polishing the nanohybrid composite resin after bleaching significantly improves its surface microhardness, enhancing its durability and resistance to surface wear.

DISCUSSION

Advances in the field of restorative dentistry together with the aesthetic needs of patients have inevitably promoted the application of conservative, simple, relatively fast, and efficient alternative techniques, such as dental bleaching.

Soares et al.[11] reported that hydrogen peroxide-based bleaching agents act as powerful oxidants, releasing reactive free radicals that degrade the composite resin matrix. This leads to the separation of polymer chains, making the resin's surface and deeper layers more vulnerable, which compromises the material's durability and clinical success. Similarly, Esmaeili et al.[12] explained that these bleaching agents oxidize dentin molecules, altering color. Overall, the oxidation process interferes with the resin's organic matrix, promoting water absorption, particle loss, and surface changes, resulting in decreased surface microhardness.

Various studies states that the oxidation reaction caused by the hydrogen peroxide based bleaching agent interferes with the structural integration of composite resins, mainly influencing their organic matrix, facilitating water absorption and particle loss, causing an alteration of the interface between the filler and the matrix, which would affect the topography of the resin surface and thus cause a decrease in the surface microhardness.

A study by Raja Rajeswari Kaminedi, et, al[13] in 2015 concluded that immediate finishing and polishing under coolant resulted in the best surface smoothness and hardness values in micro hybrid composite; however, immediate dry finishing and polishing gave the best smoothness and hardness values in nanohybrid composite. Also, another study by Negin Nasoohi, et, al[14] in 2017 revealed that dry finishing and polishing increases the microhardness and surface roughness of microhybrid and nanohybrid composite resins.

Suárez and Lozano[8] reported that composite resin polishing can provide a smoother and more resistant surface to deformation and if it is performed after 24 h of its photopolymerization, the surface microhardness values of the nanohybrid composite resins increase significantly. For this reason, in the present study, it was decided to polish the nanohybrid composite resin of the experimental group after 24 h of applying the bleaching agent.

Nanohybrid composite resins were considered as the unit of analysis because the type, particle size, monomer composition, and filler content play a critical role in their clinical behavior. The higher inorganic filler loading justifies better performance in microhardness tests.[15]

The results of this study revealed a statistically significant difference in surface microhardness between the experimental and control groups. The experimental group demonstrated a markedly higher mean microhardness (85.58) compared to the control group (59.60), with a p-value of <0.01. This indicates that the treatment applied to the experimental group resulted in a significant enhancement in the surface microhardness of the nanohybrid composite. This aligns with the study by Giovanna Gisella Ramírez-Vargas et al.[16] in 2021, which concluded that nanohybrid composite resins treated with 35% hydrogen peroxide gel showed a significant increase in surface microhardness after polishing, compared to unpolished nanohybrid composite resins.

As a limitation of this study, it is recognized that the results obtained cannot be reliably extrapolated to the clinical field, since the design of this research was in vitro. For this reason, it is advisable to perform randomized clinical trials related to the objective stated here. In addition, more comparative studies with the same proposed design involving microhybrid, incremental nanohybrid, and nanotechnology (Bulk Fill) composite resins are needed.

Hence, the results of this study suggest an alternative to improve the surface microhardness of nanohybrid composite resins by polishing that were previously subjected to bleaching process.

CONCLUSION

Within the limitations of the present in-vitro study, nanohybrid composite resins previously subjected to 22% carbamide peroxide gel significantly increased their surface microhardness when subjected to polishing treatment, unlike those that were not polished.

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