# COMPARATIVE EVALUATION OF EFFECTS OF TWO DIFFERENT BLEACHING REGIMENS ON FLEXURAL STRENGTH OF NANOHYBRID AND MICROHYBRID COMPOSITE RESINS: AN IN-VITRO STUDY

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**Abstract**

**Aim-** The aim of this study was to evaluate and compare the effects of At-home bleaching and In-office bleaching on the flexural strength of commercially available Nanohybrid and Microhybrid composite resins.

**Methodology-** A total of 60 samples of nanohybrid composite (n = 30) and microhybrid composite (n = 30) of standardized dimensions were prepared. The prepared samples were finished, polished and further stored in artificial saliva for 24 hours at 37ºC. According to the bleaching process, the samples were divided into three groups: Group A (Control); Group B (At-home bleaching) and Group C (In-office bleaching). Each group was divided into two subgroups according to composite used as: Sub-group 1 (Nanohybrid) and Sub-group 2 (Microhybrid). The samples, 20 from each group (10 from each sub-group) were examined to evaluate the flexural strength. The collected data were tabulated and statistical analysis was performed.

**Result-** A statistically significant reduction in flexural strength was observed for the nanohybrid composite when Group $A_1$ (Control) (186.41+15.10) was compared with Group $B_1$ (At-home) (137.27+14.17) and Group $C_1$ (In-office) (143.65+11.20). For the microhybrid composite, there was a statistically significant difference seen for flexural strength when Group $C_2$ (In-office) (174.78+21.89) was compared with Group $A_2$ (Control) (136.83+13.24) and Group $B_2$ (At-home) (151.90+17.79).

**Conclusion-** Flexural strength was seen best for unbleached nanohybrid composite, whereas for microhybrid composite, in-office group exhibited highest flexural strength followed by at-home group.

**Keywords:** Flexural strength, Nanohybrid composite, Microhybrid composite, At-home bleaching agent, In-office bleaching agent

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## INTRODUCTION

The esthetic goals of the patients and the esthetic aspects of dentistry today have become increasingly demanding.[1] Several aspects such as change in the texture, form, position and color of teeth can alter the smile.[2] With the growing awareness of aesthetic available options, there is more need for alternatives to unaesthetic concerns such as tooth discoloration, fluorosis, etc. Since tooth whitening is an inexpensive and widely used method, many patients prefer it to enhance the aesthetics of their teeth.[3]

The primary bleaching agents are based on hydrogen peroxide or one of its byproducts, such as carbamide peroxide. Three categories of peroxide-containing tooth whitening products are available: professional in-office agents, professionally supervised agents for patients to use at home and over-the-counter (OTC) bleaching solutions.[4] During the bleaching process, carbamide peroxide breaks down into hydrogen peroxide and urea. The hydrogen peroxide diffuses through enamel and dentin and breaks macromolecules of the stains into smaller fragments, which are lighter in color, resulting in the bleaching effect.[5]

Vital tooth bleaching procedures do not cause evident macroscopic defects. However, the results of several investigations have shown that the use of tooth whitening chemicals causes microstructural alterations in tooth structure and dental materials. It has been reported that the polymer chains and double bonds of composite resins as well as the organic matrix of glass-ionomers are affected by the free radicals produced from these agents during the bleaching procedure.[3]

Resin composites greatly differ from each other in terms of their composition, characteristics of their inorganic filler, which is known to influence the viscosity and handling of the material, as well as its physical properties, hence affecting the clinical performance of the restoration.

The composite strength is maximized when a substantial amount of evenly dispersed filler particles is embedded in the resin matrix. Resin-based composites are usually classified according to their filler characteristics, such as chemical composition, shape, and especially particle size.[6] Hybrid composites, as the name suggests, were developed in an attempt to get a combination of better properties with better surface finish, so that they retain the good mechanical properties of small particle-filled composite and at the same time provide better surface smoothness. Because of their improved properties and better finish, they can be used for a wide range of applications in both anterior and posterior teeth.[7]

This study was conducted to evaluate and compare the effect of at-home and in-office bleaching regimens on flexural strength of nanohybrid and microhybrid composite resins.

## MATERIALS AND METHOD

This in-vitro study was conducted at the Department of Conservative Dentistry & Endodontics, Darshan Dental College and Hospital, Udaipur (Raj.), Rahul Engineers Laboratory, Udaipur (Raj.) and S. N. Heat Treatment Pvt. Ltd. Aurangabad, Maharashtra, India. Sixty cuboidal samples of nanohybrid (Filtek Z250; 3M ESPE) (n = 30) and microhybrid (G-Aenial; GC) (n = 30) composite resins were prepared using a split metal mold with dimensions (2±0.1) mm x (2±0.1) mm x (25±0.2) mm according to ISO 4049/2000 specification for flexural strength evaluation.

The samples were prepared by placing the mold onto a mylar strip placed on a glass slab. The mold was condensed with the composite resin and the mylar strip was placed on the top and a constant pressure was applied using a glass slide to remove the excess material. The samples were then light polymerized using LED curing light (Satelec) and polished using Super Snap Rainbow Technique Kit (Shofu).

After preparing all the samples, the two groups (nanohybrid and microhybrid) were divided into three subgroups according to the bleaching protocol:

**Group A: Control group (n = 20)** - No bleaching was done for this group. The samples were placed in artificial saliva for two weeks at 37°C.

**Group B: At-home bleaching (n = 20)** - The samples were bleached using 10% carbamide peroxide (Opalescence Regular 10%). The bleaching agent was applied on one surface of the sample for 8 hours. The bleached samples were then washed with distilled water and stored in artificial saliva at 37°C until the next bleaching session. The procedure was repeated daily for 2 weeks.

**Group C: In-office bleaching (n = 20)** - The samples of this group were bleached using 40% hydrogen peroxide (Opalescence Boost 40%). The bleaching agent was applied on one surface of the sample for 8 minutes. The samples were then washed with distilled water. The procedure was done in 2 sessions, one week apart, three times in each session. The samples were stored in artificial saliva between each bleaching session at 37°C.

All the treated samples were subjected to a 3-point-bending test using an Instron Testing Machine (Instron 4302, Instron Corporation, England) at a crosshead speed of 1.25 mm/min until the sample fractured. The load cell was 2.5kN. The maximum load exerted on each sample was recorded and the flexural strength, σ, was calculated in MPa from the following equation:

$$\sigma = 3FL / 2BH^2$$

where, F is the maximum load, in Newton, exerted on the specimen; L is the distance, in mm, between the supports; B is the width, in mm, of the sample measured immediately prior to testing and H is the height of the sample, in mm measured immediately prior to testing.

## RESULTS

The data obtained was tabulated and statistically analyzed using SPSS software V.21.0. Effect of bleaching agents on the flexural strength and microhardness of Nanohybrid and Microhybrid composite was analyzed using Two-way ANOVA followed by Tukey's post hoc test. p value was set for $p < 0.05$ and any value more than this was considered to be non-significant.

Table 1 - Independent t test comparing Nanohybrid and Microhybrid Composite for Flexural Strength

| Groups | | N | Mean | Std. Deviation | Std. Error Mean | Mean Difference | t | p value |
|---|---|---|---|---|---|---|---|---|
| Group A-Control | Nano hybrid | 10 | 186.410 | 15.099 | 4.775 | -49.580 | 7.807 | 0.000 |
| | Micro hybrid | 10 | 136.830 | 13.242 | 4.188 | | | |
| Group B-At-home | Nano hybrid | 10 | 137.270 | 14.170 | 4.481 | 14.630 | 2.034 | 0.057 |
| | Micro hybrid | 10 | 151.900 | 17.791 | 5.626 | | | |
| Group C-In-office | Nano hybrid | 10 | 143.650 | 11.201 | 3.542 | 31.130 | 4.003 | 0.001 |
| | Micro hybrid | 10 | 174.780 | 21.894 | 6.924 | | | |

From the above table, following inference can be drawn:
There was statistically significant difference seen for flexural strength between Nanohybrid and Microhybrid composites except for Group B (At-home).

## DISCUSSION

Since being introduced by Haywood and Heymann, the use of whitening treatments to enhance the appearance of natural dentition has gained popularity. Currently, hydrogen peroxide (HP) or its derivatives, such as carbamide peroxide (CP), are the main components of bleaching agents. The bleaching agents lighten tooth structure by converting peroxides into unstable free radical. These radicals either undergo an oxidation or a reduction reaction to break down the large pigmented molecules. The oxidation/reduction process alters the chemical structure of the interlinked organic components in teeth, changing their colour. However, the use of bleaching treatments can affect restorative materials and human teeth.[8]

Since their introduction in the 1960s, composites have undergone a lot of evolution that resulted in the development of their different types. The presently available composites differ in their composition through a difference in organic chemistry and size, type and a loading volume of filler particles.[9] Dental composite resins can be used for all types of cavities both in anterior and posterior restorations. The type, size and volume of fillers that affect the handling characteristics and physical properties of composites. These resin materials have progressed from macrofills to microfills and from hybrids to microhybrids.[10]

In this study, nanohybrid and microhybrid composite resins were used as nanohybrid composites provide clinical success with their attractive appearance and durability and biocompatibility, physical properties such as increased wear resistance and surface hardness, as they consist of nanoparticles, whereas, microhybrid composites are successfully used in anterior and posterior teeth due to their physical and mechanical properties.[11]
In this study, 10% carbamide peroxide (Opalescence Regular) was used which is a well-accepted agent for home-use bleaching supervised by dentist. In the past, a 10% carbamide peroxide was considered as the standard product for the

home-use bleaching technique. The gel was applied to the external surfaces of the teeth using a customized tray.

The main advantages of the home-use technique are the ease of use, reduced chair time and a low incidence of tooth sensitivity and gingival irritation. However, the in-office technique has emerged as more popular than home use because highly concentrated products may promote faster tooth whitening (the higher the bleaching solution concentration, the more quickly a shade change will occur).[12]

Another bleaching agent used in this study was 40% hydrogen peroxide (Opalescence Boost). Depending on the temperature, pH, light, co-catalysts, presence of transitional metals and other factors, it can produce various active oxygen species. As an oxidising agent, hydrogen peroxide has the capability to produce the free radicals $HO_2$ and O. The free radical $HO_2$ of perhydroxyl is highly reactive. This may degrade macromolecular stains into smaller stain molecules. Along with the protein matrix, it is also believed to adhere to the molecular stain in the inorganic structure. Eventually, the free radicals unite to form water and molecular oxygen.[2]

Due to its lower standard deviation, coefficient of variation and less complex crack distribution, the three-point bending test is still a suitable option for determining the flexural strength of composite materials. Chung et al in their study had concluded that a three-point bending test would give out better mechanical evaluation of the dental materials. The literature stated that the three-point bending tests could better reproduce the complex forces acting on a restoration, hence, the three-point bending test was applied in present study.[13]

The bleaching agent acts on organic or inorganic structure of the composites. It is speculated that the high oxidative capacity of bleaching agents in contact with organic molecules would be able to damage the polymeric linkages that form the composite structure, making the composite more susceptible to degradation. Moreover, alterations in the inorganic phase could lead to a reduction in material properties.[14]

The results in this study showed highest flexural strength of control group (186.41+15.10) for nanohybrid composite. In-office group (143.65+11.20) showed slightly higher flexural strength as compared to at-home group (137.27+14.17), however, the difference was non-significant. Bleaching agents release peroxides, which diffuse and produce free radicals, which then trigger an oxidation and reduction reaction. These peroxides may cause the oxidative cleavage of polymer chains in composite resins, weakening the resin matrix and making the unreacted double bonds the most vulnerable regions of the polymers. Free radicals may also affect the resin-filler interface, resulting in a filler-matrix debonding that leads to microscopic cracks and a reduction in flexural strength.[15]

For the microhybrid composite, In-office group showed highest flexural strength (174.78+21.89), whereas control group exhibited least flexural strength (136.83+13.24). This could be due to the softening of resin matrix of the composite resin resulting in increase in the flexural strength.[3]

In this study, when flexural strength of bleached nanohybrid and microhybrid was compared, microhybrid (163.34+22.68) composite resin exhibited higher flexural strength as compared to nanohybrid (140.46+12.85). It can be due to the resin matrix of composites. Filtek Z250 has bis-GMA, UDMA, bis-EMA, PEGDMA and TEGDMA which might have resulted in higher flexural strength than G-Aenial which is a bis-GMA free composite resin.[16]

## CONCLUSION

Thus, within the limitations of the present study, it was concluded that unbleached samples (Control group) of nanohybrid composite exhibited highest flexural strength, whereas for microhybrid composite, in- office group showed highest flexural strength.

## CONFLICTS OF INTEREST

Authors declare that there are no conflicts of interest.

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