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Comparative evaluation of the effect of diode laser bleaching and led activated bleaching against chemical bleaching on color and micro leakage of class 5 restoration with nano hybrid composites an *in vitro* study

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Abstract
Context: The effect of bleaching on tooth coloured restorative materials remains controversial, in terms of colour and tooth restoration interfaces. Few studies investigated affirming the action of different light sources used as an adjunct to in-office bleaching and its effect on recently introduced resin based composite restorations. This study focuses on the behaviour of nano hybrid composite exposed to Diode laser and LED bleaching techniques.
Aims: The purpose of this *in vitro* study is to compare and evaluate the effect of Diode Laser and LED activated bleaching on colour and micro leakage of nano hybrid composites in Class V cavities.
Methods and Material: Standardized Class V cavities were prepared on fifty freshly extracted human first maxillary premolar teeth, and restored with nano hybrid composite (Tetric N-Ceram). The samples were randomly divided into three groups and bleaching agent used is 40% Opalescence Boost (Ultradent) in all the three groups. Group 1 was activated with Diode laser (Picasso), Group 2 was activated with a blue hybrid LED (Bluephase) and Group 3 did not receive any light activation. Group 4- control group (unbleached restoration n=5). Restoration colour was measured before bleaching and after bleaching using VITA Compact Easy shade spectrophotometer and CIELAB values of ΔE, Δa^*, Δb^* and ΔL^* were obtained. The same samples with the control group were subsequently immersed in dye solution of 2% Methylene blue and subsequently dye extraction technique was used to evaluate the micro leakage using spectrophotometer.
Statistical analysis used: The results were subjected to ANOVA, Tukey and HSD tests ($p \leq 0.05$).
Results: There was clinically perceptible change in colour ($\Delta E > 3.3$) in all the three groups. One-way ANOVA indicated no statistical difference in colour difference ($p \leq 0.05$) among the groups bleached with Diode laser, LED and chemical bleaching techniques. One-way ANOVA indicated statistical difference in micro leakage ($p \leq 0.05$) among the groups bleached with Diode laser, LED and chemical bleaching techniques and the unbleached control group. Nevertheless LED activated bleaching showed greater colour changes and least micro leakage as compared to other groups.
Conclusions: Activation of various light sources (Diode/LED) resulted in shorter duration and effective in-office bleaching. However, it may exert a negative influence on colour stability and micro leakage of Nano hybrid composites and can result in restoration failures.

Keywords: CIELAB, reflectance spectrophotometer, power bleaching, micro leakage

Introduction
Tooth whitening became largely used with the introduction of a whitening gel by Haywood and Heymann in 1989 [1], which enabled the use of bleaching agents at home originating the popular home bleaching technique [2, 3]. The latest development of power bleaching has resulted in easy to use bleaching agents using highly concentrated Hydrogen peroxide mixed with thickening agents or additional buffering agents catalyst or colouring agents [4, 5].
There are several different types of irradiation sources in use to accelerate the in office bleaching procedure [6, 7]. These techniques, using coherent [8, 9] or incoherent [10] light sources, have the advantage of being quick and convenient.

Among the newest irradiation devices are light emitting diodes (LEDs) [11] and diode lasers. Both are extremely compact devices when compared to plasma arc lamps, very efficient and therefore, need no moving, noisy parts like ventilators or refrigeration pumps [12].

Despite the advantages offered by bleaching the effect of bleaching agent on dental hard tissue is rather controversial. The most commonly reported side effects are gingival or mucosal irritation and tooth sensitivity. Tooth sensitivity is by far the most common side effects reported. Studies have reported that sensitivity occurs in 55% to 75% of the treatment groups [2, 3]. Another consideration with tooth whitening is the effects it had on enamel and dentin. Some studies have shown morphological alteration on bleached enamel, thus suggesting an erosive process causing changes in porosity and surface morphology of enamel. A majority of studies however have indicated that hydrogen peroxide and carbamide peroxide containing products had no significant deleterious effects on enamel and dentine surface microhardness [2, 13].

Colourimetry is a branch of science of colour based on digital expression of colour perceived from the object, Human evaluation of dental tooth shade is prone to suffer influence from environmental and physical variables like ambient light, differences in the number of cones and rods within the retina of the eye and many others [14]. Micro leakage has long been recognized as a major problem in restorative dentistry. Micro leakage may cause marginal discoloration [33] hypersensitivity, recurrent caries and pulpal pathosis. Hence, the analysis of the interface between the enamel and restorative materials after dental bleaching is fundamental, considering that the quality of this interface is of great relevance to the longevity of the restorations [7].

The null hypothesis was that there would be no significant difference ($p \leq 0.05$), in the colour and microleakage on nano hybrid composites subjected to LED and Diode laser activated bleaching.

Subjects and Methods

Sixty human subjects from the outpatient unit of the department of conservative Dentistry and Endodontics, Dental College and Hospital, who were interested in tooth whitening procedure, were selected to take part in this clinical study. They were so selected were in good general health & they maintained good dental health & oral hygiene. Selection of subjects was done based on presence of the right unrestored maxillary central incisor which was initially of shade A3 or darker than A3 according to the value oriented Vita shade guide, After approval from local ethical committee all the subjects gave their written consent & completed medical history form. Thorough oral prophylaxis was carried out at least one week prior to starting the study. All subjects were asked to brush their teeth twice daily with allocated tooth brush & toothpaste in order to standardized tooth cleaning procedure during the study.

Two trained qualified examiner who were blind as to treatment assignment and period, measured the baseline tooth color by using the VITA shade guide on the facial surface of right maxillary central incisor., The tabs of shade guide were arranged in the value from lightness to darkness from B1 to C4 [B1, A1, B2, D2, A2, C1, C2, D4, A3, D3, B3, A3.5, B4, C3, A4, C4]. From lightest to darkest, each shade was given a numerical value ranking from 1 to 16, in which lower number means the tooth is lighter and higher number indicating tooth is dark.. After selection of the shade it was recorded in bleaching log sheet. Prior to starting study, a calibrating session was held to review shade matching using the VITA shade guide. Shade determination was always performed under same standard conditions

Results

- The colour changes (ΔE) among different bleaching techniques, when subjected to one way ANOVA and Tukeys HSD Test showed no statistically significant difference ($p>0.05$).
- The Luminosity (L) and Hue (b^*) (Blue - Yellow) was more with Diode laser bleaching technique and Hue (a^*) (Red-Green) was better with Chemical bleaching technique. LED Activated bleaching demonstrated significantly high values than other two groups for change in colour (ΔE).
- One way ANOVA and Tukeys Post Hoc HSD Test showed significant difference in micro leakage with post bleached and control group ($p \leq 0.05$), with least micro leakage associated with LED bleaching technique.

Discussion

Power bleaching or chair side techniques use intense light sources (Halogen, Laser, LED) to activate the bleaching agent and is completed in a single in-office appointment. As bleaching of teeth has become extremely popular, the effect of bleaching agents on aesthetic appearance of restorative materials must be considered since it may affect the colour match as well as the structural integrity of restoration. Questions have always been raised regarding the effect of bleaching agents especially on the colour and micro leakage of restorative materials [7].

Colour

A great variety of methods can be used to evaluate the efficacy of tooth bleaching can be used such as: colour scales, photographs, spectrophotometer and digital image analysis using specific software programs [15]. Spectrophotometers and colorimeters have been used to measure discoloration since they eliminate the subjective interpretation of visual colour comparison [16]. These spectrophotometers calculate the values of (CIE) L* a* b* systems and directly give the idea of shade.

In order to observe differences in colour along the axes L*(luminosity), a*(red-green hue) and b*(yellow-blue hue) according to the CIE Lab system, an evaluation of the numerical values for each of the axes separately was conducted.

When analysing (L*) the luminosity factor of the restorations, There was an increase in the L* factor in all study groups post bleaching though it was not statistically significant different ($p>0.05$). There was no variation in the luminosity specific to source of restorations. Although the highest numerical values were found in the Diode laser group (3.94) followed by the blue LED group (3.2).

Factor a* when calculated showed no statistically significant difference ($p>0.05$) among different bleaching techniques. The shift towards positive red axis was observed to be highest with chemical bleaching (0.91) [17].

The component b* (yellow chroma) is the most important indicator to affect bleaching [18]. It was observed in the study that the highest mean colour changes occurred with Diode laser (2.09) as compared to LED and chemical bleaching. Although it was not statistically significant. These findings were in agreement to Sedighe *et al*. evaluating the effect of colour with 40% hydrogen peroxide bleaching on composite restoration.

ΔE value has been correlated within limits of human detection whereby few studies have suggested that normal eye can

perceive a colour difference unit greater than 1 and more than 3.3 considered clinically unacceptable [20]. It was observed that all the restorations had values above 3.3 which is more than clinical perception, enabling the detection of whitening effect of bleaching techniques. There was marginal though not statistically significant difference in ΔE values with LED (7.1) bleaching than other two groups. This may be attributed to the carotene pigment contained in Opalescence Boost bleaching agent which has its absorption peak at the emission wavelength of the LED (λ 470nm) and, therefore, efficiently absorbing the LED radiation [5]. The results are in line with those of Monaghan *et al*. who evaluated vital bleaching with 30% H_2O_2 and found significant colour change (ΔE>3), with composite restorations [21]. Simone *et al*. compared the colour change of nano filled composite with different concentration of hydrogen peroxide and concluded that there was no significant alteration of colour bleaching and no replacement of restoration was required post bleaching [22]. Sedighe *et al*. found no significant difference in colour change (ΔE) of microhybrid and nano filled composites although silorane based composite restorations more colour stability when exposed to (40% H_2O_2) Oplascence Boost [23]. Thus the first null hypothesis that Diode laser, LED activated bleaching & chemical bleaching would have no significant colour change with nano hybrid composite was accepted.

Micro leakage

Measuring the quantum of micro leakage represents one of the most important ways of comparing the adequacy of restorative materials [1, 24, 25]. Several methods have been advocated for evaluating micro leakage like dye penetration, fluid filtration, electro chemical micro leakage, bacterial micro leakage, dye extraction method. The dye penetration method is the most widely used for the micro leakage studies.

The findings are in agreement with those of Bektas *et al*. who found lase activated bleaching groups present greater micro leakage than other groups. Other than this there was no published article available on the effect of activated laser on post restorative bleaching on micro leakage. Several studies have shown that there is no change in the micro leakage of restoration post bleaching [26]. However in most instances either different bleaching agent was used (carbama peroxide) or the bleaching agent concentration varied. Khoroushi *et al*. observed that plasma arc light activated bleaching did not significantly affect the micro leakage of existing tooth-coloured restorations [41]. The findings were not in agreement with our study which can be attributed to difference in frequency wavelength (532 nm) & duration of irradiation.

Thus the second null hypothesis that Diode laser, LED activated bleaching & chemical bleaching as compared to control would have a significant micro leakage of nano hybrid composite was accepted.

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