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RESEARCH ARTICLE

COMPARISON OF THE DENTAL BLEACHING EFFICACY IN DECIDUOUS TEETH WITH DIODE LASER AND LED IRRADIATION : AN IN VITRO STUDY

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ABSTRACT

The purpose of this study was to compare the efficacy of bleaching in deciduous teeth with Diode Laser and LED Irradiation. Forty extracted caries free central incisors were used for the study (there Ciel*a*b* values were recorded). All the forty teeth were first discolored in the solution made of coco cola and tea (Ciel*a*b* values were recorded) and were then divided into 2 groups A (Laser) & B (LED). Discolored Samples in Group A were treated with the bleaching agent assisted by Laser and then there Ciel*a*b* values were recorded. Discolored Samples in Group A were treated with the bleaching agent assisted by LED and then there Ciel*a*b* values were recorded.

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INTRODUCTION

Teeth form an important part of the body which aids in chewing, speech as well as contributing to appearance. It is seen that even at a younger age there is a desire for whiter teeth. Esthetic problems in childhood and adolescence can have a significant effect on psychosocial development and interaction with peers. Tooth discoloration produces profound embarrassment and more psychological distress than can only be imagine. Negative emotions such as fear, anxiety, depression and timidity are sometimes exhibited in cases of anterior tooth discolouration. This can affect the general health and ability of an individual to participate with friends, and other roles requiring interaction with others. The psychosocial consequences of tooth discolouration could be considerable. Dentistry emphasizing esthetics was a very popular topic in the late 1800s, however concerns were raised regarding the aggressive removal of tooth structure for the placement of crowns. Bleaching was then a promising alternative for crowns in the treatment of discolored teeth. In the late 1800s, numerous bleaching agents which were either direct or indirect oxidizers were employed for the bleaching. All agents including: aluminum chloride, oxalic acid, pyrozone, hydrogen dioxide, sodium peroxide, sodium hypophosphate, chloride of lime and cyanide of potassium acted on the organic portion of the tooth The variety of bleaching agents used reflects the diverse nature of the discoloration. Oxalic acid was used for the removal of iron stains associated with pulp necrosis and hemorrhage chlorine was indicated for silver and copper stains encountered with amalgam restorations ammonia readily removed stains produced from iodine used for root canal therapy. The etiology and type of discoloration is an essential component of proper diagnosis and treatment planning for bleaching and usually dictates the prognosis of the bleaching outcome. Thus a thorough clinical examination followed by a review of the patients oral hygiene practices, dietary habits, exposure to chemicals, trauma and intake of medications are required to make a final diagnosis on the nature of the discoloration. Discoloration can be classified as extrinsic, intrinsic or a combination of both. Extrinsic discoloration is caused by the accumulation of stains on the enamel surface and can be accentuated by pitting or irregularities of the enamel, salivary composition, salivary flow rates and poor oral hygiene. Unlike extrinsic discolorations that occur on teeth surfaces, intrinsic discolorations are attributable to the presence of stain molecules within the enamel and dentin, incorporated either during tooth formation or after eruption. There are a wide variety of bleaching products available but most are based on hydrogen peroxide as the active agent. Hydrogen peroxide may be applied directly, or produced in a chemical reaction from sodium perborate or carbamide peroxide. Although most of the early dental literature focused on non-vital bleaching, oxalic acid was employed for bleaching of vital teeth as early as 1868. In 1877, Chapple

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published the first dental report on tooth bleaching using oxalic acid. In the following years, Taft and Atkinson suggested the use of chlorine for bleaching, Taft using calcium hypochlorite and Atkinson using Labarraque"s solution, a liquid chloride of soda. In 1884, Harlan published what is believed to be the first report of hydrogen peroxide which he called hydrogen dioxide. Since there were few chemical manufacturing companies in the 1800s, most dentists mixed a variety of solutions in their office attempts to speed up the bleaching process in the office were performed by using an electric current, ultra-violet rays and other heating instruments and lights.

Bleaching may either be done in-office or at home by the patient. Hydrogen peroxide (HP) at a concentration in the range of 10%-40% or other chemicals capable of producing HP (e.g., carbamide peroxide, sodium perborate) are most commonly used to oxidize organic materials, inducing tooth color change. Owing to an increased demand for whiter teeth in a short period of time, in-office bleaching assisted with the light system (LASER, LED, Halogen Lamp etc)is a popular option available to patients desiring a whiter, more attractive smile, as outcomes can already be seen in a single clinical appointment with a dental professional. Since the introduction of in-office bleaching treatments, the use of curing lights (including halogen curing lights, plasma arch, LED, LED plus LASER and LASER) has been recommended to accelerate the action of the bleaching gel. The theoretical advantage of a light source is its ability to heat the hydrogen peroxide, thereby increasing the rate of decomposition of oxygen to form oxygen-free radicals and enhancing the release of stain-containing molecules. Hence this study aims in determining the efficacy of bleaching of the primary discoloured teeth with the additional characteristics of an advanced technique imbibed in the bleaching procedure i.e. the LASER and the LED system. This study will help in creating a standard treatment protocol possibility apart from veneers, crowns etc for the discolored primary teeth and also will prompt some more in vivo studies so as to make bleaching a more routine term in the pediatric practice.

METHODOLOGY

Sampling size and sampling procedure

40 extracted caries free central incisors used for the study were obtained from the Department of Pedodontics and Preventive Dentistry.

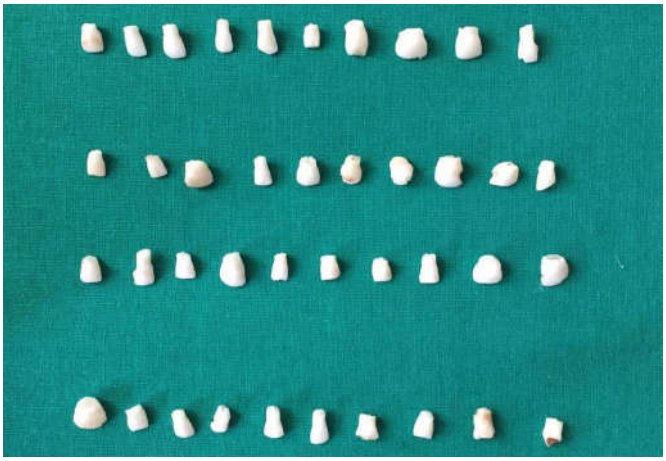


Figure 1. Forty Central Incisors

Inclusion Criteria: Caries free teeth

Exculsion Criteria: Carious teeth

Figure 2. Bleaching agent (Whiteness HP)

Figure 3. Discoloring solution

Figure 4. Discolored primary teeth

All the teeth were decoronated with the help of diamond disk and sealed with polymethyl methacrylate resin. Polishing with pumice was done for all the teeth. All these teeth were then stored in distilled water at 4 degrees Celsius in refrigerator. The initial Ciel*a*b* reading were taken for all the 40 central incisors. The samples were then immersed in solution of Coca cola and tea and stored in incubator at 37 degrees Celsius for 7 days. The solutions were changed everyday and the Ciel*a*b values for the samples were measured again. All these 40 teeth were now divided into two groups: Group A (LASER) and Group B (LED).

Group A (LASER)

A 2mm layer of the bleaching agent (Whiteness HP) was applied and were irradiated for 30 seconds. The bleaching agent was kept on the teeth surfaces for another 7 minutes and

then irradiated again for 30 seconds. Following this, the bleaching agent was washed off and a new layer was applied and irradiated again for 30 seconds. After this second irradiation, the agent was immediately washed off and the samples were rinsed. This procedure of the application of bleaching agent and exposure with Laser was done for the 20 samples. The samples were then measured for Ciel*a*b values. All the Ciel*a*b values were calculated and tabulated for statistical analysis

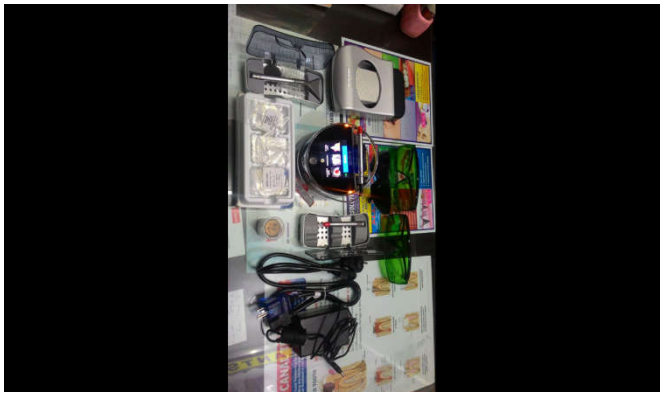


Figure 5. LASER (I LASE BIO LASE)

Figure 6. LED (PHILIPS ZOOM)

Group B (LED)

An approximately 2mm thick layer of the bleaching agent (Whiteness HP) was applied on the samples and were subsequently irradiated for 15 minutes with the LED kept at a distance of 5mm. The agent was rinsed off and a second cycle of irradiation of 15 minutes was done again. This procedure of the application of bleaching agent and irradiation with LED was done for the 20 samples. The samples were then measured for Ciel*a*b values. All the Ciel*a*b values were calculated and tabulated for statistical analysis.

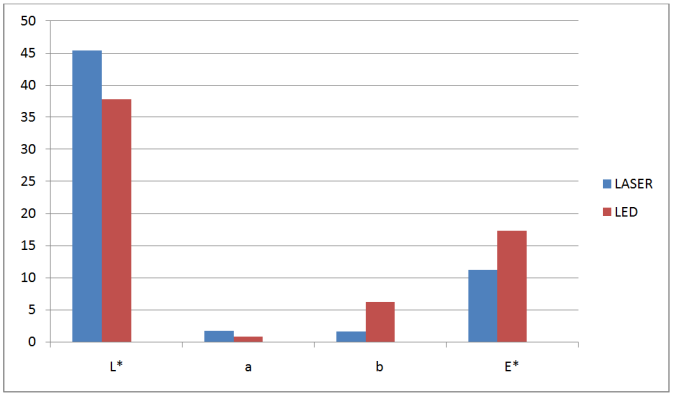
RESULTS

The comparison of the L values of the discoloured teeth and bleached teeth. For the 20 samples that were bleached with Laser the mean of the L value is 45.46 whereas the value for LED is 37.80. The L values are ranged as to be: a perfect black is said to be with a value of 0 and a perfect white with value of 100. Hence it can be said that the Laser group is better in achieving color difference as compared to LED with a significant value of 0.008* Laser could be much efficient than LED because if its better efficacy due to its mechanism of action.

Table 1. Comparison of the L*,a* ,b*, E* in deciduous teeth with diode laser and led irradiation using unpaired t test

	Group	N	Mean	Std. Deviation	t value	P value
L*	Laser	20	45.46	7.50	2.804	0.008*
	LED	20	37.80	9.62		
a*	Laser	20	1.70	0.76	3.154	0.003*
	LED	20	0.84	0.94		
b*	Laser	20	1.58	0.98	3.143	0.003*
	LED	20	6.15	6.43		
E*	Laser	20	11.18	10.34	1.333	0.191
	LED	20	17.35	17.95		

(p< 0.05 - Significant*, p < 0.001 - Highly significant**)



Graph 1. Graphical representation of L*, a*, b*, E* values of the Discolored and Bleached group

Comparison of a* values of the Discoloured and Bleached group (Table 1)

The comparison of thea* values of the discoloured and bleached teeth. For the 20 samples that were bleached with Laser mean value of a* is 1.70 whereas the value of LED is 0.84. The a* value are ranged as rednesss if the value is positive and greenness if the value is negative. In the current study the values are positive with a significant value of 0.003 hence it concluded that the samples are towards redness which is ideally acceptable. Comparison of b* values of the Discolored and Bleached group (Table 1). The comparison of the b* values of the discoloured and bleached teeth. For the 20 samples that were bleached with Laser mean value of b* is 1.58 whereas the value of LED is 6.15 The a* value are ranged as yelloweness if the value is positive and blueness if the value is negative. In the current study the values are positive with significant P value of 0.003 hence it concluded that the samples are towards yellowness.

Comparison of E* values of the Discolored and Bleached group (Table 1)

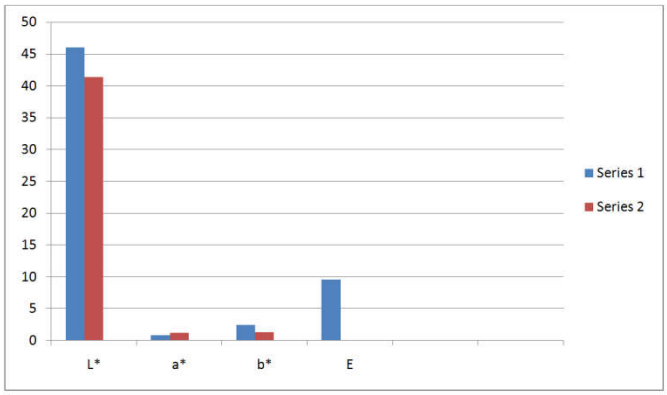
The comparison of the E* values of the discoloured and bleached teeth. For the 20 samples that were bleached with Laser mean value of b* is 17.35 whereas the value of LED is 11.18. Higher value of E (17.35) is achieved by Laser. Hence it can be concluded that Laser is better in terms of L, a* and E.

Similar results were achieved in a in vitro study conducted by Bussadori in primary teeth and Wetter in permanent teeth.

Table 2. Comparison of E* values of deciduous teeth before and after using paired t test

		N	Mean	Std. Deviation	t value	P value
Pair 1	L pre	40	45.97	5.02	1.950	0.058*
	L post	40	41.32	13.25		
Pair 2	A pre	40	0.89	0.44	2.079	0.044*
	A post	40	1.23	0.76		
Pair 3	B pre	40	2.51	1.36	3.109	0.003*
	B post	40	1.74	1.23		
Pair 4	E	40	9.56	5.07	2.171	0.036*

(p< 0.05 - Significant*, p < 0.001 - Highly significant**)



Graph 2. Graphical representation of L* a* b* values of Baseline and Bleached Group

Comparison of L values of the Baseline and Bleached group (Table 2)

The comparison of the L values of the Baseline teeth and bleached teeth. For the 20 samples that were bleached with Laser the mean of the L value is 45.497 whereas the value for LED is 41.32. The L values are ranged as to be : a perfect black is said to be with a value of 0 and a perfect white with value of 100. Hence it can be said that the Laser group is better in achieving color difference between the baseline samples to the bleached samples as compared to LED with a significant value of 0.058* Laser is much efficient than LED because if its better efficacy due to its mechanism of action

Comparison of a* values of the Discoloured and Bleached group (Table 1)

The comparison of the a* values of the discoloured and bleached teeth. For the 20 samples that were bleached with Laser mean value of a* is 0.89 whereas the value of LED is 1.23. The a* value are ranged as rednesss if the value is positive and greenness if the value is negative. In the current study the values are positive with a significant value of 0.044* hence it concluded that the samples are towards redness which is ideally acceptable.

Comparison of b* values of the Discolored and Bleached group (Table 2)

The comparison of the b* values of the discoloured and bleached teeth. For the 20 samples that were bleached with Laser mean value of b* is 2.51 whereas the value of LED is 1.74. The a* value are ranged as yellowness if the value is positive and blueness if the value is negative. In the current study the values are positive with significant P value of 3.109 hence it concluded that the samples are towards yellowness.

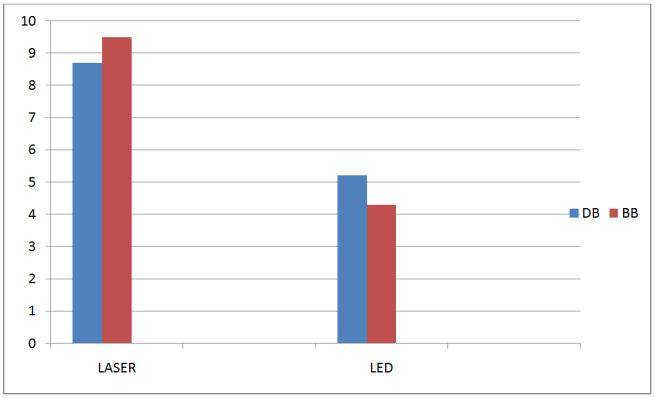
Comparison of E* values of the Baseline and Bleached group (Table 2)

The comparison of the E* values of the discoloured and bleached teeth was 9.56. Hence it can be concluded that Laser is better in terms of L , a* and E.

Table 3. E* Values of LASER * LED of Discolored and Bleached teeth

Variable	Group	N	Mean	Std. Deviation	t value	P value
Discolored and bleached (DB)	Laser	20	8.7	10.34	1.333	0.03*
	LED	20	5.2	17.95		
Baseline and bleached (BB)	Laser	20	9.5	4.84	2.628	0.002*
	LED	20	4.3	7.87		

(p< 0.05 - Significant*, p < 0.001 - Highly significant**)
(X axis – E*, Yaxis – LASER, LED)



Graph 3. Graphical Representation of E* values of LASER & LED of Discolored and Bleached teeth

Comparison of E values of the Laser and LED with Discolored and Bleached (Table 3)

The comparison of the E* values of the Laser with Discolored teeth was 8.7 and LED with Discolored teeth was 5.2. E (color difference) was observed more with the Laser group than LED. Comparison of E values of the Laser and LED with Baseline and Bleached (Table 3) The comparison of the E* values of the Laser with baseline teeth was 8.71 and LED with baseline teeth was 5.45. E (color difference) was observed more with the Laser group than LED. The Baseline group was not evaluated with bleached teeth in any of the in vitro studies.

Table 4. Comparison of the effect of Bleaching of Deciduous teeth using LASER & LED using ANOVA test

Delta E	N	Mean	Std. Deviation	F value	P value
LASER	20	9.5	4.84	0.67	<0.001**
LED	20	4.3	7.37		
Total	60	4.39	1.64		

(p< 0.05 - Significant*, p < 0.001 - Highly significant**)

DISCUSSION

Primary teeth can get discoloured because of various reasons for example – trauma, amelogenesis imperfecta etc. Tooth

discolouration has been classified according to the location of the stain, which may be either intrinsic or extrinsic. Intrinsic discolouration occurs following a change in the structural composition or thickness of the dental hard tissues. The normal colour of teeth is determined by the blue, green and pink tints of the enamel and is reinforced by the yellow through to brown shades of dentine beneath. Power bleaching is the association of Laser light, LED light, Halogen lamps etc by using traditional bleaching agents. Many in vitro and in vivo studies (Gontijo *et al*., 2008; Wetter *et al*., 2004; Brantley *et al*., 2001) have researched bleaching with laser and led and showed it to be an efficient and effective treatment for discoloured primary and permanent teeth. In the present study bleaching with Laser and LED has been tried to evaluate as a treatment modality for the discoloured primary teeth. Studies have previously been conducted on bleaching of primary teeth and desired satisfactory results have been achieved (Ananthraj *et al*., 2015 Bussadori *et al*., 2006; Brantley *et al*., 2001) Central incisors are the frequent ones to get discoloured so in this study primary central incisor were artificially stained and then bleached with laser and LED assisted by using 35% Hydrogen peroxide. Alkhatib *et al* in 2004 his review also concluded that more females and younger age group reported tooth discolouration than their counterparts (Alkhatib *et al*., 2004). Vallittu *et al* in 1996 surveyed 254 subjects for esthetic and reported that the appearance of their teeth was found to be more important to women than men and significantly more important to the young than the old (Vallittu *et al*., 1996). Mountouris *et al* in 1990 in their review stated that tetracycline stained teeth is the most severe anterior tooth discolouration (Mountouris *et al*., 1990).

Mulay *et al* in 2014 conducted an in vivo study to evaluate and compare the effect of 35% Hydrogen Peroxide and 35% Carbamide peroxide in - office bleaching agents using plasma arc and laser light sources and concluded that 35% Carbamide peroxide and plasma arc group showed significant colour change followed by 35% hydrogen peroxide plasma arc group, 35% hydrogen peroxide and laser group and 35% carbamide peroxide and laser group whereas highest change in enamel surface morphology was observed in 35% hydrogen peroxide and laser light source group followed by 35% carbamide peroxide and laser light source group, 35% hydrogen peroxide plasma arc group, 35% carbamide peroxide plasma arc group (Dr. Sanjyot Mulay and Dr Apurva Band, 2004). Donly *et al*. in 2002 conducted a clinical trial to evaluate the effects of 2 different bleaching systems, a 6.5% hydrogen peroxide strip system and a 10% carbamide peroxide tray system, in a population of preteens and teens. Digital images were obtained at baseline and after every 2-week treatment period. Average tooth color was determined in L*, a*, b* color space, where L* indicated lightness, a* indicated red-green, and b* indicated yellow-blue. Both systems significantly whitened teeth ($P < 0.0001$). There were no significant differences between groups with respect to the primary whitening response (Δb^*) on the maxillary teeth, 4 weeks of overnight treatment with the 10% carbamide peroxide tray yielded statistically significant whitening ($P < 0.05$) on the mandibular teeth compared with the 6.5% hydrogen peroxide strip used for 28 hours (Donly *et al*., 2002).

Ganesh *et al* in 2013 conducted an in vitro study to compare the bleaching efficacy of 10% carbamide peroxide, 10% hydrogen peroxide and 2g sodium perborate as bleaching agents on the artificially discolored human primary maxillary central incisors. The teeth were randomly divided into four experimental groups of 10 teeth each and the baseline color evaluation was performed. The color of the bleached teeth was determined at 0, 7 and 14 days. The data obtained were analyzed using ANOVA and Turkey's test. There was statistical significance ($P = 0.00$) among the carbamide peroxide, sodium perborate, hydrogen peroxide and control groups after 7 and 14 days and a significance of $P = 0.013$ among the carbamide peroxide, sodium perborate and hydrogen peroxide after two bleaching sessions (day 14) was seen (Ganesh *et al*., 2013). Arıkan *et al* in 2009 in a clinical study described the treatment for a darkened primary tooth with sodium perborate using the walking bleach technique and its 1-year clinical and radiographical follow-up showed no signs of any pathology and thus concluded bleaching to be a successful treatment (Arikan *et al*., 2009). Bleaching can have adverse effects, both localized and systemic (toxicity, free radical, etc). Possible localized adverse effects are on dental hard tissues and mucosa, tooth sensitivity when the bleaching material is in contact with vital teeth, interaction with adhesive mechanisms, external cervical resorption risk, damage to composite restorations, and dental material solubility. The results of the study were Laser with baseline teeth was 8.71 (E*) and LED with baseline teeth was 5.45 (E*). Thus in the present study it was revealed that LASER system was more efficient in bleaching of the discolored primary teeth than the LED. The inference of this study was in conjunction with Wetter *et al*. (2004) ($P<0.05$ The lightness increase of the association Whiteness HP and laser was significantly higher than for LED). Gontijo (Athimuthu Anantharaj *et al*., 2015) (the E* values were 4.00±5.10 – baseline 14.80±6.72, - after bleaching in the laser group, LED could not give statistically significant results), Bussadori *et al*. (2006) (At the end of the bleaching, an A1 VITA shade was obtained with satisfactory esthetic results) with respect to bleaching for primary as well as permanent teeth. The Bleaching agent used in the present study was Whiteness HP. Whiteness HP has been used by the following Wetter *et al*. (2004) (in permanent teeth), Bussadori *et al*. (2006), Gontijo *et al*. (2008) (in primary teeth). Studies by Roche Hayward *et al* in 2012 stated that LED is efficient (L* component a statistically significant difference ($p<0.05$) between base-line and directly after the LED treatment stage (whiter) was found and a complete relapse was found after the 14 day at-home treatment period. The b* component showed statistically significant differences ($p<0.05$) between base-line and the LED stage less yellow more blue) in Bleaching of permanent teeth as compared to home bleaching this however is in disjunction with the present study wherein LASER was more efficient than LED (Niklaus Ursus Wetter *et al*., 2004).

CONCLUSION

1) Laser has shown to be effective with respect to the L and a* values.
2) LED has shown to be less effective for the color change.
3) When Laser and LED were compared for there effect, it was found that Laser was much effective. Hence to conclude on the basis of current study Laser has shown to be effective than LED for bleaching of discoloured primary teeth.

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