



## Case report

## Violet LED for non-vital tooth bleaching as a new approach

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## ABSTRACT

Different light sources have been used during dental bleaching procedures. More recently, a violet LED system was introduced as a promising and viable light source, which is capable to promote dental bleaching without chemical agents, although this light source could be also associated to a bleaching agent. This case report aimed to present the association of a violet LED and a bleaching agent over a discolored non-vital tooth. After anamnesis, clinical and radiographic examinations, a dental bleaching protocol was proposed as follow: 15 applications of the violet LED during 60 s (Bright Max Whitening, MMOptics) with 30 s interval between them. Before the last 5 applications, 35% hydrogen peroxide gel (Whiteness HP Maxx, FGM) was applied inside the pulp chamber and on enamel surface of the tooth (vestibular and palatal surfaces) and then the last 5 irradiations were performed. Three sessions were performed, with 7-days interval. Color assessment using a VITA classical scale and VITA EasyShade® spectrophotometer was carried out. After dental bleaching, color changed (tooth 21) from A3.5 to B2. The protocol used in this case report showed to be satisfactory for the non-vital tooth bleaching.

## 1. Introduction

White teeth have been desired for many people due to the increased focus on aesthetics. Therefore, an increased demand for dental bleaching procedures in dental offices has been observed.

Under properly conditions, dental bleaching is considered a safety, easier and low-cost approach for discoloration treatment of vital and non-vital teeth [1].

The use of light sources has been recommended to accelerate the action of bleaching agents [2] providing a decrease on the operator time. Basically, the ability of the light source to heat the agent, increases the rate of free radicals generation and consequently the oxidative capacity [3]. However, the literature shows controversial findings about the use of light sources and the effectiveness on the dental bleaching [1].

Although, dental bleaching is described as a very simple technique, the dental bleaching can cause a risk for tooth sensitivity [4], which is the main reason for the patients avoid the dental bleaching procedure. A previous study showed that the damage is caused by the chemical agent diffusion into the pulp tissue during the dental bleaching

procedure being responsible for the sensitivity [5]. Moreover, the chemical agents used, such as hydrogen and carbamide peroxide, can generate changes on dental structure [6], such as a significant reduction of microhardness immediately after the dental bleaching [9].

In this way, novel products and technologies have been developed. More recently, a violet LED system was introduced and have been described as a promising and viable light source option for the dental bleaching. Unlike conventional approaches, violet LED is capable to provide bleaching process without the application of a chemical agent [6–8]. The emission band of the violet light coincides with the absorption peak of pigmented molecules, breaking them up and causing a molecular rearrangement. As a result, this wavelength promotes colorless and less complex molecules [6], leading the bleaching of the dental structure. Nevertheless, there are few studies that have reported clinical outcomes which use violet LED on the dental bleaching procedure.

Thus, this paper aimed to show a case report of a non-vital tooth bleaching using the violet LED system in association with a bleaching agent gel based on hydrogen peroxide and assessment of the color change after bleaching.

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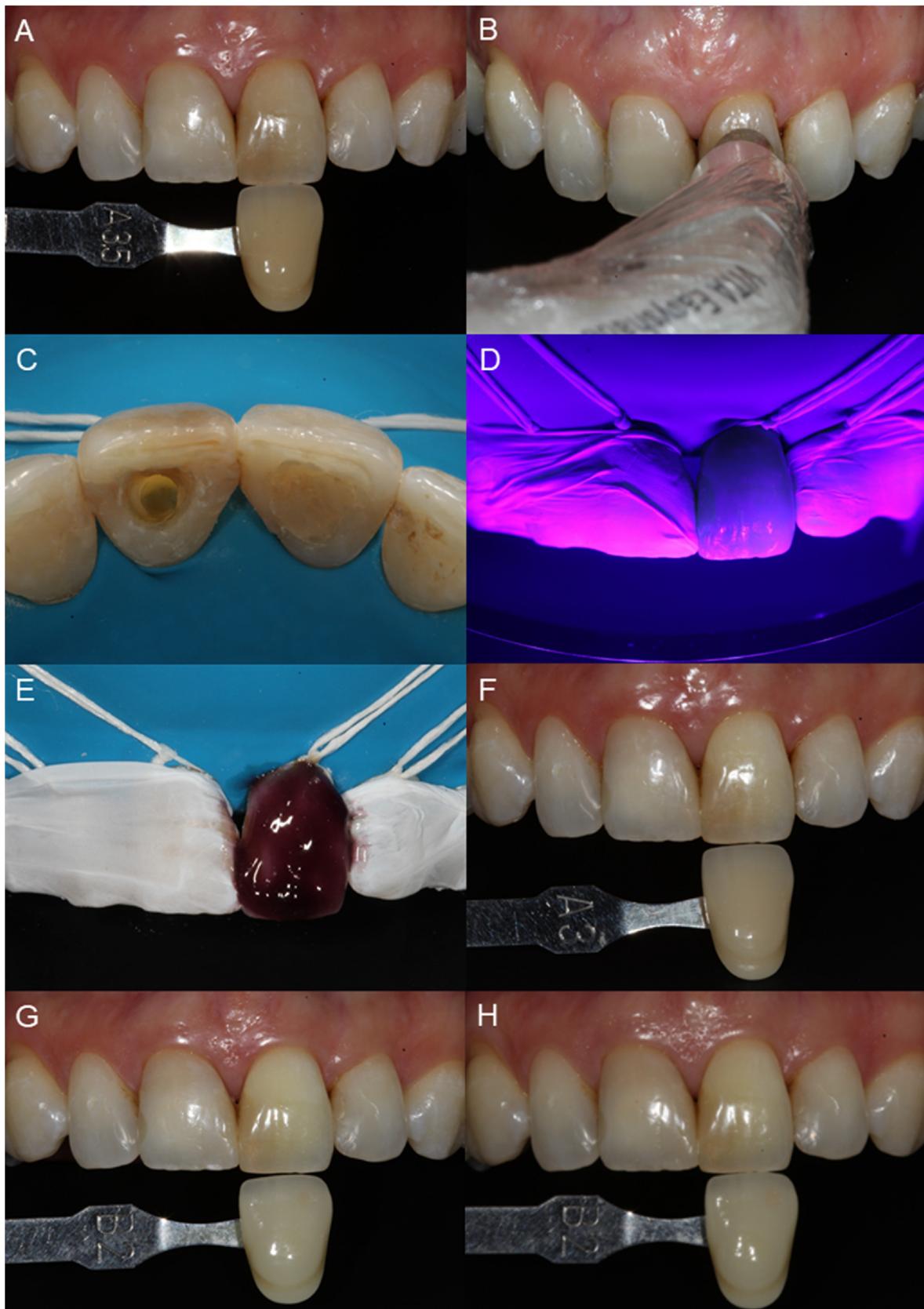
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**Fig. 1.** A – Initial dental color assessment with Vitapan Classical® Shade Guide; B – Initial dental color assessment with digital spectrophotometer (Vita Easyshade® Advance); C – Access to pulp chamber; D – Irradiation with violet LED light source; E – 35% hydrogen peroxide application; F – Dental color assessment 7 days after the 1<sup>st</sup> appointment; G – Dental color assessment 7 days after the 3<sup>rd</sup> appointment; H – 30-days follow up.

## 2. Case report

A 45 years-old female, S.C.R, reported to the Department of Restorative Dentistry at School of Dentistry, Araraquara (São Paulo State University – UNESP) with a complaint of discolored left upper central tooth. After anamnesis, clinical and radiographical examination, an endodontic treatment on the left upper central performed 6 years ago based on a history of trauma and enamel discoloration was observed (Fig. 1A). The patient reported no smoking habits.

Considering the clinical findings, a non-vital tooth bleaching using a violet LED system in association with a bleaching agent was proposed. Before the clinical procedure, the patient signed the informed consent to authorize the procedure and the use of clinical documentation for this case report.

After prophylaxis, the dental color was evaluated using a shade guide Vitapan Classical® Shade Guide (Vita Zahnfabrik, Bad Säckingen, Germany) (Fig. 1A) and a digital spectrophotometer Vita Easyshade® Advance (Vita Zahnfabrik, Bad Säckingen, Germany) (Fig. 1B). After that, the rubber dam isolation was performed, and the composite resin restoration was removed with a spherical diamond burr in order to access the pulp chamber. Three millimeter (3 mm) of gutta-percha below the amelo-cemental junction was removed using a Gates-Glidden drill (#3, Kerr Corporation, Orange, CA, USA) and the cervical region was sealed with Vitrebond™ glass ionomer cement (3 M Espe, St. Paul, MN, USA). The internal walls of the tooth were left free of any restorative material (Fig. 1C).

The dental bleaching protocol was performed as follows: 15 applications of 60 s using the violet LED light source ( $\lambda$  408 nm  $\pm$  10 nm) (Bright Max Whitening, MMOptics Ltda., São Carlos, SP, Brazil) with 30-seconds interval between them (Fig. 1D). Before the last 5 irradiations, a 35% hydrogen peroxide gel (Whiteness HP Maxx, FGM Produtos Odontológicos Ltda., Joinville, SC, Brazil. Lot. number: 261,017) was applied on the enamel surface of the vestibular and palatal faces (Fig. 1E) and then the irradiation was performed. The device containing 4 violet LEDs was used under estimated power output of 1.200 mW and irradiance of 112 mW/cm<sup>2</sup>. The light tip is transparent based on acrylic, curve and was positioned at a 90° angle as close as possible to the dental surface from the upper and lower arches at the same time.

Three bleaching sessions with a 7-days interval were carried out. Dental color assessment was performed before and after 7 days of each bleaching session (Fig. 1F and G). Three dental color measurements during each evaluation time were performed. Baseline measurements were considered before dental bleaching procedures. A 30-day follow-up was documented (Fig. 1H).

## 3. Results

The  $\Delta L^*$ ,  $\Delta a^*$ ,  $\Delta b^*$  e  $\Delta E^*$  mean values are displayed in Table 1. A visible color change was showed throughout the sessions, mainly after the last session ( $\Delta E^*$  from 6.8 for the first session to 12.2 for the third session) showing that there was a significant bleaching. Additionally, the 30-days follow-up showed color stability since the color achieved during the last session remained almost the same ( $\Delta E^* = 12.2 - \Delta E^*$

**Table 1**

$\Delta L^*$ ,  $\Delta a^*$ ,  $\Delta b^*$ ,  $\Delta E^*$ ,  $\Delta SGU^*$  mean values and dental color using Vita Easyshade® Advance and Vitapan Classical® Shade Guide measured at different bleaching sessions.

| Time          | Vita EasyShade® |              |              |              | $\Delta SGU^*$ | Vitapan Classical® |
|---------------|-----------------|--------------|--------------|--------------|----------------|--------------------|
|               | $\Delta L^*$    | $\Delta a^*$ | $\Delta b^*$ | $\Delta E^*$ |                |                    |
| Session 1     | 6.5             | -1.8         | -0.8         | 6.8          | 3              | A3                 |
| Session 2     | 6.4             | -2.2         | -1.2         | 6.9          | 7              | A2                 |
| Session 3     | 9.7             | -3.7         | -6.5         | 12.2         | 9              | B2                 |
| After 30 days | 9.2             | -3.9         | -8.4         | 13.1         | 9              | B2                 |

\* = 13.1).

Data obtained by digital spectrophotometer Vita Easyshade® Advance (Vita Zahnfabrik, Bad Säckingen, Germany) showed changes on mean values (from  $\Delta b^* = -1.2$  for the second session to  $-6.5$  for the third session and  $-8.4$ , after 30 days) which means a greater predominance of blue color. This represents a decrease in yellowness of the tooth.

According to the dental color assessment using the shade guide Vita Classical® Shade Guide, we reached a B2 color match (Table 1) 30 days after the last session, considering the initial shade (A3,5) (Fig. 1A). Regarding the digital spectrophotometer measures, we can observe the same dental colors.

The mean values of shade guide units ( $\Delta SGU$ ) are displayed in Table 1. The mean values showed that there was a considerable change between the second and third session. After 30 days, the color achieved with the dental bleaching remained stable.

## 4. Discussion

This paper was the first one to present a case report for a non-vital tooth bleaching using a violet LED system, This paper was the first one to present a case report for a non-vital tooth bleaching using a violet LED system. Our results have shown that the dental bleaching protocol using violet LED associated with a bleaching agent achieved satisfactory color improvements of the discolored non-vital tooth. The LED under violet wavelength was previously used in Dentistry for wide-field image viewing and visual monitoring of the management of plaque and dental calculus before and after periodontal scaling to improve the diagnoses and follow-up of patients with periodontal disease [10].

Our results have shown that the dental bleaching protocol using violet LED associated with a bleaching agent achieved satisfactory color improvements of the discolored non-vital tooth.

It is important to note that endodontically treated teeth are more susceptible to fracture as a result of the loss of dental structure and tooth vitality [9]. The dental bleaching protocol performed with violet LED on non-vital tooth may be a conservative and safe option, since the time of the chemical agent in contact with the dental structure was shorter than conventional approaches with hydrogen peroxide under high concentrations.

A hydrogen peroxide under 35% is the first choice for the in-office dental bleaching due to the free radical's release that promotes oxidation of the tooth pigments. In association with the bleaching gel, a LED source may be used in order to improve the oxidation reaction [6].

However, previous studies reported that the use of a light source does not increase the color change after bleaching, showing similar results than those obtained only with the use of a bleaching agent [1,2]. There are some reports regarding the adverse effects of hydrogen peroxide under high concentrations on the dental enamel, which may lead to a change on the mineral content and on the microhardness after the bleaching session [11]. As a result, these changes might to weaken the tooth by increasing brittleness and higher susceptibility to fracture.

The use of violet LED source ( $\lambda$  408 nm  $\pm$  10 nm) has emerged as an alternative to promote dental bleaching, which can be used with or without the use of bleaching agents. When the violet LED is used without any bleaching agent, the mechanism described becomes a purely physical process. The wavelength of violet light allows the absorption of light on the dental surface, breaking down the pigments responsible for staining the teeth [12].

The non-vital tooth bleaching protocol performed in this case report using a violet LED associated with 35% hydrogen peroxide can be a viable and safe option to improve the discoloration of endodontically treated teeth.

## Declaration of Competing Interest

The authors declare no any conflict of interest in this paper.

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## References

- [1] B.M. Maran, A. Burey, T. de Paris Matos, A.D. Loguercio, A. Reis, In-office dental bleaching with light vs. without light: a systematic review and meta-analysis, *J. Dent.* 70 (2018) 1–13, <https://doi.org/10.1016/j.jdent.2017.11.007>.
- [2] R.F.L. Mondelli, J.F. Azevedo, A.C. Francisoni, C.M. de Almeida, S.K. Ishikiriyama, Comparative clinical study of the effectiveness of different dental bleaching methods - two year follow-up, *J. Appl. Oral Sci.* 20 (2012) 435–443, <https://doi.org/10.1590/S1678-77572012000400008>.
- [3] S. Gurgan, F.Y. Cakir, E. Yazici, Different light-activated in-office bleaching systems: a clinical evaluation, *Lasers Med. Sci.* 25 (2010) 817–822, <https://doi.org/10.1007/s10103-009-0688-x>.
- [4] D.A. Roderjan, R. Stanislawczuk, J. Hebling, C.A. de S. Costa, A. Reis, A.D. Loguercio, Response of human pulps to different in-office bleaching techniques: preliminary findings, *Braz. Dent. J.* 26 (2015) 242–248, <https://doi.org/10.1590/0103-6440201302282>.
- [5] S. Kossatz, A. Dalanhol, T. Cunha, A. Loguercio, A. Reis, Effect of light activation on tooth sensitivity after in-office bleaching, *Oper. Dent.* 36 (2011) 251–257, <https://doi.org/10.2341/10-289-C>.
- [6] F. Zanin, Recent advances in dental bleaching with laser and LEDs, *Photomed. Laser Surg.* 34 (2016) 135–136, <https://doi.org/10.1089/pho.2016.4111>.
- [7] A.D.N. Lago, W.D.R. Ferreira, G.S. Furtado, Dental bleaching with the use of violet light only: reality or future? *Photodiagnosis Photodyn. Ther.* 17 (2017) 124–126, <https://doi.org/10.1016/j.pdpdt.2016.11.014>.
- [8] A.N. de S. Rastelli, H.B. Dias, E.T. Carrera, A.C.P. de Barros, D.D.L. dos Santos, V.H. Panhóca, V.S. Bagnato, Violet LED with low concentration carbamide peroxide for dental bleaching: a case report, *Photodiagnosis Photodyn. Ther.* 23 (2018) 270–272, <https://doi.org/10.1016/j.pdpdt.2018.06.021>.
- [9] E.S. Reeh, H.H. Messer, W.H. Douglas, Reduction in tooth stiffness as a result of endodontic and restorative procedures, *J. Endod.* 15 (1989) 512–516, [https://doi.org/10.1016/S0099-2399\(89\)80191-8](https://doi.org/10.1016/S0099-2399(89)80191-8).
- [10] C.R. Sivieri-Araujo, M.M. Fontana, A.N.S. Costa, L.P.C. Rastelli, C. Pereira, Kurachi, V.S. Bagnato, Monitoring scaling and dental calculus removal with an optical fluorescence system, *Laser Phys.* 24 (8) (2004) 085604–085609.
- [11] S. Parreiras, P. Vianna, S. Kossatz, A. Loguercio, A. Reis, Effects of light activated in-office bleaching on permeability, microhardness, and mineral content of enamel, *Oper. Dent.* 39 (2014) E225–E230, <https://doi.org/10.2341/13-031-l>.
- [12] V.H. Panhóca, B.P. de Oliveira, A.N.S. Rastelli, V.S. Bagnato, Dental bleaching using violet light alone: clinical case report, *Dentistry* 7 (2017), <https://doi.org/10.4172/2161-1122.1000459>.