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ORIGINAL ARTICLE

Dental bleaching on teeth submitted to enamel microabrasion 30 years ago—a case report of patients' compliance during bleaching treatment

Daniel Sundfeld[1] · Caio Cesar Pavani[2] · Timm Cornelius Schott[3] · Lucas Silveira Machado[4] · Núbia Inocêncya Pavesi Pini[1] · André Pinheiro de Magalhães Bertoz[5] · Renato Herman Sundfeld[2]

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Abstract

Objectives The present dental bleaching case report describes a new method that precisely quantifies the daily wearing-times of the bleaching product by inserting a microsensor in the acetate custom tray. The bleaching efficacy was also discussed since the patient was previously submitted to enamel microabrasion.

Methods The patient was submitted to enamel microabrasion in 1987, and bleaching treatment was performed in 2005. In 2017, re-bleaching was executed using 10% peroxide carbamide. The electronic microsensor, TheraMon (TheraMon® microelectronic system; Sales Agency Gschladt, Hargelsberg, Austria), was embedded in the labial region of the upper and lower acetate trays to evaluate the wearing-times of the acetate trays/bleaching product. The patient was instructed to wear the tray for 6 to 8 h/day while sleeping. After 24 days of bleaching treatment, the data obtained from the TheraMon electronic devices was collected and interpreted.

Results The patient did not entirely follow the bleaching treatment as recommended, as there was no evidence of use of the upper and lower trays for some days; additionally, the bleaching product was used for shorter and longer periods than was instructed.

Conclusions The TheraMon microeletronic device precisely measured the wearing-times of the acetate tray/bleaching product during the bleaching treatment. Teeth submitted to enamel microabrasion presented with a healthy clinical appearance after 30 years.

Clinical significance Measuring the length and frequency of use of an acetate tray/bleaching product can be important to clinicians and patients for obtaining a controlled and adequate bleaching treatment.

Keywords Dental bleaching · Enamel microabrasion · TheraMon microsensor · Wearing-times

✉ Renato Herman Sundfeld
sundfeld@foa.unesp.br

[1] Department of Restorative Dentistry and Prosthodontics, Ingá University Center - UNINGÁ, 317 PR Road, Maringá, PR, Brazil

[2] Department of Restorative Dentistry, Araçatuba Dental School, São Paulo State University - UNESP, 1192 José Bonifácio St, Araçatuba, SP, Brazil

[3] Department of Orthodontics and Orofacial Orthopedics, Eberhard Karls University, Osiamderstr. 2-8, 72076 Tübingen, Germany

[4] Department of Conservative Dentistry, School of Dentistry, Federal University of Rio Grande do Sul - UFRGS, 110 Paulo Gama Av, Porto Alegre, RG, Brazil

[5] Department of Pediatrics and Social Dentistry, Araçatuba Dental School, São Paulo State University - UNESP, 1192 José Bonifácio St, Araçatuba, SP, Brazil

Introduction

In the middle of the 1980s, the enamel microabrasion technique was successfully demonstrated for removing superficial enamel stains of any color and, hard texture, and correction of surface irregularities and imperfect enamel acquired after the removal of orthodontic appliances [1, 2]. At that time, rubber dam isolation was utilized and a mixture of 18% hydrochloric acid and fine pumice was applied on the stained area of enamel using a wooden stick, not surpassing a total of 15 applications. Today, microabrasion can be employed to remove enamel stains using a mixture of phosphoric acid with pumice or other "ready-to-use" products available in the market, which are typically comprised of 6.6% hydrochloric acid associated with fine-grit silicon carbide abrasive particles, such as Opalustre (Ultradent Inc., South Jordan, UT, USA) [3–7].

In some circumstances, teeth may become darker or more yellow after enamel microabrasion because the remaining enamel surface becomes thinner, allowing the dentin to show more evidently [4]. This situation may be circumvented by the application of carbamide peroxide (dental bleaching) in acetate trays, which has demonstrated considerable clinical success, since it is performed and supervised by a professional [3, 5–8].

However, one condition that should be considered for achieving an effective dental bleaching treatment is related to the contact time of the bleaching product on the tooth, since its daily application is under the patient's control. Previous orthodontic studies [9–15] reported the precise daily wearing-times of removable orthodontic appliances using an electronic microsensor, TheraMon (TheraMon® microelectronic system; Sales Agency Gschladt, Hargelsberg, Austria), inserted into the removable orthodontic appliances. From this perspective, the TheraMon device was embedded in the acetate custom tray to assess and quantify the precise wearing-times of the dental bleaching product during home dental bleaching.

The present clinical case report reports on an enamel microabrasion case follow-up of 30 years and describes a protocol that quantifies the wearing-times (level of patient cooperation) of the acetate trays/bleaching product of a patient undergoing home dental bleaching using 10% carbamide peroxide by incorporating the TheraMon microsensor in the acetate custom trays.

Case report

In 1987, a 14-year-old girl presented to the Araçatuba School of Dentistry (São Paulo State University—UNESP) showing white enamel stains with a hard texture, acquired due to orthodontic brackets on upper and lower teeth (Fig. 1). Treatment of the white enamel stains was carried out with the application of a mixture of 18% hydrochloric acid and fine-grained pumice. This acid/abrasive mixture was applied using a wooden stick and firm finger pressure for 5 s, not surpassing a total of 15 applications. Between each application, the enamel was washed and dried [2].

In 2005, the microabraided teeth were bleached with 15% carbamide peroxide (Opalescence—Ultradent Products Inc., South Jordan, UT, USA) (Fig. 2) [4], and in 2017 (Fig. 3), the patient wished to re-bleach the teeth: with 10% carbamide peroxide (Opalescence—Ultradent Products) adopted for this purpose.

For the dental re-bleaching treatment, maxillary and mandibular alginate impressions were made and soft vinyl mouth trays were fabricated with an electronic microsensor (TheraMon) embedded in the labial region of both acetate trays to evaluate the wearing-times of the acetate trays/bleaching product (Fig. 4). One bleaching gel tube was given to the

Fig. 1 A 14-year-old girl showing white enamel stains of a hard texture that were acquired during orthodontic treatment around fixed brackets on the upper and lower teeth

patient every week, along with instructions to place a drop of the bleaching gel into each tooth reservoir and to wear the tray 6 to 8 h per night. Four tubes of the bleaching gel were used during the course of the bleaching treatment. The embedded microsensor TheraMon did not compromise the comfort of the trays during bleaching, according to patient reports (Fig. 5).

The microsensor was used to measure the temperature of the mouth, with an accuracy of ± 0.1 °C, at 15-min intervals [14]. The information collected was transmitted by a wireless connection between the functional unit and a reading station (Fig. 6) coupled to a Universal Serial Bus (USB) connection. TheraMon software was utilized to read and interpret the data, providing a daily diagram of the wearing-times of the acetate tray/carbamide peroxide at each treatment interval (Fig. 7a, b). The time of the acetate trays recorded in mouth was considered as the wearing-times per day employed in tooth bleaching.

Figure 7 indicates that, during the dental bleaching treatment period of 24 days (beginning and end of treatment), the mean wearing-times of the acetate trays were 7.10 h/day (7:06 h/min) and 7.08 h/day (7:04 h/min) for the upper and lower arches, respectively. The patient was observed to not have worn the upper tray on the 13th, 14th, and 20th day of

Fig. 2 Eighteen years after enamel microabrasion, the teeth were bleached using 15% carbamide peroxide

Fig. 3 Thirty years after enamel microabrasion and 12 years after dental bleaching, the teeth were re-bleached using 10% carbamide peroxide

treatment, while they did not wear the lower tray on the 13th day. On the other hand, the patient wore the acetate trays/dental bleaching product for a longer period of time than instructed on the 10th, 15th, 18th, 19th, 21st, 22nd, and 23rd days of treatment and for a much shorter period of time on the 9th day of treatment for the upper acetate tray. Additionally, the lower acetate tray was worn for a longer period of time than was instructed on the second, third, tenth, 11th, 16th, 17th, 21st, and 23rd days and for less time than instructed on the ninth, 14th, and 20th days of treatment. Although the patient was instructed to wear the acetate trays containing the bleaching product for 6–8 h while sleeping, the wearing-time/day over the course of the treatment ranged from 0.25 h/day up to 10.0 h/day and 0.75 h/day to 9.75 h/day for the upper and lower acetate trays, respectively.

Finally, the patient did not wear the acetate trays/bleaching product in both arches at the same time every day, as the patient had been instructed, e.g., in the third, fourth, seventh, ninth, 12th, and 14th to 24th days of treatment. Even with the means observed in Fig. 7a, b indicating the same mean values within the period of wearing-times for the acetate trays/bleaching product, the patient did not correctly follow the recommendations for the daily wearing-time of the bleaching product on both dental arches. Even so, a satisfactory color change was observed for the teeth submitted to dental bleaching and no dental sensitivity was verified during and after dental bleaching (Fig. 8).

Fig. 4 A TheraMon microsensor embedded in the upper and lower acetate custom tray in the labial region

Fig. 5 The use of upper and lower acetate trays/10% carbamide peroxide product with TheraMon microsensor embedded in the acetate tray

Discussion

The previous clinical case for this current patient was performed in 1987 and published in 1990 [2], when microabrasion was performed to remove post-orthodontic white enamel staining caused by poor oral hygiene during orthodontic treatment.

Fig. 6 TheraMon microsensor read-out station

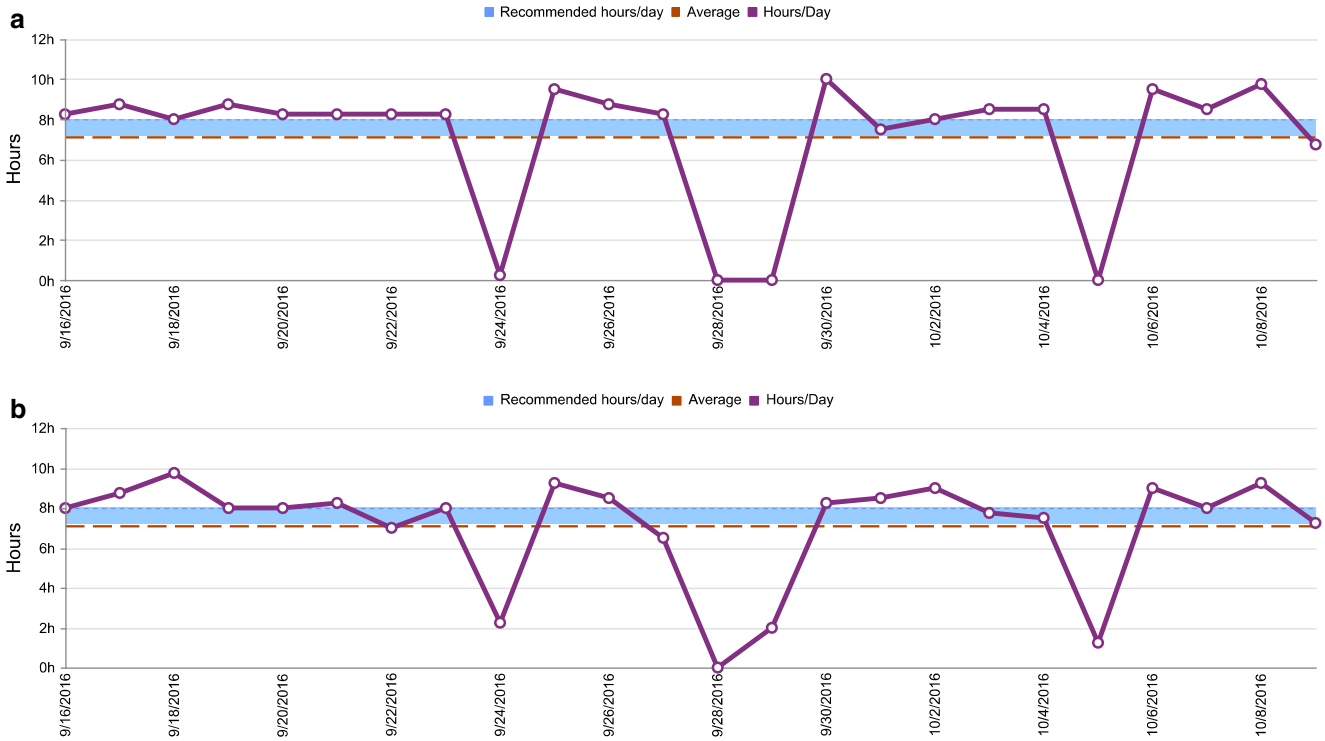

Fig. 7 Diagram evaluation of daily tooth bleaching time in the **a** upper and **b** lower arch, as measured by the TheraMon microsensor

Through the years, it has been shown that the enamel surface after microbrasion presents a considerably regular, smooth, and lustrous surface due to the compaction and deposition of calcium and phosphate breakdown products resulting from the simultaneous erosive and abrasive action of the microabrasion compound [3–7, 16] (Figs. 2, 3, and 8). Sundfeld et al. [2] used polarized light microscopy to evaluate the amount of enamel removed during enamel microabrasion using the same mixture (18% hydrochloric acid/pumice mixture) after 3 and 15 applications. Those authors verified enamel loss ranging from 25 and 140 μm, respectively, which was considered irrelevant considering the amount of remaining enamel.

It has been observed that teeth may appear darker or more yellow after enamel microabrasion, because the remaining enamel surface becomes thinner, allowing the dentin tissue to become more evident [4], and due to the increased dentin volume over time due to the physiological deposition of secondary dentin [17]. Dental color correction can be obtained with dental bleaching using carbamide peroxide gel administered in an acetate tray [3–8]. Eighteen years after enamel microabrasion, the current patient was submitted to dental bleaching using 15% carbamide peroxide (Opalescence PF, Ultradent Products Inc., South Jordan, UT, USA) and obtained a satisfactory color change at that time (Fig. 2). However, 12 years later, a return of an unaesthetic appearance was observed and the patient wished to re-bleach the teeth. The dental re-bleaching treatment utilized 10% carbamide peroxide (Opalescence PF, Ultradent Products Inc., South Jordan, UT, USA) (Figs. 5 and 8).

Fig. 8 Clinical presentation immediately after re-bleaching with 10% carbamide peroxide

Both dental bleaching treatments were performed similarly; however, a microeletronic device (TheraMon) was completely embedded in the upper and lower acetate custom trays for the more recent bleaching treatment, which measured the wearing-time/day of the acetate tray/bleaching product during the course of treatment. Although the dental bleaching treatment must be indicated and supervised by a clinician, its effectiveness is related to the degree of patient compliance, especially with regard to the daily wearing-time of the acetate trays containing the bleaching product, which is under the patient's control. Several bleaching periods, ranging from 2 to 8 h/day, have been suggested [8, 18, 19], without considering if the patient used the acetate tray/bleaching product for the time/day stipulated by the professional. It is worth noting

that, even with the literature suggesting lower wearing-times of acetate tray/dental bleaching products [18, 19], the current patient was instructed to wear the bleaching product for 6 to 8 h/day, which could provide a better degree of compliance.

The orthodontic literature [9–15] has reported the use of the TheraMon sensor, which identifies temperature changes, enabling the assessment of the wearing-times of the removable orthodontic appliances in the oral cavity. Considering these studies, the present report embedded the microsensor in the acetate custom tray to record the daily wearing-time of the acetate tray/bleaching product. The objective of the present study was successfully accomplished, as the wearing-times were precisely measured and depicted in Fig. 7.

From the start to completion of the bleaching treatment (24 days), similar wearing-times of the acetate trays were demonstrated: 7.10 h/day (7:06 h/min) (Fig. 7a) and 7.08 h/day (7:04 h/min) (Fig. 7b) for the upper and lower arches, respectively. However, the patient did not correctly follow the recommendations for the daily wearing-time of the acetate tray/bleaching product on both dental arches and did not wear the trays on 3 and 1 days of treatment for the upper and lower arches, respectively; while longer or shorter wearing-times were used than what was recommended, ranging from 0.25 to 10.0 h/day and 0.75 h/day to 10.0 h/days for the upper and lower acetate trays, respectively.

Schott and Ludwig [13] verified that patients attempt to compensate for days in which they wore their appliances for only a few hours by using the appliances for more hours than advised on other days. However, the current patient reported the days that the acetate trays/bleaching products were not worn or were worn for less time than prescribed. The reason provided was that the bleaching product was used up and not available; days when the use of acetate trays/dental bleaching was exceeded corresponded to days where the patient slept for more than 8 h.

Sensitivity was not observed in the present case report, likely due to the absence of carious lesions and exposed dentin tissue especially in the incisal and cervical regions, defective restorations, abfraction lesions, or enamel-cementum abrasion [4–7, 20]. The patient was satisfied with the final color of the teeth obtained with the bleaching treatment; even though the patient did not wear the bleaching product for 3 days in the upper arch and 1 day for the lower arch, or that the patient used the trays for about 2 h on three different days. The bleaching protocol could have been obtained in a shorter number of days of treatment if the patient had used the acetate tray/bleaching product every day, as was first stipulated. It has been reported that carbamide peroxide releases about 50% of its peroxide in the first 2 to 4 h, then the remainder over the next 2 to 6 h[21]; moreover, its degradation rate is accelerated during the first hour, with 50% of the active agent available after 2 h and 10% available after 10 h [22].

According to the present clinical case report, the microsensor TheraMon can be beneficial for both clinicians and patients for obtaining an effective bleaching treatment according to the needs and expectations of the patient. Likewise, this commercially available sensor can be inserted into the removable appliance by a dental technician as part of routine practice. It is suggested that shorter bleaching wearing-times are noteworthy for future studies employing the TheraMon microsensor to seek the ideal bleaching time and the degree of compliance of patients during dental bleaching with acetate trays and carbamide peroxide.

Conclusions

The following conclusions can be drawn from the current results:

1. Dental re-bleaching of teeth previously subjected to microabrasion presented a satisfactory bleaching result when using 10% carbamide peroxide gel.
2. The TheraMon microsensor, when embedded in a custom acetate tray, can measure the wearing-times of an acetate tray/bleaching product during home dental bleaching, enabling the assessment of the degree of the patient's compliance during treatment.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Ethical approval was not necessary for this type of clinical case report.

Informed consent For this type of study, formal consent is not required.

Submission declaration and verification The results of the manuscript have not been published elsewhere. The publication was approved by all authors and will not be published in the same form anywhere else.

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