In-Office Whitening

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Abstract

In this chapter, the step-by-step procedure of in-office whitening (or in-office bleaching) and the efficacy and side effects of this bleaching modality will be presented. Other characteristics of this protocol such as the number of clinical appointments required to achieve effective whitening, concentration of the bleaching products, the effects of dentin dehydration and demineralization on the final outcome, as well as bleaching-induced tooth sensitivity will be addressed. At the end, some frequently asked questions will be answered.

7.1 Introduction

In-office whitening is a treatment option in the dental bleaching armamentarium. Not every patient can wear tray delivery products. Some patients do not adapt well to the at-home protocol due to the need of the daily usage of a bleaching tray as well as the need to wait for some weeks to see the results of the treatment. In some cases, in-office bleaching is performed to motivate patients before starting an at-home protocol in the combined or jump-start technique.

This is the reason why in-office bleaching should be considered an alternative option to the more traditional and safer at-home bleaching procedures. Several aspects of in-office bleaching modality will be discussed in this chapter to provide

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clinicians with a better understanding of the protocol and particularities of the technique and facilitate its incorporation into the daily practice with confidence.

7.2 Efficacy

In-office whitening is performed with high concentrations of hydrogen peroxide (HP), usually ranging from 15 to 40 %. Regardless the concentration of the bleaching gel, HP is the active molecule that acts as a strong oxidizing agent through the formation of free radicals, reactive oxygen molecules, and HP anions (Bowles and Ugwuneri 1987).

Previous studies have claimed that tooth shade is affected by the intrinsic organic chromophores present in the dental structure (Fuss et al. 1989; Watts and Addy 2001; Sulieman et al. 2003; Joiner 2006). Organic chromophores are colorful chemical molecules, which consist of complex molecules such as aromatic compounds or bioinorganic metallic complexes such as chelates (Eimar et al. 2012b). These chemical compounds can be easily identified with Fourier Transform Infra-Red (FTIR) and Raman spectroscopies (Eimar et al. 2012b). However, studies using these techniques researchers were never able to detect any of these potential chromophores (Fattibene et al. 2005; Eimar et al. 2011, 2012a). More recently, researchers suggested that HP whitens teeth by mere oxidation of the transparent organic matrices. This process turns them whiter and more opaque, which results in whiter dental appearance (Kawamoto and Tsujimoto 2004; Eimar et al. 2012b).

Some particularities of in-office bleaching should, however, be discussed. The lighter appearance of teeth immediately after an in-office bleaching session cannot be only attributed to the oxidizing action of the HP into the dental organic substrate. Apart from oxidization, dental dehydration and enamel demineralization are expected to occur. As in-office bleaching is usually performed under isolation (rubber dam or light-cured gingival barrier plus lip and cheek retractors), dental dehydration will be always associated with the procedure. This effect is demonstrated when a rubber dam is used to isolate the teeth even for short periods of time (Fig. 7.1). A recent research paper (Burki et al. 2013) demonstrated that the application of a rubber dam alone, even for a short period of 10 min, would cause a lightening of the tooth for a ΔE of 7.3, without any actual bleaching having occurred. Dehydration of teeth can make them appear whiter by increasing enamel opacity. Light can no longer scatter from hydroxyapatite crystal to crystal (Fondriest 2003; Burki et al. 2013). Loss of translucency on dehydration causes more reflection, masking the underlying color of dentin, and thus appears lighter. This "lightened" teeth (by dehydration) return to a normal color after a period of hours or days (Fig. 7.1).

Apart from dehydration, enamel demineralization results from the low pH of most bleaching products currently available. Most in-office bleaching gels are delivered in low pH because they are more stable in acid solutions than in basic solutions. When HP is to be stored, a weak acid is usually added to the solution to prevent it from decomposing (Chen et al. 1993), which makes the bleaching product acidic

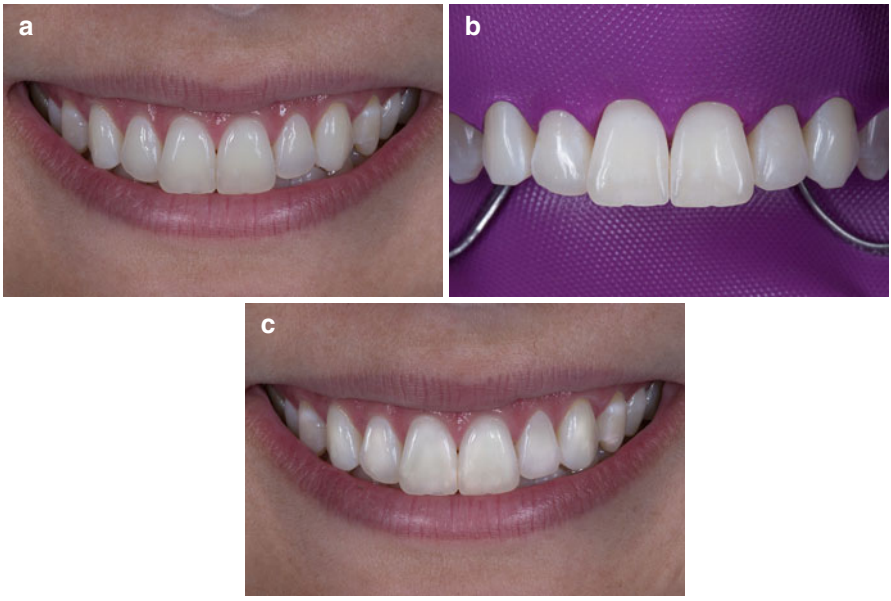

Fig. 7.1 The effect of rubber dam on lightness can be observed in these three photographs. (**a**) Patient's smile before rubber dam isolation. (**b**) The rubber dam was placed in the upper dental arch and left undisturbed for 10 min. (**c**) The effect of dehydration is observed immediately after rubber dam removal (Images provided by Camilo Andrés Pulido Mora, DDS, MS)

enough to produce enamel demineralization. The pH of in-office bleaching gels may vary from 2.0 to 9.0 (Price et al. 2000; Freire et al. 2009; Majeed et al. 2011).

Therefore, taking into consideration that transient dental dehydration and demineralization occurs concomitantly to the permanent effect of dental bleaching during in-office bleaching, the result of in-office bleaching cannot be assessed immediately after the in-office bleaching session. The reliability of color measurements is questionable if carried out immediately after treatment, leading to the conclusion that in-office whitening is as efficient as at-home bleaching.

The effect of color change when evaluated before complete dental rehydration occurred in the study of Matis et al. (2007). The graphic below shows the changes in L^* (Fig. 7.2) and b^* (Fig. 7.3) parameters after a single in-office bleaching session. In the "x" axis, time 0 means the color taken immediately after in-office bleaching and the other times represent weekly measures up to 6 weeks. In general, color change (L^* and b^* parameters) seems much more pronounced when they were measured immediately after the procedure (time 0), with significant reductions of L^* and increases of b^* after 1–2 weeks due to the dental rehydration and remineralization. Therefore, the "real" bleaching effect (produced by oxidization) can only be measured 1–2 weeks after the end of the in-office bleaching.

The difference between the "whitening outcome" observed immediately after bleaching and that measured 1 week later has been erroneously interpreted as color rebound, with some researchers concluding that in-office bleaching is not as efficient

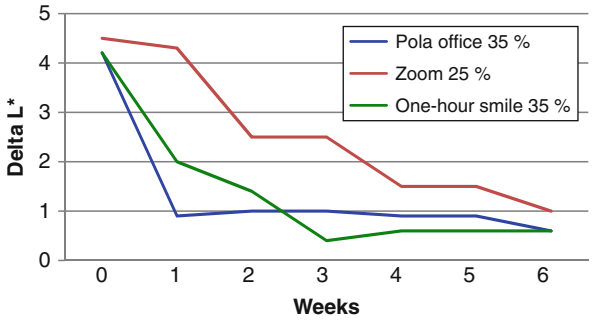

Fig. 7.2 Variation in the ΔL^* in a 6-week period after a single in-office bleaching with different products (Adapted from Matis et al. 2007)

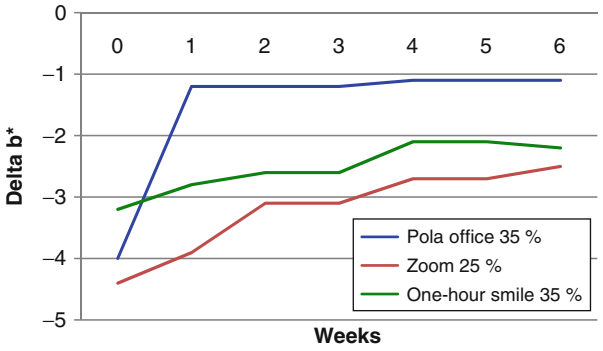

Fig. 7.3 Variation in the Δb^* in a 6-week period after a single in-office bleaching with different products (Adapted from Matis et al. 2007)

as at-home bleaching (Matis et al. 2007). Several studies have demonstrated that 1 week of at-home bleaching with 10 or 16% carbamide peroxide gel usually results in a change of two to four shade guide units in the value-oriented Vita Classical A1-D4™ shade guide (VITA Zahnfabrik H. Rauter GmbH & Co.KG, Bad Säckingen, Germany) (Zekonis et al. 2003; Bernardon et al. 2010; da Costa et al. 2010; Rezende et al. 2013). This is approximately equivalent to the change reported after a single in-office bleaching session with 35% HP gel when used for 45–60 min (Zekonis et al. 2003; Bernardon et al. 2010; Kossatz et al. 2011; Reis et al. 2011b).

There are also other factors that may explain the general belief that in-office bleaching is not effective. It is known that the whitening effect is related to the concentration, application time, and the number of changes of the in-office bleaching gel (Dietschi et al. 2006; Joiner 2006; Matis et al. 2007). In an ongoing systematic review of the literature (Luque-Martinez et al. 2016) we observed a high heterogeneity among studies in many issues, such as type of materials, concentration of the products, and significant variations in in-office bleaching protocols.

Inefficient bleaching protocols will not lead to a satisfactory bleaching outcome. For instance, some studies performed only a single in-office bleaching session (da Costa et al. 2010; Giachetti et al. 2010; Moghadam et al. 2013; Pintado-Palomino et al. 2015), which is not enough to reach patient's satisfaction (de Silva Gottardi et al. 2006; Salem and Osman 2011). At least two or three bleaching sessions may need to be performed to obtain a similar whitening degree of a 2 or 3-week at-home

bleaching (Marson et al. 2008b; Tay et al. 2009; Bernardon et al. 2010; Basting et al. 2012; Reis et al. 2011b, 2013).

Similar variation occurs in regard to product application time. While a 40–50-min application is related with a significant whitening outcome, there are reports of shorter application times, such as 10–20 min (Auschill et al. 2005; Giachetti et al. 2010; Mehta et al. 2013). A very recent clinical study reported that a single 15-min application of the 35 % HP does not achieve the same degree of whitening produced by two and three 15-min applications of the same product (Kose et al. 2015).

Some manufacturers advocate the application of their products with light activation (quartz–tungsten halogen light curing units, LEDs, and lasers) to optimize the bleaching outcome (Ziemba et al. 2005; Kishi et al. 2011; Bortolatto et al. 2014). The benefits of this association are rather controversial (Buchalla and Attin 2007; He et al. 2012), but it seems to be useless for high-concentrated HP gels (Marson et al. 2008b; Alomari and El Daraa 2010; Kossatz et al. 2011; He et al. 2012). For low-concentrated HP gels this light association may have some benefits, but this still requires further evaluations (Ziemba et al. 2005; Ontiveros and Paravina 2009; Bortolatto et al. 2014). This will be discussed in more detail in the section of frequently asked questions in this chapter.

This variation makes the comparison of the in-office bleaching protocols very difficult. However, efficient whitening has been observed in studies that employed 35 % HP, with reports of overall color change of five to eight shade guide units after two in-office bleaching sessions (Marson et al. 2008b; Tay et al. 2009; Bernardon et al. 2010; Strobl et al. 2010; Reis et al. 2011a). This wide range of color change probably is the result of the small variations in the HP concentration, number of bleaching sessions, and baseline color of the participants in the clinical trials (Rezende et al. 2015b).

7.3 Adverse Effects

As in-office bleaching is used with higher HP concentrations, there are more concerns about adverse effects in comparison with at-home bleaching. The two most frequent adverse effect of in-office bleaching is bleaching-induced tooth sensitivity (TS) and gingival tissue burning.

7.3.1 Bleaching-Induced Tooth Sensitivity (TS)

While effective bleaching is reported to occur with in-office bleaching, several publications have reported that patients undergoing bleaching procedures frequently complain of painful and uncomfortable sensations arising in the treated teeth. Although pain in bleached teeth can be evoked by cold or other stimuli, most patients complain of tingling or shooting pain (zingers) of very short duration but variable frequency (Haywood 2005) without provoking stimuli (Markowitz 2010).

Unfortunately, this side effect is very frequent. The reported risk of bleaching-induced TS in clinical trials of dental bleaching is quite variable but easily exceeds 50 %. A recent study that evaluated the individual patient data of 11 clinical trials regarding bleaching produced a more accurate estimate of these risks. For in-office bleaching in higher concentration (35 %), the risk of TS was reported to be 62.9 % (95 % CI 56.9–67.3), which was not too different from that reported for 10–16 % carbamide peroxide for at-home bleaching (51 % with a 95 % CI 41.4–60.6) (Rezende et al. 2015b). Although the risk of TS was reported to be similar, the intensity of TS was very different between bleaching protocols. In a 0–4 pain scale, the overall mean intensity of bleaching-induced TS for in-office bleaching was 2.8 ± 2.9, while for at-home bleaching was 0.5 ± 0.9 (Rezende et al. 2015b).

The etiology of bleaching-induced TS is not fully understood. Since the hydrodynamic theory of dentin sensitivity has been widely accepted as the explanation of dentinal sensation, some authors have used this theory to explain bleaching-induced TS (Swift 2005). However, pain during and following bleaching treatment can affect intact teeth lacking dentin exposure and this is in sharp contrast with the hydrodynamic theory (Markowitz 2010).

In face of that, other investigators have hypothesized that bleaching-induced TS may result from some degree of pulpal inflammation due to the higher amount of HP that reaches the pulp. It is widely known that HP can pass easily through the enamel and dentin to the pulp (Cooper et al. 1992) and can cause damage to the pulp cells as seen in Chap. 5 (Costa et al. 2010). Further proof of this passage of HP is the fact that color changes in dentin next to the pulp occur as fast they do at the dentin–enamel junction (McCaslin et al. 1999; Haywood 2005). Pulp tissue damage is likely to lead to the release of cell-derived factors, such as adenosine triphosphate (Cook and McCleskey 2002) and prostaglandins, which excite or sensitize pulpal nociceptors (Huynh and Yagiela 2003) causing the bleaching-induced TS (please refer to Chap. 5).

Several factors may affect the ability of HP to permeate the dental structures and consequently the damage produced by the bleaching gels. For instance, the amount of HP that permeates dental pulps is higher in teeth with restorations (Gokay et al. 2000; Patri et al. 2013; Parreiras et al. 2014). In restored teeth, the depth and size of the restorations (Parreiras et al. 2014), as well as the type of adhesive and restorative material (Gokay et al. 2000), may also play a significant role on the amount of HP penetration.

The tooth type is another important factor. Literature findings report that for the upper dental arch (Bonafe et al. 2013), the tooth that was reported to give most complaints of bleaching-induced TS was the upper lateral incisor. The thinner enamel and dentin layers of incisors compared to other teeth may allow the fast passage of HP to the pulp, allowing less time for the production and release of protective enzymes against damage by HP. This was also in agreement with recent histological studies of human pulps after in-office bleaching (Costa et al. 2010; Roderjan et al. 2015). In one study (Costa et al. 2010), the authors observed notable damage to the pulp tissue of lower incisors but not to premolars (Chap. 5).

Baseline color was strongly associated with TS in a recent study that pooled the data from 11 studies from the same research group (Rezende et al. 2015b). In other words, the darker the teeth, the lower the intensity and risk of TS. Darker teeth

probably have higher organic content to retain the HP in the enamel and dentin substrates, allowing less surplus HP to travel to the pulp tissue. Under these circumstances, it is possible that less HP comes in contact with the pulp tissue, which generates lower TS. This, however, is a hypothesis yet not supported by basic research.

Several approaches have been tested to minimize the adverse side effect of TS. The administration of some drugs perioperatively during in-office bleaching, such as selective anti-inflammatory drugs (etoricoxibe) (de Paula et al. 2013), nonsteroid anti-inflammatory drugs (ibuprofen) (Charakorn et al. 2009; Paula et al. 2013), antioxidants (ascorbic acid) (de Paula et al. 2014), and corticoids (dexamethasone) (Rezende et al. 2015a), was not effective to prevent the risk as well as the intensity of TS as confirmed by a recent systematic review of the literature (Faria et al. 2015). Under per-oral administration, several factors such as the immune system, lymphatic drainage, urinary excretion, and morphological characteristics of the dentin substrate may modulate the amount of the medicine that reaches the plasma and extracellular fluid around pulp cells, making these approaches not effective.

The most effective measures to minimize this side effect were through the application of topical desensitizers (Wang et al. 2015). The preoperative application of a gel composed of 5 % potassium nitrate and 2 % sodium fluoride for 10 min was capable to reduce the risk of TS by half, as well as the intensity of TS (Tay et al. 2009). The effect of fluoride in this process is not clear and the desensitizing effect of the association of sodium fluoride and potassium nitrate seems to be more related to the presence of potassium nitrate. This substance penetrates the enamel and dentin to travel to the pulp where it creates a calming effect on the nerve by affecting the transmission of nerve impulses (Ajcharanukul et al. 2007). After the nerve depolarizes in the pain stimulus response, it cannot repolarize, so the excitability of the nerve is reduced. Potassium nitrate has almost an anesthetic effect on the nerve (Haywood 2005).

In regard to the action of fluorides, it is hypothesized that the precipitation of calcium fluoride crystals in dentin can reduce the functional radius of the dentinal tubules and also the permeability of this tissue to the hydrogen peroxide. By doing so, less hydrogen peroxide reaches the pulp chamber, reducing the tooth sensitivity. This, however, is yet to be confirmed, as this process seems to occur only when there are exposed dentin surfaces.

Another study showed that previous desensitization with Gluma desensitizer (Heraeus Kulzer), composed of 5 wt% glutaraldehyde and 35 % weight% HEMA (Baba et al. 2002; Qin et al. 2006), for 1 min significantly reduced sensitivity of the anterior teeth during and after whitening compared with a placebo pretreatment (Mehta et al. 2013). The authors of this study hypothesized that glutaraldehyde (molar mass 100 g/moL) and HEMA (molar mass 130 g/moL) might penetrate through enamel and dentin along the same pathway as the peroxide radicals. On the way to the pulp, glutaraldehyde might react by cross-linking with enamel matrix proteins and with proteins in the dentin tubular liquid, thus reducing easy passage of the HP radicals to the pulp.

Although some opinion leaders claim that application of desensitizer gels prior to in-office bleaching affects the bleaching efficacy, this was not confirmed by recent meta-analyses of the literature (Wang et al. 2015), probably because the desensitizer gels used are transparent.

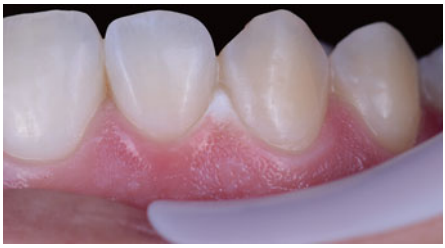

Fig. 7.4 Chemical burning of the cervical gingiva of several teeth after an in-office bleaching application with a high-concentration hydrogen peroxide

7.3.2 Gingival Tissue Irritation

As long as adequate protection of the gingival tissues is performed with a light-cured gingival barrier or rubber dam isolation, gingival burning (Fig. 7.4) is not expected to occur. This is usually not reported in clinical trials of in-office bleaching studies and reflects the clinical experience of the study authors. As seen in Chap. 4, in case this occurs the dentist should apply a drop of catalase and/or sodium bicarbonate (usually provided by the manufacturer) on the ulcerated lesion to arrest the burning effect. No other measure is usually required; but in case the patient feels any discomfort, a corticoid ointment may be prescribed to relieve pain.

7.4 Treatment Regimen with Step-By-Step Procedures

As mentioned earlier, in-office bleaching protocols vary significantly in the clinical reports. The application time of the bleaching gel, the number of bleaching sessions, whether or not the protocol is associated with light and the number of product refreshment on the dental surface are some examples.

In this chapter, we will describe all steps involved in an effective bleaching protocol and also report some of the variations of each step as long as they can still result in an effective whitening outcome. For didactic reasons, this section will be described in steps.

7.4.1 Making a Decision About the In-Office Bleaching Gel

There are many in-office bleaching products in the dental market, which makes their choice quite difficult. They vary in the active concentration of HP, which ranges usually from 15 to 40 % and in terms of pH (Freire et al. 2009; Price et al. 2000; Majeed et al. 2011). There are some products that contain other additives such as calcium gluconate and calcium phosphates and desensitizing agents (sodium fluoride, potassium nitrate). These systems also vary in their mode of application: most of them require product refreshment during a single in-office session, while for some products; a single 40–50-min application is required.

The literature is scarce regarding the comparison of these systems both in terms of effectiveness and side effects, and, therefore, the choice of these products is

usually based on empirical evidence. Comparison of in-office bleaching gels with different HP concentrations is also scarce. A single study that compared the color change and bleaching-induced TS of 20 % versus 35 % HP with 2 % calcium gluconate reported no significant difference in the risk of TS and a significant lower degree of whitening for the 20 % HP gel (Reis et al. 2013).

As previously mentioned, whitening products should have a relatively alkaline pH to minimize potential damage, but there is a wide pH variation among in-office bleaching gels (Price et al. 2000; Freire et al. 2009; Majeed et al. 2011). This variation could be the result of the different formulations used by each manufacturer, because bleaching agents contain stabilizers and other inorganic components that allow them to be stored for prolonged periods. In-office bleaching gels are delivered in low pH because they are more stable in acidic solutions than in basic solutions. When the HP is manufactured, a weak acid is usually added to the solution to prevent it from decomposing (Chen et al. 1993).

Some investigators have reported that the HP delivered in an alkaline medium increases the effectiveness of bleaching in the wool industry. This effectiveness is explained by the fact that the dissociation constant of the HP is about 11.5. In fact, the findings of one study showed that in a pH = 9.0, the dissociation rate of the HP was 2.7 times higher than that in an acidic solution (pH = 4.4) (Frysh et al. 1995) and this was recently confirmed by Torres et al. (Torres et al. 2014). They observed in vitro that the efficacy of hydrogen peroxide bleaching is directly proportional to the increase of the pH of the bleaching gel. These variations, however, did not seem to produce differences in tooth-bleaching effectiveness when products with acidic and alkaline pH were compared, although a significant decrease of tooth sensitivity has been shown for alkaline gels (Kossatz et al. 2012).

Additionally, it is worth mentioning that alkaline gels usually show more stable pH during application than acidic gels (Marson et al. 2008a), which allows them to be applied in a single application without the need of several product replenishments (Reis et al. 2011a, b; Kossatz et al. 2012).

Although there is biological plausibility to choose bleaching products containing desensitizing agents such as potassium nitrate, to the best of the authors' knowledge no randomized clinical trials have compared the TS levels produced by in-office gels with and without desensitizer agents. Only at-home clinical studies evaluated this hypothesis (Navarra et al. 2014; Gallo et al. 2009) as previously mentioned in the Chap. 6.

In summary, we recommend the use of 35 % alkaline gels, containing desensitizing agents. As mentioned in the section on frequently asked questions, reduced HP concentration can be used in the combined or jumped-started technique. In regard to the presence of desensitizing agents, we still recommend products containing it. The absence of evidence that desensitizing containing gels can reduce TS cannot be interpreted as evidence of absence of an effect. These studies are usually low powered and we cannot rule out the fact that desensitizing-containing gels can provide some beneficial effect. Until high-powered studies are published, we should work in the conservative way and use such type of products, as they do not have any known detrimental effects. Finally, products should be applied according to the respective manufacturer's instructions.

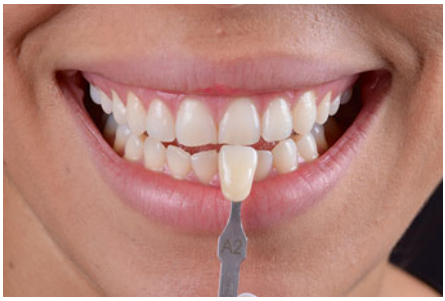

Fig. 7.5 The baseline tooth color being recorded with a value-oriented shade guide after performing a dental prophylaxis

7.4.2 Determination of the Baseline Tooth Color

This procedure allows dentist and also the patient to monitor color change during the bleaching protocol (Fig. 7.5). Patients usually very quickly get used to the new tooth color and may not remember what color their teeth were before protocol. This is even more important when both dental arches are bleached simultaneously. Shade recording can be a procedure with a value-oriented or bleach shade guide (Fig. 7.5), spectrophotometer, or by means of dental photographs.

Some authors encourage whitening one dental arch at a time (Haywood 2005), because it minimizes TS, allows the patient to monitor the opposing arch to compare progress, and it also encourages compliance. However, this procedure increases significantly the cost of the bleaching protocol, as it requires more dental visits.

Another advantage of color recording is that baseline dental color can predict the whitening degree obtained after dental bleaching. A recent multivariable regression analysis (Rezende et al. 2015b) identified a significant relationship between baseline color and age in relation to color change estimates. After adjustment for the other variables, every increase of one shade guide unit (in the value-oriented Vita Classical A1-D4™ shade guide) in the baseline color resulted in an increase of approximate 0.66 in the final color change in ΔSGU and 2.48 for the ΔE, meaning that the darker the baseline tooth color, the higher the degree of whitening. In an opposite trend, the degree of whitening is negatively affected by the participant's age (Rezende et al. 2015b).

This allows for the dentist to manage the patient's expectations in regard to the bleaching outcomes. Older patients with lighter baseline color may request more than the two bleaching sessions to achieve the same whitening degree than younger patients with darker baseline dental color.

It is important to perform a dental prophylaxis recording the baseline tooth color. A recent published paper showed a significant difference (average of two ΔE units of change) on tooth color when measured before and after dental prophylaxis. This may reach the threshold for clinical detection ($\Delta E = 3.0$) for some patients (de Geus et al. 2015).

7.4.3 Application of a Desensitizing Agent

As reported earlier, one of the main side effects of in-office dental bleaching is TS. Although this side effect cannot be completely eliminated, the number of patients that experience TS and the intensity of TS can be reduced by previous application of a desensitizing gel composed of 5 % potassium nitrate (Tay et al. 2009; Wang et al. 2015). Desensitizers composed of glutaraldehyde and HEMA was also reported to be effective to reduce the bleaching-induced TS, and can be an alternative to the potassium nitrate gel (Mehta et al. 2013).

This procedure can be performed before or after isolation of the dental arch, as the material is not aggressive to the gingival tissue. However, as the gel is usually agitated with the aid of a rotating brush it is recommended to apply the desensitizer before the protection of the soft tissues. The buccal surface of all teeth to be bleached should be covered with a 1-mm thick layer of the desensitizer and left in place for at least 10 min (Fig. 7.6). At the end of this period, the product should be agitated in each dental surface for 20 s with a rotating brush before removal. The inclusion of this step into the in-office bleaching protocol does not jeopardize the whitening efficacy of the hydrogen peroxide (Tay et al. 2009). After this period, the product should be removed with gauze (Fig. 7.7) or with a saliva ejector before application of the in-office bleaching gel. Rinsing can be performed as a final step for complete removal of the product.

7.4.4 Protection of the Soft Tissues

Hydrogen peroxide in high concentrations, such as those used for in-office bleaching, may cause burning of the dental tissues (Fig. 7.4). Several attempts should be made to avoid contact with the soft tissues.

The use of lip and cheek retractors associated with a light-cured gingival barrier (Fig. 7.8) is quite common. The former can maintain lips, cheeks, and even tongue away from the bleaching gel while the latter prevents the contact of the bleaching gel with the gingival tissue. An increased frequency of micronuclei of cells from the gingival tissue (which is an evidence of genotoxicity) was observed in patients

Fig. 7.6 Application of a desensitizing gel composed of 5 % potassium nitrate for 10 min (Dessensibilize KF 2 %, FGM, Joinville, SC, Brazil). After this period, the product should be agitated in each dental surface for 20 s with a rotating brush before removal

Fig. 7.7 Removal of the desensitizing gel with dental gauze or high-speed suction. After removal of the excesses, water rinsing was performed

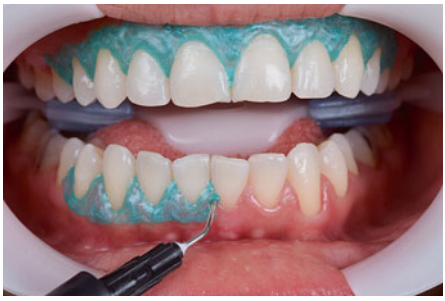

Fig. 7.8 A lip and cheek retractor (ArcFlex, FGM, Joinville, SC, Brazil) is applied, followed by the application of a light-cured gingival barrier to protect the marginal gingival tissue

submitted to in-office bleaching (Klaric et al. 2013), which may be the result of soft burning or even the contact with the gingival barrier. To avoid this, the light-curing gingival barrier should be adequately light cured (Fig. 7.8), according to the respective manufacturer's recommendations, and clinicians should look at the teeth from an incisal aspect to detect any sealing failure of the gingival tissue.

Rubber dam isolation can also be used for protection of the soft tissues. However, before rubber dam installation, a thick layer of petroleum jelly should be applied on the gingival tissue of the teeth to be bleached. Due to the hydrophobic nature of the petroleum jelly, the bleaching gel will be prevented from contacting the gingival tissue even if eventual isolation failure occurs.

7.4.5 Application of the In-Office Bleaching Gel

After choosing the in-office bleaching product, the manufacturer's instructions should be followed (Fig. 7.9 and 7.10). Variations to what is advocated by manufacturers may lead to either whitening at reduced speed or increased TS rates (Reis et al. 2011b; Kose et al. 2015). By increasing the number and/or time of application, one may increase the degree of whitening obtained but at the time the risk of TS is also increased. In an opposite trend, reducing the number and/or time of application reduces the probability of TS but also limits the degree of whitening.

Most in-office bleaching gels require replenishing the product during a period that varies from 40 to 50 min. Some products require two, three, or four product replenishments in each clinical session. There are some products, however, that are indicated for a single 40–50-min application without replenishment. These products

usually possess a basic pH that allows them to be used for longer application times without increasing the risk of TS (Kossatz et al. 2012; Reis et al. 2013). The product should be firstly removed with a cotton pellet, gauze, or high-speed suction (Fig. 7.11) before rinsing the dental surfaces with water. This procedure prevents any kind of soft tissue burning.

A recent clinical trial evaluated the impact of changing the bleaching protocol of a high-concentration (35 %) in-office bleaching product. Instead of performing three 15-min applications as suggested by the manufacturer, the product was kept for 45 min without replenishment. A reduction of the bleaching speed and increase in the TS intensity was observed, probably as a result of the slow but significant reduction of the pH of the product throughout the 45-min application (Reis et al. 2011b).

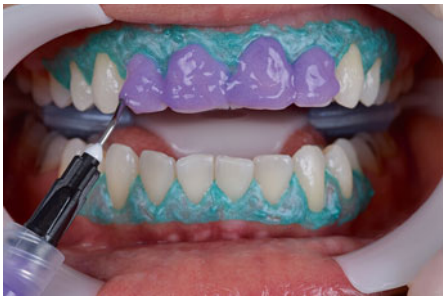

Fig. 7.9 The 35 % hydrogen peroxide in-office bleaching gel (Whiteness HP Blue 35 %, FGM, Joinville, SC, Brazil) is mixed and applied in all teeth to be bleached

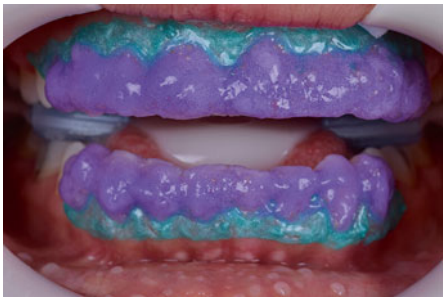

Fig. 7.10 After some time in place, bubbles are visible in the gel, which result from the decomposition of the hydrogen peroxide

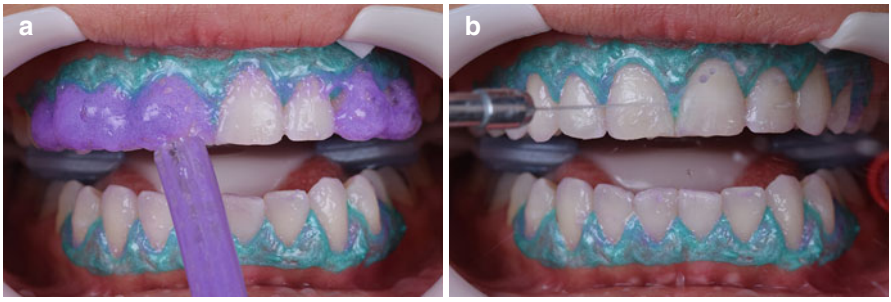

Fig. 7.11 (**a**) A suction tip was first used to remove the gel prior to (**b**) water rinsing of the tooth surfaces

As discussed in more detail in the section on frequently asked questions, some manufactures advocate the application of their products with light activation (quartz–tungsten halogen light curing units, LEDs or lasers) to optimize the bleaching outcome (Ziemba et al. 2005; Bortolatto et al. 2014). A recent systematic review of the literature concluded that light increases the risk of TS during in-office bleaching, and light may not improve the bleaching effect when high concentrations of HP (25–35 %) are employed. Therefore, dentists should use the light-activated system with great caution or avoid its use altogether (He et al. 2012). However, for low-concentrated HP gels the benefits of such association is yet to be determined.

Some manufacturers advocate the application of their products with light activation (quartz–tungsten halogen light curing units, LEDs, and lasers) to optimize the bleaching outcome (Ziemba et al. 2005; Kishi et al. 2011; Bortolatto et al. 2014). The benefits of this association are rather controversial (Buchalla and Attin 2007; He et al. 2012), but it seems to be useless for high-concentrated HP gels (Marson et al. 2008b; Alomari and El Daraa 2010; Kossatz et al. 2011; He et al. 2012). For low-concentrated HP gels, this light association may have some benefits; but this still requires further evaluations (Ziemba et al. 2005; Ontiveros and Paravina 2009; Bortolatto et al. 2014). This is discussed in more detail in the section on frequently asked questions in this chapter.

A single in-office bleaching session is usually not enough to achieve patient's satisfaction (de Silva Gottardi et al. 2006; Salem and Osman 2011). Studies that demonstrate that in-office bleaching is as effective as at-home bleaching usually performed two to three in-office bleaching sessions. Because in-office whitening often takes more than one appointment to achieve the adequate whitening, appointments generally are scheduled at least 1 week apart to allow the discomfort to dissipate. However, this procedure is purely based on empirical evidence.

Several clinical studies from our research group indicated that the TS induced by in-office only cause complaints during the initial 48 h post bleaching. Also, a recent randomized clinical trial revealed that a 2-day interval between two in-office bleaching sessions did not increase the risk and intensity of bleaching-induced TS (de Paula et al. 2015). However, in this paper, a calcium-containing alkaline gel applied for a single 40-min application without replenishment was used (de Paula et al. 2015), which prevent us from generalizing this protocol to all in-office bleaching gels present in the market.

In the clinical case, two clinical appointments were required to achieve patient satisfaction. The color achieved after the end of the bleaching procedure should be recorded with the same instrument used to record the baseline color. This measurement, however, should be done 4–7 days after the last in-office bleaching session to avoid the effects of dehydration and demineralization on the final outcomes (Fig. 7.12).

7.5 Durability of Color Change and Need for Touch-Up

As explained earlier in this chapter, the very short color reversal that occurs within some days after the in-office bleaching session cannot be interpreted as lack of effectiveness of the in-office bleaching protocol. In a way to avoid patient's

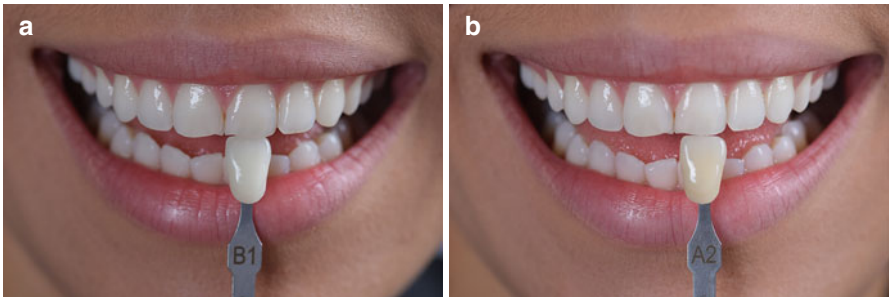

Fig. 7.12 One week after the second in-office bleaching session, the color of the patient's teeth was checked. (**a**) Teeth reached B1 color (the lightest color in the value-oriented Vita Classical shade guide), which is five tabs lighter than the baseline patient's teeth (A2) at the beginning of the treatment (**b**)

frustration, they should be instructed that a slight darkening is expected to occur in the following days as a result of dental rehydration and remineralization, and this does not necessarily mean that the bleaching was not efficient. An adequate measurement of the baseline tooth color will allow dentist to monitor the degree of color change that was due to the oxidizing nature of the hydrogen peroxide gel.

Although there are many randomized clinical trials reporting the immediate effects of several bleaching techniques, few of them evaluated the long-term efficacy of in-office bleaching (Giachetti et al. 2010; Mondelli et al. 2012; Tay et al. 2012). The few studies reported in the literature showed that in-office bleaching has stable results in periods ranging from 9 months to 2 years (Giachetti et al. 2010; Tay et al. 2012).

On the other hand, we may expect darkening of the dental structure in longer periods of time. As teeth grow older, there is a continuous deposition of secondary dentin by the pulp and higher enamel wear. Both factors together increase the yellowish appearance of the teeth. Additionally, we cannot rule out the effect of the staining produced by beverages and food (Meireles et al. 2010). Although this is usually an extrinsic staining and therefore may be easily removed by prophylaxis, it may affect the patient's overall perception of whiter teeth.

Based on the aforementioned explanations, touch-up bleaching may be performed whenever color rebound is detected. Specific protocols and products were discussed in the Chap. 6. Other option is to apply a new single in-office bleaching session that may achieve satisfactory results. It may be emphasized, however, that the literature lacks randomized clinical trials on this topic.

7.6 Frequently Asked Questions

7.6.1 Do We Need Lights to Activate Peroxidases?

As heat and light can accelerate the dissociation of hydrogen peroxide (Ontiveros 2011), both methods have been associated with in-office bleaching as early as 1918 (Abbot 1918). However, as we already mentioned earlier in this chapter, the

literature findings point out that there is no advantage of associating it with high concentrations of HP gels (Marson et al. 2008b; Alomari and El Daraa 2010; Kossatz et al. 2011; He et al. 2012).

At first glance, this seems to be contradictory. In fact, from chemical theories, one knows that in the simplest chemical reactions, the highest concentration of reactants raises collisions per unit time, and hence increases the reaction rate. However, if the reaction is complex and involves a series of consecutive steps, there might be a limit to which the increased concentration leads to faster reaction rates. We hypothesize that 35 % HP alone already produces enough free radicals for oxidizing organic component of dentin, and, thus, the increase in free radicals produced by the light activation might be useless. Consequently, the further increases in HP radicals produced by light activation do not lead to faster bleaching due to the presence of unknown rate-determining steps in the oxidizing mechanism of tooth bleaching.

On the other hand, this may not be the case when using low HP gels. Randomized clinical trials that evaluated the effect of light associated with low HP concentration seemed to show a faster whitening degree (Tavares et al. 2003; Ontiveros and Paravina 2009). This may not be the case when using low HP concentrated gels. For these gels it seems that the limiting factor of the oxidizing reaction rate was the amount of free radicals, and thus the association with light, which likely increases the amount of free radicals, may produce a faster reaction rate and a whitening degree similar to that of the 35 % HP gel associated or not with light (He et al. 2012; Bortolatto et al. 2014). However, these findings are still preliminary and require further evaluations.

7.6.2 Are Light-Activated Peroxides Available?

Some manufacturers indicated that their products contain orange-red color of carotene as colorants and these compounds can be considered as activators because they absorb primarily at wavelengths of blue lights. If the bleaching agent absorbs the light energy of this wavelength, it heats and thus decomposes (Ontiveros 2011). Unfortunately, a literature review indicated that although the temperature of the carotene-containing bleaching gel can increase considerably, this increase was not high enough to accelerate HP decomposition significantly (Buchalla and Attin 2007).

Another option is the addition of some metals to enhance the oxidizing power of the HP, as ferrous compounds or titanium dioxide. The photolysis of HP associated with these compounds needs to be activated by a very specific wavelength, which depends on the metals included (Ziemba et al. 2005; Kishi et al. 2011; Ontiveros 2011; Bortolatto et al. 2014).

For instance, one manufacturer combined iron with a low-concentrated HP formulation. With ferrous compounds, HP can be combined with iron known as Fenton reagent. Fenton reagents result in disproportion in which the iron is simultaneously reduced and oxidized to form both hydroxyl and peroxide radicals by the same HP. When Fe reacts (with or without UV radiation), the process is renewed and the redox reaction is further fueled (Ontiveros 2011). This is the reason why products that contain ferrous components recommend light activation by ultraviolet lights

(Kugel et al. 2009; Ontiveros and Paravina 2009). The use of UV lamps requires care. Patients, dentist, and auxiliaries should be protected because of the known damage the ultraviolet radiation can cause on the skin. It should be mentioned that Fenton reaction occurs with or without ultraviolet light activation. Perhaps, futures studies should focus on the evaluation of the bleaching efficacy of these bleaching systems without the use of UV lights.

Some low-concentrated HP gels (6–15 %) containing semiconductors of titanium oxide nanoparticles doped with nitrogen have shown good bleaching efficacy comparable to 35 % HP gels (Bortolatto et al. 2014; Martin et al. 2015). When exposed to blue light (LED/Laser device), these nanoparticles catalyze the formation of hydroxyl radicals from HP (Sakai et al. 2007). As these titanium oxide bleaching formulations can be used with visible lights they are safer than the previous formulations that recommend UV light activation.

7.6.3 Manufacturers Recommend Several Consecutive Applications of the In-Office Whitening Gel? How Many Applications Are Needed? For How Long?

Clinicians should follow the manufacturer's instructions for application of the in-office bleaching gels. There are some products that are necessary to be refreshed two to four times in a 40–50-min clinical session, while other products require that the product be left undisturbed for the whole period it stands on the dental surface. It is suggested that acidic gels and those that do show reduction of the pH over time should be refreshed; alkaline gels that keep the pH alkaline during application can be left on the surface for the whole application period.

However, this can be changed based on the patient's profile. In case the professionals are dealing with a very sensitive patient, the number of product refreshments as well as its application time can be reduced. This will probably reduce the risk and intensity of TS (Kose et al. 2015) but will also require more applications to achieve patient's satisfaction.

Usually, two to three in-office bleaching sessions using 35 % HP are required to show a significant color change (Marson et al. 2008b; Tay et al. 2009; Bernardon et al. 2010; Strobl et al. 2010; Reis et al. 2011a), but unfortunately this can vary depending on the baseline color of the participants in the clinical trials (Rezende et al. 2015b).

7.6.4 Are Calcium Phosphate and Fluoride Containing Gels Effective to Decrease Tooth Sensitivity Caused by In-Office Bleaching?

As previously mentioned, there are numerous studies that have exhibited microstructural changes of enamel surface induced by in-office bleaching agents (Dahl and Pallesen 2003) and it results from the low pH of most bleaching products

available in the market. Also, clinicians believe that these superficial alterations to the enamel surface increase TS induced by in-office gels, mainly because the surface becomes more porous to passage of HP.

This led different clinicians to evaluate whether the preoperative application of remineralizing agents (Loguercio et al. 2015) or the addition of different remineralizing products to in-office bleaching formulations (fluoride, calcium phosphate compounds, etc.) (Basting et al. 2012; Kossatz et al. 2012) might have an impact on the reduction of bleaching-induced TS. These studies failed to find a reduction of the bleaching-induced TS; however, no detrimental effect on the whitening efficiency was detected (Basting et al. 2012; Kossatz et al. 2012; Loguercio et al. 2015).

A recent literature review that investigated the impact of bleaching procedures on enamel surface indicated that these adverse on enamel effects are minimal. Laboratory studies that simulated the intraoral conditions as closely as possible reported that as soon as bleached enamel comes in contact with saliva, remineralization occurs and within a few days no adverse effects can be measured (Attin et al. 2009). This was also confirmed by in vivo studies when in-office gels were used after prolonged and repeated applications (Spalding et al. 2003; Cadenaro et al. 2008, 2010).

7.6.5 Why Are Some In-Office Whitening Products Referred to as "Chemically Activated"?

As previously described, the in-office gels are more stable in acid solutions than in alkaline solutions (Chen et al. 1993). This is why the majority of bleaching gels commercially available are presented in two syringes/bottles, one containing the HP product and other containing the colorants, thickening agent, etc.

When clinicians mix both syringes/bottles, a "chemical activation" occurs by mixing two components of the respective bleaching gels, which can indeed increase HP decomposition and the in-office gels are ready to use. This has led to erroneous interpretation of in-office gels being "chemically activated." Actually, the main function of the activating gel component (synonymously referred to as "catalyst" or "booster") is to increase the pH of the mixed gel to achieve a alkaline pH close to the pKa of the hydrogen peroxide (pka = 11.0), thereby increasing the decomposition rate of peroxide and the formation of oxidative radicals (Buchalla and Attin 2007).

7.6.6 Does the "Jump-Start" Technique Improve the Final Result of a Whitening Treatment?

As indicated in the Sect. 7.2, there are several factors that may explain the clinician's belief that in-office bleaching is not efficient when compared to at-home bleaching. Thus, the combination of in-office and at-home bleaching ("combined bleaching technique") has been suggested for some clinicians as a way to potentiate the bleaching effect and improve color stability (Kugel et al. 1997; Deliperi et al. 2004; Matis et al. 2009; Bernardon et al. 2010).

However, considering that both bleaching techniques (in-office and at-home techniques) are effective, the main advantage of the "jump-start" technique is for some patients who demand faster ways of bleaching (Matis et al. 2009; Bernardon et al. 2010). In this way, the "jump-start" technique, as the name suggests, is commonly used to motivate the patients to comply with the at-home bleaching protocol.

Usually, the in-office bleaching is applied before starting the at-home protocol; however, the in-office bleaching can be incorporated in any moment, mainly when there is a low response to the at-home bleaching. The number of in-office bleaching sessions associated with the at-home procedure will be dictated by the patients' demand and the whitening response to the procedure.

Usually, clinical studies that performed the combined or jump-start bleaching technique have used high hydrogen peroxide concentrations for the in-office phase (Kugel et al. 1997; Deliperi et al. 2004; Matis et al. 2009; Bernardon et al. 2010). This means that high levels of bleaching-induced TS were reported (Kugel et al. 1997; Deliperi et al. 2004; Matis et al. 2009; Bernardon et al. 2010).

More recently, a clinical study that compared a low and high concentration of HP combined with 10 % carbamide peroxide for at-home bleaching showed that both protocols yielded the same whitening effect. The constant delivery of the at-home bleaching gel for the 2 weeks following the in-office bleaching might have compensated for the lower HP concentration of the in-office gel. However, the use of the low HP concentration for the in-office phase of the bleaching protocol reduced the risk and intensity of bleaching-induced TS (Rezende et al. 2016).

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