

## Is Dental Bleaching Affected by Factors of Agents, Concentrations and Time of Treatment? A Review Article

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### Abstract

**Introduction:** Several factors can control the esthetics of a smile, including changes in the shape, texture, position and color of teeth. Currently, dental bleaching or tooth whitening is considered as one of the cosmetic dental procedures most frequently required by patients who seek a “perfect white smile”. The aim of this article was to review the techniques of dental bleaching including in-office, at-home and over-the-counter focusing on the agents applied, their concentrations and the time of treatment, and how these three factors can affect the success of dental bleaching.

**Methodology:** An internet search was done to review the articles published about the aim of our study. The search included different websites such as PubMed, Google Scholar, Web of Science, etc.

**Keywords:** Dental Bleaching; Techniques; Agents; Concentrations; Time; Laser; White Smile

### Introduction

Many elements can affect the esthetic look of a smile, and these elements are related to the texture, shape, color and position of teeth. Complex phenomena are involved in the color and appearance of teeth and they are highly affected by the type of surrounding light, light scattering, translucency, opacity and brightness of the substrate [1,2]. Among the various esthetic treatments presented to improve the dental esthetics, dental bleaching comes as the most conservative and effective technique with great popularity [1,3]. It is, nowadays, the optimal choice for external discoloration pigmentation because of its fast execution, little cost and minimal invasiveness [4]. In other words, tooth bleaching is highly requested in the field of dental medicine for its super ability to improve the color of teeth without painful procedures such as crowns or laminated veneers. Three distinct approaches come to the surface for dental bleaching and they include dentist-supervised night guard bleaching, in-office or power bleaching and over-the-counter bleaching. The Dentist-supervised night guard bleaching (at home) depends upon the application of bleaching agent to the teeth with a relatively low concentration and through a custom fabricated tray put at night for at least two weeks. Hydrogen peroxide with concentrations ranging from 3% to 50%, and carbamide peroxide from 1% to 45% are the whitening agents currently used. High concentrations of bleaching agents (15% hydrogen peroxide) are used in in-office-bleaching and they are applied for a shorter period of time. On the other hand, low concentrations of the bleaching agent (6% hydrogen peroxide) are existed in over-the-counter products and they are self-applied to the teeth via strips; they are normally employed twice a day for up to two weeks [5]. The aim of this article was to review the techniques of dental bleaching including

in-office, at-home and over-the-counter focusing on the agents applied, their concentrations and the time of treatment, and how these three factors can affect the success of dental bleaching.

### Dental bleaching methods

Tooth whitening nowadays is one of the dental procedures highly required by patients who want a “perfect white smile” [6]. Vital tooth bleaching can be conducted through three methods: in-office (professionally administered), at-home (professionally dispensed) or over-the-counter (self-administered). Among the different bleaching therapies, the at-home bleaching technique is seen as the gold standard treatment and it is due to its efficacy and biosafety [7]. Regarding the home-use technique, the main advantage is latent in being easy to use with less chair time and a low incidence of tooth sensitivity and gingival irritation [8-11]. On the other hand, what make the in-office dental bleaching gain high popularity compared to the at-home or over-the-counter bleaching techniques are the professional control, avoidance of soft tissue exposure and material ingestion, less total treatment time and the possibility of instant results [12,13]. Hydrogen peroxide or carbamide peroxide is involved in most bleaching solutions as the active ingredient which is applied with or without light activation; it is delivered through various carrier designs [14].

### Light-activated bleaching

Proponents of light-activated bleaching claim that this procedure reduces total in-office bleaching time by energizing hydrogen peroxide through the use of various light sources [6,12,15]. The theoretical advantage is the ability of the light source to heat the hydrogen peroxide, thereby increasing the rate of decomposition of oxygen and accelerating the release of free radicals with higher kinetic energy, thus enhancing the rupture of stain-containing molecules [16,17]. Despite the fact that many curing lights have been introduced onto the dental market for the purpose of accelerating the bleaching process, the effectiveness of such an approach has been controversial [6,18-26]. One of the most common side effects associated with vital tooth bleaching is tooth sensitivity. The incidence of bleaching-induced tooth sensitivity is high and it ranges from 55% to 100% according to different reports and estimates [6,13,23,27,28]; the degree of tooth sensitivity in these reports ranges from very mild to intolerable. As per the existing literature, the pulpal tissue may be badly affected by the heat or light applied for the activation of bleaching agents (halogen, light emitting diode [LED] or laser) [29,30]. It is already reported that the use of intense lights does lead to an increase in the bleach temperature, but it results in elevated intrapulpal temperatures [31] that may further affect the patient’s sensitivity and pulpal health. As dental professionals, we have strong feeling of responsibility towards our patients and hence we seek scientific knowledge about the effective, true and safe bleaching methods and those that are targeting the market and promotional speculation [32].

### Precautions in dental bleaching

It is known that the microhardness, surface roughness and enamel surface morphology are highly affected by the dental bleaching products which can increase the tooth porosity [33-36]. Thus, patients are recommended by many professionals and manufacturers to avoid eating pigment-rich foods during the stage of bleaching in order to reach the desired esthetic results [37-39]. Despite the occurrence of these alterations in the enamel, the increased risk of pigmentation during bleaching has not been confirmed considering that the challenging conditions of the oral environment have been ignored in most of these investigations [40]. *In situ* studies are considered as an intermediate step between laboratory experiments and clinical trials. They are effective in investigating the biological impacts and protective influences of saliva under experimental conditions [34,41]. Therefore, intraoral models provide a clinical reality approach while preserving the sensitivity of laboratory models since the analysis can be carried out outside the oral cavity, using sensitive and accurate methods [38]. Regarding the assessment of the effects of bleaching, three color dimensions have been considered by few studies: the value (DL), the amount of red and green (Da), and the amount of yellow and blue (Db) [3,39,42]. These color parameters are related to human eye color perception and they play an important role in getting the final result through calculating the overall change in tooth color (DE) [1,2].

### Dental bleaching and factors of success

Because of the increasing request for brighter and whiter teeth by patients, various bleaching products have been developed by the industry. Tooth discolorations are varied in terms of appearance, severity, localization, etiology and adherence to tooth structure. They are categorized as intrinsic or extrinsic. Intrinsic discoloration comes as a result of the insertion of chromatogenic material into dentin and enamel during odontogenesis or after eruption. After the eruption of tooth, intrinsic discoloration is mainly caused by pulpal necrosis, aging and iatrogenesis.

Dyes of tea, coffee, orange, carrots, red wine and tobacco stand behind the extrinsic staining of teeth [43,44]. For removing the majority of extrinsic stains, scaling and professional cleaning of discolored teeth are highly recommended. For more tenacious extrinsic discolorations and intrinsic staining, the three distinct bleaching methods should be accompanied by certain bleaching agents and concentrations: dentist-supervised night guard bleaching (at home) typically uses a relatively low concentration of bleaching agent applied to the teeth via a custom fabricated tray put at night for at least two weeks. Hydrogen peroxide at concentrations ranging from 3% to 50% and carbamide peroxide at concentrations from 1% to 45% represent the bleaching agents currently used. In in-office bleaching, high concentrations of agents (15% hydrogen peroxide) are applied for a shorter period of time. On the other hand, the over-the-counter method used products with low concentrations of the bleaching agent (6% hydrogen peroxide), they are self-applied to the teeth twice a day for up to two weeks via strips [5]. In general, hydrogen peroxide-containing products and those containing carbamide peroxide appear with similar efficacy after being tested *in vivo* [5,45]. Treatment time, besides the bleaching agent and its concentration, also plays an important role in bleaching success. After comparing the *in vitro* tooth bleaching efficacy of gels containing 5%-35% hydrogen peroxide, Sulieman and others found that the concentration is reversely correlated with the number of gels applied; the higher the concentration, the lower the number of gel applications required to produce uniform bleaching [46]. Through comparing the *in vitro* tooth bleaching efficacy of 5%, 10% and 16% carbamide peroxide gels, Leonard., *et al.* gave similar results illustrating that bleaching by 16% and 10% carbamide peroxide was initially faster than that by the 5% concentration [47]. Matis., *et al.* showed that a 15% carbamide peroxide gel showed better results of tooth bleaching than a 10% carbamide peroxide gel after two weeks of application. However, the increasing of treatment time to six weeks does not significantly affect tooth color or brightness [48]. Hypersensitivity and gingival irritation are considered as common clinical adverse effects of bleaching. Dentinal hypersensitivity was noticed in 77% of subjects while soft tissue sensitivity was observed in 22% [49].

### Focus on dental bleaching agents and their concentrations

Carbamide peroxide (CP) is a highly recommended agent in the home-use bleaching supervised by a dentist; using a customized tray, the gel can be applied to the external surfaces of the teeth [50]. In the past, a 10% CP was seen as the optimal choice for the home-use bleaching technique [51]. To raise the efficacy of bleaching agents, different concentrations of hydrogen peroxide (HP) ranging from 3% to 10% were recommended [55,57], with higher concentrations of CP [52-56]. Also, fluoride and/or other desensitizing products, such as potassium nitrate, in formulations fall under the home-use agents that may reduce tooth sensitivity [10]. However, the in-office technique has gained more popularity than the home-use one and it is due to the ability of the highly concentrated products to achieve faster tooth whitening (the higher the bleaching solution concentration, the more quickly a shade change will occur). In the in-office systems, a high concentration of HP (15% to 38%) can be applied with the possibility of using light-activation devices (e.g. light emitting diodes, plasma arc, diode laser and xenon halogen lamps) that can hasten the whitening process. However, using the light sources for the purpose of in-office tooth whitening is still debatable [58-60]. The dentist has full control on the process with the merit of ending the treatment at any time. Usually the results of color change can be noticed after one visit. Despite the in-office method enjoys the advantage of quick tooth whitening, tooth sensitivity is usually reported [58-64]. Similarly, to the home-use agents, some manufacturers have added fluoride or desensitize products into the in-office gel formulas with the aim of relieving tooth sensitivity.

Some clinical trials have compared the agents used for home-use or in-office tooth bleaching with high and low concentration, and similar whitening effect was observed regardless of the concentrations of agents and the techniques used [8,11,65,66]. Nevertheless, when the agent concentration [64,66,67] or bleaching time [54,68,69] is increased, the occurrence of tooth sensitivity or irritation gingival is highly observed. However, because of the different techniques of dental bleaching (home use or in office), the several concentrations of bleaching agents, and the incorporation of fluoride or desensitizing products in bleaching agents, it becomes hard for dentists to put their hands on the optimal choice that can be most effective for and least sensitive to patients. However bleaching gels are proven to be equal with no observed differences in efficacy and dental sensitivity regardless of their concentration, the technique used (home use or in office), or the presence of desensitizing agents. [70]. Recently, several studies have encouraged the use of bleaching gels with low concentrations reporting their effectiveness [71] and observing lower cell damage at these low concentrations of peroxide [72]. Some researches have been conducted regarding the bleaching gels catalyzed by agents such as titanium dioxide nanoparticles activated by hybrid light (laser/LED) with different concentrations (15%) [73], which present similar effectiveness, and in some cases, much lower adverse post procedure effects [73]. The As per literature, the longevity of bleaching is somewhat questionable. Some studies have indicated an observed jump in color; others show only a slight difference [74-76]. Moreover, retreating can be witnessed with the passage of time. All of these reports are associated with concentrations higher than 10% hydrogen peroxide, with only one report at 6% [77]. This report by Vano and others showed that no change was achieved in at least five units of DE initially and observed a color rebound at nine months [77].

### Conclusion

In conclusion, it is important for clinicians to know about the new in-office concentrations and to correlate these with patients. It is important to shed light upon patients' expectations regarding tooth whitening. However, they are poorly described in the literature. Tooth whitening plays an important role in esthetic perception psychosocial status. Martin and others has conducted a study indicating the positive effect on esthetic look and psychosocial comfort [78]. It would be interesting for clinicians to assure the stable existence of this effect over time.

### Bibliography

1. Caneppele TM., *et al.* "Effects of dental bleaching on the color, translucency and fluorescence properties of enamel and dentin". *European Journal of Esthetic Dentistry* 8.2 (2013): 200-212.
2. Dietschi D., *et al.* "In vitro colorimetric evaluation of the efficacy of home bleaching and over-the-counter bleaching products". *Quintessence International* 41.6 (2010): 505-516.
3. Attin T., *et al.* "Influence of tea on intrinsic colour of previously bleached enamel". *Journal of Oral Rehabilitation* 30.5 (2003): 488-494.
4. Joiner A. "The bleaching of teeth: A review of the literature". *Journal of Dentistry* 34.7 (2006): 412-419.
5. Nathoo S., *et al.* "Comparative clinical investigation of the tooth whitening efficacy of two tooth whitening gels". *Journal of Clinical Dentistry* 14.3 (2003): 64-69.
6. Marson FC., *et al.* "Clinical evaluation of in-office dental bleaching treatments with and without the use of light-activation sources". *Operative Dentistry* 33.1 (2008): 15-22.
7. Haywood VB and Heymann HO. "Nightguard vital bleaching". *Quintessence International* 20.3 (1989): 173-176.
8. Zekonis R., *et al.* "Clinical evaluation of in-office and at home bleaching treatments". *Operative Dentistry* 28 (2003): 114-121.
9. Browning WD., *et al.* "Duration and timing of sensitivity related to bleaching". *Journal of Esthetic and Restorative Dentistry* 19.5 (2007): 256-264.

10. Browning WD, *et al.* "Comparison of traditional and low sensitivity whiteners". *Operative Dentistry* 33.4 (2008): 379-385.
11. Meireles SS, *et al.* "Efficacy and safety of 10% and 16% carbamide peroxide tooth-whitening gels: A randomized clinical trial". *Operative Dentistry* 33.6 (2008): 606-612.
12. Luk K, *et al.* "Effect of light energy on peroxide tooth bleaching". *Journal of the American Dental Association* 135.2 (2004): 194-201.
13. Tay LY, *et al.* "Assessing the effect of a desensitizing agent used before in-office tooth bleaching". *Journal of the American Dental Association* 140.10 (2009): 1245-1251.
14. Haywood VB and Heymann HO. "Nightguard vital bleaching". *Quintessence International* 20.3 (1989): 173-176.
15. Joiner A. "The bleaching of teeth: A review of the literature". *Journal of Dentistry* 34.7 (2006): 412-419.
16. Caviedes-Bucheli J, *et al.* "The effect of tooth bleaching on substance P expression in human dental pulp". *Journal of Endodontics* 34.12 (2008): 1462-1465.
17. Rosenstiel SF, *et al.* "Duration of tooth color change after bleaching". *Journal of the American Dental Association* 122.4 (1991): 54-59.
18. Alomari Q and El Daraa E. "A randomized clinical trial of in-office dental bleaching with or without light activation". *The Journal of Contemporary Dental Practice* 11.1 (2010): 17-24.
19. Bernardon JK, *et al.* "Clinical performance of vital bleaching techniques". *Operative Dentistry* 35.1 (2010): 3-10.
20. Gurgan S, *et al.* "Different light activated in-office bleaching systems: a clinical evaluation". *Lasers in Medical Science* 25.6 (2010): 817-822.
21. Hein K, *et al.* "In-office vital tooth bleaching- What do lights add?" *Compendium of Continuing Education in Dentistry* 24.4A (2003): 340-352.
22. Kugel G, *et al.* "Clinical evaluation of chemical and light-activated tooth whitening systems". *Compendium of Continuing Education in Dentistry* 27.1 (2006): 54-62.
23. Kugel G, *et al.* "Clinical trial assessing light enhancement of in-office tooth whitening". *Journal of Esthetic and Restorative Dentistry* 21.5 (2009): 336-347.
24. Ontiveros JC and Paravina RD. "Color change of vital teeth exposed to bleaching performed with and without supplementary light". *Journal of Dentistry* 37.11 (2009): 840-847.
25. Papathanasiou A, *et al.* "Clinical evaluation of a 35% hydrogen peroxide in-office whitening system". *Compendium of Continuing Education in Dentistry* 23.4 (2002): 335-338.
26. Tavares M, *et al.* "Light augments tooth whitening with peroxide". *Journal of the American Dental Association* 134.2 (2003): 167-175.
27. Amengual J and Forner L. "Dentine hypersensitivity in dental bleaching: case report". *Minerva Stomatology* 58.4 (2009): 181-185.
28. Nathanson D and Parra C. "Bleaching vital teeth: a review and clinical study". *Compendium* 8.7 (1987): 490-497.
29. Ribeiro APD, *et al.* "Cytotoxic effect of a 35% hydrogen peroxide bleaching gel on odontoblast-like MDPC-23 cells". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology* 108.3 (2009): 458-464.
30. Trindade FZ, *et al.* "Trans-enamel and trans-dentinal cytotoxic effects of a 35% H<sub>2</sub>O<sub>2</sub> bleaching gel on cultured odontoblast cell lines after consecutive applications". *International Endodontics* 42.6 (2009): 516-524.

31. Baik JW, *et al.* "Effect of light-enhanced bleaching on in vitro surface and intrapulpal temperature rise". *Journal of Esthetic and Restorative Dentistry* 13.6 (2001): 370-378.
32. Leonard RH, *et al.* "Evaluation of side effects and patient's perceptions during tooth bleaching". *Journal of Esthetic and Restorative Dentistry* 19.6 (2007): 355-366.
33. Markovic L, *et al.* "Micromorphology of enamel surface after vital tooth bleaching". *Journal of Endodontics* 33.5 (2007): 607-610.
34. De Arruda AM, *et al.* "Effect of hydrogen peroxide at 35% on the morphology of enamel and interference in the remineralization process: An *in situ* study". *Operative Dentistry* 37.5 (2012): 518-525.
35. Lia Mondelli RF, *et al.* "Do different bleaching protocols affect the enamel microhardness?". *European Journal of Dentistry* 9.1 (2015): 25-30.
36. Giannini M, *et al.* "Effect of carbamide peroxide-based bleaching agents containing fluoride or calcium on tensile strength of human enamel". *Journal of Applied Oral Science* 14.2 (2006): 82-87.
37. Berger SB, *et al.* "Enamel susceptibility to red wine staining after 35% hydrogen peroxide bleaching". *Journal of Applied Oral Science* 16.3 (2008): 201-204.
38. Attia ML, *et al.* "The effect of coffee solution on tooth color during home bleaching applications". *American Journal of Dentistry* 22.3 (2009): 175-179.
39. Matis BA, *et al.* "White diet: Is it necessary during tooth whitening?" *Operative Dentistry* 40.3 (2015): 235-240.
40. Carey CM. "Tooth whitening: What we now know". *Journal of Evidence Based Dental Practice* 14 (2014): 70-76.
41. Zero DT. "In situ caries models". *Advances in Dental Research* 9.3 (1995): 214-230.
42. Delfino CS, *et al.* "Effectiveness of home bleaching agents in discolored teeth and influence on enamel microhardness". *Journal of Applied Oral Science* 17.4 (2009): 284-288.
43. Hattab FN, *et al.* "Dental discoloration: An overview" *Journal of Esthetic Dentistry* 11.6 (1999): 291-310.
44. Watts A and Addy M. "Tooth discolouration and staining: A review of the literature". *British Dental Journal* 190.6 (2001): 309-316.
45. Kihn PW, *et al.* "A clinical evaluation of 10 percent vs 15 percent carbamide peroxide tooth-whitening agents". *Journal of the American Dental Association* 131.10 (2000): 1478-1484.
46. Sulieman M, *et al.* "The effect of hydrogen peroxide concentration on the outcome of tooth whitening: An *In vitro* study". *Journal of Dentistry* 32.4 (2004): 295-299.
47. Leonard RH, *et al.* "Use of different concentrations of carbamide peroxide for bleaching teeth: An *In vitro* study". *Quintessence International* 29.8 (1998): 503-507.
48. Matis BA, *et al.* "Clinical evaluation of bleaching agents of different concentrations". *Quintessence International* 31.5 (2000): 303-310.
49. Browning WD, *et al.* "Duration and timing of sensitivity related to bleaching". *Journal of Esthetic and Restorative Dentistry* 19.5 (2007): 256-264.
50. Haywood VB and Heymann HO. "Nightguard vital bleaching". *Quintessence International* 20.3 (1989): 173-176.
51. Haywood VB. "Current status of nightguard vital bleaching". *Compendium* 21.28 (2000): S10-S17.

52. Leonard RH., *et al.* "Use of different concentrations of carbamide peroxide for bleaching teeth: An *In vitro* study". *Quintessence International* 29.8 (1998): 503-507.
53. Kihn PW., *et al.* "A clinical evaluation of 10 percent vs 15 percent carbamide peroxide tooth-whitening agents". *Journal of the American Dental Association* 131.10 (2000): 1478-1484.
54. Matis BA., *et al.* "Clinical evaluation of bleaching agents of different concentrations". *Quintessence International* 31.5 (2000): 303-310.
55. Sulieman M. "An overview of bleaching techniques: 2. Night guard vital bleaching and non-vital bleaching". *South African Dental Journal* 61.7 (2000): 352-354.
56. Braun A., *et al.* "Spectrophotometric and visual evaluation of vital tooth bleaching employing different carbamide peroxide concentrations". *Dental Materials* 23.2 (2007): 165-169.
57. Perdigão J., *et al.* "Contemporary trends and techniques in tooth whitening: A review". *Practical Procedures and Aesthetic Dentistry* 16.3 (2004): 185-192.
58. Marson FC., *et al.* "Clinical evaluation of in-office dental bleaching treatments with and without the use of light-activation sources". *Operative Dentistry* 33.1 (2008): 15-22.
59. Lima DA., *et al.* "*In vitro* evaluation of the effectiveness of bleaching agents activated by different light sources". *Journal of Prosthodontics* 18.3 (2009): 249-254.
60. Torres CR., *et al.* "Assessment of the effectiveness of light-emitting diode and diode laser hybrid light sources to intensify dental bleaching treatment". *Acta Odontologica Scandinavica* 69.3 (2011): 176-181.
61. Tay LY., *et al.* "Assessing the effect of a desensitizing agent used before in-office tooth bleaching". *Journal of the American Dental Association* 140.10 (2009): 1245-1251.
62. Al Shethri S., *et al.* "A clinical evaluation of two in-office bleaching products". *Operative Dentistry* 28.5 (2003): 488-495.
63. Kugel G., *et al.* "Clinical trial assessing light enhancement of in-office tooth whitening". *Journal of Esthetic and Restorative Dentistry* 21.5 (2009): 336-347.
64. Da Costa JB., *et al.* "Comparison of at-home and in-office tooth whitening using a novel shade guide". *Operative Dentistry* 35.4 (2010): 381-388.
65. Bizhang M., *et al.* "Comparative clinical study of the effectiveness of three different bleaching methods". *Operative Dentistry* 34.6 (2009): 635-641.
66. Bernardon JK., *et al.* "Clinical performance of vital bleaching techniques". *Operative Dentistry* 35.1 (2010): 3-10.
67. Meireles SS., *et al.* "A double-blind randomized controlled clinical trial of 10 percent versus 16 percent carbamide peroxide tooth bleaching agents: One-year follow-up". *Journal of the American Dental Association* 140.9 (2009): 1109-1117.
68. Leonard RH., *et al.* "Risk factors for developing tooth sensitivity and gingival irritation associated with nightguard vital bleaching". *Quintessence International* 28.8 (1997): 527-534.
69. Cardoso PC., *et al.* "Clinical effectiveness and tooth sensitivity associated with different bleaching times for a 10 percent carbamide peroxide gel". *Journal of the American Dental Association* 141.10 (2010): 1213-1220.
70. Javaheri DS and Janis JN. "The efficacy of reservoirs in bleaching trays". *Operative Dentistry* 25.3 (2000): 149-151.

71. Bortolatto JF, *et al.* "Low concentration H<sub>2</sub>O<sub>2</sub>/TiO<sub>2</sub> in office bleaching: A randomized clinical trial". *Journal of Dental Research* 93. 7 (2014): 66s-71s.
72. Soares DG, *et al.* "Concentrations of and application protocols for hydrogen peroxide bleaching gels: Effects on pulp cell viability and whitening efficacy". *Journal of Dentistry* 42.2 (2014): 185-198.
73. Marti'n J, *et al.* "Can an LED-laser hybrid light help to decrease hydrogen peroxide concentration while maintaining effectiveness in teeth bleaching?". *Laser Physics* 25.2 (2015): 025608.
74. Meireles SS, *et al.* "A double-blind randomized clinical trial of two carbamide peroxide tooth bleaching agents: 2-year follow-up". *Journal of Dentistry* 38.12 (2010): 956-963.
75. Giachetti L, *et al.* "A randomized clinical trial comparing at-home and in-office tooth whitening techniques: A nine month follow-up". *Journal of the American Dental Association* 141.11 (2010): 1357-1364.
76. De Geus JL, *et al.* "One-year follow-up of at-home bleaching in smokers before and after dental prophylaxis". *Journal of Dentistry* 43.11 (2015): 1346-1351.
77. Vano M DG, *et al.* "Tooth bleaching with hydrogen peroxide and nanohydroxyapatite: A 9-month follow-up randomized clinical trial". *International Journal of Dental Hygiene* 13.4 (2015): 301-307.
78. Martin J, *et al.* "Effectiveness of 6% hydrogen peroxide concentration for tooth bleaching-A double-blind, randomized clinical trial". *Journal of Dentistry* 43.8 (2015): 965-972.

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