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Review Article

Efficacy and safety of carbamide peroxide tooth-whitening gels

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ABSTRACT

Carbamide and hydrogen peroxide are the most frequently utilized compounds for various whitening techniques, that differ as per peroxide level, method of administration, and exposure period, when it comes to the active solutions accessible for important tooth whitening. The 10±1% carbamide peroxide dosage was the only level to date to acquire the American Dental Association's stamp of approval, ensuring its safety and effectiveness for at-home tooth whitening with customized trays. There has been a noticeable growth in the range of in-office tooth whitening compounds commercially available, which typically use elevated carbamide peroxide levels (30 to 37%) with or without an additional illumination. Even though tooth sensitivity appears to be the most frequent side effect of carbamide peroxide bleaching, discomfort goes away when the plan of care is finished. Sensitivity is typically linked to a background of sensitive teeth, greater administration rate, or use of greater carbamide peroxide levels. Additionally, studies have showed that using 10% carbamide peroxide at home to lighten teeth had comparable effectiveness to other methods (over the counter or in-office whitening). Patients generally prefer home vital bleaching with 10% carbamide peroxide to office procedures with 35% hydrogen peroxide. When comparing the safety utilizing 16% carbamide peroxide for nightguard vital bleaching to a placebo or 10% carbamide peroxide, patients receiving 16% reported higher gingival soreness than those administered a 10% carbamide peroxide or a placebo.

Keywords: Tooth bleaching, Whitening, Aesthetic dentistry, Carbamide peroxide, Over the counter, At-home, In-office

INTRODUCTION

For people who want to boost the visual appeal of their smiles and for cosmetic dentists, tooth color is a crucial consideration. With bespoke trays, at-home vital tooth bleaching (VTB) is now widely recognized as a secure, economical, and efficient cosmetic therapy for the management of tooth discoloration.[1] Carbamide peroxide (CP) and hydrogen peroxide (HP) are the most often used chemicals for various bleaching techniques, that differ according to peroxide level, method of administration, and exposure period.[2-5] These active materials are marketed for VTB. The bleaching agents offered for VTB can be administered to the tooth surface in a dentist's office or at home by the patient while being closely supervised by the practitioner. The only percentage of CP that has so far been approved by the American Dental Association (ADA) is 10±1% which guarantees its safety and effectiveness for

at-home tooth whitening with custom trays (CT).[2] The effectiveness and safety of this bleaching gel percentage have been described in other studies.[6,7] The efficacy and durability of the bleaching impact were not increased by increasing the CP percentage for home use, according to randomized clinical trials.[6,8] With the goal of "enhancing" the bleaching result, makers have produced a wide range of alternative bleaching chemical formulations and application techniques.[2] The number of in-office tooth whitening agents in the marketplace has consequently increased significantly. These items utilizing greater HP (15 to 40%) or CP (30 to 37%) concentrations, either alone or in combination with an additional illumination source (such as a laser, LED, halogen lamp, or plasma arc).[4,9] The findings that are accessible in the research are contradictory, regardless of how these compounds are activated. While some research has found that the usage of illumination can increase the lightening impact, others have demonstrated that the usage of photo-activation in conjunction with in-office teeth whitening had no impact on the outcomes of the 35% HP therapy.[1,10-12]

METHODS

This study is based on a comprehensive literature search conducted on 29 December 2022, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the information about efficacy and safety of CP tooth-whitening gels. There were no restrictions on date, language, participant age, or type of publication.

DISCUSSION

Since 1989, CP has been employed as a whitening compound.[13] VTB, sometimes known as "nightguard VTB," became a common procedure using a 10% CP concentration. With this method (also known as at-home bleaching), the patient can use a tray bleaching device at home while a practitioner keeps an eye on the outcomes and percentages. Before being utilized as a gel for at-home whitening, CP was employed for many years as an oral antibacterial.[13,14] In the past 13 years, a large number of home lightening products based on CP have been developed to be used with the nightguard VTB. Urea and HP are essentially mixed to create CP.[15] When CP comes in touch with salivary secretions, it disintegrates, releasing both compounds. The use of peroxides to whiten teeth was first practiced without a profound comprehension of how the whitening process would affect the composition and chemistry makeup of the enamel surface. Current research is focused on the compositional impacts of materials based on peroxide on enamel as well as the bond strengths of enamel.[15-17] The rapid bond strength of resins to enamel is negatively impacted by whitening methods based on HP and CP, according to numerous research.[15,16,18-20] Bond strengths to dentin exposed to 37% phosphoric acid for 60 seconds, followed by 60 minutes of HP treatment, were reported to be 0.0 MPa.[21] Therapeutically speaking, this decline in bond strengths is significant since tooth bleaching is frequently regarded as a preparatory procedure to enhance tooth look before the placement of a bonded restoration.[22] According to some writers' theories, [23,24] residual oxygen that prevents resin polymerizing is to blame for the negative impacts of peroxides on bonding; however, by texturing the surface, this negative effect is eliminated.[25] The proximal layer of enamel that has undergone peroxide bleaching does not become oxidized, according to surface examination techniques.[17,25] As a result, the bond-strength loss brought on by bleaching using peroxide-based bleaching solutions is not linked to the oxygen buildup inside the enamel matrix inhibiting polymerizing of resin. The decrease in enamel bond strengths, particularly for gels with low pH, may be caused by the reduction in enamel microhardness following two weeks of bleaching with 10% CP.[16] The decline in microhardness was corrected after four weeks.[16] There has been significant debate regarding the possibility that bleaching chemicals can cause cancer.[26] The United Kingdom has outlawed tooth bleaching agents that include peroxide as a result of a court decision.[26] Premalignant abnormalities can be caused by oxidative stress in oral epithelial cells.[27] Based on the dosage of HP used, the administration of DMBA (9,10-dimethyl-1,2-benzanthracene), a recognized carcinogenic comparable to those in tobacco smoke, and HP caused hyperkeratosis or mucosal neoplasms in hamsters after 22 weeks.[28] However, a new investigation showed that persistent exposure to 35% CP did not change the rat oral mucosa's cell cycle.[29] Teeth that were going to be extracted for orthodontic purposes were whitened with 10% CP for 4 hours or left untreated, depending on how much pulp tissue they had.[30] Heme oxygenase-1 (HO1) enzyme concentrations in the pulp showed no appreciable variations. Cells under oxidative stress produce more of the enzyme HO1. Based on the available data, it has been determined that using 10% CP at-home tooth bleaching gels under the supervision of a professional poses no carcinogenicity and does not result in permanent enamel deterioration.[26] The bulk of dentistry institutions in the United States teach at-home VTB, which is evidence of the peroxides' safety.[31]

At-home leaching

The most popular whitening treatment used by patients under a dentist's supervision is nightguard VTB, which uses 10% CP gel. VTB is extremely efficient, long-lasting, and safe, according to studies.[32-35] Peroxides diffuse swiftly into dentin and reach the pulpal chamber, according to the literature.[36] Even though tooth sensitivity appears to be the most frequent side effect of CP bleaching, sensitivity goes away when the course of therapy is finished.[13] Sensitivity is typically linked to a background of sensitive teeth, increased administration rate, or use of

higher CP percentages (like 20%).[13,37] Even though the ability of CP to enter the pulpal chamber may contribute to sensitivity, the penetration rate relies on the strength and the manufacturer of the commercial product.[38,39] The pH of the whitening gel is another aspect that could influence sensitivity. The pH of bleaching agents used with the at-home method falls between 5.66 and 7.35.[40] Sensitivity is also closely correlated with how often the gel is applied; patients who refresh their bleaching solution more frequently than once per day report much greater negative impacts than those who do not.[41] To reduce sensitivity during therapy, potassium nitrate and fluoride have lately been incorporated to the formula of several bleaching gels. One clinical investigation showed that 10% CP gel with potassium nitrate and fluoride added decreased sensitivity after a 2-week therapeutic period in comparison to 10% CP gel without those two ingredients.[42] It is debatable whether or not reservoirs should be included in the tray to provide room for the bleaching gel to be retained. The usage of spacers to form reservoirs for the whitening gel does not appear to boost the effectiveness of at-home bleaching, contrary to the suggestion of some producers as a photo-cured block-out epoxy or a self-adhesive strip.[43] Nevertheless, using reservoirs allows the whitening gel to remain activated for a greater duration.[44] The percentage of peroxide and the timing of administration appear to be the two key variables that affect the effectiveness of tooth whitening.[18,25] There is a perception that bleaching agents with more bleaching agent concentrations will have a greater and quicker lightening impact than those with lower bleaching agent concentrations. Following the first week of therapy, this study found that the 10 and 16% CP percentages were noticeably more efficient than the 37% percentage. According to research, gel concentration was not as crucial as bleaching chemical contact time. Although it may come as a surprise, lengthier therapy times were found to have the same impact on tooth shade improvements, regardless of the peroxide percentage utilized.[4,45] When the bleaching chemical is used in trays, VTB is more successful, according to a study that analyzed the efficiency of 25 tooth bleaching products and 9 clinical trials.[4] The contact duration between the whitening gel and the enamel layer is a crucial aspect that can enhance the results of the bleaching process, according to a clinical investigation that assessed the efficacy of eight in-office tooth bleaching systems.[4] Some researchers have challenged the requirement of photo-activating peroxide-based gels.[9-12] It has been widely established that tooth color variations can be accurately assessed using both shade guidelines and digital spectrophotometry,[46] irrespective of the subjectivity of visual tooth color evaluation. However, it is also possible to assess color parameters (L*, a*, and b*) centered on the CIELAB system in three-dimensional color space when using an impartial approach for evaluating variation in tooth coloration.[47] Data from spectrophotometers show that the enhancement in whiteness is mostly caused by an increase in lightness (higher L*) and a decrease in redness (lower a*) and yellowness (lower b*). At one week after whitening, all intervention groups in one in-vitro investigation displayed a rise in the L* and a drop in the a* and b* color parameters. Comparison of in vitro findings with those from clinical research plainly has its drawbacks because careful interpretation is required when interpreting alterations in L*, a*, and b*. However, numerous clinical studies have shown that tooth whitening gels with lesser strengths are just as efficient as those with greater strengths.[6,8,45,48] In investigations on tooth bleaching, the general coloration variation change (E*) values are frequently utilized to show the observable tooth coloration changes following intervention.[49] In the aforementioned investigation, all treated groups displayed E* values greater than 13.0 at one-week post-bleaching. Clinical studies could show that peroxide-based gels with trace levels would produce the same visibly noticeable effects as those produced by the 37% CP, which is widely utilized for in-office whitening. In addition, earlier research has shown that in-office treatments reverse color faster after bleaching than home bleaching agents relying on trays [4,45,50] The American Dental Association guidelines, which only guarantee the safety and effectiveness of bleaching process using trays with 10%–1% CP administration, could be followed by using small CP percentages for VTB. This is because all CP gels examined in investigations have produced a similar improvement in tooth shade. Because bleaching agents with high concentrations of CP improved tooth color in a manner similar to that achieved by bleaching agents with low concentrations of CP, the null hypothesis for this investigation was acknowledged. To assess if the same color enhancement is achieved with in-office or at-home CP bleaching solutions, more research and clinical trials need to be performed.

Investigations have shown that slight-to-medium tooth sensitivity and/or gingival discomfort are the most frequent consequences of at-home VTB.[50-54] Moreover, these negative effects can become more severe due to the increasing VTB.[55,56] Patients who received 16% CP in comparison to 10% CP in the first and third weeks of therapy reported considerably higher tooth sensitivity. Nevertheless, it has not been discovered that the levels of sensitivity claimed by participants in numerous research varies between the groups, with the majority of the individuals reporting no or minimal sensitivity. According to the participants, this irritation was momentary and subsided quickly when the bleaching chemical was withdrawn. Previous clinical studies examining the impact of 10% and 15% or 16.4% and 18%.[50,51,52] CP solutions included in at-home VTB did not reveal elevated tooth or gingival sensitivity. According to the most recent statistics, the whitening effectiveness was comparable among the 10% and 16% CP groups. This leads to the inquiry of if adding more carbamide or HP would improve the effectiveness of VTB. Clinical investigations that have been published have thoroughly confirmed the effectiveness and safety of 10% CP.[5,33,57,58] According to a clinical test comparing two teeth-whitening procedures, one using 35% HP and the other 10% CP, the latter resulted in noticeably whiter teeth than the in-office procedure.[50] A

further clinical experiment examined the effectiveness, adverse reactions, and level of patient tolerance of various bleaching solutions and procedures. It demonstrated that home whitening with 10% CP had the same effectiveness as the alternative ways (over the counter or in-office whitening). Typically, consumers are more accepting of 10% CP at-home VTB than 35% CP at-office therapy.[50,53] In terms of safety concerns, those who received 16% CP for nightguard VTB complained of higher gingival soreness than those who received a placebo or 10% CP.[41] Because 10% CP has a decreased risk of tooth sensitivity than 16% CP while still providing similar whitening efficacy, it is advised that it be used for VTB. Additional longitudinal and clinical studies comparing 10% and 16% CP are required to determine if the efficacy of whitening, long-term adverse impacts, and susceptibility for shade rebound phenomenon will be impacted by the strength.

CONCLUSION

Patients looking to improve the aesthetic appeal of their smiles presently have access to a range of bleaching alternatives. Practitioners need to be informed of the range of possibilities that are now present before recommending a professionally delivered bleaching intervention. In-office, at-home, or over the counter treatments can be employed to solve a variety of aesthetic difficulties depending safely and successfully on the patient's current health and the intended bleaching outcomes. At the end of a three-week regimen of at-home essential bleaching, both 10 and 16% CP percentages have been determined to be equally beneficial in improving tooth color. The bleaching products have been found to cause limited and temporary tooth sensitivity, if at all. The strengths have been found to be well-tolerated by the study subjects, with 10% CP receiving a slight edge.

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