

Review Article

The combination of sodium perborate and water as intracoronal teeth bleaching agent

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ABSTRACT

Background: The color change on post-endodontic treated teeth can be overcome by intracoronal tooth bleaching using walking bleach. Some agents used in walking bleach are combination of sodium peroxide and hydrogen peroxide, and combination of sodium perborate and water. **Purpose:** The objective of this review is to provide information and consideration of using safe and effective bleaching agents in the field of dentistry. **Reviews:** On one side, the use of sodium perborate and water combination does not cause the reduction of dentin hardness, enamel decay, and root resorption. On the other side, the use of sodium perborate and 30% hydrogen peroxide combination indicates that it takes longer time in yielding the proper color of teeth. **Conclusion:** The use of sodium perborate and water combination as bleaching agents is effective and safe.

Key words: intracoronal teeth bleaching agents, sodium peroxide, hydrogen peroxide, water

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INTRODUCTION

Efforts for tooth bleaching by endodontic treatment has been undergone for a long time. The tooth bleaching in pulp chamber is called intracoronal tooth bleaching.¹

The bleaching agents which are commonly used are sodium perborate and hydrogen peroxide. Since 1924, sodium perborate and 30% hydrogen combination have been used. The combination of sodium perborate and 30% hydrogen peroxide placed in pulp chamber are known as walking bleach technique. In further development, the combination of sodium perborate and water is applied.²

Hydrogen peroxide 30% known as superoxol may be used with or without another agent. Hydrogen peroxide 30% must be used cautiously because it can cause skin and mucosal membrane burn like chemical burn.³ The use of sodium perborate combined with hydrogen 30% is effective for tooth bleaching. As hydrogen peroxide 30% has some cautions, the use of sodium perborate and hydrogen peroxide 30% may cause unexpected complication. For example, it increases dentin permeability that can cause

the decrease of dentin hardness, and the enamel decay of external root resorption.²

Kaneko² recommends the combination of sodium perborate and water as bleaching agents. This combination may not obliterate oral mucosa. Timpawet *et al.*,³ in his research claimed that combination of sodium perborate and water is the best intracoronal tooth bleaching agent.

Based on this background, the writer needs to explain the use of sodium perborate and water as effective and safe intracoronal tooth bleaching agents. It is expected that this writing can provide information and consideration of using sodium perborate and water in the field of dentistry.

Sodium perborate

Sodium perborate is called perborate acid or metaperborate. In the form of white powder containing NaBO_3 , is water soluble, stable in dry and cool air. It decomposes and releases oxygen in hot and humid air. Usually, it is available in granular the form which has to be ground into powder before use.⁴

Sodium perborate is available in two forms: tetrahydrate and monohydrate. Sodium perborate tetrahydrate is gained

by adding hydrogen peroxide into sodium metaborate solution in 20° C. Sodium metaborate can be formulated from reaction of boraxspentahydrate and sodium hydroxy. Compared to sodium perborate tetrahydrate, sodium perborate monohydrate has more advantages. It has more oxygen, more stable in heating process, and more soluble in the water.⁵ Independently, sodium perborate in the form of crystal is difficult to be applied, but if it is combined with hydrogen peroxide 30% or water, it can be changed into pasta.¹

Sodium perborate can react with sodium tetraborate, hydrogen peroxide, and sodium hydroxide. Sodium perborate rapidly releases oxygen at temperatures above 60° C. To activate sodium perborate at lower temperature (40–60° C), sodium perborate can be blended with appropriate activator such as tetra-asetildiamin (TEAD).⁶

Superoxol blended with sodium perborate will turn out to be pasta containing sodium metaborate, water, and oxygen. The reaction of sodium perborate mixed with water will be as the following $\text{NaBO}_3 + \text{H}_2\text{O}_2 \rightarrow \text{NaBO}_2 + \text{H}_2\text{O} + \text{O}_2$. Even though the combination of hydrogen peroxide and sodium perborate is effective in tooth bleaching, both bleaching agents—hydrogen peroxide and sodium perborate—can cause unexpected complications. They can enhance dentin permeability, cause the micro leakage on restoration, and trigger the occurrence of external root resorption.³

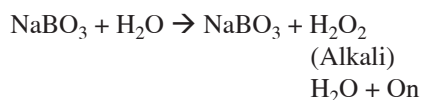
Hydrogen peroxide

Thenad^{7,8} in 1818 reported that hydrogen peroxide was made from decomposing berium peroxide with sulphate acid and phosphate acid. The hydrogen peroxide is sheer, colorless, viscous, lighter than water, more water soluble, durable for its oxidator and able to produce boundless radical which is very reactive.

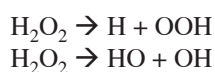
Hydrogen peroxide can dissolve because of light. Therefore, it must be stored in cool place and no direct high contact. Hydrogen peroxide can dissolve into water and reactive oxygen, as the following reaction:



It will dissolve and be ionized as the following reaction:



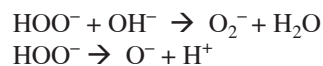
The presence of ionized sodium perborate will increase the effectiveness of unbound radical production. Hydrogen peroxide can release unbound radical, perhydroxyl anion, or combination of both. The reaction is as the following:



When perhydroxyl anion is released by H_2O_2 , the reaction will be:



Then, H_2O_2 obtains unbound radical and anion in the acid and alkali solution, as the following reaction:



These formed compounds tend to be drawn by double bond (=) alkenes by forming unstable peroxide and ultimately forming colorless alcohol, and become water soluble. Hydrogen peroxide can also increase dental tissue permeability, so it helps inward or outward ion diffusion. The reasons are because the mass of hydrogen peroxide is heavier than that of the molecules, and its ability of protein denaturation can also increase the diffusion process.⁹

The reaction between hydrogen peroxide and alcohol, ketone, carboxylic acid, and phosphate can cause fire and explosion. Hydrogen peroxide with concentration more than 50% is corrosive, can cause irritation on eyes, mucosa membrane, and skin. If this hydrogen peroxide solution is swallowed accidentally, it can be decomposed into excessive gas which can cause internal bleeding. In some cases, it can cause lung irritation because of inhaling hydrogen peroxide which concentration is more than 10%.⁷

Superoxol is a solution which is composed of 30% hydrogen peroxide and 100% distilled water. The distilled water has a molecular mass of 34.01 g/mol.¹⁰ This agent is pure, colorless, unstable, odourless liquid which must be saved into a light proof bottle, and kept away from heat since it is explosive. It is also better to save it in closed place since it can decompose easily.

Superoxol is more stable and easily applicable. It can be applied by itself or can be mixed with sodium perborate as paste in walking bleach technique.¹ However, Superoxol must be carefully used since it can cause wound like chemical burn in skin and mucosa membrane. The reason is because superoxol contains oxygen twice as much as sodium perborate, so it is reactive and can cause soft tissue burns.²

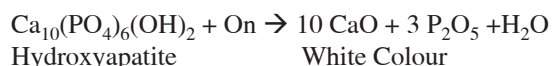
Tooth bleaching mechanism

Tooth bleaching mechanism consists of oxygen releasing action, mechanical cleansing actions, oxidation, and reduction. The bleaching process can occur if there is an alteration in pH, temperature, and light of the peroxide agent in order to produce active oxygen as oxidants. Peroxide as oxidator agent has oxidants which have single electrons as strong and unstable electrophile, so those oxidants can force other organic molecule in order to be stable and produce other oxidants. Since electrophile has only one electron in its chemical structure, it then tries to get pairs of electrons in order to be stable. Those unstable electrons will be released

and then accepted by enamel. Finally, during oxidation process those electrons will be oxidized by organic agents causing the change of the tooth colour.¹¹

The oxidants of peroxide are perhydroxyl and oxygenise. Perhydroxyl is a strong oxidant while oxygenase is a weak oxidant. The formation of perhydroxyl can be increased by increasing pH of peroxide from 9.9 to 10.9, and then this buffer process can also improve the effect of tooth bleaching.

Oxygenase as a weak oxidant has also a role in tooth bleaching. Oxygenase can react with hydroxyapatite molecules in teeth, which reaction is as below:



Oxygenase reaction with hydroxyapatite in teeth can cause CaO deposit. This CaO deposit can create white colour in teeth.¹²

DISCUSSION

The bleaching agents used for tooth bleaching after endodontic treatment are the combination of sodium perborate and 30% hydrogen peroxide, and sodium peroxide and water. The combination of each agent has weaknesses and strengths. The good bleaching agent must have strong penetration power to penetrate organic agents inside dentin tubules and enamel interprismatic chambers without devastating the crown.¹³

Enamel and dentin erosion occurs when pH is less than 4; meanwhile other researchers show that pH 4.6–7.4 can influence the structure of enamel and dentin even though it generally gives minor influence.^{14,15}

Pecora *et al.*¹⁶ did a research by using 36 first incisive tooth elements in upper jaw to analyze the effect of the bleaching agents on the hardness of dentin. The combination of sodium perborate and water resulted the least dentin hardness reduction compared to the other combination. The combination of 10% carbamide peroxide and 30% hydrogen peroxide resulted the highest dentin hardness reduction; meanwhile the combination of sodium perborate and hydrogen peroxide caused medium dentin hardness reduction.

Some researchers indicate that intracoronal bleaching agents can cause cervical root resorption. Cervical root resorption is a progressive root resorption which is from the dental epithel, generally in dental cervical area.¹⁷ This condition is caused by the acidic condition which can make hydroxyl apatite soluble so that there is demineralization of hard tissue components which then causes cervical root resorption.¹⁸

The ability of the bleaching agents can alter the acid pH around tooth produced by the penetration of the bleaching agents. The use of intracoronal bleaching agents in pulp chamber can diffuse through dentin tubule into cervical of periodontal ligament. By accumulating into cervical area

at the edge of dentinali, it can influence periodonsium tissue during the concurrence between enamel and cementum, containing bacterial colonies which can cause root resorption.¹⁰

The result of in vitro study shows that pH of dentin and cementum can become more acidic after the occupying of the combination of sodium perborate and 30% hydrogen perborate in pulp chamber. Polymorphonuclear leukocyte and osteoclast activities are increased in acid condition, as a result, it can produce hydroxyl apatite solution and stimulate demineralizing hard tissue components and also prevents the formation of new hard tissue, causing cervical root resorption.¹⁸

The alkaline condition of periodontal tissue in cervical is not good for osteocla activities so that it can prevent the devastating and dematerializing of hard tissue because of the procedures of intracoronal tooth bleaching.

The character of sodium perborate is alkaline; meanwhile the character of hydrogen peroxide is acid. Thus, if both agents are combined, it can produce an agent which is alkaline.¹⁰ Bleaching with increase the pH of post endodontic treated teeth. It shows that pH tends to increase as long as the bleaching agents are decomposed. The increasing pH is indicated by the alteration of 30% hydrogen peroxide, which is acid, to become oxygen and water.¹⁰ This difference is caused by of the different bleaching agents and method used. This alteration of pH depends on the bleaching agents used as well as the amount of 30% hydrogen peroxide which can create acid condition if it is in higher amount. This condition shows that the combination of sodium peroxide and 30% hydrogen peroxide can become acid or alkaline rely upon the amount of 30% hydrogen peroxide which is added.

The combination of sodium perborate and water produces alkaline condition so that it can not cause root resorption. According to some researchers, there is no root resorption in tooth which have been treated with intracoronal bleaching therapy by using the combination agents of sodium perborate and water. The colour of the teeth is also the same as the colour of those which have been bleached by using 30% hydrogen peroxide.

Based on the discussion above, it can be concluded that intracoronal bleaching therapy by combining sodium perborate and water has the same result in tooth bleaching as by combining sodium perborate and 30% H₂O₂, without causing root resorption and resorbing the dentin tissue.

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