EFFECT OF TWO FORMULATIONS OF 10% SODIUM ASCORBATE ON FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TOOTH SUBMITTED TO DENTAL BLEACHING WITH HYDROGEN PEROXIDE ASSOCIATED TITANIUM DIOXIDE NANOPARTICLES

ABSTRACT

PURPOSE: This study evaluated the effect of 10% sodium ascorbate (10SA), in gel (10SAg) or aqueous solution (10SAs) formulations, on fracture resistance of endodontically treated tooth submitted to dental bleaching procedures with 15% hydrogen peroxide associated with titanium dioxide (15HP-TiO2) nanoparticles and photoactivated by LED-laser. **MATERIAL AND METHODS:** Forty maxillary premolars were endodontically-treated and embedded in acrylic resin up to the cement-enamel junction. The specimens were divided into four groups (n=10): G1 (negative control): no bleaching, coronal access restored with composite resin; G2 (positive control): three dental bleaching sessions using 15HP-TiO2 and LED-laser photoactivation and restored with composite resin (positive control); G3 (10SAg): similar procedures to G2, but applied 10SA, in gel formulation, for 24 hours before restoration; G4 (10SAs): similar procedures to G3, but applied 10SA, in aqueous solution formulation. The 15HP-TiO2 was applied on buccal and lingual surfaces of the crown tooth and inside the pulp chamber and photoactivated by LED-laser. Between each bleaching session, the teeth were maintained in artificial saliva, at 37°C, for 7 days. In sequence, the teeth were submitted to fracture resistance testing using an eletromechanical machine test. The data was analyzed using ANOVA test ($p = 0.05$) **RESULTS:** There are no differences significant among the groups in relation to fracture resistance of endodontically treated teeth ($p>0.05$). **CONCLUSIONS:** The use of 10% sodium ascorbate, in gel or aqueous solution formulations, did not interfered on the fracture resistance teeth after dental bleaching using 15HP-TiO2 and LED-laser photoactivation.

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KEYWORDS

Tooth bleaching. Peroxides. Endodontics. Antioxidants. Tooth fractures.

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Received 12 Dec 2013 **Received in revised form** 16 Dec 2013 **Accepted** 20 Dec 2013

INTRODUCTION

The bleaching substances routinely used in endodontically treated teeth are hydrogen peroxide, carbamide peroxide, sodium perborate and sodium percarbonate.[1] These substances release free oxygen that diffuses into the dentin and/or enamel promoting discoloration of the substrate by an oxidation-reduction reaction.[2-4] Hydrogen peroxide has a low molecular weight and at a high concentration is caustic and can damage the oral tissues and release free radicals in high quantity.[1,5]

Dental bleaching can be accelerated by heat and photoactivation.[5] Several light sources have been proposed, such as the LED (Light Emitted Diode)-laser system, which provide a highly selective and concentrated energy source.[6] However, because the photoactivation did not substantially heat the hydrogen peroxide gel, the incorporation of dyes or pigments in the composition of the bleaching agent were proposed in order to more effectively absorb light and convert it into heat[7].

The titanium dioxide (TiO_2) is an opaque inorganic pigment, chemically inert, thermally stable and with a high capacity to reflect light.[8] Irradiated in a variable UV spectrum to blue visible light (approximately 380-450 nm), changes its electric charge providing destabilization of the hydrogen peroxide molecule.[6] Its use is still controversial, although there are reports that bleaching can be favored depending on the generation of oxidative radicals through TiO_2 photocatalysis[9]. However, it is demonstrated that the presence of TiO_2, photoactivated by ultraviolet laser or LED-laser did not improve the esthetic results provided by the 35% H_2O_2 gel.[8] Since the particle size of the pigment can also affect the results, the use of TiO_2 nanoparticles has recently been advocated.[8] Therefore, the addition of TiO_2 in the hydrogen peroxide gel is still controvesial and its effects on the tooth structure are still unknown.[10]

Several adverse effects caused by peroxides are described.[1] In particular, in endodontically treated teeth, there are reported interferences in the adhesion of restorative materials, risk of external resorption, changes in the structure of the enamel and dentin, increased dentin permeability and a reduction in the dentin microhardness.[11-22] However, the reduction of the fracture resistance of dental crowns after the use of bleaching agents, is one of the most controversial consequences.[23,24] To minimize these adverse effects, the use of antioxidants before the final restoration has been recommended.[25,26]

Sodium ascorbate is a neutral solution, antioxidant and biologically compatible, recommended to reverse the deleterious effects caused by oxidizing agents.[25-27] When used after bleaching with 38% hydrogen peroxide, it provides for the reestablishment of fracture resistance of endodontically-treated teeth.[28] However, its efficiency is directly related with the time application and/or formulation presentation to promote an efficient contact with the dentin submitted to bleaching protocols.[28-30]

Teeth immediately restored after crown bleaching with hydrogen peroxide in high concentrations have a lower fracture resistance.[24,28] But it is unknown if the bleaching treatment with new agents using lower concentrations of hydrogen peroxide associated with titanium dioxide nanoparticles and photoactivated by LED-laser system, also reduce the fracture resistance of the endodontically-treated tooth. On the other hand, there are no studies that evaluate if the previous use of 10% sodium ascorbate, in liquid or gel formulation has a beneficial effect on the crown fracture resistance.

The aim of this study was to evaluate the effect on fracture resistance strength of endodontically treated teeth, after the use of 10% sodium ascorbate, in the liquid or gel formulation, in endodontically treated teeth submitted to bleaching with hydrogen peroxide with TiO_2 nanoparticles and a photoactivated LED-laser system. The null hypothesis was that 10% ascorbate sodium, in gel or aqueous solution, does not interfered in fracture resistance of endodontically treated teeth after dental bleaching using 15HP-TiO_2.

MATERIAL AND METHODS

After Human Research Ethics Committee approval, forty human premolars with similar anatomy, obtained from extractions for orthodontic reasons from patients 15 to 25 years old were used in this study. All teeth were stored in 0.1% thymol solution and maintained at 4°C. Previous to the utilization, the teeth were immersed in distilled water for complete removal of thymol residues for 24 hours and examined under a stereomicroscope magnification of 20x (Leica microsystems, Wetzlar, Germany) to exclude and replace those teeth with fracture/cracks lines or fissures.

After the access cavity preparation, the working length was determined subtracting 1mm from the root length using a #15 K-file (Maillefer, Ballaigues, Swtizerland). The instrumentation was performed with a ProTaper system (Dentsply Maillefer, Ballaigues, Switzerland) up to a F2 instrumentation. The root canal were irrigated with 5 mL of 2.5% sodium hypochlorite solution (Clororio, São José do Rio Preto, SP, BR) between each change of instrument. In sequence, the smear layer was removed using 17% EDTA (Biodinamica Ind. Com, Ibiporã, PR Brazil), for 3 minutes and a final irrigation with 5 mL of 2.5% sodium hypochlorite was performed. The root canals were dried with absorbent paper points and obturated with AH Plus sealer (Dentsply DeTrey, Konstanz, Germany), using single cone technique. Radiographs were taken to verify the quality of the obturation.

A heated plugger (Touch´n Heat 5004; Sybron Endo, Orange, CA, USA) was used to remove 2 mm of gutta-percha from the root canal and glass ionomer cement (R Maxxion; FGM Dental Products Ltd., Joinville, SC, Brazil) was placed as a cervical barrier. All teeth were embedded in polyester resin (Maxi Rubber, São Paulo, SP, Brazil) up to the cement-enamel junction, using a cylindrical plastic matrix (25 mm long x 19,5 mm in diameter). The specimens remained untouched for 24 hours, until complete resin polymerization.

The specimens were then divided into four groups (n=10), according to the following protocol: G1: unbleached (negative control), restored with an adhesive system (Scothbond Multi-Purpose Adper Adhesive System, 3M ESPE, St Paul, MN, USA) and composite resin (Z100, 3M ESPE, St Paul, Mn USA). The access cavity was etched with 37% phosphoric acid (Condac 37; FGM Dental Products, Ltd., Joinville, SC, USA) for 15 seconds and then rinsed with a water spray for 10 seconds, leaving the dentin moist. In sequence, a adhesive system (Adper Scotchbond Multi-Purpose; 3M ESPE, St Paul, MN, USA), was applied to the dentin according to the manufacturer instructions and light cured (OrtholuxTM LED Curing Light; 3M Unitek, Sumaré, SP, Brazil) for 20 seconds. The teeth were incrementally restored with composite resin (Z100, 3M ESPE, St Paul, MN, USA), applying 1.0 mm thick layers and light cured (OrtholuxTM LED Curing Light; 3M Unitek, Sumaré, SP, Brazil) for 20 seconds, in each layer, until the complete filling of the pulp chamber.

In G2 (15HP-TiO2, positive control): bleached with 15% H_2O_2 with TiO_2 nanoparticles (Lite Lase Peroxide 15%, DMC Equipment Ltd., São Carlos, SP, Brazil), photoactivated with a LED-laser system (Whitening lase II, DMC Equipment Ltd., São Carlos, SP, BR). After the manipulation of the product, in accordance to the manufacturer instructions, a layer of 2 mm of the gel was applied to the buccal and lingual surfaces of the crown tooth and photoactivated with a LED-laser system (Whitening lase II; DMC Equipment Ltd., São Carlos, SP, BR) for 3 minutes. After the aspiration of the gel, a new application for 3 minutes was performed. An identical light application was also performed in the pulp chamber. Thus, each face was subjected to six minutes of photoactivation.

After the application and activation of the gel, all surfaces were abundantly washed with distilled water and two additional bleaching sessions, with intervals of 7 days between each, were performed. Between sessions, the pulp chambers were filled gutta percha and the coronal cavity was sealed with a temporary material (Coltosol; Vigodente SA Ind. Com., Rio de Janeiro, RJ, BR). All specimens were maintained in artificial saliva (Faculty of Pharmaceutical Sciences of Ribeirão Preto, University of São Paulo, Ribeirão Preto, SP, BR) during the study. After the conclusion of the bleaching procedures, the teeth were restorated in the same manner as G1.

In G3 (10SAg), all procedures were realized similar to G2, but after the dental bleaching, the pulp chamber was filled with 10% sodium ascorbate in natrosol (Aphoticário, Araçatuba, SP, Brazil), for 24 hours, according previous reccommendation.[28] After this period, the pulp chamber was washed with 5.0 mL distilled water, dried with an air stream and restored in a similar manner as described for G1. In G4 (10SAs), all procedures were realized similar to G3, but after the crown bleaching, the pulp chamber was filled with 10% sodium ascorbate solution (Aphoticário, Araçatuba, SP, Brazil).

After the restoration, the teeth were again maintained at 37°C and after 24 hrs submitted to fracture strength testing using an electromechanical testing machine EMIC DL 2000

(EMIC, São José dos Pinhais, PR, BR), at cross head speed of 0.5 mm/min. The test was carried out using a 5-mm diameter round bar positioned parallel to the long axis of the teeth and centered over the teeth until the bar just contacted the slopes of the buccal and lingual cusps of the tooth near the composite-tooth interface. The forces necessary to fracture each tooth were measured in KN. The moment of fracture was determined by a decrease in the force measurements in the testing machine. The data was statistically analyzed by the one-way ANOVA test ($p = 0.05$).

RESULTS

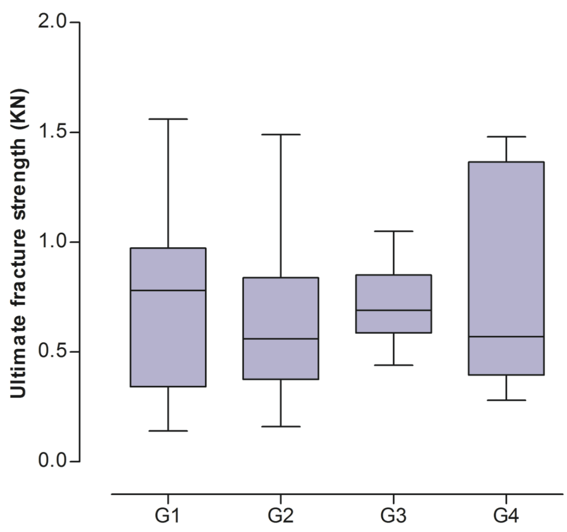
Figure 1 shows the means and standard deviations of the loads required (in KN) to fracture the crowns in each group. There are no significant statistical differences among the groups G1 (0,75 ± 0,43 KN), G2 (0,64 ± 0,38 KN), G3 (0,71 ± 0,18 KN) and G4 (0,75 ± 0,47 KN) evaluated in this study ($p > 0,05$).

DISCUSSION

The use of 10% sodium ascorbate, in the gel or liquid form, prior to the composite resin restoration in endodontically-treated teeth submitted to bleaching with 15% hydrogen peroxide associated with TiO_2 nanoparticles and photoactivated with LED-laser did not interfered in the fracture resistance teeth when compared to bleached or unbleached crowns and immediately restored. The null hypothesis was accepted.

In the current study, only the 15% peroxide hydrogen with TiO_2 photoactivated with LED-laser was evaluated. Although various techniques recommend using a combination of bleaching procedures, combining in-office and at-home bleaching procedures, only a single method to crown bleaching was used to avoid the interference of several techniques in the results.[28]

Figure 1. Mean ultimate force required to fracture the endodontically treated teeth (KN). G1: unbleach teeth; G2 (15HP-TiO2): 15% hydrogen peroxide with titanium dioxide and LED-laser photoactivation; G3 (10SAg): 10% sodium ascorbate gel; G4(10SAs): 10% sodium ascorbate solution. There are no difference between groups ($p > 0.05$).



The use of sodium ascorbate is recommended for the reestablishment of the bond strength of esthetic restorative materials, after the use of bleaching agents.[25,26,30] Free radicals released by hydrogen peroxide are combined with the hydroxyapatite and produces peroxide apatite, which degrades the two main tooth mineral components, calcium and phosphate.[31] On the other hand, the use of an antioxidant before the restoration provides a greater adhesion between the resin and tooth. When used for 24 hrs previous to the composite resin restoration, it significantly increased the fracture resistance of endodontically-treated teeth.[28]

The protocol tested in the present study compared the use of gel or solution preparations, since the use of the gel preparation should be more practical and clinically more acceptable for applications.[32] Despite different formulation, gel or liquid sodium ascorbate presentation did not increase the fracture resistance of the crowns.

The low hydrogen peroxide concentration used in present study possibly interfered in the results. The favorable effect of sodium ascorbate after dental bleaching apparently only is significant when used hydrogen peroxide in high concentration, which causes significant structural changes in dental structures.[17,28]

Between the bleaching sessions any dental bleaching protocol was not used. This procedure may have interfered in the results, because when the 9.5% hydrogen peroxide was applied as an at-home treatment combined is observed a decrease of crown resistance fracture.[28] On the other hand, the fact that none of the antioxidant protocols statistically differed for the controls groups, it may be also related to the dentin substrate characteristics and the time of the antioxidant application.[30,32]

LED-laser system has a photo-thermal effect which is responsible for the activation of the pigments, providing a photocatalytic oxidation and increasing the temperature of the bleaching agent.[33] On the other hand, temperature elevation may exacerbate cracks and/or produce cracks that favor the fracture of the dental crown.[34] Since the TiO_2 used in the bleaching agent employed in this study, presented in the light spectrum sensitization variable 380-450 nm and the LED-laser device used generates blue light and infrared laser, with a respective wavelength of 470 nm and 808 nm, it is possible that the LED-laser system did not provide the appropriate effects on the TiO_2.[6,8,35]

Further studies are still required to evaluate the effects of interaction between antioxidant (sodium ascorbate) and dental bleaching protocols on fracture resistance of endodontically treated teeth.

CONCLUSION

The use of 10% sodium ascorbate, in gel or aqueous solution formulation, for 24 hour after the dental bleaching protocol using 15% hydrogen peroxide with titanium dioxide nanoparticles and photoactivated with LED-laser, before restoration with composite resin did not interfered on the fracture resistance of endodontically treated teeth.

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