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SEM microscopic analysis of the labial tooth surfaces after the bleaching procedure done by Epic Biolase diode laser 940 nm

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ABSTRACT

Dental bleaching is a common procedure, requested and accepted by patients with aesthetic requirements.

The SEM images were taken at different degrees of magnification, always looking for cracks, porosities, or other changes at this level, which could be related to the sensitivity that appeared after such a procedure.

The standard bleaching procedure was applied to the labial surface of the tooth. Biolase Laser white 20 bleaching putty was used, which contains 45% hydrogen peroxide and then activated with 940 nm laser light.

The microscopic SEM images of the labial faces on which the 45% concentration hydrogen peroxide type bleaching gel was applied showed that they do not present any structural damage to the enamel.

Keywords: hydrogen peroxide, bleaching, laser, wavelength

INTRODUCTION

Dental bleaching is a common procedure, requested and accepted by patients with aesthetic requirements.

Specialized literature provides us with data related to the mechanisms of the teeth bleaching process using hydrogen peroxide, which acts as a strong oxidizing agent that transforms into free radicals [1].

The importance of tooth whitening for patients and consumers has seen a dramatic increase in the number of products and procedures over recent years, with a concomitant rise in publications on this topic. Literature suggests that the mechanisms of tooth whitening by peroxide occur by the diffusion of peroxide through enamel to cause oxidation and hence lightening of colored species, particularly within the dentinal regions. A number of approaches are available for measuring changes in tooth color. These include visual measurements by trained clinicians and instrumental measurements using spectrophotometry, chromameters and digital image analysis. The key factors that affect tooth whitening efficacy by peroxide containing products are concentration and time. In general, higher concentrations are faster than lower concentrations. However, lower concentrations can approach the efficacy of higher concentrations with extended treatment times. Alternative bleach systems to peroxide have received only minor attention [2].

At-home and in-office peroxide-containing bleaching agents can cause alteration in enamel at low and high concentrations as well [3].

"Power Bleaching" which originated with Abbot in 1918 and progressed to heat and heated spatulas in the 1980s, has been effects, including pulpal necrosis caused by the inability to control the highly

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reactive and caustic 35% H_2O_2 solution. The goal of a single-visit power-bleaching procedure is to whiten efficiently using controlled temperature elevation of the H_2O_2 on the tooth to prevent pulpal necrosis. The development of bleaching agents that combine H_2O_2 or its analogs with thickening agents, buffer, catalysts, or coloring agents has made power bleaching safer and more reliable [4].

A big problem often arises when we ask whether this procedure is non-invasive and free of harmful side effects, because there is much controversy about the bleaching procedure, even though is a procedure demanded by patients to have a lighter appearance of the teeth.

Comparing other dental procedures through which we can obtain a whiter smile, bleaching remains with a minimal degree of invasiveness.

A notable factor in the aesthetic appearance of the teeth is their color. Articles have been written about the so-called phenomenon of dental aesthetics from ancient times, from antiquity until today, remembering Alexander Gottlieb Baumgarten who was the one who called it "rational discourse about beauty", in his work called "Aesthetics" [5].

FIGURE 1. Samples with teeth fixed in the silicone support and the bleaching kit, with the Epic Biolase 940 nm diode laser device

PURPOSE OF THE STUDY

In this study, we tried to analyze microscopically the appearance of the labial surface of the teeth that followed a bleaching procedure with 42% hydrogen peroxide gel, activated by laser light with a wavelength of 940 nm, under a continuous wave.

The SEM images were taken at different degrees of magnification, always looking for cracks, porosities or other changes at this level, which could be related to the sensitivity that appeared after such a procedure.

The purpose of the analysis was to observe what exactly produces tooth sensitivity and what the subsequent structural changes are after bleaching.

MATERIAL AND METHOD

For the study, 5 human teeth were chosen that were extracted due to their 4th degree mobility, and with the initial consent of the patient to be used in this study.

The teeth thus extracted were cleaned and deposited in an ultrasound bath for 10 minutes with distilled water solution.

The teeth are then embedded in a silicone support with the coronal side visible, marking a demarcation line on the middle of the labial face, to obtain two distinct surfaces, which we named bleached and non-bleached surfaces (Figure 1).

The standard bleaching procedure was applied to the labial surface of the tooth. Biolase Laser white 20 bleaching putty was used, which contains 45% hydrogen peroxide and then activated with 940 nm laser light.

The bleaching kit contains a dispenser with two pastes, hydrogen peroxide and activator. At the start of the procedure, these two pastes were mixed in the contained dispenser, until a paste with a homogeneous appearance is obtained, then it is applied to the desired surface (Figure 2).

After applying the gel, it was activated in order to obtain the bleaching procedure with the help of laser light with the Diode Epic Bilase device of 940 nm, with a power of 7W, under continuous wave, for 30 seconds on each individual tooth. The procedure was repeated three times, each time removing the previously activated gel.

The result obtained is visibly lighter in terms of color nuance, but this study being performed *in vitro*, there are also certain deficiencies.

As the teeth are extracted, there is the possibility of inevitable dehydration and therefore a lighter appearance after the bleaching procedure may be diminished, but we did not want to analyze the quality of the procedure as much as the damage to the labial surface of the tooth, where the bleaching gel was applied.

After whitening, the teeth were sectioned, separating the coronal portion from the root portion. In the study, we kept the coronary part, where the bleaching procedure was performed (Figure 3).

The coronal parts were processed for introduction to the study with the help of the SEM microscope. A gold powder was deposited (Figure 4).

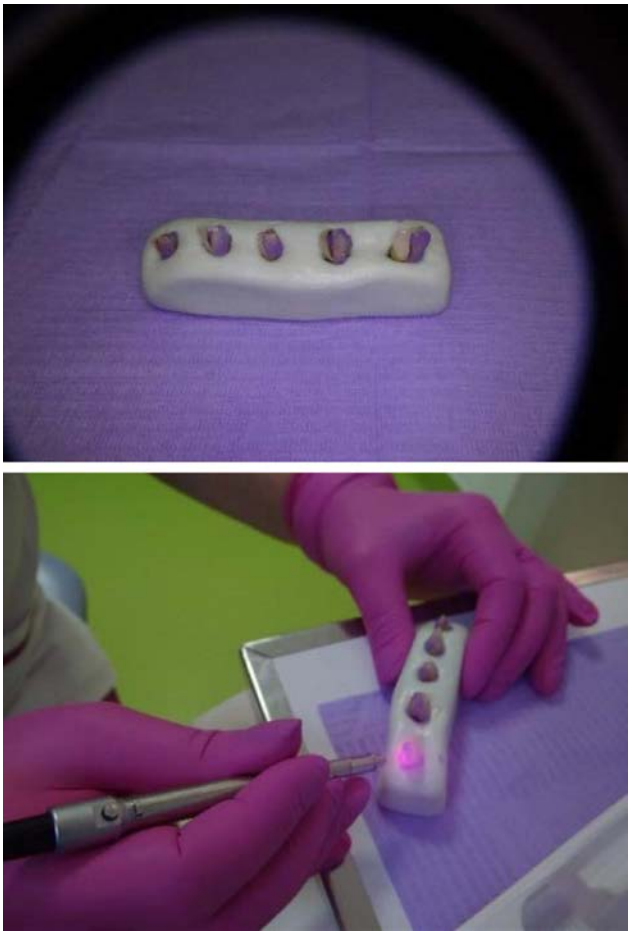

FIGURE 2. The bleaching procedure carried out on each sample with the Epic Biolase USA diode laser 940 nm

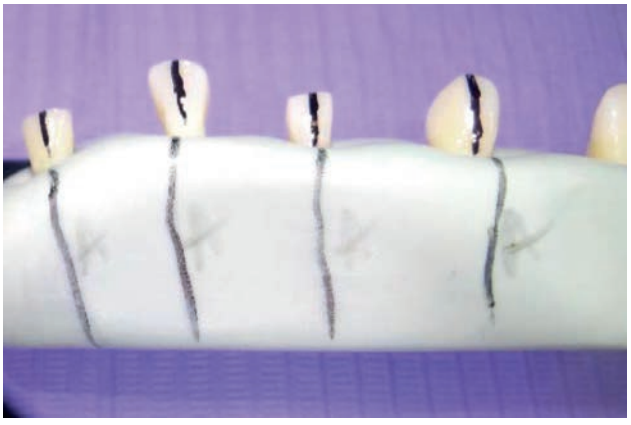

FIGURE 3. Appearance of samples after bleaching

Images were obtained at different magnifications (30, 50, 100 and 1000 X) of the labial surfaces, both for the intact ones and for those that were subjected to the bleaching process.

Areas with irregularities of the labial area were considered. The images were compared in parallel, respectively of the surfaces that were subjected to the bleaching process and of those that were not subjected to this treatment (Figure 5).

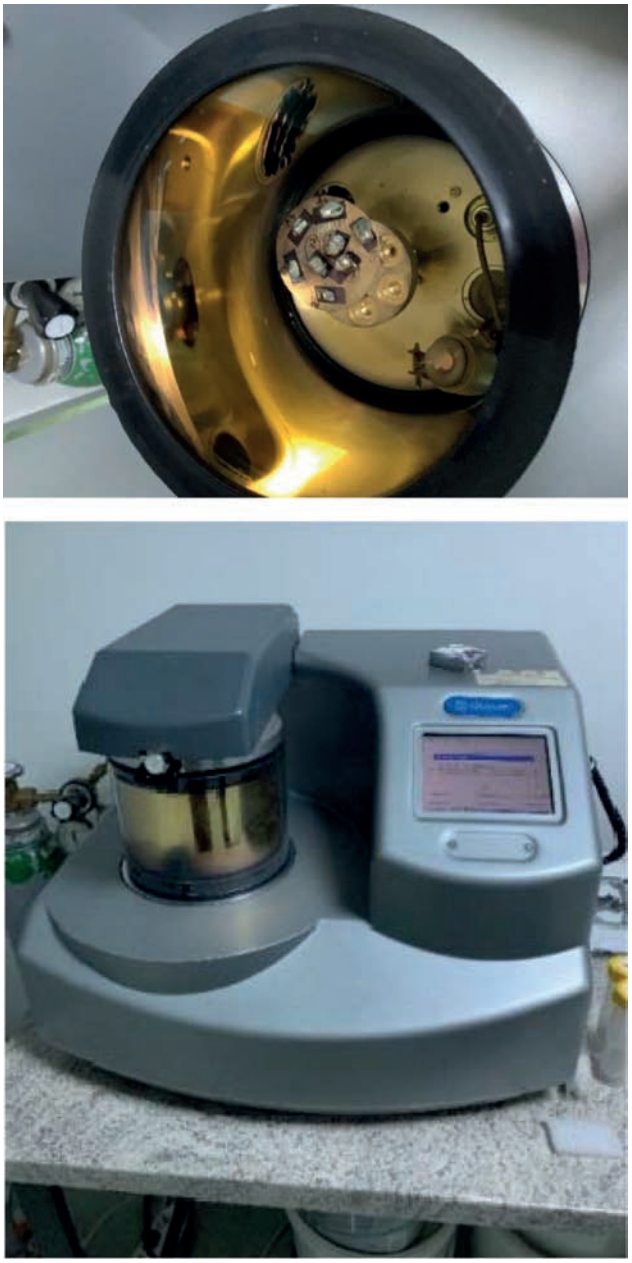

FIGURE 4. After obtaining the samples coated with gold, they were turned in the SEM microscope (Scanning Electron Microscopy)

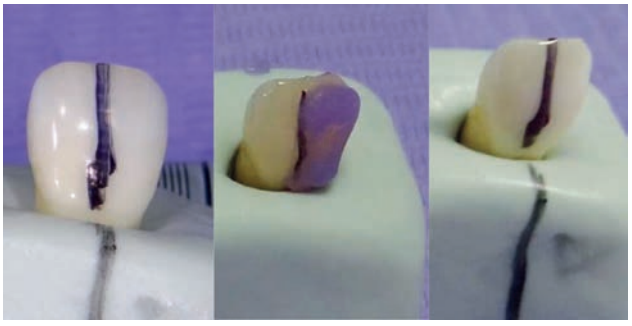

FIGURE 5. Exposure of the central incisor that had a demarcation line for comparing the areas subjected to the bleaching process and those that were not subjected to the bleaching process

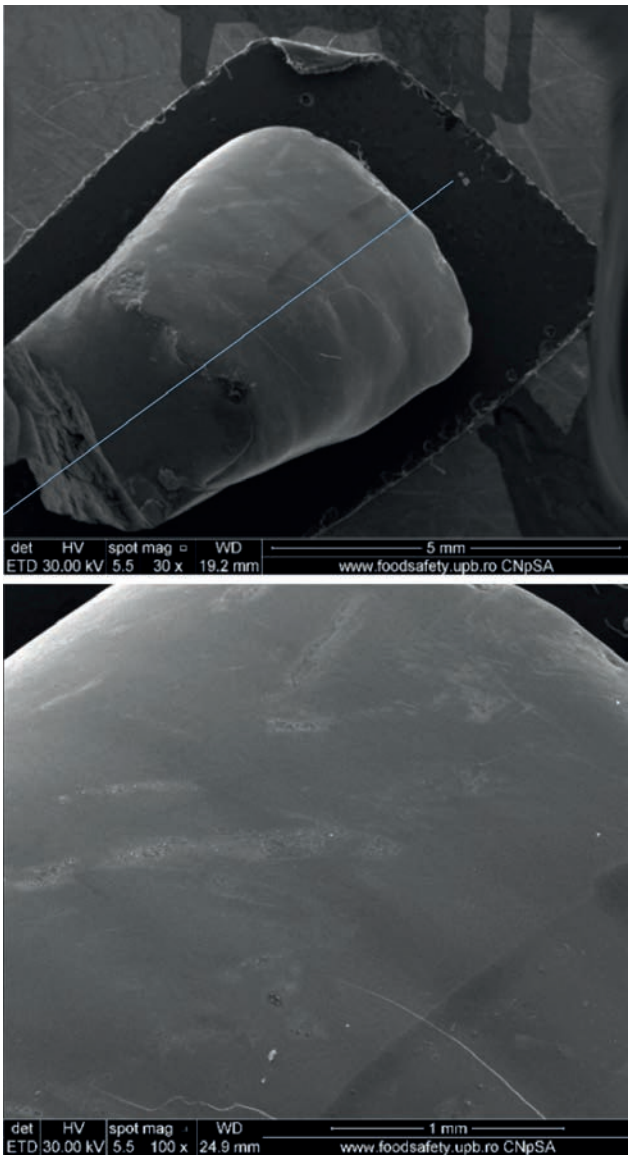

FIGURE 6. Appearance of the central incisor at the microscopic level at a magnification of 30X and 100X

RESULTS

Streaks can be observed on the surface not exposed to the bleaching process, possibly due to the abrasion processes that may have resulted in the mechanical use of the toothbrush, considering that the extracted teeth came from a 60-year-old patient, data reported in the anamnestic sheet referred to an aggressive brush habit.

At the level of the surface treated with bleaching gel, the surface is smoother and slightly corroded areas can be observed at a magnification of 1000 X (Figure 7).

Areas of mechanical abrasion can be observed on the surfaces not exposed to the bleaching process and areas with smooth and homogeneous relief can be observed on the surfaces exposed to the bleaching process.

On the surface not exposed to the bleaching process, areas of mechanical abrasion can be observed, and on the surface exposed to the bleaching process, an area with smooth and homogeneous relief can be observed.

DISCUSSIONS

Scanning electron microscopy is a well-known non-destructive technique that uses an electron beam probe to analyze surfaces details down to the nanoscale. Scanning electron microscopes produce high-resolution images that make them suitable tools for a wide range of applications in many areas of science and industry.

Rahime Zeynep Erdem and Ömer Çellik in their study evaluate the bleaching efficiency of 5 different office bleaching methods and the changes in enamel morphology after bleaching. It is discovered that the use of light activation is not necessary to increase bleaching effectiveness. Finally, we believe that enamel surface morphology may be affected after office bleaching methods; therefore, various precautions should be taken before and after bleaching [6].

Currently, bleaching products are either self-activated or enhanced by a light source. This source can be the luminous flux produced by: the special activation lamp, with light from the blue spectrum,

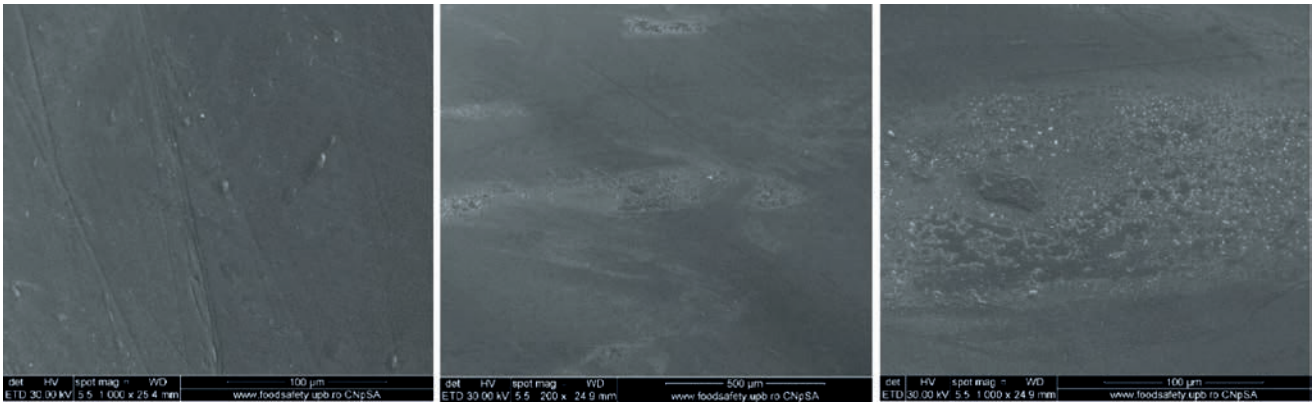

FIGURE 7. The surface not subjected to the bleaching process, at 1000X magnification and the bleached surface at the magnifiers of 200X and 1000X respectively

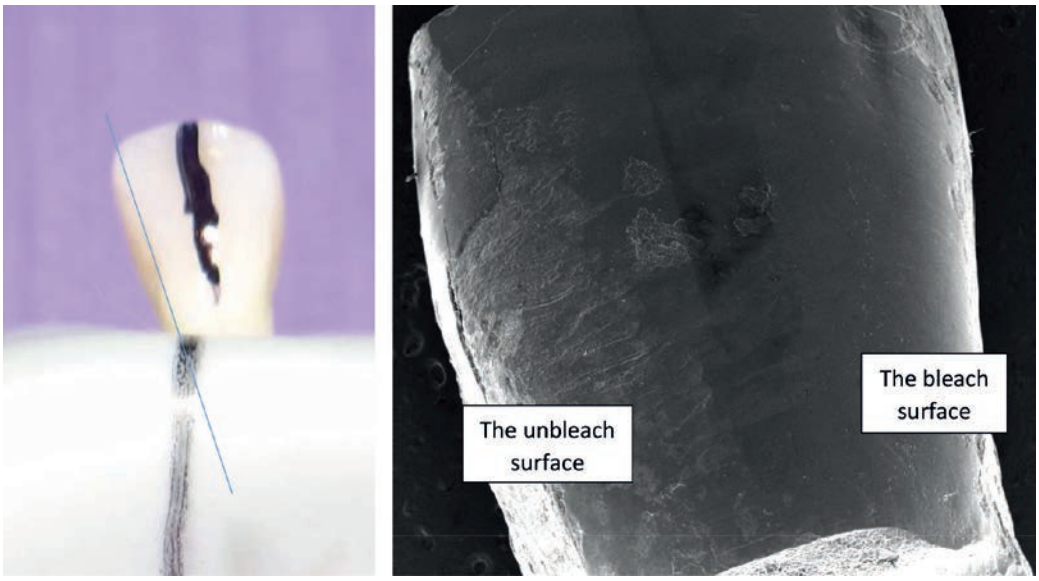

FIGURE 8. The image of the lateral incisor and the SEM image at 50X

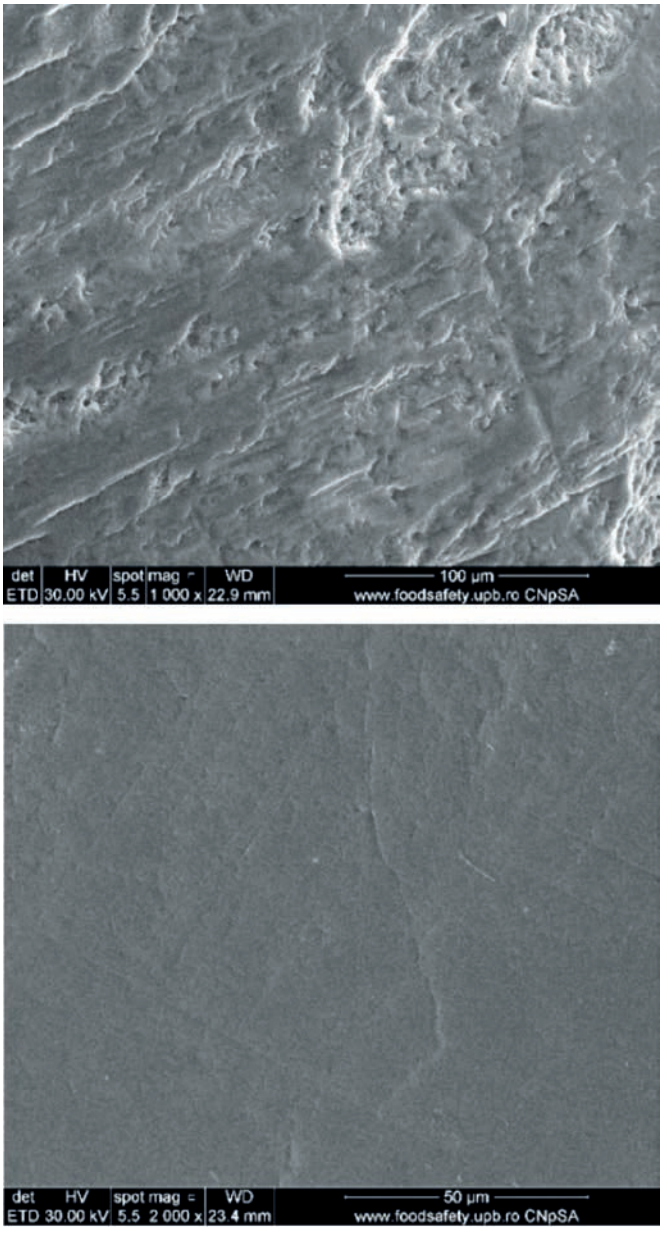

FIGURE 9. The image of a lateral incisor tooth and, respectively, the SEM image at 50X

which initiates the redox reaction; the halogen lamp, which produces radiation from the green-blue spectrum and is among the first activation methods used, but still a very widely used variant; the plasma arc lamp, which does not have a photo-thermal effect, but instead generates free radicals that amplify the bleaching effect; the gas plasma lamp, from the 400-500 nm spectrum, which uses the same technique or laser radiation [7].

Torres et al, evaluated the amount of coloring agent placed in bleaching agents. Their results showed the greater bleaching resulted when double and triple the amount of coloring agent was placed in the gel. The light energy from the laser excites the highly reactive H_2O_2 molecules, and as the molecules absorb the laser energy, the peroxide decomposes and ionizes [8].

The exposure time required for the process of bleaching the dental surfaces under the action of laser light irradiation is only 30 seconds, therefore we can appreciate that the dental surface is not degraded under the action of hydrogen peroxide, it only acts on the surfaces of the enamel.

The action of the laser with wavelengths of 940 nm is also known as having an action on chromophores, hence its ability to treat certain ailments or anaerobic infections. This brings by itself the ability to understand the bleaching procedure of some surfaces only by irradiating the colored areas with a laser beam, without using a peroxide or other substance used in the bleaching procedure, due to the absorption of chromophores under the incidence of the laser beam.

Studies have shown that the laser has proven to be the most valuable source of powerful bleaching energy with a simplistic and short-term application in the dental office [9].

The radiation of the diode laser acts on the chromophores, having a decontamination action [10].

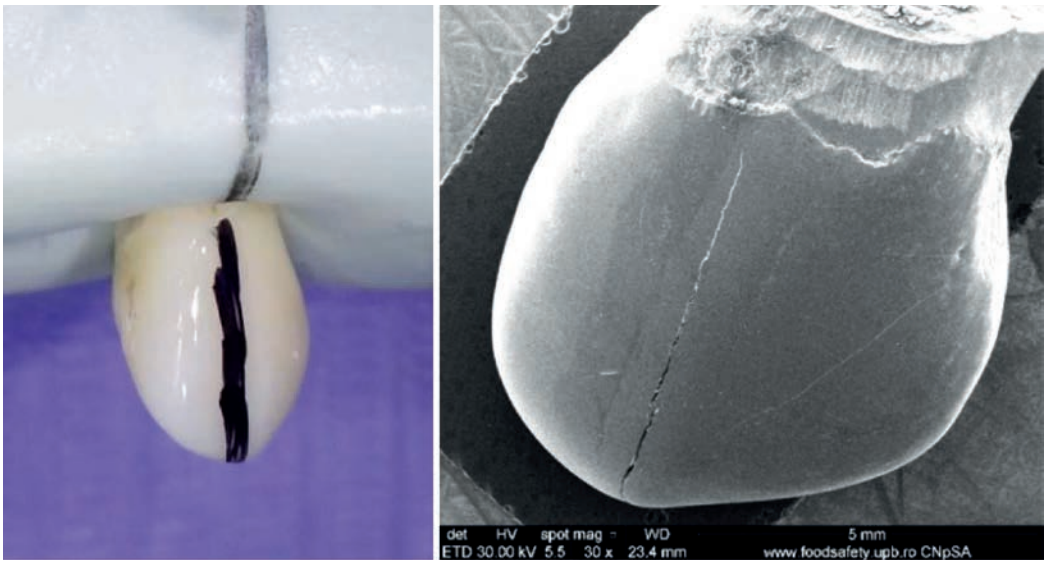

FIGURE 10. The sample of the canine tooth with the two surfaces subjected to the bleaching process and not exposed to the bleaching process analyzed microscopically at 30X

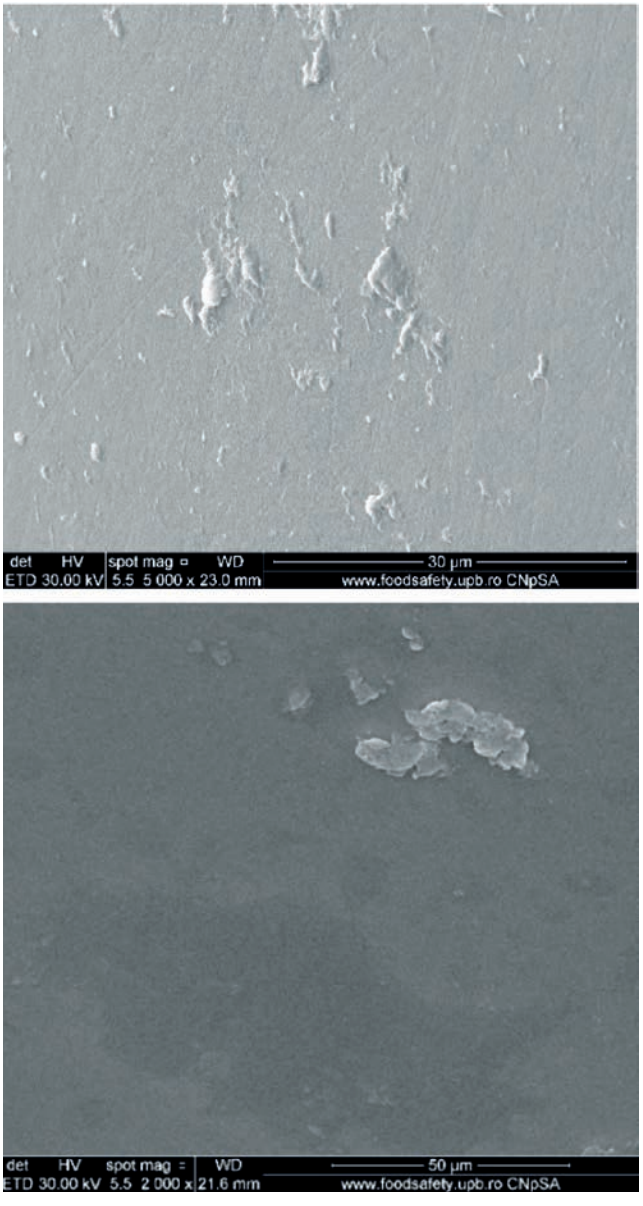

FIGURE 11. The surface not exposed to the bleaching process and the exposed surface the bleaching process

Significant differences in the chroma value are obtained for the two whitening agents and for the different light sources. In terms of lightness, the association of Laser and Whiteness HP bleaching gel showed significantly better results than when the same agent was used alone or in combination with LED. Best overall results are obtained with the Whiteness HP and Laser association [11].

However, in bleaching procedures, it is desired that the effect be as obvious as possible, without pathological implications of the exposed surfaces that is why this 45% hydrogen peroxide is also used.

The surfaces that were subjected to the bleaching process resulted in an obvious shade opening, even if the extracted teeth are dehydrated and do not behave completely like teeth in vivo.

Zhang et al, have result in their study this conclusion: suggest that KTP laser is effective at providing brighter teeth. According to the conditions used in this study, the LED and KTP laser induced a safer pulpal temperature increase when assisted with Hi-Lite bleaching gel [12].

CONCLUSIONS

The microscopic SEM images of the labial faces on which the 45% concentration hydrogen peroxide type bleaching gel was applied showed that they do not present any structural damage to the tooth enamel.

The surfaces that were subjected to the bleaching process resulted in an obvious shade opening.

This study will continue with other gel substances used in tooth bleaching, correlating the SEM microscopy aspects with the symptoms of the patients.

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