riencia más opaca y de color blanco tiza, por lo tanto, una falsa percepción del color después de una primera aplicación; por esto, se volvió a tomar el color de todas las piezas dentales ya tratadas pasadas las 24 horas. El color más frecuente encontrado en ambas técnicas está representado por la escala 1M1 de la guía de color Vita 3D-Master, siendo considerado uno de los colores más claros presentes en la gama de colores ya mencionado anteriormente.

CONCLUSIONES

- Aplicar las técnicas del presente estudio en sujetos con diferente alteración que la presentada, como se mencionó anteriormente, las técnicas están indicadas para pigmentaciones extrínsecas e intrínsecas, siempre y cuando no superen los límites de profundidad (no mayor a 0.2 mm).
- Emplear aditamentos para pulir resina de grano fino o extrafino, con el fin de generar el menor desgaste posible, de preferencia caucho y cepillo para profilaxis.
- Se recomienda no exceder un número mayor a cinco aplicaciones por sesión para ambas técnicas, por un periodo no mayor a 20 segundos.
- Poner mayor interés en el correcto diagnóstico y tratamiento para los dientes con alteraciones de color a nivel de esmalte.

Original research

Bleaching effect of hydrochloric acid (18%) and phosphoric acid (37%) on tooth enamel. An *in vitro* experimental study

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ABSTRACT

Introduction: Microabrasion is a conservative and controlled procedure that removes a superficial layer of enamel and is used to bleaching teeth. There are different microabrasive agents and their results on bleaching are diverse. **Aim:** To evaluate the bleaching effect of 18% hydrochloric acid (18% HCl) and 37% phosphoric acid (37% H_3PO_4) in bovine dental pieces. **Material and method:** In this experimental in vitro study, 74 permanent dental pieces pigmented with ground coffee for 48 hours were used. The specimens were divided into two groups (n = 37), according to the acid used: group1: 18% HCl+ pumice stone, carried out with a prophylaxis brush; group 2: 37% H_3PO_4+ pumice stone, using rubber for prophylaxis. Color change was measured with a VITA Toothguide 3D-MASTER® visual shade guide, before and after acid etching. **Results:** Statistically, mechanical microabrasion with 18%HCl produce a greater color change in pigmented bovine pieces, than that of 37% H_3PO_4 ($p < 0.01$); likewise, there is a color change in tooth pieces treated with 37% H_3PO_4 and 18% HCl before and after treatment ($p < 0.001$). **Conclusion:** Both techniques showed effectiveness in terms of changingtooth color.

Keywords: Hydrochloric acid, teeth bleaching, enamel, microabrasion.

INTRODUCTION

Currently aesthetic treatments with immediate results are chosen to correct the pigmentation in the teeth; however, there are pigmentations in the dental enamel that are not completely removed using a conventional teethbleaching, nor can they be easily covered by ceromer, resin or porcelain veneers, due to the thickness of the pigmentations.[1-3] These pigments can present some shades, whether brown or whitish, and can probably be related to enamel hypoplasia, dental fluorosis, inactive dental caries, among others.[4,5]

Since 80's of last century, microabrasion has been developed and improved as a therapeutic alternative to remove stains from tooth enamel. The procedure consists of generating a microscopic erosion and abrasion, using the mixture of an acid with pumice stone.[6]

Microabrasion is a conservative and controlled procedure for the superficial removal of the enamel through of a slight abrasion and simultaneous erosion with a special compound, on a microscopic surface of the enamel, respecting the healthy adamantine tissue.[2,3,7] Within mechanical microabrasion, the two most widely used techniques are 18% hydrochloric acid and 37% phosphoric acid, both with the use of extra-fine grain pumice stone.[8-10]

Several studies have shown that mechanical microabrasion treatment is effective in removing pigmentations, both extrinsic and intrinsic;[11] likewise, it produces a smooth and shiny appearance on the enamel.[8,12] McCloskey[13] decided to reduce the concentration of hydrochloric acid from 36 to 18%, obtaining good results in the treatments carried out. Later, Croll and Cavanaugh in 1986,[14] incorporated the use of extra fine grain pumice stone to the 18% hydrochloric acid solution, using a wooden toothpick and applying firm and constant manual pressure, producing minimally invasive erosion and abrasion on the enamel surface.

At some time this procedure was used as a bleaching teeth technique;[14,15] however, after a review regarding the action of hydrochloric acid on dental

enamel, we can affirm that it is not the right thing to do.[16] Upon contact with enamel, the acid does not act selectively, decalcifying both healthy and defective tissue and stimulates the formation of calcium or phosphorus salt which, when precipitated, prevent the acid from penetrating the dentin.[17-19] Hydrochloric acid acts as a descaling agent, softens and dissolves the enamel; however, there is no release of oxygen or peroxide, which are directly responsible for producing a bleaching itself.[19] The aim of the present report was to evaluate the bleaching effect of 18% hydrochloric acid (18% HCl) and 37% phosphoric acid (37% H_3PO_4) on the enamel of bovine dental pieces.

MATERIAL AND METHODS

An experimental, prospective and longitudinal *in vitro* study was done. For this purpose, 74 healthy bovine incisors were selected, because their chemical composition and structure is very similar to that of humans. Bovine teeth were obtained from a cattle slaughterhouse, with permission to extract the teeth of the animals. When dental pieces were extracted, they were placed in 0.9% sodium chloride saline solution, to be scraped and root smoothed to remove any remaining soft tissue. Subsequently, the specimens were immersed in coffee for 48 hours in order to create or simulate pigmentations by extrinsic agents. All the 74 bovine incisors were randomly distributed into two groups of 37 pieces each; likewise, the root of all bovine teeth was protected with pink wax to avoid the direct contact of acids with the fingertips of researcher.

To be included in the study, the bovine teeth should be an intact crown, without carious and without pigments or whitish tones. On the other hand, the pigmented teeth or with coronal fractures, with carious lesions, presence of shape anomalies, irregular edges or cusps and/or enamel beads, were excluded.

The experimental procedure was performed in the Dental Materials laboratory of Stomatology Faculty; Universidad Privada Norbert Wiene. The first step consisted of numerically labeling all the specimens from 1 to 74, with a waterproof marker. Then the initial color grading was taken using the VITA Toothguide 3D-MASTER® visual shade guide. Posteriorly, prophylaxis was carried out with an extra fine pumice stone and a low speed prophylaxis brush; the next step consisted of placing equal quantity of the 18% hydrochloric acid solution and pumice stone, in a dappencup, until a thick, wet paste was form. With the brush, the mixture was placed on the enamel surface to be treated for 10 seconds, followed by a profuse rinsing, the sample was immersed in a solution of sodium bicarbonate and water, in order to counteract the acid effect. The other study group used 37% phosphoric acid solution and pumice stone in a 1:1 ratio. The mixture was brought to the enamel surface. The mixture was was placed on the enamel surface and a firm force was applied with a resin polishing rubber and prophylaxis brush for 10 seconds. Then, a profuse wash was carried out and a new color grading was taken the tooth guide *(Figure 1)*.The acids used in this study were 18% hydrochloric acid (Claridient T.A®) and 37% phosphoric acid (Total Etch®); pumice stone (IMICRYL®), dental rubber (Smedent®) and 9.5mm polishing discs (Polishing Discs®).

At the end, in both study groups, a low-speed polishing was carried out using an extra-fine soflex disc with a resin polishing rubber and then the samples were placed at neutral fluorine gel for 4 min, to be obtained the final color of the teeth *(Figure 2)*.

The Statistical analysis was performed using SPSS 22.0 software (SPSS Inc.®, Chicago, IL, USA). The data were analyzed with the Wilcoxon rank test. Additionally, the Mann Whitney U statistical test was applied to assess differences between groups. The study was carried out with a significance level of 0.05.

RESULTS

When comparing the visual changes before and after using mechanical microabrasion, statistically significant differences were found ($p < 0.01$): before the treatment with 37% phosphoric acid, the proportion of dental pieces with 1M1 coloration was 13.5%, after applying it, the proportion of dental pieces with 1M1 staining was 37.7% *(Table 1, Figure 3)*. Similarly, a statistically significant difference was found between before and after using the 18% hydrochloric acid technique ($p < 0.01$) *(Table 2, Figure 4)*. It was observed that before the procedure 21.6% of dental pieces showed a color of 1M1; after treatment, the proportion of pieces with 1M1 color was 67.6%. Finally, when the 2 groups were compared before the procedure using the two techniques, no statistically significant differences were found; however, once applied and when compared, it was observed that applying 18% hydrochloric acid and 37% phosphoric acid, a statistical difference $p < 0.01$ was found, finding a higher proportion incoloration of 1M1 in the 18% hydrochloric acid technique.

DISCUSSION

Mechanical microabrasion is a conservative treatment, in which the enamel surface is subjected to

a combined action of an acid and an abrasive agent, in order to remove any pigment, stain or defect in dental enamel structure. We must bear in mind that for this study a VITA Toothguide 3D-MASTER visual shade guide was used, which contains a wide range of shades with 6 main groups: 0, 1, 2, 3, 4, 5 of which 0 is closest to the lightest color, and subgroups in which the colors themselves are identified: 0M1, 0M2, 0M3, 1M1, 1M2, 2L1.5, 2L2.5, 2M1, 2M2, 2M3, 2R1.5, 2R2.5, 3L1.5, 3L2. 5, 3M1, 3M2, 3M3, 3R1.5, 3R2.5, 4L1.5, 4L2.5, 4M1, 4M2, 4M3, 4R1.5, 4R2.5, 5M1, 5M2. When evaluating dental color changes in pigmented bovine teeth using mechanical microabrasion with 18% hydrochloric acid and 37% phosphoric acid techniques, their effectiveness could be verified, where the partial and / or total decrease of pigments or stains present in all treated dental pieces was observed. The afore mentioned agrees with what was stated by Sinha et al.,[20] in an *in vivo* comparative study, obtaining statistically significant results related to reduction of white point opacities, the intensity of the stains and the total area occupied by stains on fluorosis teeth with mild and moderate, after use mechanical microabrasion with 18% hydrochloric acid and 37% phosphoric acid techniques. When comparing effectiveness of both techniques in terms of a greater color change, there was a significant difference with $p < 0.01$, that is, statistically the 18% hydrochloric acid technique generates a greater color change than the 37% phosphoric acid technique.

Nevarez et al.[1] carried out a study to measurecolor changes in teeth, sensitivity and aesthetic satisfaction of the patient, applying 18% hydrochloric acid. This author obtained favorable results with the disappearance of the brownish stains in 100% in the areas of interest, there was no presence of sensitivity and patient satisfaction was total. Sheoran et al.[21] performed an in vivo study to evaluate the effectiveness of two materials (18% HCl and 37% H3PO4) in disappearance of opaque stains. The result obtained was the total satisfaction of the patient and the treatment ended with a p value < 0.001; it was also observed that after the microabrasion treatment there was no presence of sensitivity. Segundo Donly et al,[12] point out that after microabrasion with hydrochloric acid generates an atypical enamel, with new characteristics of smoothness and shine, coming from erosion and abrasion process. This microabraded structure is made up of a densely mineralized layer due to the compaction of the mineral subproducts on the enamel, with new optical properties called «glazed enamel». Consequently, the microabraded surface is more resistant to demineralization and to being colonized by *S. mutans*, which explains that the presence of sensitivity is less likely, since the layerprevents the acid from penetrating further.

Similarly Celik et al.[22] carried out a study to compare *in vivo* the efficacy of mechanical microabrasion for teeth whitening alone and in combination, obtaining the following results: in terms of patient satisfaction, combined microabrasion obtained higher scores compared to microabrasion alone, atalthough microabrasion did not cause sensitivity during the procedure, they concluded that combined microabrasion was more efficient only in teeth affected by fluorosis. Result supported by Franco et al.[23] who carried out an *in vitro* and *in situ* study to evaluate the effects of the combination of enamel microabrasion and teeth whitening according to the variables microhardness and roughness, obtaining statistically significant results, since microhardness was reduced regardless of whether it was combined with teeth whitening, although human saliva restored the microhardness of the enamel, concluding that teeth whitening does not cause significant damage to microabraded enamel and that only human saliva recovers microhardness. Similarly, Fernandes et al.[24] 25 concluded that enamel microabrasion combined with teeth whitening is a conservative and safe alternative method of treating fluorosis.

During the development of this study, important data were found that we do not find in any other publication. Since the main function of 37% phosphoric acid is to demineralize and dehydrate the enamel surface, creating a more opaque and chalk-white appearance, it is possible that a false perception of color occurs after a first application; therefore, after 24 hours the color change of all treated teeth was measured again. The most frequent color found in both techniques is represented by the 1M1 scale of the Vita Toothguide3D-Master visual shade guide, being considered one of the lightest colors in the range of colors already mentioned.

CONCLUSIONS

- To apply the techniques of this present study are indicated for extrinsic and intrinsic pigmentation as long as they do not exceed the depth limits (not greater than 0.2 mm).
- Use attachments with fine or extra grain for polishing resinin order to generate the least possible wear, preferably rubber and a brush for prophylaxis.
- It is recommended not to exceed a number greater than 5 applications per session for both techniques, for a period not exceeding 20 seconds.

- Put more interest in the correct diagnosis and treatment for teeth with enamel color alterations.

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