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Is it Possible to Perform Tooth Whitening During Orthodontic Treatment?

É possível realizar o clareamento dental durante o tratamento ortodôntico?

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ABCTRACT

Aims: Analyzed the use of H2O2 at 35% in teeth after orthodontic brackets placement in some respects: change the color, the bond resistance of the bracket to the enamel (BS) and the adhesive remnant index (ARI). Methods: Ninety bovine incisors with metal brackets were used, divided into 2 groups: (1) with whitening around orthodontic brackets and (2) without whitening. The color evaluation was performed with a portable spectrophotometer, in the incisal area and under the bracket, in two stages: before the placement of the brackets and after the adhesive strength test. During the experiment the samples were immersed in artificial saliva for 24 hours, 8 and 21 days for BS and ARI analysis. Results: No significant difference in color (under the brackets and incisal area) and in BS between areas and groups assessed. Regarding

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the ARI, the experimental group showed a significant difference in 24-hour period. Conclusion: there was uniform whitening throughout the enamel surface with orthodontics brackets bonded. The H2O2 at 35% did not show a negative effect on the BS and the ARI, however the 24 hours group showed a higher number of teeth without cement adhered to the surface of the enamel after whitening.

Keywords: Tooth whitening, orthodontic brackets, color

RESUMO

Objetivos: Analisar o uso de H2O2 a 35% nos dentes após a colocação dos braquetes ortodônticos em alguns aspectos: alterar a cor, a resistência de união do braquete ao esmalte (BS) e o índice de adesivo remanescente (ARI). Métodos: Foram utilizados noventa incisivos bovinos com braquetes metálicos, divididos em 2 grupos: (1) com clareamento em torno dos braquetes ortodônticos e (2) sem clareamento. A avaliação da cor foi realizada com um espectrofotômetro portátil, na área incisal e embaixo do braquete, em duas etapas: antes da colocação dos braquetes e após o teste de resistência do adesivo. Durante o experimento, as amostras foram imersas em saliva artificial por 24 horas, 8 e 21 dias para análise por BS e ARI. Resultados: Não houve diferença significativa na cor (sob os braquetes e na área incisal) e na BS entre as áreas e grupos avaliados. Em relação ao IRA, o grupo experimental apresentou diferença significativa no período de 24 horas. Conclusão: houve clareamento uniforme em toda a superfície do esmalte com braquetes ortodônticos colados. O H2O2 a 35% não apresentou efeito negativo sobre a SB e o IRA, porém o grupo de 24 horas apresentou maior número de dentes sem cimento aderido à superfície do esmalte após o clareamento.

Palavras-chave: clareamento dental, braquetes ortodônticos, cor.

1 INTRODUCTION

Patient satisfaction with respect to appearance, tooth color and dental alignment, have become the major causes that take patients to seek aesthetic dental treatments1,2. Some studies have shown that the demand for tooth whitening by patients in orthodontic treatment have been much higher than the recommendations of orthodontists3,4. Such knowledge has shown an early interest of some patients for tooth whitening during orthodontic treatment5, with the intention of getting faster aesthetic solutions and concomitantly acquire the desired teeth color and correct positioning of teeth in the dental arch4,6-8.

Studies have shown that H2O2 in contact with the enamel surface and the orthodontic accessories, leave them cleaner, exposed and the color more evident, improving patients' self-esteem and the interest in completing the treatment7,9. This fact is due to the low molecular weight of the H2O2 which allows a polidirecional flow through the pores present in the enamel and the dentin, removing superficial and deep stains, through a oxireduction reaction, even in the area under the orthodontic brackets10,11.

In clinical practice, the technique of teeth whitening is usually performed after the orthodontic treatment. Other authors say that the application of H2O2 prior to the orthodontic treatment can cause interference with enamel bond resistance and favor debonding of the brackets during treatment12,13. Doing teeth whitening during orthodontic treatment has raised questions to most orthodontists, due to the possibility of the presence of shadows or stains on the enamel after the removal of the metallic bracket3,11, however there are still no studies analyzing the effects on enamel and its structure in the area under the bracket7.

Furthermore, studies have reported the decrease of the bond resistance between the enamel and the bracket after use of H2O2, due to the presence of residual oxygen in the enamel pores preventing the polymerization of the resin materials10,14.

The possibility of performing dental whitening in patients who are still using brackets, with the aim of obtaining teeth color homogenization, without interfering in the union resistance between teeth and brackets, is a clinical challenge. There is only one work in the literature that reports that the use of 8% whitening tape can be used during orthodontic treatment, resulting in whitening under the metal bracket8.

Thus, the aim of this study was to evaluate the use of H2O2 to 35% in teeth with orthodontic brackets, analyzing the homogenization of color in the enamel surface, the area under the bracket in relation to the incisal area, the influence on bond resistance at different times of storage in artificial saliva and enamel condition after debonding of the bracket.

The null hypothesis of this study is that whitening performed on teeth with brackets will not show uniformly whitened teeth and that their bond strength will be altered.

2 MATERIAL AND METHODS

Ninety bovine permanent incisors were used. It was excluded from the sample teeth with cracks, fissures and presenting any defect when visually inspected. For correct storage and remineralization of enamel, the specimens were stored in artificial saliva, with pH 7.0.

To standardize the location of the evaluation of color and bonding of the orthodontic bracket areas, a delimitation of the work area, 14.0 x 8.0 mm, was held using a digital pachymeter (Absolute Digimatic, Mitutoyo, Tokyo, Japan) and marked with red enamel (Fig 2D,F). Ninety metal brackets, Edgewise Standard (Abzil, Sorocaba, SP, Brazil) were used, with an area of 12.16 mm2 (Fig 2A).

Transbond XT® resin (3M Unitek Monrovia, California, USA) was placed on the bracket base in all groups, where it was positioned in the marked area by the liner, with the aid

of a tensiometer (TP Orthodontics, Richmond, USA) using a force of 300 cN for 10 sec (15), to ensure an even thickness of the resin (Fig 2E). The excess resin around the bracket was removed. Light activation was performed with an Optilux 501 (420mw/cm², Keer, Orange) over the four sides (mesial, cervical, distal and incisal) for 10 seconds in each face (12).

The samples were randomly divided into 2 groups (n=45) and each group was subdivided into 3 groups (Figure 1).

The whitening agent used was H2O2 at 35% (Whiteness HP®, FGM, Joinville, SC, Brazil) applied over the entire enamel surface area, with three applications of 0.1 ml for 15 minutes at each application, without light activation (Fig 2C).

For both groups color measurement was made with a portable spectrophotometer VITA Easyshade (Easyshade, Viden, Brea, California), before and after H2O2 application. This evaluation was performed twice on two different areas of the enamel surface (under the brackets and incisal area) to examine the color homogeneity in the enamel (Figure 3). The color variation, ΔE (difference between the initial and final color), was calculated.

In regards to the bond resistance enamel-bracket, there was the evaluation by shear test in a universal testing machine (Instron 3342, Canton, Ohio, USA), at three different times of storage in artificial saliva (T24, T8 and T21), at a speed of 0.5 mm/min., using a chisel (Odeme Biothnology, Joçoaba, SP, Brazil) applied to the bracket/enamel interface.

After the shear test, all specimens were visually examined with a stereomicroscope (Kozo Optical and Electronic Instrumental, Nanjing, China), with an increase of 10x to access the fracture pattern and the adhesive remnant index (ARI)14,15. The weighted correlation coefficient (Kappa) was calculated to assess the correlation between the three examiners for the ordinal ARI categorical variable for each specimen. The smaller interexaminer coefficient observed was 0.668.

3 STATISTICAL ANALYSIS

For the sample calculation, the difference (ΔE) between the final value (Af) and the initial value (Ai) of the variables related to the measurement of dental color were considered.

Independent T test for sample calculation was applied, provided by the statistical program BioEstat (version 5.3), adopting a power test of 0.80 and α of 0.05, obtaining a minimum size of 11 (eleven) specimens per group. To minimize biases caused by possible losses, 15 (fifteen) specimens were allocated for each group.

Data were analyzed by SPSS statistical program (version 17.0). The outcome variables were the homogenization of color, bond resistance (tensile in MPa) obtained in the shear mechanical testing and the adhesive remnant index (ARI); and the exposure variables correspond to the tooth whitening (experimental or control), the evaluated area (under the bracket and incisal area) and storage time in saliva, 24 hours (T24), 8 days (T8) or 21 days (T21).

Initially the descriptive statistics of the variables referring to enamel color and bond resistance using mean and standard deviation was performed. The normality of the distribution was checked using the Shapiro-Wilk test. After this processing, the independent Student T test was used for comparative analysis of numerical variables between groups and regions evaluated. The two-way ANOVA test was used for comparative analysis at different storage times in saliva. The comparative analysis of the ARI frequencies between experimental and control groups was performed using Fisher's exact test. The significance level adopted was 5% ($p < 0.05$).

4 RESULTS

The comparative analysis of enamel color difference after the bonding of brackets in the groups with and without tooth whitening is expressed in Figure 3A. There was a statistically significant change of color in the group that underwent whitening (experimental group) both in the region under the bracket ($p<0.001$) and in the incisal region ($p=0.001$) than that of the control group. In the comparative analysis between the two evaluated dental regions (under the brackets and incisal area), there was no statistically significant differences in change of color with either the experimental group ($p=0.927$) and the control group ($p=0.852$). These findings suggest that the whitening generates teeth color change without statistical differences in both areas (under the brackets and incisal area).

In regard to bond resistance of the bracket, there were no differences in both groups (experimental or control) in the different time periods evaluated ($p=0.692$). (Figure 3B).

With respect to ARI, it was observed that the experimental group showed a statistically higher frequency of samples without composite adhering to enamel (score 0) than the control group ($p=0.017$) at the time period of 24 hours. In the time periods of 8 days and 21 days there were no statistically significant differences ($p=0.112$ and 0.999, respectively) in the ARI scores frequency (Figure 3C).

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5 DISCUSSION

In this study we proposed the use of H2O2 at 35% for bovine tooth whitening with the presence of orthodontic bracket. The justification of this study is due to the desire of patients to whiten their teeth while in fixed orthodontic treatment and the lack of studies addressing this issue.

The results showed that after tooth whitening there was no color change between the two areas evaluated, under the brackets and incisal area, demonstrating an effective homogenization of color throughout the enamel structure. However, few studies have analyzed this association of treatments in literature, which can be explained by the concern of researchers and orthodontists about the risks of staining and irregularities in the enamel after bracket removal7,8. However, these deleterious effects were not observed in any of the samples of the present study.

Jadad8 et. al. evaluated the effect of 8% H2O2 whitening tape for 10 days, for 45-minute sessions, in patients with orthodontic treatment and in patients who completed orthodontic treatment. The results were like the present study, showing that there was whitening under the metal bracket and that there was no significant difference in teeth color of patients who underwent whitening with and without fixed orthodontic braces. However, the low concentration of H2O2 used and the absence of color analysis in two areas of enamel, before and after whitening, have raised questions about the possibility of color differentiation in the dental enamel after the completion of treatments.

According to Li and L. Greenwall16, 2013, the type of composition and concentration of H2O2 used influences the effectiveness of whitening, because it is a technique dose/time dependent, so, the degree of whitening is determined according to the concentration of H2O2 used and the time of implementation.

In this study, the results showed that after tooth whitening there was no color difference in the areas evaluated, under the brackets and incisal area, both in the experimental group ($p=0.927$) and in the control group ($p=0.852$). These findings may be justified by porosity of the enamel, H2O2 low molecular weight and diffusion and poly-directional penetration of H2O2 through the enamel and the dentine8,16-20. The H2O2 penetration ability causes free radicals to whiten teeth poly-directionally, even in areas covered by braces, making it possible to obtain a whitening effect under the braces8.

Several studies have reported the whitening effectiveness in dental structure in relation to the initial moment, in this study this evidence was also found21-23. It was noticed that there

was a statistically significant difference in color between the experimental and the control groups, both in the area under the bracket (p = <0.001) and in the incisal area (p = 0.001).

However, while H2O2 is a common agent in the practice of teeth whitening, some studies have reported their deleterious effects on morphology and texture of the enamel surface9,24-26. Others report that there is no change to the enamel after exposure to H2O227,28. The effect on the bond resistance composite-enamel analyzed immediately after whitening, showed a significant reduction, beyond the resin-bracket bond, prior to dental whitening10,20.

Considering the results, it was noticed that after bracket bonding and immersion in artificial saliva at three different times, T24h, T8d and T21d (24 hours, 8 and 21 days), there was no statistically significant difference in bond resistance of the brackets. However, in relation to studies in teeth whitened prior to adhesion, it was noticed lower resistance values and like these data10,12-14,31. According to Reynolds, the minimum value of the bracket bond resistance is 6-8 MPa, being considered the adequate value for the orthodontic clinical needs and capable to withstand the masticatory and orthodontic forces32. These data demonstrate that the values obtained in this study fall within the bracket bond resistance standard of normality.

However, in 2014, Algahtani33, showed that when H2O2 meets resin materials, it results in changes in bond resistance and in marginal integrity. Lopez14 et al., demonstrated that the release of calcium and phosphorus ions with high concentrations of H2O2, leads to a significant loss of the Ca/P ratio in whitened samples and lowers the bond resistance. Consolaro7 et. al, claim that when whitening is carried out over the resin, an increase in infiltration caused by the H2O2 may occur. When this exposure occurs between resin and bracket on the enamel surface, an easier detachment of the bracket may occur, as the enamel pores are open; the resin bond resistance is altered, and the orthodontic applications are more prone to debond.

In ARI analysis the experimental group showed statistically significant results of score 0 and 1 in relation to the control group (p=0.017) in T24h. These results are controversial to other studies. In the other time periods evaluated, T8d and T21d, no statistically significant differences were detected (p=0.112 and 0.999)9-31.

It is worth emphasizing the need to conduct controlled clinical trials, randomized with the proposal to verify that if it would occur, in an ordinary clinical situation, the same that happened in the present study. Since, clinically, the patients are exposed to dietary coloring

agents and/or habits such as the consumption of tobacco, coffee, chocolate and others, known as pigmented agents.

6 CONCLUSION

There was uniform whitening throughout the enamel surface with orthodontics brackets bonded (under the brackets and incisal area), with no stains or shadows after removal of the orthodontic bracket, and the use of H2O2 at 35% in teeth with orthodontic brackets had no negative effect on the bond resistance of bracket.

Regarding ARI, only the experimental group in the 24 hours period showed the highest number of teeth without cement adhered to the surface of the enamel.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

Ethics Statement

All authors of the manuscript have followed the ethical standards in relation to the contents of this article.

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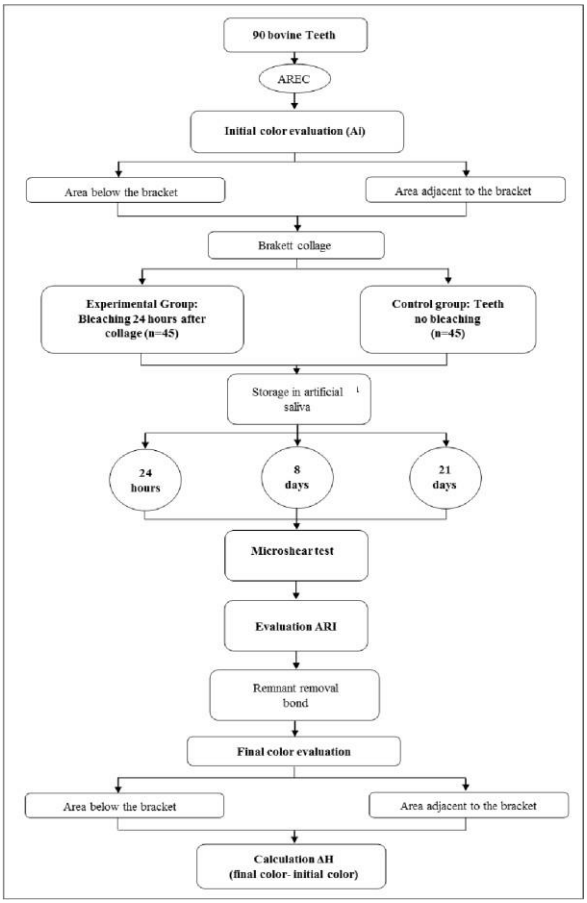
FIGURE LEGENDS:

Figure1. Flowchart

Figure 2. (A) Study area (12,16mm2) bounded with red enamel; (B) Liner was used to record the anterior portion of the dental crown; (C) Demarked area by the liner; (D) Color evaluation of the area under the bracket; (E) Color evaluation of the incisal area; (F) H2O2 sample application.

Figure 3. Results. (A) Comparative analysis of the enamel color ΔE between the study groups and the evaluated area. (B) Comparative analysis of the shear test between the groups evaluated. (C) . Distribution of ARI frequencies in the evaluated times and experimental groups and controls.



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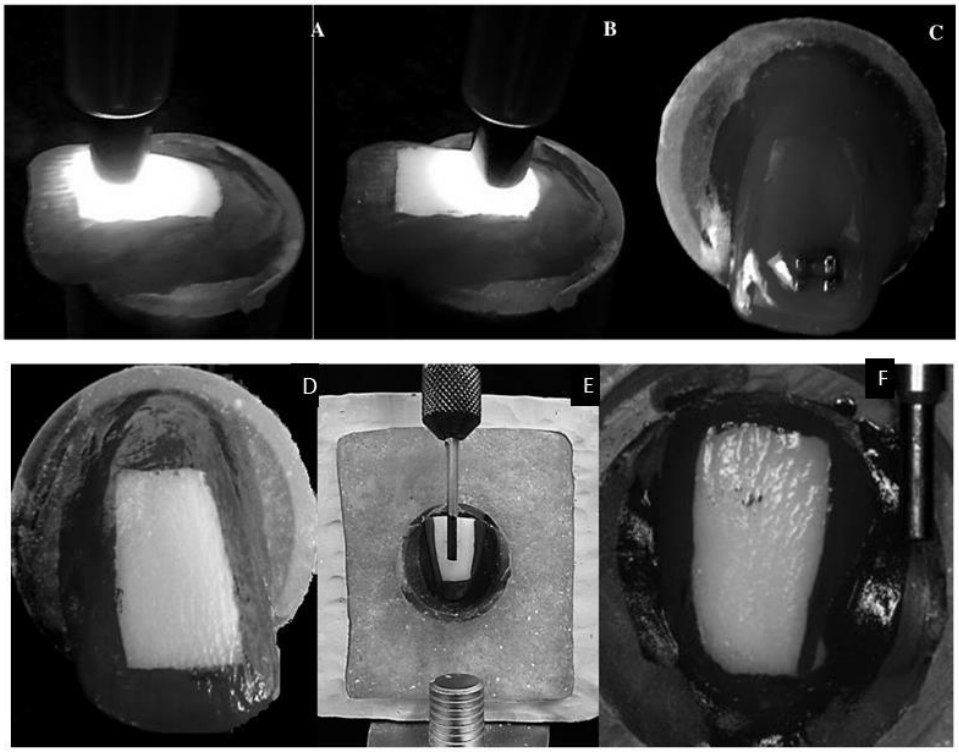

A

Groups	Area below the bracket		Area adjacente to the bracket		p-value[1]
	Average	(±DP)	Average	(±DP)	
Experimental	6,51	(2,61)	6,46	(3,28)	0,927
Control	4,37	(2,11)	4,29	(2,73)	0,852
p-value[2]	<0,001*		0,001*		

[1] Comparative analysis in the same group in different areas (Paired T-test). [2] Comparative analysis in the same area and in different groups (independent T-test). *Statistically significant difference ($p < 0,05$). ±SD = standard deviation.

B

Times	Tensile (Mpa)	
	Experimental	Controle
	Standart Deviation (±SD)	Standart Deviation (±SD)
24 hours	8,3 (5,1)	7,3 (4,1)
8 days	6,0 (2,9)	5,4 (2,9)
21days	6,4 (2,8)	3,9 (1,7)

ANOVA two-way comparative analysis between groups and different times ($p = 0,692$).

C

Groups	Times	Scores do ARI			
		0	1	2	3
Experimental	24 hours	12	3	0	0
	8 days	8	7	0	0
	21days	6	7	1	1
Control	24 hours	4	7	1	3
	8 days	3	9	1	2
	21 days	6	8	0	1

[1] Comparative analysis of scores between groups (Chi-square test), 24 hours ($p = 0.017$), 8 days ($p = 0.112$), 21 days ($p = 0,999$).