The use of microcomputed tomography to evaluate the cervical barrier in internal tooth bleaching

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Aims

Nowadays, with the advances of aesthetic dentistry, the demand for patients has been increased in search of treatments that offer a satisfactory smile. The tooth discoloration has been one of the main complaints of patients, especially when it is related to the anterior teeth, because it compromises the aesthetics. Internal or external dental bleaching has been proposed as a first alternative of aesthetic treatment to recover cases of color change (1). For bleaching of endodontically treated teeth, whitening agent is applied inside the pulp chamber over a cervical barrier. The procedure can be performed in up to 4 sessions according to the degree of dental color alteration. The function of the cervical barrier is to promote adequate sealing to minimize and even prevent the diffusion of the bleaching agent through dentinal tubules to the outer root surface, causing an inflammatory reaction, resulting in root and bone resorption (2). Therefore, the materials used for cervical barriers and their position are important factors to avoid these adverse effects and to achieve success. Different methodologies have been used to study intracoronal bleaching, such as: evaluation of optical density and quantification of hydrogen penetration (H2O2) by spectrophometry (3, 4, 5) and evaluation of fracture resistance (6), which are destructive methods and allow only bidimensional analysis. To the best of the authors' knowledge, there is no study of cervical barrier using micro-CT. Thus, the aim of this study was to evaluate, quantitatively and qualitatively, the marginal misfit and porosity of cervical barrier made of different materials after application of the bleaching gel, using microcomputed tomography analysis.

Method

Forty 6 mm-length root sections of bovine maxillary incisors were obtained and each section was apical sealed with gutta-percha. Thus, the samples were distributed into 4 groups (n=10), according to the material used for cervical barrier: Group GI (conventional glass of ionomer cement), Group GIR (glass of ionomer cement reinforced by resin), Group FR (flow resin) and Group MTA (mineral trioxide aggregate). The barriers were placed 2 mm height and the samples were subjected to four applications of 35% hydrogen peroxide for 15 min each. The samples were scanned before and after each bleaching procedure, by using a micro-CT device (SkyScan1176; Bruker-microCT, Kontich, Belgium). The scanner parameters were set at 90 kV, 278 µA, isotropic resolution of 8.6 µm, averaging frames of 2, 180° rotation and rotation step of 0.5°, using a 0.1 mm-thick copper filter.

The acquired projection images were reconstructed and co-registered by pairs (preoperative scan and each scan after bleaching agent application) using DataViewer v.1.5.1.2 software. Then, CTAn v.1.14.4.1+ software (Bruker-microCT) was used for the bidimensional (marginal misfit) and three-dimensional (porosity) evaluation of the cervical barrier materials. To bidimensional analysis of the marginal misfit, initially the coronal cross-sections of each sample was salved as dataset using DataViewer v.1.5.1.2 software. After that, in the CTAn

v.1.14.4.1+ software, it was selected the middle coronal cross-section and, the lateral and apical misfit was evaluated (µm) by six and three measurements, respectively (Figure 1).

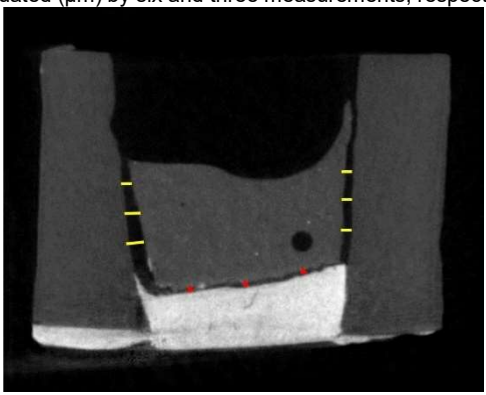

Figure 1. Evaluation of lateral (yellow marks) and apical (red marks) marginal misfit (µm) in CTAn software.

To porosity analysis (three dimensional evaluation), the ROI defined was a round with 2.5 mm of the diameter and 0,5 mm height. The same ROI was used in the analysis of each bleaching session (Figure 2). The threshold was adjusted to each material and then, the 3D porosity analysis (volume and percentage) were done.

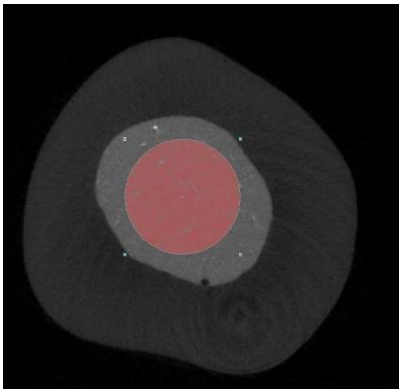

Figure 2. Region of interesting defined to analysis the porosity in CTAn software.

Results

The results of this study for marginal misfit of the cervical barrier showed statistically significant differences among the groups ($p<0.05$). RF and GI groups presented, respectively, the lowest and the highest values of lateral and apical marginal misfit (Figure 3).

In the intra-group comparison (evaluation of the influence of the bleaching session) of lateral marginal misfit, it was observed that RF and MTA groups did not present statistically significant differences, while, the second session of GIR group was statistically different from initial session. The third and fourth session of GI group were greater than others ($p<0.05$). For apical marginal misfit, no statistically difference was observed for any group ($p>0.05$).

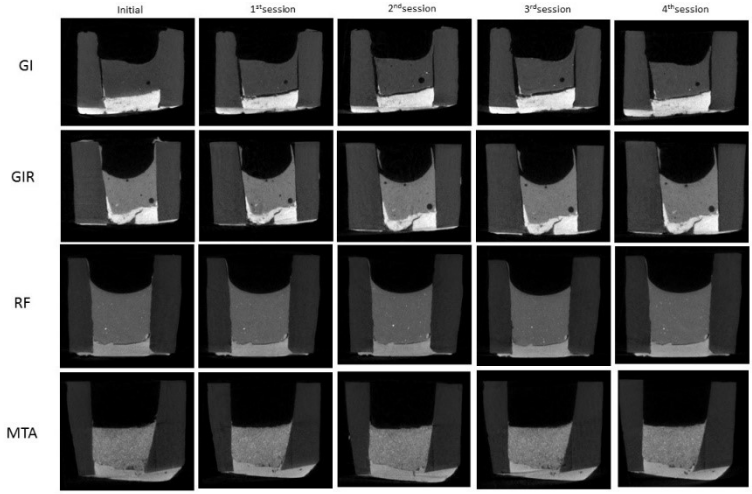

Figure 3. Marginal misfit (μm) in different materials used as cervical barrier.

Regarding the percentage and volume of pores in the different materials used for cervical barrier, statistical difference was observed among groups ($p<0.05$).RF group presented lowest values to percentage and volume of pores and GIR presented the highest values. When the intra-group comparison was made, there was no statistically significant difference of percentage and volume of pores in any of the groups ($p>0.05$) (Figure 4).

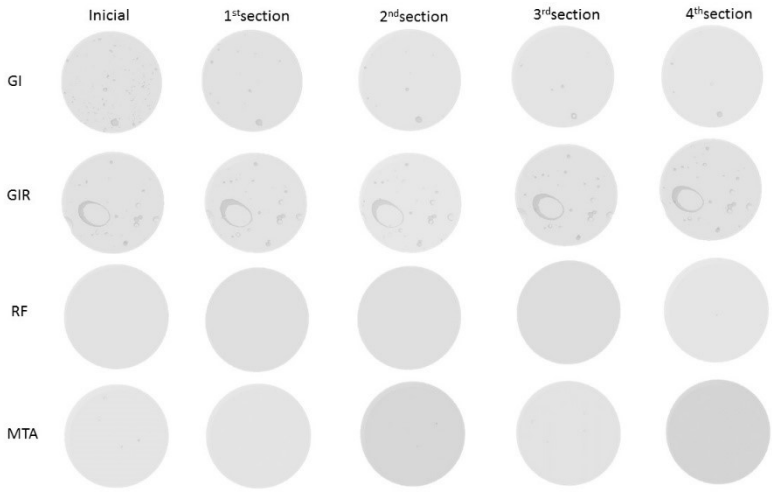

Figure 4. Porosity in different materials used as cervical barrier.

Conclusion

The microcomputed tomography was adequate to characterization and evaluation of the different materials used as cervical barrier, being that the flow resin (RF group) showed the greater marginal misfit and porosity results.

References:

1. Kwon SR, Wertz PW. Review of the mechanism of tooth withening. J Esthet Restor Dent. 240-257, 2015.
2. Vosoughhosseini S, Lotfi M, Shahmoradi K, Saghiri MA, Zand V, Mehdipour M, Ranjkesh, Mokhtari H, Salemmilani A, Doosti S. Microleakage comparison of glass-ionomer and white mineral aggregate used as a coronal barrier in nonvital bleaching. Med Oral Patol Oral Cir Bucal. 1017-1021, 2011.
3. Briso AL, Gonçalves RS, Costa FB, Gallinari Mde O, Cintra LT, Santos PH. Demineralization and hydrogen peroxide penetration in teeth with incipientes lesions. Braz Dent J. 135-140, 2015.
4. Mena-Serrano AP, Parreiras SO, do Nascimento EM, Borges CP, Berger SB, Loguercio AD, Reis A. Effects of the concentration and composition of in-office bleaching gels on hydrogen peroxide penetration into the pulp chamber. Oper Dent. 76-82. 2015.
5. Cintra LT, Benetti F, Ferreira LL, Gomes-Filho JE, Ervolino E, Gallinari Mde O, Rahal V, Briso AL. Penetration capacity, color alteration and biological response of two in-office bleaching protocols. Braz Dent J. 169-175, 2016.
6. Azevedo RA, Silva-Sousa YT, Sousa-Gabriel AE, Messias DC, Alfredo E, Silva RG. Fracture resistance of teeth subjected to internal bleaching and restored with different procedures. Braz Dent J. 117-121, 2011.