

EFFECTS OF DESENSITIZING AGENTS ON DENTINAL TUBULE OCCLUSION

EFEITOS DE AGENTES DESENSIBILIZANTES NA OBLITERAÇÃO DE TÚBULOS DENTINÁRIOS

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ABSTRACT

The aim of this study was to evaluate the features of dentinal tubules occlusion following application of three commercially available desensitizing agents: potassium oxalate-based / Oxa-Gel (OX), HEMA and glutaraldehyde-based / Gluma Desensitizer (GD) and acidulated phosphate fluoride-based / Nupro Gel (AF). Buccal cervical areas of twenty-four extracted human third molars were smoothed and wet-polished with SiC papers and diamond pastes, in order to simulate the clinical aspect of hypersensitive dentin cervical surfaces. The teeth were randomly divided into four groups (n=6), according to the dentin surface treatments: G1: untreated; G2: OX; G3: GD; G4: AF. Specimens were fractured in the lingual-buccal direction and prepared for SEM analysis. OX promoted tubule occlusion by crystal-like deposits in the lumen of the tubules. While GL created a thin layer over the dentin surface, AF application produced precipitates that occluded the tubules. According to the SEM analysis, all desensitizing agents were able to occlude the dentinal tubules.

UNITERMS: Dentin hypersensitivity; Desensitizing agents; Dentinal tubule occlusion.

RESUMO

Objetivo deste estudo foi avaliar as características de obliteração dos túbulos dentinários de três agentes dessensibilizantes: produto a base de oxalato de potássio / Oxa-Gel (OX), produto a base de HEMA e glutaraldeído / Gluma Desensitizer (GD) e produto a base de flúor-fosfato acidulado / Nupro Gel (AF). A região vestibular e cervical de vinte e quatro terceiros molares humanos extraídos foi planificada e polida com lixas de SiC e pastas de diamante para simular superfícies vestibulares dentinárias cervicais com hipersensibilidade. Os dentes foram aleatoriamente divididos em quatro grupos (n=6), de acordo com os seguintes tratamentos superficiais da dentina: G1: sem tratamento; G2: OX; G3: GD; G4: AF. Os espécimes foram fraturados no sentido línguo-vestibular e preparados para microscopia eletrônica de varredura (MEV). OX promoveu oclusão pela deposição de cristais no interior dos túbulos. Enquanto, GL criou uma camada delgada sobre a superfície da dentina, a aplicação do AF produziu a formação de precipitados que ocluíram os túbulos. De acordo com a análise em MEV, todos agentes dessensibilizantes testados foram capazes de obliterar túbulos dentinários.

UNITERMOS: Hipersensibilidade dentinária; Agentes dessensibilizantes; Oclusão de túbulos dentinários.

INTRODUCTION

Previous studies have shown that hypersensitive areas may present exposed dentinal tubules^{2,21}. The hydrodynamic theory assumes that a stimulus applied on the dentin surface causes movement of tubular fluid, which in turn activates mechanoreceptor nerves, eliciting pain and discomfort³.

According to this theory, if the functional radius of opened dentinal tubules decreases, then the permeability is also decreased, reducing dentin sensitivity. Thus, treatments for hypersensitivity should occlude dentinal tubules and prevent nerve sensitivity. Therefore, some products have been indicated to treat dentin hypersensitivity due to their ability to occlude tubules⁷.

however, they were not attached to the tubules walls. A mild mineral removal of peritubular dentin was observed at the dentinal tubules entrance.

DISCUSSION

This study evaluated the occlusion of dentinal tubules by three desensitizing agents. The active ingredient of Oxagel, Desensitizer and Nupro Gel are potassium oxalate,

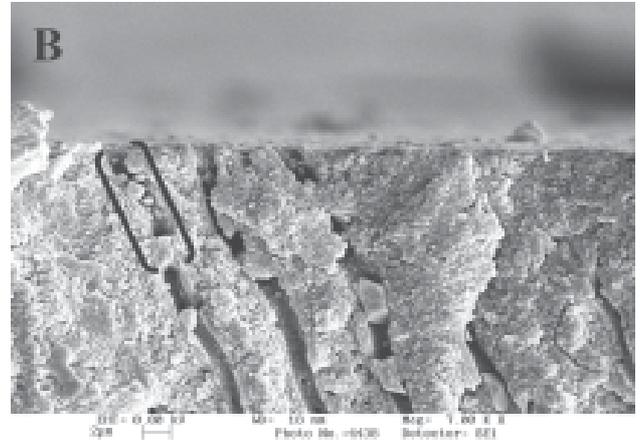
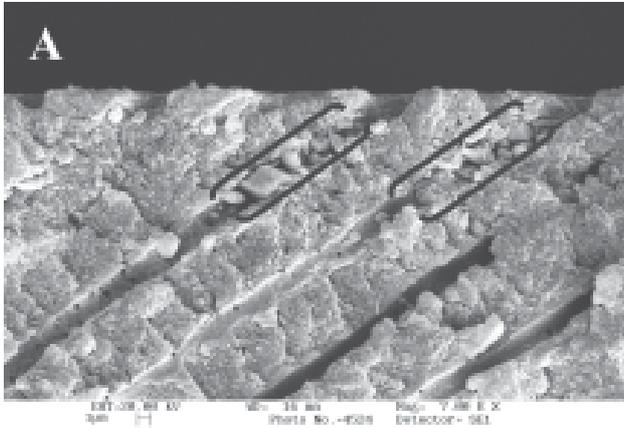


FIGURE 2- SEM micrograph of potassium oxalate-treated dentin. Note the crystal formation extending into the tubules. Areas between parentheses exhibit large formation of crystals within the dentin tubules. (A and B: x 7,000)

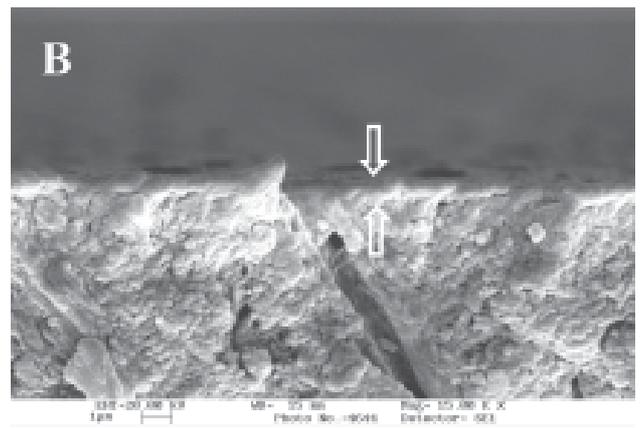
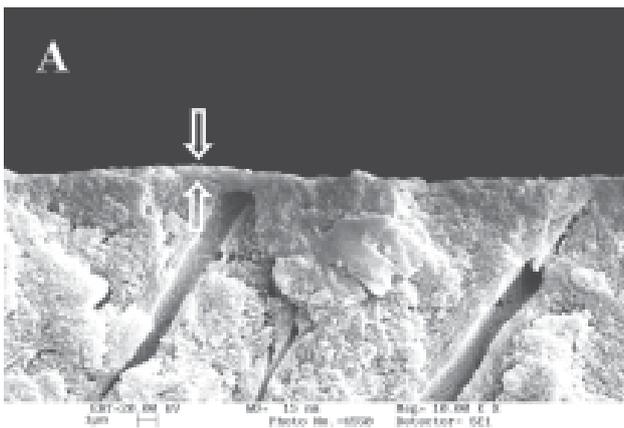


FIGURE 3- SEM micrograph of HEMA and glutaraldehyde-treated dentin. A thin layer can be seen over the dentin (between arrows), occluding the entrance of dentinal tubules. (A: x 10,000; B: x 15,000)

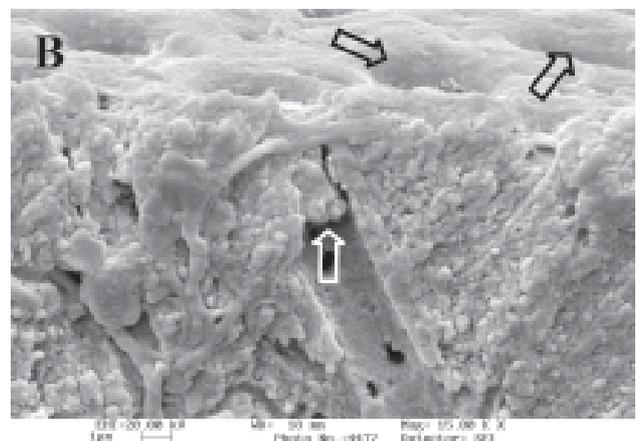
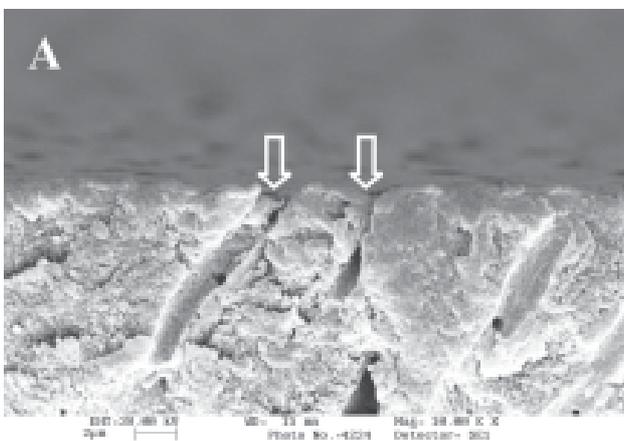


FIGURE 4- SEM micrograph of acidulated phosphate fluoride-treated dentin. Note the precipitates within the tubules and below the surface (white arrow), and the funnel shape dentinal tubules opening (black arrows). (A: x 10,000; B: x 15,000)

2-hydroxyethyl methacrylate (HEMA) + glutaraldehyde and acidulated phosphate fluoride, respectively. Desensitizing agents occluded tubules by salt precipitation or resin deposition. Thus, if hypersensitivity is due, in part, to open dentinal tubules at the dentin surface, desensitizing agents that may promote a reduction in the number of opened tubules or in their diameter could, according to the hydrodynamic theory, reduce fluid movement within the tubules, which in turn would reduce dentin hypersensitivity.

Control group specimens that were polished and ultrasonicated in order to remove smear layer presented open tubules and tubule density (Figure 1) similar to those described for sensitive areas^{2,21}. This technique applied to create artificial cervical sensitive areas does not use any chemical solution to remove the smear layer, which could alter the underlying dentin. Moreover, analysis of fractured specimens allowed verification of the simulated sensitive cervical areas for control group, intra-tubular precipitation and sub-superficial tubule occlusion for treated groups.

Dentin treated with potassium oxalate gel showed substantial crystal-like deposits within the tubule lumen (Figure 2). The gel was able to penetrate into the tubule and react with calcium ions from the dentin fluid to form insoluble calcium oxalate crystals^{6,7,9,16}. The precipitation occurred inside the dentinal tubules, extending up to 15- μ m depth and the crystal dimensions were varied, including crystals that occluded a large portion of the tubule diameters. Besides, the tubule occluding properties of potassium oxalate might be combined with the inhibitory property of potassium on intradental nerves¹⁵. This theory is based on the fact that the increased potassium ion concentration ($[K^+]$) in the extracellular fluids into the tubules may cause a sustained depolarization of the nerves¹². This will result in inactivation of action potential generation through a mechanism such as axonal accommodation¹.

Gluma Desensitizer is an aqueous solution containing 5% glutaraldehyde and 35% HEMA. Because glutaraldehyde is a biological fixative, it has been suggested that the dentinal tubules are occluded as an effect of reaction with plasma proteins from dentinal fluid. Although studies displayed transverse septa in the lumen of dentinal tubules as a result of glutaraldehyde action^{9,18}, no septum was observed in this study. The presence of a thin layer over treated dentin was noted penetrating and occluding dentinal tubules. The coat was up to 1- μ m thick and its composition was probably resinous. HEMA is a hydrophilic monomer compound of dentin bonding agents with ability to infiltrate into acid-etched and moist dental hard tissues²⁰.

Nupro Gel is a commercial product containing 1.23% fluoride and 0.1M phosphoric acid. With the acidic property, the fluoride gel was able to etch peritubular dentin and form a funneled portion of the tubule at the dentin surface. Ionized calcium in the tubular fluid and that liberated during the acid attack react with the active ingredient of the gel, sodium fluoride. The raising of ionized calcium concentration exceeded the solubility product constant for calcium fluoride, precipitating on and within the tubules⁷. Even though calcium fluoride might occlude most dentinal tubules, its

use as a desensitizing agent has been questioned due to its solubility in saliva^{13,17}.

This present SEM examination provided understanding of the potential occluding effect of three in-office desensitizing agents. The different mechanisms of dentinal tubules occlusion probably result in different effectiveness of hypersensitivity reduction (i.e. degrees of pain relief). However, the longevity of the precipitates or resins in dentinal tubules and their ability to resist acid challenge over time is unknown, although oxalate precipitates appear to wash out under challenge in the clinical environment¹⁶. Therefore, the clinical effectiveness of these materials will depend in part on the dissolution resistance or solubility level of precipitates or resins.

CONCLUSION

The results of the present study confirmed by SEM analysis of fractured dentin samples, demonstrated that Oxa-Gel, Gluma Desensitizer and Nupro Gel were able to occlude dentinal tubules by different modes. However, further research is required to provide evidence of the durability of occlusion of these desensitizing agents under simulated clinical conditions together with functional studies designed to assess their ability to reduce fluid flow (hydraulic conductance) through dentin.

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