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Occlusion of Dentinal Tubules by Nano-Hydroxyapatite

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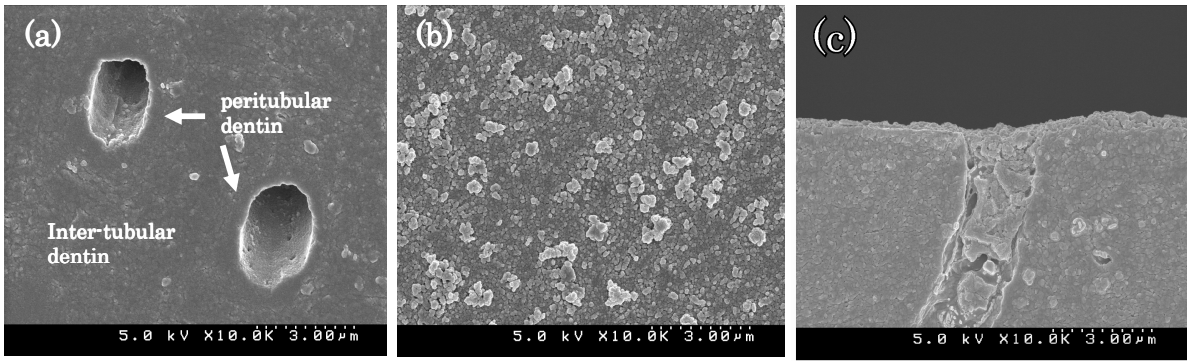
Objectives: Roughly 97% of tooth enamel and 70% of dentin comprises hydroxyapatite. Topical application of nanoparticle hydroxyapatite, via toothpastes and gels, restores mineral density to demineralized surface and subsurface enamel, improving its smoothness and preventing decay. Occlusion of exposed dentinal tubules by nano-hydroxyapatite, and by nano-hydroxyapatite/protein complexes, helping to reduce hypersensitivity, has also been reported. We examined the ability of pure nano-hydroxyapatite (nano-HAP) in vitro to occlude and provide surface coating to areas of exposed dentinal tubules.
Method: Nano-HAP was synthesized by precipitation and characterized by X-ray powder diffraction (XRD, Bruker AXS) and field emission-type scanning electron microscopy (FE-SEM, HITACHI). Specimens of human dentine were cut longitudinal to the tooth axis with a hand engine (Royal) and polished to obtain a flat surface with cleanly exposed dentinal tubules by micro grinding machine (EXAKT). Acid etching of the surface was not performed. The specimens were immersed in a nano-HAP slurry 9 minutes daily for five days, and preserved in artificial saliva (20mM-HEPES, 3.0mM-$CaCl_2$, 1.8mM-KH_2PO_4, 150mM-NaCl) at 37°C between immersions. Specimen surfaces were then observed by FE-SEM to assess the efficiency of occlusion with nano-HAP.
Results: XRD and FE-SEM showed that nano-HAP particles were spindle-shaped, 20-50 nm in size. Preparation of specimens by mechanical polishing avoided the exposure of collagen fibrils on the dentine surface and the sponge-like surface erosion or 'smear layer' that commonly result from acid etching, allowing occlusion to be more clearly observed. FE-SEM observation of the nano-HAP-treated dentine surface showed that nano-HAP uniformly occluded the dentinal tubules with a dentinal plug and that a protective layer on the surface of the dentine was also formed.
Conclusion: We concluded that nano-HAP could be an effective agent for occluding dentinal tubules, and may be useful in the treatment of hypersensitivity.



FE-SEM photographs of dentin surface (a) after mechanical polishing and (b) after treatment with nano-HAP slurry using a brushing method. (c) shows a cross section of the treated dentin surface as in (b), revealing both surface coating and tubular occlusion by nano-HAP.

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