Title: Femtosecond laser ablation of dentin

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Abstract: The surface morphology, structure and composition of human dentin treated with a femtosecond infrared laser (pulse duration 500 fs, wavelength 1030 nm, fluences ranging from 1 to 3 J cm(-2)) was studied by scanning electron microscopy, x-ray diffraction, x-ray photoelectron spectroscopy and Fourier transform infrared spectroscopy. The average dentin ablation threshold under these conditions was 0.6 +/- 0.2 J cm(-2) and the ablation rate achieved in the range 1 to 2 mu m/pulse for an average fluence of 3 J cm(-2). The ablation surfaces present an irregular and rugged appearance, with no significant traces of melting, deformation, cracking or carbonization. The smear layer was entirely removed by the laser treatment. For fluences only slightly higher than the ablation threshold the morphology of the laser-treated surfaces was very similar to the dentin fracture surfaces and the dentinal tubules remained open. For higher fluences, the surface was more porous and the dentin structure was partially concealed by ablation debris and a few resolidified droplets. Independently on the laser processing parameters and laser processing method used no sub-superficial cracking was observed. The dentin constitution and chemical composition was not significantly modified by the laser treatment in the processing parameter range used. In particular, the organic matter is not preferentially removed from the surface and no traces of high temperature phosphates, such as the beta-tricalcium phosphate, were observed. The achieved results are compatible with an electrostatic ablation mechanism. In conclusion, the high beam quality and short pulse duration of the ultrafast laser used should allow the accurate preparation of cavities, with negligible damage of the underlying material.

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