Heat-induced depth of Nd:YAG laser irradiation in biological hard tissues

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Confocal Raman spectroscopy is a non-destructive and non-invasive technique which provides surface Raman spectra and depth images of biological structures contactless with the sample, with no use of ionizing radiation to penetrate in the sample under analysis. These characteristics allow its experimental use without any side effects to the sample. The depth images are obtained by Raman microscopy and are related to the characteristics of the tissues. This study aims to characterize irradiated hard tissues and correlate the depth reached by the heat of the laser irradiation with the obtained images. For this, thirty 8 mm^2 blocks of bovine enamel and bovine root dentin, were randomized into 6 groups: G1- enamel untreated; G2- enamel irradiated with Nd:YAG micropulsed laser (1064 nm, 10 Hz- Lares Research®) using a coal paste as photoabsorber; G3- enamel irradiated with Nd:YAG nanopulsed laser (1064 nm, 20 Hz, Brilliant, Quantel Laser) using a coal paste as photoabsorber; G4-G6 (bovine root dentin in the same conditions of treatment of G1-G3). The measurements were performed in three different depth regions of the cubic shaped samples: region A- left corner above of the sample, region B- middle of the sample and Region C- right corner below of the sample. The area under the phosphate, carbonate, amide I, II, and III bands were calculated. The Raman spectra of the Nd:YAG irradiated samples detected a reduction in all the organic components of the enamel after laser irradiation. Previous studies of our group demonstrated that differences in carbonate substitution in the apatite lattice are related to the apatite instability and demineralization susceptibility. Considering that carbonate free apatite is less susceptible to acid attack, the results of this study suggest that Nd:YAG lased enamel can be more resistant to caries, in a direct correlation to the thickness of the treated area. It was found that for micropulsed Nd:YAG laser, the heat induced depth was 10 $\pm$ 2 μm and for nanopulsed laser the heat induced depth was 8 $\pm$ 3 μm. So, it is possible to correlate the heat penetration depth of the laser irradiation with the images obtained by the confocal Raman. This study was supported by CNPq/INCT 465763/2014-6 and PQ 309902/2017-7, CNPq 140619/2015-1, CNEN PD, CAPES/PROCAD 88881.068505/2014-01.