Development of new laser applications in dentistry and medicine

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Our aim at Laboratory of Biophotonics is to develop new processes in lasers in medicine and dentistry, as a diagnostic or a therapeutic tool. The study of optical properties of healthy and pathological tissues are in progress. Studies regarding heat propagation in dental tissue, aiming the development of safety protocols for clinical use, and the heat influence on composite adhesion will be discussed. The laser irradiation effects on normal and injuried biological tissue were studied by optical methods, such as FTIR, Polarized Optical Coherency Tomography, and others such as X-Ray diffraction. The Er,Cr:YSGG (2,79μm) is used for dental tissue removal but recently our group evaluated its use for caries prevention. The present work correlates the clinical and pré-clinical observations according to the crystallographic changes that can be produced by laser irradiation. The thermal action of laser irradiation can change the crystalline structure of the mineral matrix of human enamel: crystal grow, change lattice parameters or can also form new compounds. The formation of new crystallographic phases is observed in enamel irradiated with different types of laser wavelengths. One objective of this work was to identify the crystalline structure of the lased enamel. A finite element model (FEM) of a molar tooth was developed in order to understand the heat propagation through dental hard tissues under laser irradiation. The FEM theoretical results showed good correlation with the data obtained *in vitro* by a thermographic camera. Temperature rises were evaluated at the surface and pulp when teeth were irradiated with Er,Cr:YSGG laser at low fluences, with or without a photosensitizer (coal paste). The surface temperatures and heat propagation were recorded by a thermographic camera, and the pulpal temperatures were registered by type-K thermocouples. The photosensitizer was efficient in reducing heat transfer to the pulp chamber, and the fluences applied were able to achieve surface temperature rises that suggest crystallographic changes on enamel. The effect of Er,Cr:YSGG laser irradiation and fluoride application on enamel composition and its resistance to demineralization was evaluated by FT-Raman spectroscopy, energy dispersive X-ray fluorescence spectrometry and cross-sectional microhardness. The association of laser and fluoride reduced the effects of demineralization on enamel structure. The caries lesion growth was monitored by Optical Coherence Tomography. The *in vitro* study showed that the lesion progress follows a growth curve correlated with bacteria population in the culture medium. The effect of Nd:YAG laser and fluoride application on enamel microstructure and its resistance to demineralization was evaluated *in vitro* an clinically. Nd:YAG irradiation associated with APF induces a crystallographic phase transformation of the irradiated enamel which enhance its resistance to demineralization. The clinical study with 100 children and teenagers with a follow up of one year showed a decrease in the caries incidence of 45%.