38

Effect of Infrared Lasers on Chemical and Crystalline Properties of Enamel

*D.M. Zezell [a, *], P.A. Ana [a], F.G. Albero [a], J.A. Cury [b], L. Bachmann [c]*

zezell@usp.br

[a]Centro de Lasers e Aplicações, Instituto de Pesquisas Energeticas e Nucleares, [b]Piracicaba Dental School, UNICAMP, [c]Faculdade de Filosofia, Ciencias e Letras de Ribeirao Presto, Universidade de Sao Paulo, Brazil

Laser irradiation is a promising alternative for caries prevention due to the possibility of changing the microstructure of dental hard tissues. However, the changes promoted in enamel composition and crystallinity by infrared lasers are still unclear. This study investigated changes on enamel microstructure after irradiation with Nd:YAG and Er,Cr:YSGG lasers aimed at caries prevention. 15 bovine enamel slabs were randomly distributted into 6 groups: (1) unlased; (2) irradiated with Er,Cr:YSGG laser (λ = 2.78 μm) at 85 J/cm^2 (32 mJ/pulse); (3) irradiated with Nd:YAG laser (λ = 1.064 μm) at 84.9 J/cm^2 (60 mJ/pulse). Sample surfaces were analyzed by attenuated total reflection-Fourier transform infrared spectroscopy in the range 4000–650 cm^{-1} with 4 cm^{-1} resolution. Samples were also evaluated by X-ray diffraction in a synchrotron monochromatic X-ray beam (Cu-Kα, 0.0954 nm wavelength). Crystal size changes were calculated using the Scherrer equation for the crystalline planes (002), (210) and (300) simultaneously. Irradiation with Er,Cr:YSGG laser promoted a significant decrease in carbonate content of enamel (ANOVA; $p < 0.05$). After Nd:YAG irradiation, there was a significant decrease ($p < 0.05$) of carbonate and of amides I and II. Both types of laser irradiation promoted formation of α-tricalcium phosphate, β-tricalcium phosphate and tetracalcium phosphate. Also, after laser irradiation, there was a significant increase ($p < 0.05$) in crystal growth of enamel apatite, evidenced by a decrease in the full-width-at-half-maximum crystal plane parameter. It was concluded that high-intensity infrared laser irradiation changes mainly the organic and carbonate contents of enamel, and also promotes an increase in crystallite sizes and the formation of new crystallographic phases, which could explain the previously shown effect on resistance of enamel to demineralization.

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39

Caries-Preventive Effect of Infrared Lasers and Professional Fluoride Application on Enamel

*P.A. Ana [a, *], V.P. Goulart [a], C.P.M. Tabchoury [b], J.A. Cury [b], D.M. Zezell [a]*

paana@usp.br

[a]Centro de Lasers e Aplicações, Instituto de Pesquisas Energéticas e Nucleares, [b]Piracicaba Dental School, UNICAMP, Brazil

This in vitro study evaluated the effect of Nd:YAG and Er,Cr:YSGG lasers on enamel resistance to demineralization and on formation and retention of calcium fluoride-like material (CFLM), when applied before or after professional acidulated fluoride gel application (APF gel). 240 human enamel slabs were randomly distributed into 8 groups: (1) untreated; (2) treated for 4 min with APF gel (1.23% F); (3) irradiated with Nd:YAG laser (λ = 1064 nm, 84.9 J/cm^2); (4) pre-irradiated with Nd:YAG followed by APF-gel application; (5) pre-treated with APF gel followed by Nd:YAG laser irradiation; (6)–(8) similar to groups 3–5, but irradiated with Er,Cr:YSGG laser (λ = 2078 nm, 8.5 J/cm^2). After treatments, CFLM formation on enamel was determined in 10 slabs of each group and the remaining 20 slabs were submitted to a 10-day pH-cycling model. In half of these slabs enamel resistance to demineralization was evaluated by cross-sectional hardness and in the other 10 slabs CFLM retained was determined. Both lasers significantly reduced enamel demineralization (ANOVA; $p < 0.05$), and Nd:YAG laser showed the best effect. Prior APF gel application followed by laser irradiation (groups 5 and 8) showed the highest reduction of enamel demineralization; however, the combination of laser and fluoride was not more efficient than their isolated effect. CFLM formed and retained was significantly higher in groups 4, 5, 7 and 8 than in APF gel group ($p < 0.05$); also, Nd:YAG irradiated groups revealed more formation and retention of CFLM than Er,Cr:YSGG irradiated groups. In conclusion, Nd:YAG and Er,Cr:YSGG lasers increased the formation and retention of calcium fluoride-like material on enamel treated with APF gel, with Nd:YAG laser showing the best performance on reducing enamel demineralization.

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40

Effect of Slow-Release Fluoride Devices and Casein-Phosphopeptide Nanocomplexes on Enamel Remineralisation in vitro

*A.M. Al-Mullahi, K.J. Toumba **

k.j.toumba@leeds.ac.uk

Paediatric Dentistry, Leeds Dental Institute, University of Leeds, Leeds, UK

The aim was to investigate the remineralisation effect of slow-release fluoride glass devices (SFGD), casein phosphopeptide-amorphous calcium phosphate nanocomplexes (CPP-ACP) and both together on enamel following pH cycling in vitro. 80 bovine enamel slabs were allocated to each of four groups (20/group): SFGD; CPP-ACP; SFG + CPP-ACP; Control (no intervention). Baseline surface hardness (Knoop) (SH) was measured for all slabs which were then subjected to a pH cycling regime for 10 days and SH was then re-measured. The pH cycling regime involved immersion 5 times daily (each for 5 mins) in demineralisation solution (1.5 mM $CaCl_2$, 0.9 mM KH_2PO_4, 50 mM acetic acid, pH 4.8) with the enamel slabs immersed in day-time artifical saliva (0.7 mM $CaCO_3$, pH 6.8) between dippings. After the last exposure to demineralisation solution all the slabs were stored in night time saliva (0.5 mM CCO_3, pH 6.8). Enamel slabs in the SFGD and CPP-ACP/SFGD group were exposed all the time to two SFGD devices per group during the cycling regime. Slabs in the CPP-ACP group