

Analysis of acid resistance of enamel treated with Nd:YAG laser and fluoride in different pHs

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Abstract

Background. High power lasers can be used in caries prevention to increase resistance of tooth structure to demineralization through changes in microstructure.

Objectives. This study was designed to evaluate the preventive effect of treatment with the Nd:YAG laser and fluoride on dental caries by analyzing the acid resistance of treated enamel subjected to different pH conditions.

Materials and methods. A total of 180 samples of human dental enamel were prepared, homogenized with surface microhardness and randomized into 12 groups (n = 15): negative control, positive control (fluoride only), Nd:YAG irradiation, and Nd:YAG + fluoride. Each treatment included 3 different groups for pH cycling, at pH = 5, pH = 4.5 and pH = 4. In the proposed treatment, topical application of acidulated phosphate fluoride (1.23%) was used followed by laser irradiation (Nd:YAG, $\lambda = 1,064$ nm, energy density per pulse = 84 J/cm², repetition rate = 10 Hz, pulse width = 300 ms). Samples were analyzed using optical coherence tomography (OCT) and Fourier transform infrared spectroscopy (FTIR) in the attenuated total reflection (ATR) mode. The OCT is a non-contact imaging technique which generates cross-sectional images of tissue with high resolution, providing a profile of backscattered light intensity over tissue depth that can indicate the demineralization level. Intensities of infrared bands (ATR/FTIR) are proportional to the amount of components in the tissue, allowing to determine variations which occurred due to a specific treatment.

Results. In FTIR, the areas under the collagen, phosphate, carbonate, amide I, and amide II bands were analyzed using the locally developed software – IR Hard Tissue®. There was an increase in the phosphate values in the Nd:YAG + fluoride group, with a statistical difference regarding pH = 4.5 (multiple comparison analysis of variance (ANOVA) + Dunnett, $p > 0.05$). There was a positive decrease in collagen in the Nd:YAG + fluoride groups, with a significant difference for the other groups at pH 4.5, and a significant difference for the other groups at pH 4, except for the isolated Nd:YAG group. There was no statistical difference for carbonate values. In the OCT analysis, a decrease in the attenuation coefficient was noticeable, indicating less demineralization. At pH = 5, there was a significant difference in the Nd:YAG + fluoride group for all treatments, except for the isolated Nd:YAG group. At pH = 4.5 and pH = 4, the only group with statistical difference from the others was the Nd:YAG + fluoride group (multiple comparison ANOVA + Dunnett, $p > 0.05$).

Conclusions. The treatment with the Nd:YAG laser and fluoride is effective in increasing enamel acid resistance, being more beneficial than the use of fluoride alone, even in critical pH conditions for fluoride-treated enamel (pH = 4.5).

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