Raman spectroscopy investigation of human teeth with radiation therapy

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***Abstract*—Radiation-related caries (radiation caries) is a frequently complication of patients with radiotherapy in the head and neck region. Raman spectroscopy is a suitable tool to detect crystalline defect. The aim of this study is to investigate the crystallinity of the mineral part of the irradiated teeth by Raman spectroscopy. The ν_1 PO_4^{3-} band at 960cm^{-1} slightly shifts to a lower position indicated a less crystalline in the c-axis of hydroxyapatit of radiated enamel and dentin. The micro-Raman spectrums show that the radiation damage may have an effect on the crystal integrity of the enamel and dentine.**

I. Introduction

The development of radiation-related caries (radiation caries) is the same as normal caries which is a dynamic process of bacterial infection to demineralize the dental hard tissues, except that the former progress is suddenly and in some instances the dentition can be lost completely within very short periods.[1] Radiation damage to dentition is thought to be the result of hyposalivation (reduced salivary flow) and direct radiogenic damage.[2] Previous studies show that only little reduction on microhardness were found in irradiated dentin of patients with a total radiotherapy dosage of 60Gy [3], however, no changes were found on the enamel regions even the tooth went through a sterilization dosage of 25kGy. Although the direct radiogenic damage to enamel was thought not a direct factor leading to radiation caries, the changes in crystallinity due to radiation is not clear. The aim of this study is to investigate the crystallinity of the mineral part of the irradiated teeth by Raman spectroscopy.

II. Materials and Methods

Two extracted third molar from patients with/without radiotherapy (total dosage of 65Gy) were collected. The teeth were stored in 70% ethanol and sagittally cut into 1.5mm slab. We use a micro-Raman spectroscopy (Horiba HR800 with Olympus BX41, 532 nm laser) with a spatial resolution of 1μm; the beam was focus on occlusive enamel, bacterial infected enamel, and dentin regions of both radiated and controlled samples. The Knoop's microhardness were measured on occlusive enamel samples (n=13) using a Matsuzausa MXT 70 at a load of 500g for 15seconds.

III. Result

The Raman main band positions (in cm^{-1}) of enamel are identified as ν_2 PO_4^{3-}(432), ν_2 PO_4^{3-}(450, 588, 608), ν_1 PO_4^{3-}(960), ν_3 PO_4^{3-}(1030, 1046, 1071), B type ν_1 CO_3^{2-}(1069), and A type ν_1 CO_3^{2-}(1102) which were similar to previous studies.[4] Since there are about 30% of protein and water in the dentin region, compare to 2% in the enamel region, the Raman band positions reveal lower intensity in phosphate, however a high ratio of carbonate to phosphate intensity, and present additional bands at 1243/1271, 1455, and 1667 cm^{-1} which assigned to amide III (N-H), δ (C-H) and amide I (C=O), respectively. The highest band present at 960cm^{-1} corresponding to the ν_1 PO_4^{3-} band, the intensities were lower for radiated enamel and dentin. Moreover, the ν_1 PO_4^{3-} band of radiated enamel and dentin all slightly shifts to lower position which indicated a less crystalline in the c-axis of hydroxyapatite.[5] The band intensity ofν_1 CO_3^{2-} between radiated and normal enamel is the same high indicate that carbonate substituted hydroxyapatite in enamel is not increased by radiation. After *t*-test analysis, we found that there is no significant difference between the mean values of microhardness (KHN) of radiated enamel (247.3 ± 17.3) and controlled enamel (239.3 ± 10.5).

IV. Conclusion

Our results indicate that the radiation damage may have an effect on the crystal integrity of the enamel and dentine, though the microhardness is similar of radiated and normal enamel. Further studies by transmission electron microscopy may need to demonstrate the crystalline defect of irradiated teeth.

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