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Enamel White Spot Lesions: Formation and Molecular Structure Analysis by Confocal Raman Microscopy *in vitro*

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Introduction: White lesions are white opacities of outer enamel surface which represent an early phase of caries formation.

Materials & Methods: In this study; 20 human sound premolars were subjected to pH cycling procedure to induce WSLs *in vitro*. Besides; 3 teeth with naturally developed WSLs were used as a reference. All specimens were characterized by confocal Raman microscopy which has been used for the first time in this study to detect small changes in enamel structure and providing a high resolution chemical and morphological map based on phosphate peak intensity alterations at 960 cm^{-1}. Enamel crystallinity is determined by measuring changes in ratio of intense phosphate peaks at 960/950 cm^{-1}. In order to detect variations in carbonate content in different zones of each sample; ratio of intensities of PO_4^{3-} to CO_3^{2-} peak at (960/1070 cm^{-1}) and that of $CO_3^{2-}$to PO_4^{3-} at (1070/960 cm^{-1}) were calculated throughout the cross section of each sample.

Results: Lesion depth measurement was based on phosphate peak intensity alterations and found to increase linearly with gradual rise in number of cycles except for 8 cycle's lesion, where a considerable loss of enamel layer has taken place. A statistically significant difference ($p< 0.05$) was found between all examined groups.

Intact surface layer of the lesion was well crystallized then crystallinity decreased abruptly in lesion zone and started to increase gradually in the intermediate zone before it has reached to its maximum value in sound enamel beyond subsurface lesion. Reconstructed images derived from PO_4^{3-}/CO_3^{2-} & CO_3^{2-}/PO_4^{3-} ratios revealed a reduction in PO_4^{3-}/CO_3^{2-} ratio in lesion zone in comparison to sound enamel zone and the opposite is true for CO_3^{2-}/PO_4^{3-} ratio.

Conclusion: Our protocol is a reliable to reproduce WSLs *in vitro* in a relatively short period to test the efficacy of reminerlizing dental products. Confocal Raman microscopy can provide a high resolution chemical and morphological map of examined specimen, detecting even very small changes in its chemical composition. Data analysis of each acquired scan which comprising tenth thousands of single spectrum, is used to reconstruct different Raman detailed images. Therefore Raman microscopy could be considered as a superior alternative to Raman spectroscopy.

Keywords: White spot lesion (WSL), Phosphate peak, Crystallinity, KMCA (K-mean cluster analysis), nanoindentation (NI), mechanical properties.

Biography:

Dr. Rand Al-Obaidi received her master degree of science in preventive dentistry from the University of Baghdad. She then worked at the University of Mustansiriya has assistant-lecturer and lecturer. Dr. Al-Obaidihas joined the University of Montpellier/Laboratoire Bioingénierieet Nanoscience (EA4203) as a PhD student after obtaining a scholarship from Iraqi government. Her research concerns the fabrication of enamel white spot lesions *in vitro* and their remineralization and characterization by advanced optical and mechanical techniques. Dr. Al-Obaidi hopes developing a dental diagnostic instrument based on Raman microscopy principles that will help the early diagnosis of these lesions and presenting a treatment mode that will facilitate the non-invasive treatment of this serious dental health problem.