Research for the Portable Dental Caries Detection device using Quantitative light-induced fluorescence

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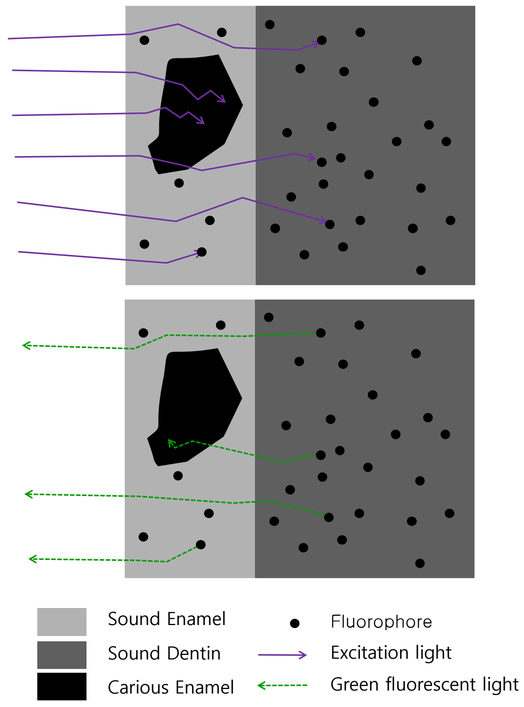
INTRODUCTION

Quantitative light-induced green fluorescence

- Early detection and monitoring of dental caries, especially in daily life, remains problematic. Soun d tooth tissue emits green (500nm ~550nm) fluor escence when it is excited by blue light centered at around 390nm wavelength. On the other hand, a white spot lesion which is the initial stage of de ntal caries shows decreased green fluorescence due to its loss of mineral components including fl uorophores.
- By measuring the loss of the green fluorescence quantitatively, white spot lesions can be detected as an indicator of initial caries.
- Right figure shows the principle of the light-indu ced green fluorescence of a tooth. Surface reflect ion is neglected to make it simple.

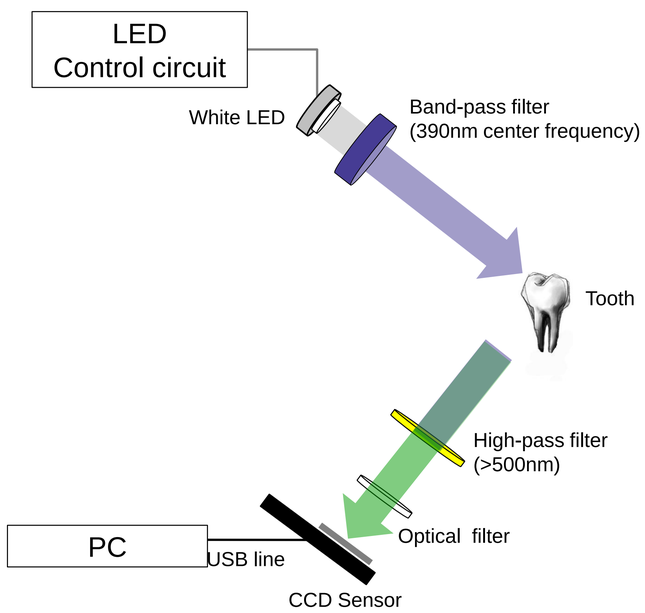


- The aim of this study was to develop a portable dental caries detection device using Quantitativ e Light-induced Fluorescence (QLF).

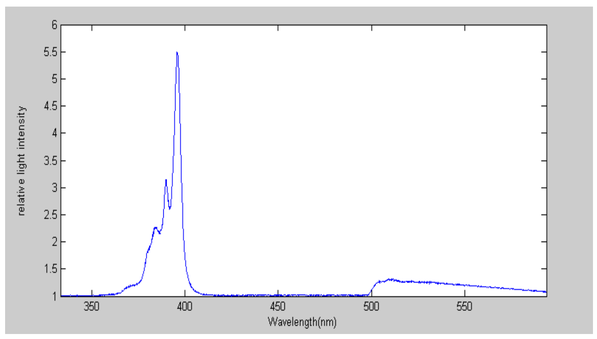
METHODOLOGY

Hardware configuration

- A portable QLF device was fabricated using a LED light source, a CCD module, and vario us optical filters.
- Light source composed of white LED, LED control circuit and, band-pass filter(B390, Hoya , Japan) produces blue excitation light. Unlike conventional QLF device, high luminescence white LED was used instead of arc lamp.
- High-pass filter(Kodak written filter yellow, USA) is needed to eliminate directly reflected e xcitation light having higher light intensity. Cut-off frequency of the high-pass filter is 500nm , so that excitation light which have much shorter wavelength can be blocked.
- Acquired fluorescence image by CCD sensor, is transmitted to the PC using USB interface



Performance evaluation

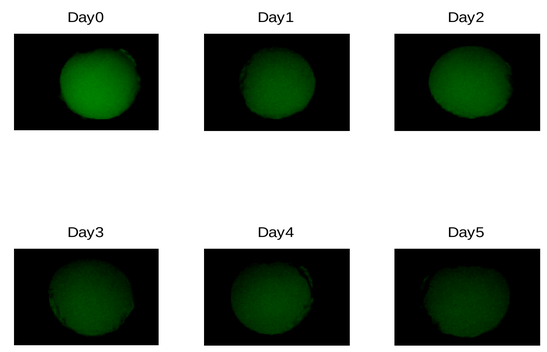


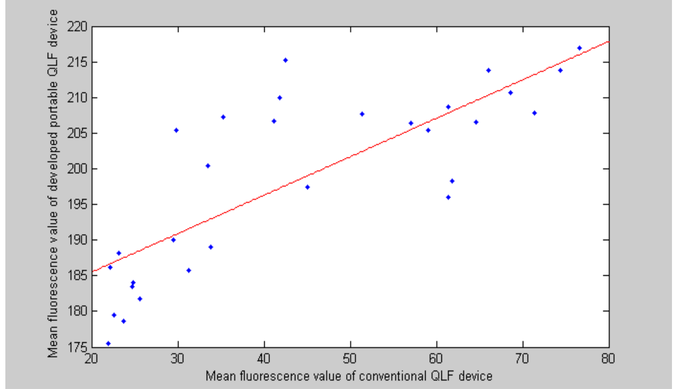
- Left figure shows spectrum of the excitation light and induced green fluorescence. As expected, w ave length of the induced fluorescence was betw een 500nm and 550nm. Excitation light intensity was 5.5 times higher than induced fluorescent lig ht , which accentuate the need of high-pass filter.

- To simulate white spot lesions, five sound bovine teeth wer e demineralized by treatment with pH 4.8 acid solution for fiv e days.
- Using a conventional desktop style QLF device (Inspektor Pro, Inspektor Research System, Nederland) and the develo ped portable device, the loss of green fluorescence was me asured and compared quantitatively.

RESULTS

- Right figure shows induced green fluorescence for 5 consecutive days using development potable dental caries detector.
- Induced green fluorescence was gradually decreased as dimineralization proceeded
- MATLAB(The Mathworks, USA) image processing tool was used to process fluorescence images which acquired by developed portable QLF device and conventional desktop style QLF device.





- The measured green fluorescence intensity values from two devices were strongly correlated (r = 0.79)

DISCUSSION

- A portable QLF-based dental caries detection device was fabricated as a tooth brush type probe co nnected to a PC and test results show the compromised performance compared to the high-cost an d relatively large-size reference device.
- After design optimization and optical components' performance improvement, the developed portabl e dental caries detection device is expected to contribute significantly to early detecting dental carie s not only in dental clinics also in daily life.

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