# Near-IR Imaging of Early Dental Decay

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## Abstract

New imaging technologies are needed for the early detection of dental caries in the occlusal and interproximal surfaces. If carious lesions are detected early enough, they can be arrested or reversed by nonsurgical means through fluoride therapy, antibacterial regimens, dietary changes, or by low-intensity laser irradiation. The success of this type of therapy is contingent on early caries detection and also requires imaging modalities that can safely and accurately monitor the success of such treatment. The ability to monitor enamel caries while delivering nonsurgical therapy will also enable the *in vivo* testing of the effectiveness of different anticaries agents and dietary changes. Near-infrared (IR) dental transillumination is an imaging modality useful for detecting early **interproximal caries**, since enamel is highly transparent in the near-IR at 1300 nm. In this study, a near-IR transillumination system was used to acquire images through tooth sections of varying thickness and whole teeth in order to demonstrate the utility of a near-IR dental transillumination system for the imaging of early dental caries. Simulated lesions, which model the optical scattering of natural dental caries, were placed in plano-parallel dental enamel sections. The contrast ratio between the simulated lesions and surrounding sound enamel was calculated from analysis of acquired projection images. The results show significant contrast between the lesion and the enamel (> 0.35) and a spatial line profile that clearly resolves the lesion in samples as thick as 6.75 mm. This study clearly demonstrates that a near-IR transillumination system has considerable potential for the imaging of early dental decay. Polarization Sensitive Optical Coherence Tomography (PS-OCT) is a nondestructive near-IR imaging method that has great potential for imaging **carious pits and fissures**. In this study, PS-OCT was used to monitor the 14-day progression of artificial caries, produced with a remineralization/demineralization protocol, in the pits and fissures of 10 posterior teeth. The polarization-sensitive system, recording images in both the parallel (∥)-axis and perpendicular (⊥)-axis, was useful for enhancing the image contrast of the artificial caries and minimizing the interference of the strong reflection at the air-enamel surface. With the integrated reflectivity of the backscattered signal, it was demonstrated that PS-OCT can be used to nondestructively monitor the progression of carious lesions.
Devices used in this study include:

- OCDR optical coherence domain reflectometry system (Optiphase, Van Nuys, California)
- 20 mW output power 1310 nm superluminescent diode (SLED) 50 nm bandwidth (Covega, Jessup, Maryland)
- 20 mW output power 1310 nm SLED 30 nm bandwidth (OptoSpeed, Switzerland)
- 150 W halogen lamp, Visar (Den-Mat, Santa Maria, California)
- 3.5 mW output power 1310 nm SLED 25 nm bandwidth (Qphotonics Inc., Chesapeake, Virginia)
- InGaAs focal plane array Alpha NIR (Indigo Systems, Goleta, California) with Infinimite lens (Infinity, Boulder, Colorado).

Biography: Dr. Jones is in his sixth year of an NIH-funded DDS/PhD, Dental Scientist Training Program at University of California, San Francisco. Last June, he completed his dental degree and is currently working on his thesis in near-IR imaging of dental enamel under the mentorship of Dr. Daniel Fried.

Disclosure: Dr. Jones has no relationships with any dental laser manufacturer. There are no conflicts of interest with any of these devices used in the study.

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