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Measurement of Pulsatile Blood Flow in the Teeth using Laser Speckle Imaging

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Background and Objective

In endodontics, a major diagnostic challenge is the accurate assessment of pulp status. In this study, we designed and characterized a fiber-based laser speckle imaging system to study pulsatile blood flow in the tooth.

Study Design/Materials and Methods

To take transilluminated laser speckle images of the teeth, we built a custom fiber-based probe. To assess our ability to detect changes in pulsatile flow, we performed *in vitro* and preliminary *in vivo* tests on tissue-simulating phantoms and human teeth. We imaged flow of intralipid in a glass microchannel at simulated heart rates ranging from 40 beats/minute (bpm) to 120 bpm (0.67–2.00 Hz). We also collected *in vivo* data from the upper front incisors of healthy subjects. From the measured raw speckle data, we calculated temporal speckle contrast versus time. With frequency-domain analysis, we identified the frequency components of the contrast waveforms.

Results

With our approach, we observed *in vitro* the presence of pulsatile flow at different simulated heart rates. We characterized simulated heart rate with an accuracy of and >98%. In the *in vivo* proof-of-principle experiment, we measured heart rates of 69, 90, and 57 bpm, which agreed with measurements of subject heart rate taken with a wearable, commercial pulse oximeter.

Conclusions

We designed, built, and tested the performance of a dental imaging probe. Data from *in vitro* and *in vivo* tests strongly suggest that this probe can detect the presence of pulsatile flow. LSI may enable endodontists to noninvasively assess pulpal vitality via direct measurement of blood flow.