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Okayama University research: Promising imaging method for the early detection of dental caries

(Okayama, 25 December) **Researchers at Okayama University report in *Scientific Reports* that optical coherence tomography, an imaging method based on infrared radiation, can be used for detecting dental caries on the surface of rear teeth. As infrared light is non-ionizing, the method is safer than radiography, which involves X-rays.**

Dental caries affects more than 90% of the world's adult population. And often, dental caries is detected 'too late', requiring invasive teeth treatment. Visual examination (by a dentist) and radiography are currently the main tools for diagnosing caries. However, they are not completely efficient for detecting caries in rear teeth (so-called posterior teeth) — moreover, radiography is considered problematic for pregnant women and infants. A promising alternative technique, which is non-invasive and does not involve X-rays, is optical coherence tomography (OCT): an imaging method that can be used to create a 3D representation of teeth. Now, Associate professor SHIMADA Yasushi and Professor YOSHIYAMA Masahiro from Okayama University and colleagues have tested the accuracy of OCT for diagnosing caries in posterior teeth. They found that the method could indeed become a viable alternative for radiography.

In OCT, a sample is irradiated with infrared light; different types of tissue scatter and absorb the infrared radiation differently. Scattering/absorption images (that are 2-dimensional) obtained for many different irradiation angles can then be combined into a 3D visualization of the sample. Because dental caries has a specific response to the radiation, it can be detected on the 3D image — in principle.

To check whether OCT is actually accurate enough for detecting caries in posterior teeth, Associate professor SHIMADA and Professor YOSHIYAMA and colleagues compared radiography and OCT results for 51 proximal surfaces of 36 molars. (The proximal surfaces of teeth are those that are adjacent to other teeth.) The study was performed *ex vivo*: the molars were mounted in silicone blocks in a way corresponding to their normal anatomical position. The degree of caries present on the surface was marked histologically with a score from 0 to 5, corresponding to "sound tooth surface" and "distinct cavity with visible dentin", respectively. (Dentin is the material just below the enamel that normally tops a tooth's surface.)

In order to make a quantitative comparison between radiography and OCT, certain parameters like sensitivity and specificity for the detection of caries were evaluated by 13 dentists. A statistical analysis then led to the conclusion that OCT appears to be a suitable

method for diagnosing proximal enamel damage, and for following-up on whether non-invasive treatment — typically based on stopping and reversing the demineralization of the enamel layer — is successful. Quoting the scientists: “OCT can be a safer option for the diagnosis of proximal caries in posterior teeth that can be applied to the patients without X-ray exposure.”

Background

Caries

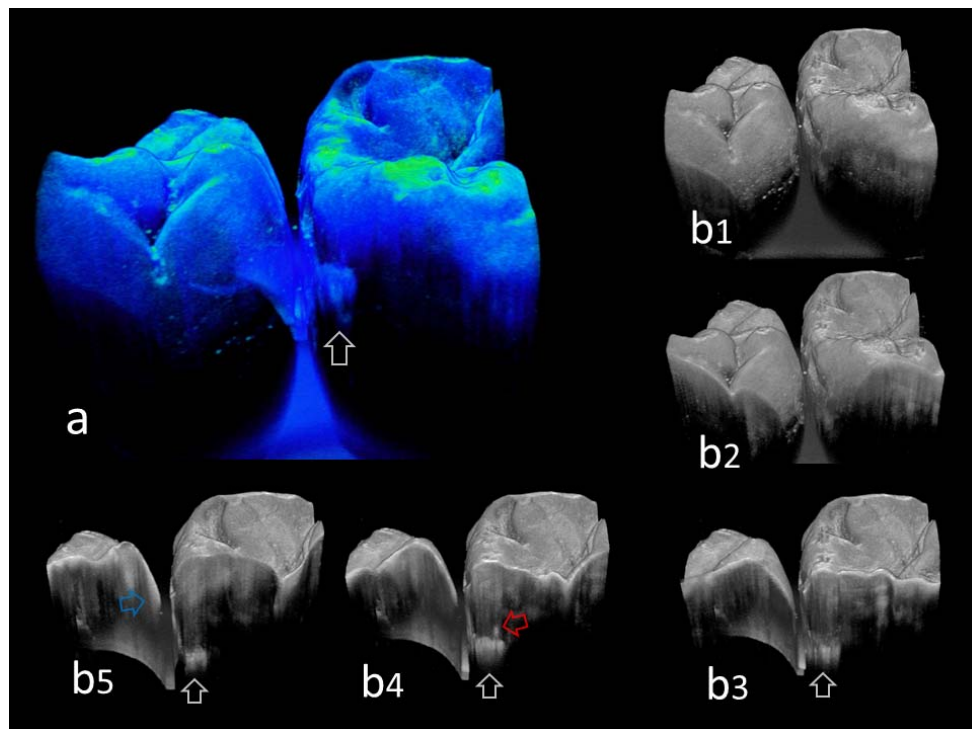
Dental caries, also known as dental decay or cavities, is the result of the process where acids produced by bacteria break down tooth material. Symptoms of caries can include tooth pain, difficulty with eating; complications can include inflammation of tissue around the affected tooth, its loss, and abscess formation. The acids are produced by bacteria breaking down food rests and/or sugar on the surface of the tooth. The main prevention of dental caries is the regular cleaning of teeth. Treatments of dental caries depend on the extent of destruction. For early-stage caries, non-invasive approaches exist, based on reversing the destruction process by introducing calcium, phosphate and fluoride ions in the oral environment. For later-stage caries, invasive restorative treatments are necessary, or even tooth removal.

To avoid invasive treatments, early detection of caries is crucial. Existing methods are visual examination by a dentist and radiography, but the latter is problematic for pregnant women and infants. Associate professor SHIMADA Yasushi and Professor YOSHIYAMA Masahiro from Okayama University and colleagues have now shown that a technique called optical coherence tomography (OCT) is a promising alternative for the early detection of caries in the rear teeth.

Optical coherence tomography

Optical coherence tomography (OCT) is an imaging technique based on the ability of particular samples, including biological tissue, to scatter or absorb low-coherence radiation. The type of radiation used in OCT is typically near-infrared light. As this is relatively long-wavelength light, it can penetrate well into the scattering sample.

It is possible to combine several 2D images recorded for various irradiation directions into a 3D image ('3D reconstruction'). Shimada and colleagues applied OCT to examine the surface of teeth, and found that the method allows detecting different stages of caries on the surface of rear teeth.



Caption

- a. Pseudocolor 3D OCT image of posterior teeth processed translucently. Presence of caries at the proximal surface was clearly imaged with the lesion location and size (white arrow). b1-5. Sequential 2D images acquired in 3D view from different thickness. White arrows: caries within the enamel. Red arrow: dentin caries. Blue arrow: slight change of enamel surface because of caries.

Reference

Yasushi Shimada, Michael F Burrow, Kazuyuki Araki, Yuan Zhou, Keiichi Hosaka, Alireza Sadr, Masahiro Yoshiyama, Takashi Miyazaki, Yasunori Sumi, Junji Tagami. 3D imaging of proximal caries in posterior teeth using optical coherence tomography. *Scientific Reports*, (2020) 10:15754.

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Okayama University is located in the heart of Japan approximately 3 hours west of Tokyo by Shinkansen.

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