

TECHNOLOGY

Overcoming a Clinical Challenge

Detecting Caries Around Amalgam Restorations

Detecting caries around amalgam restorations is challenging. Typically, older amalgam restorations may cause some marginal staining, but visually, the margins may appear intact and sound. The detection of secondary caries in its early stages is challenging,¹ especially with current detection methods including radiography, explorer, and visual examination.



Stephen Abrams, DDS

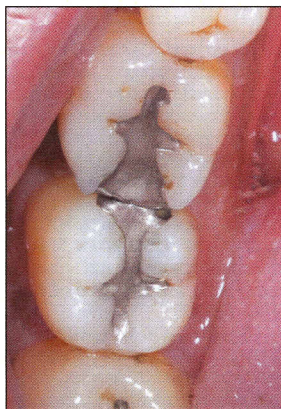


Figure 1. Occlusal view of mandibular molars.

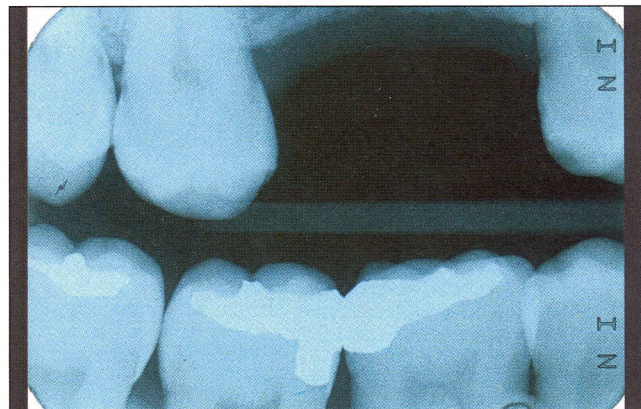


Figure 2. Bite-wing radiograph, taken at the time of treatment.

Discoloration next to the restoration or ditched amalgam margins is not necessarily indicative of secondary caries.²

CASE EXAMPLE

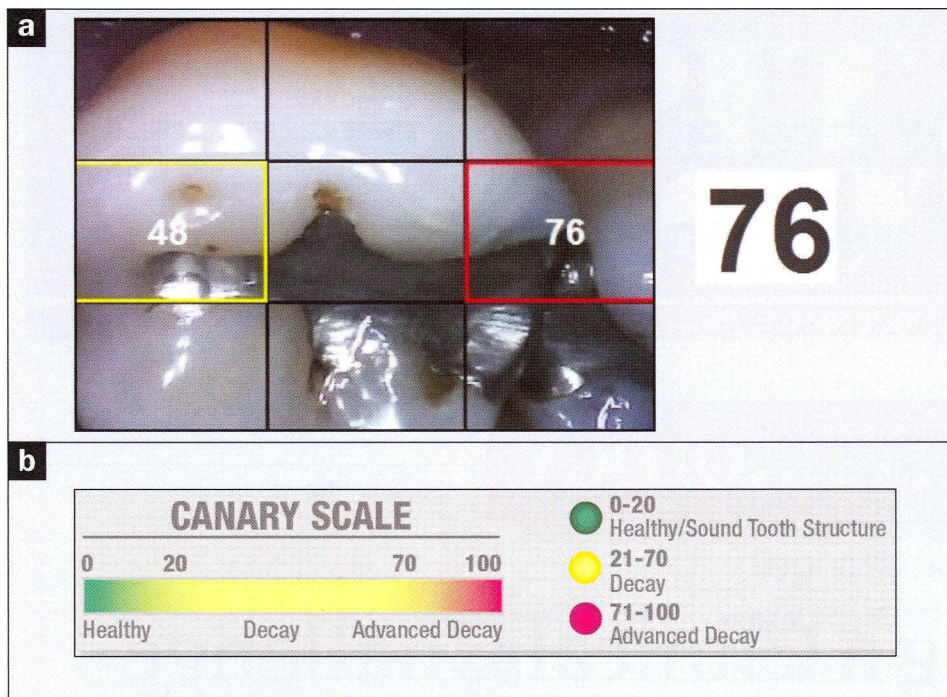
In the clinical situation shared here, the patient had been complaining of pain on the mandibular right side. Visually, the restorations appeared worn, but the margins were intact (Figure 1). A bite-wing radiograph did not reveal any radiolucency around the restorations on the molar teeth (Figure 2). It is important to note that bite-wing radiographs are not always ideal for detecting enamel secondary caries,³⁻⁵ especially when they are found

on occlusal and/or smooth surfaces. The restoration also inhibits the ability of radiographs to detect caries along the walls of the restoration.⁶ All of these factors create clinical challenges for the practitioner.

In this clinical case, we were faced with a dilemma. Do we watch and wait for further symptoms to develop? Do we remove both restorations to see if decay is present? Are there other caries detection devices that can detect caries around the amalgam margins?

Caries Detection Options

There are various caries detection devices on the market today, but they have their



Figures 3a and 3b. (a) Canary Scan and (b) Canary Scale.

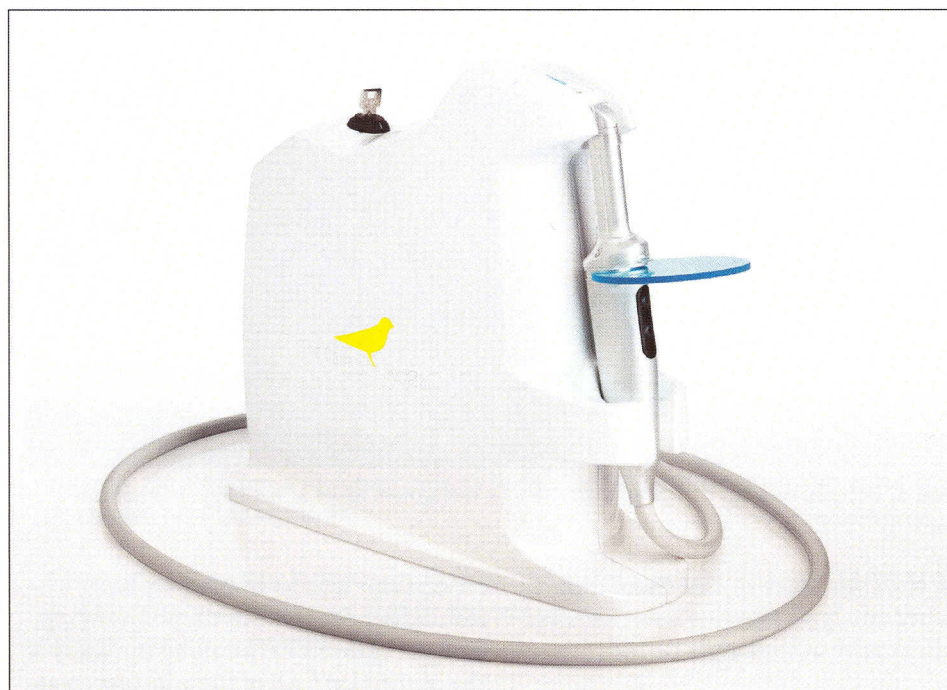


Figure 5. The Canary System (Quantum Dental Technologies).

limitations, especially fluorescence-based devices. A number of studies have concluded that measuring fluorescence is not suitable for detecting caries around restoration margins or beneath dental sealants due to false positive readings.⁷⁻¹⁰ *CLINICIANS REPORT*¹¹ found in March 2012 that existing restorations interfered with readings. Furthermore, fluorescence does not give any information about lesion size or depth, and, in addition, it

does not penetrate beneath the tooth surface due to the scattering of light from stain, plaque, organic deposits, and surface features, such as pits and fissures.^{12,13}

Caries Detection Technology to Examine Restoration Margins

For this case, we decided to use The Canary System (Quantum Dental Technologies), since it could examine the marginal interface of the amalgam and

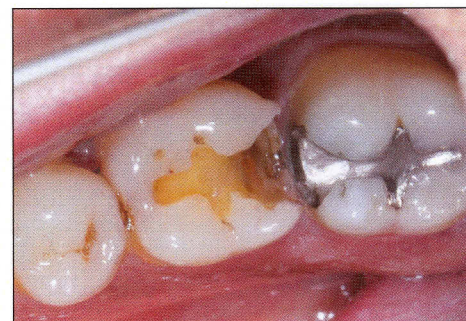


Figure 4. Removal of the amalgam reveals caries in the disto-buccal and mesial portions of the occlusal preparation.

detect caries at or beneath the intact margins. We scanned the margins of the mandibular first molar with The Canary System and found a Canary Number of 76 along the disto-buccal margin; and, a Canary Number of 46 at the mesial portion of the restoration (Figure 3). Both these readings indicated that there was caries around the restoration margins. Removal of the amalgam restoration confirmed the presence of caries in both areas.

The Canary System Technology Explained

The Canary System uses energy conversion technology to image and examine the tooth. Pulses of laser light are aimed at the tooth, and the light is then converted to heat (photothermal radiometry [PTR]) and light (luminescence [LUM]), which are emitted from the tooth surface between pulses. These harmless pulses of laser light enable the clinician to examine subsurface caries up to 5.0 mm below the surface.^{14,15}

Caries modify the thermal properties (PTR) and luminescence (LUM) of healthy teeth. As a lesion grows, there is a corresponding change in the signal. In effect, the heat confined to the region with crystalline disintegration (dental caries) increases the PTR and decreases the LUM. As remineralization progresses and enamel prisms start to reform their structure, the thermal and luminescence properties begin to revert toward those of healthy tooth structure.¹⁶⁻¹⁸

The Canary System creates a Canary Number (ranging from zero to 100) from an algorithm combining the PTR and LUM readings, which are directly linked to the status of the enamel or root surface crystal structure (Figure 4).¹⁹ A Canary Number of less than 20 indicates healthy

crystal structure. A Canary Number greater than 70 indicates a large lesion that may justify restoration. Canary Numbers falling between 20 and 70 indicate the presence of early carious lesions or cracks that may require restoration, particularly at restorative margins.²⁰ If the caries is located beneath a healthy layer of enamel, The Canary measures both healthy tissue and caries. The healthy crystal structure overlying the caries dampens the signal, decreasing the Canary Number.

Research has shown that The Canary System (Figure 5) can also detect caries around the margins of restorations²¹⁻²⁴ including intact ceramic crown margins.²⁵

IN SUMMARY

The clinical case shared in this article shows how The Canary System was used to successfully diagnose the source of pain—secondary caries around the margin of an amalgam restoration. Accurate detection allowed us to correctly identify the pain source, treat the caries, and preserve tooth structure.

Caries detection is more than simply shining laser light on teeth and looking at the glow. It involves understanding how energy interacts with tooth structure and restorative materials. Using the PTR-LUM technology found in this new high-tech system, one can accurately examine the margins of restoration to detect caries and cracks.♦

References

- Kidd EA, Toffenetti F, Mjör IA. Secondary caries. *Int Dent J*. 1992;42:127-138.
- Kidd EA, Joyston-Bechal S, Beighton D. Marginal ditching and staining as a predictor of secondary caries around amalgam restorations: a clinical and microbiological study. *J Dent Res*. 1995;74:1206-1211.
- Bamzahim M, Shi XQ, Angmar-Månsson B. Secondary caries detection by DIAGNOdent and radiography: a comparative in vitro study. *Acta Odontol Scand*. 2004;62:61-64.
- Ekstrand KR, Ricketts DN, Kidd EA. Reproducibility and accuracy of three methods for assessment of demineralization depth of the occlusal surface: an in vitro examination. *Caries Res*. 1997;31:224-231.
- Rocha RO, Ardenghi TM, Oliveira LB, et al. In vivo effectiveness of laser fluorescence compared to visual inspection and radiography for the detection of occlusal caries in primary teeth. *Caries Res*. 2003;37:437-441.
- Espelid I, Tveit AB, Erickson RL, et al. Radiopacity of restorations and detection of secondary caries. *Dent Mater*. 1991;7:114-117.
- Gostanian HV, Shey Z, Kasinathan C, et al. An in vitro evaluation of the effect of sealant characteristics on laser fluorescence for caries detection. *Pediatr Dent*. 2006;28:445-450.
- Hosoya Y, Matsuzaka K, Inoue T, et al. Influence of tooth-polishing pastes and sealants on DIAGNOdent values. *Quintessence Int*. 2004;35:605-611.
- Lussi A, Reich E. The influence of toothpastes and prophylaxis pastes on fluorescence measurements for caries detection in vitro. *Eur J Oral Sci*. 2005;113:141-144.
- Hitij T, Fidler A. Effect of dental material fluorescence on DIAGNOdent readings. *Acta Odontol Scand*. 2008;66:13-17.
- Christensen GJ. New caries detection systems: reliable and accurate. *CLINICIANS REPORT*. 2012;5:1.
- Liang R, Wong V, Marcus M, et al. Multimodal imaging system for dental caries detection. In: Rechmann P, Fried D, eds. *Proceedings of SPIE, Vol. 6425: Lasers in Dentistry XIII*. Bellingham, WA: SPIE; 2007.
- Hall A, Girkin JM. A review of potential new diagnostic modalities for caries lesions. *J Dent Res*. 2004;83(special issue C):C89-C94.
- Jeon RJ, Phan TD, Wu A, et al. Photoacoustic quantitative detection of the different degrees of demineralization of dental enamel by acid etching. *J Phys*. 2005;125(IV):721-723. DOI: 10.1051/jp4:2005125165.
- Jeon RJ, Matvienko A, Mandelis A, et al. Detection of interproximal demineralized lesions on human teeth in vitro using frequency-domain infrared photoacoustic radiometry and modulated luminescence. *J Biomed Opt*. 2007;12:034028.
- Matvienko A, Jeon RJ, Mandelis A, et al. Photoacoustic detection of incipient dental caries: experiment and modeling. In: Cullum BM, Porterfield DM, eds. *Proceedings of SPIE, Vol. 6759: Smart Biomedical and Physiological Sensor Technology V*. Bellingham, WA: SPIE; 2007.
- Jeon RJ, Hellen A, Matvienko A, et al. Experimental investigation of demineralization and remineralization of human teeth using infrared photoacoustic radiometry and modulated luminescence. In: Oraevsky AA, Wang LV, eds. *Proceedings of SPIE, Vol. 6856: Photons Plus Ultrasound: Imaging and Sensing 2008*. Bellingham, WA: SPIE; 2008.
- Matvienko A, Mandelis A, Abrams S. Robust multiparameter method of evaluating the optical and thermal properties of a layered tissue structure using photoacoustic radiometry. *Appl Opt*. 2009;48:3192-3203.
- Garcia JA, Mandelis A, Abrams SH, et al. Photoacoustic radiometry and modulated luminescence: application to dental caries detection. In: Popp J, Tuchin VV, Chiou A, et al, eds. *Handbook of Biophotonics, Volume 2: Photonics for Health Care*. Weinheim, Germany: Wiley-VCH; 2012.
- Abrams SH, Sivagurunathan K, Jeon RJ, et al. Multi-center clinical study to evaluate the safety and effectiveness of The Canary System (PTR-LUM technology). Presented at: 58th Annual ORCA [European Organisation for Caries Research] Congress; July 6-9, 2011; Kaunas, Lithuania. *Caries Res*. 2011;45(2):174-242. Published online on May 12, 2011.
- Wong B, Abrams SH, Sivagurunathan K, et al. Detection of caries around restorations with The Canary System. *J Dent Res*. 2012;91(special issue B): Abstract 1824.
- Kim J, Mandelis A, Matvienko A, et al. Detection of dental secondary caries using frequency-domain infrared photoacoustic radiometry (PTR) and modulated luminescence (LUM). *Int J Thermophys*. 2012;33:1778-1786.
- Abrams SH. Detecting caries at the margins of restorations with the Canary System. *Dental Tribune (Canada Edition)*. May 2012;6:14.
- Kim J, Mandelis A, Matvienko A, et al. Detection of dental secondary caries using frequency-domain infrared photoacoustic radiometry (PTR) and modulated luminescence (LUM). Presented at: XVI International Conference on Photoacoustic and Photoacoustic Phenomena; November 27-December 1, 2011; Merida, Yucatan, Mexico.
- Wong B, Abrams SH, Silvertown JD, et al. Detection of caries around ceramic crown restorations with The Canary System and DIAGNOdent. Presented at: 60th ORCA [European Organisation for Caries Research] Congress; July 3-6, 2013; Liverpool, England. Abstract 86. *Caries Res*. 2013;47(5):433-531. Published online on June 12, 2013.

Dr. Abrams is a general dental practitioner with more than 34 years of clinical experience. Upon graduation from the University of Toronto Faculty of Dentistry in 1980, he established a group practice in Toronto, which has grown to involve both general dentists and dental specialists. In 1999, he began working on a noninvasive, laser-based device for the detection and monitoring of caries and currently jointly holds patents on this technology. He is a senior member of the European Organization for Caries Research and the International Association for Dental Research, where he has presented a number of papers on the detection of caries using The Canary System. He also has honorary Fellowships in a number of dental societies, including Pierre Fauchard, Academy of Dentistry International, and the International College of Dentists. He has been active in the Ontario Dental Association (ODA), chairing their Dental Benefits Task Force for the past 13 years. In 2002, he was awarded the Barnabus Day Award from the ODA for 20 years of distinguished service to the dental profession. In 2006, he founded Quantum Dental Technologies to finish development of The Canary System, which is currently available in Canada and Europe. He has published more than 90 articles internationally on various topics. He can be reached via e-mail at stephen@thecanarysystem.com.

Disclosure: Dr. Abrams is president and co-founder of Quantum Dental Technologies, which has developed The Canary System mentioned in this article. He has not received any compensation for writing this article.