Detection of interproximal caries *in vitro* using The Canary System®

B. Wong[1], S. H. Abrams[1], C. Tasevski[2], K. Sivagurunathan[1], R. J. Jeon[1], J. D. Silvertown[1], W. M. P. Hellen[2], G. I. Elman[2], B. T. Amaechi[3]

[1]Quantum Dental Technologies, Toronto, ON, Canada
[2]Cliffcrest Dental Office, Scarborough, ON, Canada
[3]Comprehensive Dentistry, University of Texas Health Science Center at San Antonio, San Antonio, TX

Introduction

- Detection of non-cavitated interproximal caries is of great importance because disease progression may be halted at this stage, remineralized or minimally restored, thereby preserving natural tooth structure.

- Visual and tactile methods of interproximal caries detection is challenging due to inaccessibility.

- Interproximal lesions at contact point can be difficult to identify on radiographs.

- Therefore, an adjunct method that can assist clinicians in the detection and quantification of interproximal caries would be of value in the prevention and management of dental caries.

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Objective

- To evaluate the ability of The Canary System, International Caries Detection and Assessment System (ICDAS II), and radiographic examination to detect natural interproximal decay *in vitro*.

Caries Codes
0 = Sound tooth surface
1 = First visual change in enamel
2 = Distinct visual change in enamel
3 = Enamel breakdown, no dentine visible
4 = Underlying dentinal shadow (not cavitated into dentine)
5 = Distinct cavity with visible dentine
6 = Extensive distinct cavity with visible dentine

Visual Examination (ICDAS II)

**Radiographic Examination**

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The Science Behind The Canary System®

➢ **Energy Conversion Technology**

- Pulses (2 Hz) of laser light (660 nm.) are shone on the tooth surface for 5 seconds.

- Tooth glows (Luminescence, LUM) and releases heat (Photo-Thermal Radiometry, PTR).

- Canary algorithm combines detected signals to create a **Canary Number**, which reflects the tooth's state of mineralization and crystallization.

- Dental caries affect PTR-LUM signals.

- Detects 50 micron lesion up to 5 mm below the surface.

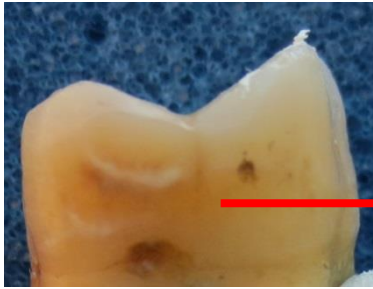The Canary System
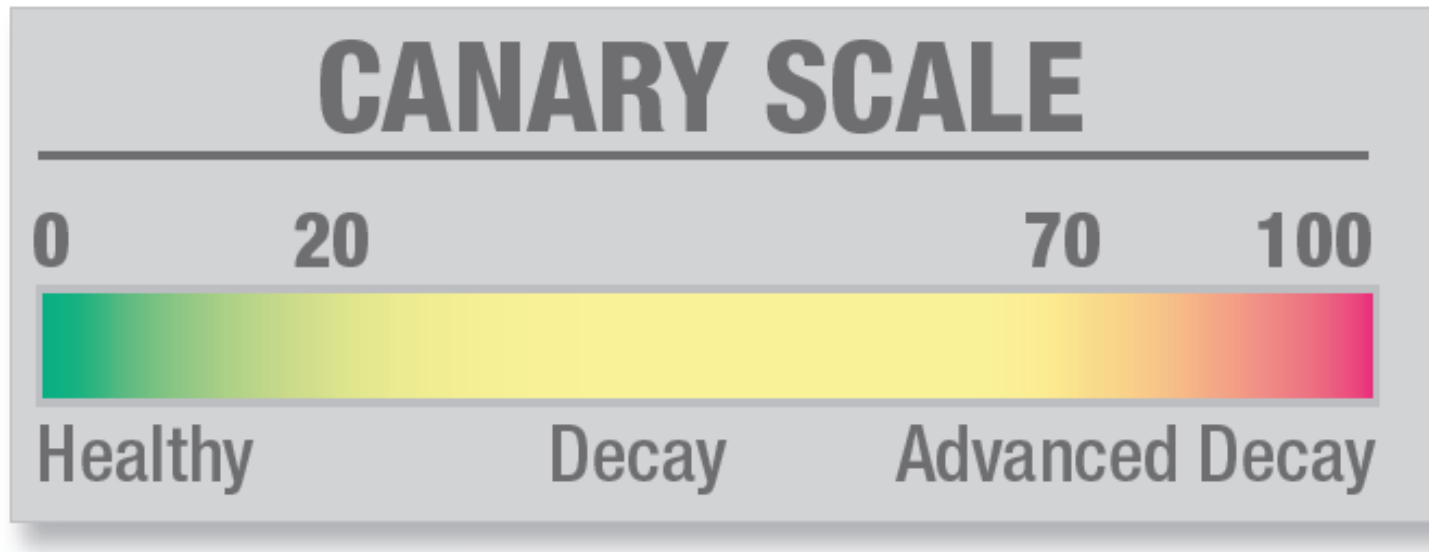
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Previous Studies

- Demonstrated the ability of the core technology of The Canary System, called photothermal radiometry-luminescence (or PTR-LUM) technology, to detect very early artificially demineralized interproximal lesions.

  - Jeon RJ et al. J Bio Optics. 2007;12(3):034028.

  - Jeon RJ et al. Caries Res. 2006;40:348.

- PTR-LUM corroborated with µ-CT, TMR, SEM and PLM.

  - Jeon RJ et al. J Bio Optics. 2007;12(3):034028.

  - Mandelis A et al. Eur Phys J. Special Topics. 2008;153;467-469.

  - Jeon RJ et al. J Bio Optics. 2008;13(3);034025.

  - Matvienko A et al. Proc. SPIE BiOS. 2009;7166 (12);71660C1-12.

  - Wong et al. J Dent Res. 92 (Spec. Iss. A), 7, 2013.

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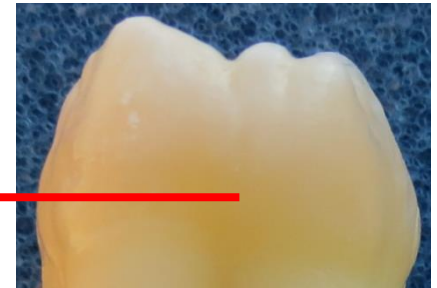
Materials and Methods

- Twenty interproximal surfaces of ten pairs of extracted permanent human teeth were examined.

Visually carious interproximal surface of Tooth #1

Adapted from: Buchalla W et al. Caries Research. 2002;36:320–326.

Visually sound interproximal surface of Tooth #2

Materials and Methods – The Canary System Scans from Buccal and Lingual Surfaces
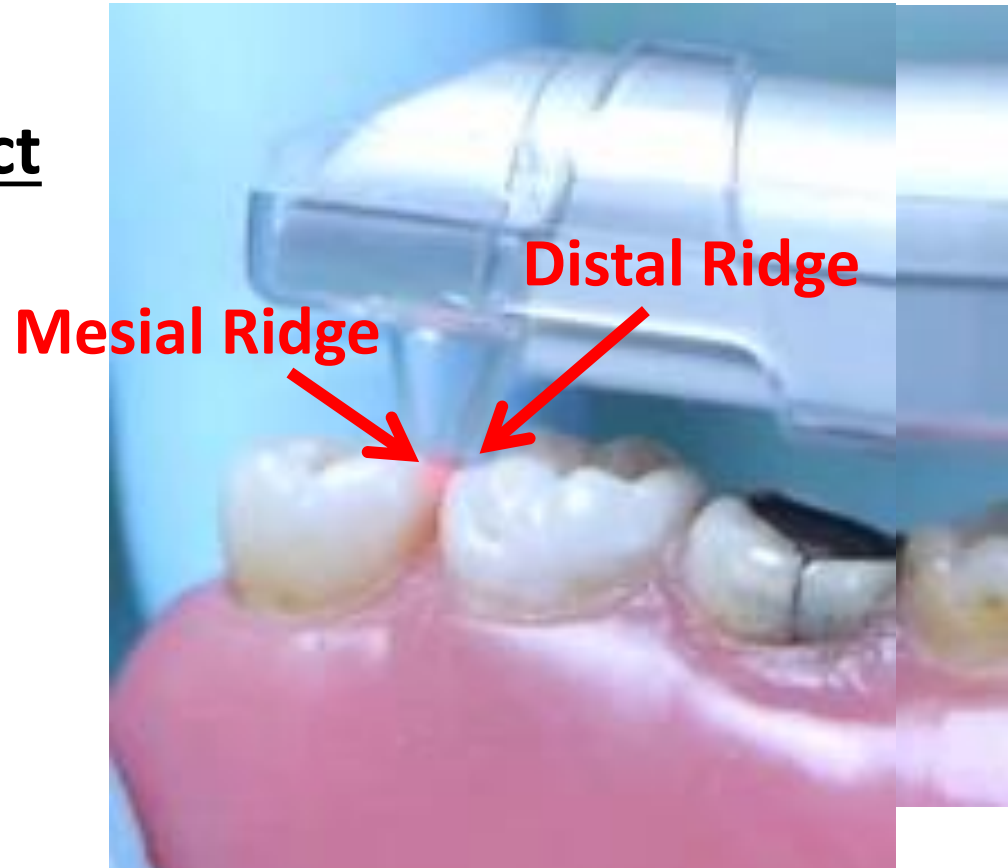
Four areas were scanned at the contact point:

(1) Distal-buccal (**DB**)

(2) Distal-lingual (**DL**)

(3) Mesial-lingual (**ML**)

(4) Mesial-buccal (**MB**)

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Materials and Methods – The Canary System Scans from Occlusal Surfaces

Two areas were scanned at the contact point:

(1) Distal ridge

(2) Mesial ridge

Mesial Ridge

Distal Ridge

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Materials and Methods – ICDAS II and Radiographic Examination

- Two blinded dental clinicians independently scored the interproximal surface of each tooth using:

  1. ICDAS II

     I. Buccal and lingual

   II. Occlusal

  2. Radiographs

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Materials and Methods - Validation

- Sensitivity and specificity values were calculated according to:

  i. Direct visual inspection

  ii. Polarized Light Microscopy (PLM) was performed blinded at the Department of Comprehensive Dentistry, University of Texas Health Science Center at San Antonio as validation

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Sensitivity and Specificity – Direct Visual Inspection
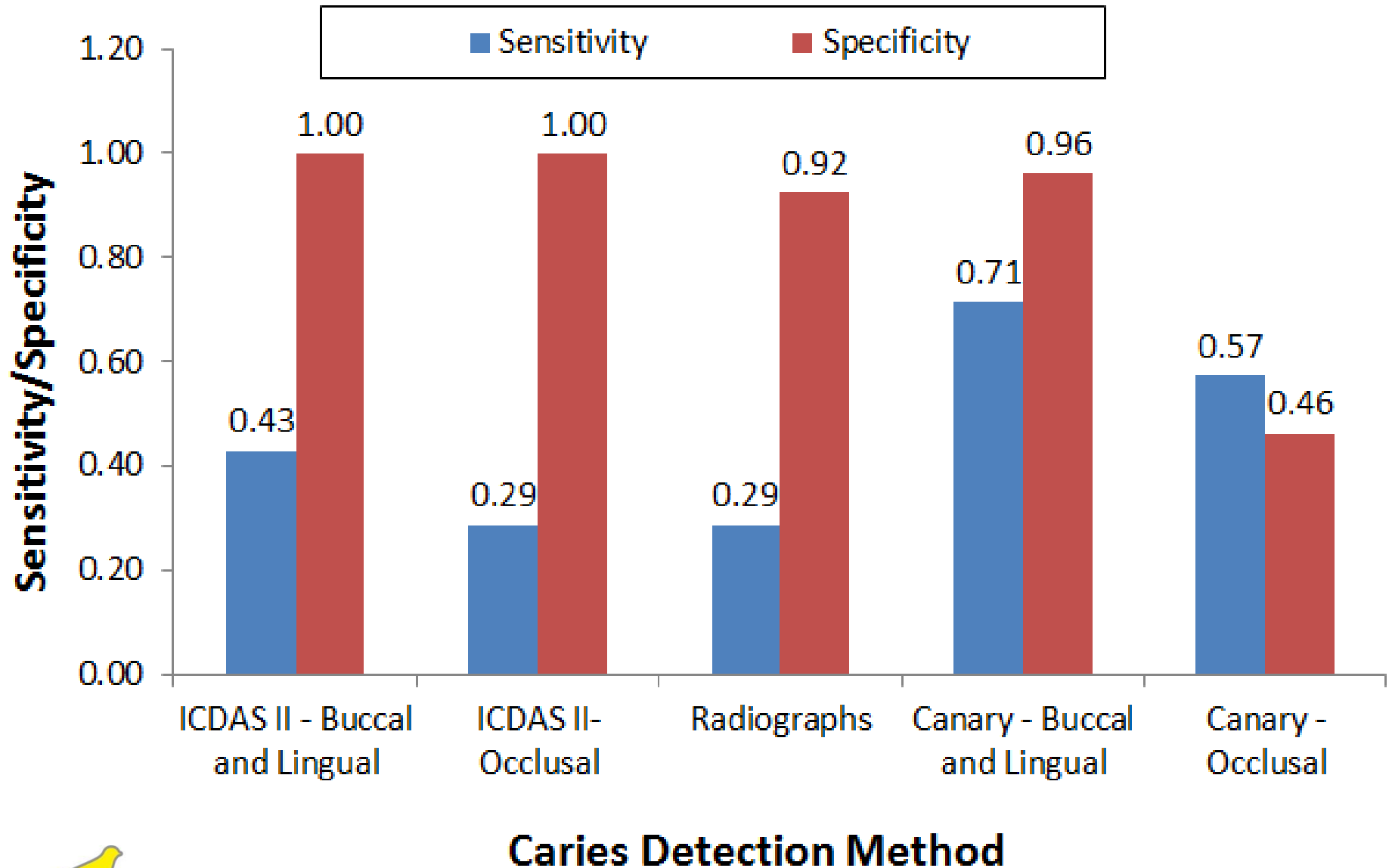
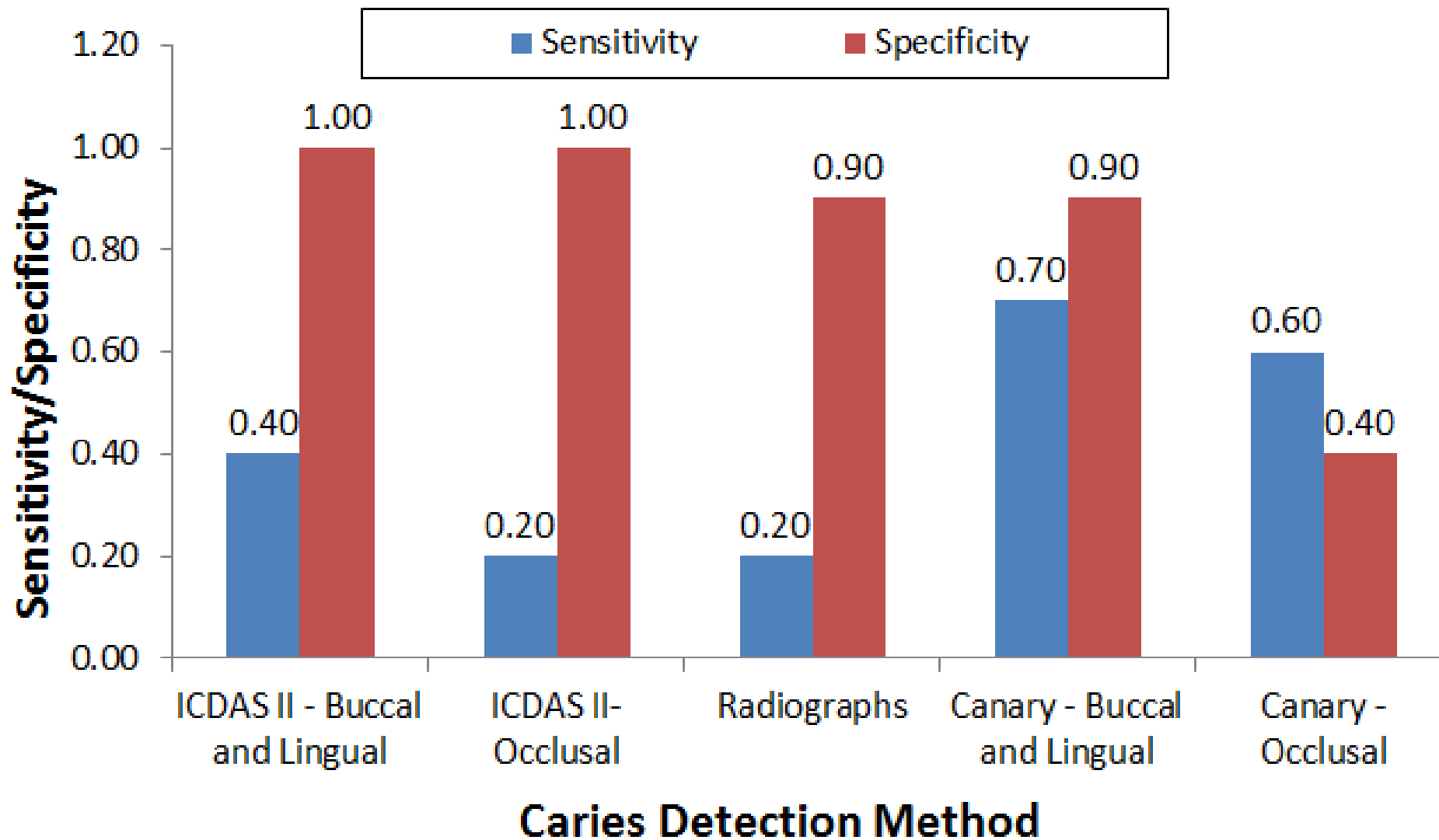# Sensitivity and Specificity – PLM Findings
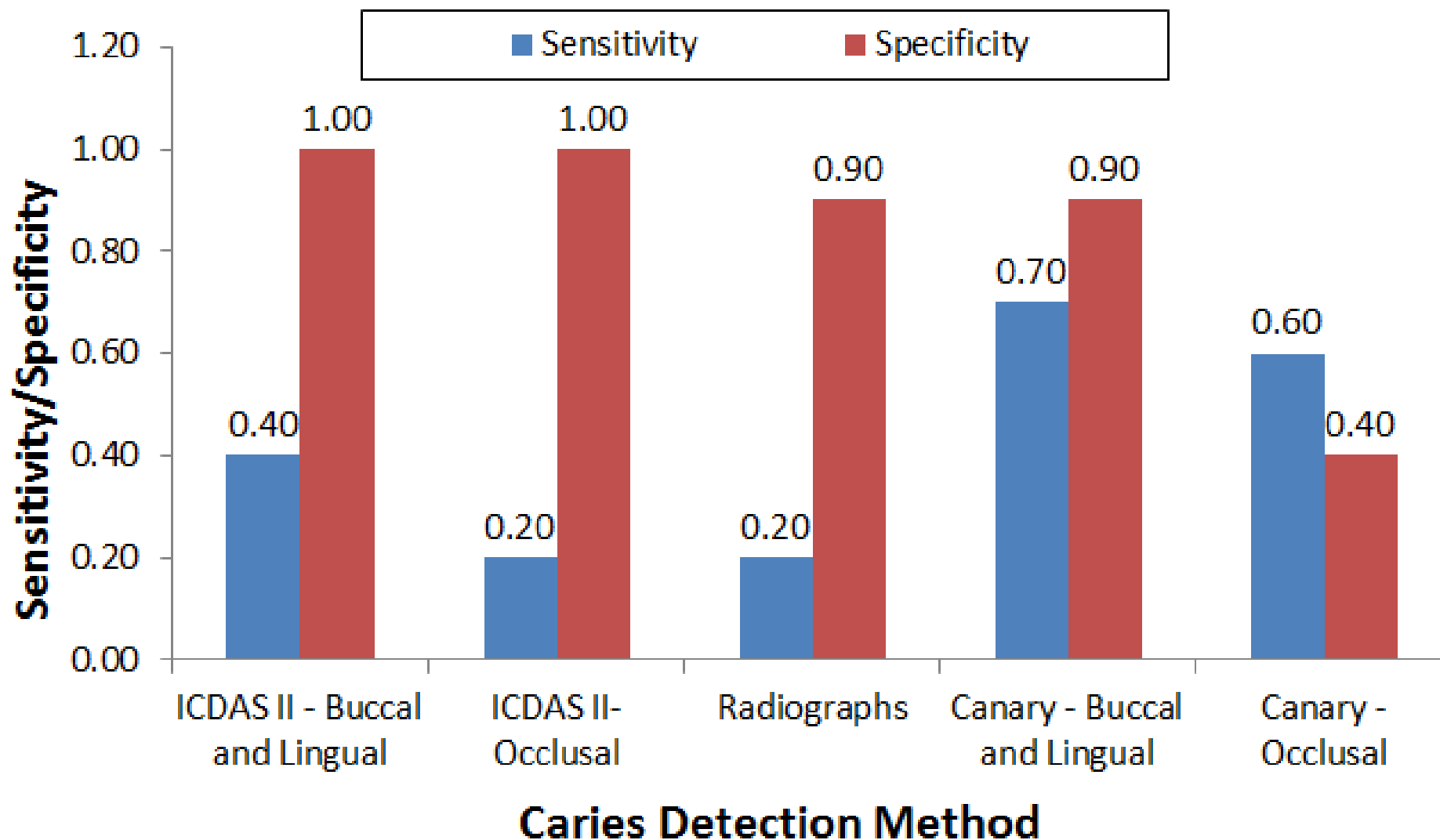
Radiographic Examination

- In this study:

  o High **specificity** (correctly identify absence of caries)

  o Low **sensitivity** (correctly identify presence of caries)

- Similar results reported by previous studies:

  o Pretty IA. J Can Dent Assoc. 2004; 70(6):388–94.
  o Maia AMA e al. Dentomaxillofac Radiol. 2011 Oct;40(7):429-33.
  o Senel B et al. Dentomaxillofac Radiol. 2010 Dec;39(8):501-11.
  o Abesi F et al. Iran J Radiol. 2012 Mar;9(1):17-21.
  o Abreu M et al. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001;91(3):381-5.
  o da Silva Neto JM. Braz Dent J. 2008;19(2):97-102.
  o Bader JD et al. J Dent Educ. 2001 Oct;65(10):960-8.
  o Dove SB. J Dent Educ. 2001;65(10):985-990.
  o Yang J et al. Dent Clin North Am. 2005; 49: 739–752.
  o Pereira AC et al. Caries Res. 2001;35:83-89.
  o Wenzel A. Oral radiology. Principles and interpretation. 5th ed. St. Louis:Mosby; 2004. p. 297–313.

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Sensitivity and Specificity – PLM Findings

Bar chart titled "Sensitivity and Specificity – PLM Findings" with legend: Sensitivity (blue), Specificity (red). Y-axis: Sensitivity/Specificity (0.00 to 1.20). X-axis: Caries Detection Method.

- ICDAS II - Buccal and Lingual: Sensitivity 0.40, Specificity 1.00
- ICDAS II- Occlusal: Sensitivity 0.20, Specificity 1.00
- Radiographs: Sensitivity 0.20, Specificity 0.90
- Canary - Buccal and Lingual: Sensitivity 0.70, Specificity 0.90
- Canary - Occlusal: Sensitivity 0.60, Specificity 0.40

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Buccal and Lingual Scans

Conclusions

- This pilot study demonstrated the potential of The Canary System to detect interproximal caries with high sensitivity and specificity when scanning from the buccal and lingual surfaces.

- ICDAS II and radiographic examination resulted in high specificity but poor sensitivity in detecting interproximal caries as previously reported.

- Further *in vitro* studies with larger sample size should be designed to investigate the accuracy and reliability of The Canary System for non-cavitated interproximal caries detection.

- *In vivo* study evaluating the ability of ICDAS II, radiographs, and The Canary System for interproximal caries detection has recently been completed.

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Thank You

For more information contact:

Bonny Wong
Research Associate, Quantum Dental Technologies

t.   (647) 455-2088
e.   bonny@thecanarysystem.com