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

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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.
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  The Canary System®
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 Scale

CANYAR SCALE

0 20 70 100

Healthy Decay Advanced Decay
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.
  

• PTR-LUM corroborated with µ-CT, TMR, SEM and PLM.
  
  o Jeon RJ et al. J Bio Optics. 2008;13(3);034025.
  o Matvienko A et al. Proc. SPIE BiOS. 2009;7166 (12);71660C1-12.
Materials and Methods

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

Four areas were scanned at the contact point:

1. Distal-buccal (DB)
2. Distal-lingual (DL)
3. Mesial-lingual (ML)
4. Mesial-buccal (MB)
Two areas were scanned at the contact point:

(1) Distal ridge

(2) Mesial ridge
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
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
Sensitivity and Specificity – Direct Visual Inspection

![Graph showing sensitivity and specificity for different caries detection methods.]

- **ICDAS II - Buccal and Lingual**: Sensitivity = 0.43, Specificity = 1.00
- **ICDAS II - Occlusal**: Sensitivity = 0.29, Specificity = 1.00
- **Radiographs**: Sensitivity = 0.29, Specificity = 0.92
- **Canary - Buccal and Lingual**: Sensitivity = 0.71, Specificity = 0.96
- **Canary - Occlusal**: Sensitivity = 0.57, Specificity = 0.46
Sensitivity and Specificity – PLM Findings

The graph shows the sensitivity and specificity of different caries detection methods:

- **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

The Canary System
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:
Sensitivity and Specificity – PLM Findings
The Canary System

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.
Thank You

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