Effect of Placing an Opaque Sealant on Canary Number Readings

S. H. Abrams[1], B. Wong[1], K. Sivagurunathan[1], R. J. Jeon[1], J. D. Silvertown[1], A. Hellen[1], A. Mandelis[1,2], W. M. P. Hellen[3], G. I. Elman[3], K. Ramalingam[4], R.A. Ccahuana-Vasquez[4], B. T. Amaechi[4]

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

Introduction

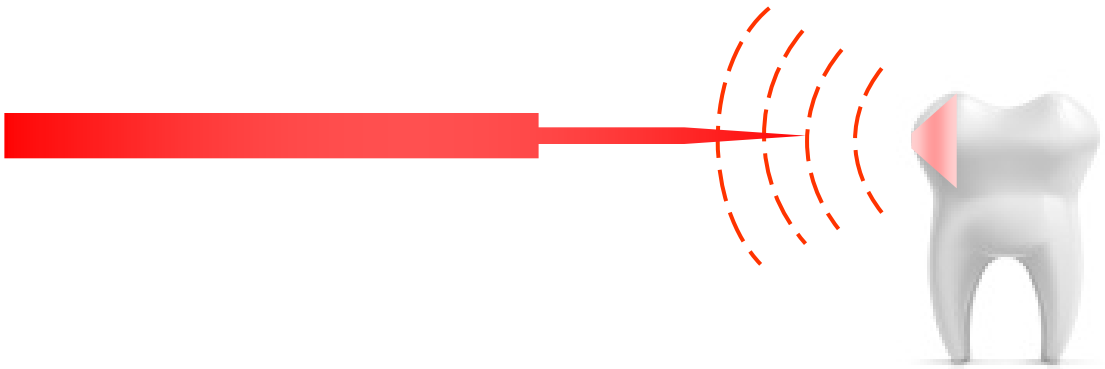
- Pit and fissure sealants can prevent development of caries
- Over time, margins may lift or open allowing the ingress of oral fluids and bacteria
- Visual, tactile and radiographic methods of caries detection are difficult under sealed fissures
- Long-term success of caries management with sealant treatment requires an adjunct method that is able to assist clinicians in the detection, monitoring and documentation of caries beneath sealant

The Canary System™

The Science Behind The Canary System™

- Pulses of laser light hit the tooth surface.
- Tooth glows (Luminescence, LUM) and releases heat (Photo-Thermal Radiometry, PTR).

➢ **Energy Conversion Technology**



Temperature increase < 1°C ***not harmful***

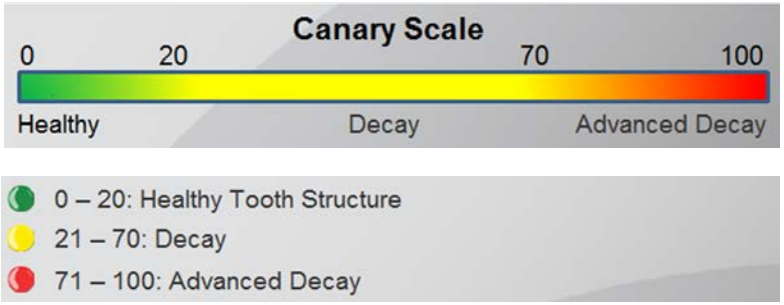
- Detected signals reflect the tooth's condition.
- Detects 50 micron lesion up to 5 mm below the surface.

The Canary Number

- The Canary algorithm is the core function that takes PTR-LUM amplitudes and phases and converts to a numerical scale:

- The strength of the converted heat signal **(PTR Amplitude)**
- Time delay of the converted heat to reach the surface **(PTR Phase)**
- The strength of the emitted luminescence **(LUM Amplitude)**
- Time delay of the emitted luminescence **(LUM Phase)**

Canary Number



The Canary System

Objectives

1. Evaluate the ability of The Canary System™ to detect caries beneath intact sealants.

2. Correlate the Canary Number to caries lesion depth.

3. Compare the effectiveness of The Canary System™ and laser fluorescence (DIAGNOdent™) to detect decay under intact sealants.

Materials and Methods

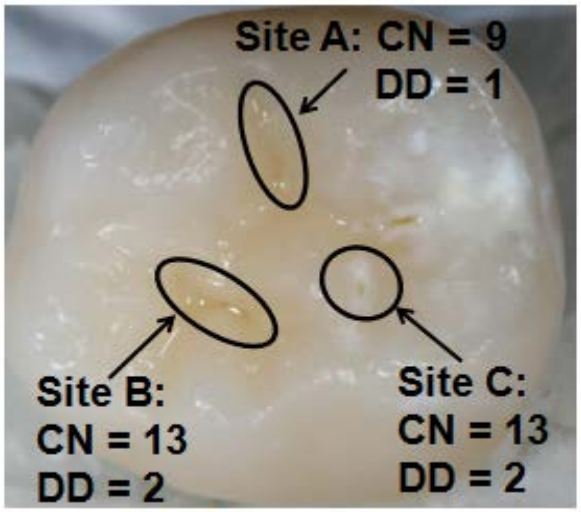
1. Extracted human teeth (n = 28) contained 103 clinically sound and carious occlusal pits and fissures.
2. Examined and ranked sites as carious or non-carious in a blinded fashion.
3. Pits & fissures were scanned with The Canary System™ and DIAGNOdent Classic™ before and after placement of an opaque sealant (3M ESPE Clinpro Sealant™).
4. Polarized Light Microscopy (PLM) was performed at the University of Texas as the ‘gold standard’

Materials and Methods

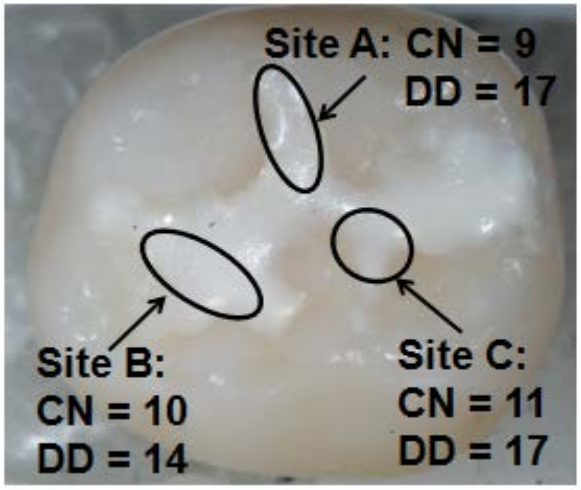
Statistics:

- Post-sealant sensitivity and specificity
- Correlation with lesion depth using PLM as the ‘gold standard’ (Spearman's rank correlation coefficient)
- DIAGNOdent™ and Canary Number readings before and after sealant application (Wilcoxon’s matched-pairs signed-ranks test, p value < 0.05)

Sound Tooth Sample

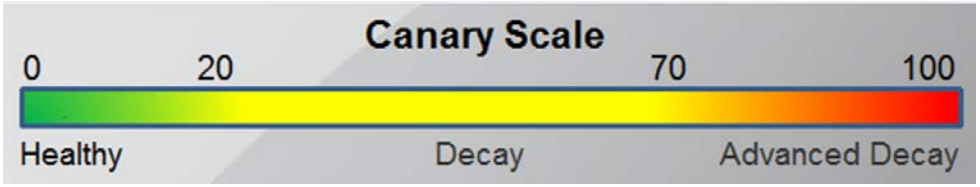


(A) Pre-sealant



(B) Post-sealant

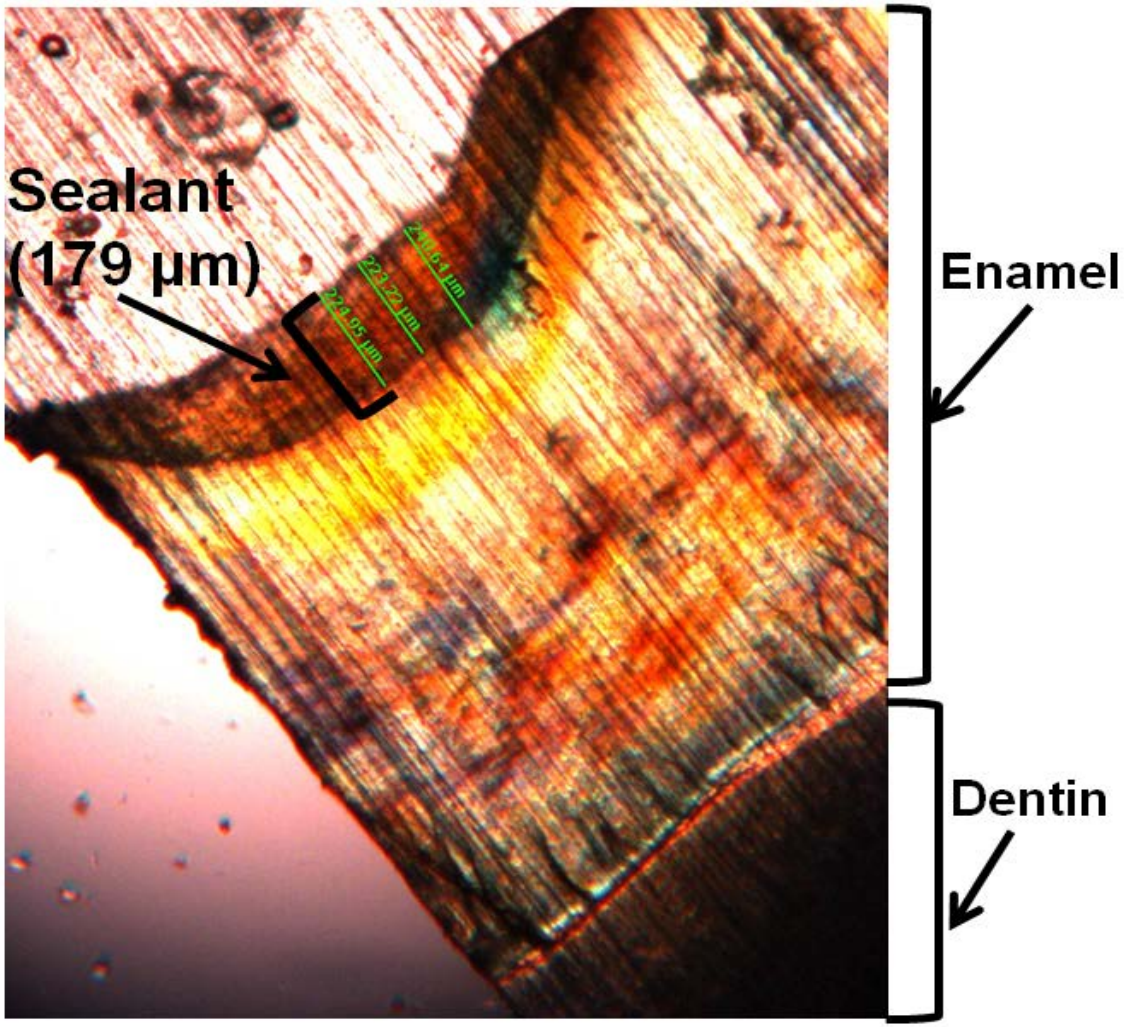
DIAGNOdent Scale (according to KaVo)	
Display value:	**Therapy:**
0 - 14	No special measures.
15 - 20	Prophylactic measures.
21 - 30	Intensive prophylaxis/restoration: Indication dependent on * caries activity. * caries risk. * recall interval, etc.
from 30	Restoration/intensive prophylaxis.



- 0 – 20: Healthy Tooth Structure
- 21 – 70: Decay
- 71 – 100: Advanced Decay

The Canary System

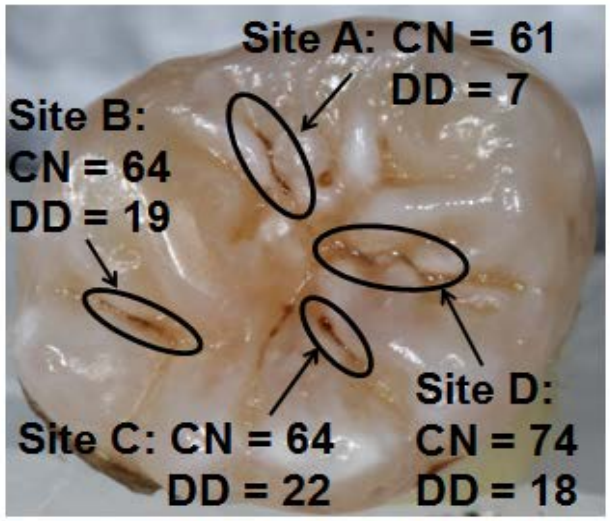
PLM Sound Tooth Sample



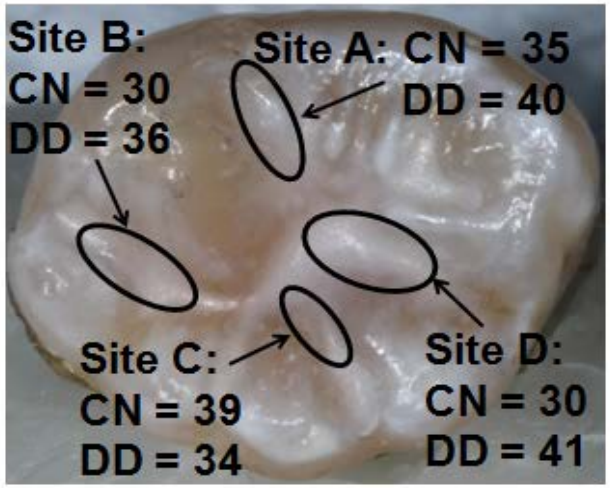
(C) PLM image of healthy fissure (Site A)

The Canary System

Carious Tooth Sample

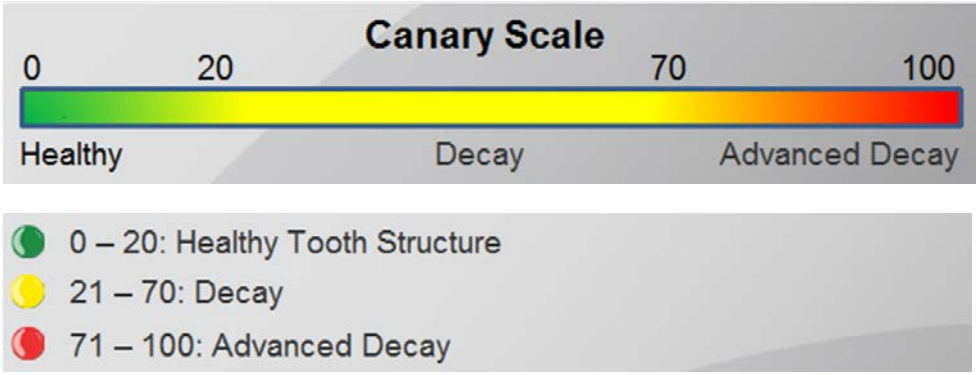


(A) Pre-sealant



(B) Post-sealant

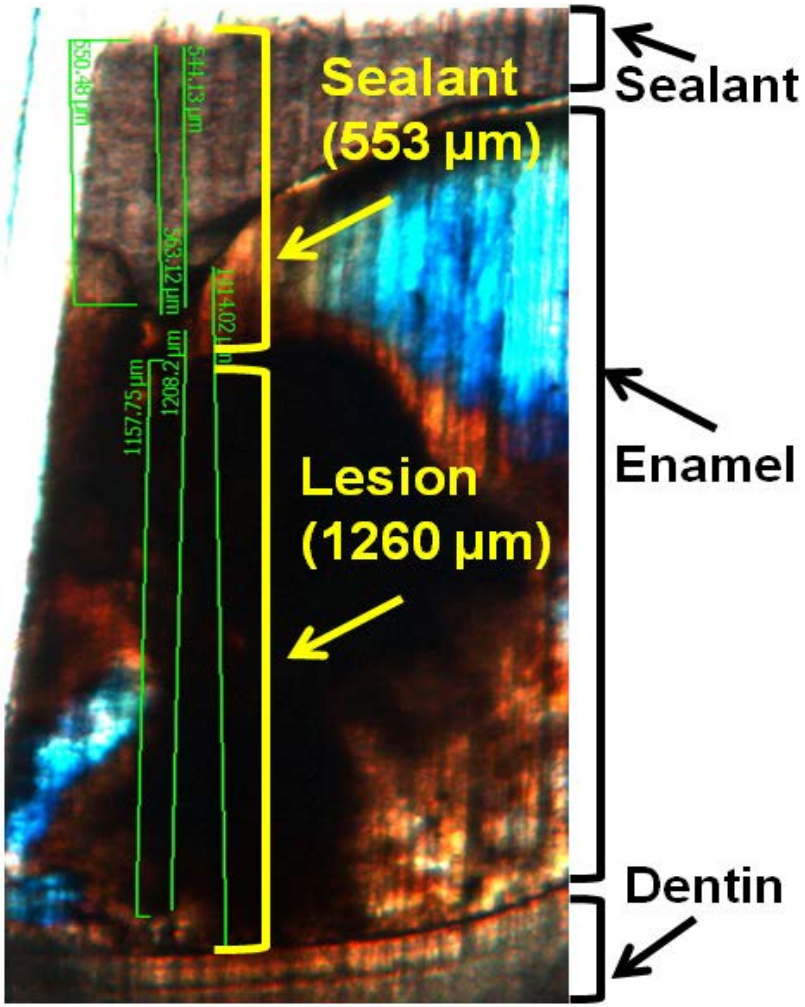
DIAGNOdent Scale (according to KaVo)	
Display value:	**Therapy:**
0 - 14	No special measures.
15 - 20	Prophylactic measures.
21 - 30	Intensive prophylaxis/restoration: Indication dependent on * caries activity. * caries risk. * recall interval, etc.
from 30	Restoration/intensive prophylaxis.



The Canary System

PLM Carious Tooth Sample

	Canary Number	DIAGNOdent
Pre-Sealant	74	18
Post Sealant	30	41



(C) PLM image of carious fissure (Site D)

The Canary System

Canary Number & DIAGNOdent™ readings Before & After Sealing

	The Canary System™		DIAGNOdent™	
	Before Sealant Placement	After Sealant Placement	Before Sealant Placement	After Sealant Placement
Sound (n = 38)	26 ± 22	14 ± 4*	2 ± 2	26 ± 13*
Carious (n = 65)	65 ± 23	30 ± 13*	10 ± 16	35 ± 15*

* $p < 0.05$ for difference between pre-sealing compared with post-sealing (related-samples Wilcoxon signed-rank test).

Post-Sealant Sensitivity & Specificity

	The Canary System™	DIAGNOdent™
Sensitivity	0.83	0.64
Specificity	0.79	0.46

Post-sealant Canary Numbers of Carious Sites Compared with Lesion Depth & Histological Observations

Post-sealant Canary Number	Sample size	Histological observations*
Lesion depth > 1000 microns (n = 14)		
CN > 20	93% (n = 13)	D_3
CN ≤ 20	7% (n = 1)	D_2
Lesion depth 500-1000 microns (n = 17)		
CN > 20	71% (n = 12)	D_2
CN ≤ 20	29% (n = 5)	D_1, D_2
Lesion depth < 500 microns (n = 34)		
CN > 20	59% (n = 20)	D_1
CN ≤ 20	41% (n = 14)	D_1

*D_1: histological caries penetrating less than one-half the enamel thickness; D_2: histological caries extending beyond the outer half, but not through, the enamel; D_3: histological caries penetrating up to one-half the dentinal thickness

Post-Sealant Canary Numbers of Sound Sites Compared with Lesion Depth and Histological Observations

Post-sealant Canary Number	Sample size	Histological observations*
Sound (n = 38)		
CN > 20	5% (n = 2)	D_0
CN ≤ 20	95% (n = 36)	D_0

*D_0: intact

The Canary System

Observations

- Canary Numbers > 20 consistently obtained for 93% of sealed caries of greater than 1000 microns in size.
- Canary Numbers ≤ 20 consistently obtained for 95% of sealed sound pits and fissures.

Conclusions

- The Canary System™ was able to detect caries beneath sealants with higher sensitivity and specificity than DIAGNOdent™.
- Canary Number readings were dampened by 53% following sealant placement.
    - As expected, signal attenuation through the opaque sealant was evident in The Canary System™ due to increased scattering of the incident and converted light.
- DIAGNOdent™ values increased following sealant placement.
    - May be attributed to the intrinsic fluorescence properties of the sealant materials.
    - DIAGNOdent™ readings significantly increased by 346%, resulting in potential overestimation of caries beneath sealant.

Clinical Applications

- Canary Numbers > 20 indicated presence of caries beneath sealant.

- The Canary System™ has the potential to assist in detection and monitoring of caries under opaque sealants.

The Canary System

by Quantum Dental Technologies

Visit Booth # 908
Exhibit Hall CECONFI

Thank You

For more information contact:

Stephen Abrams, DDS
President, Quantum Dental Technologies

t. (416) 265-1400 (dental practice)
m. (416) 523-8453
e. stephen@thecanarysystem.com

Visit Poster #1824 “Detection of Caries around Restorations with The Canary System™