Effect of Placing an Opaque Sealant on Canary Number Readings

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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
• Pulses of laser light hit the tooth surface.

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

➢ Energy Conversion Technology

• 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 Scale]

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

Site A: CN = 9
DD = 1

Site B:
CN = 13
DD = 2

Site C:
CN = 13
DD = 2

(B) Post-sealant

Site A: CN = 9
DD = 17

Site B:
CN = 10
DD = 14

Site C:
CN = 11
DD = 17

<table>
<thead>
<tr>
<th>Display value</th>
<th>Therapy:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 14</td>
<td>No special measures.</td>
</tr>
<tr>
<td>15 - 20</td>
<td>Prophylactic measures.</td>
</tr>
<tr>
<td></td>
<td>* caries risk.</td>
</tr>
<tr>
<td></td>
<td>* recall interval, etc.</td>
</tr>
<tr>
<td>from 30</td>
<td>Restoration/intensive prophylaxis.</td>
</tr>
</tbody>
</table>

Canary Scale

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21 - 70: Decay
71 - 100: Advanced Decay
PLM Sound Tooth Sample

(C) PLM image of healthy fissure (Site A)
Carious Tooth Sample

(A) Pre-sealant

Site A: CN = 61, DD = 7
Site B: CN = 64, DD = 19
Site C: CN = 64, DD = 22

(B) Post-sealant

Site A: CN = 35, DD = 40
Site B: CN = 30, DD = 36
Site C: CN = 39, DD = 34
Site D: CN = 74, DD = 18

DIAGNOdent Scale (according to KaVo)

<table>
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<td>Prophylactic measures.</td>
</tr>
<tr>
<td>21 - 30</td>
<td>Intensive prophylaxis/restoration:</td>
</tr>
<tr>
<td></td>
<td>Indication dependent on</td>
</tr>
<tr>
<td></td>
<td>* caries activity.</td>
</tr>
<tr>
<td></td>
<td>* caries risk.</td>
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Canary Scale

0 - 20: Healthy Tooth Structure
21 - 70: Decay
71 - 100: Advanced Decay
## PLM Carious Tooth Sample

<table>
<thead>
<tr>
<th></th>
<th>Canary Number</th>
<th>DIAGNOdent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Sealant</td>
<td>74</td>
<td>18</td>
</tr>
<tr>
<td>Post Sealant</td>
<td>30</td>
<td>41</td>
</tr>
</tbody>
</table>

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

- **Sealant (553 μm)**
- **Lesion (1260 μm)**
The Canary System™

<table>
<thead>
<tr>
<th></th>
<th>Before Sealant Placement</th>
<th>After Sealant Placement</th>
<th>DIAGNOdent™ Before Sealant Placement</th>
<th>After Sealant Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sound (n = 38)</strong></td>
<td>26 ± 22</td>
<td>14 ± 4*</td>
<td>2 ± 2</td>
<td>26 ± 13*</td>
</tr>
<tr>
<td><strong>Carious (n = 65)</strong></td>
<td>65 ± 23</td>
<td>30 ± 13*</td>
<td>10 ± 16</td>
<td>35 ± 15*</td>
</tr>
</tbody>
</table>

* p < 0.05 for difference between pre-sealing compared with post-sealing (related-samples Wilcoxon signed-rank test).
<table>
<thead>
<tr>
<th></th>
<th>The Canary System™</th>
<th>DIAGNOdent™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.83</td>
<td>0.64</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.79</td>
<td>0.46</td>
</tr>
</tbody>
</table>
Post-sealant Canary Numbers of Carious Sites Compared with Lesion Depth & Histological Observations

<table>
<thead>
<tr>
<th>Post-sealant Canary Number</th>
<th>Sample size</th>
<th>Histological observations*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion depth &gt; 1000 microns (n = 14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CN &gt; 20</td>
<td>93% (n = 13)</td>
<td>D₃</td>
</tr>
<tr>
<td>CN ≤ 20</td>
<td>7% (n = 1)</td>
<td>D₂</td>
</tr>
<tr>
<td>Lesion depth 500-1000 microns (n = 17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CN &gt; 20</td>
<td>71% (n = 12)</td>
<td>D₂</td>
</tr>
<tr>
<td>CN ≤ 20</td>
<td>29% (n = 5)</td>
<td>D₁, D₂</td>
</tr>
<tr>
<td>Lesion depth &lt; 500 microns (n = 34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CN &gt; 20</td>
<td>59% (n = 20)</td>
<td>D₁</td>
</tr>
<tr>
<td>CN ≤ 20</td>
<td>41% (n = 14)</td>
<td>D₁</td>
</tr>
</tbody>
</table>

*D₁: histological caries penetrating less than one-half the enamel thickness; D₂: histological caries extending beyond the outer half, but not through, the enamel; D₃: histological caries penetrating up to one-half the dentinal thickness
### Post-Sealant Canary Numbers of Sound Sites Compared with Lesion Depth and Histological Observations

<table>
<thead>
<tr>
<th>Post-sealant Canary Number</th>
<th>Sample size</th>
<th>Histological observations*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound (n = 38)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CN &gt; 20</td>
<td>5% (n = 2)</td>
<td>D₀</td>
</tr>
<tr>
<td>CN ≤ 20</td>
<td>95% (n = 36)</td>
<td>D₀</td>
</tr>
</tbody>
</table>

*D₀: intact
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.
  
  o 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.
  
  o May be attributed to the intrinsic fluorescence properties of the sealant materials.

  o 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.
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Thank You

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