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CORRELATION WITH CARIES LESION DEPTH OF THE CANARY SYSTEM, DIAGNODENT AND ICDAS II

B. Wong[a], S.H. Abrams[a,b] , K. Sivagurunathan[a], J.D. Silvertown[a], A. Hellen[a], A. Mandelis[a,c], W.M.P. Hellen[b], G.I. Elman[b], S.M. Mathew[d], P.K. Mensinkai[d], B.T. Amaechi[d*]

[a]Quantum Dental Technologies Inc., Toronto, Canada; [b]Cliffcrest Dental Office, Scarborough, Canada
[c]University of Toronto, Toronto, Canada ; [d]University of Texas Health Science Center, San Antonio, Texas, USA

AIMS

This study investigated the correlation of the depth of natural caries lesion to Canary Numbers derived from Canary System, numerical readings from DIAGNOdent, and lesion scores from ICDAS II

BACKGROUND

Caries remains a significant health problem for both children and adults. Accurate detection as well as quantification of the size of the developing lesions at a very early stage will provide the practitioner with the opportunity to initiate early preventive therapy. Ability to longitudinally quantify the mineral changes in a lesion will enable the effect of advice and treatments tailored to inhibit demineralization and promote caries remineralization to be monitored. However, there is not yet a device that can achieve these with enough sensitivity and specificity in all tooth surfaces. Therefore, there is still a strong need to develop a device which cannot only detect early caries but also quantitatively monitor its remineralization.

The Canary System™ (Fig. 1) is a laser-based system that directly assesses the status of the enamel or root crystal structure by using Photothermal Radiometry (PTR) and Luminescence (LUM). Pulses of laser light are shone on the tooth and the laser light is converted to heat (PTR) and light (LUM), which are emitted from the tooth surface when the laser is off (Figure 2). The Canary System (CS) measures four signals: (1) The strength of the converted heat (PTR amplitude); (2) The time delay of the converted heat to reach the surface (PTR phase); (3) The strength of the converted luminescent light (LUM amplitude); and (4) The time delay of the converted luminescent light (LUM phase). The Canary System then converts these effects (PTR-LUM amplitudes and phases) into a numerical scale 'The Canary Number'(Figure 3), an algorithm that expresses the severity of the caries lesion. By modulating the laser beam at low frequency (2Hz), the CS is able to collect information from a hemispherical area beneath the laser beam that is 1.5 mm in diameter by 5 mm in depth [Jeon et al., 2004].

The present study investigated the relationship between the Canary number and the depth of the caries lesion. The Canary System was compared on this basis with the DIAGNOdent and the ICDAS II caries scoring system.

Figure 1: The Canary System

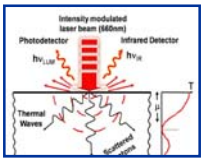

Figure 2: Illustration of the principles of Photothermal Radiometry and Luminescence

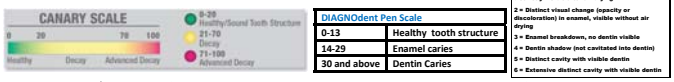

Figure 3: The scale/scoring codes for the Canary System, DIAGNOdent and ICDAS II, indicating the severity of a caries lesion

RESULTS

Table 1. Correlation of caries lesion depth as determined by PLM with Canary Numbers, DIAGNOdent readings and ICDAS II scores

Caries Detection Method	Pearson's Correlation Coefficient
The Canary System	**0.84**
DIAGNOdent	**0.21**
ICDAS II	**0.77**

Table 2. Caries lesion depth compared to mean±SD Canary Number, DIAGNOdent reading and ICDAS II score (Please refer to Figure 3 for severity scales.

Lesion Depth (µm)	Number of Sites	Canary Number (Mean±SD)	DIAGNOdent Readings (Mean±SD)	ICDAS II Scores (Mean±SD)
Sound	**3**	**11 ± 1**	**1 ± 1**	**0 ± 0**
<800	**11**	**55 ± 15**	**7 ± 11**	**2 ± 1**
>800	**6**	**75 ± 22**	**8 ± 9**	**2 ± 1**

SPONSOR

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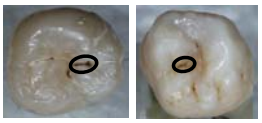
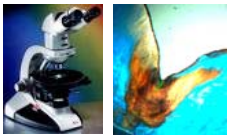
MATERIAL and METHODS



20 tooth surface sites with status ranging from healthy to varying levels caries were examined on 10 human molars and premolars as follows.

First, two blinded dentists used ICDAS II criteria to scored the sites, and the consensus score was recorded for each examined site

Second, an operator, experienced with the use of The Canary system (CS) and DIAGNOdent (DD), used the two devices to examine the same sites, and recorded the Canary Numbers from The CS and the readings from the DD



Third, Polarized Light Microscopy (PLM) performed by blinded scorers was used as the 'gold standard' to confirm the presence or absence of a caries lesion on each examined spot and to determine caries lesion depth (µm)

The Canary Numbers (CNs), DIAGNOdent readings and ICDAS scores of the examined sites were correlated with the depth of detected caries lesions (lesion depth) using Pearson's coefficient of correlation

DISCUSSIONS and CONCLUSIONS

This study demonstrated that The Canary System exhibit much higher correlation with caries lesion depth compared to DIAGNOdent and ICDAS II.

Canary Numbers increased with increasing caries lesion depth (Table 2).

This strong correlation may be explained by the ability of The Canary System to measure the volume of demineralization (mineral loss of tooth structure) of a 3D area of 1.5 mm in diameter and 5 mm in depth beneath the tooth surface.

In contrast, DIAGNOdent was poorly correlated with caries lesion depth (Table 1 and 2)

DIAGNOdent is based on the phenomenon of laser-induced fluorescence of the enamel where porphyrins present in carious tissue fluoresce when stimulated by DIAGNOdent

Therefore, we conclude that DIAGNOdent may not provide accurate estimation of caries lesion depth since it is detecting porphyrin fluorescence and not mineral content of enamel crystal structure

With an overall Pearson's Correlation Coefficient of 0.84 in this study, the potential of The Canary System as an aid to dental professionals for the detection of caries and estimation of caries lesion depth has been demonstrated

REFERENCES

Jeon RJ, Mandelis A, Sanchez V, Abrams SH. Nonintrusive, noncontacting frequency-domain photothermal radiometry and luminescence depth profilometry of carious and artificial subsurface lesions in human teeth. *J Biomed Opt*. 2004:9(4):804–819.