



## Abstract

**Objectives:** Early stage white spot lesions (WSL) are often difficult to detect without some means to indicate the presence of the demineralization. There is a sensitive caries detection system based on photothermal radiometry-modulated luminescence (PTR-LUM) technology called the Canary System. This system uses an infrared laser that penetrates 5mm into the tooth which creates infra-red and luminescence signals that are related to mineral integrity. The signal is converted into a "Canary Number" (CN) which is interpreted to indicate the presence of caries. We wanted to determine if PTR-LUM technology is effective for detecting early stage WSL. Our hypothesis was that there would be a positive linear relationship between the CN and visual WSL scores.

**Methods:** 36 premolars that were extracted for orthodontic therapy were evaluated for WSL by the Canary System and visually for the presence of WSL under magnification. CN were determined at the labial gingival, incisal surfaces and left and right interproximal surfaces. The CN were averaged for each tooth. Visual determination was with the teeth gently dried and observed under a 10x dissecting microscope for WSL in the same zones as for the Canary System measurements. The number of zones with WSL for each tooth were summed to yield the visual WSL score. Digital microphotographs were taken for reference.

**Results:** The average CN score was  $29.0 \pm 6.1$ , range 21-42,  $n=36$ ; and the median visual WSL was 1, range 0-3,  $n=36$ . Because the visual WSL score is not parametric, a Spearman's correlation was run to determine the relationship between the CN and visual WSL scores. There was a strong, positive monotonic correlation between CN and WSL scores ( $R_s = 0.656$ ,  $n = 36$ ,  $p < 0.0001$ ).

**Conclusions:** The hypothesis is supported, there is a strong positive relationship between CN and visual WSL scores. This shows the Canary system is sufficiently sensitive to detect early WSL, thus giving an early warning of caries activity allowing for early intervention to preserve tooth integrity.

## Introduction

The Canary System (Quantum Dental Technologies, Inc.) utilizes low powered lasers that pulse infrared and red laser light into the tooth which in turn generates infra-red and luminescence signals (PTR-LUM). The PTR-LUM response is converted into a Canary Number (CN) that is directly related to the quality of the mineral structure (demineralization).

The Canary Number Scale is between 0 and 100 where the lower CN (less than 20) suggest healthy enamel and higher CN suggest the presence of cracks or caries.



## Canary System

The Canary System can detect and quantify the progression of early caries before they are large enough to appear on dental x-rays. By using a laser pulse at a frequency of 2Hz, the laser light can penetrate below the tooth surface and permit detection of a carious lesion as small as 50 microns.



## Purpose

Our goal was to determine if PTR-LUM technology is effective for detecting early stage WSL. Our hypothesis was that there would be a positive linear relationship between the CN and visual WSL scores.

## Study Design

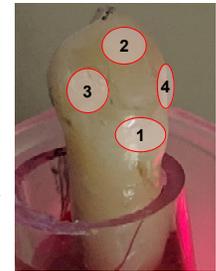
- In these in vitro experiments, Thirty-six teeth were evaluated for WSL by the Canary System and visual inspection. (Institutional approval was obtained prior to experimentation).
- Some of the samples were further analyzed by use of  $\mu$ CT (x-ray tomography) to map WSL locations.
- Descriptive analysis Mean, Median, Range, Standard Deviation, and Number were determined for both data sets to describe the results.
- Statistical analysis to compare the WSL scores to the CN was by Spearman's Ranked Correlation, Pearson's Correlation.



Scanning the gingival surface

## Methods: Sample Preparation

- In these in vitro experiments, we used the Canary System in the Quick Scan mode to analyze the labial gingival (1) and left (3) and right (4) interproximal surfaces of 36 premolars that were extracted for orthodontic therapy. (Institutional approval was obtained prior to experimentation).
- The CN score for the tooth was the average of the four CN values.
- These surfaces were evaluated for the presence of WSL under low power magnification.
- The Visual WSL score for each tooth was the sum of the surfaces that had visual WSL.



## Results



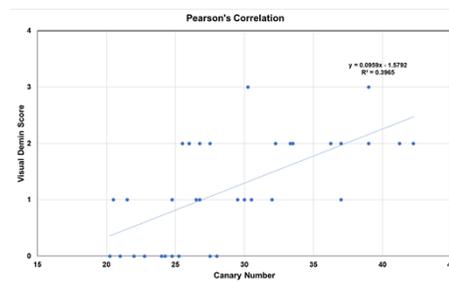
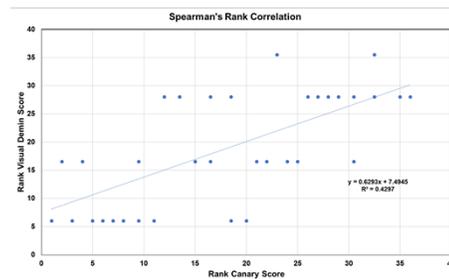
Quick Scan of an early WSL surface



Quick Scan of a healthy surface

Method	Median	Range	Mean	Std.Dev	n
Canary	27.5	21 - 42	29.0	6.1	36
Visual	1.0	0 - 3	1.2	-0.9	36

- Because the visual WSL score is not parametric, a Spearman's Rank Correlation was run to determine the relationship between the CN and visual WSL scores.
- There was a strong, positive monotonic correlation between CN and WSL scores ( $R_s = 0.656$ ,  $p < 0.0001$ ).
- The correlation between the CN and Visual Scores was evaluated by Pearson's Correlation
- There was a strong, positive relationship between the CN and visual WSL scores ( $R_p = 0.630$ ,  $p < 0001$ ).



## Discussion

- All WSL observed by Canary System or visual inspection were in the very early stages.
- More early stage WSL (CN ~ 25) were detected than were visually observed.
- The similar correlations for the ranked and the unranked data indicates that the sample of the population have similar normal distributions.

## Conclusions

- The hypothesis is supported, there is a strong positive relationship between CN and visual WSL scores.
- This larger CN scale allows for greater sensitivity in the detection and classification of the severity of the WSL than does the visual evaluation.
- The Canary system is sufficiently sensitive to detect early WSL, thus giving an early warning of caries activity allowing for early intervention to preserve tooth integrity.

## Funding

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