In vitro study of the Canary System for proximal caries detection

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OBJECTIVE

Proximal caries lesions are usually difficult to detect, because they are not directly visible and accessible. The most commonly used methods for detecting and assessing proximal caries, despite their limitations, are bitewing radiography (BW) and visual examination with International Caries Detection and Assessment System (ICDAS) II. Recently, a diagnostic tool based on combined frequency-domain laser-induced infrared photothermal radiometry (PTR) and modulated luminescence (LUM), the Canary System (CS), was introduced for early detection of dental caries.

The aim of this study was to investigate the accuracy of the PTR-LUM-based CS to detect proximal caries *in vitro*, and compare it to conventional methods, ICDAS-II and BW.

METHODS

Extracted human teeth with or without proximal caries were assessed by blinded examiners:

Visual examination

Visible proximal surfaces of each tooth (50 teeth excluding third molars and incisors) were assessed by ICDAS-II before setting the teeth in five manikin mouth models. The scoring criteria were: 0: sound tooth surface; 1: first visual change (opacity or discoloration) in enamel hardly visible on the wet surface but distinctly visible after air drying; 2: distinct visual change (opacity or discoloration) in enamel, visible without air drying; 3: localized enamel breakdown without visible dentin; 4: underlying dark shadow from dentin without cavitation; 5: distinct cavity with visible dentin; 6: extensive distinct cavity with visible dentin.

Radiographic examination

Then contacting proximal surfaces in mouth models were assessed by BW. The radiologist recorded caries as follows: score 0: no radiolucency; score 1: radiolucency in the enamel; score 2: radiolucency in the outer one-half of the dentin; score 3: radiolucency in the inner one-half of the dentin.

The Canary System examination

Contacting proximal surfaces in mouth models were assessed by CS (Quantum Dental Technologies Toronto, ON, Canada) through the corresponding marginal ridge, the buccal and lingual surfaces. CS indicates the presence or absence of caries using a Canary scale with Canary numbers ranging from 0 to 100. Canary numbers ≤ 20 signify absence of caries lesion while numbers above 20 signify presence of varying levels of caries lesion. Prior to imaging, each surface was dried for 5 s. The highest value from the 3 measurements of each surface was recorded.

Histological examination by PLM

A tooth slice was cut perpendicularly to the surface on the proximal surfaces of each tooth. Slices were examined using polarizing-light microscope (PLM; Model BH-2, Olympus, Japan) with histologic scores: 0: caries-free; 1: caries extending as much as halfway through the enamel; 2: caries extending into the inner one-half of the enamel; 3: caries in the outer one-half of the dentin; and 4: deep dentin caries involving the inner one-half of the dentin. The histological validation served as a gold standard.

Statistical analysis

Pairwise comparisons were performed on the area under the curve (AUC), sensitivity and specificity of the three tests, and were corrected for multiple comparisons using Bonferroni's method. The sensitivities and specificities were compared using a test of proportions and AUC values were compared using DeLong's method of nonparametric testing of AUC values.

RESULTS

Table 1.
Validity of CS, ICDAS-II, and BW test of carious lesions on proximal surfaces using the histological examination as the validating criterion.

Parameters	Canary System	ICDAS-II test	Radiograph test
False positive	7	14	5
False negative	4	16	44
Sensitivity	0.933[a, b]	0.733[a, c]	0.267[b, c]
Specificity	0.825	0.65	0.875
AUC	0.862[a, b]	0.681[a]	0.577[b]

[a, b, c] - different superscript letters show statistical differences between detection tests (p<0.05)

Figure 1.
Receiver operating characteristic (ROC) curves for CS test, ICDAS-II test, and BW test.
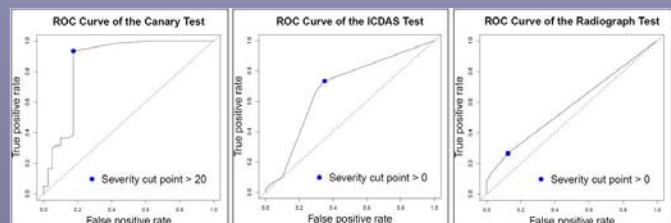
CONCLUSIONS

- The accuracy of the Canary System in detecting proximal caries lesions is greater than that of conventional ICDAS-II and BW.
- The Canary System presented the highest sensitivity among the investigated methods but without significant differences in specificity.
- The Canary System can be a valuable method for proximal caries lesions detection.