

Comparative Evaluation of Diagnodent and Digital Radiography in Dental Caries Diagnosis at the National Hospital Abuja: a Diagnostic Accuracy Study

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ABSTRACT

Objective

Early caries detection is crucial for preventing and controlling the spread of dental caries. Conventional detection techniques (visual and radiographic) rely on subjective judgment and are prone to misinterpretation, which may lead to mismanagement. This highlights the need for objective and quantitative methods to detect and monitor the progression of carious lesions. Among several emerging diagnostic devices, laser fluorescence—particularly Diagnodent—has generated considerable interest. This study aimed to compare the performance of Diagnodent and digital bitewing radiography in detecting early dental caries, using Ekstrand's criteria and manufacturer-recommended Diagnodent thresholds.

Study Design:

This diagnostic accuracy study was conducted at the Restorative Dentistry Unit of the National Hospital, Abuja, from 8 August to 9 November 2022. Ethical approval was obtained from the Health Research Ethics Committee (HREC) of the National Hospital, Abuja (Approval No. NHA/EC/078/2019).

Participants:

Thirty-one participants with 130 premolar and molar teeth that met the inclusion criteria were randomly selected.

Test Methods:

Teeth with incipient, non-cavitated enamel caries were examined using Diagnodent, digital bitewing radiographs, and visual examination (considered the gold standard). Visual and radiographic assessments followed Ekstrand's criteria, while Diagnodent results were interpreted using the manufacturer's cut-off values. Sensitivity, specificity,

predictive values, overall accuracy, and Kappa scores (intra- and inter-examiner agreement) were calculated. Data were analyzed using IBM SPSS Version 26.0. The significance level was set at $P < 0.05$.

Outcomes:

For occlusal surfaces, the sensitivity of early caries detection was 95.6%, 80.0%, and 100% for visual examination, Diagnodent, and bitewing radiography, respectively. The corresponding specificity values were 90.2%, 95.4%, and 27.3%. On interproximal surfaces, all methods recorded 100% sensitivity, but bitewing radiography had the lowest specificity (70.9%). Differences in specificity among diagnostic methods were statistically significant ($P < 0.05$) for both occlusal and interproximal surfaces, while sensitivity differences were not. Overall diagnostic accuracy was statistically significant for all three methods on both surfaces. Kappa scores for intra- and inter-examiner agreement were 0.9 for each diagnostic method. Diagnodent was more accurate than bitewing radiography for detecting early carious lesions on both occlusal and interproximal surfaces. Although Diagnodent demonstrated high accuracy, it is recommended as an adjunct to visual and radiographic methods rather than a standalone tool.

RATIONALE

Dental caries is a complex disease characterized by progressive demineralization of the tooth's inorganic component, along with disintegration of the organic matrix due to acidic by-products from cariogenic microorganisms metabolizing dietary carbohydrates.¹ The enamel, dentine, and cementum are gradually destroyed, ultimately leading to cavitation.¹ As one of the most prevalent oral diseases globally, early and accurate diagnosis of dental caries is essential to prevent disease progression and the need for restorative interventions.² Traditionally, caries has been diagnosed using visual, visuo-tactile, and radiographic methods.³ However, conventional methods are increasingly considered inadequate for modern caries management because they primarily detect advanced, irreversible lesions and often miss non-cavitated occlusal and interproximal caries in their early stages. To address these limitations, various new diagnostic technologies have been introduced, including electrical conductance measurement (ECM), fibre-optic transillumination (FOTI), and quantitative

fluorescence devices such as Diagnodent.⁴ Although several comparative studies^{5–8} have evaluated Diagnodent's diagnostic accuracy against other techniques, the results remain inconsistent. Therefore, further research is warranted to strengthen the evidence and guide practice.

OBJECTIVE

The aim of this study was to evaluate Diagnodent and digital radiographic methods in diagnosing early dental caries lesions, using visual examination as the gold standard. Ekstrand's criteria and Diagnodent manufacturer's values were applied for assessment of premolars and molars among patients attending the Restorative Unit, Dental and Maxillofacial Department of the National Hospital, Abuja.

HYPOTHESES

H₀: There is no significant difference between the diagnostic accuracy of Diagnodent and traditional radiographic methods in detecting early dental caries.

H₁: There is a significant difference between the diagnostic accuracy of Diagnodent and traditional radiographic methods in detecting early dental caries.

METHODS

This study adhered to the Standards for Reporting Diagnostic Accuracy Studies (STARD) guidelines. Ethical Approval: Ethical approval was obtained from the Health Research Ethics Committee (HREC) of the National Hospital, Abuja (Approval No. NHA/EC/078/2019). Informed consent was obtained from all participants prior to study commencement.

Study Design:

This was a diagnostic accuracy study with a cross-sectional design.

Study Participants:

Participants were aged between 18 and 60 years and provided informed consent to participate.

Inclusion Criteria

- Premolars and molars with sound occlusal and interproximal surfaces

- White spot lesions
- Yellow or brown discolorations without cavitation
- Intact or incipient, inconspicuous caries with or without color change

Exclusion Criteria

- Teeth previously restored with any material
- Hypoplastic teeth
- Teeth with wear lesions

Test Description

Conventional methods are useful for detecting advanced lesions but often fail to identify non-cavitated occlusal and interproximal caries, especially in their early stages. Diagnodent provides an objective method to detect and monitor lesion progression. This study compared the diagnostic accuracy of Diagnodent and digital bitewing radiography in detecting early caries, using Ekstrand's criteria and Diagnodent manufacturer's thresholds.

Study Setting and Participant Recruitment

This study was conducted at the Restorative Dentistry Outpatient Clinic, Dental and Maxillofacial Department, National Hospital Abuja, between 8 August and 9 November 2022. A simple random sampling method was used to recruit participants who met the inclusion criteria. All qualifying teeth among the selected participants were included. Based on an alpha value of 0.05, a 95% confidence interval, and 80% power, the minimum sample size was calculated as 130 teeth. In total, 31 participants with 130 teeth were enrolled.

Test Methods–Examiner Calibration

Two examiners were calibrated using Ekstrand et al.¹¹ criteria for visual and radiographic examination, and trained in the use of the Diagnodent Pen (2190 KaVo, Biberach, Germany) on 10 premolars and 10 molars not included in the study. Each tooth was examined independently by both examiners using all three methods—visual, radiographic, and Diagnodent—and scores were recorded. Examiners were blinded to each other's results. When scores matched, they were recorded directly; when they differed, the average of both scores was recorded as the final score for that tooth. Kappa scores were calculated for intra- and inter-examiner agreement. Table 1

Table 1: Kappa scores for intra and inter-examiners' agreement for occlusal and interproximal surfaces

Diagnostic methods	Intra-examiners' agreement		Inter-examiners' agreement	
	Occlusal	Interproximal	Occlusal	Interproximal
Visual	0.899	0.875	0.897	0.871
Radiographic	0.905	0.924	0.904	0.922
Diagnodent	0.989	0.989	0.986	0.988

The kappa scores for intra- and inter-examiner agreement on occlusal and interproximal surfaces indicated almost perfect agreement.

General Examination

A comprehensive extra-oral and intra-oral clinical examination was conducted by the examiner. Intra-orally, the gingivae, tongue, floor of the mouth, buccal mucosa, palatal mucosa, and teeth were examined, and all findings were recorded. Occlusal and interproximal surfaces of premolars and molars in both the upper and lower arches were evaluated for white spot lesions and yellow or brown discolorations. This initial visual inspection was performed through mere observation of surface changes, rather than based on any specific diagnostic criteria.

Pre-examination Prophylaxis

All teeth that met the inclusion criteria were scaled and polished using a bristle brush on a slow-speed handpiece, with interproximal cleaning performed using dental floss.

Outcome Measures and Gold Standard

Visual examination served as the gold standard against which the Diagnodent and digital radiographic methods were compared. The primary outcome measures included sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy.

Visual, Diagnodent, and Radiographic Examinations

Following prophylaxis, visual examination was conducted first, followed immediately by Diagnodent assessment and finally by digital radiographic examination. Visual and radiographic assessments were based on Ekstrand's criteria.¹¹ Diagnodent evaluations followed the manufacturer's recommended protocol. All examinations were performed independently by two calibrated examiners.

Visual Examination

Premolars and molars were visually assessed for occlusal pit and fissure or interproximal caries. Teeth were dried for

three seconds with an air jet and re-examined under a standard halogen dental operating light. Caries status was scored using Ekstrand et al.'s criteria¹¹:

- V0: No or slight change in enamel translucency after prolonged air-drying.
- V1: Opacity or discoloration hardly visible when wet, but clearly visible after air-drying.
- V2: Opacity or discoloration clearly visible without air-drying.
- V3: Localized enamel breakdown in opaque or discolored enamel and/or greyish discoloration from the underlying dentine.
- V4: Cavitation in opaque or discolored enamel, exposing the dentine.

Only teeth scoring V0, V1, or V2 were included in the study. Teeth with V3 or V4 scores were excluded.

Diagnodent Examination

Laser fluorescence evaluation was performed using the Diagnodent Pen (2190 KaVo, Biberach, Germany), equipped with an occlusal tip (Probe A) and an approximal tip (Probe B). The device was calibrated before each use using the manufacturer-supplied ceramic standard. Probe tips were zeroed on a non-carious, unstained area of the tooth before scanning. For occlusal assessment, Probe A was tracked across the entire surface, and the peak reading was recorded. For interproximal lesions, Probe B was placed beneath the contact point and moved along the marginal ridge from the buccal and then the lingual/palatal aspects, with the highest reading recorded. Only premolars and molars that met the inclusion criteria were examined. The presence or absence of caries was determined using the manufacturer's cut-off values (Table 2). Specifically, Diagnodent scores of 0–24 for occlusal surfaces and 0–15 for interproximal surfaces were included in the study. Each score was documented and subjected to statistical analysis.

Table 2: Manufacturer's cut-off points for diagnodent 2190 KaVo Biberach Germany

Display values for fissure caries	Display values for proximal caries	Implication
0–12	0-7	Healthy tooth substance
13–24	8-15	Beginning demineralization
>25	>16	Strong demineralization

Radiographic Examination

Bitewing radiographs were taken using a digital radiographic sensor (Kodak RVG 5200, Carestream Health, Rochester, NY, USA). The radiographs were captured with the exposure parameters set to 70 kVp and 8 mA for 0.20 seconds using a standard X-ray unit. Radiographic interpretation was performed independently

by two calibrated examiners in a darkened room using a diagnostic monitor. Carious lesions were scored using the Ekstrand radiographic criteria.¹¹

The radiographic scores were as follows:

- R0: No radiolucency visible.
- R1: Radiolucency in the outer half of enamel.
- R2: Radiolucency in the inner half of enamel, up to the

dentinoenamel junction (DEJ).

- R3: Radiolucency in the outer half of dentine.
- R4: Radiolucency in the inner half of dentine.
- Only teeth with scores R0 to R2 were included in the study. Those with scores R3 and R4 were excluded, in line with the inclusion criteria.

Calibration of Examiners

Two examiners were calibrated prior to data collection using a set of standardized images and clinical scenarios. Calibration was considered successful when the intra- and inter-examiner kappa scores for detection of carious lesions exceeded 0.80, indicating almost perfect agreement.¹²

Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics such as means, standard deviations, and percentages were used to summarize the data. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated for the Diagnodent and radiographic methods, using visual examination as the reference standard. The level of agreement between the diagnostic methods was determined using Cohen's kappa statistic. A p-value < 0.05 was considered statistically significant.



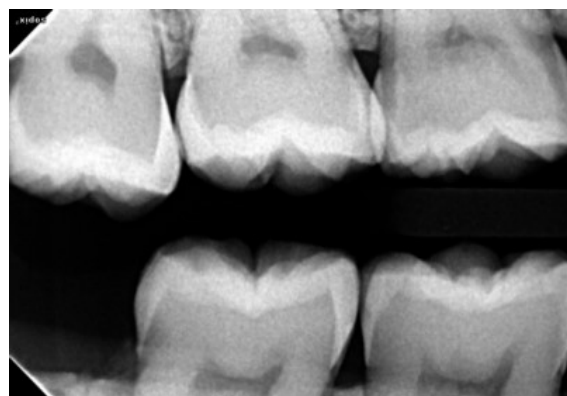
A. Visual examination of the occlusal surfaces of teeth 44,45,46 with air jet in the lower right quadrant of the mouth (Score V0)



B. Pen diagnodent examination of the occlusal surface of tooth 46 in the lower right quadrant of the mouth (score 03)



C. Pen diagnodent examination of the on tooth 18 interproximal surface of tooth 46



D. Bitewing radiograph showing R0

RESULTS

Demographics: A total of thirty-one (31) participants, comprising one hundred and thirty (130) teeth, were

recruited for the study. Table 3 presents the demographic characteristics of the participants, with an overall mean age of 37.29 ± 12.2 years.

Table 3: Socio-demographic characteristics of participants

Variable	Frequency (n=31)	Percentage
Age group (Years)		
≤30	9	2.9
31-40	11	35.5
41-50	5	16.1
>50	6	19.4
Mean(SD)	37.29(12.2)	
Sex		
Male	13	41.9
Female	18	58.1
Educational level		
Primary	1	3.2
Secondary	4	12.9
Tertiary	26	83.9
Ethnic group		
Yoruba	7	22.6
Igbo	10	32.3
Hausa	10	32.3
Others	4	12.9
Socio-economic status		
High	2	6.5
Middle	23	74.2
Low	6	19.4

SD=Standard deviation, Others were two other languages namely, Ijaw and Tiv (2 Ijaw and 2 Tiv)

Detection of occlusal caries

Visual Examination: Of the 130 teeth examined, 33 (25.4%) exhibited opacity or discoloration that was barely visible on a wet surface but became clearly visible after air-drying. Additionally, 23 (17.7%) teeth showed opacity or discoloration that was distinctly visible without the need for air-drying.

Radiographic Examination: Digital bitewing

radiographs of the occlusal surfaces revealed radiolucency within the enamel in 29 (22.3%) teeth, while 18 (13.8%) teeth showed radiolucency extending into the dentine but limited to the outer third.

DIAGNOdent Examination: DIAGNOdent assessment of the occlusal surfaces identified early demineralization in 95 (73.1%) teeth. These lesions were not detected by either the gold standard or radiographic examination. (Table 4)

Table 4: Dental caries assessment of occlusal surface using all methods

Variable	Frequency (n=130)	Percentage (%)
Visual examination		
Score 0 (None or slight change in enamel translucency after prolonged air drying)	74	56.9
Score 1 (Opacity or discoloration hardly visible on the wet surface but distinctly visible after air drying)	33	25.4
Score 2 (Opacity or discoloration distinctly visible without air-drying)	23	17.7
Radiographic		
Score 0 (No radiolucency visible)	83	63.9
Score 1 (Radiolucency visible in the enamel)	29	22.3
Score 2 (Radiolucency visible in the dentine but restricted to the outer third of the dentine)	18	13.8
Diagnodent examination		
Healthy tooth surface	35	26.9
Beginning demineralization	95	73.1
Strong demineralization	0	0.0

Detection of Interproximal Caries

Visual Examination: Visual inspection of the interproximal surfaces revealed opacity or discoloration in 9 teeth (6.9%), which was barely visible on a wet surface but became clearly visible after air-drying. Additionally, 2 teeth (1.5%) exhibited cavitated lesions in areas of opaque or discolored enamel, with dentine exposure.

Radiographic Examination: Bitewing digital

radiographs detected radiolucency confined to the enamel in 4 teeth (3.1%), while radiolucency extending into the dentine—limited to the outer third—was observed in 7 teeth (5.4%).

DIAGNOdent Examination: DIAGNOdent assessment identified early demineralization in 41 teeth (31.5%), which was a higher detection rate than the other two methods. No cases of strong demineralization were recorded. (Table 5)

Table 4: Dental caries assessment of occlusal surface using all methods

Variable	Frequency (n=130)	Percentage (%)
Visual examination		
Score 0 (None or slight change in enamel translucency after prolonged air drying)	119	91.5
Score 1 (Opacity or discoloration hardly visible on the wet surface but distinctly visible after air drying)	9	6.9
Score 2 (Opacity or discoloration distinctly visible without air-drying)	2	1.5
Radiographic examination		
Score 0 (No radiolucency visible)	119	91.5
Score 1 (Radiolucency visible in the enamel)	4	3.1
Score 2 (Radiolucency visible in the dentine but restricted to the outer third of the dentine)	7	5.4
Diagnodent examination		
Healthy tooth surface	89	68.5
Beginning demineralization	41	31.5
Strong demineralization	0	0.0

Diagnostic Accuracy: Examination of Occlusal Surfaces of Premolars

Sensitivity: All three diagnostic methods demonstrated 100% sensitivity.

Specificity: DIAGNOdent recorded the highest specificity, which was significantly greater than those of visual and radiographic examinations ($p < 0.001$).

Diagnostic Accuracy: Examination of Interproximal Surfaces

DIAGNOdent matched the gold standard in specificity (100%), while radiographic examination yielded the lowest specificity (80.5%). DIAGNOdent showed significantly higher specificity than both the gold standard and radiographic methods ($p = 0.041$).

Overall Diagnostic Accuracy (Indicator of the Most Valuable Method)

DIAGNOdent achieved a higher overall diagnostic accuracy on both occlusal (77.3%) and interproximal (100%) surfaces of premolars compared to radiographic

examination, which recorded 36.4% and 81.8% accuracy, respectively (Table 6).

Diagnostic Accuracy: Examination of Occlusal Surfaces of Molars

Specificity: All three methods demonstrated high specificity, with DIAGNOdent achieving the highest value.

Diagnostic Accuracy: Examination of Interproximal Surfaces

On interproximal surfaces, both visual examination and DIAGNOdent demonstrated high sensitivity and specificity. Radiographic examination recorded the lowest diagnostic values, primarily due to lower specificity.

Overall Diagnostic Accuracy (Indicator of the Most Valuable Method):

DIAGNOdent outperformed the other methods with overall diagnostic accuracy values of 82.6% and 99.8% for occlusal and interproximal surfaces of molars, respectively. In contrast, radiographic examination showed lower accuracy rates of 77.9% and 73.3%. These

differences were statistically significant ($p = 0.027$ and $p = 0.010$, respectively) (Table 7).

Summary of Diagnostic Accuracy

For premolars, visual examination generally performed best across both surface types. On occlusal surfaces, DIAGNodent demonstrated high specificity but limited

sensitivity, while radiographic examination exhibited a higher rate of false positives. For interproximal surfaces, both visual examination and DIAGNodent performed perfectly, whereas radiographic examination showed reduced specificity and accuracy due to more false positives.

Table 6: Diagnostic accuracy of the two diagnostic methods in detecting dental caries as compared with the gold standard (Visual) in premolars

	Occlusal surface				Interproximal surface			
	Visual	Diagnodent	Radiographic	p-value	Visual	Diagnodent	Radiographic	p-value
TP, n (%)	6 (13.8)	3 (6.8)	7 (15.9)	NA	3 (6.8)	3 (6.8)	3 (6.8)	NA
TN, n (%)	30 (68.2)	31 (70.5)	9 (20.5)	NA	41 (93.2)	41 (93.2)	33 (75.0)	NA
FP, n (%)	3 (6.8)	2 (4.5)	24 (54.5)	NA	0 (0.0)	0 (0.0)	8 (18.2)	NA
FN, n (%)	5 (11.4)	8 (18.2)	4 (9.1)	NA	0 (0.0)	0 (0.0)	0 (0.0)	NA
Sensitivity,	54.5	27.3	63.6	0.293	100.0	100.0	100.0	1.000
% (95% CI)	(28.0 - 78.7)	(9.8 - 56.6)	(35.3 - 84.8)		(43.8 - 100.0)	(43.8 - 100.0)	(43.8 - 100.0)	
Specificity,	90.9	93.9	27.3	<0.001*	100.0	100.0	80.5	0.041*
% (95% CI)	(76.4 - 96.9)	(80.3 - 98.3)	(15.1 - 44.2)		(91.4 - 100.0)	(91.4 - 100.0)	(66.0 - 89.8)	
PPV,	66.7	60.0	22.6	<0.001*	100.0	100.0	27.3	0.001
% (95% CI)	(35.4 - 88.0)	(23.1 - 88.2)	(11.4 - 39.8)		(43.8 - 100.0)	(43.8 - 100.0)	(9.8 - 56.6)	
NPV,	85.7	79.5	69.2	0.127	100.0	100.0	100.0	1.000
% (95% CI)	(70.6 - 93.7)	(64.5 - 89.2)	(42.3 - 87.3)		(91.4 - 100.0)	(91.4 - 100.0)	(89.6 - 100.0)	
Overall accuracy,	81.8	77.3	36.4	<0.001*	100.0	100.0	81.8	0.043*
% (95% CI)	(68.0 - 90.5)	(63.0 - 87.2)	(23.8 - 51.2)		(92.0 - 100.0)	(92.0 - 100.0)	(68.0 - 90.5)	

CI: Confidence interval, NA: Not applicable; *significant

Table 7: Diagnostic accuracy of two diagnostic methods in detecting dental caries as compared with the gold standard (Visual) in molars

	Occlusal surface				Interproximal surface			
	Visual	Diagnodent	Radiographic	p-value	Visual	Diagnodent	Radiographic	p-value
TP, n (%)	43 (50.0)	36 (41.9%)	45 (52.3%)	NA	7 (8.1%)	7 (8.1%)	7 (8.1%)	NA
TN, n (%)	37 (43.0)	35 (40.7%)	22 (25.6%)	NA	78 (90.7%)	78 (90.7%)	56 (65.1%)	NA
FP, n (%)	4 (4.7)	6 (7.0%)	19 (22.1%)	NA	1 (1.2%)	1 (1.2%)	23 (26.7%)	NA
FN, n (%)	2 (2.3)	9 (10.5%)	0 (0.0)	NA	0 (0.0)	0 (0.0)	0 (0.0)	NA
Sensitivity,	95.6	80.0	100.0	0.285	100.0	100.0	100.0	1.000
% (95% CI)	(85.2 - 98.8)	(66.2 - 89.1)	(92.1 - 100.0)		(64.6 - 100.0)	(64.6 - 100.0)	(64.6 - 100.0)	
Specificity	90.2	95.4	53.7	0.042*	98.7	98.7	70.9	0.036*
% (95% CI)	(77.4 - 96.1)	(71.6 - 93.1)	(38.8 - 68.0)		(93.1 - 99.8)	(93.1 - 99.8)	(60.1 - 79.8)	
PPV	91.5	85.7	70.3	0.103	87.5	87.5	29.1	<0.001*
% (95% CI)	(80.1 - 96.6)	(72.1 - 93.3)	(58.2 - 80.1)		(52.9 - 97.8)	(52.9 - 97.8)	(11.8 - 40.9)	
NPV	94.9	79.5	100.0	0.076	100.0	100.0	100.0	1.000
% (95% CI)	(83.2 - 98.6)	(65.4 - 88.8)	(85.1 - 100.0)		(95.3 - 100.0)	(95.3 - 100.0)	(95.3 - 100.0)	
Overall accuracy,	93.0	82.6	77.9	0.027*	98.8	98.8	73.3	0.010*
% (95% CI)	(85.6 - 96.7)	(73.2 - 89.2)	(68.0 - 85.4)		(93.9 - 99.8)	(93.9 - 99.8)	(63.1 - 81.5)	

Note: CI – Confidence Interval; NA – Not Applicable; *Significant

For occlusal surfaces in molars, visual examination demonstrated the best overall diagnostic performance, offering an excellent balance between sensitivity and specificity. Although the radiographic method achieved perfect sensitivity, it exhibited significantly lower specificity and overall diagnostic accuracy.

For interproximal surfaces, both visual examination and DIAGNodent performed identically, with perfect sensitivity and negative predictive value (NPV), as well as nearly perfect specificity and overall accuracy. Both methods significantly outperformed the radiographic method in terms of specificity, positive predictive value (PPV), and overall diagnostic accuracy.

DISCUSSION

Findings:

While the diagnostic accuracy of traditional methods—such as visual, visuo-tactile, and conventional radiographic techniques—is well established, these methods primarily detect dental caries at an advanced stage, typically after cavitation has occurred. Given the impact of dental caries on quality of life, early diagnosis and treatment are essential to halt the demineralization process, reduce treatment costs, and minimize the complexity of restorative procedures. This underscores the need for a diagnostic tool capable of detecting early-

stage caries without visible cavitation or invasive procedures. One such tool is Diagnodent, a modern device that detects early occlusal and interproximal carious lesions. Hence, the rationale for this study.³

Our core objective was to compare the diagnostic accuracy of Diagnodent. It demonstrated high diagnostic accuracy—reflected by its sensitivity, specificity, and overall accuracy—on the occlusal and interproximal surfaces of molars, but showed relatively low sensitivity on the occlusal surfaces of premolars. The high sensitivity of Diagnodent suggests its effectiveness in detecting caries, particularly at the early stage. This finding aligns with previous studies^{7,15} that demonstrated the device's potential in diagnosing non-cavitated and incipient carious lesions. This can be attributed to its use of laser fluorescence to detect signals from organic components in carious tissue, thereby enabling early detection and preserving tooth structure.¹³ However, since Diagnodent is prone to false positives in the presence of plaque and stains, its use is best complemented with other diagnostic techniques. Therefore, combining Diagnodent with visual and radiographic methods may enhance diagnostic accuracy and reduce the likelihood of overtreatment.⁹

Radiographic examination has long aided clinicians in caries detection. In this study, bitewing radiographs showed high sensitivity and specificity for interproximal surfaces, supporting the well-established utility of radiographs in detecting interproximal caries.⁴ However, radiographs demonstrated low specificity and accuracy in diagnosing early caries on the occlusal surfaces of premolars and molars. Although radiographic assessment remains effective for detecting dentinal caries,¹⁶ its limitations—including poor detection of early lesions, its two-dimensional nature, and anatomical overlap in the oral cavity—have spurred the development of alternative diagnostic technologies.¹⁶ Sole reliance on radiographs for early caries diagnosis may result in missed or delayed detection of lesions, particularly on occlusal surfaces.¹⁷ Therefore, incorporating other methods such as visual inspection and adjunctive technologies like Diagnodent can improve diagnostic accuracy and facilitate earlier caries detection.¹⁸

We also assessed the overall diagnostic performance of all three methods. All showed high diagnostic accuracy, with visual examination achieving the highest, followed by Diagnodent and then digital bitewing radiography, which recorded the lowest overall accuracy.

Implications:

Despite its commendable diagnostic performance, Diagnodent should be used as an adjunct to visual and radiographic examinations due to its tendency to yield

false positives.

Trade-offs (Limitations):

This study employed visual examination as the gold standard. A comparison with histopathological evaluation could have yielded more definitive diagnostic accuracy.

Take-home (Conclusion):

Diagnodent demonstrated greater accuracy than bitewing radiography in detecting early carious lesions on both occlusal and interproximal surfaces of premolars and molars, though visual examination remained the most accurate. While Diagnodent is a reliable adjunct, it should not replace conventional diagnostic methods but rather complement them.

Expectations for Future Research:

Future research should compare Diagnodent and traditional diagnostic methods with the addition of histopathological evaluation to improve diagnostic validation.

Recommendation:

A multi-method diagnostic approach combining Diagnodent with visual and bitewing radiographic examinations is recommended for early and accurate caries detection.

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Conflicts of Interest:

The authors declare no conflicts of interest.

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