



## Influence of Examiner's Clinical Experience in Detecting Occlusal Caries Lesions in Primary Teeth

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### Abstract

**Purpose:** The purpose of this study was to evaluate the effect of examiner's clinical experience in detecting occlusal caries lesions in primary teeth using visual inspection and the diode laser fluorescence (LF) method.

**Methods:** Eighty-seven suspected occlusal sites in 50 exfoliated or extracted primary molars were evaluated via the visual inspection and LF (DIAGNOdent) by 3 last-year dental students, 3 recent graduate dentists, and 3 pediatric dentistry specialists. After the examination, the teeth were cut and evaluated in stereomicroscope. Sensitivity, specificity, and accuracy were calculated, and the values were compared using the McNemar change test at the enamel and dentin caries lesion thresholds. The means of Cohen's kappa values among the different groups of examiners were compared with the ANOVA and Student-Newman-Keuls test.

**Results:** At the enamel caries lesions threshold, there was no difference in accuracy among the different groups of examiners using both the methods. At the dentin caries threshold, however, the students achieved the worst results using visual inspection. Nevertheless, regarding visual inspection, the dental students presented higher sensitivity and lower specificity than the other examiner groups at both thresholds. When using the LF method, there was no significant difference among the parameters, and the interexaminer agreement was higher.

**Conclusions:** Detecting caries lesions with the laser fluorescence device presents lower variation with respect to the examiner's experience. (Pediatr Dent. 2005;27:238-243)

**KEYWORDS:** CARIES DETECTION, VISUAL INSPECTION,  
LASER FLUORESCENCE, OCCLUSAL CARIES, PRIMARY TEETH

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Caries prevalence has decreased in most Western countries. This reduction, however, is more evident in smooth surfaces. Consequently, the proportion of occlusal caries lesions has increased.<sup>1-3</sup> To deal with this fact, caries diagnosis methods have sought early detection and better accuracy to avoid unnecessary operative treatment.<sup>3,4</sup>

Visual inspection has shown high specificity in occlusal caries lesions detection, but has presented low sensitivity and reproducibility.<sup>5-11</sup> Sensitivity is the ability of the diagnostic test to detect a carious tooth when it is truly affected by dental caries. Specificity is the probability that the diagnostic test will be negative among the sound teeth. Accuracy is the number of true diagnoses (true positive diagnoses+true negative ones) divided by the number of examined sites.<sup>12</sup> Furthermore, visual inspection has presented different results varying with the examiner's experience.<sup>13</sup> This variability has also occurred with the radiographic method in detecting occlusal and approximal caries lesions.<sup>14-16</sup>

The diode laser fluorescence (LF) device is a tool that aids detection of caries lesions in occlusal and smooth surfaces. The device emits light of a specific wavelength ( $\lambda=655$  nm) that is absorbed by dental tissue and is partially

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re-emitted as near-infrared fluorescence light. The fluorescence is translated in a numerical scale from 0 to 99, where caries lesions present higher values.<sup>17</sup> The LF performance has been extensively studied.<sup>5-8,11,13,18-26</sup> The method has presented high sensitivity in detecting occlusal caries in permanent teeth, but lower specificity than with visual inspection.<sup>7,8,13,20,23</sup> Conversely, LF has presented greater specificity in primary teeth than permanent teeth.<sup>5,11,18,19,23,26</sup>

The LF method has shown better performance than the visual and tactile method (using an explorer) in detecting occlusal caries lesions in permanent teeth, even when the visual and tactile examinations were performed by dentists with different experience.<sup>13</sup> Nevertheless, in this earlier study, the LF method was employed by one dentist.<sup>13</sup> Therefore, the influence of operator experience with the LF method remains unclear.

Previous studies using operators with different experience to detect caries have used permanent teeth.<sup>13-16</sup> Primary teeth present structural differences,<sup>27</sup> however, and the caries lesions progress faster than in permanent teeth.<sup>28</sup> Moreover, there is an insufficient number of caries detection studies using primary teeth.<sup>9</sup>

The aim of this *in vitro* study was to evaluate the effect of the examiner's clinical experience in detecting occlusal caries lesions in primary teeth using visual inspection and the laser fluorescence method.

## Methods

### Sample preparation

This study's protocol was approved by the Ethics Committee of the Faculty of Dentistry, Metropolitan University of Santos, Santos, Brazil. Fifty primary molars were donated by the Bank of Teeth (Faculty of Dentistry, University of São Paulo, São Paulo, Brazil). Each tooth's occlusal surface was photographed. One or 2 suspected sites were located and dotted on the picture. Next, 87 suspected sites were selected. Inclusion criteria for teeth and sites were:

1. apparent absence of occlusal restorations and fissure sealants;
2. absence of pigmentations and hypoplastic pits;
3. absence of frank occlusal cavitation and large carious lesions on smooth and approximal surfaces.

The teeth were cleaned with a pumice/water slurry, rinsed with tap water, and stored in tap water until the end of the study for no longer than 3 months.

### Examiners

Each method was performed by 9 examiners divided, according to their experience, into 3 groups:

1. last-year dental students;
2. recent graduate dentists with less than 1 year of experience;
3. pediatric dentistry specialists with at least 7 years of experience.

The examiners did not receive any training—only a brief explanation about: (1) the methods; (2) how to perform the visual inspection; and (3) how to use the laser device. The examinations were made independently by each examiner, with the specimens in numerical order: first with the visual inspection and then with the LF device.

### Methods of caries detection

The caries detection methods used in this study were: (1) visual inspection; and (2) the LF method. To perform the visual inspection, teeth were removed from the storage solution and dried with compressed air from a 3-in-1 syringe for 10 seconds. The teeth were examined in a dental unit with operating light illumination, and the operator stayed at a distance of at least 20 cm from the teeth. The examiners were advised to document if the tooth was sound or if it had advanced enamel caries lesions or dentin caries lesions.

The LF method was performed using a DIAGNOdent device (Kavo, Biberach, Germany). Probe tip A (for occlusal surfaces) was used for the LF measurements. The laser device was calibrated against the porcelain reference object before the examination and then recalibrated after every tenth tooth. The laser device was also calibrated on a sound surface of every tooth prior to the examination of the suspected site. This laser fluorescence reading was subtracted electronically from the fluorescence of the occlusal site under examination. For the examination, the drying time was standardized at 3 seconds.<sup>18</sup> The tip was placed on the site and rotated around its vertical axis. The maximum value was then recorded. Two measurements were taken at each occlusal site, and the mean value was calculated.

The presence or absence of carious lesions was determined using the cutoff limits from a previous study in primary teeth<sup>11</sup>: 0 to 4=sound/early enamel; 5 to 12=advanced enamel caries; and >12=dentinal caries.

### Histopathological analysis

After the examinations, buccolingual sections about 300 µm thick were cut perpendicular to the suspected occlusal sites with a water-cooled diamond blade. The teeth slices were polished with silicon carbide paper (400, 600, and 1,000 grits in sequence). Specimens were examined under stereomicroscope with reflected light at ×16 to ×32 magnification. The slices were observed by 2 examiners (FMM and LRDC) in a joint session until they reached a consensus. The lesions were defined by the extension of a whitish demineralized zone or a brown zone in occlusopulpal direction. The lesions were classified in a 5-point scale:

1. D1=caries lesion limited to the outer half of the enamel;
2. D2=caries extending into the inner half of the enamel, but not to the amelodentinal junction;
3. D3=caries limited to the outer half of the dentine;
4. D4=caries involving the inner half of the dentine;
5. D0=no caries.

### Statistical analysis

The sensitivity, specificity, and accuracy were calculated for each method, for sites at the D2 and D3 thresholds. The cutoff points used for the LF method were proposed in a previous report.<sup>11</sup> The McNemar Change test was applied to compare the performance of the different groups of examiners with each method, as well as to compare the different methods of caries detection.

Interexaminer reproducibility in each group was assessed by calculating Cohen's kappa.<sup>29</sup> The means of kappa values (N=3) of different groups of examiners, as well as the values of each method (N=9) were compared using ANOVA and Student-Newman-Keuls test. The level of significance was taken as  $P < .05$  for every statistical test.

### Results

The histopathological examination showed that, in this sample with 87 sites, 41 were sound surfaces or with initial enamel caries lesions (D0, D1), 41 had deep enamel caries lesions (D2), and 5 had caries in dentin (D3, D4).

At the D2 threshold, there was no statistically significant difference among the different examiners regarding accuracy with visual inspection or the LF method. Dental students achieved higher sensitivity (0.74) and recent graduate dentists achieved higher specificity (0.91) using visual inspection at this threshold. With the LF method, specialists obtained higher sensitivity (0.41), and the other groups obtained higher specificity at the enamel caries lesions threshold (Table 1).

At the D3 threshold, the students reached higher sensitivity (0.67) and lower specificity and accuracy (0.76 for both parameters) with the visual method than the other examiners. There was no statistically significant difference in any parameter among the group of examiners with the LF method (Table 1).

Recent graduate dentists presented a similar performance concerning the accuracy of detecting enamel lesions using both methods at the D3 threshold. This group of examiners achieved better sensitivity with the visual inspection and better specificity with the DIAGNOdent at the D2 threshold. Students and specialists presented better specificity and accuracy with the LF method, but only at the dentin caries lesions threshold. Students and specialists alike got better sensitivity with visual inspection, but only the students presented worse specificity with this method at the D2 threshold (Table 1).

When all the examiners were considered altogether (to verify the performance of the method instead of the examiner), visual inspection at the enamel caries lesions threshold showed better sensitivity and lower specificity than the LF method. At the D3 threshold, LF presented a statistically significantly higher specificity and accuracy than the visual inspection method (Table 2).

Regarding reproducibility, the operators showed statistically significant differences only when using visual inspection, while the recent graduate dentists presented greater agreement among the groups. Students and specialists presented better interexaminer reproducibility with the LF method than with the visual one. Conversely, the recent graduate dentists presented similar reproducibility with both methods. Concerning the methods (ie, all the examiners for each method), LF achieved significantly higher reproducibility than the visual inspection (Table 3).

### Discussion

The present study's goal was to evaluate:

1. 2 different methods of occlusal caries lesions detection;
2. if the operator's experience influences the performance of these methods.

Table 1. Performance of Caries Detection Methods With Different Operator Groups\*

Operators†	D2 threshold								
	Sensitivity			Specificity			Accuracy		
	Visual	LF‡	§	Visual	LF	§	Visual	LF	§
DS	0.74 <sup>a</sup>	0.35 <sup>a</sup>	§	0.58 <sup>a</sup>	0.97 <sup>a</sup>	§	0.66 <sup>a</sup>	0.64 <sup>a</sup>	NS
RGD	0.46 <sup>b</sup>	0.29 <sup>a</sup>	§	0.91 <sup>b</sup>	0.98 <sup>a</sup>	§	0.67 <sup>a</sup>	0.62 <sup>a</sup>	NS
SP	0.53 <sup>b</sup>	0.40 <sup>b</sup>	§	0.81 <sup>c</sup>	0.89 <sup>b</sup>	NS	0.66 <sup>a</sup>	0.63 <sup>a</sup>	NS
Operators	D3 threshold								
	Sensitivity			Specificity			Accuracy		
	Visual	LF‡	§	Visual	LF	§	Visual	LF	§
DS	0.67 <sup>a</sup>	0.33 <sup>a</sup>	NS	0.76 <sup>a</sup>	1.00 <sup>a</sup>	§	0.76 <sup>a</sup>	0.96 <sup>a</sup>	§
RGD	0.13 <sup>b</sup>	0.33 <sup>a</sup>	NS	0.99 <sup>b</sup>	1.00 <sup>a</sup>	NS	0.94 <sup>b</sup>	0.96 <sup>a</sup>	NS
SP	0.13 <sup>b</sup>	0.33 <sup>a</sup>	NS	0.96 <sup>c</sup>	0.99 <sup>a</sup>	§	0.91 <sup>b</sup>	0.95 <sup>a</sup>	§

NS=non-significant difference between methods ( $P > .05$ ).

\*Performance is measured in sensitivity, specificity, and accuracy in detecting occlusal caries lesions affecting enamel or dentine. D2=enamel caries lesions threshold; D3=dentin caries lesions threshold. Different letters express statistically significant difference within the same column ( $P < .05$ ).

†DS=dental student; RGD=recent graduate dentist; SP=pediatric dentistry specialist.

‡LF=laser fluorescence method.

§Statistically significant difference between both methods ( $P < .05$ ).

**Table 2. Overall Performance of Different Caries Detection Methods\***

Method	Sensitivity		Specificity		Accuracy	
	D2	D3	D2	D3	D2	D3
Visual	0.58 <sup>a</sup>	0.31 <sup>a</sup>	0.76 <sup>a</sup>	0.91 <sup>a</sup>	0.66 <sup>a</sup>	0.87 <sup>a</sup>
LF	0.35 <sup>b</sup>	0.33 <sup>a</sup>	0.95 <sup>b</sup>	1.00 <sup>b</sup>	0.63 <sup>a</sup>	0.96 <sup>b</sup>

\*Performance is measured in sensitivity, specificity, and accuracy in diagnosing occlusal caries lesions affecting enamel or dentine, regardless of the operator's experience. D2=enamel caries lesions threshold; D3=dentin caries lesions threshold. Different letters express statistically significant difference among values within the same column ( $P<.05$ ). No. of examiners=9 (3 dental students, 3 recent graduate dentists, and 3 pediatric dentistry specialists).

Few studies have evaluated the effect of the examiner's experience, and the majority of these studies used permanent teeth.<sup>13-16</sup>

Other authors have observed that the visual and tactile methods present different results according to the examiner's experience.<sup>13</sup> In this previous report, where the less experienced dentists were those with less than 5 years of experience, and the more experienced dentists were those with more than 5 years, there was no statistically significant difference in the results obtained by either group of examiners. Moreover, the LF device presented better performance than the other methods.<sup>13</sup>

In this study, when analyzing the visual inspection results, the authors found that there was a similarity among the different groups of dentists regarding the accuracy at the D2 threshold. On the other hand, recent graduate dentists and specialists presented better accuracy than the dental students at the dentin caries lesions threshold. Dental students showed higher sensitivity, while recent graduate dentists presented higher specificity with both the D2 and D3 caries lesions.

In earlier studies, dental students or less experienced dentists also displayed higher sensitivity in detecting occlusal caries lesions in permanent teeth using radiographic<sup>16</sup> or visual and tactile methods.<sup>13</sup> These results also occurred when comparing dental students with dentists in exams detecting approximal caries lesions in permanent teeth using bitewing radiographs.<sup>15</sup>

More experienced dentists usually have higher specificity.<sup>15,16</sup> Dental students have shown higher specificity than dental hygiene students in detecting proximal caries lesions with radiographic examination.<sup>14</sup> This fact was also observed in this study, and it is probably affected by the best clinical discernment from the more experienced dentists in the caries lesions approach. Dental students, however, are more inclined to classify any pigmentation or morphological alteration as caries lesions. Thus, pigmentation could be confounded with enamel caries lesions and morphological alterations as dentin caries lesions.

Concerning the LF method, in both caries lesions thresholds (D2 and D3), the different examiners performed no differently. Only at the D2 threshold did the specialists present higher sensitivity and lower specificity than the

other examiner groups. Other authors have asserted that the use of a caries detector device, such as LF, could minimize differences among examiners with different experiences in detecting caries lesions.<sup>13</sup> The present study's results confirm this assertion.

Other studies have shown that the LF device presents higher values of interexaminer reproducibility.<sup>5-8,11,17,20,21,26</sup> This finding could explain the similar performance among the different groups in the present study. The DIAGNOdent method showed better reproducibility and better homogeneity among all examiners than the visual inspection method.

In a previous study using visual and tactile methods, the authors did not observe differences related to the dentists' experience.<sup>13</sup> In contrast, in another research using bitewing radiographic examination, there was a greater agreement between the dentists than between the students.<sup>16</sup> In the present study, visual inspection yielded lower interexaminer reproducibility, mainly among the specialists and the students. This lower reproducibility with visual inspection found in this study is consistent with previous reports.<sup>6,8,11,20-22,26</sup>

When considering the methods' performances, the LF device presented better accuracy than visual inspection at the D3 threshold. This fact has been observed by other authors in permanent<sup>8,13,20,22</sup> and deciduous teeth.<sup>5,6,11</sup> At this threshold (D3), caries lesions detection with LF achieved better specificity and similar sensitivity than with visual inspection. Nevertheless, other studies have shown different results (higher sensitivity and lower specificity with the LF).<sup>5,8,20-22</sup>

When considering the methods' performances, the LF device presented better accuracy than visual inspection at the D3 threshold. This fact has been observed by other authors in permanent<sup>8,13,20,22</sup> and deciduous teeth.<sup>5,6,11</sup> At this threshold (D3), caries lesions detection with LF achieved better specificity and similar sensitivity than with visual inspection. Nevertheless, other studies have shown different results (higher sensitivity and lower specificity with the LF).<sup>5,8,20-22</sup>

**Table 3. Mean±SD of Kappa Values Obtained for Interexaminer Reproducibility of Diagnostic Methods\***

Operators†	Visual	LF‡
DS	0.21±0.11 <sup>aA</sup>	0.69±0.06 <sup>aB</sup>
RGD	0.42±0.16 <sup>bA</sup>	0.61±0.01 <sup>aA</sup>
SP	0.25±0.04 <sup>aA</sup>	0.50±0.09 <sup>aB</sup>
All operators	0.29±0.14 <sup>A</sup>	0.60±0.10 <sup>B</sup>

\*Operators are grouped according to their experience. Statistics were computed based on 3 pairwise Cohen's kappa coefficient, contrasting the results from the different methods for detection of occlusal caries lesions. Uppercase letters express statistically significant difference among values within the same row ( $P<.05$ ). Lowercase letters express statistically significant difference among values within the same column ( $P<.05$ ).

†DS=dental student; RGD=recent graduate dentist; SP=pediatric dentistry specialist.

‡LF=laser fluorescence method.



The high specificity values obtained in the present study could be explained by the low prevalence of caries lesions involving dentin in the sample. Furthermore, teeth with pigmentation were excluded, because they could act as a confounding factor. Stained fissures have presented higher LF readings, and, consequently, an increase of false-positive diagnosis.<sup>23</sup> Thus, a sample lacking teeth with pigmentation tends to present higher specificity.

In caries lesions involving enamel (D2 threshold), the examiners using visual inspection got better sensitivity and worse specificity than with LF method, similar to results of earlier studies in primary teeth.<sup>6,26</sup> Some authors have asserted that the DIAGNOdent device would be useful in early detection of caries lesions.<sup>7,17,30</sup> This assertion disagrees with the present study's results. In fact, research studies have shown that LF values did not correlate with mineral loss<sup>31</sup> and that LF didn't effectively detect in vitro remineralization<sup>25</sup> in smooth surface caries lesions.

Despite the best performance with the LF device, examiners achieved good results with visual inspection. This performance could be improved with previous training and the use of a visual caries index.<sup>32</sup> Furthermore, visual inspection has presented good specificity and is faster than the LF method.<sup>10, 17</sup> Thus, visual inspection must be the method of choice in daily clinical practice, and the LF method can be used as a valuable ancillary to the visual method.<sup>5,7,11,17,20,22</sup>

## Conclusions

The diode laser fluorescence method is less affected by the examiner's experience in detecting occlusal caries lesions in primary teeth. Visual inspection has achieved good results, however, proving it a worthy method for use on a daily basis.

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## ABSTRACT OF THE SCIENTIFIC LITERATURE



### PULP-DENTINE CHANGES AND ROOT RESORPTION IN PATIENTS PRESCRIBED NABUMETONE

Pulpitis, external root resorption, and pain may be experienced during orthodontic movement. The use of nonsteroidal anti-inflammatory drugs (NSAIDs) has been suggested to control these changes. The purpose of this study was to observe: (1) pulp-dentinal reactions; (2) root resorption; (3) tooth pain; and (4) tooth movement after the application of a 4-ounce intrusive orthodontic force to human maxillary first premolars in patients given the NSAID nabumetone. Thirty-four maxillary first premolars were evaluated. A placebo was prescribed to 17 patients after an intrusive force was activated and reactivated for an 8-week period on the right side. The same procedure was repeated on the left side after patients were given nabumetone. Pulp-dentinal reactions and external root resorption were evaluated by histology. Pain and movement were also evaluated. Nabumetone was found to be useful in reducing pulpitis, external root resorption, and pain caused by intrusive orthodontic movement without altering tooth movement in response to the application of orthodontic force.

**Comments:** Some authors have suggested that the use of NSAIDs during orthodontic treatment does not influence the amount of tooth movement, while others indicated that the tooth movement rate is slower when NSAIDs are used. This study concluded that the use of nabumetone does not block orthodontic movements. There was a decrease of only 0.13 mm per month. The use of nabumetone was useful in reducing pulpitis, external root resorption, and pain caused by intrusive orthodontic movement. **FSS**

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