

Radiographic and Laser Fluorescence Methods Have No Benefits for Detecting Caries in Primary Teeth

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Key Words

Dental caries · International Caries Detection and Assessment System · Laser fluorescence method · Radiograph · Visual inspection

Abstract

Clinical guidelines advise that dentists take radiographs in children to detect caries lesions missed by visual inspection; however, due to the current low caries prevalence in most countries, we hypothesized that the adjunct methods of caries detection would not significantly improve the detection of primary molar lesions in comparison to visual inspection alone. We evaluated the performance of visual inspection, alone or in combination with radiographic and laser fluorescence pen (LFpen) methods, in detecting occlusal and approximal caries lesions in primary molars. Two examiners evaluated children who had sought dental treatment with these diagnostic strategies. The reference standard involved the temporary separation of approximal and operative interventions for occlusal surfaces. The sensitivity, specificity, accuracy and utility of diagnostic strategies were calculated. Simultaneous combined strategies increased sensitivities but decreased specificities. Furthermore, no differences were observed in accuracy and utility, parameters more in-

fluenced by caries prevalence. In conclusion, adjunct radiographic and laser fluorescence methods offer no benefits to the detection of caries in primary teeth in comparison to visual inspection alone; hence, present clinical guidelines should be re-evaluated.

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Many clinical guidelines used throughout the world recommend that dentists take 2 bitewing radiographs in children to detect caries lesions in primary molars [Espelid et al., 2003; AAPD, 2008; Cordeiro and Abreu-e-Lima, 2009]. This recommendation derives from the fact that dentists who perform clinical examinations can often overlook caries lesions, primarily on occlusal and approximal surfaces [Bader et al., 2002; Braga et al., 2010].

The radiographic method does increase the sensitivity of visual inspection [Bader et al., 2002; Novaes et al., 2009, 2010; Matos et al., 2011]; however, this method is technique-sensitive and exposes patients to ionizing radiation [Wenzel, 2004]. Fluorescence-based methods have been proposed as a possible alternative [Lussi et al., 2004], wherein a recent pen-type laser fluorescence device (LFpen) has been demonstrated to achieve a performance comparable to that of the radiographic method in

the detection of approximal [Braga et al., 2009; Novaes et al., 2009, 2010] and occlusal [Neuhaus et al., 2010; Matos et al., 2011] caries lesions in primary molars.

Considering the current low caries prevalence in several countries [Cleaton-Jones et al., 2006], the actual necessity of caries detection methods should be evaluated. Most studies that have investigated caries detection methods have not considered disease prevalence in the interpretation of their findings. The increase in sensitivity that is provided by additional inspection methods consequently decreases specificity; hence, the number of errors tends to be higher in populations with low caries prevalence [Baelum, 2010]. It was recently observed that there was no benefit in additional radiographic examination when compared to a clinical examination only for the detection of approximal caries lesions in permanent teeth [Baelum et al., 2012]. However, with regard to primary teeth which present significant anatomical and compositional differences compared to permanent ones [Mortimer, 1970; Shellis, 1984], this issue has not yet been investigated.

Thus, our working hypothesis is that adjunct methods do not provide additional benefits in comparison to visual inspection alone in the detection of caries lesions in primary molars. To test this premise, we investigated the performance of visual inspection and the additional radiographic and LFpen methods, on their own and combined, in detecting occlusal and approximal caries lesions in primary molars using a random sample of children undergoing dental treatment.

Materials and Methods

Ethics Approval and Subject Selection

The study was approved by the local committee for ethics in research. Written informed consent was obtained from all the parents. The participants were randomly selected from a pool of enrolment forms of children (4–12 years old) who had sought dental treatment at our school. The researchers were unaware of the children's oral conditions.

The subjects were allocated to the occlusal or approximal studies. Previous manuscripts using these samples have been published; however, since we did not consider the caries prevalence in those analyses, this research contains secondary analysis of the data obtained in the earlier studies [Novaes et al., 2009, 2010; Matos et al., 2011].

Examination Methods

The performance of the methods was only investigated for the detection of non-evident caries lesions indicated for operative treatment at both approximal and occlusal surfaces. At approximal surfaces, we can define non-evident caries lesion as a surface

with an intact marginal ridge but with a non-obvious cavitated lesion. On the other hand, an evident caries lesion would be a surface with a broken marginal ridge and/or with the cavitation extending to the buccal or lingual surfaces. At occlusal surfaces, non-evident caries lesions would be caries lesions reaching the dentine but with the surface without evidence of a cavity or a cavity that is visually limited to the enamel. Evident caries lesions would be defined as surfaces with cavities visually reaching the dentine.

For both occlusal and approximal studies, two trained examiners (T.F.N. and R.M.) separately performed the evaluations using visual inspection, radiographic and LFpen methods. The examinations were conducted in a dental chair under illumination, after the teeth had been cleaned with a rotating bristle brush and a pumice/water slurry. Visual inspection was performed with a plane buccal mirror and ball-point probe, using the International Caries Detection and Assessment System (ICDAS) [Ismail et al., 2007]. Teeth were examined wet and were then dried with a 3-in-1 syringe.

For the radiographic examination, 2 bitewings were taken using Kodak Insight radiographic films (22 × 35 mm, Eastman Kodak, Rochester, N.Y., USA) and an X-ray machine (Spectro ×70, Dabi Atlante, Ribeirão Preto, Brazil), which was operated at 70 kV and 8 mA, with an exposure time of 0.3 s. The examiner evaluated the captured images on a backlit screen using different criteria.

For approximal surfaces, the criteria were [Ekstrand et al., 1997]:

0. No radiolucency visible
1. Radiolucency visible in enamel
2. Radiolucency visible in dentine, but restricted to the outer 1/3 of dentine
3. Radiolucency extending to the middle 1/3 of dentine
4. Radiolucency in the inner 1/3 of dentine.

For occlusal surfaces, the criteria were [Rodrigues et al., 2008]:

0. No radiolucency visible
1. Radiolucency visible in enamel
2. Radiolucency visible in dentine, but restricted to the outer half of dentine
3. Radiolucency extending to the inner half of dentine.

For the LFpen method, a DIAGNOdent pen (Kavo, Biberach, Germany) was used according to the manufacturer's instructions. Tip 1 was used for approximal surfaces, whereas tip 2 was used for occlusal surfaces. Teeth were dried for 5 s with a 3-in-1 syringe.

Approximal Surfaces Study

For this study, 132 children were invited to participate; however, only 126 (53 males and 73 females) completed the study (a positive response rate of 95.5%). The mean age of the included children was 7.4 years old [standard deviation (SD) 1.6 years]. Two children were sick during the study period, three did not attend the recall sessions and another was excluded due to the use of a fixed orthodontic appliance.

Primary molars with large carious lesions, frank approximal cavitations (absence of a marginal ridge), restorations and instances of an absent contact point were excluded from this study. Therefore, non-evident sound surfaces or approximal caries lesions were included, totaling 1,213 surfaces.

The reference standard for approximal surfaces involved temporary separation using orthodontic rubber rings placed around

the contact points for 7 days. Two examiners evaluated each surface for the presence of cavities. More details concerning the approximal surfaces study have been described previously [Novaes et al., 2009, 2010]. Since cavitated caries lesions at approximal surfaces should usually be treated operatively, we considered these lesions as the threshold for the analysis.

The cut-off point for visual inspection was an ICDAS score of ≥ 3 , and visible radiolucency in dentine with the radiographic method. LFpen values higher than 16 were used as a cut-off point to indicate the presence of caries lesions [Novaes et al., 2009].

Occlusal Surfaces Study

For the occlusal surfaces study, 70 children were invited; however, two subjects refused (a positive response rate of 97.1%), resulting in the inclusion of 30 male and 38 female participants with a mean age (SD) of 7.3 (1.6) years. The exclusion criteria for the occlusal surfaces included the presence of restorations, frank occlusal cavitation or large caries lesions on other surfaces. One suspect site in each primary molar was chosen, comprising 407 occlusal surfaces.

As the reference standard, the presence of dentine caries lesions was checked after operative treatment. Teeth classified with an ICDAS score of ≥ 3 and/or with a radiographic image of caries lesion reaching the dentine were submitted for operative intervention. Two examiners assessed the cavity with a probe to distinguish carious from sound dentine, according to the colour and hardness of the tooth. Other teeth were considered to be sound. We chose dentine lesions as the threshold to indicate operative treatment because of the fast progression of caries lesions reaching the dentine [Poorterman et al., 2003]. The cut-off point for visual inspection was an ICDAS score of 3, visible radiolucency in dentine for the radiographic method and readings higher than 34 for the LFpen method. More details about this part of the study have been reported previously [Matos et al., 2011].

Statistical Analysis

For the analyses, approximal surfaces were dichotomized into sound and cavitated, whereas occlusal surfaces were dichotomized into sound and dentine caries lesions. The diagnostic performances of the investigated methods were analyzed alone and in combination using 2 different strategies: simultaneous and sequential testing.

The simultaneous approach classifies the surface as decayed if 1 positive result was obtained in at least 1 test. This combination increases the net sensitivity but decreases the net specificity. On the other hand, sequential testing only considers the teeth to be decayed if positive results are obtained by both visual inspection and the adjunct method. This strategy increases the net specificity but decreases the net sensitivity [Gordis, 2009].

The performance of the methods was first evaluated in terms of sensitivity and specificity. However, these parameters are not extensively influenced by the disease prevalence in the studied population [Guyatt et al., 2006]. To consider the prevalence, we calculated the accuracy and utility. Accuracy is defined as the average of sensitivity and specificity values weighted by the prevalence [Alberg et al., 2004]. Sensitivity, specificity and accuracy 95% confidence intervals (CI) were calculated using an approach appropriate for clustered samples [Rao and Scott, 1992]. Diagnostic strategies were compared using the McNemar test.

The utility considers different weights for the various distinct possible results that could be obtained [Mileman and van den Hout, 2009]. Two researchers (F.M.M. and M.M.B.) conferred regarding the weights for each possible result on several aspects of the different surfaces, such as the possibility of arresting the lesion with non-operative treatment, problems in missing a caries lesion and the longevity, efficacy and cost of the restoration. For approximal surfaces, the assigned weights for the results were: true negative (TN) = 100, true positive (TP) = 80, false negative (FN) = 40 and false positive (FP) = 10. For occlusal surfaces, the values were TN = 100, TP = 80, FN = 55 and FP = 15.

The accuracies and utilities of some of the diagnostic strategies were plotted in order to extrapolate the results for populations with different hypothetical caries prevalence values. We also calculated parameters for non-testing and always-treating. The former considers all surfaces as sound, whereas the latter classifies them as decayed [Mileman and van den Hout, 2009]. We performed this extrapolation considering that sensitivity and specificity do not significantly change in populations with different prevalence of the disease [Guyatt et al., 2006; Gordis, 2009].

Next, subgroup analyses were done in groups of children with a higher prevalence of non-evident caries lesions. To identify these groups, multilevel analyses were performed and the odds ratio (OR) and associated 95% CI were calculated. Several independent variables were tested, relating to the surface (mesial or distal, for approximal surfaces), tooth type (e.g. first or second molars, upper or lower) and children (e.g. dmf-s + DMF-S, age, gender). Firstly, univariate analysis was performed to exclude variables with a p value < 0.20 . Explanatory variables were then selected for the final models only if they had a p value < 0.05 after adjustment for other variables. These variables were considered as having higher prevalence in the further analysis. After the identification of these groups, the same diagnostic parameters were calculated again.

The software used for multilevel analysis was MLWin 12.10 (Centre for Multilevel Modeling, Bristol, UK). For other analyses, we used MedCalc 12.1.3.0 (MedCalc, Mariakerke, Belgium). The level of significance for all analyses was fixed at 5%.

Results

Our sample comprised 1,162 sound or non-cavitated approximal caries lesions (95.8%) and 51 cavitated lesions with an intact marginal ridge (4.2%). For occlusal surfaces, 386 surfaces were sound or with enamel caries lesions (94.8%) and 21 surfaces presented dentine caries lesions (5.2%).

In all the analyses, both examiners had a similar performance and the same trends were observed. For approximal surfaces, we observed that the radiographic and LFpen methods, alone or combined simultaneously with visual inspection, presented significantly higher sensitivities than visual inspection alone. Nevertheless, these strategies presented lower specificities. Regarding the accuracies and utilities, however, no significant differences were observed between using adjunct methods and vi-

Table 1. The performance of diagnostic strategies to detect non-evident cavitated approximal caries lesions in primary molars

Diagnostic strategies	Sensitivity	Specificity	Accuracy	Utility
Examiner 1				
Visual inspection	0.255 (0.122–0.388)	0.998 (0.996–1.000)	0.967 (0.953–0.981)	98
Radiograph	0.588 (0.481–0.695)*	0.982 (0.973–0.991)*	0.965 (0.954–0.977)	97
LFpen	0.569 (0.446–0.691)*	0.975 (0.963–0.987)*	0.958 (0.945–0.971)	96
Visual + radiograph (simultaneous)	0.686 (0.577–0.796)*	0.981 (0.972–0.990)*	0.967 (0.958–0.979)	97
Visual + radiograph (sequential)	0.157 (0.050–0.264)	0.999 (0.997–1.000)	0.964 (0.949–0.978)	98
Visual + LFpen (simultaneous)	0.647 (0.532–0.762)*	0.973 (0.961–0.985)*	0.960 (0.946–0.973)	96
Visual + LFpen (sequential)	0.176 (0.065–0.288)	1.000 (1.000–1.000)	0.965 (0.951–0.980)	98
Examiner 2				
Visual inspection	0.235 (0.107–0.364)	0.996 (0.992–0.999)	0.964 (0.950–0.978)	98
Radiograph	0.569 (0.454–0.683)*	0.985 (0.976–0.993)*	0.967 (0.954–0.980)	97
LFpen	0.471 (0.324–0.617)*	0.974 (0.963–0.986)*	0.953 (0.939–0.967)	96
Visual + radiograph (simultaneous)	0.647 (0.522–0.772)*	0.981 (0.972–0.990)*	0.967 (0.955–0.979)	97
Visual + radiograph (sequential)	0.157 (0.050–0.263)	0.999 (0.997–1.000)	0.964 (0.950–0.978)	98
Visual + LFpen (simultaneous)	0.549 (0.418–0.680)*	0.970 (0.958–0.982)*	0.952 (0.938–0.966)	96
Visual + LFpen (sequential)	0.157 (0.039–0.274)	1.000 (1.000–1.000)	0.965 (0.950–0.979)	98

Total number of surfaces = 1,213, prevalence = 0.042, non-test utility = 97 and treatment utility = 13. Figures in parentheses are 95% CIs. * Statistically significant difference compared to the visual inspection only.

sual inspection only. The sequential strategies did not exhibit differences (table 1).

Concerning the occlusal study, no differences among the strategies were observed in terms of sensitivity; however, LFpen used alone and both the simultaneous testing approaches exhibited lower specificities and accuracies compared to the visual inspection. The utility values of the visual inspection and the sequential strategies were higher than those of the other strategies (table 2).

The multiple multilevel analyses demonstrated that the groups with a higher prevalence of non-evident approximal caries lesions included the distal surfaces of the first primary molars (OR 2.46; 95% CI 1.31–4.61), children who were older than 8 years of age (OR 6.04; 95% CI 1.62–22.60) and children with a dmfs plus DMF-S of greater than 3 (OR 5.83; 95% CI 2.20–15.47). For occlusal surfaces, the groups included second primary molars (OR 12.86; 95% CI = 2.80–59.08) and children with a dmfs plus DMF-S greater than 3 (OR 7.76; 95% CI 2.28–26.42).

The performance of each diagnostic strategy by both examiners was separately calculated for each subgroup, wherein the same trends that had been observed with the entire sample were also observed in most of the analyses. The exception involved the subgroup of children who had a high experience of caries on occlusal surfaces ($n = 118$, caries prevalence = 12.7%). For both examiners, a unique difference was obtained for the strategy that combined the

radiographic method with the visual inspection in the context of sequential testing (utility = 96) in comparison to the visual inspection only (utility = 93). This superiority derived from the lower performance of the visual inspection (sensitivity = 0.80 and specificity = 0.95) obtained in this subgroup compared to that of all samples (table 2).

We only plotted the graphics based on the results of the first examiner, since they performed similarly. We observed that the simultaneous testing strategies for detecting approximal cavitated caries lesions offers enhanced diagnostic accuracy when the disease prevalence is >10% (fig. 1a), but only an enhanced utility when the disease prevalence is >25% (fig. 1b). On occlusal surfaces, the advantages of simultaneous testing in terms of accuracy were only observed in populations with a prevalence of non-evident dentine caries lesions of >30% (fig. 2a), whereas the advantages in terms of utility were observed in populations with a prevalence of >80% (fig. 2b).

Discussion

Although the adjunct radiographic and LFpen methods increase the sensitivity of visual inspection performed alone in detecting approximal and occlusal caries lesions in primary teeth [Bader et al., 2002; Braga et al., 2009; Novaes et al., 2009, 2010; Neuhaus et al., 2010; Matos et al.,

Table 2. The performance of diagnostic strategies to detect non-evident occlusal caries lesions reaching the dentine in primary molars

Diagnostic strategies	Sensitivity	Specificity	Accuracy	Utility
Examiner 1				
Visual inspection	0.857 (0.675–1.000)	0.984 (0.970–0.999)	0.978 (0.958–0.997)	98
Radiograph	0.762 (0.579–0.944)	0.966 (0.944–0.989)	0.956 (0.933–0.978)	96
LFpen	0.952 (0.864–1.000)	0.883 (0.839–0.927)*	0.887 (0.846–0.928)*	89
Visual + radiograph (simultaneous)	1.000 (1.000–1.000)	0.953 (0.927–0.980)*	0.956 (0.931–0.980)*	95
Visual + radiograph (sequential)	0.619 (0.415–0.823)	0.997 (0.992–1.000)	0.978 (0.963–0.993)	98
Visual + LFpen (simultaneous)	1.000 (1.000–1.000)	0.878 (0.833–0.923)*	0.885 (0.842–0.927)*	89
Visual + LFpen (sequential)	0.810 (0.624–0.996)	0.990 (0.980–1.000)	0.980 (0.964–0.996)	98
Examiner 2				
Visual inspection	0.857 (0.675–1.000)	0.984 (0.970–0.999)	0.978 (0.958–0.997)	98
Radiograph	0.762 (0.579–0.944)	0.961 (0.936–0.986)	0.951 (0.923–0.978)	96
LFpen	1.000 (1.000–1.000)	0.860 (0.815–0.905)*	0.867 (0.826–0.909)*	88
Visual + radiograph (simultaneous)	1.000 (1.000–1.000)	0.948 (0.919–0.977)*	0.951 (0.924–0.978)*	95
Visual + radiograph (sequential)	0.619 (0.416–0.822)	0.997 (0.992–1.000)	0.978 (0.963–0.993)	98
Visual + LFpen (simultaneous)	1.000 (1.000–1.000)	0.855 (0.809–0.900)*	0.862 (0.820–0.905)*	87
Visual + LFpen (sequential)	0.857 (0.676–1.000)	0.990 (0.980–1.000)	0.983 (0.969–0.997)	98

Total number of surfaces = 407, prevalence = 0.052, non-test utility = 98 and treatment utility = 18. Figures in parentheses are 95% CIs. * Statistically significant difference compared to visual inspection performed alone.

2011], the analyses used in most studies have not considered the prevalence of these lesions. In low prevalence populations, the number of additional TP results achieved using adjunct caries detection methods tends to be lower than the number of FP results due to lower specificity [Baelum, 2010]; however, this hypothesis has yet to be empirically confirmed for primary teeth. This investigation is the first study to have demonstrated that adjunct methods do not actually offer any benefits in detecting approximal and occlusal caries lesions in primary molars in comparison to only the visual inspection being performed.

These findings were obtained when the examiners employed methods to detect caries lesions indicated for operative treatment. We did not present the results when the methods were used to detect non-cavitated caries lesions. This option was because the radiographic and laser fluorescence methods have not shown good performance in detecting initial caries lesions in both occlusal and approximal surfaces [Wenzel, 2004; Braga et al., 2008; Novaes et al., 2009, 2010; Braga et al., 2010; Matos et al., 2011], and the visual inspection has been the best method to detect initial caries lesions [Braga et al., 2010].

We tested the adjunct methods in association with visual inspection using the sequential and simultaneous strategies to detect non-evident cavitated or dentine caries lesions. Earlier in vitro studies have already tested associated methods [Souza-Zaroni et al., 2006; Rodrigues

et al., 2008; Pereira et al., 2009; Neuhaus et al., 2010]; however, these prior laboratorial studies are limited because they fail to consider the actual prevalence of caries lesions. Combining diagnostic methods makes sense when researchers select an appropriate spectrum of patients that does not appreciably affect the disease prevalence in the target population [Guyatt et al., 2006].

Many studies that have failed to consider caries prevalence in their analyses [Souza-Zaroni et al., 2006; Rodrigues et al., 2008; Novaes et al., 2009; Neuhaus et al., 2010] and clinical guidelines [Espelid et al., 2003; AAPD, 2008; Cordeiro and Abreu-e-Lima, 2009] have advocated the benefits of adjunct methods used simultaneously with visual inspection due to the increase in the net sensitivity in the caries detection process. Nevertheless, these authors have not realized that this procedure provokes a significant increase in FP results [Baelum, 2010]. The strength of our study was testing the methods in a random sample of children who had presented for dental treatment, and that the examiners had no previous knowledge of each subject's oral conditions. This procedure avoided a selection bias and considered the actual caries prevalence, and our findings can be extrapolated to the dental office setting.

In fact, we found that the prevalence of non-evident approximal (4.2%) and occlusal caries lesions (5.2%) was low. If we had included evident caries lesions, the preva-

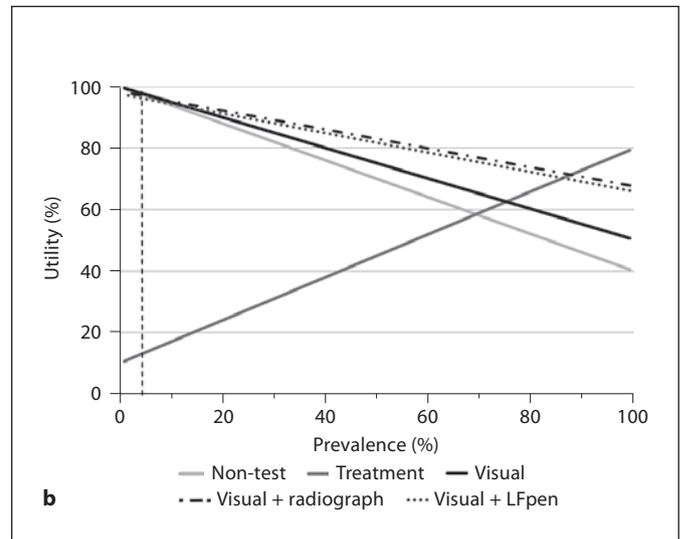
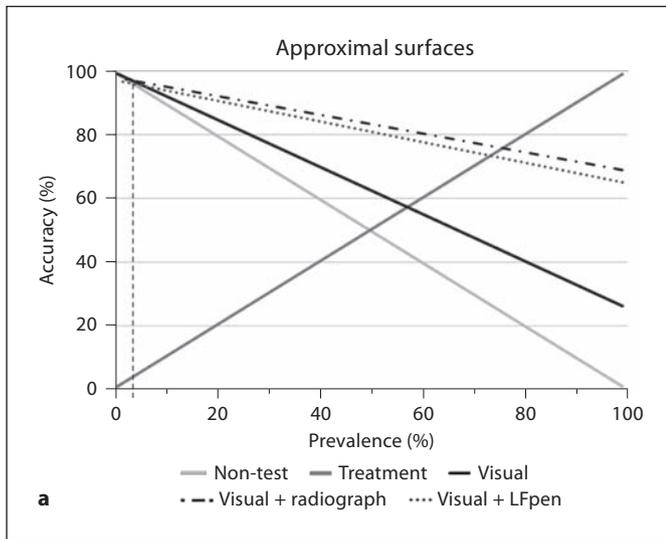


Fig. 1. The accuracy (a) and utility (b) of visual inspection alone and combined with the radiographic and LFpen using the simultaneous strategy in the detection of approximal cavitated caries lesions considering different prevalence values. The dotted vertical line represents the prevalence of caries lesions in our sample.

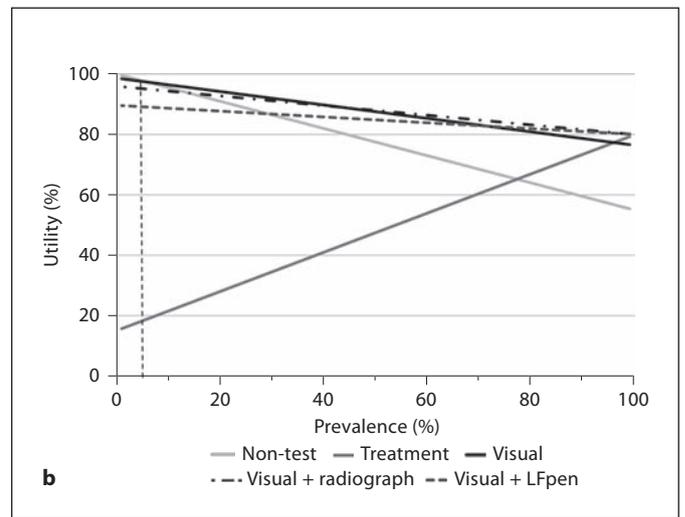
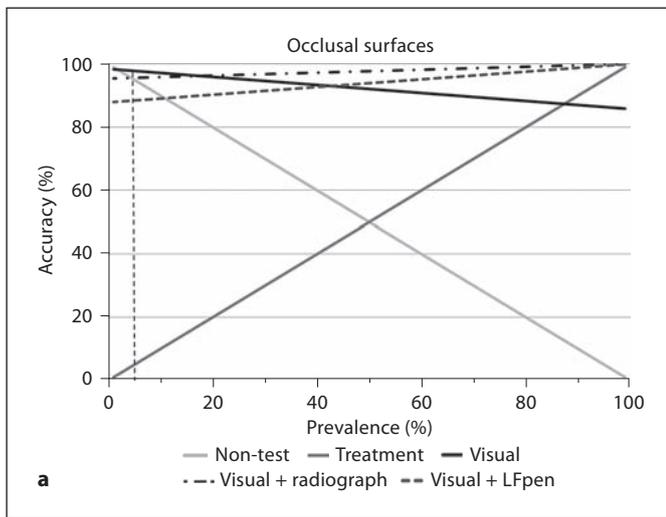


Fig. 2. The accuracy (a) and utility (b) of visual inspection alone and combined with the radiographic and LFpen using the simultaneous strategy in the detection of occlusal caries lesions reaching the dentine considering different prevalence values. The dotted vertical line represents the prevalence of caries lesions in our sample.

lence would be higher. Nevertheless, detecting frank approximal (with a broken marginal ridge) or occlusal lesions is definitely not a challenge, justifying our inclusion criteria. Adjunct methods would be indicated to aid the clinician in detecting hidden (non-apparent) caries lesions. Nevertheless, in primary teeth, these methods were not useful. It is most likely that the low prevalence of non-

evident caries lesions in primary teeth is due to a faster progression of caries [Shellis, 1984] and a thinner enamel [Mortimer, 1970] in comparison to permanent teeth. Consequently, we speculate that a higher prevalence of non-evident caries lesions in permanent teeth would be expected, and the combined strategies could perform better in this type of teeth. Nevertheless, a recent study

observed that the radiographic method combined with a visual inspection did not present advantages in comparison to the clinical examination performed alone in the detection of approximal caries lesions in permanent teeth [Baelum et al., 2011].

The sequential combination of visual and radiographic methods in detecting occlusal lesions, contrary to the recommendation of clinical guidelines which advise a simultaneous strategy, presented superiority only among children with higher caries experience. Lower performance of the visual inspection in this subgroup was probably caused by confirmation bias [Elstein and Schwartz, 2002] due to the examiner potentially overestimating the diagnosis because of the worse oral conditions of the children in this group. Nevertheless, subgroup analyses should be interpreted with caution [Guyatt et al., 2006], and additional studies should directly address this possibility.

At occlusal surfaces, the reference standard (operative treatment) was applied only in teeth classified as carious when visual and radiographic methods were used simultaneously. Therefore, an incorporation bias was introduced. However, this probable overestimation of the performance of this strategy was not higher than the performance of visual inspection performed alone, and so, in consequence, this possible bias did not change our findings.

Another limitation of our study is that the values used to weight the different possible results were not empirically calculated. These values were attributed considering that an FP is the worst result because it leads to unnecessary operative treatment. On the other hand, some missed lesions (FN results) could be arrested by controlling the etiological factors of caries. Considering the attributed weights, the utilities associated with combining caries detection methods were similar or lower than those obtained via visual inspection only. Other authors may, nevertheless, prefer to attribute different weights to calculate the utilities. Despite this limitation, the accuracy of combined strategies, which weights equally FP and FN results, also exhibited no benefits.

Another point must be interpreted with caution. The methods were carried out by two trained examiners in ideal clinical conditions. This fact could have overestimated the performance of the methods. Therefore, the results should be replicated in other populations and by other examiners in pragmatic studies, in order for our findings to be confirmed.

Visual inspection is an easy technique and is routinely performed in clinical practice [Braga et al., 2010]. Furthermore, this method permits the evaluation of two im-

portant aspects so as to reach a correct treatment decision, namely activity status and surface integrity [Baelum, 2010]. Therefore, a judicious visual inspection using a validated scoring system [Ismail et al., 2007; Braga et al., 2010] offers the best benefits in detecting caries lesions in primary molars; hence, it should be the method of choice in daily clinical practice.

In conclusion, notwithstanding the increase of sensitivity, the LFPen and radiographic methods do not offer any benefits to the detection of non-evident occlusal and approximal caries lesions in primary molars. Radiographs could be indicated, although not specifically to detect missed caries lesions, but, instead, to check the proximity of the carious tissue to the pulp or to evaluate the periapical tissue [Braga et al., 2010]. Therefore, the clinical guidelines on prescribing dental radiographs in children [Espelid et al., 2003; AAPD, 2008; Cordeiro and Abreu-e-Lima, 2009] should be re-evaluated.

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Disclosure Statement

The authors have no commercial interests in the products mentioned in this paper. The authors certify that they have no affiliation with or financial involvement in any organization or entity with a direct financial or personal interest in the subject matter or materials discussed in the paper.

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