

# Knowledge of the Methods Used by Dentists for Diagnosis and Treatment of Caries Lesions: A Pilot Study

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## ABSTRACT

**Objective:** To investigate the methods used by dentists for diagnosis and treatment of dental caries lesions.

**Material and Methods:** This cross-sectional study was developed by sending a validated questionnaire to dentists in the southeastern region of Brazil with questions about detection methods and the indicated procedures for treating lesions. **Results:** Three hundred and ninety-eight responses were identified after distributing the questionnaire. The state with the highest percentage of respondents was Espírito Santo (n=140). The respondents' mean time since dental school graduation was 12.9 years ( $\pm 11.4$ ). Regarding the diagnosis, 39.4% of the dentists used the explorer probe to detect occlusal lesions, 79.6% performed drying with an air jet, 65.8% of dentists performed biofilm removal and follow-up for active initial occlusal lesions, and 60.3% applied fluorides. For active caries lesions reaching the enamel dentinal junction, the dentists performed selective caries removal followed by restoration for both occlusal lesions (79.6%) and proximal lesions (78.1%). **Conclusion:** Visual-tactile and radiographic examinations were the detection methods of most dentists. A conservative approach was identified more frequently for initial, non-cavitated lesions and an operative approach for dentine tissue lesions. Conservative, non-invasive treatment still seems challenging for professionals when lesions reach the dentine tissue.

**Keywords:** Dental Caries; Dentists; Diagnostic Techniques and Procedures.

## ■ Introduction

Dental caries has been described as a local imbalance, a dysbiosis dependent on the biofilm-diet binomial interaction [1]. Although epidemiological surveys have shown a decline in the prevalence and severity of dental caries, it is still the most prevalent chronic disease of the oral cavity [2,3]. The risk factors for dental caries can be biological, socioeconomic, demographic, and behavioral. Among the biological characteristics, the previous history of caries seems to be the parameter with the highest predictive value; indeed, the presence of caries in the deciduous dentition strongly correlates with the development of lesions in the future [4,5]. In addition, the influence of social inequalities in oral health has been described as one factor contributing to high levels of the disease, especially in less economically well-off social groups [6,7].

Based on updated knowledge about cariology, the early detection of clinical signs of the disease has been recommended so that the disease can be controlled through a minimally invasive approach [8-10]. In addition, for correct clinical decision-making, up-to-date knowledge about the development of the disease, the methods available to detect it early, and the tools and procedures available for its control and treatment are essential [3]. The minimally invasive approach consists of maximum preservation of dental structure via substituting a mechanistic treatment model for a health-promotion approach in which minimally invasive alternatives prevent the dental element from entering a repetitive restorative cycle [11]. The restorative clinical procedure has become part of a set of measures aimed at promoting oral health, which may or may not be used in the treatment of the disease, depending on the stage of the structure impairment [10]. Thus, the objective of this study was to investigate the methods dentists in the southeastern region of Brazil chose for the detection of carious lesions and to analyze their clinical decision-making regarding the prevention and control mechanisms and therapeutic approaches used in their patients and considering the different stages of activity and severity of carious lesions.

## ■ Material and Methods

### Study Design and Ethical Clearance

This cross-sectional study was submitted and approved by the local research and local ethics committee (Nº 5.073.465). The study was conducted with a sample of dentists from the southeastern region of Brazil registered in each region's dental council. In total, 177.547 dentists were registered with the dental councils of the southeast region of Brazil.

### Data Collection

This study was developed through the application of a translated adaptation of the validated questionnaire "Assessment of Caries Diagnosis and Caries Treatment" from the "Dental Practice-Based Research Network" (Research Network Based on Dental Practice) [12]. This questionnaire contained items related to caries diagnosis, methods of detecting lesions, and clinical conduct based on the different stages of activity and severity of caries lesions. Participants chose among percentage and semantic differentials, marking the answer closest to their attitude, conduct, or opinion. The questionnaire was disseminated in a Google Form together with the invitation to participate in the study, the free-and-informed consent form, and the questions in the questionnaire. This form was then e-mailed to the dental councils in the southeastern region of Brazil (Rio de Janeiro, São Paulo, Minas Gerais, and Espírito Santo). After receiving the link, the councils made the form available in their weekly electronic bulletins, which were sent to each council's subscribers.

### Data Analysis

The data were stored in a database and categorized and evaluated using the software Statistical Package for the Social Sciences, Version 21.0 (IBM Corp., Chicago, USA). The answers to the questions in the applied questionnaire were categorized for descriptive presentation in tables with the frequencies and percentages of the answers. The associations of answers about the clinical diagnostic methods used, the most critical variables for dental treatment, and time since graduation were investigated using the chi-square test. The significance level considered was 95%.

## ■ Results

We identified 398 responses after distributing the questionnaire by e-mail between December 2021 and November 2022. The study participants' records identified dental surgeons who graduated between 1965 and 2022. The state with the highest percentage of respondents was Espírito Santo (n=140), followed by Rio de Janeiro (n=127). The average time since dental school graduation for the participants in the study sample was 12.9 years ( $\pm 11.4$ ), with 241 dentists (60.6%) having graduated fewer than 12 years prior.

The results showed that 39.4% of dentists used the explorer probe to detect occlusal lesions, and 79.6% performed drying with air jets during the clinical visual examination (in 100% of their patients). The participants reported that they used radiographs in all their patients to diagnose carious lesions on the occlusal (18.1%) and proximal (34.7%) surfaces (Table 1). The majority of respondents (52%) affirmed that they did not evaluate caries risks in their patients. However, most of them (82.7%) agreed that caries risk assessment is a predictor of developing a future lesion.

The variables most important for a patient's treatment plan, in descending order of importance and listed with a percentage of respondents agreeing on each item's importance, were the following: standard of oral hygiene (98.0%), patient commitment (97.7%), the activity of caries (97.5%), use of orthodontic appliance (96.7%), knowledge about the progression of caries (96.5%), presence of extensive restorations (96.2%), change in salivary function (96.0%), recent caries (94.7%), diet (94.5%), patient's age (93.2%), access to fluoride compounds (91.7%), patient's subjective assessment (91.5%), patient's economic situation (91.0%), and parents and family members' experience with caries (77.1%).

Regarding preventing and controlling carious lesions, 25.6% of dentists used topical application of fluoride in the office as a fluoride gel, fluoride varnish, or fluoride mouthwash for all patients. Most dentists used occlusal sealants in permanent teeth for fewer than 50% of patients (Table 2). For the associations between the use of an explorer probe, application of sealants in permanent teeth, application of topical fluoride in the office, and time since dental school graduation, a statistically significant difference ( $p < 0.05$ ) was observed for the group of dentists with fewer than 12 years since graduation. The use of radiographs as an additional diagnostic method for lesions on the occlusal and proximal surfaces showed no difference when associated with time since graduation ( $p > 0.05$ ) (Table 3).

Regarding the therapeutic approach for inactive white spot lesions on the occlusal surface, 51.8% of the dentists responded that they did not perform any treatment on their patients. The primary methods to manage initial active occlusal lesions were biofilm removal and follow-up (65.8% of the dentists) and application of fluorides (60.3% of the dentists). In active caries lesions reaching the enamel-dentinal junction, the professionals performed selective caries removal followed by restoration for both occlusal lesions (79.6% of their patients) and proximal lesions (78.1% of their patients). Please note that the participants could choose multiple treatment options in these questions (Table 4).

**Table 1. Frequency of answers concerning questions about the diagnosis of dental caries lesions.**

When you examine patients to determine if they have:	Answers					
	0%	1 to 24%	25 to 49%	50 to 74%	75 to 99%	100.0%
For a caries lesion, in what percentage of these patients do you use magnification to help diagnose the lesion?	64.3	13.3	3.8	4.3	3.5	10.8
For a primary occlusal carious lesion, what percentage of these patients do you use an explorer to help diagnose the lesion?	20.7	12.8	5.3	9.0	12.8	39.4
For a carious lesion at the margin of an existing restoration (secondary caries), what percentage of these patients do you use an explorer to help diagnose the lesion?	10.3	11.3	8.3	12.1	14.8	43.2
For a primary carious lesion, what percentage of these patients do you use air-drying to help diagnose the lesion?	0.2	2.3	1.8	4.3	11.8	79.6
For a primary carious lesion on the occlusal surface, what percent of these patients do you use laser fluorescence?	89.2	6.4	1.5	1.3	0.8	0.8
For a carious lesion on an anterior tooth's proximal (mesial or distal) surface, what percentage of these patients do you use fiber optic transillumination?	82.8	7.3	4.0	3.3	1.3	1.3
For a carious lesion on the occlusal surface, in what percent of these patients do you use radiographs to help diagnose the lesion?	7.5	18.1	18.1	23.6	14.6	18.1
For a proximal (mesial or distal) surface caries lesion, what percent of these patients do you use radiographs to help diagnose the lesion?	0.3	5.5	10.0	23.4	26.1	34.7

**Table 2. Frequency of answers in relation to questions about preventive measures and control of dental caries.**

Questions	Answers					
	0%	1 to 24%	25 to 49%	50 to 74%	75 to 99%	100.0%
Do you apply dental sealants on the occlusal surface of at least one of their permanent teeth?	21.6	36.2	19.1	15.3	5.8	2.0
Do you apply an in-office fluoride application, such as fluoride gel, fluoride varnish, or fluoride rinse?	4.8	14.8	11.6	19.1	24.1	25.6
Recommend non-prescription fluoridated rinse?	4.3	25.9	12.6	11.6	4.3	2.8
Recommend sugarless chewing gum or xylitol chewing gum?	71.8	16.3	4.5	2.0	2.3	3.0

**Table 3. Association between variables related to diagnosis and control of injuries and graduation time.**

Questions		Graduate Time		p-value*
		< 12 Years	≥ 12 Years	
		N (%)	N (%)	
Sharp Probe	Never	37 (15.4)	44 (28.4)	0.007**
	Sometimes	102 (42.3)	57 (36.8)	
	Always	102 (42.3)	54 (34.8)	
Sealant	Never	47 (19.5)	39 (25.1)	0.03**
	Sometimes	192 (79.7)	110 (71.0)	
	Always	2 (0.8)	6 (3.9)	
Fluoride	Never	6 (2.5)	13 (8.4)	0.02**
	Sometimes	170 (70.5)	106 (68.4)	
	Always	65 (27.0)	36 (23.2)	
Radiography	Never	13 (5.4)	17 (11.0)	0.10
Occlusal	Sometimes	186 (77.2)	109 (70.3)	
Lesions diagnosis	Always	42 (17.4)	29 (18.7)	
Radiography	Never	1 (0.4)	0 (0.0)	0.43
Proximal	Sometimes	162 (67.2)	97 (62.6)	
Lesions diagnosis	Always	78 (32.4)	58 (37.4)	

\*Qui-square test; \*\*Statistically Significant.

**Table 4. Frequency of answers regarding treatment procedures at different stages of dental caries lesions.**

Management	Answers (%)							
	No Treatment	Biofilm Control	Topical Fluoride	Fluoride Mouthwash	Fluid Sealant/ Resin Application	Selective Removal/Restore	Restoration Polishing/Repair	Replacement of Restoration
Inactive non-Cavitated Occlusal Lesion	51.8	71.4	45.7	19.6	20.4	3.5	6.3	1.5
Inactive non-Cavitated Proximal Lesion	49.7	74.1	46.7	23.9	6.0	3.0	6.8	1.5
Active non-Cavitated Occlusal Lesion	12.1	65.8	60.3	31.7	36.4	25.4	5.8	2.3
Active non-Cavitated Proximal Lesion	12.1	68.6	61.3	35.2	17.1	31.9	6.5	4.3
Active Cavitated Occlusal Lesion (Enamel-Dentin Junction)	2.0	45.7	27.4	17.1	17.8	79.6	5.3	12.3
Active Cavitated Proximal Lesion (Enamel-Dentin Junction)	2.3	47.0	27.4	20.1	12.6	78.1	7.0	14.8
Active Cavitated Occlusal Lesion; Affected Dentin	0.8	42.2	25.4	17.8	7.0	85.2	5.5	16.6
Secondary Caries; Affected Dentin	1.0	39.2	22.4	16.3	4.0	45.2	13.1	66.8
Secondary Caries; No Affected Dentin	1.3	37.9	22.4	17.1	6.8	39.4	37.4	38.4

## ■ Discussion

The results of the present study showed that the diagnostic method most used by dentists for clinical diagnosis was the association of drying the dental surfaces and the use of an exploratory probe. This result was similar to that in the study by Tagliaferro et al. [13], in which 92% of professionals reported using air drying as a diagnostic method, and 64% used the explorer probe to identify caries lesions on the occlusal surface. According to the literature, drying with an air jet is essential for viewing carious lesions, especially in their initial stages [14]. The visual-tactile inspection should always be performed with clean teeth and under good lighting [15]. However, studies showed that probing surfaces to detect caries lesions have low sensitivity because the retention of the probe in a certain region depends on other factors besides the presence of caries, such as the morphological characteristic of the point probed or the pressure exerted during the probe [16]. In addition, the probing performed with a sharp explorer probe can damage the surface integrity of the partially demineralized enamel, which may be considered an iatrogenic procedure, converting an incipient lesion susceptible to remineralization in a cavity with a chance of progressive destruction [17-19]. The use of a ball-point probe to diagnose caries should be restricted to the careful removal of biofilm and residues that may be deposited on the tooth surface, especially in the fissures, before the visual examination [20]. Surprisingly, dentists who had been dentists for fewer than 12 years since dental school graduation reported using the Explorer probe more frequently on their patients than dentists who used it for longer periods since graduation. However, it is important to note that the item in the questionnaire did not specify whether the probe was a sharp or ball-point probe.

Auxiliary diagnostic methods, such as laser fluorescence and transillumination, have been used in fewer than 20% of patients. Although these additional means of diagnosis constitute simple, comfortable, and non-invasive methods for the patient, they have some limitations: the impossibility of diagnosing secondary caries surrounding the restorations and greater applicability for the detection of proximal lesions [21,22]. On the other hand, if these methods are used to detect occlusal lesions, they will not damage the tooth structure, as can happen with the negligent use of a sharp explorer probe [23]. Regarding radiographs, respondent dentists used them more frequently for diagnosing proximal caries than for diagnosing occlusal lesions. This more significant number of radiographs used to help diagnose proximal lesions was due to greater difficulty visualizing the affected area [24]. The American Academy of Pediatric Dentistry suggests that intraoral radiographs should be taken in all situations in which tooth surfaces cannot be visualized, regardless of the signs and symptoms present [25]. Moreover, the current recommendation from the European Academy of Pediatric Dentistry suggests that x-ray-free methods (transillumination and tooth separation) should be used in cases where interproximal lesions have been detected during clinical examination (cavitated or non-cavitated). In addition, the authors pointed out that the risk and caries activity must be evaluated regularly and must be considered in the indication of initial and monitoring radiographic examinations [26].

Additional methods can be used as auxiliary means for diagnosing a carious lesion. However, the visual-tactile clinical examination associated with a radiographic examination is still the most common method for this purpose [8]. In addition, although auxiliary diagnostic methods can increase the sensitivity of the clinical examination, the usefulness of these methods has been questioned. The detection of early lesions may lead to an overdiagnosis, causing unnecessary interventions. These early lesions may progress slowly or may not progress at all, so they may receive treatment later or require no treatment. Visual inspection is the only method that allows the diagnostic evaluation of caries lesions. It also makes it possible to estimate the depth of the lesion and the presence of cavitation and assess the potential and retention of biofilm in addition to the activity of dental caries [27].

When investigating the practices for preventing and controlling dental caries, we observed that dentists used fluoride compounds for professional topical application more frequently than they applied sealants or mouthwashes containing fluoride. Fluoride is considered effective and safe in the prevention and control of dental caries, and research has shown that fluoride acts by reducing the speed of progression of already established lesions. The mechanism of action of compounds or products containing fluoride consists of forming calcium fluoride ( $\text{CaF}_2$ ) reservoirs on the tooth surface, which exert an anticaries effect when dissolved in the saliva/biofilm interface. The formation of  $\text{CaF}_2$  is directly proportional to the concentration of fluoride in these products [28].

Currently, the sealing of pits and fissures is indicated preventively in patients who are considered at high risk of caries and for control and stoppage of initial caries lesions [29]. The sealing of caries lesions aims to considerably reduce the viable bacterial flora as well as the metabolic activity of the bacteria present, preventing the progression of the lesion if the sealing remains without signs of infiltration. Thus, existing lesions tend to become inactive, even though bacteria remain under the sealant [30]. It is important to note that some professionals still need to be convinced to adopt this technique due to uncertainty about its effectiveness or concern about the persistence of microorganisms under the sealant. This reluctance leads those professionals to adopt invasive techniques for the removal of caries lesions, even if they are incipient. However, the literature indicates that pit and fissure sealants applied to initial caries lesions are effective in stopping carious lesions as long as marginal integrity is preserved and control exams are performed [31].

In the present study, most participants did not assess the patient's caries risk but considered this assessment important as a predictor of new lesions. Caries risk assessment is essential to understanding the patient's cariogenic profile and to guide the treatment plan, which must be carried out individually and consider the factors that may increase the susceptibility of each patient in developing the disease resulting from exposure to specific risk factors or the absence of protective factors [4]. Among the risk factors dentists considered most important in the preparation of the treatment plan, the four most common were the standard of oral hygiene, the patient's commitment to caries activity, the presence of orthodontic appliances, and the presence of extensive restorations. Different factors have been investigated as possible risks for the incidence of new carious lesions [32,33]. A scoping review published in March 2021 identified risk factors related to the development of caries. Although there were different predictive factors, the literature indicated that socioeconomic status, lack of access to dental treatment, and eating habits were the most prevalent conditions at the onset of the disease [34]. In the present study, diet was not considered the most important variable for most professionals; rather, past caries experience and, more specifically, lesion activity (current experience) were identified as important predictors of the disease. There is evidence that these factors correspond to the main criteria used by professionals to determine caries risk. If patients have high caries activity, with multiple active lesions, their caries risk is also high [35]. Although caries risk assessment and past caries experience were not cited as the main factors for planning dental treatment, 42.2% of respondent dentists agreed that the assessment of caries risk can predict whether the patient will have a greater chance of developing new lesions in the future. In this sense, caries' risk should be assessed in order to design the treatment plan while considering each patient's needs.

Regarding the approach to initial occlusal or proximal inactive lesions, the participants chose to control the biofilm, apply topical fluoride in the office, and seal the lesions. The literature shows that inactive enamel lesions, regardless of the surface on which they are located, do not require any intervention, only patient monitoring [36]. Concerning the treatment of active white spots of caries on the occlusal surface, most respondents chose non-invasive (control of dental biofilm, application of fluoride compounds) or minimally

invasive (application of sealants) approaches. However, many dentists reported adopting a more invasive and operative approach, contrary to scientific evidence that initial active enamel lesions can be treated using non-invasive and micro-invasive methods such as sealants and infiltrates [36,37]. Therefore, the treatment of non-cavitated active occlusal lesions may involve, among other non-invasive approaches, the topical application of fluorides to prevent the progression of the lesion and promote its remineralization as well as the sealing of pits and fissures to function as a physical barrier. Proximal carious lesions should not be treated invasively if there is no cavitation and can be completely paralyzed if the biofilm is disorganized regularly and eating habits are modified. In summary, the literature recommends that active carious lesions require a therapeutic approach but not always an operative treatment, except when there is a need to restore the integrity of the tooth structure; injuries considered chronic or paralyzed should be periodically monitored by the professional but do not require additional treatment [10].

In the clinical setting for cavitated caries lesions in the occlusal area reaching the dentinal-enamel junction, most professionals indicated selective removal of carious tissue followed by restoration, both for lesions on the occlusal and proximal surfaces. Although the participants also reported the indication of dental biofilm removal and topical application of fluorides, this result suggests that dentists acted in an invasive way when there was cavitation, even if the lesion was restricted to the enamel-dentin junction. However, there is evidence in the literature that supports a conservative approach, such as the application of resin sealants, for cavitated lesions on occlusal surfaces that reach the outer half of the dentin with an extension diameter of up to 3 mm in deciduous and permanent teeth, without painful symptoms [36].

Regarding active caries lesions located on the occlusal surface, reaching half of the dentin, most dentists reported performing operative treatment, such as selective removal followed by restoration, following what has been described in the literature. In active lesions in dentin involving more than one surface or whose occlusal surface has an opening greater than 3 mm, invasive techniques through restorations are recommended. The selective removal of carious tissue and the technique of atraumatic restorative treatment and out. It is noteworthy that selective removal is recommended in all medium and deep lesions before restorations made with adhesive materials. The Hall technique is also considered a restorative treatment option mainly for deciduous teeth with two or more surfaces impacted by the caries lesion [38].

The most common choice for clinically managing secondary active carious lesions was selective removal and total restoration replacement, even if the lesion did not compromise the dentine. Many dentists have concerns about the best conduct in these cases. Still, it is essential to note that not every restoration should be completely replaced because the repair is often sufficient to increase the longevity of the restoration [9,39].




Health measures, oral hygiene instruction, and dietary guidance are recommended for active caries patients regardless of the carious lesion's type and location. Restorative treatment maintains the integrity of the tooth surface, but when performed in isolation, it does not control the disease, does not promote health, and fails quite often [40].

## ■ Conclusion

The results suggest that visual-tactile and radiographic examinations are still the methods of choice for most dentists to detect caries lesions. Regarding the clinical practices for disease prevention and control, a conservative approach was taken more frequently for initial, non-cavitated lesions and an operative approach for lesions involving the dentine tissue, regardless of their stage of progression. Thus, choosing conservative, non-invasive treatment still seems challenging for professionals when lesions reach the dentine tissue.



## ■ Authors' Contributions

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MRRC		<a href="https://orcid.org/0000-0003-1628-029X">https://orcid.org/0000-0003-1628-029X</a>	Formal Analysis, Writing - Original Draft and Writing - Review and Editing.
MRTCA		<a href="https://orcid.org/0000-0003-2165-7784">https://orcid.org/0000-0003-2165-7784</a>	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft and Writing - Review and Editing.

All authors declare that they contributed to a critical review of intellectual content and approval of the final version to be published.

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None.

## ■ Conflict of Interest

The authors declare no conflicts of interest.

## ■ Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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