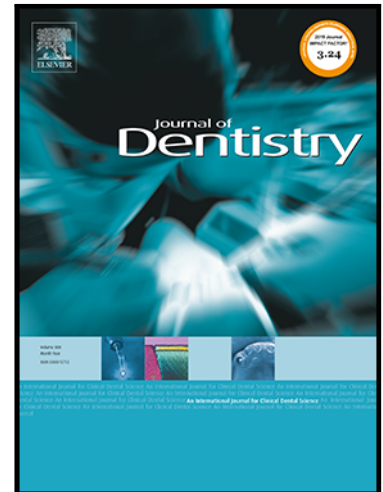


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PII: S0300-5712(24)00040-X
DOI: <https://doi.org/10.1016/j.jdent.2024.104870>
Reference: JJOD 104870



To appear in: *Journal of Dentistry*

Received date: 1 January 2024
Revised date: 27 January 2024
Accepted date: 29 January 2024

Please cite this article as: Richard Johannes Wierichs , Isabelle Kaspari , Sabrina Maniewicz , Guglielmo Campus , Christian Tennert , Thiago Saads Carvalho , Samira Helena Niemeyer , Diagnosing and recording root caries: a survey among Swiss dentists, *Journal of Dentistry* (2024), doi: <https://doi.org/10.1016/j.jdent.2024.104870>

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Diagnosing and recording root caries: a survey among Swiss dentists

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Short title: A survey on diagnosing and recording root caries

Keywords: root caries, questionnaire, management, Diagnosis, education, non-invasive treatment

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ABSTRACT

Objectives: Despite the increase in the root caries prevalence, little is still known about how dentists manage this condition. The present study aimed to evaluate the knowledge of dentists on diagnosing and recording root caries lesions (RCL).

Methods: The survey consisted of three domains: (1) dentists' knowledge on diagnosing, recording and managing RCL; (2) information about their current general clinical routines; and (3) their demographics.. The four Swiss Universities distributed the survey via e-mail lists for

alumni or professionals participating in continuing education. The data was quality checked. Construct validity, internal reliability and intraclass correlation (ICC) were assessed.

Results:The survey was answered by 383 dentists from 25(out of 26) cantons [mean(SD) working experience: 22.5(12) years]. The majority replied that they see less than 5 patients with RCL per week, whereas 41 have at least 5 per week, and 40% (157 dentists) do not distinguish RCL from coronal caries in their patients' medical records. When diagnosing active RCL, tactile sensation was the most predominant criterion (n=380), whereas color (n=224) and visual appearance (n=129) of the lesion were less often selected. The most often chosen risk factors for RCL were poor oral hygiene and presence of biofilm. The responses were significantly influenced by the participants' place of education, their age and working area.

Conclusion:The present survey highlights the huge diversity in diagnosing, recording and assessing risk factors of RCL. The benefits of an appropriate diagnosis, recording and management of risk factors of RCL should be highlighted in under- and postgraduate dental education.

Clinical Significance: A great diversity in diagnosing, recording and assessing risk factors of RXL was observed, which might strongly impact how dentists manage RCL. The study emphasizes the necessity for intensive efforts to bridge the gap between guideline recommendations and their implementation in private dental practices.

INTRODUCTION

Life expectancy has gradually increased in the recent decades, and this has been accompanied by an increase in health vulnerabilities in the elderly population, including the risk for developing root caries lesions (RCL). The problem with RCL is further accentuated with the decrease in motor skills of the aging population, leading to difficulties in performing proper oral hygiene [1, 2], and, in turn, causing more oral health problems [3] such as higher indices

of gingival recession and root exposure. Consequently, there is a growing concern about RCL [4-6] in the daily dental practice.

This concern has been further scrutinized by the European Federation of Conservative Dentistry (EFCD) and American Dental Association (ADA), who showed that there are discrepancies in how dentists manage RCL [4-7]. RCL relies on the exposure of root areas, mostly due to gingival recession from either aging, inflammation or trauma (e.g., following incorrect toothbrushing). It typically develops above the gingival line. At early stages, gingival recession corresponds to the area around (or very close to) the cemento-enamel junction (CEJ) [8, 9], which might be one reason why the CEJ is often indicated as the primary localization for RCL [10]. However, RCL can manifest at various locations on the root surfaces, mostly in places where dental plaque accumulates. So, it predominantly occurs on the proximal (mesial and distal) surfaces, followed by the facial/buccal surfaces. RCL tend to start out as wide, spread-out, and shallow lesions, following the path along the gingival line and the surface of the tooth's root. As the condition progresses, more advanced RCL tend to deepen, and expand toward the inner pulp of the tooth [8].

For diagnosing RCL visual, tactile, radiographic, and location criteria have been considered appropriate [9, 11, 12]. In recent years, numerous indices have been developed to visually and tactually identify different lesions stages. However, there is uncertainty regarding the use of these indices in private clinics. Even during the validation process of the present questionnaire, a significant variability in the chosen visual and tactile criteria for distinguishing between active and inactive RCL was observed, despite the fact that all participants were affiliated with university clinics [10].

In this regard, a questionnaire to evaluate how dentists diagnose, record and manage root caries lesions, in its original (English) and its translated (French, German and Italian) versions was developed and validated recently [10]. The present paper reports the results of dentists from Switzerland, specifically their knowledge on diagnosing and how they record root caries in their practices.

MATERIALS & METHODS

Survey

The survey was made using a standardized and recently validated questionnaire [10]. The questionnaire contained closed-ended questions, with a combination of multiple-choice and checkbox questions, as well as Likert scales. It is structured in three parts: 1) Questions on the dentists' general clinical routine (e.g. what kind of patients are treated in their practice, including information on their diagnostic methods and documentation of findings); 2) Questions on the dentists' knowledge/practices, specifically regarding two clinical cases containing clinical pictures, x-rays and other necessary information about the patient (e.g. the dentists' views on diagnosis, recording and management of root caries is evaluated); 3) Questions on the dentists' demographics (e.g. year and place of graduation, specialization/area of practice, location of work, etc).

The target population of the survey were dentists actively working in national health systems and in private or public clinics, including general and specialist dentists. The survey was distributed via e-mail lists for alumni from all four Swiss dental universities, to dentists undergoing continuing education at these universities, as well as by the newsletter of the Swiss Dental Association (SSO). Thus, up to 4.000 dentists in Switzerland were informed about the survey [13]. All responses were anonymous. No reminders were sent.

Ethical aspects

The participation of the dentists was voluntary. They were informed about the study and the privacy of their data. Privacy was obtained by using the REDCap platform, which allows for anonymous answers, keeping the identity of the subjects blinded. The dentists were asked to answer questions on demographics, but their identities were neither requested nor revealed. Individual responses were also not of interest, but rather the collective and combined outcomes derived from each participant at an aggregate level.

According to the European Guidelines for Good Clinical Practice (CPMP/ICH/135/95) and the Ethics Committee of the Canton of Bern, no approval by the local ethics committee was required (BASEC-Nr: Req-2020-00632) [10].

Data management and statistical analysis

The questionnaire was analyzed as done previously [10, 14]. For this, the data of the questionnaire was organized by using a databank and statistical analysis was performed with IBM SPSS 26.

Data were evaluated for normal distribution using Shapiro-Wilk test and descriptive analysis performed accordingly. Statistical comparison between the criteria of each (sub-)question was performed using Mann-Whitney U test (continuous data: date of birth and years since dental license), χ^2 test (nominal and ordinal data: all other items) or intraclass correlation coefficients (analysis how strongly units in the same group resemble each other). To assess patterns of answers between items, data were firstly transformed into binary variables.

Afterwards, univariate analysis using χ^2 test was performed to select variables for inclusion in the correlation analysis of binary variables.

RESULTS

A total of 383 dentists, from both genders (44% female, 56% male) and from 25 out of 26 cantons of Switzerland replied to the questionnaire. They had a mean (standard deviation) work experience of 22.5 (12) years, and their main area of practice was general dentistry (338 dentists), followed by prosthodontics (186 dentists) and endodontics (172 dentists).

Only 41 dentists replied having at least 5 patients with root caries per week (table 1), whereas 53 dentists have less than one patient with root caries per week, and 6 never have this type of patients. The vast majority replied having such patients only rarely or sometimes (149 and 130 dentists, respectively).

Diagnosing active root caries

Tactile sensation seemed to be the most predominant criterion for diagnosing active RCL. Soft or leathery on probing was the most chosen criterion (160 dentist), followed by very soft on probing (35 dentists). One hundred and forty-one dentists considered both criteria. Only for 3 dentists tactile sensation was not a predominant factor.

Color was not a predominant criterion for 224 dentists when diagnosing active root caries lesions (table 1). However, since multiple selection was allowed, from the mentioned 224 dentists 16 also included yellowish or light brown surface as a criterion, 7 included dark brown to black surface, 5 included yellowish or light brown surface and dark brown to black surface, and 2 included whitish surface. Overall, of the different colors, the yellowish or light brown surface was the most chosen criterion (138 dentists).

In terms of visual appearance, most of the dentists (244) replied that matte or dull surface as a criterion of an active root caries lesion, and 129 do not consider visual appearance as a predominant criterion. However, 14 dentists chose both criteria, and 13 dentists chose both matte or dull surface and shiny.

Presence of cavitation was considered as criterion by 243 dentists, however 13 of them also mentioned that cavitation is not a predominant criterion, and 131 dentists considered only that cavitation is not a predominant criterion.

Regarding the location of the lesion, 208 dentists considered areas of biofilm accumulation important, but 63 of them also considered one or more of the other criteria as predominant. The location was not a predominant criterion for 127 dentists, but only 102 of them chose this criterium only.

Besides of visual tactile evaluation 11 dentists use x-rays and 5 consider the overall caries activity to assist in the diagnosis of root caries lesions. In contrast to the rare contact with root caries (only 41 dentists replied to have at least 5 patients with root caries per week), most of the dentists replied to feel confident or very confident (244 and 66 dentists, respectively) when diagnosing root caries lesions. However, 5 dentists replied to feel very uncertain, and 61 to feel uncertain.

Risk factors to develop root caries

The dentists were also asked to give their opinion about the importance of some factors for a patient with exposed root surface to develop root caries lesions (table 2). Most of the dentists replied to agree or strongly agree that poor oral hygiene and presence of biofilm at the root surfaces are important risk factors. The same was observed for medication, (low) salivary flow rate, and high amount of *S. mutans* in saliva. Dentists had contradicting opinions on other factors: existing untreated coronal caries (135 dentists disagreed and 160 agreed), presence of periodontitis (124 disagreed and 166 agreed), presence of restored surfaces (156 disagreed and 160 agreed), smoking (198 disagreed and 121 agreed), and untreated Diabetes (130 disagreed and 170 agreed). For the majority of dentists root canal treatment is not a risk factor for root caries (128 and 199 dentists have strongly disagreed and disagreed, respectively).

Clinical records of root caries

When recording root caries lesions, 157 dentists do not distinguish them from coronal caries lesions. Eighty-one dentists thought it is not necessary/important to distinguish the lesions and 47 dentists replied that the charting system does not allow it. Further 14 chose both reasons. In contrast, 221 dentists reported to distinguish the lesions, of whom 68 record the lesions in the (electronic) patient file, 64 in the (electronic) odontogram/dental chart, and 85 record in both places.

Subanalysis of responses depending on the place of education (University), participants' age and working area

When considering the place of education of the participants, some significant differences were observed between the main four universities in Switzerland (table 3). For the diagnose of active root caries lesions, the visual appearance was the only factor that showed significant difference between the universities ($p=0.04$). Three out of four universities considered a matte or dull surface to be criterion of an active root caries lesion. When recording root caries lesions, the graduates of only one university did not distinguish them from coronal caries ($p<0.001$), while the graduates of the other three universities did.

The participants' age was divided into three groups: ≤ 40 years, 41–60 years and ≥ 60 years (table 3). Significant differences were observed for visual appearance ($p < 0.01$) and for tactile sensation ($p \leq 0.002$). Participants between 41 and 60 years did not consider visual appearance as a criterion of an active root caries lesions, while participants younger than 40 years and older than 60 years considered matte or dull surface a criterion of an active root caries lesion. The working area was divided into three groups: city, rural area and town (table 3). A significant difference was only observed for presence of cavitation. For participants of rural areas, the presence of a cavitation was not a significant predictor of an active root caries ($p < 0,02$), whereas for participants of cities and towns it was.

DISCUSSION

When using this validated questionnaire, respondents from 25 out of 26 cantons and various work settings replied to the questionnaire. Considering the total number of dentists practicing in the country, the calculated response rate seems very low (9%), especially in comparison to previous studies that achieved response rates between 26% and 35% [6, 14]. In these studies, modified tailored design methods with respondent-friendly questionnaire designs, multiple contact approaches, sent return envelopes and personalized correspondent letters were used [15]. In contrast, due to data protection regulations in Switzerland, the present survey could only be distributed via non-personalized e-mail lists for alumni and/or continuing education by all four Swiss dental Universities as well as via the newsletter of the Swiss Dental Association (SSO). Thus, the exact number of contacted dentists remained unclear. Furthermore, no targeted reminder messages could be sent to people who have not yet responded. So, the calculation of the response-rate using the total number of dentists in Switzerland is an (over)estimation, and this could explain the seemingly low response rate obtained in the present study. Nevertheless, a total of 383 dentists from both genders, representing respondents from 25 out of 26 cantons, various work settings (city, town, and rural areas) and all four Swiss universities, participated in the survey. While the limitation of a response rate, likely below 10%, has to be acknowledged, the collected data still provides valuable insights in the daily routine.

The findings of this survey illustrated a high discrepancy between the dentists in the diagnosis, recording and knowledge of risk factors related to root caries lesions. These findings are of interest and may indicate a learning need for dentists.

The participants of the survey had a mean of approximately 23 years of working experience, and most of them work as general dentists. We could expect that the group of responders would frequently be confronted with patients with root caries, since in a previous study on Swiss residents over 70 years, almost half of the participants had at least one RCL [16]. However, most of the dentists have replied to rarely or sometimes see patients with root caries

in their clinic, yet most of the dentists feel confident or very confident when diagnosing root caries. This could demonstrate an underestimation of managing root caries lesions.

Regarding the presence of cavitation, this was marked as a predominant criterion for active lesions by two-thirds of the dentists. However, active root caries lesions may not necessarily be cavitated [17, 18]. This knowledge is important during the decision-making for treatment, and any unclarity in defining active lesions will invariably lead to undertreatment or overtreatment.

The majority of the dentists distinguish root caries from coronal caries when recording in the patient file and/or dental chart. However, 41% still do not do so, and their reasons were either because their charting system does not allow it (39% of them) and/or they thought that it is not necessary/important (61%). A previous survey on root caries performed in Queensland [6] found an even higher number of dentists (77%) do not distinguish RCL from coronal caries, where 30% do not find it necessary/important and 70% said the reasons were due to their charting systems. Even 10 years after the last survey [6], problems in recording root caries lesions can still be seen, especially due to limitations of the charting systems.

In the sub-analysis of responses, significant differences between the different places of education (university), participant ages and working areas could be observed. For instance, the graduates of three out of four universities considered matte or dull surface to be a criterion of an active root caries lesion, which shows a degree of uncertainty between dentists after graduation. The presence of a cavitation was not a significant predictor of an active root caries for participants of rural clinics, but it was for participants of cities and towns. This also highlights discrepancies in how dentists diagnose and consequently manage root caries, even in such an apparently homogenous group of dentists in a small country such as Switzerland.

The questionnaire was available in four languages: English, French, German, and Italian. All these languages had been already fully analyzed during the validation period, providing an overall intraclass correlation coefficient of 96% [10]. So, language was not expected to influence the present results and it was, therefore, not analyzed in this paper. Furthermore, the participants were able to swap between all four languages at any time of the study.

In spite of the limitations of the present survey, we have observed a great diversity in the diagnosis, recording and assessing risk factors of root caries lesions by dentists in Switzerland, which might strongly impact how they manage this condition. These findings are related with the place of education, participants' age and the area where they work. The dentists, however, do not encounter such lesions often in their practices, but a nation-wide task-force could be useful to align their current knowledge with the most recent scientific data. Since the questionnaire is available in 4 major western languages, we also recommend this survey in other countries. Dentists would highly benefit from such guidelines, especially from national organizations taking the local problems into consideration. Furthermore, the benefits of an appropriate diagnosis, recording and management of risk factors of root caries lesions should be highlighted in under- and postgraduate dental education, and professional regulation should embrace a more standardized root caries management.

ACKNOWLEDGMENT

The authors acknowledge all the persons that were involved in the design and carrying out of this survey. We thank Alain Reimann for his help with RedCap. The authors also acknowledge the dentists that took part in this survey.

STATEMENT OF ETHICS

This study is reported according to the COPE guidelines.

CONFLICT OF INTEREST STATEMENT

The authors declare no potential conflicts of interests.

FUNDING SOURCES

This study is supported by the Swiss Dental Association (SSO; Grant No. 327-21).

AUTHOR CONTRIBUTIONS

R.J.W., S.H.N. and T.S.C. designed and planned the study; R.J.W. S.M. and C.T. contacted all Swiss Universities and the SSO to distribute the survey; R.J.W., S.H.N., S.M., G.C. and T.S.C. prepared the questionnaire; R.J.W., I.K. and G.C. performed the statistical analysis; R.J.W., S.H.N., T.S.C. wrote the manuscript; S.M., G.C., and C.T. commented on the manuscript; all authors revised the manuscript.

DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this article [and/or] its supplementary material files. Further enquiries can be directed to the corresponding author.

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DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this article [and/or] its supplementary material files. Further enquiries can be directed to the corresponding author.

Table 1: Questions and response options (n = number of responders)

How often do you see patients with root caries?	
Never	6
Yes, almost never (< 1 Patients average/week)	53
Yes, rarely (1-2 Patients average/week)	149
Yes, sometimes (3-5 Patients average/week)	130
Yes, frequently (> 5 Patients average/week)	41
n/a	4
When distinguish between active and inactive root caries lesions which criteria do you use to diagnose active ones?	
<u>Color</u>	
Whitish surface	60
Yellowish or light brown surface	138
Dark brown to black surface	72
Color is not a predominant criterion when discriminating between active and inactive root caries lesions	224
overall	494
<u>Visual appearance:</u>	
Matte or dull surface	244
Shiny	27
Visual appearance is not a predominant criterion when discriminating between active and inactive root caries lesions	129
overall	400
<u>Tactile sensation:</u>	
Soft or leathery on probing	331
Very soft on probing	200
Hard on probing	36
Tactile sensation is not a predominant criterion when discriminating between active and inactive root caries lesions	6
overall	573
<u>Cavitation:</u>	
Presence of cavitation	243
Absence of cavitation	22
Cavitation is not a predominant criterion when discriminating between active and inactive root caries lesions	144
overall	409
<u>Location:</u>	
Close to the gingival margin	84
Distant from the gingival margin	10
Close to the cementoenamel junction	55
Areas of biofilm accumulation are more important than the distance to the gingival margin and to the cement-enamel junction	208
Location is not a predominant criterion when discriminating between active and inactive root caries lesions	127
overall	400
Do you record root caries lesions in a way that distinguishes them from coronal caries lesions?	
no	157
no, not necessary	97
no, not possible in charta	62
no, other reason	8
yes	221
yes, no info	4
In both	85
In the (electronic) odontogram/ dental chart	64
In the (electronic) patient file	68
n/a	5

Table 2: Risk factors associated with root caries (n = number of responders)

The following factors are important for a patient with exposed root surface to develop root caries. Do you agree or disagree?					
	strongly agree	agree	disagree	strongly disagree	n/a
Existing untreated coronal caries	50	160	135	24	14
Medication	153	201	17	4	8
Poor oral hygiene	282	92	4	1	4
Presence of periodontitis	57	166	124	27	9
Presence of restored surfaces	27	160	156	26	14
Root canal treatment	2	39	199	128	15
(Low) salivary flow rate	1	120	255	0	7
High amount of S mutans in saliva	65	228	54	6	30
Smoking	24	121	198	29	11
Uncontrolled Diabetes	52	170	130	15	16
Presence of plaque (or biofilm) at the root surfaces to be assessed	245	129	4	1	4
How do you feel when diagnosing root caries lesion?					
	Very uncertain	Very confident	Uncertain	Confident	n/a
	5	66	61	244	7

Table 3: Relative Responses of question 2 and 3 depending on the place of education (University), participants' age and working area

When distinguish between active and inactive root caries lesions which criteria do you use to diagnose active ones?										
Color	place of education (University)				participants' age			working area		
	Univer sity 1	Univer sity 2	Univer sity 3	Univer sity 4	21- 40	41- 60	<6 0	Cit y	Rural area	To wn
Whitish surface	33%	29%	39%	36%	39 %	34 %	40 %	34 %	33%	40 %
Yellowish or light brown surface	17%	14%	11%	18%	22 %	12 %	21 %	15 %	15%	18 %
Dark brown to black surface	53%	65%	61%	64%	56 %	63 %	53 %	63 %	62%	52 %
Color is not a predominant criterion when discriminating between active and inactive root caries lesions	19%	17%	24%	12%	21 %	19 %	19 %	20 %	13%	19 %
Visual appearance:										
Matte or dull surface	53%	72%	61%	64%	80 %	56 %	68 %	61 %	69%	73 %
Shiny	8%	5%	4%	5%	11 %	5% %	6 %	8% %	10%	4% %
Visual appearance is not a predominant criterion when discriminating between active and inactive root caries lesions	42%	32%	37%	34%	21 %	42 %	31 %	37 %	28%	28 %
Tactile sensation:										
Soft or leathery on probing	86%	88%	93%	86%	92 %	86 %	85 %	90 %	82%	86 %
Very soft on probing	67%	63%	40%	63%	64 %	47 %	59 %	51 %	64%	53 %
Hard on probing	11%	10%	8%	8%	11 %	7% %	15 %	10 %	5%	10 %
Tactile sensation is not a predominant criterion when discriminating between active and inactive root caries lesions	0%	3%	1%	0%	1% %	2% %	0 %	2% %	0%	1% %
Cavitation:										
Presence of cavitation	53%	60%	66%	63%	72 %	61 %	60 %	65 %	54%	66 %
Absence of cavitation	8%	3%	5%	7%	9% %	4% %	7 %	6% %	0%	7% %
Cavitation is not a predominant criterion when discriminating between active and inactive root caries lesions	47%	40%	37%	39%	32 %	43 %	37 %	37 %	54%	34 %
Location:										
Close to the gingival margin	28%	23%	22%	16%	28 %	18 %	19 %	22 %	21%	22 %
Distant from the gingival margin	6%	3%	3%	1%	5% %	2% %	1 %	3% %	5%	2% %
Close to the cemento-enamel junction	22%	9%	14%	12%	13 %	15 %	13 %	14 %	21%	13 %
Areas of biofilm accumulation are more important than the distance to the gingival margin and to the cement-enamel junction	64%	55%	47%	67%	52 %	55 %	54 %	52 %	62%	59 %
Location is not a predominant criterion when discriminating between active and inactive root caries lesions	31%	40%	38%	29%	34 %	36 %	31 %	37 %	31%	29 %
Do you record root caries lesions in a way that distinguishes them from coronal caries lesions?										

no	31%	31%	63%	28%	36%	41%	50%	41%	42%	10%
no, not necessary	45%	58%	72%	71%	56%	60%	74%	61%	69%	63%
no, not possible in charta	64%	38%	28%	38%	44%	41%	29%	33%	38%	51%
no, other reason	0%	0%	7%	5%	3%	8%	3%	5%	6%	6%
yes	69%	69%	37%	72%	64%	59%	50%	59%	59%	58%
In both	25%	41%	11%	36%	23%	30%	35%	28%	22%	31%
In the (electronic) odontogram/ dental chart	21%	17%	69%	18%	43%	23%	32%	30%	26%	33%
In the (electronic) patient file	50%	41%	17%	42%	34%	44%	29%	40%	52%	29%

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

All other authors declare no conflicts of interests.