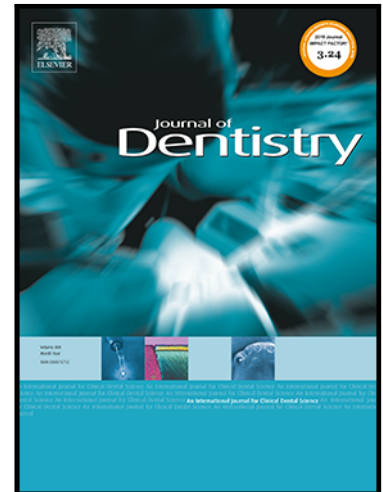


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Decision making and management of root caries: a practice-based survey

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Short title: Diagnosing, recording, and managing root caries

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ABSTRACT

Objectives: With increasing life expectancy and improved preventive measures, teeth are retained longer, leading to a rise in prevalence of root caries lesions (RCL). However, little is known about how dentists manage this condition. The present survey aimed to evaluate the knowledge of Swiss dentists on decision making and management of RCL.

Method: The survey evaluated dentists' knowledge, clinical routines, and demographics concerning RCL. Dentists were contacted via email and local newsletters, and 383 dentists from 25 (out of 26) cantons responded. Mann-Whitney U test, χ^2 test, intraclass correlation coefficients, Spearman correlation and Chi Square were used.

Results:The dentists had a mean(SD) working experience of 22.5(12) years. Most dentists correctly classified an inactive (67%) and an active (81%)RCL. Although the inactive lesion did not call for restorative treatments, 61% of the dentist declared they would restore it. From the active lesion,83% would restore it. The invasive treatments leaned toward complete caries excavation with composite resin as preferred restorative material. There were significant correlations between material choice and expected success rates. Among the non-invasive options, oral hygiene instructions and (highly-)fluoridated toothpaste were favored. Most dentists declared having a recall system for such patients, with biannual follow-ups preferred. The dentists' place of education significantly influenced restorative decisions ($p<0.001$), while participants' age (≥ 60 years) impacted activity status ($p=0.048$) and restorative decisions ($p=0.02$).

Conclusion:Material preferences for non-invasive or invasive management varied greatly and there were minimal differences in the management of inactive or an active RCL. Moreover, diagnosing active lesions appeared easier than diagnosing inactive ones.

Clinical Significance: Despite diverse material preferences for (non-)invasive treatments, a strong positive correlation existed between the chosen restorative material and its expected 2-year success rate. Moreover, diagnosing active lesions appeared easier than diagnosing inactive ones. The outcome emphasizes the need to align guideline recommendations with their application in private dental practices.

Keywords: Diagnosing; recording; managing root caries

INTRODUCTION

In recent decades, life expectancy has increased and this increase in age may bring many health vulnerabilities in the elderly population, including decreased motor skills, and therefore increased risk for developing root caries lesions (RCL). Although there are several non-invasive approaches to prevent initiation or to inactivate RCLs [1], invasive approaches have still been often chosen to manage such lesions [2]. On the one hand, there is a growing concern about RCL in the daily practice [3-5], but on the other hand, the European Federation of Conservative Dentistry (EFCD) and American Dental Association (ADA) are concerned that there are discrepancies in how dentists manage RCL [3-6].

The success rate of RCL management can be influenced by several factors, including operator's expertise, knowledge, and the chosen approach. For non-cavitated inactive RCL, non-invasive methods such as monitoring and individualized oral health instructions can be performed [7, 8]. Invasive interventions become necessary for active cavitated lesions [3-6]. An alternative strategy involves a dual approach, initially inactivating the lesions and subsequently restoring them.

Another factor influencing the success rate of RCL management seems to be the frequency of check-ups [7, 8]. A higher check-up frequency, exceeding twice a year, correlates with increased intervention rates on inactive lesions, potentially leading to unnecessary treatments where direct intervention might not be essential [7]. Additionally, for invasive treatment, the extension of the restoration and the restorative material seem to be major determinants of clinical success [8, 9]. For instance, it was observed that restorations extending to the proximal area, or involving two surfaces, exhibit failure rates twice as high than those of single-surface restorations [8].

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]. Our previous study reported a great diversity in diagnosing, recording and assessing risk factors of RCL [11]. The aim is now to report the results on the knowledge of dentists working in Switzerland, regarding decision making and management of root caries lesions.

MATERIALS & METHODS

Survey

The survey was performed using a previous standardized and validated questionnaire [10, 11]. This questionnaire comprised closed-ended questions, incorporating a mix of multiple-choice and checkbox queries, along with Likert scales and it is structured in three parts [11]. In the present manuscript the results derived from questions related to two clinical cases, one showing an inactive root caries lesion and the other an active lesion, were included (appendix). Identical questions were available for both cases, enabling an examination of variations in decision-making based on the diagnosis. These questions covered non-invasive and invasive treatment options, as well as questions on survival rates expected for different restorative materials.

Dentists actively working in national health systems and/or in private or public clinics, including general and specialist dentists were aimed to be reached. The survey was distributed via e-mail to the alumni lists 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). No reminders or personalized e-mails or letters were sent. All responses were anonymous.

Ethical aspects

The survey was performed according to the European Guidelines for Good Clinical Practice (CPMP/ICH/135/95). Furthermore, according to the Ethics Committee of the Canton of Bern the project does not fall under the Human Research Act, Art. 2, para. 1 and 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 [10-12]. For this, the data of the questionnaire was organized 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 of the groups 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), intraclass correlation coefficients (analysis of how strongly units in the same group resemble each other), Spearman correlation (correlation analysis of ranked data) and Chi Square (correlation analysis of dichotomous data). 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 within dimensional analysis.

RESULTS

Demographic data of the participating dentists can be found in Table 1. 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).

Classification of the lesions

The first clinical case (Figure 1A) depicts an inactive RCL, and the second (Figure 1B) depicts an active RCL. Both these cases can be treated with non-invasive approaches, however the active RCL would need an invasive treatment with a restoration of the cavitation. For the first case, most of the dentists correctly identified the lesion as inactive (66.8%), while 28.7% replied that the lesion was active (4.5% no reply) (table 2). However, 60.8% would restore this lesion whereas 34.7% (would not. For the second, most dentists correctly identified an active

lesion (80.9%), while 16.2% replied that the lesion was inactive (2.9% no reply), And 82.8% of the dentists would restore this lesion, while 13.8% would not.

Nonetheless, for both lesions, there was a significant correlation between activity classification and invasive management ($p \leq 0.011$, Chi Square)

Non-invasive management options

When asked about non-invasive treatments options that the dentists use in their clinical routine for patients with such lesions, the following combination of management options was most often selected for both types of lesions: instruction of patients to improve oral hygiene at home, advise the regular use of toothpaste with 5000 ppm of fluoride, in-office biofilm removal and in-office application of 5% fluoride varnish. Regarding the single options, most of the dentists replied to instruct the patients to improve oral hygiene at home (first case/second case: 87.7%/90.3%), followed by in-office biofilm removal (74.4%/78.1%). Regarding the at-home use of toothpaste, 46.0%/35.8% would advise the use of regular toothpaste with 1450 ppm F⁻ and 49.9%/62.9% would advise highly fluoridated toothpaste with 5000 ppm F⁻. Application of fluoride varnish was stated by 51.7%/52.5% of the dentists, the use of silver diamine fluoride solution by 8.6%/12.3% and the use of chlorhexidine varnish by 9.7%/8.6%.

Invasive management options

Among of the dentists who would treat RCLs invasively, most of them would perform a complete caries excavation (105 dentists out of 133 would excavate the first case / 230 out of 317 dentists would excavate the second case). Furthermore, a vestibulo-approximal access was preferred (74.4%/78.9%) to an occluso-approximal slot (15.8%/1.9%) or an atraumatic restorative management (9.0%/18.9%).

Regarding the type of materials/restorations preferred (for the first / second cases), most of the dentists (106 dentists / 271 dentists) would “almost always” or “always” use composite resin, followed by flowable composite (60 dentists / 163 dentists). However, 15 dentists / 36 dentists would “almost never” or “never” use composite resin, and 52 dentists / 108 dentists would “almost never” or “never” use flowable composite. Although 105 dentists / 247 dentists replied that they “almost never” or “never” use amalgam, 1 dentist / 4 dentists replied to “always” use amalgam (27 dentists / 69 dentists did not reply). For use of crown, we obtained the highest

number of dentists that did not reply (37 dentists / 69 dentists), whereas 92 dentists / 246 dentists would never or almost never use crown, and 4 dentists would almost always use. For glass ionomer cement (GIC) and resin modified GIC the responses were diverse, with only few dentists replying to “always” use this type of materials (5 and 2 dentists / 79 and 72 dentists). In both cases there was a significant strong positive correlation between the restorative material which would be used and its expected 2-year success rate of 61-80% or 81-100% ($r \geq 0.420$, $p < 0.001$, Spearman correlation). For both cases there was one exception: the correlation was only moderate for Amalgam in the first case ($r_{\text{Amalgam}} = 0.305$, $p_{\text{Amalgam}} = 0.006$) and for resin composite in the second case ($r_{\text{resin composite}} = 0.287$, $p_{\text{resin composite}} < 0.001$) (Table 3).

Follow-up

The dentists were asked about a recall program for this kind of patients. The majority replied to have a recall system (81.7%), whereas 15.1% replied not to have a recall system, (3.1% no reply). For the first clinical case the most chosen recall interval was every 6 months (61.1% of dentists), followed by 3 months (27.2%) and yearly (7.6%). For the second clinical case the most chosen recall interval was every 3 months (48.3% of dentists), followed by 6 months (43.3%) whereas a few dentists replied to use a yearly or monthly recall system (3.1% and 2.1%, respectively).

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

Considering the place of education of the participants, some significant differences were observed between the four Switzerland universities. Graduates of one of these universities would restore the lesion of the first case significantly more often than graduates of the other three universities ($p < 0.001$). Conversely, the graduates of this one university would restore the lesion of the second case significantly less often ($p < 0.001$). In both cases the graduates of this one university recommended highly fluoridated toothpaste and biofilm removal less often than graduates of the other three universities ($p < 0.001$).

The participants' age was divided into three groups: ≤ 40 years, 41–60 years and ≥ 60 years (Table 1). A significant difference was observed for activity status ($p = 0.048$) and restorative management ($p = 0.02$) of the lesion of the first case. Participants ≥ 60 years significantly more

often classified the lesion as active and would significantly more often restore the lesion than both other age groups.

There was no significant difference regarding the working area of the participants (city, rural area and town).

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DISCUSSION

The present questionnaire was applied in Switzerland and it was answered by respondents from 25 out of 26 cantons with a mean working experience of 22 years and various work settings. The results derived from questions related to two clinical cases: one showing an inactive root caries lesion and the other an active lesion. Interestingly, although the materials used for non-invasive or invasive treatments varied greatly between the respondents, there were hardly any differences in the management of an inactive or an active RCL. Moreover, it seemed easier for the respondents to diagnose an active lesion than an inactive one.

Recently, it has been observed that the majority of dentists differentiate between root and coronal caries and between active and inactive root caries when documenting lesions. [11]. However, there was considerable variability between dentists in assessing criteria such as color, visual appearance, tactile sensation, cavitation, and localization to differentiate between active and inactive lesions. It was interesting to note that the majority of the dentists correctly rated the activity status of the two clinical cases. Additionally, significant differentiation between the two cases – inactive and active – was evident among most participants and subgroups.

As it was already observed in a similar survey a decade ago [5], both at-home and in-office remineralizing agents seem to be widely employed. This is in agreement with the latest EFCD and ADA guidelines to treat (in)active root caries lesions [3, 4] with non-restorative approaches. However, in contrast to the guidelines, in which highly fluoridated toothpaste is recommended in patients with increased (root) caries susceptibility and/or (in)active root caries lesions, 46% of the participants would recommend regular toothpaste with 1450 ppm F⁻ although the patient of the first case had compromised motor-skills. The participants (63%) seemed to follow the guidelines and recommended highly fluoridated toothpastes only for the active lesion.

The inactive lesion was treated non-invasively by most of the participants (250 out of 383). This is also in agreement with the EFCD and ADA guidelines, which advocate considering inactive RCL as scars that inherently do not need additional invasive interventions. In the case of the active lesion, a different trend emerged, as most participants (317 out of 383) opted for

an invasive approach with a vestibulo-approximal access. The same participants recommended the use of highly fluoridated toothpastes for these active RCLs in conjunction with the restorative treatment. So it remains unclear whether they recommend the toothpaste as a preventive approach to reduce the initiation of new lesions in the future, or if they first strive for a re-hardening of the softened dentin before restoring the lesion, thus, firstly, treating any gingival inflammation and, secondly, decreasing the restoration size.

Almost all participants instruct the patients to improve oral hygiene at home, and most of them perform in-office biofilm removal, regardless of the activity of the lesions. These choices may actually stem from the preventive principles inbuilt in dentists during their education, rather than being specifically tailored to managing root caries in the specified cases. As for the use of highly concentrated fluoride products, the activity of lesion seemed to influence the material of choice only for the use of silver diamine fluoride, although the difference was very low (8.6% for inactive lesions versus 12.3% for active). Moreover, conventional fluoride varnish was preferred over silver diamine fluoride solution and chlorhexidine varnish in this context. This is also in accordance with the guideline from ORCA and EFCD, which has shown a higher agreement for the use of fluoride varnish than chlorhexidine varnish [4].

It has been emphasized that there is a greater need for controlling caries lesions and maintaining oral health in elderly rather than prioritizing restoration or aesthetic outcomes [4]. Nevertheless, it is noteworthy that one third of the participants would still opt to restore the inactive lesion. As in the case description a 79 year-old man with compromised motor skills was described and on the second case with an inactive lesion in a patient without general health impairment was presented, it remains unclear whether the decision to restore the inactive lesions was done because of the inactive lesion or because of the general health status. Interestingly, for two third of the participants the compromised general health status did not influence the decision to non-invasively treat the inactive lesion.

Moreover, 72% of the dentists who decided to restore the active lesion (second clinical case) also considered a complete excavation. Only one participant considered selective caries excavation and 27% would use atraumatic restorative treatment (ART). This observation is, on the one hand, in agreement with a survey on complete and incomplete coronal caries removal

[12], where 72 of dentists (strongly) agreed that complete caries removal is necessary to avoid caries progression, pulpal complications and to achieve high restoration longevity. On the other hand, this observation is in contrast to a meta-analysis of randomized controlled trials, where significantly reduced risks of pulp exposure and pulpal complications as well as no significant difference in the risk for failure were observed for incompletely excavated teeth compared to completely excavated ones [13]. Thus, the current most considered procedure for root caries (complete excavation) among the participants of the present survey is in contrast to the advocated approach of selective caries excavation for coronal caries, a practice that has been endorsed for over a decade.

As mentioned before, more than a quarter of the dentists would use ART to restore the lesion of the second case. ART has been mostly used in pediatric dentistry, with the advantage of being a fast and easy method, providing more comfort to the patients and helping avoiding pulp exposure. This method has also been advocated for the elderly and has been considered for the management of caries lesions in this age-group. A five-year controlled clinical trial revealed comparable survival rates when treating caries lesions in the elderly using ART and conventional techniques [14]. Regarding root caries, some recent meta-analyses on root caries restorations have not analyzed specific excavation techniques [1, 2], but one meta-analysis did, and it showed that ART was associated with a borderline significantly increased risk of failure compared to conventional techniques (CT) [15]. The authors, however, highlighted that there is still no compelling evidence to support either one or the other technique for restoring RCLs in older adults.

Regardless of activity, most dentists would use resin composite followed by flowable composite to restore RCL. Resin-modified glass ionomer cement was preferred over conventional GIC. In terms of the materials used, there was a strong correlation between the dentists' beliefs about the expected 2-year success rate, indicating that dentists have strong beliefs about the materials they choose. However, the literature is still inconclusive regarding the best material to be used for restoring RCL, with contradicting results being reported [2, 8]. It is important to note that restoring a root caries lesion is challenging and the success rate of restorations is related not only to the material, but also to the location, humidity control, and

patient-related conditions such as saliva, hygiene, fluoride, etc. [3, 4]. In addition, a major limitation of restoring root caries lesions is that they are often dentinal lesions only, which has a lower bond strength than enamel [16, 17]. Another consideration that may affect the success rate of a restoration is the extent of the lesion and how the lesion is accessed. To the best of our knowledge, only one study has compared the restorative treatment of single and two-surface root caries lesions [8] showing that proximal extension of the RCL significantly shortens the longevity of the restoration. Furthermore, the influence of the lesion access (e.g. occluso-approximal vs vestibulo-proximal) has not been analyzed in an *in vivo* nor in a *vitro* study yet.

The recall interval proposed by the participants was slightly influenced by the activity of the caries lesions and patients' conditions. In both cases, the 6-month interval was the prevailing choice, however for the case involving active lesion, there was a slightly higher preference for a 3-month interval. Moreover, although most participants replied to have a recall system, 15% of them replied not to have a recall system. On the one hand, the availability of a recall system is important to provide information on oral diseases and behaviours and to motivate dental care, as well as to control the caries process and hygiene conditions. Nevertheless, it has also been shown that recall systems were often linked to an increase in invasive treatments, with restorations being replaced more frequently [7, 18]. Dental hygienists can play an important role in maintaining the oral health of elderly and providing preventive measures [5].

The most important limitation of this survey is the response rate, which was likely below 10%. Since 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 the collected data provides valuable insights in the daily routine of Swiss dentist. However, it is not a representative sample of dentists in Switzerland.

In spite of the limitations of the present survey, material preferences for non-invasive or invasive treatment varied greatly and there were minimal differences in the management of inactive or an active RCL. These findings are related with the place of education and participants' age. Moreover, diagnosing active lesions appeared easier than diagnosing

inactive ones. This emphasizes the urgent need to align guideline recommendations with their application in private dental practices.

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REFERENCES

- [1] R.J. Wierichs, H. Meyer-Lueckel, Systematic review on noninvasive treatment of root caries lesions, *J Dent Res* 94(2) (2015) 261-71.
<https://doi.org/10.1177/0022034514557330>
- [2] J. Schmidt, S. Proesl, E. Schulz-Kornas, R. Haak, H. Meyer-Lueckel, G. Campus, M. Esteves-Oliveira, Systematic review and network meta-analysis of restorative therapy and adhesive strategies in root caries lesions, *J Dent* 142 (2024) 104776.
<https://doi.org/10.1016/j.jdent.2023.104776>
- [3] R.L. Slayton, O. Urquhart, M.W.B. Araujo, M. Fontana, S. Guzmán-Armstrong, M.M. Nascimento, B.B. Nový, N. Tinanoff, R.J. Weyant, M.S. Wolff, D.A. Young, D.T. Zero, M.P. Tampi, L. Pilcher, L. Banfield, A. Carrasco-Labra, Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions: A report from the American Dental Association, *J Am Dent Assoc* 149(10) (2018) 837-849.e19.
<https://doi.org/10.1016/j.adaj.2018.07.002>
- [4] S. Paris, A. Banerjee, P. Bottenberg, L. Breschi, G. Campus, S. Doméjean, K. Ekstrand, R.A. Giacaman, R. Haak, M. Hannig, R. Hickel, H. Juric, A. Lussi, V. Machiulskiene, D. Manton, A. Jablonski-Momeni, R. Santamaria, F. Schwendicke, C.H. Splieth, H. Tassery, A. Zandona, D. Zero, S. Zimmer, N. Opdam, How to Intervene in the Caries Process in Older Adults: A Joint ORCA and EFCD Expert Delphi Consensus Statement, *Caries Res* 54(5-6) (2020) 1-7.
<https://doi.org/10.1159/000510843>
- [5] B.J. Garton, P.J. Ford, Root caries: a survey of Queensland dentists, *Int J Dent Hyg* 11(3) (2013) 216-25. <https://doi.org/10.1111/idh.12018>
- [6] M.R.O. Carrilho, Root caries: from prevalence to therapy., *Monogr Oral Sci.* Basel, Karger2017.
- [7] R.J. Wierichs, E.J. Kramer, H. Meyer-Lueckel, Risk factors for failure in the management of cervical caries lesions, *Clin Oral Investig* 21(6) (2017) 2123-2131.
<https://doi.org/10.1007/s00784-016-2002-1>
- [8] R.J. Wierichs, E.J. Kramer, H. Meyer-Lueckel, Risk factors for failure of class V restorations of carious cervical lesions in general dental practices, *J Dent* 77 (2018) 87-92. <https://doi.org/10.1016/j.jdent.2018.07.013>
- [9] J. Schmidt, S. Proesl, E. Schulz-Kornas, R. Haak, H. Meyer-Lueckel, G. Campus, M. Esteves-Oliveira, Systematic review and network meta-analysis of restorative

- therapy and adhesive strategies in root caries lesions, *J Dent* (2023) 104776.
<https://doi.org/10.1016/j.jdent.2023.104776>
- [10] S.H. Niemeyer, S. Maniewicz, G. Campus, C. Tennert, B. Yilmaz, A. Zekeridou, A. Rocuzzo, M. Esteves-Oliveira, T.S. Carvalho, R.J. Wierichs, Design, development and validation of a questionnaire to assess dentists' knowledge and experience in diagnosing, recording, and managing root caries, *Clin Oral Investig* 27(6) (2023) 2705-2711. <https://doi.org/10.1007/s00784-022-04842-x>
- [11] R.J. Wierichs, I. Kaspari, S. Maniewicz, G. Campus, C. Tennert, T.S. Carvalho, S.H. Niemeyer, Diagnosing and recording root caries: A survey among Swiss dentists, *J Dent* 142 (2024) 104870. <https://doi.org/10.1016/j.jdent.2024.104870>
- [12] F. Schwendicke, H. Meyer-Lueckel, C. Dorfer, S. Paris, Attitudes and behaviour regarding deep dentin caries removal: a survey among German dentists, *Caries Res* 47(6) (2013) 566-73. <https://doi.org/10.1159/000351662>
- [13] F. Schwendicke, C.E. Dorfer, S. Paris, Incomplete caries removal: a systematic review and meta-analysis, *J Dent Res* 92(4) (2013) 306-14.
<https://doi.org/10.1177/0022034513477425>
- [14] C. da Mata, G. McKenna, L. Anweigi, M. Hayes, M. Cronin, N. Woods, D. O'Mahony, P.F. Allen, An RCT of atraumatic restorative treatment for older adults: 5 year results, *J Dent* 83 (2019) 95-99. <https://doi.org/10.1016/j.jdent.2019.03.003>
- [15] H. Meyer-Lueckel, V. Machiulskiene, R.A. Giacaman, How to Intervene in the Root Caries Process? Systematic Review and Meta-Analyses, *Caries Res* 53(6) (2019) 599-608. <https://doi.org/10.1159/000501588>
- [16] Q. Li, G. Huang, A. Li, D. Qiu, Y. Dong, Promoting bond durability by a novel fabricated bioactive dentin adhesive, *J Dent* 143 (2024) 104905.
<https://doi.org/10.1016/j.jdent.2024.104905>
- [17] W.W. Barkmeier, P.D. Hammesfahr, M.A. Latta, Bond strength of composite to enamel and dentin using Prime & Bond 2.1, *Oper Dent* 24(1) (1999) 51-6.
- [18] R.J. Wierichs, E.J. Kramer, H. Meyer-Lueckel, Risk Factors for Failure of Direct Restorations in General Dental Practices, *J Dent Res* 99(9) (2020) 1039-1046.
<https://doi.org/10.1177/0022034520924390>

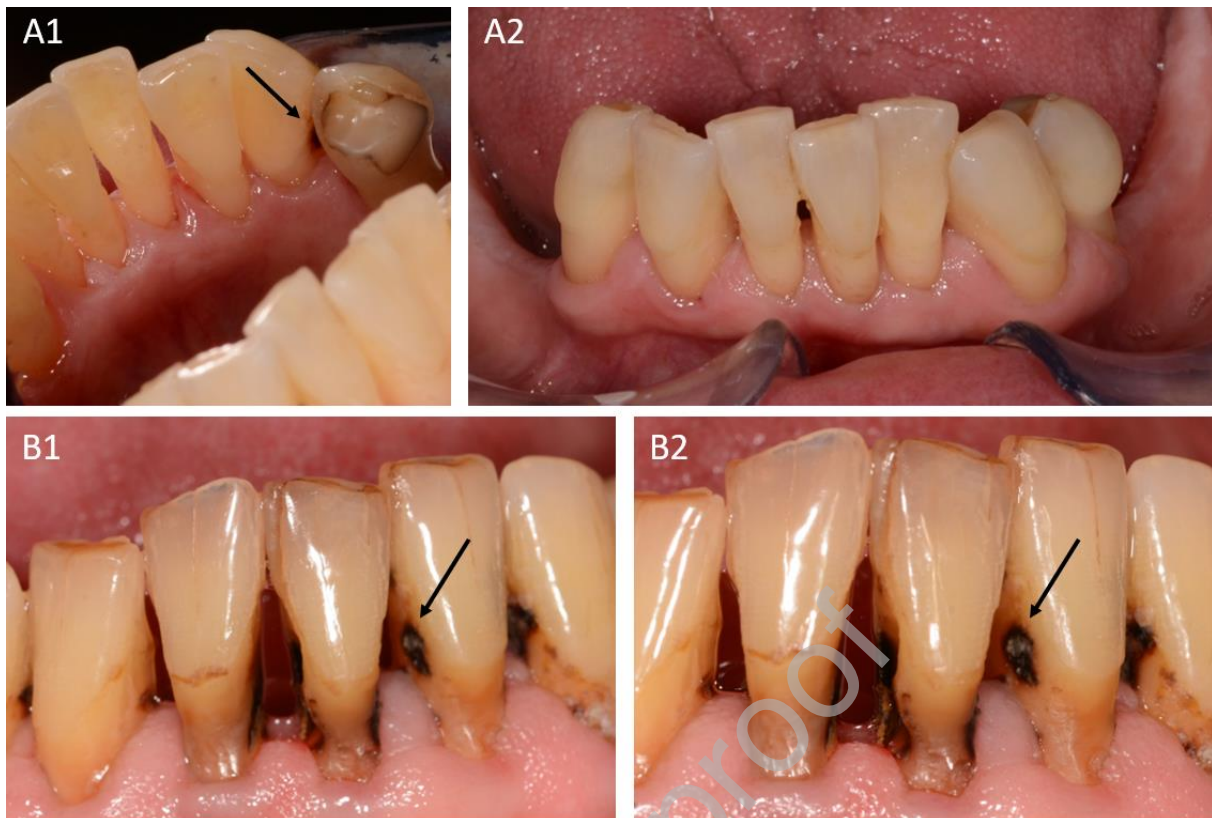


Fig.1 Pictures provided in the survey together with patient description and related questions.

A) Image of the clinical case A, showing the inactive root caries lesion on tooth 33 distal [10]. The patient was a 79 year-old male with compromised motor skills.

B) Image of the clinical case B, showing a cavitated active root caries lesion on tooth 31 mesial [10]. The patient was a 68 year-old female with good general health, controlled diabetes by continual use of medication.

C) Table 1. Characteristics of the participating dentists

Demographic variable	<i>n</i>
Number of participating dentists	383
Sex (female/male)	44%/56%
Dentists' age	
≤40 years	102
41–60 years	195
≥60 years	68
Work experience [mean (SD): 22.5 (12) years]	
≤5 years	33
6-10 years	79
11-20 years	87
21-30 years	95
31-40 years	42
Regional distribution	25 out of 26 cantons
University	

Basel	36
Bern	78
Geneva	95
Zurich	76
Other	81
Practice setting	
City	233
Town	83
Rural area	39
Main area of practice	
General dentistry (n=338)	338
Prosthodontics (n=186)	186
Endodontics (n=172)	172
Working hours	
0-2h	3
2-5h	3
5-10h	8
10-20h	34
20-30h	101
30-40h	213
Frequency of patients with RCL	
Yes, frequently (> 5 Patients average/week)	41
Yes, sometimes (3-5 Patients average/week)	130
Yes, rarely (1-2 Patients average/week)	149
Yes, almost never (< 1 Patients average/week)	53
Never	6
Confidence in treating RCL	
Very confident	66
Confident	244
Uncertain	5
Very uncertain	61

D)

E)

F) **Table 2. Questions and response options (n = number of responders)**

How do you feel when diagnosing root caries lesion?				
Very uncertain	Very confident	Uncertain	Confident	n/a
5	66	61	244	7
In your opinion, the marked root caries lesion on this tooth is:				
	Clinical Case A	Clinical Case B		
Active	17	310		
Inactive	110	62		
n/a	256	11		
In your clinical routine, do you use any of the following treatment options for such lesions? (more than one option was possible)				
Improve oral hygiene at home	336	346		
Use of toothpaste with 1450 ppm	176	137		
Use of toothpaste with 5000 ppm F	191	241		
In-office biofilm removal	285	299		
In-office root scaling	132	134		

In-office application of chlorhexidine varnish	37	33
In-office application of 38% silver diamine fluoride solution	33	47
In-office application of 5% fluoride varnish	198	201
Would you restore such a lesion?		
No	233	53
Yes	133	317
n/a	17	13
If yes, which method to remove root caries do you use:		
Complete caries excavation	105	230
Selective caries excavation	28	1
No caries excavation	12	86
If yes, how would you access the lesion?		
With slot preparation (occluso-approximal)	21	6
With slot preparation (vestibulo-approximal)	99	250
With atraumatic restorative treatment (ART)	12	60
n/a	1	1
Do you have a recall program for this kind of patient in your practice?		
No	58	53
Yes	313	319
n/a	12	11
What recall interval do you suggest for this kind of patient?		
None	1	1
Weekly	-	-
Monthly	4	8
Every 3 months	104	185
Every 6 months	234	166
Yearly	29	12
Two years or longer	-	-
n/a	11	11

G)

H)

I)

J)

K)

L) Table 3. Correlation analysis of materials which would be used in the first and second clinical case and their expected 2-year success rates.

<i>Material</i>	<i>First clinical case</i>			<i>Second clinical case</i>		
	<i>r-value</i>	<i>p-value</i>	<i>interpretation</i>	<i>r-value</i>	<i>p-value</i>	<i>interpretation</i>
Amalgam	0.305	0.006	moderate	0.426	<0.001	strong
Compomer	0.443	<0.001	strong	0.503	<0.001	strong
Composite	0.478	<0.001	strong	0.287	<0.001	weak
Flow	0.606	<0.001	strong	0.657	<0.001	strong
Crown	0.42	<0.001	strong	0.381	<0.001	strong
GIC	0.567	<0.001	strong	0.654	<0.001	strong
Resin GIC	0.527	<0.001	strong	0.637	<0.001	strong

M)

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STATEMENT OF ETHICS

This study is reported according to the COPE guidelines.

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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., Y.B. 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 Y material files. Further enquiries can be directed to the corresponding author.

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.

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