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Surface characteristics and lesion depth/activity of suspicious occlusal carious lesions: findings from the National Dental Practice-Based Research Network

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Abstract

Background—A lesion on an occlusal tooth surface with no cavitation and no radiographic radiolucency, but where caries is suspected due to surface roughness, opacities, or staining can be defined as a suspicious occlusal carious lesion (SOCL). Our objective was to quantify the characteristics of SOCLs and their relationship to lesion depth/activity after surgically opening these lesions.

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Methods—Ninety-three dentists participated. When consented patients presented with a SOCL, information was recorded about the tooth, lesion, treatment(s) done and, if the SOCL was opened surgically, its lesion depth. The Rao-Scott cluster-adjusted chi-square test was used to evaluate associations between lesion depth and color, roughness, patient risk, and luster.

Results—1593 SOCLs were analyzed. Lesion color varied from yellow/light brown (40%) to dark brown/black (47%), with 13% other color. A majority (69%) of SOCLs had a rough surface when examined with an explorer. Over 1/3 of the SOCLs (39%) were treated surgically. Of the surgically treated SOCLs (n=585), 61% had dentinal caries. There were statistically significant associations between lesion depth and color ($p=0.03$), luster ($p=0.04$) and roughness ($p=0.01$). 52% of patients were classified as being at elevated caries risk. There were no significant associations between lesion depth and patient risk ($p=0.07$).

Conclusion—Although statistically significant, the clinical characteristics studied do not provide accurate guidance for making definitive treatment decisions, and result in high rates of false positives.

Practical implications—Given that 39% of opened lesions did not have dentinal caries or were inactive, evidence-based preventive management is an appropriate alternative to surgical intervention.

Keywords

practice-based research; questionable lesions; multi-center studies; clinical research; dental caries

Keywords

Evidence-based dentistry; carious lesions; dentin

INTRODUCTION

Suspicious occlusal caries lesions (SOCLs) can be characterized as initial caries lesions on occlusal tooth surfaces that have no cavitation and no radiographic evidence of caries, but the presence of a carious lesion is suspected due to roughness, surface opacities, or staining. Such lesions may be difficult to detect¹⁻⁵ and often present a diagnostic challenge because of the difficulty in determining if the lesion has penetrated into dentin^{3, 6-7}. Non-invasive therapies (fluoride, sealant) are commonly recommended when lesions are confined to enamel or when dentinal lesions are inactive, while invasive treatments, such as preventive resin restorations or full restorations, are reserved for active lesions that have penetrated into dentin⁸⁻⁹. In the event of uncertainty, non-invasive treatments are recommended because the proportion of these lesions that progress is small and progression is seldom rapid^{8,10-11}. Ismail et al. found that although general dentists spend the bulk of their time restoring lesions, there is a growing interest in the preventive aspects of managing these lesions¹². It is pertinent to gather evidence from ongoing research studies that further evaluate the characteristics, diagnostic, management and treatment strategies in order to develop guidelines that can help dentists manage their patients and their oral health. Providing the appropriate care for these lesions may reduce the number of invasive procedures being

performed. This is important because invasive treatment initiates the almost-inevitable re-restoration cycle¹³.

Although suspicious occlusal caries lesions pose diagnostic difficulty and uncertainty, very little descriptive information is available. To our knowledge, only one study has been done to estimate the prevalence of SOCLs; it was done by the National Dental Practice-Based Research Network (“network”). The results of this study suggest that SOCLs are commonly encountered in daily clinical practice, with approximately 1/3 of patients exhibiting such lesions at a given time. On average, practitioners saw 55 patients a month with an unrestored occlusal surface, which translated into approximately 19 SOCLs encountered per month¹⁴. Additionally, this same study from the network found that almost one-half of the lesions for which practitioners performed invasive procedures did not penetrate clinically into dentin¹⁵. While a majority of dentists in the network subscribe to the “restorative threshold” of caries penetrating into dentin, their ability to preoperatively detect when this penetration has occurred is not optimal¹⁶. Given their high prevalence and scarcity of descriptive information, gaining a better understanding of these lesions is essential for informed treatment decision-making. The purpose of this study was to quantify the characteristics of SOCLs and their relationship to caries risk and lesion depth and activity, as judged by clinicians’ reports after they surgically opened these lesions.

METHODS

The results presented here were generated as a part of a larger study conducted in dental practices in the network. The network is a consortium of dental practices established to answer questions raised by dental practitioners in everyday clinical practice and to evaluate the effectiveness of strategies to prevent, manage and treat oral diseases and conditions^{17–18}.

Selection and recruitment process

Network practitioners were recruited by Regional Coordinators (RC) through letters and announcements sent to licensed practitioners from all six network regions (Western, Midwest, Southwest, South Central, South Atlantic, and Northeast). To be eligible for this study, practitioners had to complete an Enrollment Questionnaire (EQ), attend an orientation session or watch a video of it, and complete their training in human subjects’ protection. The EQ, which is publicly available at <http://nationaldentalpbrn.org/enrollment.php>, collects information about practitioner, practice, and patient characteristics. Once practitioners completed the requirements, the RC provided a training session with the practitioner and staff that included an overview of the study, steps to complete the necessary forms, and answered any questions they had related to the study. The network’s applicable Institutional Review Boards approved the study; all participants provided informed consent after receiving a full explanation of the procedures.

Study Design

Data were collected by network dentists (practitioners) in their offices. If a patient presented with a SOCL on a permanent molar, was 6 years of age or older, and consented (or if a minor, assented, in conjunction with parental/guardian consent) to participate in the study,

the practitioner completed data collection and patient characteristics forms using their typical examination procedures. These forms included specific information about the patient and lesion. Lesion characteristics queried included luster (chalky or shiny), color (opaque, white spot, yellow/light brown, dark brown/black, or other), and roughness of the surface with the use of an explorer (did not use an explorer, yes, or no roughness). Practitioners recorded patient risk factors, such as other teeth with caries lesions, restorations in the previous three years, visible heavy plaque, high cariogenic diet, inadequate saliva flow, and infrequent/unpredictable recall intervals. Practitioners then categorized their patients as “low” or “elevated” caries risk. Practitioners then recorded the treatment plan for the suspected lesion, which could have included monitoring, oral hygiene instruction, fluoride (in office or prescription), sealant with no preparation, enameloplasty, preventive resin restorations, or full restoration. Practitioners also indicated if the lesion was opened surgically, and if so, they recorded lesion depth (using the E0–E2, D1–D3 classification system¹⁹) and activity. E0 (no caries), inactive/arrested caries, active caries in the outer half of the enamel (E1), active caries in the inner half of the enamel (E2), active caries in the outer 1/3 of dentin (D1), active caries in the middle 1/3 of dentin (D2), or active caries in the middle 1/3 of dentin (D3). Additionally, practitioners were provided sample photographs of SOCL lesions as well as examples of stepwise removal of SOCL lesions to illustrate how to determine maximum penetration into enamel or dentin. Practices were asked to enroll approximately 20 lesions. Examples of the data collection forms are available at <http://nationaldentalpbrn.org/study-results/>.

Statistical Methods

The Rao-Scott cluster-adjusted chi-square test was used to evaluate associations between lesion depth and color, roughness, patient risk, and luster, accounting for clustering by dentist.

RESULTS

Practices/Practitioners and Patients

93 dentists from all six network regions participated. As shown in Table 1, of these 93 practitioners, 34 were female, 69 were non-Hispanic white, and 69 graduated from dental school more than 15 years prior to the study. The numbers of practitioners per region were fairly equally distributed, ranging from 13 in the Western region to 18 in the South Central region.

As shown in Table 1 for patients, 72% were 19 years of age or older, with a mean age ($\pm$ SD) of 32 ± 17 years. More than half (59%; $n=943$) were female and a majority (75%; $n=1,114$) were non-Hispanic white, (87%; $n=1,337$) had dental insurance and, for those 19 years old or older, approximately 1/3 had some college education or a bachelor's degree.

Tooth/Lesion

Overall, practitioners recorded data for 1593 lesions. As shown in Table 2, 64% ($n=1,019$) of lesions involved molars, 53% ($n=852$) presented with a chalky luster as opposed to shiny, 47% ($n=751$) were dark brown/black in color as opposed to yellow/light brown, opaque, or

white spot, and 69% (n=1,096) had a rough texture as opposed to smooth. More than 60% (n=991) of the patients did not present with caries risk factors such as heavy plaque, cariogenic diet, infrequent recall, or xerostomia. Almost all the lesions were diagnosed using an explorer or by air-drying (96%; n=1,534) and a majority were diagnosed using magnification (67%; n=1,065). Specific treatment for the SOCL included monitoring (38%; n=906), oral hygiene instruction (21%; n=487), and a full restoration (15%; n=362). When categorized by invasive vs non-invasive treatment received, less than one half (39%; n=612) of the lesions were treated through invasive means (sealant with tooth structure altered; enameloplasty; preventive resin restoration; or full restoration).

Treatment planned and corresponding lesion depth

For lesions receiving invasive treatment, there was a general pattern of more invasive planned treatment for lesions that were found to be deeper when opened (Table 3). Nearly three quarters of D1–D3 lesions had been planned for a full restoration, while 41% of E1–E2 lesions were so planned, and 13% of inactive/arrested lesions and no detectable lesions. Preventive resin restorations were more commonly planned for these latter lesions and for E1–E2 lesions (53% for both groups), with 15% of D1–D3 lesions so planned.

Appendix A shows a comparison between practitioners' estimated pre-treatment depth (n=1593) and the actual depth of those lesions treated invasively (n=585). For the lesions where practitioners estimated the depth to be E1, 88% (555/[638-5]) were not opened, and of those opened, 28% (22/[638-555-5]) were indeed E1 when opened. For lesions with an estimated depth of E2, 59% (241/[428-18]) were not opened, and of those opened, 38% (64/[428-241-18]) were indeed E2 when opened. For lesions with pre-operative estimates of depth at D1, 21% (71/[372-41]) were not opened, and of those opened, 48% (126/[372-41-71]) did indeed have an actual depth of D1.

Lesion color/luster, roughness, risk and lesion depth

There were clinical descriptive data for 585 of the 612 lesions treated invasively (27 patients did not return for final treatment). As shown in Table 4, within these 585 lesions, there were statistically significant associations between lesion depth and color (p=0.03), luster (p=0.04), and roughness (p=0.01), but no statistically significant association between lesion depth and caries risk of the patient (p=0.07).

With respect to lesion color, of the 204 invasively-treated lesions that were yellow/light brown, a little over half (54%; n=111) had caries into dentin. Conversely, of the 274 dark brown/black lesions that were opened, a majority (68%; n=186) had caries into dentin. The color of opened lesions with caries limited to the enamel was more equally distributed across the three color categories.

With respect to lesion luster, of the 393 chalky lesions that were opened surgically, a majority (66%; n=258) had caries into dentin. A little more than half (53%; n=101) of the 192 invasively-treated shiny lesions had caries into dentin.

A large majority (82%; n=477) of the 585 SOCL lesions in the study did have surface roughness. Of these 477 lesions with surface roughness that were opened, most (64%;

n=307) had caries into dentin. This is in contrast to the 89 opened SOCLs that had no surface roughness where ½ (49%; n=44) had dentinal caries.

As shown in Table 4, of the 585 patients with a SOCL that was opened surgically, about ½ (52%; n=305) were described by the practitioner as being in a patient at elevated caries risk. There was no significant association between the lesion depth and caries risk of the patient; of those patients who had a lesion opened and who were described as low riskn (n=280), 55% (n=155) had caries into dentin, compared to 67% (n=204) for those who had a lesion opened ad who were in the elevated risk group (n=305).

DISCUSSION

Dental care has slowly evolved from a time of restoring all carious lesions, regardless of size, to “early detection and management”⁸. Diagnosing caries can be thought of as a process that involves three steps: detection, assessment of the severity, and assessment of the activity²⁰, which will lead to an appropriate treatment plan. Assessment of severity and activity can be established by cues such as color, feel, and luster of the lesion²¹, as well as caries risk of the patient. Makhija et al. studied 2,603 SOCL in 82 practices¹⁴. Their findings showed that a majority of the lesions were on molars (69%), about ½ were chalky (49%), approximately ½ were rough (45%), and most were dark in color (85%). The lesions in our study had a higher percentage of surface roughness (69%) and a lower percentage that were dark in color (47%). A recent meta-analysis of 30 observational studies including more than 18,000 practitioners found that many practitioners still were choosing invasive treatment of enamel occlusal lesions²²; however, our study results showed that 61% of the lesions enrolled were were treated non-invasively.

For the Makhija study, the lesions were followed an average of 20 months at which time clinicians continued to monitor 927 (90%) of the 1,033 monitored lesions, sealed 61 (6%), and invasively treated 45 (4%)¹¹. This finding suggests that non-invasive treatment at baseline was appropriate for these lesions, and is consistent with another longitudinal study done by Hamilton et al¹⁰. The Hamilton et al, study was a randomized trial that evaluated air abrasion as compared to monitoring in 223 SOCLs. After two years, only 16% of the lesions in the monitoring arm had caries that progressed into dentin requiring invasive treatment. Given the evidence that, if done properly, non-invasive options such as sealants may be successful at arresting these types of lesions^{23–24}.

There are some limitations with our current study which investigated diagnosis and treatment as delivered in routine, “real world” clinical practice and therefore made no attempt to standardize or calibrate that diagnosis or treatment. Each practice was trained specifically for this study so as to standardize the data collection process, but no effort was made to standardize diagnostic or treatment methods for SOCLs – indeed, such standardization would not be desirable because an objective of the study was to determine the distribution of the characteristics of these lesions given the diagnostic methods that dentists normally use in routine practice. Additionally, in contrast to the previous studies that examined a random sample of teeth, the teeth included in this study were selected because the practitioner determined that the characteristics of the tooth and patient suggested that the

surface might have a lesion, hence the term “suspicious”. Because this study was observational in nature, not all teeth were treated surgically, so the lesion depth of the unopened teeth could not be determined. Network members are not recruited randomly, so factors associated with network participation (*e.g.*, an interest in clinical research) may make network dentists unrepresentative of dentists at large. While we cannot assert that network dentists are entirely representative, we can state that they have much in common with dentists at large, while also offering substantial diversity in these characteristics. This assertion is warranted because: 1) substantial percentages of network general dentists are represented in the various response categories of the characteristics in the Enrollment Questionnaire; 2) findings from several network studies document that network general dentists report patterns of diagnosis and treatment that are similar to patterns determined from non-network general dentists^{25–30} and 3) the similarity of network dentists to non-network dentists using the 2010 ADA Survey of Dental Practice³¹.

It is interesting to note that of the 204 lesions that were yellow/light brown and treated invasively, 46% (n=93) had no caries, inactive caries, or caries limited to the enamel and 54% (n=111) had caries into dentin. This is in contrast to the 274 dark brown/black lesions that were treated invasively, where 32% (n=111) had no caries, inactive caries, or caries limited to the enamel and 68% (n=88) had caries into dentin. This is in line with the findings from another study that found a correlation between color and lesion depth, in which darker lesions were more likely to have caries penetrating the dentin compared to the lighter lesions¹⁰. However, dark brown/black color apparently did not, by itself, influence practitioners’ decisions to open a lesion, as the prevalence of dark brown/black lesions was identical in both overall and opened lesions (47%).

There was a statistically significant association between surface roughness ($p=0.01$) and lesion depth. As the severity of the opened lesion depth increased, the percentage of “yes” to surface roughness also increased. The percentages ranged from almost none (3%; n=12) in the “no caries” category and gradually increased to 64% (n=307) in the “dentin” category. Roughness apparently did influence decisions to open lesions, as the prevalence of roughness was higher for opened lesions (82%; n=477) than for the overall sample (69%; n=1096). Similarly, chalky lesions were significantly associated with caries into the dentin, and apparently influenced practitioners’ decisions, with a greater prevalence of chalky lesions in the opened lesion group (66%; n=258) than in the overall sample (53%; n=852). Although there was not a statistically significant association between lesion depth and patient risk, it is interesting to note that persons at elevated risk had a high percentage of their lesions into dentin (67%; n=204), with small percentages of their SOCLs with no caries (3%; n=8), inactive caries (5%; n=16), or into the enamel only (25%; n=77). These findings are consistent with other studies that have shown that patients in elevated-risk categories are at greater risk for future caries and this is an important factor to consider when developing a treatment plan^{32–33}. Our results suggest that patient risk influenced decisions to open lesions, as elevated-risk prevalence was higher among opened lesions (52%; n=305) than in the overall sample (35%; n=554).

CONCLUSIONS

Despite the statistically significant associations between the clinical characteristics that we examined and the presence of caries extending into dentin, and despite the apparent use of these characteristics by the participating practitioners, these characteristics do not seem to be strong independent predictors of dentinal caries in clinical practice. In response to the question “When you treated the lesion, what did you find?”, practitioners reported active caries extending into the dentin of 359 of 585 lesions receiving surgical treatment (61%). Thus, this study found an overall false positive (defined as a lesion that is either: (1) not into dentin; or (2) inactive) rate for intervening due to dentinal caries was 39%. In addition, due to the design of our study, we cannot speak to the presence or absence of caries into dentin for the lesions that were unopened. Given the equivocal nature of the relationship between lesion characteristics and dentin penetration, practitioners should exercise caution before selecting surgical treatment. Until more-accurate means of detecting caries penetration into dentin become available, this study, along with recent literature that points to non-invasive management of early caries lesions³⁴, strengthen the recommendation that conservative management is the more-appropriate course for SOCLs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Sawle RF, Andlaw RJ. Has occlusal caries become more difficult to diagnose? Br Dent J. 1988; 164(7):209–211. [PubMed: 3163930]
2. Ketley CE, Holt RD. Visual and radiographic diagnosis of occlusal caries in first permanent molars and in second primary molars. Br Dent J. 1993; 174(10):364–370. [PubMed: 8494666]
3. Pine CM, Bosch JJ. Dynamics of and diagnostic methods for detecting small carious lesions. Caries Res. 1996; 30(6):381–388. [PubMed: 8946093]
4. Pitts NB. Diagnostic tools and measurements-impact on appropriate care. Community Dent Oral Epidemiol. 1997; 25(1):24–35. [PubMed: 9088689]
5. Ouellet A, Hondrum SO, Pietz DM. Detection of occlusal carious lesions. Gen Dent. 2002; 50(4): 346–350. [PubMed: 12640851]
6. Lussi A. Comparison of different methods for the diagnosis of fissure caries without cavitation. Caries Res. 1993; 27(5):409–416. [PubMed: 8242679]
7. Kidd EAM, Ricketts DNJ, Pitts NB. Occlusal caries diagnosis: a changing challenge for clinician and epidemiologists. J Dent. 1993; 21(6):323–331. [PubMed: 8258581]

8. Bader JD, Shugars DA. The evidence supporting alternative management strategies for early occlusal caries and suspected occlusal dentinal caries. *J Evid Based Dent Pract.* 2006; 6(1):91–100. [PubMed: 17138407]
9. Fejerskov, O., Kidd, E., editors. *Dental caries: the disease and its clinical management.* 2. Hoboken, N.J.: Wiley-Blackwell; 2008.
10. Hamilton JC, Dennison JB, Stoffers KW, Gregory WA, Welch KB. Early treatment of incipient carious lesions: a two-year clinical evaluation. *JADA.* 2002; 133(12):1643–1651. [PubMed: 12512664]
11. Makhija SK, Gilbert GH, Funkhouser E, Bader JD, Gordan VV, Rindal DB, Qvist V, Nørrisgaard P. National Dental PBRN Collaborative Group. Twenty-month follow-up of occlusal caries lesions deemed questionable at baseline: findings from the National Dental Practice-Based Research Network. *J Am Dent Assoc.* 2014; 145(11):1112–8. [PubMed: 25359642]
12. Ismail AI, Hasson H, Sohn W. Dental caries in the second millennium. *J Dent Educ.* 2001; 65(10): 953–959. [PubMed: 11699996]
13. Brantley CF, Bader JD, Shugars DA, Nesbit SP. Does the cycle of reresoration lead to larger restorations? *J Am Dent Assoc.* 1995; 126(10):1407–13. [PubMed: 7594013]
14. Makhija SK, Gilbert GH, Funkhouser EM, Bader JD, Gordan VV, Rindal DB, Bauer M, Pihlstrom DJ, Qvist V. National Dental PBRN Collaborative Group. The prevalence of questionable occlusal caries: findings from The Dental Practice-Based Research Network. *JADA.* 2012; 143(12):1343–1350. [PubMed: 23204090]
15. Makhija SK, Gilbert GH, Funkhouser E, Bader JD, Gordan VV, Rindal DB, Pihlstrom DJ, Qvist V. National Dental PBRN Collaborative Group. Characteristics, detection methods, and treatment of questionable occlusal carious lesions: findings from the National Dental Practice-Based Research Network. *Caries Res.* 2014; 48(3):200–207. [PubMed: 24480989]
16. Gordan VV, Bader JD, Garvan CW, Richman JS, Qvist V, Fellows JL, Rindal DB, Gilbert GH. Dental Practice-Based Research Network Collaborative Group. Restorative treatment thresholds for occlusal primary caries among dentists in the dental practice-based research network. *J Am Dent Assoc.* 2010; 141(2):171–84. [PubMed: 20123876]
17. Gilbert GH, Williams OD, Korelitz JJ, Fellows JL, Gordan VV, Makhija SK, Meyerowitz C, Oates TW, Rindal DB, Benjamin PL, Foy PJ. National Dental PBRN Collaborative Group. Purpose, structure, and function of the United States National Dental Practice-Based Research Network. *J Dent.* 2013; 41(11):1051–1059. [PubMed: 23597500]
18. Makhija SK, Gilbert GH, Rindal DB, Benjamin PL, Richman JS, Pihlstrom DJ. DBPRN Collaborative Group. Dentists in practice-based research networks have much in common with dentists at large: evidence from The Dental PBRN. *Gen Dent.* 2009; 57(3):270–275. [PubMed: 19819818]
19. Anusavice KJ. Present and future approaches for the control of caries. *J Dent Educ.* 2005; 69(5): 538–534. [PubMed: 15897335]
20. Ekstrand KR, Ricketts DN, Kidd EA. Occlusal caries: pathology, diagnosis and logical management. *Dent Update.* 2001; 28(8):380–7. [PubMed: 11764611]
21. Pitts NB, Stamm J. International Consensus Workshop on Caries Clinical Trials (ICW-CCT) Final Consensus Statements: Agreeing Where the Evidence Leads. *J Dent Res.* 2004; 83(Spec No C):C125–128. [PubMed: 15286139]
22. Innes NPT, Schwendicke F. Restorative thresholds for carious lesions: systematic review and meta-analysis. *J Dent Res.* 2017; 96(5):501–508. [PubMed: 28195749]
23. Fontana M, Platt JA, Eckert GJ, Gonzales-Cabezas C, Yoker K, Zero DT, Ando M, Soto-Rojas AE, Perters MC. Monitoring of sound and carious surfaces under sealants over 44 months. *J Dent Res.* 2015; 93(11):1070–1075.
24. Dorri M, Dunne SM, Walsh T, Schwendicke F. Micro-invasive interventions of managing proximal dental decay in primary and permanent teeth. *Cochrane Database Syst Rev.* 2015; 5(11)
25. Makhija SK, Gilbert GH, Rindal DB, Benjamin PL, Richman JS, Pihlstrom DJ, Qvist V. DPBRN Collaborative Group. Practices participating in a dental PBRN have substantial and advantageous diversity even though as a group they have much in common with dentists at large. *BMC Oral Health.* 2009; 9:26. [PubMed: 19832991]

26. Makhija SK, Gilbert GH, Rindal DB, Benjamin PL, Richman JS, Pihstrom DJ. DPBRN Collaborative Group. Dentists in practice-based research networks have much in common with dentists at large: evidence from the Dental Practice-Based Research Network. *Gen Dent.* 2009; 57(3):270–5. [PubMed: 19819818]
27. Gordan VV, Garvan CW, Heft MW, Fellows JL, Qvist V, Rindal DB, Gilbert GH. DPBRN Collaborative Group. Restorative treatment thresholds for interproximal primary caries based on radiographic images: findings from the Dental Practice-Based Research Network. *Gen Dent.* 2009; 57(6):654–63. quiz 64–6, 595, 680. [PubMed: 19906618]
28. Gordan VV, Garvan CW, Richman JS, Fellows JL, Rindal DB, Qvist V, Heft MW, Williams OD, Gilbert GH. DPBRN Collaborative Group. How dentists diagnose and treat defective restorations: evidence from the dental practice-based research network. *Oper Dent.* 2009; 34(6):664–73. [PubMed: 19953775]
29. Norton WE, Funkhouser E, Makhija SK, Gordan VV, Bader JD, Rindal DB, Pihlstrom DJ, Hilton TJ, Frantsve-Hawley J, Gilbert GH. National Dental PBRN Collaborative Group. Concordance between clinical practice and published evidence: findings from The National Dental Practice-Based Research Network. *J Am Dent Assoc.* 2014; 145(1):22–31. [PubMed: 24379327]
30. Gilbert GH, Riley JL III, Eleazer PD, Benjamin PL, Funkhouser E. National Dental PBRN Collaborative Group. Discordance between presumed standard of care and actual clinical practice: the example of rubber dam use during root canal treatment in the National Dental Practice-Based Research Network. *BMJ Open.* 2015; 5(12):e009779.
31. American Dental Association Survey Center. The 2010 Survey of Dental Practice. Chicago: American Dental Association; 2012.
32. Arrica M, Carta G, Cocco F, Grazia Cagetti M, Sale S, Ierardo G, Strohmenger L, Ottolenghi L, Campus G. Does a social/behavioural gradient in dental health exist among adults? A cross-sectional study. *J Int Med Res.* 2017 epub ahead of print.
33. Hujoel PP, Lingstrom P. Nutrition, dental caries, and periodontal disease: a narrative review. *J Clin Periodontol.* 2017; 44(Auppl 18):S79–84. [PubMed: 28266117]
34. Wright JT, Tampi MP, Graham L, Estrich C, Crall JJ, Fontana M, Gillette EJ, Nový BB, Dhar V, Donly K, Hewlett ER, Quinonez RB, Chaffin J, Crespín M, Iafolla T, Diegal MD, Carrasco-Labra A. Sealants for preventing and arresting pit-and-fissure occlusal caries in primary and permanent molars: A systematic review of randomized controlled trials-a report of the American Dental Association and the American Academy of Pediatric Dentistry. *JADA.* 2016; 147(8):631–645. [PubMed: 27470524]

Table 1

Number (%) of practice/practitioner and patient characteristics *

Practice/Practitioner n=93	
Gender	
Male	59 (63)
Female	34 (37)
Race	
Non-Hispanic White	69 (75)
Non-Hispanic Black	7 (7)
Other	16 (18)
Years since graduation	
<5	6 (7)
5–15	18 (19)
>15	69 (74)
Region	
Western	13 (14)
Midwest	14 (15)
Southwest	17 (18)
South Central	18 (19)
South Atlantic	16 (17)
Northeast	15 (16)
Patient n=1593	
Age	
<19 years	443 (28)
19 years	1147 (72)
Mean age (SD)	32 (17)
Gender	
Male	650 (41)
Female	943 (59)
Race	
Non-Hispanic White	1114 (75)
Non-Hispanic Black	237 (16)
Other	125 (8)
Any dental insurance	
Yes	1337 (87)
No	207 (13)
Education[±]	

Less than high school diploma	20 (2)
High school graduate	149 (13)
Some college	393 (34)
Bachelor's degree	368 (32)
Graduate Degree	205 (18)
Decline to answer	12 (1)

* Not all columns add to 1593 due to missing values.

⁺ For those 19 years of age

Table 2

Tooth, lesion, diagnostic and treatment characteristics * (%)

Tooth/Lesion n=1593	
Tooth Number	
Molar	1019 (64)
Premolar	575 (36)
Luster	
Chalky	852 (53)
Shiny	741 (47)
Color	
Yellow/light brown	637 (40)
Dark brown/black	751 (47)
Other	105 (13)
Surface roughness	
Yes	1096 (69)
No	458 (29)
Did not use an explorer	39 (2)
Patient's Risk Factors	
Heavy plaque	273 (17)
Cariogenic diet	268 (17)
Infrequent recall	28 (2)
Xerostomia	326 (21)
None of the above	991 (62)
Patient's Overall Risk Level	
Low	1039 (65)
Elevated	554 (35)
Diagnostic Aids Used for this SOCL	
Dental explorer	1534 (96)
Air drying	1507 (95)
Magnification	1065 (67)
Radiographs	942 (59)
Specific Treatment Done for this SOCL [±]	
Monitor	906 (38)
Oral hygiene instruction	487 (21)
In-office fluoride	206 (9)
Prescription fluoride	78 (3)

Sealant (no preparation)	67 (3)
Enameloplasty	45 (2)
Preventive resin restoration	205 (9)
Full restoration	362 (15)
Categorized Treatment Done for this SOCL	
Non-invasive (monitor, OHI, fluoride, sealant)	933 (61)
Invasive (sealant that alters tooth structure, enameloplasty, preventive resin restoration, full restoration)	612 (39)

* Not all columns add to 1593 due to missing values.

[±] More than one choice was permitted so columns add up to more than 1593

Table 3

Treatment planned ^{*} and corresponding lesion depth for lesions treated invasively (%) n=589[±]

Treatment	No Caries	Inactive/Arrested Caries	E1	E2	D1	D2	D3	Pt did not return for treatment
Enameloplasty (n=36)	7 (37)	11 (27)	2 (5)	5 (4)	3 (2)	1 (1)	0 (0)	7 (14)
Preventive resin restoration (n=186)	8 (42)	24 (58)	27 (63)	54 (49)	36 (26)	11 (9)	3 (9)	13 (27)
Full restoration (n=356)	2 (11)	6 (15)	13 (30)	49 (44)	128 (71)	99 (88)	31 (91)	28 (57)
Enameloplasty and preventive resin restoration (n=5)	1 (5)	0 (0)	1 (2)	1 (1)	2 (1)	0 (0)	0 (0)	0 (0)
Enameloplasty and full restoration (n=1)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Preventive resin restoration and full restoration (n=5)	1 (5)	0 (0)	0 (0)	1 (1)	0 (0)	2 (2)	0 (0)	1 (2)
Total (n=589)	19	41	43	110	180	113	34	49

^{*} More than 1 treatment could be chosen

[±] 35 lesions were indicated as not having been opened based on Q12 despite an invasive treatment chosen in Q 11.

Table 4

Overall, color, luster, risk, surface roughness, and lesion depth for lesions treated invasively (n=585) (%)

Lesion depth	Response to the question “When you opened the lesion, what did you find?”			
No caries	22 (4)			
Inactive caries	42 (7)			
Enamel	162 (28)			
Dentin	359 (61)			
Lesion color				
	Yellow/light brown N=204	Dark brown/black N=274	Other * N=107	P-value
No caries	12 (6)	3 (1)	7 (7)	0.03
Inactive caries	12 (6)	22 (8)	8 (7)	
Enamel	69 (34)	63 (23)	30 (28)	
Dentin	111 (54)	186 (68)	62 (58)	
Lesion luster				
	Chalky N=393	Shiny N=192		P-value
No caries	14 (4)	8 (4)		0.04
Inactive caries	22 (5)	20 (10)		
Enamel	99 (25)	63 (33)		
Dentin	258 (66)	101 (53)		
Surface roughness				
	Did not use an explorer N=19	No N=89	Yes N=477	P-value
No caries	1 (5)	9 (11)	12 (3)	0.01
Inactive caries	1 (5)	10 (11)	31 (6)	
Enamel	9 (47)	26 (29)	127 (27)	
Dentin	8 (43)	44 (49)	307 (64)	
Patient risk				
	Low N=280	Elevated N=305		P-value
No caries	14 (6)	8 (3)		0.07
Inactive caries	26 (9)	16 (5)		
Enamel	85 (30)	77 (25)		
Dentin	155 (55)	204 (67)		

* Other includes opaque, white spot lesion, and all descriptions other than yellow/light brown or dark brown/black.