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Differences Between Reported And Actual Restored Caries Lesion Depths: Results From The Dental PBRN

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Abstract

Objective—The objectives of this research were to (1) quantify the discordance between the caries lesion depth at which dentists restored initial lesions during a clinical study (“actual depth”) and the lesion depth that they reported during a hypothetical clinical scenario (“reported depth”); (2) test the hypothesis that certain practitioner, practice, patient, and caries lesion characteristics are significantly associated with this discordance.

Methods—Practitioner-investigators who perform restorative dentistry in their practices completed an enrollment questionnaire and participated in two consecutive studies on caries diagnosis and treatment. The first study was a survey asking about caries treatment. The second study collected data on restorations placed in routine clinical practice due to caries in patients over 19 years of age on occlusal surfaces only or proximal surfaces only. We report results on 2691 restorations placed by 205 dentists in 1930 patients with complete data.

Results—Discordance between actual depth and reported depth occurred in only about 2% of the restorations done due to proximal caries, but about 49% of the restorations done due to occlusal caries. Practice type, restorative material used and the diagnostic methods used were significantly associated with discordance.

Conclusion—Dentists frequently restored occlusal caries at a shallower depth as compared to their reported depth, but the discordance was very small for proximal lesions. Discordance for occlusal caries was more common when radiographs were not taken or if a resin restoration was placed.

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⁷The DPBRN Collaborative Group includes practitioner-investigators, faculty investigators and staff investigators who contributed to this DPBRN activity. A list is at www.dpbrn.org/users/publications/Default.aspx

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Keywords

Caries; threshold; restoration; remineralization; decision making

INTRODUCTION

Dental caries is a prevalent infectious disease(1–4) with a significant impact on dental health services. Restorative treatments represent the bulk of general dentists' workload and they are expected to increase dramatically due to high caries prevalence in the aging population(4). Despite major advancements in caries prevention, placement of restorations and extraction of teeth remain widespread and may even be the norm(5–7). Many ways to decrease the number of restorations have been suggested. Accurate pre-operative diagnosis of caries depth(8), clear treatment guidelines, and provider feedback on their caries management performance are just a few.

Many dentists routinely perform operative procedures on caries lesions that still have a chance to remineralize. In 2002, the Hamilton study(9) found that “watching” an incipient caries lesion and intervening operatively after two years if deemed necessary did not result in a larger restoration. Early stages of caries lesions may be arrested or “healed”(10–11). At present, the American Dental Association Council on Scientific Affairs recommendations for caries restorative threshold is against surgically restoring caries confined to enamel due to their potential to arrest and remineralize(12–13). Despite this recommendation, many dentists continue to intervene when caries are still in enamel. Moreover, marked variations exist among clinicians and teachers of restorative dentistry in caries management and prevention(13–15). Of particular importance for long-term caries management is the decision to place the first restoration on a tooth surface(16). This moment often is the beginning of an unfortunate cycle of restoration replacement over subsequent decades. Each succeeding restoration is progressively larger, ultimately leading to a large restoration that places the tooth at substantially increased risk for endodontic treatment or extraction(17–21).

The decision to place the first restoration influences not only the tooth prognosis, but also the cost of treatment over lifetime(22–23). Restorative decisions affect future assessments of patient caries risk because they are based in part on the number of existing restorations(24–27) and may influence future restorative treatments decisions for the patient. Reducing overtreatment of early caries will postpone the beginning of the restoration replacement cycle, decrease the restoration burden in dental practice, improve oral health and reduce the overall cost of care(28).

Most studies to date have evaluated dentists' caries restorative thresholds through questionnaires(8, 29–31). There is only limited information on the discordance between dentists' reported and actual intervention depths(32–33). The ability of dentists to adequately assess the treatment they provide will be a necessary first step in improving quality of care.

The objectives of this research were to: (1) quantify the discordance between the caries lesion depth at which dentists restored initial lesions during a clinical study (“actual depth”) and the lesion depth that they reported restoring caries for a hypothetical clinical scenario (“reported depth”); (2) test the hypothesis that certain practitioner, practice, patient, and caries lesion characteristics are significantly associated with this discordance. The research setting is The Dental Practice-Based Research Network (DPBRN) based in the United States of America with a Scandinavian region. This network is a consortium of dental practices

with a broad representation of practice types, dentists, and treatment philosophies conducting research with the ultimate goal of improving quality of care in dental practices(34–36).

MATERIALS AND METHODS

Selection and recruitment process

We recruited 229 DPBRN enrolled dentists, commonly referred to as practitioner investigators (p-is), who performed restorative dentistry in their practices, completed a 101-item enrollment questionnaire that collected data on provider and practice characteristics and participated in two consecutive studies on caries diagnosis and treatment. The first study was a survey asking the dentist about how they diagnose and treat caries. The aims of this study were to: (a) quantify the percentages of DPBRN dentists who report using selected methods for caries diagnosis; (b) quantify the percentage of DPBRN dentists who report using a caries-risk assessment protocol of any variety; (c) quantify the percentages of DPBRN dentists who report intervening surgically at various caries depths. The second study was an observational clinical study collecting data during routine clinical practice on restorations placed due to caries on previously unrestored surfaces. The aims for this study were to: (a) quantify DPBRN p-i pre-operative and post-operative assessments of the depth of the caries lesion being treated; and (b) quantify the prevalence of dental material types used to restore the first restoration in a permanent tooth surface. The study recorded the main reason that the restoration was placed, the preoperative and postoperative depth of the caries lesion on the previously unrestored surface, and the type of dental restorative material that was used. P-is and their staff were trained by research coordinators regarding the protocol and data collection forms. The p-is recorded information about an average of 50 consecutive restorations that they placed on unrestored permanent tooth surfaces. The study collected data on 8,351 consecutive restorations inserted due to primary caries in 5,810 patients. We included only restorations placed due to caries lesions that were limited to the occlusal surface or the proximal surface. This resulted in a sample consisting of 3001 restorations placed by 216 practitioners. Of these, 2691 restorations placed by 205 dentists in 1930 patients had complete data for both reported and actual depths, and were included in the current report. An adequate representation of p-is from all five main DPBRN regions was obtained: Alabama/Mississippi (AL/MS), Florida/Georgia (FL/GA), HealthPartners and private practice dentists in Minnesota (MN), Permanente Dental Associates dentists (PDA) in Oregon/Washington, and Denmark, Norway, and Sweden (SK). These studies were approved by the respective Institutional Review Board (IRB) of all participating regions.

Data collection process

Data from the DPBRN enrollment questionnaire and two sequential cross-sectional studies were used. The DPBRN enrollment questionnaire and the data collection forms for DPBRN Studies 3 (survey questions 30–34) and Study 4 (clinical data collection form) are provided as supplements to the publications section of the DPBRN website (<http://www.dentalpbrn.org/users/publications/Supplement.aspx>). The first study had p-is complete a survey on practice patterns in which photos of occlusal caries and radiographs of proximal caries in successive caries depth levels were presented. They were asked to indicate the caries threshold at which they would intervene surgically in two scenarios: high- and low-risk patients (Figure 1). The survey also asked about patient-level characteristics considered in making clinical decisions (active caries lesion, recent caries, several large restorations, current oral hygiene, presence of dental appliances, access to fluoride, diet, decreased salivary function, your subjective assessment of the patient, patient knowledge of caries progression, patient commitment to follow-up, age and socio-economic status). This question provided the patient-level variables described below. In a subsequent clinical study,

p-is reported the pre-treatment caries depth on 50 consecutive first restorations at which they restored a previously un-restored surface. Only proximal and occlusal caries were included in the current report. For the clinical study DPBRN clinicians were asked to estimate the caries lesion depth pre-operatively {E1 (outer ½ of enamel), E2 (inner ½ of enamel), D1 (outer 1/3 of dentin), D2 (middle 1/3 of dentin), D3 (inner 1/3 of dentin)} by using whatever diagnostic methods (clinical assessments including probing, radiographs, transillumination or optical technique-such as Diagnodent were the options on the data collection form) they used. The surveys and data collection forms were pilot-tested to assess the feasibility and comprehension of each questionnaire item.

Variable selection

Several variables were considered as possibly associated with discordance between reported and actual depths. Dentist demographics and practice characteristics (obtained from the enrollment questionnaire) included in the analysis were: gender, race, ethnicity, years since graduation, practice type (large group practice, public health clinic and small private practice), workload and use of caries risk assessment (yes/no response). Patient-level factors which could influence p-is' treatment decisions were also analyzed. They included: patient's age, gender, ethnicity, and dental insurance. Lesion characteristics considered were tooth type (molar, premolar, etc.) and the practitioner's pre-operative estimates of lesion depth. Restorative material (amalgam, composite resin, indirect composite resin, glass ionomer, ceramic, cast metal, combined ceramic/metal or temporary restoration) and diagnostic methods were also tested for significant association with discordance.

Statistical Analysis

Statistical analysis was conducted using SAS software version 9.2 (Cary, N.C.). Because only occlusal and proximal caries scenarios were included in the survey and only those resulted in reported caries threshold data, caries with other surface involvement were excluded from this analysis. To insure an unbiased data set, caries on more than one tooth surface such as occlusal-proximal caries, were excluded from the analysis as well.

Restored lesions were categorized as either "actual is less than reported" or "actual is greater than or equal to reported". Unadjusted counts and percentages of actual depths that were less than the reported depths were calculated for each level of categorical predictor variables. Statistical significance of associations between underestimation (actual < reported) was evaluated using restoration-level analyses based on generalized estimating equation modeling to account for clustering due to multiple observations within practitioner and patient. Separate analyses were conducted for occlusal and for proximal lesions.

RESULTS

A total of 2691 restorations placed by 205 dentists in 1930 patients had complete data for both actual depths (clinical data) and paired reported responses (dentist's response to the hypothetical scenario on the survey), and were included in these results. Most restorations were placed to treat lesions that had extended to a D1 (57.6%) depth, followed by D2 (24.2%), E2 (8.9%), D3 (6.7%), and E1 (2.6%). Of all the restorations with complete data on tooth type and surfaces with caries involvement, 39% were Class II, 32% were Class I, 16% Class III, and 2% were Class V restorations. Of these, 1122 occlusal caries restorations and 1569 proximal caries restorations were included in the current report.

Table 1 summarizes the relationship between actual and reported caries threshold by caries location. There is agreement or concordance between the reported and actual treatment for about 29% of occlusal and 36% of proximal caries. As previously stated, we were most

interested in the discordance where dentists intervened with a restoration at actual caries depths less than reported depths. We found that this occurred for only about 2% of the restorations done to treat proximal caries, but for about 49% of the restorations done to treat occlusal caries.

We examined several dentist and patient characteristics that were associated with discordance as shown in Table 2. Most of the variables were not significant in the multivariate model. We found a significant association of practice type, with large group practice having a higher rate of discordance. Patient race was found to be marginally significant.

Next we examined the choice of materials to restore the occlusal surface. We found that amalgam (vs. not using amalgam) was associated with actual not less than reported depth for occlusal surfaces ($p = 0.0007$). Amalgam was used on 35% of lesions with actual less than reported, versus 44% of lesions for which actual was not less than reported. Direct resin was also associated with actual being less than reported ($p = 0.0005$), being used on 62% of lesions with actual less than reported and 52% of lesions with actual not less than reported. In other words, direct resin is used more frequently in occlusal lesions that are restored at a lesser actual depth than reported.

When we examined the diagnostic methods associated with discordance, we found that clinical assessments were not associated, being used in 92% of actual reported lesions and 93% of those not less than reported ($p = 0.2036$). Radiographs were associated with less discordance, being used in 42% of the restorations in which the actual depth was less than the reported depth, 54% of those not less than reported ($p < 0.0001$). Optical techniques were used infrequently and not found to be significant ($p = 0.0957$).

DISCUSSION

The difference between providers' perception of the treatment rendered and actual treatment is a well recognized and worthy problem in medicine and dentistry(32, 37–39). Our findings are in line with current literature.

Our questionnaire included photographs for occlusal caries and radiographs for proximal caries. Thus, part of the variation may be explained by the difference in the clinical estimation of caries depth through photographs provided in a survey and actual clinical examination. Radiographs are more readily duplicated with a high quality photograph. This is consistent with observing a larger concordance between reported and actual treatments for proximal caries. Most dentists use radiographs to diagnose proximal caries. The presence of radiographs for proximal caries in our survey coincides with the way p-is diagnose proximal caries in their daily practice and explains why a smaller percentage of dentists were discordant for these lesions. When dentists used radiographs to diagnose occlusal caries, the concordance was higher compared to when they relied on clinical examination only. These findings suggest that different diagnostic methods impact actual treatment decisions.

Material used to restore an occlusal surface was associated with the dentist's decision to restore the surface earlier than predicted(21). Possibly the dentist sees a resin restoration as less damaging to the tooth surface and will be more comfortable making the decision to restore the occlusal surface when unsure of the actual depth of the caries lesion. An alternative explanation is that when the dentist removes the caries and the lesion is shallow, resin is more commonly selected to restore the tooth.

Practice type was associated with the level of discordance for occlusal surfaces. When examining the reported data, dentists in large group practice report intervening on caries at

later stages. This higher rate of discordance suggests that often is not the case. We also need to consider the possibility that large group practices see more new patients or patients who had been seen by another dentist. This may result in a different practice pattern because of uncertainty about current caries status.

Ideally treatment decisions should reflect the oral and general health of the patient. Most literature in dentistry describes tooth, patient, dentist, and practice characteristics as important factors in treatment decisions(40–43). However, treatment pattern variations have been linked to many other factors, such as type of visit (emergency vs. non-emergency)(44), dentist specialty status(45), patient preference(46), patient-dentist relation(47), and uncertainty of diagnosis(48) or treatment outcomes(40). It is possible that some of these factors also played a role in the difference between the reported caries treatment threshold and the clinical treatment provided but we were not able to measure them. The dentist and patient level factors included in our study were not statistically significant predictors of the underestimation of restorative caries threshold.

These results also support the need for better diagnostic criteria that improve our ability to discriminate the caries depth and avoid unnecessary invasive treatment. This need is most apparent for occlusal caries.

CONCLUSION

The decision regarding which caries lesion depth to intervene surgically is an important event in the life of a tooth. The substantial discordance between actual and reported depths for occlusal surfaces suggests the need for definitive diagnostic methods to improve consistency of clinical decision-making for these surfaces. Use of radiographs and other factors may explain this discordance.

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SECTION 5: Please use the following guide for the treatment codes used in questions 30-32. For each tooth, circle the letter which corresponds to the treatment option you would recommend for each of the first lesions. If treatment code "0" (none) is chosen, please identify the way you would treat the tooth (amalgam, composite, etc.).

1. No treatment today. Refer the patient regularly.	6. Medical filling and preventive resin restoration.
2. In-office fluoride.	7. An amalgam and a sealant.
3. Amalgam rest and prescription fluoride.	8. An amalgam and a preventive resin restoration.
4. Prescription for fluoride.	9. Composite restoration and preventive resin restoration.
5. One indirect or indirect resin over tooth (orthodontic bracket).	10. Composite restoration and preventive resin restoration.
11. Medical filling and sealant.	12. Other treatment (Please specify):

30. Suppose the patient is a 10-year-old child with no relevant medical history. She has no caries and is in your office today for a routine visit. She has no dental restorations, no dental caries, and is not missing any teeth. Circle the letter that best describes the treatment you would recommend for the tooth.

31. Now suppose the patient has 12 teeth with existing dental restorations, heavy plaque and calculus, multiple Class V white spot lesions, and is not missing any teeth. Circle the letter that best describes the treatment you would recommend for the tooth.

32. Now suppose the patient is a 10-year-old child with no relevant medical history. She has no caries and is in your office today for a routine visit. She has no dental restorations, no dental caries, and is not missing any teeth. Circle the letter that best describes the treatment you would recommend for the tooth.

SECTION 6: For questions 33 & 34, please circle the one number that corresponds to the lesion depth at which you think it is best to do a permanent restoration (composite, amalgam, etc.) instead of only doing preventive therapy?

33. Suppose the patient is a 30-year-old female with no relevant medical history. She has no complaints and is in your office today for a routine visit. She has been attending your practice once every two years on a regular basis for the past 6 years. She has no dental restorations, no dental caries, and is not missing any teeth.

34. Now suppose the patient has 12 teeth with existing dental restorations, heavy plaque and calculus, multiple Class V white spot lesions, and is not missing any teeth. At what lesion depth do you think it would be best to do a permanent restoration instead of only doing preventive therapy?

Figure 1.
Relevant questions from the dentist survey.

Table 1

Comparison between actual caries lesion depth at which a restoration was done compared to the depth reported during a hypothetical clinical scenario

<i>Occlusal</i>						
	Actual < Reported		Actual = Reported		Actual > Reported	
	N	%	N	%	N	%
Actual						Total
E1	52	96.3	2	3.7	0	0.0
E2	139	81.3	29	20.0	3	1.8
D1	352	55.4	199	31.3	84	13.2
D2	5	2.3	90	40.7	126	57.0
D3	0	0.0	2	4.9	39	95.1
Total	548	48.8	322	28.7	252	22.5
<i>Proximal</i>						
	Actual < Reported		Actual = Reported		Actual > Reported	
	N	%	N	%	N	%
						Total
E1	16	100.0	0	0.0	0	0.0
E2	11	15.5	56	78.9	4	5.6
D1	10	1.1	494	54.0	411	44.9
D2	0	0.0	10	2.3	419	97.7
D3	0	0.0	0	0.0	138	100.0
Total	37	2.4	560	35.7	972	62.0
						1569

Table 2

Dentist and patient characteristics (p-values) as predictors of discordance between actual and reported depths

	Proximal			Occlusal		
	univariate	block	Final multivariate	univariate	block	Final multivariate
<i>Dentist Characteristics</i>						
Gender	0.5467			0.1757		
Race	*			0.3780		
Hispanic	0.5132			0.2558		
Years Since Graduated	0.0677	0.0677	0.7382	0.8743		
Type of practice	0.5038			0.0020	0.0077	<0.0001 **
Workload	0.7940			0.1233		
Caries Risk						
Assessment	0.7152			0.0680	0.3052	
<i>Patient Characteristics</i>						
Gender	0.3074			0.2987		
Race	*			0.0268	0.0268	0.0716
Ethnicity	0.8825			0.9576		
Dental						
Insurance	0.0171	0.0171	0.179	0.4492		
Age	0.5362			0.4865		

* estimation algorithm failed due to small cell frequencies

** large group practice vs. small private practice is significant