Published in final edited form as:
J Dent. 2014 December ; 42(12): 1528–1534. doi:10.1016/j.jdent.2014.09.005.

The decision to repair or replace a defective restoration is affected by who placed the original restoration: findings from the National Dental PBRN

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Abstract

Objectives—To evaluate how restoration characteristics are associated with the decision to repair or replace an existing restoration. The following hypotheses were studied: Dentists who placed the original restoration are more likely to repair instead of replace restorations (H1) that are in molar teeth; (H2) that are in the upper arch; (H3) that have amalgam restorative material; (H4) if a fracture is not the primary reason for the defect; and (H5) when the restoration comprises more than one surface.

[g]The National Dental Practice-Based Research Network Collaborative Group includes practitioners, faculty and staff investigators who contributed to this network activity. A list of these people is available at http://nationaldentalpbrn.org/collaborative-group.php under the title “Reasons for Replacement or Repair of Dental Restorations.”

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Disclosure. None of the authors reported any disclosures.

Methods—This cross-sectional study used a consecutive patient/restoration recruitment design. 194 dentists members of a dental practice-based research network recorded data on restorations in permanent teeth that needed repair or replacement.

Results—For 6,623 of the 8,770 defective restorations in 6,643 patients, the treatment was provided by the dentist who had not placed the original restoration (75%). The 2-way interaction revealed that dentists who had placed the original restoration often chose to repair when the defective restoration was in a molar, relative to premolar or anterior teeth (OR = 2.2, $p < .001$); and chose to replace when the restoration had amalgam (OR = 0.5, $p < .001$), and when it was a fracture compared to another reason (OR = 0.8, p = 001).

Conclusion—Most dentists are not conservative when they revisit a restoration that they originally placed regardless of type of failure, number of surfaces or material used. However, dentists who had placed the original restoration were significantly more likely to repair it when the defective restoration was in a molar tooth.

Introduction

Every day most general dentists devote a large portion of their clinical time examining existing restorations.[1, 2, 3, and 4] When clinicians deem a restoration defective, four main scenarios are usually encountered: 1) the restoration is fractured; 2) the margin of the restoration is ditched; 3) the margin of the restoration has caries; or 4) the margin of the restoration is stained. The diagnosis that relates to the presence of caries or staining around the margins of restorations is inconsistent among dental practitioners and it often does not rely on objective criteria.[5, 6, and 7] When deciding on what treatment to provide to a defective restoration, dentists are faced with multiple treatment options, e.g., replacement, repair, sealant, polishing, or no treatment. Despite these options, most dentists decide to replace an existing restoration that deviates from the ideal, regardless of its location and longevity.[8, 9, and 10] Studies have also suggested that change in the dental care provider significantly increases the odds of patients receiving new restorations.[11, 12, 13, 14, and 15]

Previous clinical studies conducted in practice-based settings have also indicated that restorations involving multiple surfaces have lower longevity than restorations with a single surface.[16] Tooth type also seems to have an effect on restoration longevity, with molars demonstrating lower long-term success rates than anterior teeth.[17]

Based on a previous study, we have already established that dentists who placed the original restoration are more likely to repair than replace an existing restoration, compared to a dentist who is not the one who placed the defective restoration.[18] The aim of this secondary analysis was to evaluate how restoration characteristics are significantly associated with the decision to repair or replace an existing restoration, as a function of who placed the original restoration. The following hypotheses were studied: Dentists who placed the original restoration are more likely to repair instead of replace restorations (H1) that are in molar teeth; (H2) that are in the upper arch; (H3) that have amalgam restorative material; (H4) if a fracture is not the primary reason for the defect; and (H5) when the restoration comprises more than one surface.

Method

Selection and recruitment process

This cross-sectional study included 194 dentists of the National Dental Practice-Based Research Network (the "network"), a consortium of dental practices and dental organizations focused on improving the scientific basis for clinical decision making.[19] The network was funded in 2012 and builds on the former regional dental networks, including the Dental Practice-Based Research Network (DPBRN), that existed from 2003 to 2012.[20] The DPBRN was established in 2003 with a seven-year grant from the National Institute of Dental and Craniofacial Research, National Institutes of Health. The data for this study were collected under the auspices of the DPBRN from 2008 to 2009. That organization subsequently evolved into The National Dental PBRN, under the aegis of which we prepared the manuscript of this article.

At the time of this study, the network was composed primarily of clinicians from five regions: Alabama/Mississippi; Florida/Georgia; dentists in Minnesota, either employed by HealthPartners in Bloomington, Minn., or in private practice; Permanente Dental Associates, in cooperation with Kaiser Permanente's Center for Health Research in Portland, Ore.; and dentists from Denmark, Norway and Sweden. Each of the 194 participating dentists recorded data for 50 or more consecutive restorations deemed defective during clinical visits. Practice structures differed by network region. Dentists from the AL/MS and FL/GA regions were primarily from solo or small group practices, MN and PDA dentists were primarily from large group practices, and SK dentists were in public or private health care settings. The Institutional Review Boards of each participating region approved the study.

Network dentists were recruited through continuing education courses and/or mass mailings to licensed dentists within the participating regions. As part of the eligibility criteria, all dentists completed (1) an enrollment questionnaire describing their demographic and practice characteristics and certain personal characteristics, (2) an assessment of caries diagnosis and caries treatment questionnaire, (3) a training in human subjects protection, and (4) a in-practice network orientation session with the regional coordinator. Additional requirements varied by network region and are described elsewhere.[21] Copies of the questionnaires and summary data for dentists' demographic and practice characteristics are also available at http://www.dpbrn.org/users/publications/Default.aspx and elsewhere.[22 and 23]

This study used a consecutive patient/restoration recruitment design. Once the study was started, every patient scheduled to have a repair or replacement of a restoration on a permanent tooth was asked to participate until 50 restorations were enrolled. Patients who returned for additional appointments while data collection was still ongoing were not eligible for further data collection. In order to increase the numbers of patients only restorations eligible during the first appointment were enrolled and only a maximum of four eligible restorations per patient during that first appointment were included. A consecutive patient/restoration log form was used to record information on eligible restorations whether or not the patient participated in the study. All the data collection forms used for this study are available at http://www.DentalPBRN.org/users/publications/Supplement.aspx.

Variable selection—Replacement of the restoration was characterized as the removal of the defective original restoration and any adjacent pathologically altered and discolored tooth tissue that was esthetically unacceptable. Repair was characterized as the conservative removal of part of the defective original restoration and any adjacent pathologically and/or discolored enamel/dentin tissues that were esthetically unacceptable followed by placement of restorative material. Repair also included light grinding and polishing; removal of overhangs, polishing discolored tooth-colored restorations, or sealing margins. Functioning restorations that had not failed but were replaced to become part of a larger restoration were not recorded as replacements.

Dentists collected data for each enrolled restoration that needed repair or replacement on permanent tooth surfaces. Data collected included: (1) the main reason for repair or replacement of the restoration (see Table 1); (2) tooth type and tooth surfaces being restored; and (3) the selection of the restorative materials. Dentists diagnosed the need to repair or replace the existing restoration based on the diagnostic methods they typically use in their practice, which consist mainly of visual-tactile in association with radiographic examinations.

Restorative materials selected included amalgam, directly placed resin-based composite (RBC), indirectly placed resin-based composite (IRBC), glass-ionomer or resin-modified glass-ionomer (GI/RMGI), ceramic or porcelain, cast gold or other metallic-based material, combined metal-ceramic material, and temporary restorative materials. In addition, practitioners reported whether a base, lining or bonding material was applied prior to the restorative material, and the type of agent used, *i.e.* resin-based bonding material, GI/RMGI, calcium hydroxide-based cement or liner, varnish, and any other non-specified material.

Information about gender, age, race, ethnicity, and insurance coverage of enrolled patients was also recorded. Characteristics of the network practitioners who participated in this study have been previously described.[22]

The Data Collection Form was pre-tested by 16 practitioner members of the network. Pre-testing consisted of assessing the feasibility of the form in the flow of a busy practice environment, as well as the comprehension and intuitiveness of the classification criteria. The pre-testing phase for each of these groups met a test-retest reliability of kappa > 0.70 or ICC > 0.70.

Statistical analysis

Descriptive statistics were calculated for dentist, patient, and restoration variables. A binary logistic model, with Generalized Estimating Equations to adjust for clustering within dental practices and restorations within patients, was used to test the hypotheses about how dentists differ on decision-making to repair or replace an existing “defective/failed” restoration, when they did or did not place the original restoration. The models included a “dentist who placed the original restoration” variable coded as performed the restoration (yes) = 1 and (no) = 0 for those dentists who did not place the original restoration.

Restoration characteristics hypothesized to influence the repair/replacement decision even after stratifying by “dentist who placed the original restoration” were as follows. “Tooth type”: coded as “molar” = 1, and “premolar” or “anterior” = 0; “Arch”: coded as “upper” = 1 and “lower” = 0; “Original restorative material”: coded as “amalgam” = 1, “direct tooth colored/ indirect tooth colored/ gold” = 0; “Fractured restoration”: coded as 1 when “ fractured restoration was the primary reason for the defect/failure” and 0 when “fractured restoration was not the primary reason for the defect/failure”; “the number of surfaces in the original restoration”: coded as 1, 2, 3, and 4.

Variables hypothesized to influence the repair/replace decision (“tooth type”, “arch”, “original restoration material”, “fractured restoration” variable, and the “number of surfaces in the original restoration”) were tested individually. Two-way interactions involving the “dentist placed” variable with “secondary fractured restoration”, “tooth type”, the “original restoration material”, and the “number of surfaces in the original restoration” were tested individually. For all significant interactions, models were run separately for (1) dentists who had placed the original restoration and (2) dentists who had not placed the restoration. A set of control variables that included type of practice, dental insurance, dentist year of graduation, and patient age was included as covariates in all models. A critical value of p =. 01 was used as a conservative adjustment for multiple comparisons in interpreting significant interactions.

Results

Data were collected on 9,484 restorations from a total of 7,502 patients and are described in detail in earlier publications.[18 and 22] Complete data were available for 8,770 restorations from a total of 6,643 patients for the tested variables. For 6,623 of the 8,770 original defective restorations (75%), the treatment was provided by the dentist who not had placed the original restoration. For 584 of the restorative visits, the original restoration was missing; consequently, these treatment visits were dropped from the regression models since their treatment requires a replacement rather than offering a choice between repair or replacement. Characteristics of the tooth and restoration are presented in Table 1 and 2. Table 2 also shows the number of restorations replaced and repaired by all dentists (n=8,186), by dentist who placed the original restoration (n=1,920), and not by the dentist who placed the original restoration (n=6,266) according to restoration characteristics.

The results of multivariable logistic regression analysis indicated that if the original dentist had placed the original restoration, repair was more likely (OR = 1.6, $p < .001$) than if another dentist had placed the restoration. A repair was more likely to be performed when the defective restoration was in a molar (OR = 1.9, $p< .001$) compared to premolar and anterior teeth. There was no association between arch and the decision to repair or replace ($p = .204$). We tested for a tooth×arch interaction, and it was not significant ($p = .063$). A repair was less likely to be performed when the original restoration was an amalgam (OR = 0.4, $p<.001$) or when the original restoration was fractured (OR = 0.7, $p<.001$). A greater number of surfaces was associated with increased likelihood of a repair (OR = 0.8, p =.008). These latter results have been previously reported.[18]

Test of hypothesis 1

The 2-way interaction between the "dentist who placed the original restoration" variable and the "molar" variable was significant (p = .008). When the defective restoration was in a molar, dentists who had placed the original restoration took a more conservative approach and more often chose to repair the restoration relative to premolar or anterior teeth (OR = 2.2, p < .001; molar = 39%, premolar, anterior = 30%), than dentists who had not placed the restoration (OR = 1.3, p = .002, molar = 25%, premolar, anterior = 22%).

Test of hypothesis 2

The 2-way interaction between the "dentist who placed the original restoration" variable and the "arch" variable was not significant (p = .082). No further analyses were performed.

Test of hypothesis 3

The 2-way interaction between the "dentist who placed the original restoration" variable and the "amalgam" variable was significant (p = .009). When the defective restoration material was *amalgam*, dentists who had placed the original restoration took a less conservative approach and chose to repair less often compared to when the material was not an amalgam (OR = 0.5, p < .001, amalgam = 28%, not amalgam = 39%), than dentists who had not placed the restoration (OR = 0.4, p < .001, amalgam = 18%, not amalgam = 33%), even though both groups of dentists replaced an amalgam restoration more frequently than a non-amalgam restoration.

Test of hypothesis 4

The 2-way interaction between the original dentist and "fractured restoration" variable was statistically significant (p = .007). When the primary reason for the decision to repair or replace an original restoration was a fracture in the restoration, dentists who had placed the original restoration were less likely to repair the restoration when it was a fracture compared to another reason (OR = 0.8, p = 001, fracture = 32%, not fracture = 36%). The restoration status as fractured did not influence the decision to repair over a replacement among dentists who had not placed the existing restoration (p = .973), as they were equally likely (24%) to replace the restoration when it was fractured compared to all other reasons.

Test of hypothesis 5

The 2-way interaction between the "dentist who placed the original restoration" variable and the "number of surfaces in the original restoration" variable was not significant (p = .062). No further analyses were performed.

Discussion

Replacement of existing restorations constitutes the majority of the work performed by general dental practices.[3 and 24] and it has contributed to the perpetuation of the "Repeat Restoration Cycle".[25] Hence, at each intervention, the restorative cycle will result in the removal of more tooth structure, which may lead to increase in treatment costs and/or tooth loss.[26 and 27] Consequently, the decision to repair or replace an existing restoration is a

critical step in treatment planning and it invariably affects the longevity of the restored tooth.

Several patient's and dentist's variables influence the longevity of direct restorations.[28, 29, and 30] When the analyses took into consideration dentists' decisions based on who had placed the original restoration, we observed that tooth arch location and the number of surfaces involved were not relevant, as both groups of dentists (those who placed the original restoration and those who did not) were more likely to choose to repair restorations that involved multiple surfaces. Studies have shown that larger restorations have greater failure rates.[17, 31, 32, and 33]. Therefore, it is possible that dentists considered that, short of opting for a full coverage in the tooth in question, a repair was a better approach when multiple surfaces were involved.

Tooth type has also been shown to affect restoration longevity, with molars demonstrating long-term success rates lower than those of anterior teeth.[17] Interestingly, the first hypothesis of the study was accepted, and when the defective restoration was in a molar, dentists who had placed the original restoration were more likely to repair it than replace it. Often molar restorations show lower longevity rates when compared to anterior teeth; therefore, choosing to repair it may have given the tooth an alternative other than electing a more-extensive restoration requiring full coverage of the tooth. That finding did not hold true when the restorative material was amalgam, where both groups of dentists (those who placed the original restoration and those who did not) chose to replace the entire restoration as opposed to repairing it. Despite the fact that studies have discussed the safety of amalgam as a restorative material,[34, 35, 36, and 37] amalgam restorations are being replaced, and most likely it is because of its inferior aesthetic appearance, alleged adverse health effects, and environmental concerns.[38, 39, and 40]. Consistent with the fact that the use of amalgam as a restorative material is decreasing in general dental practice,[41 and 42] dentists chose to replace defective restorations that had amalgam as the restorative material.

Although not a hypothesis of this study, restoration fractures accounted for almost one-third of all repaired or replaced restorations (2,484, Table 1), which is consistent with the findings from clinical trials done elsewhere in which fractures do account for a substantial number of failures in direct and indirect restorative dental materials.[43, 44, 45, and 46] Moreover, amalgam and resin-based composites accounted for 93% of all restorations in this study, and restoration fracture in amalgam was more predominant than in dental resin composites restorations (Table 1).

The fourth hypothesis was accepted since dentists who placed the original restoration were significantly more likely to have decided to replace when the restoration was primarily diagnosed as fractured (OR = 0.8, p = .001, Table 3). On the other hand, dentists who did not place the original restoration did not seem to be driven to make the decision to replace or repair if a fracture was present (p=.973). Decision-making can be viewed as a structured approach to find solutions to a problem after evaluating data.[47 and 48] Hence, one would expect that dentists who originally placed a restoration could decide for repair since they would have known the history of the restoration. One fact that may have contributed to such decision-making is the lack of training or clinical experience with restoration repairs.

Presently, the training of pre-doctoral students on repair of existing restorations seems to have gained some acceptance in dental schools, not only in the US but also worldwide.[49, 50,51, and 52] However, the repair of existing restorations is not well recognized by the dental community and some dental schools are still reluctant to include it in their curriculum.[50] Additionally, The American Dental Association's Code on Dental Procedures and Nomenclature does not have a procedure code for resin-based composite restoration repairs,[51] which unfortunately may inhibit clinicians from proposing this treatment option and ultimately limit patients' access to this dental treatment.

One limitation of the study is that information regarding the extent of the fracture was not collected and this may have influenced the decision-making in favor of replacement.

Conclusion

In conclusion, most dentists are not conservative when they revisit a restoration that they originally placed regardless of type of failure, number of surfaces or material used. However, dentists who had placed the original restoration were significantly more likely to repair it when the defective restoration was in a molar tooth.

Acknowledgments

This work was supported by grants U01-DE-16746, U01-DE-16747 and U19-DE-22516 from the National Institutes of Health, Bethesda, MD. The authors would like to acknowledge Ms. Negar Fallahazad, graduate student in the Department of Biostatistics at Florida International University (Miami, FL) for her contribution with the organization and review of the tables in the result section.

Opinions and assertions contained herein are those of the authors and are not to be construed as necessarily representing the views of the respective organizations or the National Institutes of Health. All participants in this investigation provided informed consent after receiving a full explanation of the nature of the procedures.

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Table 1

Patient (n=6,643) and restoration (n=8,770) characteristics for study participants

Variable	N (%)
Patients characteristics (n=6,643)	
Female gender (missing = 13)	3,792 (57)
Patient age (Mean=51.2, SD=16.1)	
Hispanic ethnicity (missing=91)	629 (10)
Race (missing=79)	
White	5,919 (90)
Black	404 (6)
Asian	83 (1)
American Indian or Alaskan native	59 (<1)
Other	56 (1)
Dental Insurance	1,447 (22)
Restoration data (n=8,770)	
Tooth	
Anterior	1,761 (20)
Pre-molar	2,259 (26)
Molar	4,750 (54)
Treatment	
Restoration replaced	6,550 (75)
Restoration repaired	2,220 (25)
Number of surfaces for original restoration	
One	2,022 (23)
Two	3,087 (35)
Three or more	3,661 (42)
Dentist placed the original restoration	2,147 (25)
Dentist did not place the original restoration *Restoration material*	6,623 (75)
Amalgam	4,886 (56)
Direct tooth colored	3,241 (37)
Indirect tooth colored	464 (5)
Gold	179 (2)
Primary reason for treatment (repair or replacement)	
Secondary-recurrent caries	3,858 (44)
Restoration fracture	2,484 (28)
Degrade/ditched	680 (8)
Restoration missing	584 (7)
Margin/restoration discolored	268 (3)
Patient request	168 (2)

Variable	N (%)
Pain/sensitivity	94 (1)
Other	620 (7)

Table 2

Number of restorations replaced and repaired by all dentists (n=8,186), by original dentist (n=1,920), and not by original dentist (n=6,266) according to tooth type, material of the original restoration, arch location, number of surfaces, reason for defect, and number of defective restorations per patient.*

Characteristics	All dentists n=8,186		Original dentist n=1,920		Not original dentist n=6,226	
Tooth type	**Replaced n (%)**	**Repaired n (%)**	**Replaced n (%)**	**Repaired n (%)**	**Replaced n (%)**	**Repaired n (%)**
Molar tooth (n=4,569)	3,284 (72)	1,285 (28)	599 (61)	383 (39)	2,685 (75)	902 (25)
Premolar, anterior (n=3,617)	2,747 (76)	870 (24)	658 (70)	280 (30)	2,089 (78)	590 (22)
Material						
Amalgam (n=2,155)	1,212 (56)	943 (44)	570 (72)	227 (28)	3,212 (82)	716 (18)
Not amalgam (n=6,031)	4,819 (65)	1,212 (35)	687 (61)	436 (39)	1,562 (67)	776 (33)
Arch location						
Upper arch (n=4,588)	3,372 (74)	1,216 (26)	732 (67)	360 (33)	2,640 (75)	856 (25)
Lower arch (n=3,598)	2,659 (74)	939 (26)	525 (46)	606 (54)	2,134 (77)	636 (23)
Surface						
Single surface (n=1,822)	1,246 (69)	576 (31)	242 (61)	157 (39)	1,004 (71)	419 (29)
Two surfaces (n=2,913)	2,288 (79)	625 (21)	459 (69)	202 (31)	1,829 (81)	423 (19)
Three surfaces (n=2,033)	1,400 (70)	633 (30)	302 (61)	192 (39)	1,108 (72)	431 (28)
Four more surfaces (n=1,418)	1,006 (71)	412 (29)	254 (69)	112 (31)	752 (72)	300 (28)
Reason						
Fracture reason for defect (n=2,484)	1,845 (74)	639 (26)	443 (68)	200 (32)	1,402 (76)	439 (24)
Another reason for defect (n=5,702)	4,186 (63)	1,516 (27)	814 (64)	463 (36)	3,372 (76)	1,053 (24)
Number of defective restoration						
1 defective restoration (n=4,645)	3,445 (74)	1,200 (26)	761 (66)	392 (34)	2,684 (77)	808 (23)
2 defective restorations (n=2,250)	1,615 (72)	635 (28)	312 (66)	162 (34)	1,303 (74)	473 (26)
3–4 defective restorations (n=1,291)	971 (75)	320 (25)	184 (63)	109 (37)	787 (79)	211 (21)

*because the numbers in this table differ from those in Table 1 (e.g., 2,147 in Table 1 for “dentist placed the original restoration” compared to 1,920 in Table 2).

Table 3

Regression coefficients for restoration characteristics for dentists who placed and did not place the original restoration

Restoration Characteristics	**Original dentists who placed the original restorations**			***Restoration Characteristics***	**New dentist who did not place the original restoration**		
	β (Std. Error)	**p-value**	**OR (95% CI)**		**β (Std. Error)**	**p-value**	**OR (95% CI)**
Tooth site (molar) (more likely to repair)	0.750 (0.116)	<0.001	2.2 (1.7–2.6)	Tooth site (molar) (more likely to repair)	0.318 (.073)	0.002	1.3 (1.1–1.6)
Material (amalgam) (*less* likely to repair)	−0.646 (0.112)	<0.001	0.5 (0.4–0.6)	Material (amalgam) (*less* likely to repair)	−0.997 (0.071)	<0.001	0.4 (0.3–0.4)
Fractured restoration (*less* likely to repair)	−0.200 (0.101)	0.001	0.8 (0.7–0.9)	Fractured restoration (*less* likely to repair)	0.003 (0.086)	0.973	1.0 (0.9–1.1)