Published in final edited form as:
J Dent. 2011 April ; 39(4): 302–308. doi:10.1016/j.jdent.2011.01.007.

Association between caries location and restorative material treatment provided

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Abstract

Objectives—This cross-sectional study by the Northwest PRECEDENT practitioners correlated the location of caries diagnosed in the past 12 months with treatment provided.

Methods—An oral health survey was conducted on up to 20 patients per practice for 101 practices in the Northwest PRECEDENT network. A total of 1943 eligible patients were randomly assessed for the location of and treatment provided for caries lesions diagnosed within the past 12 months. Regression analysis using Generalized Estimating Equations (GEE) was performed to assess association of treatment to tooth location and surface characterization, adjusting for age, practice location (urban/rural), dentist gender, and experience level. The analysis accounts for clustering by practice using robust variance estimates.

Results—Overall, 55.4% of patients exhibited recent caries and 42.8% received treatment for at least one permanent tooth. 18% of treated teeth were treated with amalgam, and 72% were treated with composite. This percentage varied as a function of tooth surface characteristics, patient characteristics, and dentist characteristics. The results suggest that restoration selection does depend on tooth type and which surfaces are being restored. The odds of a molar receiving an amalgam restoration are 2.44 (95% CI=1.81–3.30) times higher as compared to a bicuspid, adjusting for all other covariates. When the restoration includes the occlusal surface of a tooth the odds are 0.42 (95% CI=0.20–0.89) times as great that amalgam will be placed. When the restoration includes the mesial or distal surface of the tooth the odds for amalgam restoration are 2.49 (95% CI=1.25–4.95) times higher compared to when it does not include these surfaces.

Conclusion—Restorative material choice varied based on caries location and practitioner gender.

Introduction

A dramatic change in the use of dental restorative materials began when resin composites became a viable alternative to amalgam. As a result the popularity of amalgam has decreased, in part because of concerns (valid or not) about its safety, but primarily because composite has shown to be a reliable and esthetic alternative. A number of surveys have been done to track the trends of restorative materials used in private practices.[1–7] The majority of these cross-sectional studies have been conducted outside the U.S. and asked dentists within the study to report on a given number of consecutively placed restorations. The results show an overwhelming increase in the use of resin composites as use of amalgam has decreased. Though fewer surveys on restorative material selection have been done in the U.S., the results show the same trend as in other countries but at a slower rate.[3,5,7]

Numerous studies have been performed in an attempt to compare the longevity of amalgam to resin composites when used as a posterior restorative material. Manhart et al (2004) performed a review of the dental literature to provide a survey on the longevity of stress-bearing posterior restorations.[8] The dental literature was reviewed for longitudinal, controlled clinical studies and retrospective cross-sectional studies of posterior restorations. The survey compared 51 composite studies and 42 amalgam studies and reported a similar five year success rate with amalgam showing slightly higher success at 94% versus 93% for resin composite. This study also pointed out that premolars generally offer more favorable conditions than molars for resin composite. When studies exceed five years, amalgam typically has a higher survival rate. In a controlled clinical trial Bernardo et al. (2007) performed a seven year study comparing the two materials as a posterior restorative treatment and survival rates were more pronounced in favor of amalgam with 94.4% survival vs. 85.5% for resin composite.[9] This same study estimated the risk of secondary caries to be 3.5 times greater for posterior composites. This is significant in that recurrent caries has been shown by numerous authors to be the primary reason for replacement of both composites and amalgams.[8,9–20] Mjor et al (1999) reported on 642 restorations placed in private practices showing the median age of replacement for amalgam at 15 years versus 8 for composite.[5] This study did not differentiate between anterior and posterior restorations.

Of those surveys which tracked the use of restorative material, few showed a correlation of material with location of restoration placed.[5,21] One study done in Norway reported that amalgam predominated for 2–3 surface class II restorations.[5] A more recent study was conducted by the Dental Practice-Based Research Network (DPBRN). The purpose of the study was to determine why initial restorations are being placed, and a portion of the data correlated caries location and restorative material. Dentists in DPBRN used amalgam for 47 percent of molar restorations and 45 percent of premolar restorations; composite was used for 48 percent of the molar restorations and 50 percent of the premolar restorations.[21]

Whether location of caries impacts the longevity of composite restorations is a clinically relevant question, requiring further study of the correlation between the location of the diagnosed caries and the restorative material used. An up-to-date study of U.S. dentists tracking these trends and utilizing a randomized selection of patients would be very useful to establish quantified data indicating the current restorative preferences and trends in dental care.

Northwest PRECEDENT is a regional dental Practice-based Research Network (PBRN) encompassing 5 states (Oregon, Washington, Idaho, Montana, and Utah), comprised of approximately 190 practitioners and funded by NIDCR (DE0165750/DE016752). The initial project undertaken by the network was one that helped to characterize the practices, the

patient populations, and oral disease indicators within the network. The data used for this query were obtained from this initial project. The purpose of this study was to evaluate whether any trends or associations could be determined regarding the use of restorative materials and the location of the caries.

Methods and Materials

An oral health survey was conducted in the Northwest PRECEDENT practice-based research network (PBRN), which is composed of general dentists, orthodontists, and pediatric dentists. All general dentists who are members were asked to participate. Various data were collected on the oral health status of the subjects, including the focus of this study: the association between caries lesions diagnosed within the past 12 months and the restorative material provided. Subjects were randomly selected from the patient population of the individual private practices participating in the study. In order to achieve randomization, the network provided each practice with a starting appointment for enrollment, and then advised the practice to subsequently enroll every n^{th} patient until a total of 20 were enrolled per practice. The patient interval (n) was calculated using an algorithm that incorporates the number of patients needed per practice for the study, the average number of patients seen per day by the practice, and the desire to limit enrollment to no more than one patient per day to minimize disruption to the participating practices. When the study was terminated, 101 dentists had enrolled 20 patients, 2 had enrolled 19 and 6 others had enrolled between 5–12 patients. This sample represents approximately 1.5% of the active dentists in the five state region. In total 1943 patients were surveyed, of which 769 patients with permanent teeth treated with amalgam or composite were included in the study.

Data for the oral health survey were collected from both a direct oral examination of the patient and from information provided in the patient's chart. For this study, patients were assessed for the location of and treatment provided for caries lesions diagnosed within the past 12 months. The specific data used for this study were collected by asking office staff, by way of survey question #6, (see figure 1) to answer yes or no to the following question: Has the patient had 1 or more new caries in the past 12 months? This included lesions diagnosed at the recently-completed visit. If the practitioners answered yes, they were then directed to complete the table indicating tooth number, surfaces and type of treatment.

The subjects were categorized by age categories (1–17 years old, 18–64 years old and 65+ years old), by dentist experience level (<16 years and 16+ years), dentist gender, and practice location (urban, suburban, and rural). The data were analyzed with GEE multiple logistic regression.[22] The estimated odds ratios assess the association of treatment to tooth location and surface characterization, adjusting for age, practice location, dentist gender and experience level. The generalized estimating equations account for the clustering of patients within practice. Statistical analyses were performed using SAS 9.2 (SAS Institute Inc, Cary, NC, USA).

Results

From all 1943 surveyed patients, 55.4% exhibited caries within the past 12 months and 42.8% received treatment for at least one permanent tooth. (Figure 2) Amalgam was used to treat 18% of permanent teeth, and 72% were treated with resin composite. The remaining teeth were treated with glass ionomer, fluoride or indirect restorations, with the percentage varying as a function of tooth surface characteristics, patient characteristics, and dentist characteristics.

Table 1 provides the distribution of the number of surfaces treated and location of caries for permanent teeth treated with resin composite or amalgam (N=1880 teeth in 769 patients). Only 1.1% of amalgam restorations were performed on anterior teeth while 70.8% were performed on molars. The distribution of tooth types was more even for composite fillings, with only 45.5% on molar teeth.

Of the 430 anterior teeth, the proportion treated with amalgam is 0.0095 (or 0.95%) with 95% design-adjusted confidence interval (CI) of (0.00, 0.019). Thus, an anterior tooth had only a miniscule likelihood that it would be treated with amalgam. Since data were so sparse for amalgam treatment on anterior teeth, anterior teeth are not included further in the analysis.

The estimated odds ratios for an amalgam restoration from the GEE logistic model are presented in Table 2. The odds in this study are defined as the probability of amalgam restoration versus resin composite restoration. Because restoration with other restorative materials occurred in such low frequency, it was not possible to include them in the statistical evaluation. Instead we focused on the use of amalgam versus resin composite.

The results suggest that the selection of restorative material is influenced by tooth type and which surfaces are being restored. The following statistically significant outcomes (α = 0.05) were found from the adjusted logistic model. Molars were more likely to receive an amalgam restoration than a tooth located more anterior; the odds of a molar receiving an amalgam restoration were 2.44 times as high as a bicuspid (95% CI=1.81–3.30), adjusting for all other covariates (Table 2). When a restoration includes the occlusal surface of a tooth the odds were 0.42 times as great that amalgam will be placed (95% CI = 0.20–0.89) as compared to restorations which do not include the occlusal surface. When the restoration includes the mesial and or distal surface of the tooth the odds for amalgam restoration were 2.49 (95% CI=1.25–4.95) times as high compared to when it does not include these surfaces. If the facial surface was included in the restoration, the odds were reduced by approximately half that amalgam would be used compared to if the facial surface was not included in the restoration (odds ratio = 0.51; 95% CI=0.28–0.95).

Other demographic information appeared to influence the restorative choice. Patients who were 65 years and older had 2.5 (95%CI=1.08 – 5.83) times higher odds to receive amalgam restoration compared to the 18–64 year age range. Male dentists are much less likely than their female counterparts to place an amalgam restoration (odds ratio = 0.18; 95% CI = 0.06–0.49). Offices that see more than 50 patients per week compared to offices that see less than 41 patients per week are more likely to place an amalgam restoration (odds ratio = 2.16; 95% CI = 1.00–4.76).

There were additional trends in the results that did not rise to the level of significance. Amalgam placement is more likely when the number of surfaces being restored increases, when a three or four surface restoration is placed, when the patient is a male patient, and when the dentist has been in practice 16 or more years. Patients seen in urban, suburban, and rural practices appear to have close to equal odds of receiving an amalgam or composite restoration in comparable circumstances.

Discussion

Amalgam has a long history of clinical success, yet its popularity has endured a slow and steady decline.[23–25] As amalgam decreases in popularity, resin composite has increased partly due to the development of reliable adhesive systems, which has led more dentists to view composite as a viable and useful alternative to amalgam. Also, dental schools are increasing training in the use of composite in their curricula.[20,26,27] Patients are becoming

more aware of their options and requesting esthetic and metal-free restorations. All of these factors have contributed to the shift away from amalgam as the once primary posterior restorative material.

Case selection is an important aspect of material selection and use for posterior teeth. Resin composite will always require meticulous clinical technique. There are still clinical situations in which many practitioners consider amalgam to be a preferable restorative material,[28–32] namely when the operating site cannot be appropriately isolated and or when the restoration is going to endure heavy occlusal stresses. This survey shows that although the use of amalgam is decreasing, tooth type and surfaces being restored still influence the practitioner's choice of restorative material. Molars have 2.5 times higher odds to receive an amalgam restoration than bicuspids. Practitioners, understanding that molars undergo heavy occlusal stresses, may be recommending amalgam in these clinical situations. Posterior teeth can be more difficult to properly isolate, creating a less than ideal environment for resin composite. In addition to these challenges, some practitioners find it more difficult to re-create an ideal interproximal contact with resin composite. This seems to be more of a challenge with molars, which may also contribute to the continued use of amalgam by some practitioners when restoring these teeth.

The increased use of composite in posterior teeth found in this survey of practices in Northwest PRECEDENT is reflected in the greater dental population of the Pacific Northwest. Data from the Washington Dental Service (WDS), on amalgam and composite restorations for nearly 2 million patients provided by over 14,000 dentists from 1993 to 2009 (inclusive) revealed that the number of composite restorations in posterior teeth exceeded the number of amalgam restorations in posterior teeth between 1998 and 1999. That discrepancy has increased each year until 2009, the most recent year for which this data is available. By 2009, the ratio of posterior composite restorations relative to posterior amalgam restorations is 4.87. Whether or not the occlusal surface is included in the restoration appears to make little difference in the increased use of composite vs. amalgam. If the occlusal surface is included in the restoration, the ratio of posterior composite restorations relative to amalgam restorations is 4.73.[33]

Amalgam is more prevalent when the mesial or distal surface of the tooth is included in the restoration. A survey done in Norway a decade ago also noted that amalgam was the restorative material of choice for two and three surface restorations.[5] Recent evidence shows that as the number of restoration surfaces increases, composites tend to show increased failure rates.[9] Occlusal tooth preparations can be easily and well isolated. When the preparation extends into a mesial or distal box the gingival margin is more difficult to isolate. When isolation is difficult or not ideal practitioners may recommend amalgam, which may explain the tendency for amalgam to be more prevalent in these restorations.

The odds of older patients and more posterior teeth to receive an amalgam restoration are increased in comparison to younger patients and more anterior located teeth. There is a non significant increase in the odds for males as compared to females to receive amalgam restorations. These trends could all be an indication that as dentists gain confidence in resin composite as a restorative material, patients' preference may exert more influence on the restorative material selected. Older patients have been treated with amalgam in the past, and perhaps they are more comfortable to continue using the same restorative material. Posterior composite restorations are more time consuming and more expensive. Older patients may not have the ability tolerate longer appointments, and may not have the disposable income to opt for the higher price. Another explanation for increased use of amalgam in older patients is xerostomia or decreased salivary function. As patients age they are often taking more medications and as the number of medications increases so does the likelihood of

xerostomia as a side effect.[34,35] Xerostomia has been shown to be a risk factor for increased caries.[36,37] This factor combined with a trend towards higher mutans streptococci levels in plaque adjacent to composite restorations compared to amalgam restorations,[38] and an increased trend for higher failure rates for composite restorations compared to amalgam restorations in high caries risk patients,[39,40] may stimulate increased amalgam placement for xerostomic patients. Female patients may have a higher cosmetic concern and thus choose the tooth colored restorative material. Patients in general may have a stronger preference for resin composite in areas that are visible when smiling, thus the trend that more anterior located teeth are more likely to receive composite.

Dental school curricula have changed in the past thirty years as well. Schools once emphasized instruction of amalgam and cast gold restorations. Now both anterior and posterior composite restorations receive much more emphasis in the curriculum.[26,27,41] Consequently there is an increasing proportion of new dental graduates that are competent and capable of becoming very proficient at placing posterior resin composite restorations. This may be a major influence in the trend towards replacing amalgam. While not statistically significant, this study suggests that dentists with 16 years or less experience are more likely to place composite than those dentist in practice for 16 years or more. This may be a reflection of their dental school experience.

Practices that see more patients are more likely to place amalgam than those practices seeing fewer patients per week. Most practitioners feel, and research confirms that amalgam is faster to place and finish than composite. This may be an explanation to the correlation between number of patients seen per week and an increase in probability of placing amalgam.[42] Although based on a low proportion of female dentists, the data showed that male dentists are significantly more likely to place a composite restoration. No explanation for this trend is readily available.

A recent study done by the Dental Practice-based Research Network (DPBRN), also correlated restorative material to restoration type in outpatient dental practices from five regions, four within the United States and one including dentists from the Scandinavian countries of Denmark, Norway, and Sweden.[21] This study used a consecutive patient/ restoration recruitment design. The results showed an almost equal use of amalgam and composite for molar restorations (47 and 48 percent respectively). The results also showed that composite was used more frequently in premolars (50 percent compared to 45 percent for amalgam), and 93 percent of anterior restorations were done with composite. Amalgam was the predominant material used in class II restorations in all regions except Scandinavia.

There have been few surveys done in the United States tracking restorative material use. The majority was done in Europe and did not track restorative material with restoration type. Most of these studies reported on a select number of consecutively placed restorations. The current study is unique in that it is a practice-based study and the samples were randomly selected. The outcomes highlight the importance of all dental practitioners to learn to use resin composite in an array of clinical situations, and to be aware of the importance of meticulous clinical techniques in order to achieve success.

This study was done utilizing the Northwest PRECEDENT practice based research network. It was done with a well-designed protocol that included a random selection of subjects seen in the practice setting. This protocol captures the realities of daily dental practice, using a large sample of subjects. The goal of the study was to determine whether there were any trends with regard to caries location and material type. This is a decision dentists must make on a daily basis; there are few decisions as basic yet important as which material to use in each unique clinical situation. It is valuable to have data to guide practitioners make this

decision. The study could be improved if it extended to dentists in a larger geographical area. Also, since the study depended on individual dentists' diagnosis of caries, the study is limited in that there was no formal training or standardization done.

Conclusion

The purpose of this study was to evaluate whether any trends or associations could be determined regarding the use of restorative materials and the location of the carious lesions. The results indicate that restorative material choice varied based on caries location, practitioner gender, patient age, and the number of patients seen in the practice per week.

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CARIES LESIONS IN THE PAST 12 MONTHS Yes No

6. Has the patient had 1 or more new caries lesions in the past 12 months? (including lesions diagnosed at the recently-completed visit)

7. If yes complete the table below.

Enter each tooth on a separate row in the table (separate lesions on the same tooth are entered in the same row). If there were more than 10 teeth in the past 12 months, provide the information for the 10 most recent. For tooth # use 1-32 for permanent teeth or A-T primary teeth. Mark "X" to indicate response in each field.

	Surfaces							Treatment						
	Tooth #	Occlusal	Mesial	Distal	Facial	Lingual	Root	None	Amalgam	Composite	Glass Ionomer	Fluoride	Indirect	If other specify
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

Figure 1.
Survey instrument

Patient demographics

- Number of patients surveyed: 1943
- Proportion of patients with recent caries: 55.4% (N=1077)
- Proportion of patients receiving treatment for at least one permanent tooth: 42.8% (N=833)
- Proportion of patients receiving amalgam or composite restoration for at least one permanent tooth: 39.6% (N=769)
- Age and gender distribution of the patients receiving amalgam or composite restoration for at least one permanent tooth:

  Age: 1-17: 11.57%; 18-64: 72.69%; 65 and above: 15.47%

  Male: 45.25%; Female: 54.75%

Figure 2.

J Dent. Author manuscript; available in PMC 2013 March 23.

Table 1

Distribution of number of surfaces treated and location for caries by amalgam and composite restorations.

	Amalgam		**Composite**	
	N	***(%)***	***N***	***(%)***
Number of Surfaces				
1	125	(33.78)	648	(42.91)
2	154	(41.62)	580	(38.41)
3	68	(18.38)	218	(14.44)
4+	23	(6.22)	64	(4.24)
Tooth Type				
Anterior	4	(1.08)	426	(28.21)
Bicuspid	104	(28.11)	397	(26.29)
Molar	262	(70.81)	687	(45.50)
Occlusal Restoration does not include O surface	97	(26.22)	559	(37.02)
Restoration includes O surface	273	(73.78)	951	(62.98)
Mesial/Distal Restoration does not include M/D surface	120	(32.43)	687	(45.50)
Restoration includes M/D surface	250	(67.57)	823	(54.50)
Facial Restoration				

	Amalgam		Composite	
	N	*(%)*	*N*	*(%)*
does not include F surface	291	(78.65)	1037	(68.68)
Restoration includes F surface	79	(21.35)	473	(31.32)
Lingual Restoration does not include L surface	306	(82.70)	1191	(78.87)
Restoration includes L surface	64	(17.30)	319	(21.13)
Root Restoration does not include root surface	364	(98.38)	1504	(99.60)
Restoration includes root surface	6	(1.62)	6	(0.40)
Patient age (years)				
Missing	1	(0.27)	2	(0.13)
< 17	43	(11.62)	168	(11.13)
18 – 64	274	(74.05)	1144	(75.76)
65+	52	(14.05)	196	(12.98)
Patient gender				
Female	188	(50.81)	833	(55.17)

	Amalgam		**Composite**	
	N	***(%)***	***N***	***(%)***
Male	182	(49.19)	677	(44.83)
Dentist gender				
Female	113	(30.54)	175	(11.59)
Male	257	(69.46)	1335	(88.41)
Dentist experience				
16+	218	(58.92)	858	(56.82)
less than 16	152	(41.08)	652	(43.18)
Practice location				
Unknown	14	(3.78)	89	(5.89)
Rural	126	(34.05)	529	(35.03)
Suburban	150	(40.54)	684	(45.30)
Urban	80	(21.62)	208	(13.77)
Patients per week				
41–50	38	(10.27)	364	(24.11)
50+	213	(57.57)	576	(38.15)
less than 41	119	(32.16)	570	(37.75)

Table 2

Adjusted odds ratios (OR) and 95% Confidence Intervals (CI) for association between amalgam restorations and tooth surface type, adjusted for patient age and gender, dentist gender, experience and practice characteristics. (N=1367)

Parameter	Level	OR	95% CI	p-value
Number of Surfaces	2 (vs. 1)	0.92	(0.46 1.85)	0.818
Number of Surfaces	3 (vs. 1)	1.49	(0.58 3.86)	0.407
Number of Surfaces	4+ (vs. 1)	1.58	(0.42 5.94)	0.498
Tooth type	Molar (vs. Bicuspid)	2.44	(1.81 3.30)	**<.001**
Occlusal surface	Yes	0.42	(0.20 0.89)	**0.024**
Mesi/dist surface	Yes	2.49	(1.25 4.95)	**0.01**
Facial surface	Yes	0.51	(0.28 0.95)	**0.034**
Lingual surface	Yes	0.72	(0.44 1.19)	0.202
Root surface	Yes	1.85	(0.51 6.75)	0.35
Patient Age	18–64 years old (vs. 1–17)	1.16	(0.59 2.27)	0.668
Patient Age	65+ years old (vs. 1–17)	2.5	(1.08 5.83)	**0.033**
Patient Gender	Male (vs. female)	1.23	(0.83 1.84)	0.297
Dentist Gender	Female (vs. male)	5.68	(2.05 15.70)	**<.001**
Dentist Experience	16+ (vs. less than 16)	1.65	(0.70 3.90)	0.256
Practice Location	Suburban (vs. Urban)	1.18	(0.47 3.01)	0.722
Practice Location	Rural (vs. Urban)	1.38	(0.48 3.96)	0.553
Patients per week	41–50 (vs. less than 41)	0.37	(0.11 1.27)	0.113
Patients per week	50+ (vs. less than 41)	2.16	(1.00 4.67)	**0.05**