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Restoration of Non-carious Tooth Defects by Dentists in The Dental Practice-Based Research Network - DPBRN

Dr. Marcelle M. Nascimento, DDS, MS, PhD[Assistant Professor],
Department of Operative Dentistry, College of Dentistry, University of Florida, Gainesville, Florida, USA

Dr. Valeria V. Gordan, DDS, MS, MS-CI*[Professor],
Department of Operative Dentistry, College of Dentistry, University of Florida, Gainesville, Florida, USA

Dr. Vibeke Qvist, DDS, PhD, Dr. Odont[Associate Professor],
Department of Cariology and Endodontics, School of Dentistry, Faculty of Health Sciences, University of Copenhagen, Copenhagen, Denmark

Dr. James D. Bader, DDS, MPH[Research Professor],
School of Dentistry, Department of Operative Dentistry at the University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

Dr. D. Brad Rindal, DDS[Investigator and dental health provider],
HealthPartners, Minneapolis, Minnesota, USA

Dr. O. Dale Williams, MPH, PhD[Professor],
Division of Preventive Medicine, School of Medicine, University of Alabama at Birmingham, Birmingham, Alabama, USA

Dr. Daniel Gewartowski, DDS[DPBRN practitioner-investigator in private practice],
Boca Raton, Florida, USA

Dr. Jeffrey L. Fellows, PhD[Investigator],
Center for Health Research, Kaiser Permanente Northwest, Portland, Oregon, USA

Dr. Mark S. Litaker, Ph.D.[Associate Professor], and
Department of General Dental Sciences, School of Dentistry, University of Alabama at Birmingham, Birmingham, Alabama, USA

Dr. Gregg H. Gilbert, DDS, MBA[Professor and Chair]
Department of General Dental Sciences, School of Dentistry, University of Alabama at Birmingham, Birmingham, Alabama, USA

For The DPBRN Collaborative Group

Abstract

Objective—To quantify the reasons for placing restorations on non-carious tooth defects (NCTD) by Dental Practice-Based Research Network (DPBRN) dentists, and associated tooth, patient and dentist characteristics.

*Corresponding author: Valeria V. Gordan, University of Florida, College of Dentistry, P.O. Box 100415, Gainesville, FL 32610-04415, Phone: 352 273 5846, Fax: 352 846 1643, vgordan@dental.ufl.edu.

The DPBRN Collaborative Group comprises practitioner-investigators, faculty investigators, and staff investigators who contributed to this DPBRN activity. A list of these persons is at http://www.dpbrn.org/users/publications/Default.aspx

Methods—Data were collected on placement of 1,301 restorations due to NCTD by 178 DPBRN dentists. Information included: (1) main clinical occurrence or reason, other than dental caries, for restoring previously un-restored permanent tooth surfaces, (2) characteristics of patients who received treatment, (3) dentists' and dental practices' characteristics, (4) tooth and surfaces restored, and (5) restorative materials employed.

Results—Restorations were most often placed to treat abrasion, abfraction, and erosion (AAE) lesions (46%) and tooth fracture (31%). Patients older than 40 years received restorations mainly due to AAE ($p<0.0001$). Premolar and anterior teeth were mostly restored due to AAE; molar teeth were mostly restored due to tooth fracture ($p<0.0001$). Directly placed resin-based composite (RBC) was largely used to restore AAE and tooth fracture ($p<0.0001$).

Conclusion—AAE and tooth fracture are the main reasons for restoring non-carious tooth surfaces among DPBRN practices. Premolar and anterior teeth of patients older than 40 years are most likely to receive restorations due to AAE; molars are most likely to receive restorations due to tooth fracture. Both types of NCTD are most often restored with RBC.

Keywords

non-carious tooth defects; abrasion; abfraction; erosion; tooth fracture; resin-based composite; DPBRN

Introduction

Restorations are usually required to replace tooth tissue lost by dental caries[1], but loss of tissue can also occur as a result of non-carious tooth defects (NCTD) such as abrasion, abfraction, erosion lesions (AAE) or tooth fracture. Restorations also may be needed to re-establish function and esthetics of teeth with developmental defects or inherent discoloration, *i.e.* enamel hypoplasia or dental fluorosis. The various types of NCTD can affect tooth sensitivity, dental plaque retention, structural integrity and pulpal vitality, which also may be conditions that require placing a restoration [2, 3]. Thus, the decision to restore NCTD may be based not only on the need to replace lost tooth tissue, but also to prevent further damage or for esthetic reasons.

Abrasion, abfraction, and erosion lesions (AAE) have been identified as causes of hard tissue loss. Clinical appearance and tooth location of AAE can vary depending on the type and severity of the etiological factors involved [4]. The etiology of AAE appears to be multifactorial, with patient factors being responsible for the various degrees of tooth loss [3, 5–7]. The prevalence of AAE in dental practice has been reported to range from 5% to 85% [4, 5, 8–11]. As the population ages and teeth are retained longer, the incidence of AAE may increase, but their treatment varies considerably between dentists [12]. Although several management strategies have been proposed to treat AAE [13–16], the lack of clinical evidence about the prognosis of these lesions with or without intervention may be a major contributor to variation in dentists' management decisions.

The prevalence of tooth fracture may vary by tooth type and restorative status of the tooth [17, 18]. The etiology of tooth fracture and other types of NCTD has been identified [4, 12, 15, 17–19], but marked variations are evident in dental practice concerning the diagnosis and management of NCTD. No specific guidelines are available in the literature to assist dentists regarding when and how these defects should be restored. In the absence of information about the outcomes of alternative interventions, management decisions are primarily based on dentists' beliefs about the effectiveness of restorative interventions in terms of longevity and minimization of further disease [20].

The Dental Practice-Based Research Network (DPBRN) is a consortium of dental practices with a broad representation of practice types, treatment philosophies and patient populations, including substantial diversity with regard to the race, ethnicity, socioeconomic status, geography, and rural/urban area of residence of both its practitioner-investigators and its patients [21, 22]. This DPBRN study was undertaken to identify and quantify the: (1) main clinical occurrence or existing condition, other than dental caries, that led to reasons for restoring of previously un-restored permanent tooth surfaces, (2) characteristics of patients who received this treatment, (3) characteristics of dentists and dental practices that provided this treatment, (4) teeth and surfaces restored, and (5) restorative materials employed.

Materials and Methods

DPBRN dentists

Practitioner-investigators from The DPBRN who perform restorative dentistry in their practices were eligible for this study. The DPBRN comprises outpatient dental practices mainly from five regions: AL/MS: Alabama/Mississippi; FL/GA: Florida/Georgia; MN: dentists employed by HealthPartners and other practitioners in Minnesota; PDA: Permanente Dental Associates in cooperation with Kaiser Permanente Center for Health Research, Portland, Oregon; and SK: Denmark, Norway, and Sweden [23]. DPBRN dentists can be characterized by practice type: (1) a solo or small group private practice (SGP; < 4 dentists); (2) a large group practice (LGP; ≥ 4 dentists); or (3) a public health practice (PHP). Public health practices were defined as those that receive the majority of their funding from public sources. This study was approved by the respective Institutional Review Board of the participating regions [24].

DPBRN 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 an enrollment questionnaire describing their demographic and practice characteristics. For the current study, dentists attended a training session with the DPBRN regional coordinator, who explained in detail using a training manual how to properly complete the study protocol [25]. These questionnaires and study forms and further details about the recruitment process and training sessions are available at http://www.dentalpbrn.org/users/publications/Supplement.aspx.

The current study was conducted over a period of 30 months (July, 2006 to December, 2008) during which dentists from various DPBRN regions contributed data at various times. The study used a consecutive patient/restoration recruitment design. Once the study was started in a practice, every patient scheduled to have a restoration on a previously unrestored permanent tooth surface was asked to participate until 50 restorations had been enrolled. Patients who returned for additional appointments while data collection was ongoing were not eligible for further data collection. In order to increase the number of patients who would be enrolled, 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.

Restorations of Non-carious Tooth Defects

As part of a larger study of restorations placed on previously un-restored permanent tooth surfaces [1], DPBRN dentists provided information about consecutive restorations placed due to non-carious tooth defects (NCTD) as previously described [1]. Dentists also provided information on the characteristics of patients who received these restorations (age, gender, ethnicity, race, insurance coverage). All the data collection forms used for this study are

available at http://www.DentalPBRN.org/users/publications/Supplement.aspx. NCTD was defined as any clinical occurrence or existing condition, other than dental caries, that may require restorative treatment due to reasons for repairing the condition. Participating DPBRN dentists identified NCTD based on the examination methods they typically used. The data collection forms recorded the reasons for placement of NCTD restorations; response options included: (1) abrasion, abfraction, and erosion lesions, also referred as AAE; (2) tooth fracture; (3) developmental defect or hypoplasia; (4) cosmetic reasons; (5) restoration of endodontically-treated tooth; and/or (6) other unspecified defects or reasons.

Dentists also indicated the tooth type and tooth surfaces being restored as well as the restorative material(s) used. The response options for restorative material included: amalgam, directly placed resin-based composite (RBC), indirectly placed resin-based composite, 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.

Statistical Analysis

Associations between patient, dentist and restoration characteristics and reasons for restoration of NCTD were evaluated using the chi-square statistic, with adjustment for correlation among multiple restorations placed by the same dentist. Adjustment was based on calculation of the effective sample size for each test, using variance inflation factors (VIF) based on the intraclass correlation coefficient (ICC) and the average number of restorations recorded by each practitioner. The ICC was calculated from generalized estimating equations modeling using each of the reasons for restoration as the outcome variable. VIF was calculated as $1 + (m - 1)$ (ICC), where m is the average number of restorations per practitioner. The effective sample size is the number of independent observations that would be required to obtain an amount of information equal to that provided by the observed correlated observations. Multiple logistic regression modeling implemented by generalized estimating equations (GEE) was used to identify predictors of reasons for restoring NCTD. The four reasons included were AAE, tooth fracture, cosmetic reasons, and all other reasons (developmental defects or hypoplasia, restorations of endodontically-treated teeth, and unspecified reasons). Independent variables were grouped into three blocks consisting of patient characteristics (gender and age group), dentist and dental practice characteristics (dentist years of experience, patient visits per week, assessment of caries risk, and type of practice as being solo or small group, large group practice, and public health). Tooth surface was classified into four categories, as “Occlusal (O) or Incisal (I)”, “Mesial (M) or Distal (D)”, “Buccal (B) or Lingual (L)”, and a “multiple surfaces” (O/I/M/D/B/L) category for restorations including more than one of these three surface combinations. DPBRN regions were considered as a separate block. Variables significant at $p < 0.10$ in the individual models were included in the respective block model. Variables significant at $p < 0.05$ in the block models were used along with DPBRN regions in a single multivariable model. Variables which were significant at $p < 0.05$ in this model were retained in a final multivariable model. This process was conducted separately for each of the four reasons for NCTD restoration. Data were analyzed using SAS software version 9.2 (Cary, N.C.).

Results

A total of 182 DPBRN dentists collected data on 1,479 restorations placed due to NCTD in previously un-restored permanent tooth surfaces from 966 patients. Of the 1,479 NCTD restorations, 140 restorations with more than one reason and 38 restorations with no reason indicated were excluded from this study. Therefore, we report here only the information regarding the 1,301 restorations in which only one NCTD reason was indicated for

placement of restorations. A total of 178 DPBRN dentists reported information regarding the 1,301 NCTD restorations from 874 patients (1.49 restorations per patient). Of the total 874 patients, 70.1% received one restoration, 17.2% two restorations, 6.4% three restorations and 6.3% four restorations. Each of the 178 participating dentists reported an average of 7.31 [standard deviation (sd) = 5.74; minimum = 1; maximum = 28) restorations to this study. The mean number of patients per dentist was 4.9 (sd = 3.92, minimum = 1, maximum = 20).

With respect to the total 1,301 NCTD restorations, 46% were placed due to AAE, 31% due to tooth fracture, 7% for cosmetic reasons, and 16% due to all other reasons, i.e. developmental defects or hypoplasia, restorations of endodontically-treated teeth, and unspecified reasons.

Table 1 presents the characteristics of patients who received restorative treatment, by reasons for restoring NCTD. AAE and tooth fracture were the main reasons for placement of NCTD restorations on patients older than 20 years; patients younger than 20 years received restorations mainly due to other reasons ($p<0.0001$). Most restorations (55%) placed in patients older than 40 years were due to AAE. Logistic regression analysis revealed that the variable “patient age group” was significantly associated with placement of restorations due to AAE ($p < 0.0001$) and other reasons ($p < 0.0001$). Of note, the majority of the restorations received by White patients and Asian patients were done due to AAE; while Black patients received restorations mainly due to other reasons ($p=0.0246$) as shown in Table 1.

Not shown in tabular form, most of the restorations placed by White and Asian dentists were due to AAE; while Black dentists placed restorations mainly due to other reasons ($p=0.0017$). A statistically significant difference was also found when the reasons for restoring NCTD were compared among the type of practices ($p=0.0002$). Specifically, tooth fracture (46% of all LGP restorations) followed by AAE (40% of all LGP restorations) were the main reasons for placement of restorations by LGP dentists; while the majority of the restorations placed by SGP were due to AAE (50% of all SGP restorations), and a more uniform distribution among the main reasons for restoring was found between PHP dentists.

The characteristics of the tooth being restored, by type of NCTD are shown in Table 2. Premolar and anterior teeth were mostly restored due to AAE, whereas molar teeth were mostly restored due to tooth fracture ($p<0.0001$). The variable “tooth type” was significantly associated with placement due to AAE ($p < 0.0001$), tooth fracture ($p = 0.0009$), cosmetic reasons ($p = 0.0003$), and other reasons ($p = 0.0039$) as revealed by the regression analysis. Both maxillary and mandibular teeth received restorations mainly due to AAE, followed by tooth fracture ($p=0.0503$). In addition, there was a statistically significant difference between the reasons for restoring NCTD among the tooth surfaces ($p<0.0001$). The O/I surfaces were restored most commonly due to other reasons (42% of all O/I restorations), followed by AAE (37% of all O/I restorations). As expected, B/L surfaces were mainly restored due to AAE. Notably, tooth fracture was the main reason for placement of restorations on M/D surfaces (60% of all M/D restorations) and on multiple surfaces (64% of all multiple surfaces restorations). The regression analysis supported these observations because the variable “tooth surface” was significantly associated with placement of AAE ($p < 0.0001$) and tooth fracture ($p < 0.0001$) restorations.

Table 3 presents the restorative materials most commonly used to restore NCTD. The majority of the restorations using amalgam were due to tooth fracture (75% of all amalgam restorations; $p<0.0001$). RBC was largely used to restore AAE (54% of all RBC restorations) and those due to tooth fracture (26% of all RBC restorations). Most of the

restorations using GI/RMGI were due to AAE (67% of all GI/RMGI restorations) and other reasons (22% of all GI/RMGI restorations).

Supplementary tables from this study are available at http://www.DentalPBRN.org/users/publications/Supplement.aspx; and provide information on: (1) the distribution of the number of restorations placed due to NCTD, per patient and by reason for restoration; (2) the multiple logistic regression analysis of the reasons for restoring NCTD; (3) the number and percentage of DPBRN dentists and patients participating in the study, and the number and percentage of restorations placed by dentists from each DPBRN region; and (4) the distribution of the reasons for the restoration, by tooth characteristics and type of restorative material used.

Discussion

Non-carious tooth defects (NCTD) are relatively common clinical conditions [4, 5, 8–11] that may require restorative treatment. Our previous study revealed that 15 percent (1,479 of 9,890 restorations) of restorations placed on previously un-restored permanent tooth surfaces by DPBRN dentists were due to NCTD[1]. This present DPBRN study examined the reasons for placement of restorations on NCTD, and explored their association with teeth, patient and dentist characteristics. This study reports the range of dentists' decisions to restore NCTD; no information was reported about tooth defects in which restorative treatment was not done. Abrasion, abfraction, and erosion lesions (AAE), as diagnosed clinically by DPBRN dentists, were the main reasons for the placement of restorations on NCTD, followed by tooth fracture. Treatment planning for AAE remains an area of variability among dentists as reported by Bader and collaborators [12]. DPBRN studies provide valuable clinical information from a broad representation of dental practice types, treatment philosophies and patient populations. Knowledge of the factors affecting the restorative decision process by DPBRN dentists may provide the basis for standardized criteria for prevention, diagnosis, and management of AAE.

It is important to emphasize that the training sessions and training manual offered to DPBRN dentists were developed to ensure that the data collection forms were completed correctly and consistently by the dentists. However and consistent with studies typical in PBRNs, there was no standardization process for how clinical diagnosis of NCTD should be done. This is because we wanted to assure that dentists answered questions based on how they diagnose in their everyday clinical practice, allowing for evaluation of their clinical management of tooth defects. That is, the data collection process is standardized, but we intentionally made no effort to standardize how dentists diagnose and treat NCTD, so as to make inferences about typical clinical practice.

In this study, restorations received by White and Asian patients were mainly due to AAE and restorations received by Black patients were mainly due to other reasons. Although no specific data exist in the literature regarding the racial predilection of AAE or any other NCTD, it is possible that culture, dietary and behavioral factors may be associated with the differences observed on the type of NCTD restoration placed on patients of different races. Noteworthy, the majority of restorations placed by White and Asian dentists were due to AAE, and Black dentists placed restorations mainly due to other reasons. It is also possible that the types of NCTDs restored by dentists of different races may be influenced by their different patient populations.

Multivariable logistic regression models were used to identify significant associations between patient and teeth characteristics, and receipt of restorative treatment due to AAE. Our findings showed that the buccal and lingual surfaces of premolar teeth are more

commonly the locations of restorations due to AAE, consistent with other reports [3, 5, 7, 11, 15, 26–30]. The higher susceptibility of premolars to AAE has been attributed to their natural anatomical morphology, greater occlusal forces in association with the progressive development of group function from anterior to posterior, the accessibility of toothbrushes, and harmful brushing techniques [5, 7, 31, 32]. Our finding that patients older than 40 years were more commonly recipients of restorations due to AAE is in line with the results from other studies [3, 5, 11, 28, 33–35]. Older patients have been exposed to the related etiologic factors for a much longer period of time than younger patients [3, 6]. Gingival recession and bone loss, which are associated with aging, can also increase the likelihood of these cervical lesions [30, 36, 37].

The observation that premolar teeth of patients older than 40 years are more commonly the sites of restorations due to AAE highlights the importance of preventive interventions at an earlier age in order to avoid the need for future restorative treatment. Preventive interventions may include changes in patient's behavior, such as diet, brushing technique, and the use of protective nightguards to reduce clenching or bruxing. Occlusal adjustment has also been proposed to prevent lesion progression [11, 38] but the effectiveness of this intervention is not supported by evidence [14, 15]. Clearly, successful prevention of AAE in adults requires a better understanding of the risk factors for AAE and how these risk factors change over time. The value of restorative dentistry to treat AAE remains a controversial issue in clinical practice [15]. Failure of restorations placed due to AAE is commonly observed because the multifactorial etiology of these lesions may not be managed effectively. Restorative challenges for AAE are also attributed to difficulty in moisture control, in gaining access to subgingival margins [13, 14] and in treating the sclerotic dentin, the main affected tissue of these defects, with adhesive techniques [16].

Limited longevity of AAE restorations is a continuing problem in dentistry [38]. Occlusal loads and the quality of dental substrates [38–40] as well as mechanical properties of restorative materials [41] have been considered important factors affecting the retention and clinical performance of AAE restorations. Authors have suggested that during the selection of restorative materials for cervical lesions, the low modulus of elasticity, good adhesion to dentin, resistance to wear and ability to endure acid dissolution [5, 6, 15, 32] should be considered. In this study, composite resin was shown to be the material of choice to restore AAE (94 % of all AAE restorations) and all other NCTD. Although the use of glass ionomer cements (GICs), resin-modified GICs (RMGICs), and the lamination technique of GIC RMGIC liner/base with resin composite, have been advocated for AAE restorations[40, 42], only 4% of these restorations were placed with glass ionomer material by DPBRN dentists. Unfortunately, long-term clinical studies evaluating the performance of the different restorative materials on cervical lesions are rare [43]. The longevity of all restorations placed and reported in this study will be further assessed in a long-term DPBRN study. This information may result in better estimates of success and longevity of AAE restorations and therefore support informed restorative treatment decisions.

Tooth fracture was identified as the second most common non-carious reason requiring restorative treatment. Multiple tooth surfaces (cusp fracture) or only the mesial and distal surfaces (possibly the marginal ridges) of molar teeth were more commonly restored. Based on the variables used in this study, no patient or dentist characteristic was associated with restoration due to tooth fracture. Previous studies revealed that complete cusp fracture of posterior teeth is more common than incomplete fracture [19, 44]. Even though cusp fracture is known to occur frequently [19, 45, 46], and risk indicators [17, 18, 46] and teeth at higher risk have been identified [19], little attention has been given to the magnitude of which preventive interventions for tooth fracture may affect patient's oral health. Dentists often decide to place crowns as a preventive intervention for teeth identified as being at risk for fracture[47];

albeit crowns may be a more extensive treatment than that required to replaced tooth tissues lost by an eventual fracture. In the current study, only directly placed restorations due to tooth fracture were reported by DPBRN dentists. As noted, the clinical outcomes of these and all other NC restorations will be evaluated in a long-term DPBRN study.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Characteristics of patients who received restorative treatment, by reason for the restoration.

		AAE	Tooth fracture	Cosmetic reasons	Others	Total
Age group in years [N (%)]*	**<20**	5 (4%)	28 (20%)	14 (10%)	90 (66%)	137 (100%)
	20–40	96 (39%)	87 (35%)	21 (8%)	46 (18%)	250 (100%)
	41–60	330 (53%)	190 (31%)	41(7%)	53 (9%)	614 (100%)
	>60	170 (57%)	103 (34%)	11(4%)	15 (5%)	299 (100%)
	Total	601 (46%)	408 (31%)	87 (7%)	204 (16%)	1300 (100%)
Gender [N (%)]	**Male**	256 (44%)	199 (34%)	33 (6%)	93 (16%)	581 (100%)
	Female	344 (48%)	209 (29%)	54 (8%)	110 (15%)	717 (100%)
	Total	600 (46%)	408 (31%)	87 (7%)	203 (16%)	1298 (100%)
Ethnicity [N (%)]	**Hispanic**	30 (39%)	15 (20%)	9 (12%)	22 (29%)	76 (100%)
	Not Hispanic	566 (48%)	360 (31%)	78 (6%)	176 (15%)	1180 (100%)
	Total	596 (47%)	375 (30%)	87 (7%)	198 (16%)	1256 (100%)
Race [N (%)]*	**White**	526 (50%)	324 (31%)	74 (7%)	130 (12%)	1054 (100%)
	Black	21 (24%)	23 (26%)	7 (8%)	37 (42%)	88 (100%)
	Asian	37 (60%)	18 (29%)	0	7 (11%)	62 (100%)
	Other race	6 (26%)	10 (44%)	1 (4%)	6 (26%)	23 (100%)
	Total	590 (48%)	375 (31%)	82 (7%)	180 (15%)	1227 (100%)
Insurance coverage [N (%)]	**Yes**	478 (47%)	323 (32%)	63 (6%)	156 (15%)	1020 (100%)
	No	119 (43%)	86 (31%)	24 (9%)	48 (17%)	277 (100%)
	Total	597 (46%)	409 (31%)	87 (7%)	204 (16%)	1297 (100%)

Counts are the number of restorations, not the number of patients. Percentages are within rows for each patient characteristic. Of the 1,301 restorations reported in this study, data were collected on patient's age from 1,300 restorations; 1,298 on gender; 1,256 on ethnicity; 1,227 on race; and 1,297 on insurance coverage. AAE: abrasion, abfraction, or erosion lesions; Others: developmental defects or hypoplasia, endodontically-treated teeth, or other unspecified reasons; Black: Black or African-American; Other race: American Indian/Alaska Native, Native Hawaiian/Pacific Islander and others.

P-values are based on chi-square tests, adjusted for the effects of multiple observations per dentist; *age group in years: $p<0.0001$ and *race: $p=0.0246$. The associations between other variables and reasons for restoration were not statistically significant.

Table 2

Characteristics of the tooth being restored, by reason for the restoration.

		AAE	Tooth fracture	Cosmetic reasons	Others	Total
Tooth Type [N(%)]*	**Molar**	102 (25%)	180 (44%)	1 (0%)	123 (30%)	406 (100%)
	Premolar	276 (72%)	65 (17%)	6 (2%)	39 (10%)	386 (100%)
	Anterior	223 (44%)	164 (32%)	80 (16%)	42 (8%)	509 (100%)
	Total	601 (46%)	409 (31%)	87 (7%)	204 (16%)	1301 (100%)
Tooth location [N(%)]*	**Maxillary**	328 (45%)	238 (33%)	69 (10%)	91 (13%)	726 (100%)
	Mandibular	273 (47%)	171 (30%)	18 (3%)	113 (20%)	575 (100%)
	Total	601 (46%)	409 (31%)	87 (7%)	204 (16%)	1301 (100%)
Tooth surface [N(%)]*	**O and/or I**	81 (37%)	32 (15%)	13 (6%)	91 (42%)	217 (100%)
	M and/or D	7 (8%)	53 (60%)	12 (14%)	16 (18%)	88 (100%)
	B and/or L	456 (77%)	71 (12%)	20 (3%)	49 (8%)	596 (100%)
	Multiple (O/I/M/D/B/L)	53 (14%)	244 (64%)	41 (11%)	42 (11%)	380 (100%)
	Total	597 (47%)	400 (31%)	86 (7%)	198 (15%)	1281 (100%)

Counts are the number of restorations, not the number of tooth characteristics. Percentages are within rows for each tooth characteristic. Of the 1,301 restorations reported in this study, data were collected on tooth surface from 1,281 restorations. AAE: abrasion, abfraction, or erosion lesions; Others: developmental defects or hypoplasia, endodontically-treated teeth, or other unspecified reasons; O: occlusal; M: mesial; D: distal; B: buccal/facial; L: lingual/palatal; and I: incisal tooth surfaces.

P-values are based on chi-square tests, adjusted for the effects of multiple observations per dentist; *tooth type: $p<0.0001$, * tooth location: $p=0.0503$, and *tooth surface: $p < 0.0001$. The associations between other variables and reasons for restoration were not statistically significant.

Table 3

Distribution of reasons for the restoration, by type of restorative material used.

Restorative Material*	AAE	Tooth fracture	Cosmetic reasons	Others	Total
Amalgam	5 (5%)	68 (75%)	0	18 (20%)	91 (100%)
Direct Composite Resin (RBC)	566 (54%)	273 (26%)	77 (7%)	142 (13%)	1058 (100%)
Glass ionomer (GI/RMGI)	24 (67%)	3 (8%)	1 (3%)	8 (22%)	36 (100%)
Other materials	4 (5%)	37 (49%)	9 (12%)	26 (34%)	76 (100%)
Total [N(%)]	599 (48%)	381 (30%)	87 (7%)	194 (15%)	1261 (100%)

Counts are the number of restorations, not the number of restorative materials. Percentages are within rows for each restorative material. Of the 1,301 restorations reported in this study, data were collected on restorative materials from 1,261 restorations in which only one type of material was indicated. AAE: abrasion, abfraction, or erosion lesions; Others: developmental defects or hypoplasia, endodontically-treated teeth, orother unspecified defects or reasons. RBC: directly placed resin-based composite; GI/RMGI: glass-ionomer or resin-modified glass-ionomer; Other materials: indirectly placed resin-based composite, ceramic or porcelain, cast gold or other metallic-based material, combined metal-ceramic material, and temporary restorative material.

P-values are based on chi-square tests, adjusted for the effects of multiple observations per dentist; *restorative material: $p<0.0001$. The associations between other variables and reasons for restoration were not statistically significant.