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## Treatment Recommendations for Single-Unit Crowns: Findings from The National Dental Practice-Based Research Network

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### Abstract

**Background**—Objectives were to: (1) quantify practitioner variation in likelihood to recommend a crown; and (2) test whether certain dentist, practice, and clinical factors are significantly associated with this likelihood.

**Methods**—Dentists in the National Dental Practice-Based Research Network completed a questionnaire about indications for single-unit crowns. In four clinical scenarios, practitioners ranked their likelihood of recommending a single-unit crown. These responses were used to calculate a dentist-specific “Crown Factor” (CF; range 0–12). A higher score implies a higher likelihood to recommend a crown. Certain characteristics were tested for statistically significant associations with the CF.

**Results**—1,777 of 2,132 eligible dentists responded (83%). Practitioners were most likely to recommend crowns for teeth that were fractured, cracked, endodontically-treated, or had a broken

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restoration. Practitioners overwhelmingly recommended crowns for posterior teeth treated endodontically (94%). Practice owners, Southwest practitioners, and practitioners with a balanced work load were more likely to recommend crowns, as were practitioners who use optical scanners for digital impressions.

**Conclusions**—There is substantial variation in the likelihood of recommending a crown. While consensus exists in some areas (posterior endodontic treatment), variation dominates in others (size of an existing restoration). Recommendations varied by type of practice, network region, practice busyness, patient insurance status, and use of optical scanners.

**Practical Implications**—Recommendations for crowns may be influenced by factors unrelated to tooth and patient variables. A concern for tooth fracture -- whether from endodontic treatment, fractured teeth, or large restorations -- prompted many clinicians to recommend crowns.

## Keywords

Dentistry; Prosthodontics; Crowns

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## INTRODUCTION

Dentists recommend single-unit crowns for many reasons. A tooth might have a large carious lesion, a fracture, or a large filling, putting the tooth at risk for further breakdown. A tooth might be a source of pain, suggesting a crack, or a tooth might have had endodontic treatment. These situations may prompt a dentist to recommend a crown in order to increase the tooth's longevity and optimize the patient's oral health.<sup>1</sup>

However, little scientific evidence exists to guide dentists when making certain treatment recommendations.<sup>2, 3</sup> Most dentists would agree, for example, that a large restoration might be a reason to recommend a crown for a particular tooth. The question then becomes, "Exactly how 'large' does a restoration have to be in order to justify recommending a crown for the tooth?" Some dentists might repair a particular restoration, others may replace it, and still others may recommend placing an inlay or a single-unit crown.<sup>4-6</sup>

When making treatment recommendations, practitioners must manage a complex mix of clinical, social, and diagnostic factors.<sup>7, 8</sup> They base their recommendations on patient assessment, perceived risks and benefits, personal preference, treatment cost, and clinical experience.<sup>9</sup> These complexities lead to variation in treatment recommendations between practitioners.<sup>10-13</sup> Some treatment recommendations are not directly related to the clinical circumstance of the tooth.<sup>14</sup> For example, patients with a college education may be less likely to receive a recommendation for a crown.<sup>15, 16</sup>

In circumstances for which clinical scientific evidence is absent, clinicians may gain valuable insight by observing colleagues and knowing what techniques are reported by other dentists as effective. The results presented in this study detail clinicians' treatment decisions for single-unit crowns and what factors lead to these recommendations. Additionally, we identify non-patient factors that may influence the decision to recommend a crown. The objectives for this study were to: (1) describe and quantify practitioner variation in

likelihood to recommend a single-unit crown; and (2) test whether certain dentist, practice, and clinical factors are significantly associated with this likelihood.

## MATERIALS AND METHODS

This study is based on a questionnaire completed by dentists in the National Dental Practice-Based Research Network (PBRN; “network”). The network is a consortium of dental practices and dental organizations focused on improving the scientific basis for clinical decision-making.<sup>17</sup> Detailed information about the network is available at its web site.<sup>18</sup> The network’s applicable Institutional Review Boards approved the study; all participants provided informed consent after receiving a full explanation of the procedures.

### Enrollment Questionnaire

As part of the enrollment process, practitioners completed an Enrollment Questionnaire that describes themselves, their practice(s), and their patient population. This questionnaire is publicly available at “<http://www.nationaldentalpbrn.org/study-results.php>” under the heading “Factors for Successful Crowns” and collects information about practitioner, practice and patient characteristics. Questionnaire items, which had documented test/re-test reliability, were taken from our previous work in a practice-based study of dental care.<sup>19, 20</sup> The typical enrollee completes the questionnaire online, although a paper option is available.

### Study Questionnaire Development

The questionnaire for this study was developed by a study group of the authors, dentists with clinical expertise, statisticians, and laboratory technicians. Its purpose was to measure current practices in fabricating crowns, and treatment recommendations for single-unit crowns. The survey was reviewed by IDEA Services (Instrument Design, Evaluation, and Analysis Services, Westat, Rockville, MD), a group with expertise in questionnaire development and implementation, as well as National Institute of Dental and Craniofacial Research (NIDCR) program officers and practitioners with prosthodontic content expertise. After extensive internal review, IDEA Services pre-tested the questionnaire via cognitive interviewing by telephone with a regionally diverse group of eight practicing dentists. Cognitive interviewers probed the dentist’s comprehension of each question. The interviewers also asked practitioners to identify items of clinical interest that were not addressed in the survey. Results from the pretest prompted further modification of the questionnaire.

Dentists enrolled in the network were eligible for the study if they met all of these criteria: (1) completed an Enrollment Questionnaire; (2) were currently practicing and treating patients in the United States; (3) were in the network’s “limited” or “full” network participation category; and (4) reported on the Enrollment Questionnaire that they currently do at least some restorative dentistry in their practices. A total of 2,299 network clinicians met these criteria.

Pre-printed invitation letters were mailed (postal) to eligible practitioners, informing them that they would receive an email with a link to the electronic version of the questionnaire. At the time of the email, practitioners were given the option to request a paper version of the

survey, as this has been shown to improve response rates.<sup>21</sup> Practitioners were asked to complete the questionnaire within two weeks. A reminder letter was sent after the second and fourth weeks to those who had not completed the questionnaire. After six weeks, email and postal reminders were sent with a printed version of the questionnaire and practitioners were offered the option of completing the online or paper versions. After eight weeks, a final postal questionnaire attempt was made with a letter that also encouraged the dentist to complete the questionnaire online. Data collection was closed after 12 weeks from the original email invitation. Practitioners or their business entities were remunerated \$75 for completing the questionnaire if desired. Data were collected from February 2015 to August 2015.

### Questionnaire Content

The first question of the survey confirmed that the invited clinician did at least one crown in a typical month. The Questionnaire is publicly available (<http://www.nationaldentalpbrn.org/study-results.php>) under the heading “Factors for Successful Crowns”. Among other questions, practitioners were asked why they recommended crowns for patients. Dentists were asked, “Rank the top three MOST COMMON reasons you recommend a crown in your practice, with 1 being the most common and 3 being the least common,” and were given the following list: Active caries, Endodontic Therapy, Large Restoration, Broken Restoration, Esthetics, Change Vertical Dimension, RPD Abutment, and Other. The Other category received a large number of responses related to fractured teeth or cracked teeth; these were categorized subsequently during data analysis into an additional group labeled Fractured or Cracked Tooth.

### Crown Factor

We had a particular interest in learning which restorations would indicate the need for a crown based primarily on the size and condition of the restoration and tooth. A series of four questions showed photographs of teeth with various restorations. Practitioners were asked if they would recommend a crown for each of the four teeth represented (shown in Fig. 1 from smallest to largest; in the questionnaire these were in a mixed order). Practitioners were given this clinical scenario to accompany the four figures: “Assume each patient is a 40 year-old female patient of yours who attends her annual recall visits on a dependable basis, has no relevant medical history, is at low risk for dental decay, has satisfactory occlusion with minimal wear, and is financially able to pay for a crown out-of-pocket.”

The four response options were “very likely to recommend a crown,” “likely to recommend a crown,” “not likely to recommend a crown,” and “definitely not recommend a crown.” These were assigned a value of 3, 2, 1 and 0, respectively. The answers to the four questions for each clinician were summed to create a “Crown Factor” (CF; range 0–12) for each dentist. Practitioners who did not answer any of the four questions were excluded from this part of the study.

Other responses on this questionnaire and from the network’s Enrollment Questionnaire were tested to determine whether they were significantly ( $p<0.05$ ) associated with the Crown

Factor. These were questions relating to practice type, years in practice, perceived practice busyness, and insurance coverage of patients.

### Statistical Analyses

Power analysis was conducted based on an anticipated sample size of 1,500 completed questionnaires. This sample size would yield sufficient precision to estimate response percentages within  $\pm 2.53\%$ , at the 95% confidence level. To document test/re-test reliability of the questionnaire items, 47 respondents completed the questionnaire twice online. For categorical responses, kappa and weighted kappa were used; for numeric items, Pearson's correlation coefficient was calculated to determine test-retest reliability. Descriptive statistics are presented as counts and percentages for categorical variables, and as means and standard deviations for continuous measures. Potential predictors of crown factor were evaluated using analysis of variance (ANOVA) and multiple regression analysis.

## RESULTS

For this study, 2,299 dentists were selected to participate. Of these dentists, 101 were deemed ineligible before beginning the questionnaire (no longer in active practice; deceased; specialists who do not do single-unit permanent crowns). An additional 66 were deemed ineligible once completing at least part of the questionnaire (do not do at least one crown each month). This left a total of 2,132 eligible persons, of whom 1,777 responded, for a response rate of 83%. Among the 47 test/re-test participants, the mean (SD) time between test and re-test was 15.5 (3.0) days. For categorical variables, agreement between time 1 and time 2 showed a mean weighted kappa of 0.62 (IQR: 0.46, 0.79). Mean test-retest reliability for numeric variables was 0.75.

Dentist and practice characteristics are shown in Table 1. The majority of respondents were male, and many had been in practice for over 20 years. Most of the respondents, 73%, were practice owners. Respondents were split fairly evenly across regions, and the majority work full time (86%). Only 3% of respondents were specialists, including 32 prosthodontists.

Dentists ranked the following crown indication factors the highest: Fractured or Cracked Tooth, Endodontic Therapy, and Broken Restorations. These were followed by Active Caries and Large Restoration. Responses are listed in Table 2.

As shown in Table 2, if a posterior tooth had been treated endodontically, practitioners were strongly in favor of recommending a crown, with 94% stating they would recommend a crown over 75% of the time. This percentage was lower when considering anterior teeth with endodontic treatment. The responses were evenly distributed, with about half of respondents recommending a crown over half the time.

Practitioners viewed photographs of posterior teeth with restorations (Fig. 1) and offered opinions of whether the tooth should receive a crown. These clinical photographs depicted teeth with a variety of restorations, from an occlusal alloy to a large MOD restoration. The responses to these questions from the survey are displayed in Table 3. In response to the occlusal alloy in Fig. 1A, 98% of respondents reported they would not likely or definitely

not recommend a crown. The largest restoration, Fig. 1D, also produced a homogenous response, with 97% of practitioners reporting that they were very likely or likely to recommend a crown. The other restorations (Fig. 1B and 1C) produced more divergent responses.

Among clinician and practice variables, neither clinician gender, race, specialty status, nor full-time commitment were significantly associated with the likelihood to recommend a crown based on the four restorations shown to practitioners in the questionnaire (Table 4). However, type of practice showed a significant association with CF, with practice owners and associates more likely than other groups to recommend a crown. Associates were more likely to recommend a crown than Permanente, Health Partners, or Academic clinicians. Practice Owners were more likely to recommend a crown than Academics or Health Partners clinicians. Public Health clinicians were more likely to recommend a crown than Academic and Health Partners clinicians. Permanente dentists were more likely to recommend a crown than Health Partners practitioners. Private insurance status was also significantly associated with the likelihood to recommend a crown. In practices where less than 40% of patients had private insurance, clinicians were significantly less likely to recommend a crown than practices that had 40–79% insurance coverage.

Practitioners in the Midwest and Northeast were less likely to recommend crowns than practitioners from other parts of the country, while the highest crown factor was noted in the Southwest.

Perceived practice busyness was significantly associated with the likelihood to recommend a crown. Clinicians who reported a balanced practice load were more likely to recommend a crown than practitioners who were too busy to see all their patients or practitioners who felt burdened by their schedules. Practitioners who reported being not busy were more likely to recommend a crown than the ones who reported they were overly busy.

The use of optical scanners and in-office milling units was associated with a higher CF. Practitioners with an in-office milling unit were more likely to recommend a crown than either dentists using a commercial laboratory or an in-office laboratory. If clinicians use an optical scanner more than 75 percent of the time for crown impressions, they recommend a crown more often than people who use scanners less frequently or not at all (Table 4).

## DISCUSSION

One clear area of consensus among dentists in this study is that crowns should be recommended when posterior teeth have had endodontic treatment. This recommendation is consistent with evidence from the literature. One study of over 1 million teeth showed a correlation between lack of coronal coverage in endodontically treated teeth and tooth fracture.<sup>22</sup> Another study found the 5-year survival of endodontically treated molars without crowns was only 36 percent.<sup>23</sup> An additional study found that molar survival without a crown is 50%, while survival increases to 98% with coronal coverage.<sup>24</sup> A retrospective cohort analysis suggested that uncrowned endodontically treated teeth have a 6 times higher incidence of extraction than teeth with crowns; also, second molars were at higher risk than

other teeth.<sup>25</sup> The same benefit, however, is not always noted for anterior teeth in many of these studies.<sup>22–24, 26</sup> Other factors influence tooth longevity for endodontically treated teeth, such as number of missing teeth and plaque control.<sup>27</sup> In this sense, practitioners responding to this survey echo findings in the literature when making clinical decisions, as manifested by their frequently recommending crowns for posterior teeth treated endodontically, and sometimes recommending crowns for anterior teeth.

Broken cusps and fractured teeth were also reasons practitioners frequently cited to recommend crowns. The rate for coronal fractures is 89 per 1000 person years, with more fractures occurring in posterior teeth.<sup>28</sup> Expressed another way, a dentist with 1000 patients in a practice might see 90 fractured teeth per year. One study found a lower estimate, at 20.5 per 1000 person years.<sup>29</sup> The vast majority of these expose the dentin, and about half extend beyond the gingival crest of the dentinoenamel junction. Serious consequences (pulpal involvement or extraction) of these fractures range from 7–15 percent.<sup>30, 31</sup> Fracture lines in the enamel of posterior teeth have also been recognized as a risk factor for tooth coronal fracture,<sup>3</sup> where a tactilely detectable fracture line increased odds of fracture an astounding 75-fold. Given this evidence, and the incidence of reported tooth fractures, it seems reasonable that clinicians would recommend crowns when teeth are fractured or cracked.

Evidence in the literature supports crowning teeth with ‘large’ restorations to increase tooth longevity. One prospective cohort study examined over 40,000 patients for 3 months. In that time window, 238 fractures occurred. About 77 percent of the fractured teeth had restorations that involved 3 or more surfaces.<sup>29</sup> Findings from other studies also suggest that larger restoration volume is associated with an increased fracture risk.<sup>1, 3, 11, 32, 33</sup> Clinicians responding to this survey did list “Large Restoration” as a reason to recommend a crown, but not as highly as endodontic treatment or a cracked tooth. It should be noted that most clinicians will strongly consider patient preferences, expectations and other patient-centered factors when recommending crowns, in addition to the clinical findings. These types of patient factors were not explored in this survey. It is also fair to point out that crowns are generally profitable for a dental office, and finances may impact treatment recommendations. These issues were not directly addressed in the survey.

The response to the photographs of teeth with restorations proved interesting. There are limitations to this question, such as the fact that practitioners are looking at a two-dimensional photograph and therefore cannot examine the tooth clinically. Additionally, some practitioners might recommend an onlay or other restoration with cuspal coverage instead of a crown, and this was not provided as a response option. Nonetheless, the responses highlight the variability between practitioners when making treatment decisions. The MOD restoration in a premolar (Fig. 1C) produced the most divergent responses, with roughly one third of practitioners each responding very likely, likely, or not likely to recommend a crown. More agreement existed with the small occlusal restoration (Fig. 1A), where 98 percent of practitioners were either not likely or would definitely not recommend a crown. Conversely, when shown a large MOD amalgam and a fractured buccal cusp (Fig. 1D), 97 percent of practitioners endorsed “very likely” or “likely” to recommend a crown. It appears that more consensus exists regarding very large or small restorations, and great variation of treatment recommendations exists in the middle. Variables significantly

associated with the likelihood to recommend a crown (CF) were Type of Practice, Network Region, Private Insurance Status, Practice Busyness, and Optical Scanner Use. To our knowledge, this is the first time that such associations have been reported. It is interesting to observe that factors unrelated to the tooth or patient may influence treatment recommendations. Practice owners and associates recommended crowns more than other clinicians. This could be due to financial incentives to provide crowns, or it could be that the solo practitioner believes that the crown has the highest rate of success, and wants to provide this treatment, regardless of cost to the patient. Practitioners in the Health Partners group had a low propensity to recommend crowns, which could reflect an emphasis on preventive dentistry pervasive in this group, or perhaps a lack of financial incentive for the clinician to provide a higher-cost treatment option. Additional variation may be due to different dentists having different opinions in any given clinical situation regarding the benefit of a crown. Private insurance status was significantly associated with the crown factor. This may reflect access to care issues or how patient preferences impact a practitioner recommendation. For example, if the clinician knows the patient has insurance coverage, he or she might recommend a crown more often.

It is unclear why the likelihood to recommend a crown varied by network region. This could be related to patient populations, or cultural differences, such as a belief in a “wait and see” attitude versus a “fix it before it breaks” attitude. Also, it should be recognized that practice type varies between regions, which might confound this variable. Practice Busyness was significantly associated with treatment recommendations. This factor has been shown to impact other aspects of clinical care, such as restoration longevity.<sup>34</sup> Generally, the busier a clinician the less likely he/she is to recommend a crown. Presumably, this is because making a crown would take more time than other options, such as a direct restoration, and further burden the schedule.

As the use of digital imaging and milling becomes more prevalent, it was interesting to observe that frequent use of an optical scanner was associated with a higher propensity to recommend a crown. Similarly, in-office milling was associated with a significantly higher CF. Recognizing that many practitioners with an optical scanner will also utilize an in-office milling unit, the presence of this technology implies more recommendations for crowns. This could be due to the increased efficiency of providing this treatment (one appointment instead of two), higher patient demand for crowns, or these practitioners simply like doing crowns and are therefore more apt to have in-office milling and/or optical scanners.

This study does have certain limitations, and conclusions should take these into account. This study measured treatment recommendations using hypothetical clinical scenarios, which may differ from actual clinical treatment behavior. This study relied on questionnaire information rather than direct observation of procedures. Additionally, although the response rate was very good, it is possible that non-respondents would have reported different behavior. The questionnaire listed “broken restoration” as an indication for crowns, but did not provide “cracked tooth” as a specific response. The latter was a popular choice listed in the “other” category. It is possible that as an additional, specific category more clinicians would have selected this as a reason. The two-dimensional photographs used in the questionnaire could be interpreted in different ways, and this is a limitation of the study.



Although network practitioners have much in common with dentists at large<sup>35, 36</sup> it may be that their crown procedures are not representative of a wider representation of dentists. Additionally, network members are not recruited randomly, so factors associated with network participation (*e.g.*, an interest in clinical research) may make network dentists unrepresentative of dentists at large. While we cannot assert that network dentists are entirely representative, we can state that they have much in common with dentists at large, while also offering substantial diversity in these characteristics. This assertion is warranted because: 1) substantial percentages of network general dentists are represented in the various response categories of the characteristics in the Enrollment Questionnaire; 2) findings from several network studies document that network general dentists report patterns of diagnosis and treatment that are similar to patterns determined from non-network general dentists<sup>37–39</sup> and 3) the similarity of network dentists to non-network dentists using the best available national source, the 2010 ADA Survey of Dental Practice.<sup>40</sup>

In summary, it is clear that a complex interaction of factors can influence treatment recommendations. Dominant factors include items associated with tooth fracture, such as endodontic therapy, cracked or fractured teeth, and large restorations. Other factors are more subtle, and can be related to the clinician, such as where a practice is located, how busy it is, patient insurance status, or whether or not the practice utilizes in-office scanners. When making treatment decisions, clinicians should recognize that factors other than the patient or the tooth itself may influence their decisions.

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## LIST OF ABBREVIATIONS

<b>ANOVA</b>	analysis of variance
<b>CF</b>	crown factor
<b>PBRN</b>	practice-based research network
<b>NIDCR</b>	National Institute of Dental and Craniofacial Research
<b>RPD</b>	removable partial denture
<b>SD</b>	standard deviation

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## APPENDIX

[Note to reviewers: The purpose of this appendix is to make certain information directly accessible to the reviewers in a single document. This Appendix will not appear in the published version of the manuscript. The typical reader will have access to this Appendix via <http://nationaldentalpbrn.org/study-results.php>, “Factors for Successful Crowns” section.]

**Table A1**

Regarding the various restorations shown in Fig 1, numbers (row percent<sup>1</sup>) of respondents by category and their likelihood to recommend a crown

Characteristic	Very Likely to Recommend Crown	Likely to Recommend Crown	Not Likely to Recommend Crown	Definitely Not Recommend Crown	Total	P Value
Figure 1A, an occlusal restoration						
<b>Gender</b>						
Male	5 (0.4)	24 (2)	388 (30)	865 (67)	1282	0.23
Female	1 (0.2)	9 (2)	170 (35)	302 (63)	482	
Total	6	33	558	1167	1764	
<b>Years Since Dental School Graduation</b>						0.72
<10	1 (0.3)	6 (2)	91 (31)	194 (66)	292	
10–19	1 (0.3)	9 (2)	132 (36)	225 (61)	367	
20–29	2 (0.5)	6 (2)	120 (31)	253 (66)	381	
30+	2 (0.3)	12 (2)	220 (30)	499 (68)	733	
Total	6	33	563	1171	1773	
<b>Type of Practice</b>						<b>0.0009</b>
Owner of Private Practice	5 (0.4)	23 (2)	433 (33)	833 (64)	1294	
Associate in Priv. Practice	0	6 (3)	76 (37)	125 (60)	207	
Health Partners <sup>2</sup>	0	0	6 (14)	38 (86)	44	
Permanente <sup>2</sup>	0	0	17 (24)	53 (76)	70	
Other Managed Care	0	1 (10)	0	9 (90)	10	
Public Health, Community	0	2 (3)	17 (27)	45 (70)	64	
Federal Government	0	0	5 (21)	19 (79)	24	
Academic	1 (2)	0	4 (8)	43 (90)	48	
Total	6	32	558	1165	1761	
<b>Network Region<sup>3</sup></b>						<b>0.04</b>
Western	0	6 (2)	90 (31)	196 (67)	292	
Midwest	1 (0.5)	2 (1)	51 (28)	126 (70)	180	
Southwest	0	9 (3)	120 (39)	181 (58)	310	
South Central	3 (2)	6 (2)	112 (34)	209 (63)	330	
South Atlantic	1 (0.3)	7 (2)	103 (32)	216 (66)	327	
Northeast	1 (0.3)	3 (0.9)	87 (26)	246 (73)	337	
Total	6	33	563	1174	1776	
<b>Time Commitment</b>						0.11
Full time	4 (0.3)	30 (2)	484 (32)	989 (66)	1507	
Part time (<32 hrs)	2 (0.8)	1 (0.4)	74 (29)	176 (70)	253	
Total	6	31	558	1165	1760	

Characteristic	Very Likely to Recommend Crown	Likely to Recommend Crown	Not Likely to Recommend Crown	Definitely Not Recommend Crown	Total	P Value
<b>Specialty Status</b>						
General Dentist	6 (0.3)	32 (2)	551 (32)	1129 (66)	1718	0.37
Specialist	0	1 (2)	12 (21)	43 (77)	56	
Total	6	33	563	1172	1774	
<b>Race</b>						
White	6 (0.4)	29 (2)	461 (32)	955 (66)	1451	0.91
Black/African-American	0	1 (1)	21 (27)	55 (71)	77	
Asian	0	3 (2)	48 (30)	109 (68)	160	
Other	0	0	24 (34)	46 (66)	70	
Total	6	33	554	1165	1758	
Figure 1B, a DO alloy						
<b>Gender</b>						
Male	148 (12)	463 (36)	602 (47)	67 (5)	1280	0.51
Female	57 (12)	168 (35)	239 (50)	18 (4)	482	
Total	205	631	841	85	1762	
<b>Years Since Dental School Graduation</b>						
<10	28 (10)	101 (35)	151 (52)	11 (4)	291	0.20
10–19	39 (11)	132 (36)	185 (50)	11 (3)	367	
20–29	51 (13)	129 (34)	180 (47)	22 (6)	382	
30+	90 (12)	275 (38)	324 (44)	42 (6)	731	
Total	208	637	840	86	1771	
<b>Type of Practice</b>						
Owner of Private Practice	167 (13)	479 (37)	592 (46)	55 (4)	1293	<0.0001
Associate in Priv. Practice	30 (14)	85 (41)	85 (41)	7 (3)	207	
Health Partners <sup>2</sup>	0	10 (23)	27 (63)	6 (14)	43	
Permanente <sup>2</sup>	1 (1)	22 (31)	43 (61)	4 (6)	70	
Other Managed Care	1 (10)	2 (20)	4 (40)	3 (30)	10	
Public Health, Community	4 (0.2)	16 (1)	40 (2)	4 (0.2)	64	
Federal Government	3 (12)	8 (33)	13 (54)	0	24	
Academic	0	9 (19)	32 (67)	7 (16)	48	
Total	206	631	836	86	1759	
<b>Network Region<sup>3</sup></b>						
Western	37 (13)	98 (34)	145 (50)	12 (4)	292	0.0005
Midwest	16 (9)	54 (30)	96 (54)	13 (7)	179	
Southwest	51 (16)	128 (41)	124 (40)	8 (3)	311	
South Central	42 (13)	127 (38)	146 (42)	15 (5)	330	

Characteristic	Very Likely to Recommend Crown	Likely to Recommend Crown	Not Likely to Recommend Crown	Definitely Not Recommend Crown	Total	P Value
South Atlantic	37 (11)	125 (38)	150 (46)	14 (4)	326	
Northeast	25 (7)	105 (31)	182 (54)	24 (7)	336	
Total	208	637	843	86	1774	
<b>Time Commitment</b>						
Full time	177 (12)	548 (36)	709 (47)	72 (5)	1506	0.73
Part time (<32 hrs)	27 (11)	85 (34)	126 (50)	14 (6)	252	
Total	204	633	835	86	1758	
<b>Specialty Status</b>						
General Dentist	205 (12)	619 (36)	810 (47)	82 (5)	1716	0.31
Specialist	3 (5)	18 (32)	31 (55)	4 (7)	56	
Total	208	637	841	86	1772	
<b>Race</b>						
White	176 (12)	520 (36)	678 (47)	75 (5)	1449	0.08
Black/African-American	10 (13)	32 (42)	32 (42)	3 (4)	77	
Asian	16 (10)	45 (28)	92 (58)	7 (4)	160	
Other	6 (9)	33 (47)	31 (44)	0	70	
Total	208	630	833	85	1756	
Figure 1C, an MOD restoration						
<b>Gender</b>						
Male	369 (29)	457 (36)	395 (31)	60 (5)	1281	0.06
Female	139 (29)	196 (41)	136 (28)	12 (2)	483	
Total	508	653	531	72	1764	
<b>Years Since Dental School Graduation</b>						
<10	68 (23)	120 (41)	97 (33)	7 (2)	292	0.001
10–19	114 (31)	153 (42)	93 (25)	7 (2)	367	
20–29	126 (33)	132 (35)	105 (27)	19 (5)	382	
30+	204 (28)	252 (34)	236 (32)	40 (5)	732	
Total	512	657	531	73	1773	
<b>Type of Practice</b>						
Owner of Private Practice	408 (32)	466 (36)	366 (28)	54 (4)	1294	<0.0001
Associate in Priv. Practice	60 (29)	90 (43)	53 (26)	4 (2)	207	
Health Partners <sup>2</sup>	1 (2)	15 (34)	24 (55)	4 (9)	44	
Permanente <sup>2</sup>	9 (13)	36 (51)	23 (33)	2 (3)	70	
Other Managed Care	1 (10)	3 (30)	5 (50)	1 (10)	10	
Public Health, Community	22 (34)	18 (28)	22 (34)	2 (3)	64	
Federal Government	1 (4)	8 (33)	14 (58)	1 (4)	24	

Characteristic	Very Likely to Recommend Crown	Likely to Recommend Crown	Not Likely to Recommend Crown	Definitely Not Recommend Crown	Total	P Value
Academic	4 (8)	17 (35)	22 (46)	5 (10)	48	
Total	506	653	529	73	1761	
<b>Network Region<sup>3</sup></b>						<b>0.0008</b>
Western	75 (26)	126 (43)	83 (28)	8 (3)	292	
Midwest	41 (23)	61 (34)	70 (39)	8 (4)	180	
Southwest	120 (39)	105 (34)	79 (25)	7 (2)	311	
South Central	104 (32)	113 (34)	96 (28)	16 (5)	329	
South Atlantic	92 (28)	128 (39)	93 (28)	14 (4)	327	
Northeast	81 (24)	124 (37)	112 (33)	20 (6)	337	
Total	513	657	533	73	1776	
<b>Time Commitment</b>						0.39
Full time	438 (29)	562 (37)	449 (30)	58 (4)	1507	
Part time (<32 hrs)	68 (27)	90 (36)	80 (32)	15 (6)	253	
Total	506	652	529	73	1760	
<b>Specialty Status</b>						0.17
General Dentist	498 (29)	642 (37)	507 (30)	71 (4)	1718	
Specialist	15 (27)	15 (27)	24 (43)	56 (4)	56	
Total	513	657	531	73	1774	
<b>Race</b>						0.12
White	413 (28)	528 (36)	444 (31)	65 (4)	1450	
Black/African-American	30 (39)	23 (30)	23 (30)	1 (1)	77	
Asian	45 (28)	69 (43)	40 (25)	7 (4)	161	
Other	21 (30)	32 (46)	17 (24)	0	70	
Total	509	652	524	73	1758	
Figure 1D, an MOD alloy with a broken cusp						
<b>Gender</b>						<b>0.047</b>
Male	1129 (88)	113 (9)	28 (2)	12 (1)	1282	
Female	406 (84)	62 (13)	13 (3)	2 (0.4)	483	
Total	1535	175	41	14	1765	
<b>Years Since Dental School Graduation</b>						0.20
<10	249 (85)	36 (12)	5 (2)	2 (0.7)	292	
10–19	320 (87)	38 (10)	7 (2)	2 (0.6)	367	
20–29	319 (84)	45 (12)	14 (4)	4 (1)	382	
30+	655 (90)	57 (8)	15 (2)	6 (0.8)	733	
Total	1543	176	41	14	1774	

Characteristic	Very Likely to Recommend Crown	Likely to Recommend Crown	Not Likely to Recommend Crown	Definitely Not Recommend Crown	Total	P Value
<b>Type of Practice</b>						
Owner of Private Practice	1144 (88)	110 (8)	30 (2)	11 (0.9)	1295	<b>&lt;0.0001</b>
Associate in Priv. Practice	182 (88)	19 (9)	5 (2)	1 (0.4)	207	
Health Partners <sup>2</sup>	25 (57)	15 (34)	4 (9)	0	44	
Permanente <sup>2</sup>	61 (87)	7 (10)	1 (1)	1 (1)	70	
Other Managed Care	7 (70)	3 (30)	0	0	10	
Public Health, Community	55 (86)	8 (13)	1 (2)	0	64	
Federal Government	21 (88)	3 (13)	0	0	24	
Academic	37 (77)	10 (21)	0	1 (2)	48	
Total	1532	175	41	14	1762	
<b>Network Region<sup>3</sup></b>						
Western	260 (89)	26 (9)	5 (2)	1 (0.3)	292	0.25
Midwest	148 (82)	25 (14)	5 (3)	2 (1)	180	
Southwest	275 (88)	26 (8)	8 (3)	2 (0.6)	311	
South Central	283 (86)	36 (11)	9 (3)	2 (0.6)	330	
South Atlantic	297 (91)	19 (6)	8 (2)	3 (0.9)	327	
Northeast	283 (84)	44 (13)	6 (2)	4 (1)	337	
Total	1546	176	41	14	1777	
<b>Time Commitment</b>						
Full time	1313 (87)	147 (10)	36 (2)	12 (0.8)	1508	0.84
Part time (<32 hrs)	217 (86)	29 (11)	5 (2)	2 (0.8)	253	
Total	1530	176	41	14	1761	
<b>Specialty Status</b>						
General Dentist	1503 (87)	166 (10)	37 (2)	13 (0.8)	1719	<b>0.02</b>
Specialist	42 (75)	9 (16)	4 (7)	1 (2)	56	
Total	1545	175	41	14	1775	
<b>Race</b>						
White	1264 (87)	140 (10)	36 (2)	11 (0.7)	1451	0.84
Black/African-American	67 (87)	9 (12)	0	1 (1.3)	77	
Asian	138 (86)	18 (11)	4 (2)	1 (0.6)	70	
Other	64 (91)	4 (6)	1 (1)	1 (1)	161	
Total	1533	171	41	14	1759	

<sup>1</sup>Due to missing values, not all rows add to 100%, and not all totals sum to 1,777.

<sup>2</sup>Either HealthPartners Dental Group in greater Minneapolis, MN or Permanente Dental Associates in greater Portland, OR.

<sup>3</sup>Reported on Enrollment Questionnaire as the state, subsequently categorized into one of the six regions of the network.



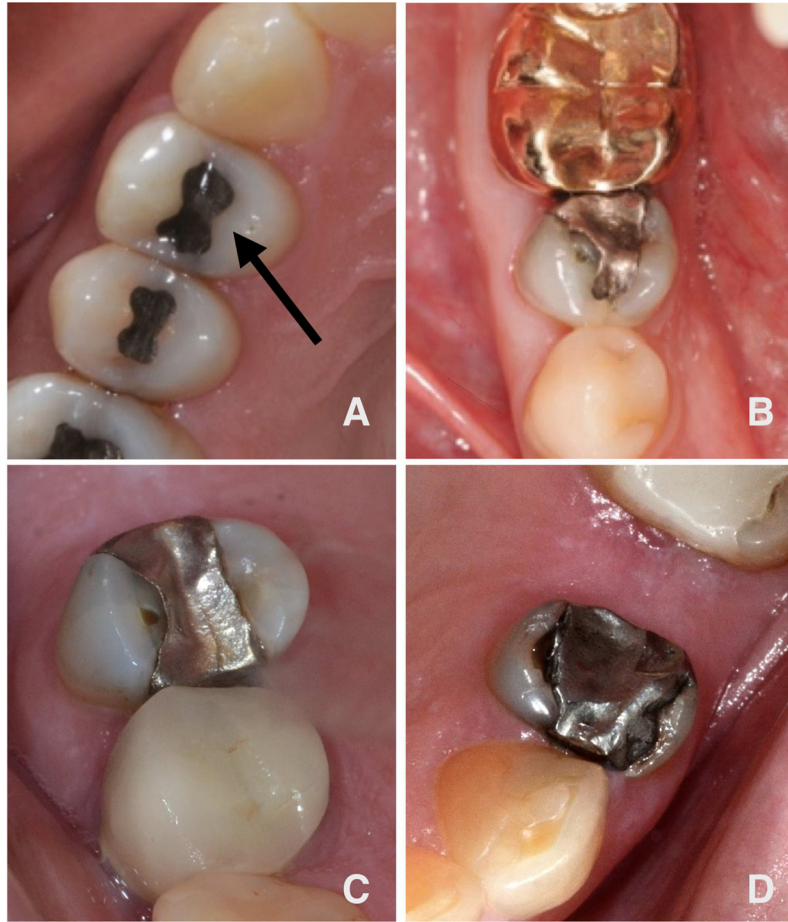


Fig. 1.

**Table 1**

Characteristics of dentists participating in survey

Characteristics	Number <sup>1</sup> (n=1,777)	Percent (%)
<b>Dentist Characteristics</b>		
<b>Gender</b>		
Male	1282	73
Female	483	27
<b>Years Since Dental School Graduation</b>		
<10	292	16
10–19	367	21
20–29	382	22
30+	733	41
<b>Type of Practice</b>		
Owner of Private Practice	1295	73
Associate in Private Practice	207	12
Health Partners <sup>2</sup>	44	3
Permanente <sup>2</sup>	70	4
Public Health, Community	64	4
Academic	48	3
<b>Network Region<sup>3</sup></b>		
Western	292	16
Midwest	180	10
Southwest	311	18
South Central	330	19
South Atlantic	327	18
Northeast	337	19
<b>Time Commitment</b>		
Full time	1508	86
Part time (<32 hrs)	253	14
<b>Specialty Status</b>		
General Dentist	1719	97
Specialist	56	3
<b>Race</b>		
White	1451	82
Black/African-American	77	4
Asian	161	9
Other	70	4

Characteristics	Number <sup>1</sup> (n=1,777)	Percent (%)
<b>Patient Population Characteristics</b>		
<b>Private Insurance Status</b>		
<40% Private Insurance	249	14
40–79% Private Insurance	1017	58
80%+ Private Insurance	476	27
<b>Patient Appointment Regularity</b>		
<50% of Patients Regularly Visit	274	16
50–79% Regularly Visit	1044	60
80%+ Regularly Visit	428	25

<sup>1</sup>Due to missing values, not all columns add to 100%.

<sup>2</sup>Either HealthPartners Dental Group in greater Minneapolis, MN or Permanente Dental Associates in greater Portland, OR.

<sup>3</sup>Reported on Enrollment Questionnaire as the state, subsequently categorized into one of the six regions of the network.

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**Table 2**

Survey responses showing the leading reasons practitioners recommend crowns; how often practitioners recommend crowns for posterior teeth following endodontic therapy, and how often for anterior teeth

<b>Indications for Crowns: Responses (N=1,777)</b>	
<b>Crown Indications</b>	<b>Mean Ranking<sup>I</sup> (±SD)</b>
Fractured or Cracked Tooth	1.8 (0.86)
Endodontic Therapy	1.9 (0.79)
Broken Restoration	1.9 (0.80)
Active Caries	2.1 (0.84)
Large Restoration	2.1 (0.79)
Change Vertical Dimension	2.7 (0.53)
RPD Abutment	2.7 (0.55)
Esthetics	2.8 (0.52)
<b>Yes Response, Percent (n)</b>	
<b>Posterior Endo</b>	
Recommend Crown >75%	94.1 (1671)
Recommend Crown 50–74%	4.6 (82)
Recommend Crown 25–49%	1.0 (18)
Recommend Crown <25%	0.2 (4)
<b>Anterior Endo</b>	
Recommend Crown >75%	18.6 (331)
Recommend Crown 50–74%	31.7 (562)
Recommend Crown 25–49%	26.3 (466)
Recommend Crown <25%	23.4 (416)

<sup>I</sup>When considering the ranking, a lower number indicates a condition which is more likely to prompt a recommendation for a crown. Range is 0–12.

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**Table 3**

Recommendations for crowns by practitioners responding to this survey. Photographs of posterior teeth with restorations are shown in Figure 1

<b>Recommendations for Crowns</b>	
<b>Figure 1A: Occlusal Restoration</b>	
	<b>Percent (n)</b>
Very likely to recommend a crown	0.3 (6)
Likely to recommend a crown	1.9 (33)
Not likely to recommend a crown	32 (563)
Definitely not recommend a crown	66 (1174)
<b>Figure 1B: DO Restoration</b>	
	<b>Percent (n)</b>
Very likely to recommend a crown	12 (208)
Likely to recommend a crown	36 (637)
Not likely to recommend a crown	48 (843)
Definitely not recommend a crown	5 (86)
<b>Figure 1C: MOD Restoration</b>	
	<b>Percent (n)</b>
Very likely to recommend a crown	29 (513)
Likely to recommend a crown	37 (657)
Not likely to recommend a crown	30 (533)
Definitely not recommend a crown	4 (73)
<b>Figure 1D: MOD with Fracture</b>	
	<b>Percent (n)</b>
Very likely to recommend a crown	87 (1546)
Likely to recommend a crown	10 (176)
Not likely to recommend a crown	2 (41)
Definitely not recommend a crown	1 (14)

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**Table 4**

Dentist and practice factors associated with the likelihood of recommending a crown (Crown Factor)

Characteristics	Number (n)	Crown Factor <sup>I</sup> (SD)	P Value*
<b>Gender</b>			
Male	1279	6.6 (1.8)	.36
Female	481	6.7 (1.8)	
<b>Race</b>			
White	1448	6.6 (1.9)	0.41
Black/African-American	77	6.8 (1.7)	
Asian	159	6.5 (1.7)	
Other	70	6.9 (1.4)	
<b>Type of Practice</b>			
Owner of Private Practice	1291	6.8 (1.8)	<0.0001
Associate in Private Practice	207	6.9 (1.8)	
Health Partners	43	5.0 (1.7)	
Permanente	70	6.1 (1.5)	
Public Health, Community	64	6.4 (1.7)	
Academic	48	5.3 (1.7)	
<b>Network Region</b>			
Western	292	6.7 (1.8)	<0.0001
Midwest	179	6.3 (2.0)	
Southwest	310	7.1 (1.8)	
South Central	329	6.7 (1.9)	
South Atlantic	326	6.7 (1.8)	
Northeast	336	6.3 (1.8)	
<b>Practice Busyness</b>			
Too busy	101	6.1 (1.7)	0.0002
Burdened	327	6.4 (1.9)	
Balanced	908	6.8 (1.8)	
Not busy	434	6.7 (1.9)	
<b>Time ommitment</b>			
Full Time	1504	6.7 (1.8)	0.11
Part Time (<32 hrs)	252	6.5 (1.8)	
<b>Private Insurance Status</b>			
<40% Private Insurance	249	6.4 (2.0)	0.02
40–79% Private Insurance	1017	6.7 (1.8)	
80%+ Private Insurance	476	6.5 (1.8)	
<b>Laboratory</b>			

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Characteristics	Number (n)	Crown Factor <sup>I</sup> (SD)	P Value*
Commercial	1561	6.6 (1.8)	<b>0.0003</b>
In Office Traditional	47	6.3 (1.9)	
In Office Milling	163	7.2 (1.8)	
<b>Optical Scanner Use</b>			
High: 75% or more	146	7.2 (1.7)	<b>0.0006</b>
Less than 75%	1626	6.6 (1.9)	

<sup>I</sup>Clinical photographs were used to calculate a “Crown Factor” (CF) number for practitioners responding to the survey. A higher number indicates a person is more likely to recommend a crown. Range is 0–12. The Crown Factor was associated with some clinician and practice variables. The CF value is listed ±Standard Deviation (SD).

\* Analysis of variance

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