

Impression Techniques Used for Single-Unit Crowns: Findings from the National Dental Practice-Based Research Network

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Keywords

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Abstract

Purpose: To: (1) determine which impression and gingival displacement techniques practitioners use for single-unit crowns on natural teeth; and (2) test whether certain dentist and practice characteristics are significantly associated with the use of these techniques.

Materials and Methods: Dentists participating in the National Dental Practice-Based Research Network were eligible for this survey study. The study used a questionnaire developed by clinicians, statisticians, laboratory technicians, and survey experts. The questionnaire was pretested via cognitive interviewing with a regionally diverse group of practitioners. The survey included questions regarding gingival displacement and impression techniques. Survey responses were compared by dentist and practice characteristics using ANOVA.

Results: The response rate was 1777 of 2132 eligible dentists (83%). Regarding gingival displacement, most clinicians reported using either a single cord (35%) or dual cord (35%) technique. About 16% of respondents preferred an injectable retraction technique. For making impressions, the most frequently used techniques and materials are: poly(vinyl siloxane), 77%; polyether, 12%; optical/digital, 9%. A dental auxiliary or assistant made the final impression 2% of the time. Regarding dual-arch impression trays, 23% of practitioners report they typically use a metal frame tray, 60% use a plastic frame, and 16% do not use a dual-arch tray. Clinicians using optical impression techniques were more likely to be private practice owners or associates.

Conclusions: This study documents current techniques for gingival displacement and making impressions for crowns. Certain dentist and practice characteristics are significantly associated with these techniques.

Clinicians frequently offer crowns to patients as a treatment option. Whether to protect a tooth from fracture, improve esthetics, or restore decayed surfaces, crowns provide a solution for a variety of restorative needs. Although crowns are a common factor in daily practice, little is known about the prevalence of different techniques used to make crown impressions, or variations in techniques that may exist regionally or by practice/dentist characteristics.

Steps associated with making a crown include gingival displacement, impression of the prepared tooth, obtaining a jaw relationship record, and registration of the opposing dentition. The first step, gingival retraction or displacement, often uses a mechanical element placed into the gingival sulcus, such as a cord or paste.¹⁻³ A general goal is to create a gap of about 0.2 mm or more around the finish line of the preparation.^{4,5} Cordless and cord techniques can both provide this level of

retraction. One recent survey reported that 92% of dentists use retraction cord.⁶ Often a chemical agent is added to induce hemostasis,⁷ or the gingival tissues might be removed surgically with a rotary instrument, laser, or heated electrode.^{2,6} In some studies, the techniques using retraction cord provided more displacement, but cordless techniques (paste) may have advantages in patient comfort and fewer inflammatory markers.⁸⁻¹⁰ The use of compression caps and lasers has also been reported.¹¹⁻¹³

A multitude of techniques exist for making impressions for single-unit crowns, with variations in impression materials, techniques, and tray types.^{14,15} Many clinicians use poly(vinyl siloxane) (PVS) polymeric impression materials.¹⁵⁻¹⁷ Even within this category, clinicians must pick a particular technique. For example, some authors advocate a putty-wash technique, during which the tray is filled with a high-viscosity PVS material, and a lower-viscosity material is injected around the prepared tooth.¹⁸ Other studies demonstrate that a two-stage technique is superior. In this technique, a preliminary impression is made before tooth preparation, sometimes using a spacer to provide relief in the impression. After tooth preparation, a second impression is made using a lower viscosity material.¹⁹⁻²² Clinicians also commonly use other combinations of viscosity materials both to load the impression tray and to syringe around a prepared tooth.^{23,24}

Similarly, variation exists in the type of tray used to capture the impression. One study examined 1403 impressions submitted to a commercial laboratory in the United States: a majority of the trays used were plastic (62%), and most were dual-arch (73%).²⁵ In a U.K. survey of dentists, 61% used a full-arch plastic tray for crown impressions.²⁶ Another U.K. survey reports 65% of impressions used a flexible tray.²⁷ While some studies suggest that custom trays or rigid metal trays produce superior impressions,²⁸⁻³¹ other authors conclude that plastic dual-arch trays, even though less rigid, provide acceptable clinical results.³²⁻³⁵ It is possible that higher-viscosity materials may distort more when using a dual-arch tray system.^{36,37}

Advances in technology offer additional options for impressions, including the use of optical (digital) techniques for making crowns. One study examined 50 crowns made with optical impressions in a general practice and documented a median marginal gap of 46 μm .³⁸ Several studies compared digital and polymeric impression techniques by making multiple impressions and crowns for the same tooth and comparing the fit of these crowns. In these studies, the fit of the digitally produced crown was similar to or better than conventional techniques.³⁹⁻⁴¹ In vitro work also supports the use of digital impression techniques, claiming clinically acceptable marginal fit and internal adaptation.⁴²⁻⁴⁶ Some data suggest that the optical impression may be faster^{47,48} or offer higher patient satisfaction.⁴⁹ Optical impressions crowns may also boast fewer chairside adjustments.

The results presented in this study used questionnaire data from clinicians describing the techniques they commonly (or regularly or routinely) use to achieve gingival displacement and obtain impressions. Additionally, we identify dentist and practice characteristics significantly associated with use of these techniques. In circumstances for which clinical scientific evidence is equivocal, clinicians may gain valuable insight by observing colleagues and knowing what techniques are reported

by other dentists as effective. While every dentist learns these techniques in dental school, technology and materials change rapidly, so it is helpful to identify current techniques widely used in general clinical practice.

Materials and methods

This study is based on two surveys completed by dentists in the National Dental Practice-Based Research Network (PBRN; “network”). This included the Enrollment Questionnaire, and the Clinical Techniques Questionnaire. The network is a consortium of dental practices and dental organizations focused on improving the scientific basis for clinical decision-making.⁵⁰ Detailed information about the network is available at its website.⁵¹ 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, all practitioners completed an Enrollment Questionnaire describing themselves, their practice(s), and their patient population. This questionnaire is publicly available at “<http://www.nationaldentalpbrn.org/study-results/2016/>” 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.^{52,53} The typical enrollee completed the questionnaire online, although a paper option is available.

Clinical techniques questionnaire development

The Clinical Techniques Questionnaire for this study was developed by a focus group including the authors, other dentists with clinical expertise, statisticians, and laboratory technicians. Its purpose was to measure current practices in treatment planning, preparing, and fabricating single-unit crowns on natural teeth. 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 2299 network clinicians met these criteria.

Preprinted 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.⁵⁴ Practitioners were asked to complete the questionnaire within 2 weeks. A reminder letter was sent after the second and fourth weeks to those who had not completed the questionnaire. After 6 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 8 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.

Clinical techniques questionnaire content

The first question of the clinical techniques 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/2016/>) under the heading “Factors for Successful Crowns.” Questions from the survey considered in this manuscript focused on techniques for making impressions, such as the use of different materials, retraction techniques, and tray types. Other questions from the survey focused on treatment recommendations,⁵⁵ material choices, and crown preparation techniques.

One question asked dentists to rank their most commonly used impression techniques and materials. To contrast optical impressions with polymeric impressions, data were stratified based on 90% usage or more. Dentists who use polymeric impression materials more than 90% of the time were compared to dentists who use optical impression techniques more than 90% of the time.

Statistical analyses

Power analysis was conducted based on an anticipated sample size of 1500 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/retest reliability of the questionnaire items, 47 respondents completed the questionnaire twice online. Test-retest reliability was evaluated using percent agreement, Cohen’s kappa, and weighted kappa for categorical responses and the Pearson correlation coefficient for continuous responses. Descriptive statistics are presented as counts and percentages for categorical variables, and as means and standard deviations (SD) for continuous measures. Associations between dentist and practice characteristics and survey responses were evaluated using chi-square and multiple logistic regression analyses.

Results

For this study, 2299 dentists were selected to participate. Of these, 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 2132 eligible clinicians, of whom 1777 responded, for a response rate of 83%. Among the 47 test/retest participants, the mean (SD) time between test and retest 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 distributed fairly evenly across regions, and the majority work full time (86%). Only 3% of respondents were specialists, including 32 prosthodontists.

Dentists indicated their most commonly used method of gingival retraction (Table 2). Possible responses included: none, dual cord, single cord, injectable retraction material (e.g., Expasyl), dual impression (wash) technique, gingival troughing (e.g., electrical or laser tissue removal), and other. Only two clinicians reported using a dual impression (wash) technique, and four reported gingival troughing; for the purposes of reporting in Table 2 these were combined with the “Other” category. Most clinicians used either a single cord (35%) or dual cord (35%) technique. About 16% of respondents preferred an injectable retraction technique. These preferences correlated significantly with dentist and practice characteristics.

Dentists reported using chemical agents to control hemostasis on $57 \pm 38\%$ of impressions. Some 37% of respondents use these agents more than 90% of the time, and 22% use them less than 10% of the time.

When making crown impressions, dentists were asked to indicate the percentage of time they use the following techniques: PVS, polyether, optical (digital or CAD/CAM), hydrocolloid, or other. While some clinicians might use 100% PVS, as an example, other clinicians might use multiple techniques in varying percentages. The average (\pm SD) responses overall for each technique were: PVS, 77% (39); polyether, 12% (30); optical, 9% (26); hydrocolloid, 1% (10); other, 1% (9).

The dentist who prepared the tooth made the impression 98% of the time, and an assistant made the final impression 2% of the time. The dentist who prepared the tooth made the provisional 49% of the time, and an assistant made the provisional 50% of the time. The remaining responses included offices that do not make provisionals, or make them with a combination of efforts between the dentist and auxiliary.

Most clinicians (57%) use a heavy-body material as their material of choice to load the tray for an impression; others commonly use a medium-body material (34%) (Table 3). Differences in selecting materials exist by gender, race, years since graduation, type of practice, and region. Females report using more heavy-body materials to load the tray, and clinicians identifying as white tend to use heavy-body materials less often. Clinicians graduating more than 15 years ago use heavy body materials to load the tray less often.

The large majority of clinicians, 77%, report using a light-viscosity material to syringe around a tooth for a polymeric

Table 1 Characteristics of dentists participating in this survey

	Number ^a (n = 1777)	Percent (%)
Dentist characteristics		
Gender		
Male	1282	73
Female	483	27
Years since dental school graduation		
<10	292	16
10–19	367	21
20–29	382	22
30+	733	41
Type of practice		
Owner of private practice	1295	73
Associate in private practice	207	12
HealthPartners ^b	44	3
Permanente ^b	70	4
Public health, community	64	4
Academic	48	2
Other	34	2
Network Region^c		
Western	292	16
Midwest	180	10
Southwest	311	18
South Central	330	19
South Atlantic	327	18
Northeast	337	19
Time commitment		
Full time	1508	86
Part time (<32 hours)	253	14
Specialty status		
General Dentist	1719	97
Specialist	56	3
Race		
White	1451	82
Black/African-American	77	4
Asian	161	9
Other	70	4
Patient population characteristics		
Private insurance status		
<40% Private insurance	249	14
40–79% Private insurance	1017	58
80%+ Private insurance	476	27
Patient appointment regularity		
<50% of Patients regularly visit	274	16
50–79% Regularly visit	1044	60
80%+ Regularly visit	428	25

^aDue to missing values, reported sample sizes vary.

^bEither HealthPartners Dental Group in greater Minneapolis, MN or Permanente Dental Associates in greater Portland, OR.

^cReported on Enrollment Questionnaire as the state, subsequently categorized into one of the six regions of the network.

impression. About 12% use an ultra-light viscosity, and 8% use medium-viscosity materials for this purpose. Regarding optical impression techniques, about 8% of dentists use optical impressions most of the time (defined as more than 75%), while 6% use optical impressions more than 90% of the time. About 2% of clinicians exclusively use optical techniques for making impressions.

For the question, “If you use a dual-arch tray for final crown impressions, select the tray that most resembles the style used in your office” clinicians were given the option to pick a metal-framed quadrant tray, an all-plastic quadrant tray, or the response “I do not use a triple tray (dual arch) impression.” As shown in Table 4, 23% chose the metal-framed tray, 60% chose the plastic tray, and 16% reported not using a dual-arch

Table 2 Frequency (%) of preferred gingival displacement techniques, overall and by dentist and practice characteristics

Characteristics	None	Dual cord	Single cord	Injectable	Other	p Value*	Total ^a
Overall	100 (6)	612 (35)	626 (35)	279 (16)	156 (9)		1773
Gender							
Male	85 (7)	424 (33)	439 (34)	214 (17)	119 (9)	0.004	1281 (73)
Female	15 (3)	184 (38)	183 (38)	65 (13)	36 (7)		483 (27)
Race							
White	87 (6)	469 (32)	520 (36)	239 (16)	135 (9)	0.01	1450 (82)
Black/African-American	2 (3)	32 (42)	28 (36)	8 (10)	7 (9)		77 (4)
Asian	6 (4)	75 (47)	55 (34)	18 (11)	7 (4)		161 (9)
Other	4 (6)	32 (46)	18 (26)	9 (13)	7 (10)		70 (4)
Years since graduation							
<5	0	31 (44)	26 (37)	7 (10)	6 (9)	0.01	70 (4)
5-15	19 (4)	177 (40)	154 (35)	62 (14)	3 (7)		444 (25)
>15	81 (6)	404 (32)	446 (35)	210 (17)	118 (9)		1259 (71)
Type of practice							
Owner of private practice	81 (6)	385 (30)	457 (35)	239 (18)	132 (10)	<0.0001	1294 (73)
Associate in private practice	14 (7)	75 (36)	77 (37)	28 (14)	13 (6)		207 (11)
HealthPartners	0	14 (32)	24 (54)	6 (14)	0		44 (3)
Permanente	0	51 (73)	18 (25)	0	1 (1)		70 (4)
Public health, community	2 (3)	34 (53)	23 (36)	2 (3)	3 (5)		64 (4)
Academic	0	32 (67)	12 (25)	1 (2)	3 (6)		48 (3)
Other	1 (3)	18 (53)	10 (29)	2 (6)	3 (9)		34 (2)
Network region							
Western	9 (3)	169 (58)	81 (28)	14 (5)	19 (7)	<0.0001	292 (16)
Midwest	3 (2)	68 (38)	68 (38)	33 (18)	8 (4)		180 (10)
Southwest	21 (7)	108 (35)	110 (36)	51 (16)	21 (7)		311 (18)
South Central	24 (7)	70 (21)	125 (38)	71 (22)	40 (12)		330 (19)
South Atlantic	16 (5)	113 (35)	126 (39)	40 (12)	31 (10)		326 (18)
Northeast	27 (8)	87 (26)	116 (34)	70 (21)	37 (11)		337 (19)
Practice busyness							
Too busy	3 (3)	50 (50)	36 (36)	10 (10)	2 (2)	<0.0001	101 (5)
Burdened	14 (4)	136 (42)	96 (29)	47 (14)	34 (10)		327 (18)
Balanced	59 (6)	299 (33)	321 (35)	151 (17)	80 (9)		910 (51)
Not busy	24 (6)	130 (30)	172 (39)	70 (16)	40 (9)		436 (25)
Private insurance status							
<40% Private Insurance	2 (4)	24 (46)	13 (25)	6 (12)	7 (13)	0.04	52 (3)
40–79% Private insurance	51 (7)	234 (31)	269 (36)	132 (17)	71 (9)		757 (43)
80%+ Private insurance	45 (5)	348 (37)	338 (36)	136 (14)	78 (8)		945 (54)

^aDue to missing values, reported sample sizes vary.

technique. These responses correlated significantly with all of the practice characteristics listed in Table 4.

Table 5 compares the characteristics of dentists who use optical impressions more than 90% of the time to dentists who use polymeric materials more than 90% of the time. White dentists, private practice owners, and dentists who reported being less busy, were significantly more likely to report using optical impressions more than 90% of the time.

Discussion

The use of optical scanners is perhaps reaching a tipping point, with dentists reporting they use optical impressions about 9% of the time to make single-unit crown impressions. This trend is expected to continue, as more clinicians choose to make crown

impressions digitally,^{14,56} and apply this technology to other aspects of dentistry, such as fabricating removable prostheses.⁵⁷ However, there is little documentation of the prevalence of these techniques in private practice, or which practitioner characteristics correlate with their use. Three factors were significantly correlated with the use of digital scanners among clinicians who used digital impressions more than 90% of the time for single-unit crown impressions: race, type of practice, and practice busyness. While the use of advanced technology is often associated with younger people, that was not the case in this sample, with no difference among users who had graduated from dental school recently, compared to those who had been in practice longer. It appears that the use of digital scanners has appeal across all generations of dentists.

By practice type, the clinicians who used digital impressions were more likely practice owners or associates, while clinicians

Table 3 Frequency (%) of impression tray material choice, overall and by dentist and practice characteristics

Characteristics	Optical only	Medium body	Heavy body	Putty	<i>p</i> Value*	Total ^a
Overall	39 (2)	606 (34)	997 (57)	119 (7)		1761
Gender						
Male	31 (2)	451 (35)	691 (54)	96 (8)	0.01	1269 (73)
Female	8 (2)	152 (32)	298 (62)	22 (5)		480 (27)
Race						
White	32 (2)	518 (36)	777 (54)	110 (8)	0.0002	1437 (82)
Black/African-American	1 (1)	23 (30)	50 (65)	3 (4)		77 (4)
Asian	4 (3)	52 (33)	100 (63)	4 (3)		160 (9)
Other	1 (1)	10 (15)	57 (83)	1 (1)		69 (4)
Years since graduation						
<5	1 (1)	23 (34)	43 (63)	1 (1)	<0.0001	68 (4)
5-15	8 (2)	126 (28)	292 (66)	17 (4)		443 (25)
>15	30 (2)	457 (37)	660 (53)	101 (8)		1248 (71)
Type of practice						
Owner of private practice	36 (3)	428 (33)	717 (56)	105 (8)	0.003	1286 (74)
Associate in private practice	3 (1)	65 (32)	134 (66)	2 (1)		204 (12)
HealthPartners	0	21 (49)	20 (47)	2 (5)		43 (2)
Permanente	0	32 (46)	37 (53)	1 (1)		70 (4)
Public health, community	0	23 (37)	36 (57)	4 (6)		63 (4)
Academic	0	24 (50)	22 (46)	2 (4)		48 (3)
Other	0	9 (26)	22 (65)	3 (9)		34 (2)
Network region						
Western	6 (2)	85 (30)	181 (62)	18 (6)	0.03	290 (16)
Midwest	1 (1)	68 (38)	103 (58)	5 (3)		177 (10)
Southwest	9 (3)	92 (30)	186 (60)	21 (7)		308 (17)
South Central	6 (2)	116 (35)	183 (55)	25 (8)		330 (19)
South Atlantic	5 (2)	113 (34)	182 (56)	24 (7)		324 (18)
Northeast	12 (4)	132 (40)	162 (49)	26 (8)		332 (19)
Practice busyness						
Too busy	2 (2)	39 (39)	54 (54)	5 (5)	0.6	100 (6)
Burdened	7 (7)	113 (35)	188 (57)	15 (5)		327 (18)
Balanced	19 (2)	295 (32)	524 (58)	64 (7)		910 (51)
Not busy	11 (3)	158 (36)	231 (53)	34 (8)		436 (25)

^aDue to missing values, reported sample sizes vary.

in large group practices did not report widespread use of digital impression technology. This is somewhat surprising, as a larger office may have greater financial resources for the use of an optical scanner. The association may reflect a more nimble decision structure present in a smaller private practice, or a desire to standardize techniques and materials within a larger group structure, pushing the group toward more conventional materials. Also, with a larger group, more people must agree on an expensive capital investment, and in particular the brand or type of technology to purchase. This may delay the decision in some cases.

Practices that were not overly busy were more likely to use digital technology. This may be associated with having adequate time to implement a new impression technique into practice. Also, clinicians burdened with their clinical load may be less likely to invest time into new technology, particularly when its use has not reached a point of majority use within the industry. Finally, clinicians of different races reported different levels of digital impression utilization, with clinicians reporting their race as white or other using digital impressions more

than clinicians who reported their race as black or Asian. It is unclear why these differences exist.

The most popular overall impression material for single-unit crowns was polymeric impression materials, especially PVS materials. These numbers were slightly lower than a U.K. dentist survey, which reported about 90% use of silicone materials (addition and condensation) and 9% of dentists using polyether materials.⁵⁸ That same study, published in 2005, reported that 1% of restorations were made using CAD/CAM technology, far lower than the results presented here, over a decade later. A similar study, published in 2012 by the same author, found that addition silicone was used 71% of the time, and polyether materials 17%, numbers similar to our findings.⁵⁹ They also noted that female clinicians were less likely to use polyether impression materials.

The polymeric material viscosity used to fill the impression tray varied statistically by most parameters reported in this study. Overall, approximately one-third of practitioners use medium body in the tray, and two-thirds use putty in the tray. This occurs despite some evidence that suggests that

Table 4 Frequency (%) of tray choice for dual-arch impressions, overall and by dentist and practice characteristics

Characteristics	Do not use	Metal frame	Plastic frame	ρ Value*	Total ^a
Overall	288 (16)	415 (23)	1068 (60)		1771
Gender				0.02	
Male	227 (18)	303 (24)	750 (59)		1280 (73)
Female	60 (12)	110 (23)	312 (65)		482 (27)
Race				0.0001	
White	260 (18)	345 (24)	843 (58)		1448 (82)
Black/African-American	9 (12)	11 (14)	57 (74)		77 (4)
Asian	10 (6)	36 (22)	115 (71)		161 (9)
Other	5 (7)	19 (27)	46 (66)		70 (4)
Years since graduation				<0.0001	
<5	7 (10)	13 (19)	50 (71)		70 (4)
5-15	33 (7)	118 (27)	293 (66)		444 (25)
>15	248 (20)	284 (23)	725 (58)		1257 (71)
Type of practice				<0.0001	
Owner of private practice	242 (19)	279 (22)	771 (60)		1292 (73)
Associate in private practice	15 (7)	41 (20)	151 (73)		207 (12)
HealthPartners	3 (4)	34 (77)	7 (16)		44 (3)
Permanente	3 (4)	36 (51)	31 (44)		70 (4)
Public health, community	7 (11)	6 (9)	51 (80)		64 (4)
Academic	12 (25)	14 (29)	22 (46)		48 (3)
Other	6 (18)	3 (9)	25 (74)		34 (2)
Network region				<0.0001	
Western	23 (8)	95 (33)	174 (60)		292 (16)
Midwest	17 (9)	85 (47)	78 (43)		180 (10)
Southwest	39 (13)	53 (17)	218 (70)		310 (17)
South Central	53 (16)	71 (22)	206 (62)		330 (19)
South Atlantic	84 (26)	51 (16)	192 (59)		327 (18)
Northeast	73 (22)	60 (18)	202 (60)		335 (19)
Practice busyness				0.002	
Too busy	9 (9)	24 (24)	68 (67)		101 (6)
Burdened	34 (10)	95 (29)	197 (60)		326 (18)
Balanced	161 (18)	199 (22)	549 (60)		909 (51)
Not busy	84 (19)	97 (22)	255 (58)		436 (25)
Private insurance status				<0.0001	
<40% Private insurance	18 (35)	9 (17)	25 (48)		52 (3)
40-79% Private insurance	166 (22)	160 (21)	431 (57)		757 (43)
80%+ Private insurance	103 (11)	241 (26)	599 (65)		943 (54)

*Due to missing values, reported sample sizes vary.

higher-viscosity materials distort impressions more when using disposable trays.^{33,36,37} Clinicians who graduated more than 15 years ago reported less use of heavy-body materials in the tray, but a higher use of putty. Clinicians in larger group practices reported frequent use of medium-body materials in the impression trays, at 49% and 46% for HealthPartners and Permanente Dental Associates clinicians, respectively. This may be due to an effort to standardize material choice by using a medium-viscosity material to appeal to various dentist preferences in a large group setting.

The overall use of dual-arch trays in this survey was similar to that reported by Mitchell *et al*,²⁵ who observed that about 60% of dual-arch trays used are plastic. Of the impressions examined in that study, 73% were dual-arch; however, this also included impressions for implant crowns, inlays, onlays, and

veneers, which were types of restorations not considered in this survey. The results were echoed by Storey and Coward,²⁷ with 65% of impressions made with flexible trays. While some controversy exists regarding the use of a dual-arch impression tray, clearly it is popular in practice. The use of the dual-arch impression tray is supported in the literature.^{28,32-36} Considering practice characteristics, several factors were associated with tray choice. Black and Asian clinicians used more plastic frame dual-arch trays, while white clinicians were more likely not to use a dual-arch technique. Clinicians who had been in practice more than 15 years were less likely to use a dual-arch technique, which may reflect a change in views over time regarding this technique. Clinicians in the HealthPartners group were much more likely to use a metal frame dual-arch tray than a plastic one, reflecting a possible group preference for this technique.

Table 5 Frequency (%) of characteristics of dentists who use optical impression techniques more than 90% of the time compared to dentists who use polymeric impression techniques or other techniques more than 90% of the time

Characteristics	Polymeric impression	Optical impression	Other	p Value*	Total
Overall	1433 (82)	99 (6)	223 (13)		1775
Gender					
Male	1043 (81)	76 (6)	163 (13)	0.7	1282 (73)
Female	398 (82)	24 (5)	61 (13)		483 (27)
Race					
White	1196 (82)	87 (6)	168 (12)	0.02	1451 (82)
Black/African-American	64 (83)	1 (1)	12 (16)		77 (4)
Asian	126 (78)	5 (3)	30 (19)		161 (9)
Other	52 (74)	4 (6)	14 (20)		70 (4)
Years since graduation					
<5	54 (77)	5 (7)	11 (16)	0.8	70 (4)
5–15	363 (82)	27 (6)	4 (12)		444 (25)
>15	1032 (82)	68 (5)	160 (13)		1260 (71)
Type of practice					
Owner of private practice	1042 (80)	91 (7)	162 (13)	<0.0001	1295 (74)
Associate in private practice	167 (81)	6 (3)	34 (16)		207 (12)
HealthPartners	39 (89)	0	5 (11)		44 (3)
Permanente	66 (94)	0	4 (6)		70 (4)
Public health, community	62 (97)	0	2 (3)		64 (4)
Academic	34 (71)	1 (2)	13 (27)		48 (3)
Network region					
Western	246 (84)	17 (6)	29 (10)	0.1	292 (16)
Midwest	161 (89)	4 (2)	15 (8)		180 (10)
Southwest	249 (80)	23 (7)	39 (13)		311 (18)
South Central	270 (82)	19 (6)	41 (12)		
South Atlantic	260 (80)	17 (5)	50 (15)		
Northeast	266 (79)	20 (6)	51 (15)		
Practice busyness					
Too busy	92 (91)	3 (3)	6 (6)	0.03	101 (6)
Burdened	271 (83)	9 (3)	47 (14)		327 (18)
Balanced	736 (81)	57 (6)	118 (13)		911 (51)
Not busy	351 (81)	31 (7)	54 (12)		436 (25)
Private insurance status					
<40% Private insurance	41 (79)	5 (10)	6 (12)	0.08	52 (3)
40–79% Private insurance	603 (80)	53 (7)	102 (13)		758 (43)
80%+ Private insurance	789 (83)	41 (4)	115 (12)		945 (54)

¹Due to missing values, reported sample sizes vary.

It is unclear why practitioners from different parts of the country would use different tray types, but regional differences are notable. This may reflect differences in philosophies at dental schools located in these regions or differences in regional key opinion leaders, or perhaps vendor marketing and opinion in a particular area.

Interest is growing in expanded duty dental assistant functions. It was noted in this survey that 2% of final crown impressions, and 50% of provisionals, are made by dental auxiliaries. Future analyses from this study will evaluate the fit of crowns clinically. If differences exist between dentist impressions and auxiliary impressions regarding clinical crown acceptability, these may become evident. This data will contribute to the discussion of expanded duty functions.

This study does have certain limitations, and conclusions should take these into account. This study used self-reported information, which may differ from actual behavior during clinical treatment. Additionally, although the response rate was very good, it is possible that non-respondents would have reported different behavior. Although network practitioners have much in common with dentists at large^{60,61} it may be that their crown procedures are not representative of a wider representation of dentists. 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 similar to patterns determined from non-network general dentists;⁶²⁻⁶⁴ and (3) the similarity of network dentists to non-network dentists using the best available national source, the 2010 ADA Survey of Dental Practice.⁶⁵

Conclusion

By understanding the wide variety of techniques used to make impressions for single-unit crowns, clinicians may modify their own techniques and approaches to optimize impression and gingival retraction techniques. Clinicians learn from other clinicians. Great variability exists regarding the type of techniques used for gingival displacement and impression making, and these variations are significantly associated with dentist and practice characteristics.

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