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General Dentists' Use of Isolation Techniques During Root Canal Treatment: from the National Dental Practice-Based Research Network

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Abstract

Introduction—A preliminary study done by a National Dental Practice-Based Research Network precursor observed that 44% of general dentists (GDs) reported always using a rubber dam (RD) during root canal treatment (RCT). This full-scale study quantified use of all isolation techniques, including RD use.

Methods—Network practitioners completed a questionnaire about isolation techniques used during RCT. Network Enrollment Questionnaire data provided practitioner characteristics.

Results—1,490 of 1,716 eligible GDs participated (87%); 697 (47%) reported always using a RD. This percentage varied by tooth type. These GDs were more likely to always use a RD: do not own a private practice; perform less than 10 RCT/month; have postgraduate training.

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Conclusions—Most GDs do not use a RD all the time. Ironically, RDs are used more frequently by GDs who do not perform molar RCT. RD use varies with tooth type and certain dentist, practice, and patient characteristics.

Introduction

Rubber dam (RD) use during non-surgical root canal treatment (RCT) procedures is considered the standard of care by some practitioners, including the American Association of Endodontists. (1, 2) This is due to its function as a barrier to prevent oral pathogens from entering the accessed tooth and preventing instruments and medicaments from being swallowed or inhaled.(1) A recent population-based study found that the survival probability of initial RCT after 3.43 years is significantly greater when a RD was used, although the magnitude of the difference was only about 2% (90.3% with RD, 88.8% without RD).(3) Literature from the past five decades reveals that RD use during RCTs varies by year of publication and country in which the study was conducted.(4–18) Of studies conducted in the United States, the prevalence of always using a RD was about 7% in 1967, 62% in 1989, 58% in 2008 and 60% in 2014.(19–22)

A previous study conducted by the former regional Dental Practice-Based Research Network (DPBRN) determined that 44% of general dentists (GDs) reported always using a RD for RCT procedures.(23) The study also found that the most common alternative isolation methods were cotton rolls and gauze squares. A study of English GDs also reported cotton rolls as an alternative to RD, and found 29% of GDs used cotton rolls alone or with napkins and sponges, while 37% used a RD.(24) The English study found no correlation between use of RD and the dentists' age group, gender, university of qualification. The former DPBRN study also reported the use of Isolite® as a method for achieving isolation. Isolite® is a rubber-like mouthpiece that simultaneously provides light, suction, retraction, and aspiration prevention (<http://www.isolitesystems.com>). Of the GDs who reported using Isolite®, 32% used it instead of a RD, 16% used it in conjunction with a RD and 52% may have either used it as the solitary or adjunctive method of isolation.(23) Although no published clinical studies have reported its efficacy for isolation in RCTs, Isolite® has been shown to be as effective as cotton roll isolation when placing dental sealants.(25)

The tooth type in which the RCT is performed has also been examined as a factor when dentists decide to use a RD. A 2007 study reported that 27% of anterior, 32% of premolar and 40% of molar RCTs were always performed with a RD.(26) A similar survey was completed by dental students in Wales; students were more likely to use RDs in molars (92%) and premolars (94%) than anterior teeth (88%) at one school, but more likely to use RDs in anterior (86%) and premolar teeth (86%) than molar teeth (81%) at another.(27) A 2014 review of the Taiwan National Health Insurance Program reported that 10.3% of anterior, 15% of premolar and 18.4% of molar RCTs were performed with a RD.(3)

The previous PBRN study only comprised three questions that were nested within a much larger survey. However, it did provide a strong justification to conduct a full-scale study devoted exclusively to the topic of isolation techniques. The current study employed a new, comprehensive survey with different questions aimed at discovering the clinical factors

related to isolation method selection. The objectives are to: (1) quantify use of all isolation techniques during RCTs, including RD use; and (2) determine if specific dentist, practice, patient and clinical characteristics are significantly associated with their use.

Methods

The National Dental Practice-Based Research Network (“network”) is a consortium of dental practices and dental organizations focused on improving the scientific basis for clinical decision-making.(28) Many details about the network are available at its web site (<http://nationaldentalpbrn.org/>).

Enrollment Questionnaire

Prior to the study, the applicable Institutional Review Boards approved the study; all participants provided informed consent after receiving a full explanation of the nature of the procedures. As part of the enrollment process, practitioners complete an Enrollment Questionnaire (<http://nationaldentalpbrn.org/enrollment.php>). The dentist, practice, and patient population characteristics from this questionnaire that were tested for their association with use of certain isolation techniques are listed in Table 2, as are certain clinical characteristics that were taken from the Isolation Techniques questionnaire. Questionnaire items from the Enrollment Questionnaire, which had documented test/re-test reliability, were taken from previous work in a practice-based study of dental care and a PBRN that ultimately led to the National Dental PBRN.(29)

Content of the Isolation Techniques Questionnaire

After confirming that the respondent was still a GD and that he or she does at least one RCT each month (as compared to the “do at least some RCTs” criterion taken from the Enrollment Questionnaire), the respondent was then asked for the number of RCTs performed and referred each month, separately for anterior, premolar, and molar teeth, and for teeth with subgingival caries. Additionally, the questionnaire asked for the frequency of use of isolation methods for each of these circumstances. A copy of the full questionnaire is publicly available (“Isolation Techniques...” section at <http://nationaldentalpbrn.org/study-results.php>).

Administration of the Isolation Techniques Questionnaire

By January 31, 2014, more than 5,000 persons had completed an Enrollment Questionnaire. A total of 1,876 of these were invited to complete the Isolation Techniques questionnaire because they were: a GD; currently practicing/seeing patients in the United States; performing at least some RCTs; and at least “limited” or “full” network participants. Pre-printed invitation letters were postal mailed to eligible practitioners, inviting them to participate and informing them they would receive an email with a link to the electronic version of the questionnaire. At the time of the email, the practitioners were given the option to request a paper version of the survey.

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. After eight weeks, a final postal questionnaire attempt was made with a letter encouraging the dentist to complete the questionnaire online. If a response was not received within two weeks, these dentists were considered non-respondents and were contacted by a Regional Coordinator to ensure that the network communications had been received and that the dentist was not interested in participating. Data collection was closed after 12 weeks from the original email invitation. Practitioners or their business entities were remunerated \$50 for completing the questionnaire if they confirmed at the end of the survey that they would like remuneration. Data were collected from February 2014 to July 2014. To document test/re-test reliability of these questionnaire items, a total of 43 respondents did the same questionnaire twice online. The mean (S.D.) time between test and re-test was 15.5 (3.0) days. The agreement between time 1 and time 2 was quantified using a mean weighted kappa score, which was 0.62, with an inter-quartile range of 0.46 to 0.79.

Statistical methods

The outcomes of interest were the frequency of use of different types of isolation techniques by tooth type. The characteristics listed in Table 2 as well as frequency of treated and referred patients specific for tooth type functioned as independent variables. For characteristics that were categorical, two-way frequency tables (with counts and percentages) were created and significance of differences ascertained using a chi-square test. When the characteristic was numerical, either t-tests (with means and standard deviations), or nonparametric alternative (number RCT performed, referred), Wilcoxon rank sum tests (with medians and inter-quartile range [IQR]) were generated. Spearman's rank correlation was used to ascertain relation among numerical variables. Independent associations with consistent use of RDs when performing RCTs were ascertained with logistic regression. Full tables of results and details of these associations are publicly available ("Isolation Techniques..." section at <http://nationaldentalpbrn.org/study-results.php>). All analyses were done using SAS.(30)

Results

Of the 1,876 dentists invited to participate, 24 were determined to be ineligible before beginning the questionnaire (no longer a GD; no longer in active practice; no longer do any RCT; deceased). An additional 136 were determined to be ineligible once completing the questionnaire (3 responded on the questionnaire that they no longer were a GD; 133 do not do at least one RCT each month). This left a total of 1,716 eligible persons, of whom 1,500 responded, for a response rate of 88% (1,500/1,716). Of the 1,500 respondents, 12 were incomplete (9 logged in only; 3 completed less than half the survey).

There were few differences between those who participated in the survey and those who did not. Those who reported that they practiced with either the Health Partners or Permanente Dental Associates groups (two large group practices in the network; <https://www.healthpartners.com/public> and <http://www.pda-dental.com/>) participated at higher rates (97%), compared to 87% in private practice and 81% in all other practice types ($p<0.001$). GDs who were members of a dental organization, e.g., ADA, participated at

higher rates than non-members (88% vs. 81%, $p=0.002$). These differences remained significant in adjusted, logistic regression analysis. There were no differences in participation with regard to dentist's gender, race, age, years since graduation from dental school, rural/urban practice location, and whether or not the GD had additional training, or selected patient characteristics.

Virtually all of the 1,490 practitioners perform RCT on anterior ($n=1,485$, 99.7%) and premolar teeth ($n=1,432$, 96.1%); 67% ($n=1,004$) perform RCT on molars; 70% ($n=1,043$) on teeth with subgingival caries; and 3% ($n=53$) performed RCT solely on anterior teeth. The mean and median number of RCT performed a month was 10.6 (SD=10.1) and 8 [IQR: 4–13], respectively. The mean and median number of RCT referred each month was 6.4 (SD=9.4) and 4 [IQR: 2–8], respectively. In general, the more RCT performed per month, the fewer referred ($r=-0.18$, $p<0.001$). Compared to practitioners who did not perform RCT on molars, those who did RCT on molars performed more RCT each month (mean 13.4 vs. 4.8, $p<0.001$).

Presented in Table 1 is the frequency of usage of different root canal isolation techniques by tooth type. Overall, 47% of practitioners consistently (always) use RDs and 15% never use them. Cotton rolls are used at least sometimes by almost half of the practitioners, 47%, and all the time by 12%. Isolite[®] was only used by 8–9% ($n=126$), 3% ($n=39$) used a method other than these 3 (i.e., bite block, cheek retractor, or saliva ejector), and 5% ($n=70$) at least occasionally, do not use any method of isolation.

Consistent use of RDs is less common for anterior teeth (48%) than premolars (58%) or molars (60%) ($p<0.001$), although this varies with whether the GD performs RCT on molars. There is less difference by tooth type (anterior and premolar teeth) among GDs who do not do molar RCT. In contrast, GDs who perform RCT on molars, report always using RDs less frequently (45%) for anterior teeth than for premolars (56%) or molars (60%) ($p<0.001$). There was less difference (but still statistically significant) by tooth type in the frequency of some use ($>0\%$) of cotton rolls. Cotton rolls were used more frequently for anterior teeth than for premolars or molars ($p<0.001$), and, as with RDs, the difference is greater among GDs who perform RCT in molars. There was no significant difference in use of Isolite[®] by tooth type. Among the 222 GDs who never use RDs, cotton rolls were used most frequently; 69% always used them. Again, there was a difference in use between GDs who do and who do not perform RCT on molars. Of the latter, over 80% always used cotton rolls on anterior teeth and on premolars, 63–65% of GDs who perform RCT on molars always use cotton rolls, regardless of tooth type. Isolation technique use on teeth with subgingival caries was very similar to use on anterior teeth (Table 1).

Associations with consistent use of RD

In bivariate analysis, practitioners who are female, younger (< 35 yr and 35–44 yr), more-recent graduates, had additional training (i.e., General Practice Residency, Advanced Education in General Dentistry, or Fellowship of the Academy of General Dentistry), were members of either large group managed care practices or federal, academic practices (compared to private, or public, community), practiced in the same building as an endodontist, practiced in a rural area, practiced in the Western region, performed fewer than

10 RCT a month, or performed RCT on molars were more likely to report always using RDs (Table 2). In adjusted analysis, four characteristics remained significant at $p<0.001$: additional training (OR=1.5; 95% CI:1.2–1.9); members of either large group managed care practices or federal, academic practices (compared to private, or public, community) (OR=5.0; 95% CI: 3.1–8.0); from Western region (OR=2.5; 95% CI: 1.7–5.7); and performing fewer than 10 RCT a month (OR= 0.6; 95% CI: 0.5–0.7).

Discussion

RD use in general

The preliminary study conducted by the former DPBRN concluded that 44% of GDs reported always using a RD for RCT.(23) The results of the current study reveal that 47% of GDs always use RDs, with 48% of anterior RCTs, 58% of premolar RCTs, 60% of molar RCTs and 51% of RCTs with subgingival caries. As over 99% of the GDs who perform RCTs treat at least some anterior teeth, both studies agree that slightly less than half of all GDs always use RDs on all RCTs. In another recent survey of GDs in the United States, 60% indicated that they used a RD for all RCTs.(22) These studies reveal that a large portion of GDs in the United States are not consistent with recommendations from the American Association of Endodontists that RDs should always be used for RCT as a standard of care.(2) Common reasons that dentists have reported for not using a RD include patient discomfort, time required for placement, difficulty in use, and cost of equipment.(1)

Rubber dam and supplemental isolation method usage by area of the mouth

A lower frequency of RD use for RCTs in anterior teeth than premolar or molars was observed. This result was expected, as anecdotal evidence suggests a propensity to avoid RD use in anterior RCTs due to a decreased likelihood of dropping instruments or over-dispensing irrigant due to easier accessibility, a shorter working time due to a lesser number of canals, and the ease of alternative modes of isolation due to the remoteness of the salivary ducts. A similar trend towards decreased RD use in anterior teeth was observed in previous studies.(3, 26, 27)

The results also indicate that the use of cotton rolls is more prevalent in anterior RCTs (46%) than premolar (36%) or molar (32%) RCTs. A cotton roll may both displace the lip and absorb saliva in the maxillary anterior vestibule. The tongue typically presents a significant obstacle for cotton roll isolation while working in the anterior mandibular segment. Adequate isolation with a cotton roll alone is very challenging in the mouth's posterior region due to proximity of salivary ducts, gravitational pooling of saliva and insufficient retention of the cotton roll in the posterior vestibule. Although some clinicians use cotton rolls as a supplemental form of isolation, many dentists use them as the only form of isolation. Cotton rolls were always used in the group of GDs who never use RDs for 71% of anterior, 71% of premolar and 64% of molar RCTs. Several of these clinicians included comments that continuous high-volume saliva ejection was used to supplement the use of cotton rolls. Another isolation strategy that was categorically grouped with cotton roll isolation is the use of dri-angles. Dri-angles are absorbent pads that can be placed over the

parotid duct. A major limitation of cotton rolls and similar products is that they do not protect the throat and soft tissue from dropped instruments or excess irrigant.

Use of Isolite® showed no trend towards increased use in any region of the mouth. It was always used in 2% of anterior, premolar and molar RCTs. GDs who use Isolite® are not commonly using it in conjunction with a RD; all GDs who always used Isolite® also never used a RD. Isolite®, however, does not appear to be a primary alternative method for those who do not use RDs. Among GDs who never use RDs for RCTs, Isolite® use was 11% for anterior, 11% for premolar and 16% for molar RCTs.

The study determined that 70% of GDs perform RCTs on teeth with subgingival caries and 51% of those dentists use a RD. Use of a RD on teeth with subgingival caries presents a clinical challenge due to the difficulty of effectively placing a clamp and containing irrigant. Several GDs indicated that they partially restore the tooth with composite or glass ionomer restorative material prior to starting the RCT. One dentist indicated using a matrix band and split RD.

Association between RD use and selected dentist/practice characteristics

Significant differences in RD use could be seen based on practice characteristics. GDs who do not own a private practice reported significantly higher use of RDs. Previous studies also observed that practitioners in group practices use RDs more often than those in solo private practices.(13, 20) Rural dentists were less likely to use RDs. Similarly, a Taiwanese study showed that dentists in medical centers and regional and district hospitals were more likely to use RDs compared to dentists in local clinics.(3) Finally, GDs who practiced in the same building as an endodontist were more likely to use RDs. Previous studies have shown nearly ubiquitous RD use by endodontists. (11, 23) One interpretation of these findings is that GDs who have less peer and/or specialist interaction are less influenced to use a RD.

Additionally, it is possible that patients in communities with greater options for RCT treatment may question a GD who is not using rubber dams for RCTs. The trend for increased RD compliance of GDs in large group practices is likely influenced by an employer expectation to use RDs for all RCTs.

Certain dentist characteristics were also associated with lower compliance with RD use. GDs who performed more than 10 RCTs per month were less likely to consistently use a RD. Additionally, GDs who performed at least 1 molar RCT per month were less likely to use a RD than the GDs who performed only anterior and premolar RCTs. These results suggest that GDs who perform RCTs more frequently on more-difficult teeth, who are presumably more experienced, are less likely to always use a RD. These findings are contrary to what was expected. It is possible that this group of GDs forgoes RD isolation due to a perceived time savings, reduced treatment time due to increased dentist efficiency, a lower risk of dropped instruments due to use of a rotary system, difficulty in placing RD clamp due to tooth location or clinical presentation, or a history of clinical success without using a RD. GDs closer to their year of graduation were more likely to use a RD. Higher usage by recent graduates was also observed in previous studies.(6, 13) This finding is in contrast to another study that showed a trend for older practitioners to use RDs more than their younger counterparts.(7) GDs who had additional training had higher compliance with

rubber dam usage. These findings suggest that education, particularly related to the benefits of RD usage, is more effective at predicting compliance than clinical experience. Dentists closer to their year of graduation may be more likely to practice the methods of isolation taught in dental school. Dentists who learned endodontic techniques in general practice residency training or continuing education courses may be more likely to adhere to recommendations for RD use.

This study does have certain limitations, and conclusions made from it should take these into account. The main limitation is that it relies 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. Furthermore, although network practitioners have much in common with dentists at large(31, 32), it is possible that their RCT procedures are not representative of dentists at large. 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 it cannot be asserted that network dentists are entirely representative, 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 GDs are represented in the various response categories of the characteristics listed in Table 2; 2) findings from several network studies document that network GDs report patterns of diagnosis and treatment that are similar to patterns determined from non-network GDs,(23, 33–34) and 3) the similarity of network GDs to non-network GDs using the best available national source, the 2010 ADA Survey of Dental Practice.(35)

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Table 1
Type and frequency of isolation method used overall and according to tooth type and clinical characteristics

<u>Isolation method and frequency</u>		<u>Does NOT perform RCT on molars</u>				<u>Performs RCT on molars</u>			
	ALL (N=1490)	Subgingival (N=1041)	Anterior (N=1485)	Premolar (N=1432)	Molar (N=1003*)	Anterior (N=1000)	Premolar (N=999)	Molar (N=1003*)	
	N	%	%	%	%	%	%	%	%
<u>Rubber dam use</u>									
none	222	15	20	19	16	15	18	14	15
1-89%	329	22	18	17	14	14	15	13	14
90-99%	242	16	11	15	12	11	13	9	11
100%	697	47	51	48	58	60	54	63	60
<u>Cotton rolls</u>									
none	788	53	58	54	64	68	56	66	68
1-49%	419	28	16	19	14	13	16	13	13
50-99%	104	7	10	11	9	7	11	8	7
100%	179	12	16	16	12	11	17	14	11
<u>Isolite use</u>									
none	1364	92	92	93	93	91	95	96	91
1-99%	103	7	6	6	6	7	4	4	7
100%	23	2	2	2	2	2	1	0	2
Use any 'other' method	39	3	3	2	1	2	1	1	2
Use no isolation method	70	5	3	4	4	3	3	2	3

* One dentist who reported performing RCT on molars, did not report on isolation techniques used

Table 2

Frequency of 100% rubber dam use for selected practitioner, practice, patient, and clinical characteristics (significance of differences listed in italics)

	Number of respondents*	Percentage of total respondents (%)	Percentage that use rubber dams 100% (%)
PRACTITIONER CHARACTERISTICS			
<u>Gender</u>			
Male	1142	77	44
Female	339	23	55
			<i>p<0.001</i>
<u>Race and ethnicity**</u>			
White	1170	79	45
Black	70	5	34
Asian	145	10	59
Other	9	1	89
Hispanic	78	5	45
			<i>p<0.001</i>
<u>Age (years)</u>			
< 35	160	11	59
35 – 44	332	22	50
45 – 54	310	21	44
55 – 64	525	35	44
65 and older	157	11	41
			<i>p=0.006</i>
<u>Years in since graduation</u>			
< 10	278	19	56
10–19	298	20	48
20–29	341	23	46
30+	570	38	42
			<i>p<0.001</i>
<u>Additional training</u>			
None	874	59	42
Any	616	41	54
			<i>p<0.001</i>
<u>Membership in dental organizations</u>			
None	186	12	44
Any	1304	88	47
			<i>p=0.4</i>
PRACTICE CHARACTERISTICS			
<u>Practice type</u>			
Owner of private practice	1097	74	40

	Number of respondents*	Percentage of total respondents (%)	Percentage that use rubber dams 100% (%)
Associate small group private practice	175	12	54
Member large group (HP/PDA)	101	7	91
Public, community, publicly-funded	63	4	52
Federal, academic, other managed care	49	3	71
			<i>p<0.001</i>
<u>Endodontist in same location</u>			
No	1444	97	46
Yes	46	3	80
			<i>p<0.001</i>
<u>Rural</u>			
No	1231	83	49
Yes	256	17	37
			<i>p=0.001</i>
<u>More than one practice location</u>			
No	1257	84	47
Yes	232	16	46
			<i>p=0.8</i>
<u>Region</u>			
Western	173	12	74
Midwest	139	9	68
Southwest	255	17	44
South Central	356	24	31
South Atlantic	252	17	46
Northeast	315	21	44
			<i>p<0.001</i>
PATIENT CHARACTERISTICS			
<u>Percent patients with private insurance</u>			
< 40%	205	14	50
40–79%	876	60	41
80%+	378	26	57
			<i>p=0.001</i>
<u>Percent patients come in regularly</u>			
< 50%	269	18	43
50–79%	875	60	47
80%+	320	22	49
			<i>p=0.4</i>
CLINICAL CHARACTERISTICS			
<u>Frequency perform root canals</u>			
1–5	535	36	59
6–10	438	29	44

	Number of respondents*	Percentage of total respondents (%)	Percentage that use rubber dams 100% (%)
> 10	517	35	36
			<i>p<0.001</i>
<u>Perform root canals on molars</u>			
No	486	33	54
Yes	1004	67	44
			<i>p=0.001</i>

* Not all columns sum to 1490 due to missing data

** although Race and Ethnicity appear as separate questions in the Enrollment Survey, many Hispanic respondents did not provide a Race or indicated "Hispanic" as their Race; therefore, Race and Ethnicity were combined for this analysis.