

Defining Endodontic Residents' Clinical Experiences: A National Survey

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Abstract: Endodontic residency programs across the U.S. vary in the exposure they provide to residents in procedures, protocols, and equipment. Having information on the range of clinical experiences provided in programs would be useful for program directors and for applicants who are seeking the best fit for their residency. The aim of this study was to collect information from residents in U.S. endodontic residency programs about the procedures and equipment they experienced in their programs. In January 2018, a 14-question survey was emailed to all 437 endodontic residents with an email address in the 2016-17 American Association of Endodontists Membership Directory. Survey items asked about the number of endodontic procedures, techniques employed, and products used in residents' programs. A total of 133 endodontic residents responded to all or part of the survey, for a 30% response rate. The majority reported completing 151-250 nonsurgical root canals, 26-50 nonsurgical retreatments, 0-10 surgical retreatments, and 0-10 regenerative endodontic procedures during their residencies. All respondents said they used a surgical operating microscope (SOM), and 82% reported using a multi-file rotary system for nonsurgical procedures. Respondents reported that the main instruments they used were Dentsply Sirona file systems, and the most commonly used obturation technique was warm vertical compaction/condensation, reported by 92% of respondents. These endodontic residents reported being exposed to a variety of procedures, products, and protocols during their residency. Based on information they provided, prospective endodontic residency applicants can expect to use the SOM for treatment, to gain extensive experience in primary nonsurgical endodontic treatment, and to not perform endodontic surgery during their first year of postgraduate training.

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Based on accreditation standards of the Commission on Dental Accreditation, each accredited endodontic residency program in the U.S. is required to provide residents with experiences and training in various areas of the profession.¹ However, the exact numbers of procedures completed in such areas as surgical and nonsurgical endodontic procedures and regenerative endodontics are not usually reported on programs' websites. The American Association of Endodontists (AAE) provides some general information: according to the AAE, residents can expect to complete 150-250 or more endodontic procedures.² However, the AAE website does not provide specifics on residents' clinical experience, such as descriptions of instrumentation and techniques used in the programs, to help applicants assess which programs provide the kind of experience they seek.

About 10% of the total number of U.S. dental students applying to an advanced dental specialty program apply to an endodontic residency program.³ Of those who applied to an endodontic residency, only approximately 5% matriculated, with the average program receiving nearly 80 applications and accepting between three and 20 applicants.⁴ Thus, it is clear that the application process is highly competitive for the specialty of endodontics. However, while applications to and enrollments in endodontics specialty programs increased between 2006 and 2017, information on clinical experiences of endodontic residents in the American Dental Association (ADA) data is limited.³⁻⁵ As a result, applicants may not have access to details of what to expect once they matriculate into an endodontic postgraduate program.

Gilbreth's study found that the experiences practitioners had during training shaped their private

practice treatment of patients.⁶ In that study conducted in 2013, when alumni of a postgraduate endodontic program were surveyed about their clinical decision process, they reported they continued to use the clinical protocols and theories they learned in their residency. Over 50% of those surveyed said they still used some or all facets of the techniques they acquired as residents. These findings suggest that prospective endodontic residents can expect to practice endodontics in a similar fashion to how they were taught.

Previous studies found that endodontic residency program protocols were substantially different from each other, which can ultimately lead to differences in treatment modalities among practitioners.⁷⁻¹⁰ In two of those studies, the endodontic residents' generally negative perceptions of the application process for residency programs and the perception of 33% of surveyed endodontic residents that their postdoctoral training was inadequate suggest that more information is needed about the clinical knowledge and experience provided in these programs.^{8,9} Therefore, the aim of this study was to collect information from residents in U.S. endodontics residency programs about the procedures and equipment they experienced in their programs. We hoped the results would be useful for future applicants to those programs and for program directors to be able to compare the education they provide to that in other programs.

Methods

The Institutional Review Board of the University of Connecticut Health Center School of Dental Medicine approved this study with "exempt" status on October 25, 2017 (protocol number 18-031-3). Using the web service SurveyMonkey (San Mateo, CA), we emailed invitations to participate in the study to all endodontic residents with a current and active university-administered or forwarding email address used for correspondence listed in the 2016-17 AAE Membership Directory (n=437).

The initial invitation, consisting of a cover letter explaining the purpose of the study and containing a link to the survey, was sent in January 2018. Invitation emails were sent on two occasions at two-week intervals. The survey was resent to only those participants who had not responded after the initial invitation. The contents of the survey questions as well as the respondents' data were maintained on SurveyMonkey's servers for the duration of the study.

SurveyMonkey provided a secure method to track respondents to prevent sending follow-up emails to those who had already completed the survey.

The survey consisted of 14 questions. No personal information was collected. Survey items asked about the duration of respondents' residency program, their education prior to matriculation, and the degree and/or certificate they would receive on completion of the program. Other questions asked about the average number of endodontic procedures completed during the residency and the methods and techniques used in the program. Descriptive statistics were calculated for number and percentage of respondents.

Results

Of the 437 surveys sent to U.S. endodontics residents, 108 were fully completed, and 25 were partially completed, for a total of 133 and an overall response rate of 30%. All incomplete survey responses were included in the analysis.

The majority of the respondents (81%) reported they were attending a two-year endodontic residency program, 18% were attending a three-year program, and one respondent was attending a program that was longer than three years. Among the respondents, 8% were first-year residents, 74% were second-year residents, 11% were third-year residents, and 7% were in more than a third year while pursuing a fellowship or PhD. Regarding where they received their dental education prior to the endodontic residency, 82% of the respondents reported attending a U.S. dental school, 14% a non-U.S. dental school, and 4% both a non-U.S. dental school and a two-year U.S. program to earn a U.S. DDS or DMD.

When we asked respondents to report their experience in dentistry immediately preceding the endodontic residency, 44% said they were practicing as general dentists, 32% came straight from dental school, 20% came from a General Practice Residency (GPR) or Advanced Education in General Dentistry (AEGD) program, and 4% had attended another specialty program. Over half (57%) of the respondents said they were pursuing a certificate in endodontics and a master's degree, while 42% were pursuing a certificate only. Only one respondent was pursuing a combined certificate in endodontics and PhD.

We asked respondents to indicate how many procedures they performed during their endodontics residency in the following categories: nonsurgical

root canal treatment (RCT), nonsurgical root canal retreatment (RETX), surgical root canal retreatment (SX), and regenerative endodontic procedures (REG). The results for RCT and RETX, as well as for apicoectomy, are shown in Table 1. SX and REG were the procedures least experienced by these residents. Less than half (46%) indicated they completed 0-10 SX, 31% completed 11-20 SX, and 23% stated they completed over 20 SX procedures. The vast majority (94%) performed 0-10 REG during their endodontic training, with 6% performing 11-20 REG procedures and no respondents reporting over 20. When we asked about the timing of performing surgical endodontic procedures, 44% of the respondents said they were allowed to perform SX in their first year of endodontic residency, while 56% were not. All the respondents (100%) reported using a surgical operating microscope (SOM) while performing the majority of endodontic treatments.

With regard to instrumentation, 82% of respondents stated they used a multi-file rotary system when performing RCT and RETX, and 18% reported using both multi-file and single-file systems. A total of 104 participants responded to the open-ended question asking them to list the main file systems to which they had exposure in their endodontic program. A wide

variety of file systems was reported, but the most widely used were from the ProTaper multi-file brands, accounting for 78% of responses. In addition, 73% reported using Vortex Blue (VB) multi-file brand. The most used single-file reciprocation brands were WaveOne (WO) and WaveOne Gold (WOG), with use by 26% of respondents. Other widely used file brands listed were EdgeEndo (30.8%) and EndoSequence (24.0%). A complete list is shown in Table 2.

Finally, respondents were asked to select from the following list all the obturation techniques they used for filling a root canal space: lateral condensation (LC), warm vertical hybrid with apical down-pack followed by backfill system (WVHT), single cone technique with bioceramic sealer (SCBS), and carrier-based obturation such as Thermafil and Guttacore. The most used method reported was WVHT, selected by 92% of respondents, but over half also selected LC and SCBS (Table 1).

Discussion

All responding residents to our survey were in endodontic residency programs of at least two years' duration, with the majority indicating they

Table 1. Procedures, systems, and techniques used in participants' endodontic residency program, by number and percentage of total respondents to these items (n=108)

Procedure/System/Technique	Number	Percent
Cases of the following procedures completed during endodontic residency		
Non-surgical root canal treatment		
<50	6	6%
50-150	26	24%
151-250	76	70%
>250	0	0
Non-surgical root canal retreatment		
0-25	25	23%
26-50	47	44%
>50	36	33%
Apicoectomy		
0-10	50	46%
11-20	33	31%
>20	25	23%
Use of multi-file rotary system, single file reciprocation system, or both		
Multi-file rotary system	89	82%
Single file reciprocation system	0	0
Both	19	18%
Obturation technique(s) used (select all that apply)		
Lateral condensation (LC)	55	51%
Warm vertical hybrid with apical down-pack followed by backfill system (WVHT)	99	92%
Single cone technique with bioceramic sealer (SCBS)	61	56%
Carrier-based obturation (Thermafil, Guttacore, or similar)	11	10%

Table 2. File brands used by respondents in their endodontic programs, by percentage of respondents to this open-ended question (N=104)

File Brand	Manufacturer	Percent Reporting Use
PTG, PTN, PTU	Dentsply Sirona (York, PA)	77.9%
Vortex Blue	Dentsply Sirona (York, PA)	73.1%
EdgeEndo	EdgeEndo LLC (Albuquerque, NM)	30.8%
WO and WO Gold	Dentsply Sirona (York, PA)	26.0%
EndoSequence	Brasseler USA (Savannah, GA)	24.0%
SS White (VTaper1,2)	SS White Dental (Lakewood, NJ)	12.5%
Vortex	Dentsply Sirona (York, PA)	11.5%
K3/K3XF	Kerr Corp. (Orange, CA)	10.6%
TRUShape	Dentsply Sirona (York, PA)	9.6%
Hyflex	Coltène/Whaledent Inc. (Altstätten, Switzerland)	5.8%
Twisted File	Kerr Corp. (Orange, CA)	5.8%
XP-Endo	Brasseler USA (Savannah, GA)	5.8%
TF-Adaptive	Kerr Corp. (Orange, CA)	4.8%
BioRaCe	Brasseler USA (Savannah, GA)	3.9%
ESX	Brasseler USA (Savannah, GA)	2.9%
KontrolFlex	Brasseler USA (Savannah, GA)	1.0%

PTG=ProTaper Gold, PTN=ProTaper Next, PTU=ProTaper Universal, WO=WaveOne, WO Gold=WaveOne Gold

were in their second year. This length of program corresponds to the CODA requirement that endodontic advanced specialty programs must be a minimum of 24 months.¹ Nearly all respondents reported they had entered their endodontic residency directly from practicing general dentistry or dental school. Only 4% had come from another specialty program. Among the respondents, 57% were in programs that conferred both a Certificate in Endodontics and a master's degree upon completion of the program. Only 1% reported being enrolled in a Certificate in Endodontics and PhD program, perhaps because of the multiple years of education required.

According to the responding residents, the most commonly performed procedure in their programs was RCT, with most reporting they performed 151 to 250 during their endodontic residency. This number is consistent with information on the AAE website, which reports the average number of "non-surgical procedures" in each program by state as 150-250.² However, it is unclear whether the AAE number encompasses both RCT and RETX as both are non-surgical procedures. A CODA representative confirmed that endodontic procedural data from U.S. residencies are privileged and not readily available to the public.¹¹

According to the results of our study, RETX procedures were being performed far less than primary endodontic therapy. The increase in implant placements over the past two decades has likely had a direct impact on patients' decision to extract rather

than attempt to save their natural dentition. This trend is despite Zitzmann et al.'s findings that good long-term success rates and greater flexibility in clinical management indicate that RCT and RETX should be performed first in most instances, before placement of an implant.¹² Another possible reason for substantially lower numbers of RETX procedures than RCT could be financial strain on the patient as most state dental insurance programs do not cover RETX.¹³ Patients covered by those programs are more likely to have a tooth extracted and not replace it with an implant, so fixed and removable partial dentures tend to be their treatment of choice.

Most of the respondents to our survey reported that surgical retreatment of failing endodontically treated teeth was the procedure they were most unfamiliar with when entering their residency program. Regardless of respondents' year in the program, the majority described completing fewer than 20 SX procedures in their residency. This finding corresponded to the fact that over 50% of respondents stated they could not perform surgical procedures during their first year. Delaying those procedures to the second year is likely because performing surgical endodontics requires significant experience to be competent, especially for multi-rooted molars.¹⁴ This finding may also be due in part to a rise in the use of implants.¹³

Over 90% of the respondents in our study reported they performed only zero to ten REG procedures during their residency. This number made REG the least experienced procedure among those

surveyed. While this procedure is no more invasive than RCT, which was the most frequently performed procedure, Lee et al. found that its outcomes and protocols have not been fully elucidated.¹⁵ Furthermore, alternative procedures and variations in treatment modalities were found to contribute to a lack of familiarity with REG in endodontics.¹⁶ Case selection is another factor that may contribute to the infrequency in performing this procedure as two studies found that most REG cases were done on children less than 16 years of age.^{16,17} Endodontic residents may not have the opportunity to see many of these cases because pediatric residents are most often managing these young patients. The same two studies found that referring practitioners and other dental specialists are often not aware of REG endodontic protocols, which may lead them to explore other treatment modalities in lieu of endodontic intervention.

All the residents who responded to our survey reported that they use magnification in the form of the SOM, which is the standard of practice in providing endodontic treatment.¹⁸ The improved outcomes when using the SOM are well documented,^{19,20} so it is likely that residency programs understand the importance of training residents to use the SOM.

Our results suggest that endodontic residents are exposed to a variety of rotary and reciprocation endodontic file instrumentation systems. The development of new endodontic rotary and reciprocation systems, along with larger numbers of new files on the market, accounts for these residents' exposure to a variety of file systems. Typically, they are treating multi-canaled teeth with significant anatomical complexities that may require different systems to be used, according to Hülsmann et al.²¹

The findings of our study also suggest that residents are gaining experience in a variety of obturation techniques, which aids in their experience, especially when complex cases arise. Over 90% of the respondents reported being exposed to WVHT. While technique-sensitive, this method has been used for over 20 years and has shown favorable outcomes when mastered.²² Many residents reported using the relatively new bioceramic sealers with single cone obturation technique. The single-cone technique, sometimes referred to as "hydraulic condensation," permits the sealing of the canal spaces with only one application of gutta-percha via the master cone.²³ Though bioceramic sealers are designed specifically for use during single cone obturation, other sealers can be used as well. While WVHT uses a second method of gutta-percha application, single-cone

techniques do not require this extra step. Thus, it can be postulated that the ease of application is one reason for its increased use.

Carrier-based obturation techniques were not used as often among our study's respondents. Only 10% reported using this obturation protocol. Proponents of this obturation method claim it can better negotiate curvatures and seal complex root canal anatomy compared to the conventional warm vertical techniques.²⁴ One possible reason for its limited use during residency training is the reported difficulties encountered during its retreatment, as the carrier cannot always be predictably removed.^{24,25}

One limitation of our study was the response rate of 30%. While this response rate was low, it was similar to other online survey studies in endodontics.²⁶⁻³¹ However, the results should be interpreted with caution as this study may not provide a complete representation of U.S. endodontic residency program clinical experiences. Future endodontic program applicants should not interpret our findings as evidence of what they can expect for the quantity of endodontic clinical procedures they will perform. Another limitation of our study is the lack of evidence concerning the outcomes of the clinical procedures performed by these residents. While valuable information was obtained regarding the quantity of endodontic treatment performed, the quality of these treatments could not be assessed. An additional limitation is that there are no prior research studies regarding endodontic residency clinical experiences. Thus, comparisons were impossible to perform. Future studies are needed to provide findings that can be compared to ours. Trends in experience could be determined if additional evaluations were done in the future, using our findings as a baseline. This information would be valuable for the profession as a whole as well as for endodontic applicants. Greater transparency about the educational experience provided by each endodontic program would also greatly aid in evaluation of postgraduate endodontic program clinical experiences.

Conclusion

In our study, responding endodontic residents reported being exposed to a variety of procedures, products, and protocols during their residency. Their responses also suggest that a prospective endodontic applicant can expect to use the SOM for treatment and that extensive experience in primary nonsurgical

endodontic treatment is prevalent in residency programs. Based on the data collected, applicants should not expect to perform endodontic surgery during their first year of postgraduate training.

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