

Current Trends in Endodontic Practice: Emergency Treatments and Technological Armamentarium

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Abstract

The current clinical practice of endodontics includes the utilization of a variety of new technological advances and materials. The last comprehensive survey that compared treatment modalities used in endodontic practices was conducted in 1990. The purpose of the current survey was to determine the frequency with which these new endodontic technologies and materials are being used in endodontic practices today. An e-mail questionnaire was sent to the 636 active diplomates of the American Board of Endodontics with current e-mail addresses. Two hundred thirty-two diplomates responded for a response rate of 35%. Calcium hydroxide was found to be the most frequently used intracanal medicament for all cases diagnosed with necrotic pulps. Ibuprofen was the most frequently prescribed medication for pain, and penicillin was the most frequently prescribed antibiotic when an active infection was present. Eighty-two percent of the respondents are still incorporating hand files in some fashion during the cleansing and shaping phase of treatment. Lateral condensation and continuous wave were the most common methods used for obturation. Digital radiography was reported as being used by 72.5% of the respondents, whereas 45.3% reported using the microscope greater than 75% of the patient treatment. Ultrasonics was used by 97.8% of the respondents. It appears from the results that new endodontic technology is currently being used in the endodontic offices of those who responded to the survey. (*J Endod* 2009;35:35–39)

Key Words

American Board of Endodontics, electronic apex locator, mineral trioxide aggregate, survey

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In 1977, a survey (1) was conducted to determine trends in the management of endodontic emergencies. A second survey (2) conducted in 1990 compared treatment modalities being rendered in endodontic practices. According to Gatewood et al. (2), there was a greater trend toward complete instrumentation of root canals to the apex in emergency situations than was reported in 1977 (1). The number of respondents who left teeth open when a nonvital pulp was present decreased dramatically in the 13-year period between surveys. In 1971, it was reported that 44.3% of endodontists cultured routinely, and 28.3% cultured only when indicated at the emergency visit (3). Results of the 1977 survey revealed that only 16.6% of the participants cultured at emergency visits, and this decreased to 9.6% in 1990.

Many changes have occurred with regard to endodontic equipment and materials since the last survey in 1990 (2). Technologies available for use in endodontic offices today include battery or electric motors with gear-reduction handpieces using nickel-titanium rotary file systems, new-generation electronic apex locators (EALs), improved digital radiographic sensors, operating microscopes, and ultrasonic units with a variety of tips designed specifically for use when performing both nonsurgical and surgical endodontic procedures. There are also new materials and methods for obturating the prepared root canal system. Current postgraduate endodontic training programs include the implementation of these new technologies and materials. New ultrasonic units and specially designed endodontic tips provide the clinician with the options of performing nonsurgical retreatments and surgical root-end preparations that conserve more tooth structure. The location and instrumentation of calcified root canal systems are also enhanced using the ultrasonic technology. The improved magnification and illumination systems allow the operator to better visualize the working field during the nonsurgical and surgical procedures they perform. All of these things result in more efficient delivery of care to the patient. Mineral trioxide aggregate (MTA) was developed and introduced for use in endodontics in the early 1990s so its use was not addressed in either of the two earlier surveys (1, 2). Clinicians are no longer limited to the traditional materials such as amalgam, Super EBA cement, intermediate restorative material (IRM), Cavit (3M ESPE, St Paul, MN), and glass ionomers for perforation repairs and root-end fillings. Since 1990, there have been no recent surveys of the endodontic community to determine how frequently the new technology and materials are being used. The primary purpose of this survey was to determine the current use of new endodontic technology and materials by diplomates of the American Board of Endodontics (ABE). A second purpose was to compare the current use of intracanal medications and level of instrumentation in emergency endodontic situations with the use reported in the 1990 survey (2).

Materials and Methods

E-mails surveys were sent to the 636 active diplomates of the ABE with current e-mail addresses. The emergency portion of the questionnaire was designed to be similar to the one used by Dorn et al. in 1977 (1). The remaining portions of the survey were related to the current use of new technology, new materials, and medications. Survey Monkey (www.surveymonkey.com), a Web site dedicated to conducting and analyzing surveys, was used to manage the results. Respondents were asked to check all areas of the questionnaire that applied so it was possible to have multiple responses for each question. Percentages were then calculated based on the number of respondents to each question. The investigators were blinded as to the identification of the diplo-

TABLE 1. Most Frequently Used Intracanal Medicaments

	Formocresol (%)	Calcium Hydroxide (%)	2% Chlorhexidine (%)	No Medicament (%)
Irreversible pulpitis and normal periapex	3.4	39.8	7.2	49.6
Irreversible pulpitis and acute apical periodontitis	2.1	43.7	8.4	45.8
Necrotic pulp with acute apical periodontitis, no swelling	2.0	59.8	13.3	24.9
Necrotic pulp, fluctuant swelling, with drainage	2.0	66.0	14.0	18.0
Necrotic pulp, fluctuant swelling, no drainage	2.0	64.8	13.4	19.8
Necrotic pulp, diffuse facial swelling, drainage through canals	2.4	64.0	13.4	20.2
Necrotic pulp, diffuse facial swelling, no drainage	2.4	65.9	12.7	19.0

mates who responded, but the demographic information that was collected included sex, current work status, and number of years in practice. The results did not lend themselves to any type of statistical analysis.

Results

Out of the 636 diplomates contacted by e-mail, 232 (35%) responded and completed the survey. Eighty-eight percent of the respondents were male, and 12% were female. Of the 232 respondents, 71% worked full time (>30 hours per week), 21% were in private practice, 18% reported to be involved in education, and 3% were retired. With regard to practice experience, 67.4% of the respondents had worked more than 20 years, 16.1% had worked 16 to 19 years, 8% had worked 11 to 15 years, 8% had worked 6 to 10 years, and 0.9% reported they had worked less than 5 years. The percentages calculated for each section of the questionnaire are shown in Tables 1 through 16.

The significant findings from the current survey will be summarized as follows. In the seven emergency scenarios listed in Table 1, the maximum reported use of formocresol today is only 3.4%. The most frequently used intracanal medicament today in these seven situations is calcium hydroxide. Its use ranges from a low of 39.8% to a high of 66%. The use of no intracanal medicament seems to be specifically related to the emergency situation. Of the respondents, 49.6% did not use any medicament in cases of irreversible pulpitis with normal periradicular tissues, whereas 19% reported using no medicament in cases with necrotic pulps, diffuse swelling, and no drainage.

Table 2 reports the findings with regard to the level of instrumentation in the seven emergency situations. Between 30% and 40% of the

respondents instrumented to the level of the “Apex” reading on the EAL, regardless of the emergency situation.

For the nonemergency categories, the most frequently prescribed analgesic was ibuprofen (Table 3), and the most frequently prescribed antibiotic was penicillin (Table 4). In first-time root canal treatment cases with closed apices, 5.25% and 2.5% NaOCl were the most frequently used irrigating solutions, but, in teeth with open apices, sterile saline or sterile water were the first choices. In retreatment cases with closed apices, MTAD was the first choice, whereas MTAD and 0.12% and 2% chlorhexidine were the equal choices in teeth in this group with open apices (Table 5). Over 90% of the respondents used either a crown-down or combination technique for preparation of the root canal system (Table 6). Hand files were being used in some manner by 82.1% of the respondents, whereas there was fairly equal distribution in the use of the rotary systems except for the Lightspeed system with a reported usage of only 5.8% (Table 7). Over one half of the respondents were using radiographs to determine working length (Table 8), whereas 72.5% were capturing their radiographic images with a digital system (Table 9).

The data in Table 10 show that 45.3% of the respondents were using the operating microscope greater than 75% of the time during patient treatment. Only 2.2% of the respondents reported that they did not use an ultrasonic system in some manner during first-time treatment, retreatment, or surgery (Table 11). For perforation repair coronal to crestal bone, almost half of the respondents used glass ionomer cement, whereas 96.1% used MTA if the perforation was apical to the crestal bone (Table 12). MTA was also the most frequently used root-

TABLE 2. Level of Instrumentation for Different Situations

	.5 to 1 mm Short of Radiographic Apex (%)	To Radiographic Apex (%)	To “Apex” Reading on EAL (%)	.5 to 1 mm Short of “Apex” Reading on EAL (%)
Irreversible pulpitis and normal periapex	31.3	11.2	31.3	26.2
Irreversible pulpitis and acute apical periodontitis	30.4	12.2	31.3	26.1
Necrotic pulp with acute apical periodontitis, no swelling	23.3	19.4	36.6	20.7
Necrotic pulp, fluctuant swelling, with drainage	21.7	22.6	36.1	19.6
Necrotic pulp, fluctuant swelling, no drainage	21.7	22.2	37.0	19.1
Necrotic pulp, diffuse facial swelling, drainage through canals	21.6	22.5	36.4	19.5
Necrotic pulp, diffuse facial swelling, no drainage	21.2	22.5	37.2	19.0

EAL, electronic apex locator.

TABLE 3. Most Frequently Prescribed Analgesics

Analgesic	Response Percent
Ibuprofen	87.1
Vicodin	40.6
Acetaminophen	20.5
Tylenol #3	13.8
Percocet	7.1
Vicoprofen	4.5
Lortab	4.0
Percodan	0.5
Other	4.9

Vicodin: Abbott Laboratories, Abbott Park, IL; Tylenol #3: Ortho-McNeil, Raritan, NJ; Percocet: Endo Pharmaceuticals, Chadds Ford, PA; Vicoprofen: Abbott Laboratories, Abbott Park, IL; Percodan: Endo Pharmaceuticals, Chadds Ford, PA.

end-filling material (Table 13). There were almost an equal percentage of those responding who were using either the continuous-wave (48.2%) or lateral condensation (43.6%) method for root canal obturation (Table 14), and the sealer of choice (74.6%) was zinc oxide and eugenol based (Table 15). Cavit and IRM were the two top choices for temporary restorative materials (Table 16).

Discussion

Two challenges in conducting a survey are to develop a questionnaire that is thorough enough to provide useful information yet short enough to encourage a favorable response rate. The 35% response rate in this study was likely because of the fact that it was delivered via e-mail instead of standard mail. The questionnaire was designed to be short and concise; however, the inboxes on some computers may have been set up with filters that send e-mails from an unknown source directly to junk mail.

The demographic information obtained is not surprising. Most active diplomates of the ABE are male, and most would have over 5 years of clinical experience. The maturity of this population is also reflected in that 67.4% reported being in practice for over 20 years.

The seven emergency categories were selected so that comparisons could be made with the 1977 (1) and 1990 (2) survey results with regard to the type of intracanal medication and the level to which root canals were being instrumented in these situations. Compared with the two earlier surveys (1, 2), the use of formocresol as an intracanal medicament has continued to decrease. In the seven emergency situations, the maximum reported use of formocresol today was only 3.4% (Table 1) as compared with a maximum use of 43.3% in 1977 (2) and 34.5% in 1990 (4). The use of calcium hydroxide as the intracanal medicament in these situations continues to increase. In the current survey, the use of calcium hydroxide was reported from a low of 39.8% to a high of 66%. There was no reported use of calcium hydroxide in 1977, and the use reported in 1990 (4) ranged from 13.5% to 24.7%. Chlorhexidine, which was not being used at either of the two earlier times, now has a reported use between 7.2% and 14%. In cases of

TABLE 4. Most Frequently Prescribed Antibiotics

Analgesic	Response Percent
Penicillin	52.5
Amoxicillin	38.6
Clindamycin	20.6
Augmentin	3.1
Metronidazole	1.4
Cephalexin	0.9
Erythromycin	0.5
Other	1.8

Amoxicillin: GlaxoSmithKline, London, UK; Augmentin: GlaxoSmithKline, London, UK.

TABLE 5. Most Frequently Used Irrigating Solutions for Different Situations

	Closed Apex (1 st RCT)	Open Apex (1 st RCT)	Closed Apex (retreat RCT)	Open Apex (retreat RCT)
5.25% NaOCl	28.7	21.7	27.7	21.9
2.5% NaOCl	26.4	25.2	25.2	23.2
2% Chlorhexidine	15.5	23.8	27.7	33.0
.12% Chlorhexidine	17.8	28.9	22.2	31.1
MTAD	18.8	18.8	31.3	31.3
Sterile saline/H ₂ O	19.2	38.5	13.5	28.8

MTAD, mixture of tetracycline isomer, acid, and detergent; RCT, root canal treatment.

irreversible pulpitis with normal periapex, there has been a significant change from the previous surveys. Almost 50% of the respondents reported they used no intracanal medicament in this emergency situation. This compares with the 8.4% reported in 1977 (2) and 10.6% in 1990 (4). This most likely reflects the increase in the number of cases presenting with irreversible pulpitis and a normal periapex where the entire root canal therapy is being completed in one visit rather than multiple visits. When acute apical periodontitis is added to the pulpal diagnosis of irreversible pulpitis, the percentage of respondents in all three surveys is very similar (Table 1).

The most common response for level of instrumentation in all the seven emergency situations in this survey was to the "Apex" reading on the EAL. The only exception noted was in the case of irreversible pulpitis with a normal periapex in which a similar percentage of respondents stated they would instrument 0.5 to 1.0 mm short of the "radiographic" apex (Table 2). In the current survey, over 50% of the diplomates were using an EAL to determine the level to which root canals were to be instrumented in the seven emergency situations. This reflects the technological advances that have been made since the last survey (2) to improve the clinical accuracy of the new EALs. There is an overall increasing acceptance in the use of the EAL, but, as Table 8 reflects, radiographs remain the most common means of determining working length. Neither of the two earlier surveys (1, 2) differentiated if the level of instrumentation was determined radiographically or by using an EAL. The current survey failed to include any radiographic or EAL categories that would have captured any diplomates who were extending the level of instrumentation past the apex in one or more of the seven emergency situations.

It was not surprising that ibuprofen was the most frequently prescribed analgesic in that it is probably the most popular and readily available over-the-counter analgesic available today (Table 3). In the 1990 report (2), the use of nonsteroidal inflammatory analgesics in the seven emergency categories ranged from 34.7% to 52.5%. Vicodin (Abbott Laboratories, Abbott Park, IL), at 40.6%, was the most frequently prescribed narcotic but was a distant second to ibuprofen in the current study. This would be expected because the narcotic analgesics would be reserved for patients with more severe pain. The previous two studies did not break the narcotics down by name as was done in the present study so no direct comparisons could be made. For simplicity sake, the current survey only asked for the most frequently prescribed analgesics and did not attempt to link responses to a specific category of pain, such as mild, moderate, or severe.

TABLE 6. Style of Instrumentation Technique

	Response Percent
Crown-down	46.8
Step back	6.4
Combination	50.5

TABLE 7. Style of Instrumentation

	Response Percent
Hand file	82.1
ProTaper	33.6
Profile	30.9
Profile GT	21.1
K3	18.8
Sequence	15.3
Profile Series 29	14.4
Light Speed	5.8

Protaper, Profile, Profile GT, and Profile Series 29: Dentsply Tulsa Dental Specialties, Dentsply International, Tulsa, OK; K3: SybronEndo, Orange, CA; Sequence: Brasseler USA, Savannah, GA; Lightspeed: Lightspeed Technology, Inc., San Antonio, TX.

Penicillin (52.5%) was the most frequently prescribed antibiotic in this study (Table 4). Yingling et al. (4) reported that for 61.5% of the respondents to their survey, penicillin was the first-choice antibiotic for patients with no medical allergies. In the present study, amoxicillin (GlaxoSmithKline, London, UK) (38.6%) and clindamycin (20.6%) are the next two most frequently prescribed antibiotics. The current study did not attempt to be as specific as the previous study (4) regarding all the situations in which antibiotics would be required. The 1977 (1) and 1990 (2) surveys only reported on antibiotic use in the seven emergency situations and did not ask which specific antibiotics were used for each scenario.

The question on the survey with regard to the use of irrigating solutions was designed to determine the percentage of diplomates who had incorporated the use of chlorhexidine and MTAD into their practices. MTAD was introduced for use as an irrigating agent by Torabinejad et al. in 2003 (5). Recommendations (6) for the use of chlorhexidine as a root canal-irrigating agent, especially in retreatment situations (7), have increased over the past few years. It was interesting to note that approximately one in five respondents were using these two irrigating solutions in first-time treatment cases, both in teeth with open and closed apices (Table 5). The percentage using these two agents rose to approximately one in three in retreatment situations. Our results showed that these agents are now being used almost as frequently as NaOCl in the four clinical situations addressed in the current survey.

Tables 6 and 7 reflect the current instruments and instrumentation methods being used for root canal preparation. The step back method was used by only 6.4% of the diplomates. This technique was very popular in the 1960s and 1970s before crown-down hand and rotary methods were introduced. The crown-down, hand and rotary combination, and combination of different rotary instrumentation were the reported to be used by an almost equal percentage of respondents. Upon reviewing the results from question seven, it was noted that most diplomates were using hand instrumentation (Table 7). It was impossible from the way the question was worded to determine if the hand instruments were being used alone or in combination with one of the rotary systems. Most likely, they were being used in combination with a rotary system because most of these systems recommend establishing root canal patency to a size #15 or #20 before introducing the rotary files into the canal (8). The three rotary systems that were used most frequently were the ProFile, ProTaper, and ProFile GT (Dentsply Tulsa Dental Specialties, Dentsply International, Tulsa, OK).

TABLE 8. Style of Working Length Determination

	Response Percent
Radiographs	52.5
EAL	38.6
Combination	8.9

TABLE 9. Type of Radiographic Image

	Response Percent
Conventional	36.0
Digital	72.5

TABLE 10. Use of a Microscope

	Response Percent
Greater than 75% of the time	45.3
Between 75%–50% of the time	11.2
Between 50%–25% of the time	13.9
Less than 25% of the time	21.5
Never	9

TABLE 11. Use of Ultrasonics

	Response Percent
To locate canals	69.2
To remove posts	93.8
For retro-preps	91.5
No use at all	2.2

TABLE 12. Material of Choice for Perforation Repair

	MTA (%)	Super EBA (%)	Glass Ionomer (%)	Amalgam (%)
Perforation coronal to crestal bone	28.0	3.67	48.0	20.4
Perforation apical to crestal bone	96.1	1.3	1.8	0.9

MTA, mineral trioxide aggregate.

TABLE 13. Material of Choice for Root-end Filling

	MTA (%)	Super EBA (%)	Glass Ionomer (%)	Amalgam (%)
Root-end-filling material	61.4	34.3	0.8	3.4

TABLE 14. Method of Obturation

	Response Percent
Continuous wave	48.2
Lateral condensation	43.6
Vertical compaction (Schilder)	20.2
One cone technique	3.2
Thermoplasticized gutta-percha core	6.0
Thermafil	0.5

Thermafil: Dentsply Tulsa Dental Specialties, Dentsply International, Tulsa, OK.

TABLE 15. Choice of Sealer

	Response Percent
Zinc oxide eugenol	74.6
AH Plus	18.9
AH 26	6.5
Sealapex	5.9

AH Plus, AH 26: Dentsply Tulsa Dental Specialties, Dentsply International, Tulsa, OK; Sealapex: SybronEndo Corporation, Orange, CA.

Almost one half of the diplomates are now using the EAL alone or in combination with radiographs to determine working length (Table 8). This reflects the technologic advances and more accurate length

TABLE 16. Choice of Temporary Filling Material

	Response Percent
Cavit	68.1
IRM	40.5
Glass ionomer	10.5
Zinc oxide eugenol	3.8

IRM, intermediate restoration material. Cavit: 3M ESPE, St. Paul, MN.

determinations that are now being achieved with modern EAL units. Survey results also reflect the use of improved technology in the area of endodontic radiography. Over seventy percent of the diplomates reported using digital radiography compared with a much smaller percentage still using conventional radiographic equipment (Table 9). Over 50% of the diplomates were using the operating microscope more than one half the time, and 45.3% were using it 75% or more of the time (Table 10). There were only 2.2% of the diplomates that were not using ultrasonics in their practices (Table 11). Over two thirds of the respondents were using this technology to locate root canals, and over 90% were using it to remove posts and to perform root-end cavity preparations. The high percentage of those using the microscope and ultrasonics provides additional evidence that these new technologies are being incorporated into the modern practice of endodontics.

MTA was the most popular material for both perforation repairs and root-end fillings (Tables 12 and 13). The articles that have been published on MTA are too numerous to list, but most have confirmed that its properties make it the material of choice for these two procedures. The use of MTA reported in this survey confirms that the research results have translated to increased clinical use of the material.

The continuous-wave technique has now surpassed lateral condensation as the obturation method of choice for the group of ABE diplomates who responded to the current survey (Table 14). Only 3.2% reported using a one-cone technique. It will be interesting in the future to determine if the one-cone technique increases in popularity because many of the companies that produce rotary instruments are also marketing gutta-percha cones that match the size of the last rotary file that was used to prepare the canal. This survey requested information about the specific technique used but not the material. Reflecting back, a question should have been asked about materials being used because the Resilon (RESILON RESEARCH, LLC, North Branford, CT)/Epiphany (Pentron Clinical Technologies, LLC, Wallingford, CT.) method has now been on the market for more than 2 years. The results would have at

least served as a baseline for comparison purposes for future surveys conducted to determine the use of different obturating materials. It was interesting to note in the results that 74.6% of the respondents were still using zinc oxide–eugenol–based root canal sealer (Table 15). AH Plus has replaced AH 26 as the second most popular sealer. Even though many new root canal sealers have been introduced, the zinc oxide–eugenol sealers remain the “gold” standard in this material category.

Over two thirds of the respondents were using Cavit as their temporary filling material of choice (Table 16). IRM was the second most popular choice. Both of these materials have been marketed for over 50 years and, at this time, have not been replaced by any new restorative materials for the purpose of sealing access preparations on a temporary basis.

In conclusion, it can be stated that from the results of this survey that new endodontic technology and materials have been incorporated into the clinical practice of endodontics for that group of active diplomates of the ABE who responded to this survey. Hopefully, the results are a reflection of the armamentarium and materials being incorporated into every modern endodontic practice. The way to substantiate the results reported in this study would be to conduct a survey of the entire membership of the American Association of Endodontists and incorporate the suggestions for improvement noted in our discussion section.

References

1. Dorn SO, Moodnik RM, Feldman MJ, Borden BG. Treatment of the endodontic emergencies: a report on a questionnaire. Part I. *J Endod* 1977;3:94–100.
2. Gatewood RS, Himel VT, Dorn SO. Treatment of the endodontic emergency: a decade later. *J Endod* 1990;16:284–91.
3. Lane AJ, Grossman LE. Culturing root canals by endodontic diplomates: a report based on a questionnaire. *Oral Surg* 1971;32:461.
4. Yingling NM, Byrne BE, Hartwell GR. Antibiotic use by members of the American Association of Endodontists in the year 2000: report of a national survey. *J Endod* 2002;28:396–404.
5. Torabinejad M, Shabahang S, Apicco RM, Kettering JD. The antimicrobial effect of MTAD: an in vitro investigation. *J Endod* 2003;29:170–5.
6. Ercan E, Özekinci T, Atakul F, Gül K. Antibacterial activity of 2% chlorhexidine gluconate and 5.25% sodium hypochlorite in infected root canal: in vivo study. *J Endod* 2004;30:84–7.
7. Ohara P, Torabinejad M, Kettering JD. Antibacterial effects of various endodontic irrigants on selected anaerobic bacteria. *Endod Dent Traumatol* 1993;9:95–100.
8. Blum J-Y, Machou P, Ruddle C, Micallef JP. Analysis of mechanical preparations in extracted teeth using ProTaper Rotary instruments: value of the safety quotient. *J Endod* 2003;29:567–75.