

A questionnaire survey of endodontic practice profile among dentists in Hong Kong

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ABSTRACT Objectives. The present study aimed to gather information on the prevailing endodontic practice of general dental practitioners in Hong Kong. **Methods.** A cross-sectional postal survey was conducted on 1167 members of the Hong Kong Dental Association in 2001. Information about the materials and techniques used in endodontic treatment was collected. **Results.** A total of 369 replies were received, of which 343 with valid responses were analyzed, which accounted for 29% of the population surveyed. About half of the respondents (56%) performed one to five endodontic treatments weekly. Over one quarter (28%) routinely used a rubber dam in endodontic treatment. A wide variety of instruments were used for root canal preparation; stainless steel hand files being the most popular (89%). Rotary nickel-titanium instrumentation was practiced by 21% of respondents. Sodium hypochlorite irrigation and calcium hydroxide dressings were used by 63% and 43% of respondents, respectively. Most general dental practitioners (87%) obturated root canals with lateral compaction of gutta-percha. Single-visit treatment was not common; less than 20% of respondents practiced it to a limited extent. **Conclusion.** Within the limits and the low response rate to the present survey, the results suggest that Hong Kong general dental practitioners treat root canals using techniques and materials commonly taught in dental schools, often as multiple-visit treatments. The utilization of rubber dams in root canal treatment remains low.

Introduction

Endodontics is one of the fastest-growing disciplines in daily clinical practice, whereas contemporary endodontics often involves the introduction of many new instruments, materials, and techniques. Nowadays, general dental practitioners (GDPs) are faced with a multitude of materials and techniques for such procedures, whilst dental schools consciously attempt to tailor their curricula towards evidence-based interventions. Thus, there is a need to promulgate the latest concepts and practices of contemporary endodontics not only for the undergraduate

students but also for GDPs.

With the increased awareness of continuing education by the GDPs, numerous different endodontic education programs are available to the profession. Due to new developments in rotary instruments, most continuing education courses offered in endodontics are related to instrumentation techniques. However, there is insufficient evidence as to whether these courses provide what GDPs actually need^{1,2}. In addition, identifying important areas where GDPs require further improvement and regular updating remains a challenge³. The purpose of this study was to initiate the collection of data regarding routine endodontic treatments performed by the GDPs in Hong Kong.

Methods

A questionnaire survey dealing with materials and techniques used in endodontic treatment was conducted in 2001, among Hong Kong GDPs. A total of 1167

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questionnaires were sent to all members of the Hong Kong Dental Association. Since the study was designed to explore the endodontic practice profile among GDPs, dental specialists and dentists with limited practice in any discipline were excluded.

An introductory covering letter clearly disclosed the identity of the researchers and the purposes of the study. Respondents were instructed to complete the questionnaires and return them within a week and assured that their replies would remain confidential to ensure anonymity. No reminders or follow-up letter were sent. The 2-page questionnaire contained 28 questions relating to different aspects of endodontic practice, and asked for a few background details about each respondent (Table 1). Whenever multiple answers were received, each answer was counted.

Results

A total of 369 GDPs (32%) returned the questionnaires. Among all the questionnaires received, 22 were considered invalid because only the first page was completed, and therefore they were excluded from the study. One respondent was from a practice not providing endodontic therapy and three others had ceased dental practice, for which reasons their responses were also excluded. Thus 343 GDPs were deemed to have made valid responses, giving a response rate of 29%.

Respondent and practice profile

The training backgrounds and practice profiles of the respondents are listed in Table 2. Approximately 78% (n=266) were in private practice and 22% (n=77) worked in the government/university sector, or for non-profit organizations. Sixty percent (n=206) had received their training in the University of Hong Kong (HKU). Most respondents (n=335, 98%) performed first-time root canal treatment on a regular basis, whereas only 40% (n=137) regularly perform re-treatment procedures. About 56% (n=191) carried out five or less root canal procedures weekly.

Number of visits per endodontic treatment

Respondents were asked to give an estimate of the number of visits required to complete the root canal procedures for single-rooted (vital and non-vital) and multi-rooted (vital and non-vital) teeth. One respondent did not answer this question. The results are summarized in

Figure 1.

Preoperative radiographs

Approximately 78% of respondents (n=266) routinely took preoperative radiographs before commencing endodontic treatments, 22% (n=75) did so occasionally, and two (0.6%) replied that they rarely did so.

Rubber dam utilization

Only 28% (n=96) of respondents always used rubber dam isolation during endodontic treatments. The majority (n=247, 72%) were infrequent or non-users of rubber dams.

Root canal irrigants

A variety of agents were mentioned for irrigating the root canal; many respondents indicated that they used more than one irrigating agent. Sodium hypochlorite and normal saline solutions were the most popular agents, used by 63% (n=217) and 60% (n=205) of the respondents, respectively. Another 25% also used local anesthetic solution. Other less commonly employed irrigating agents included hydrogen peroxide (13%), ethylene diamine tetra acetate (11%), and chlorhexidine solutions (4%). Among those respondents who did not employ rubber dam isolation (n=87), 38 used sodium hypochlorite solution as irrigant.

Working length determination

Various working length determination methods were employed. Roughly 62% (n=213) of respondents obtained working length radiographically, whereas 34% (n=118) used radiography in conjunction with an electronic apex locator (EAL) and 5% used only the EAL. About 15% of respondents relied on tactile sensation.

Instrument selection and maintenance

For root canal preparation and debridement, 89% (n=304) of the respondents used stainless steel hand files; nickel-titanium hand files were used by 36% (n=123) and about 21% (n=73) reported using rotary nickel-titanium instruments. Endosonic root canal preparation was practiced by 10% (n=36) of respondents.

Disposal of the endodontic files after single use was practiced by 4% (n=14) of the respondents. Endodontic

Table 1 Survey of endodontic practice by the general practitioners

-
1. Year of qualification: _____
 2. Are you a HKU graduate? Yes No
 3. Are you currently practicing dentistry? Yes No
 4. Type of practice:
 - Private
 - Government/hospital
 - Others (please specify) _____
 (If you are running a specialist practice, this is the end of the questionnaire. Thank you!)
 5. Do you regularly treat (tick all those which apply):
 - single-rooted endodontic cases
 - multi-rooted endodontic cases
 - re-treatment cases
 6. On the average, how many root canal therapy do you perform per week?
 - 0-5 teeth 6-10 teeth 11-15 teeth 16-20 teeth 21 teeth or above
 7. Are you satisfied with your current endodontic technique? Yes No
 8. If No, in what aspects (please specify): _____
 9. In your endodontic treatment, do you use rubber dam?
 - Always
 - Occasionally
 - Never
 10. Do you take a pre-operative radiograph?
 - Always
 - Occasionally
 - Never
 11. To prepare canal(s), do you routinely use:
 - stainless steel hand file (brand: _____)
 - nickel-titanium hand file (brand: _____)
 - endosonic instrumentation (brand: _____)
 - rotary nickel-titanium files (brand: _____)
 - Motor: air-motor electric motor
 - others (please specify) _____
 12. Do you use 'open drainage'? Always Occasionally Never
 13. For irrigation of root canals, what irrigant would you use?
 - Normal saline
 - Sodium hypochlorite
 - Local anesthetic solution
 - Hydrogen peroxide
 - Ethylene diamine tetra acetate
 - Others (please specify) _____
 14. How would you normally determine the 'working length'?
 - Tactile
 - Working length radiograph only
 - Electronic apex locator only
 - Electronic apex locator and measurement radiograph
 15. Do you always use lubricating/chelating agent during root canal instrumentation?
 - Yes (brand: _____) No
 16. What type of obturation/filling technique do you routinely use (e.g. gutta-percha points+AH plus+lateral condensation) _____
 17. Usual number of visits to complete endodontic therapy:
 - Single-rooted tooth, vital ()
 - Single-rooted tooth, non-vital ()
 - Multi-rooted tooth, vital ()
 - Multi-rooted tooth, non-vital ()
 18. If more than one visit, do you dress canal(s) between visits? Yes No
 19. If Yes, what dressing/medication do you use?
 - Vital pulpectomy: _____
 - Necrotic pulp: _____
 20. Do you prescribe antibiotics for patients undergoing endodontic therapy?
 - If symptom or pain is present Yes No
 - If sinus tract is present Yes No
 - If swelling is present Yes No
 - If tooth is tender to percussion Yes No

21. Which antibiotic would you prescribe?
 Penicillin V
 Broad-spectrum penicillin (amoxycillin, ampicillin)
 Metronidazole
 Tetracycline
 Others (please specify) _____
22. How do you sterilize your endodontic files?
 Autoclave
 Cold sterilization
 Glass bead/hot salt (heat sterilization)
 Dispose after a single use
 Others (please specify) _____
23. When would you dispose the endodontic files?
 After a single use
 After _____ times of use
 The file becomes blunt (decreased cutting efficiency)
 See signs of distortion
 Others (please specify) _____
24. What are the major concerns when you purchase endodontic files (please rank from 1-9, with 1 being most important)?
 Brand _____ Materials (e.g. stainless steel, NiTi) _____ Flexibility _____ Durability _____ Cutting efficiency _____
 Cutting tip/flute design _____ Size availability _____ Price _____ Others (please specify) _____
25. Do you feel that your dental school's training in endodontic therapy was adequate?
 Inadequate 1 2 3 4 5 Adequate
26. If any, which aspect do you think is the most inadequate: _____
27. Do you think that you need further training in endodontics after graduation:
 Yes No
28. If Yes, would you prefer:
 postgraduate program (e.g. MDS, MSc)
 part-time structured program (e.g. postgraduate diploma)
 continuing education courses
 lecture presentations only

Thank you

Table 2 The training background and practice profile of the respondents

Year of graduation	Type of practice		Total
	Private	Government/hospital/ non-profit organizations	
1961-1980	57	10	67
1981-2000	199	67	264
Not stated	10	0	12
Total	266	77	343

files were re-used after sterilization with either autoclaves (n=272, 79%) or cold disinfection (n=78, 23%). The files were discarded once signs of distortion were noted (n=244, 71%) or when they became blunt (n=215, 63%).

Obturation technique

Either cold or warm lateral compaction of gutta-percha with a root canal sealer was used by 87% (n=300) of respondents. Other less popular options included the thermo-plasticized gutta-percha techniques, such as ThermaFil system (Dentsply Maillefer, Baillaigues,

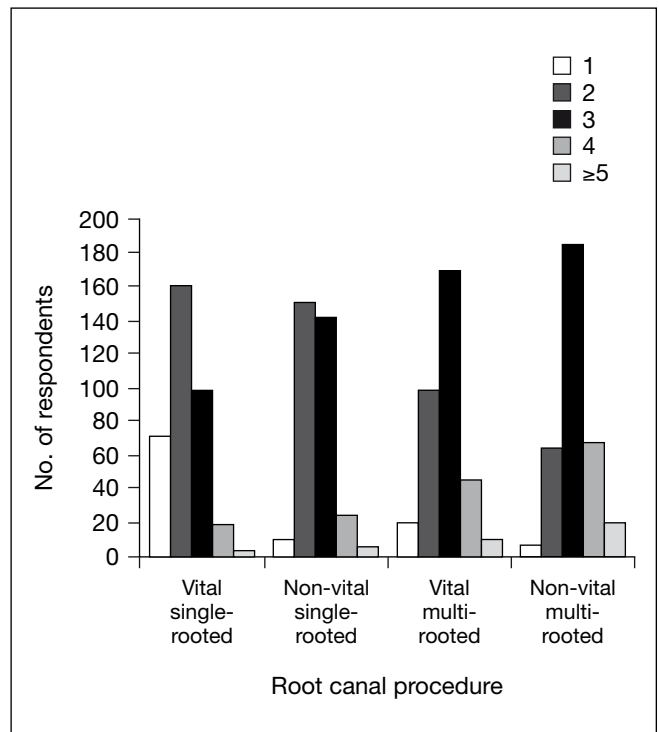


Figure 1 The number of visits to complete a course of endodontic treatment

Table 3 The most commonly used medications for each clinical condition *

Medication	Condition	
	Vital teeth	Necrotic teeth
Calcium hydroxide	116	149
Formocresol	92	64
Ledermix	82	67

* Multiple responses accepted

Switzerland) [n=17, 5%], warm vertical compaction (n=9, 3%), continuous waves of condensation technique (n=6, 2%), and Obtura II injectable Gutta-Percha System (Obtura Corp, Fentan [MO], US) [n=3, 1%]. One respondent used a silver-point technique for the obturation material and another an N-2 cement (Hayer-Werken GmbH, Duisburg, Germany).

Inter-appointment dressing

About 92% of respondents employed intracanal medications for multi-visit treatments. The remaining 8% (n=29) did not use any form of dressing and usually left root canal space unfilled. The medicaments of choice for both vital teeth and necrotic teeth conditions are shown in Table 3.

For vital pulpectomy, non-setting calcium hydroxide paste was the most popular (n=116), followed by formocresol (n=92) and Ledermix (Lederle, Wayne [NJ], US) [n=82]. For the treatment of teeth with pulpal necrosis, calcium hydroxide paste was the most popular (n=149) medicament. Ledermix (n=67) and formocresol (n=64) were the second and third most popular, respectively.

Use of systemic antibiotics

Antibiotics were prescribed for clinical conditions shown in Figure 2. Many respondents replied that they used more than one antibiotic during endodontic treatment. The most frequently prescribed were in the order: amoxicillin (n=284, 83%), metronidazole (n=106, 31%), and penicillin V (n=59, 17%).

Endodontic trainings

Perceptions about the adequacy of undergraduate endodontic trainings were also obtained in this study. The overall mean score of the respondents was 3.18 in a Likert scale from 1 to 5. The mean scores from HKU and

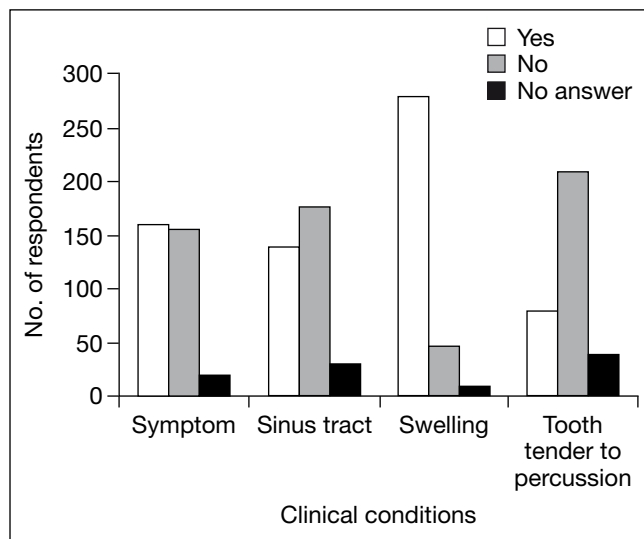


Figure 2 The clinical conditions for which antibiotics were prescribed

non-HKU graduates were 3.21 and 3.12, respectively with no significant difference (Mann-Whitney *U* test, $P=0.4750$). About 92% (n=316) expressed they required further training after graduation. Among these, 93% (191/206) were HKU graduates and 91% (125/137) were non-HKU graduates; there being no significant difference pertaining to this response (Fisher's exact test, $P=0.6839$). About 73% of respondents (n=251) would have preferred continuing education courses, whereas part-time structured programs (postgraduate modular and diploma courses) were also welcomed by 37% (n=128). Approximately 6% (n=22) would have preferred a full-time postgraduate program.

Discussions

Postal surveys provide a simple means of data collection from a diverse sample, but are often weak owing to poor rates of return. The overall response rate of the present survey was only 29%, thus data retrieved could not be considered fully representative of GDPs in Hong Kong for really meaningful analysis. However, the present cross-sectional survey of over 300 dental professionals from different types of dental practices (including private practices, government clinics, and health care centers) could reveal information relevant to endodontics prevailing in Hong Kong.

From the present study, it appears that conventional first-time endodontic treatment for single- or multi-rooted

teeth are routine procedures for GDPs. About one third of those surveyed are willing to attempt non-surgical endodontic re-treatment. Endodontic treatments of single-rooted or multi-rooted teeth are completed in three or more visits. In contrast, single-visit endodontic treatments are not commonly employed, except for vital single-rooted teeth.

High-quality radiographs had been suggested for accurate diagnosis and preoperative assessment of potentially difficult cases⁴ to enable appropriate case selection. Besides, this preoperative evidence also constitutes an important dental record^{4,5}. Despite its importance, the present study found that only about 78% of the surveyed GDPs routinely examine preoperative radiographs.

All endodontic procedures should be performed with a rubber dam, which should be considered standard care⁴. The purposes of rubber dam protection are two-folded; being primarily, to reduce the risk of foreign body inhalation or ingestion by the patient and secondarily to provide an aseptic environment for endodontic procedures. These benefits notwithstanding, its application has not been well embraced by independent practices⁶. Root canal treatment without a rubber dam can be hazardous and is legally indefensible, should aspiration of an instrument occur⁷. Regrettably, as in the UK⁸, only about a quarter of respondents routinely used a rubber dam during root canal therapy. Furthermore, around 10% of respondents regularly employed sodium hypochlorite irrigation without a rubber dam, despite this irrigant being caustic and distasteful. Although rubber dam isolation is taught as mandatory during undergraduate training, its importance appears to be ignored by GDPs⁸.

Working length determination is one of the most critical steps in endodontics, as it facilitates biomechanical preparation and obturation of the root canal system⁹. Failure to accurately determine the length of the root canal often results in apical perforation; overextension of irrigants or obturation materials into the peri-radicular tissues, may also lead to incomplete instrumentation and obturation. A majority of the respondents were using the radiographs to determine the working length. This method has inherent inaccuracies, as the apical foramen may not be detectable on radiographs¹⁰. Electronic apex locators have the advantage of being able to locate the apical foramen^{11,12}. Nevertheless, EAL is not a substitute for radiographs since the latter provide valuable supplementary information about root canal morphology as well

as peri-radicular anatomy. It therefore seems logical to combine the use of EALs with radiographs to enable an efficient and accurate determination of working length. This protocol was actually practiced by about one third of respondents surveyed in this study.

Non-rotary manual endodontic files were commonly used by the GDPs surveyed. Recently introduced rotary nickel-titanium files have enabled quicker root canal preparation, as these instruments are able to produce a uniformly tapered canal configuration with minimum canal transportation¹³. They also reduce the incidences of peri-radicular irritation and postoperative discomfort¹⁴. However, unpredictable instrument separation remains a deterrent to their popularity¹⁵. Only about one fifth of respondents were using these rotary instruments in root canal preparation.

Once used beyond their limit, either wear or fracture occurs in endodontic files. To prevent file breakage, operators often choose to discard them after a fixed period of use, which may be sensible option as it is not possible to detect early fatigue cracks in frequently re-used files. However, the majority of respondents only replaced their instruments when signs of distortion or bluntness were obvious, which is likely to result in a higher risk of instrument separation in the canal.

The role of bacteria in the pathogenesis of peri-radicular lesions has been well documented^{16,17}. The pathogen could be eliminated by irrigation with an antimicrobial agent. Mechanical preparation only serves to shape the canals and facilitate an effective irrigation. The ideal irrigant should combine antimicrobial action and a capacity to dissolve organic remnants¹⁸. Irrigants such as local anesthetic solution, sterile water, and saline that have no antibacterial effect could only dislodge and flush out the debris. Sodium hypochlorite solution has long been known to be effective and is a preferred agent for endodontic irrigation¹⁹. Its advantages include high tissue dissolving and disinfecting capability. As it was recommended by the dental school in Hong Kong, sodium hypochlorite seems to be gaining popularity locally, in contrast to the situation in the UK⁸.

Root canal obturation serves to prevent the ingress of microorganisms into the already cleaned root canal system. The lateral condensation technique with a root canal sealer, which was taught locally, was the most common among the surveyed GDPs. Lateral compaction of gutta-percha is a relatively simple and versatile tech-

nique that has produced good results and does not require expensive equipment²⁰. There was a trend towards the use of some forms of heated gutta-percha. It has been shown that thermo-plasticized gutta-percha is better adapted to the canal walls and may fill lateral canals better than lateral condensation²¹. The single-cone obturation technique with silver points was nearly obsolete. This technique has been shown to be ineffective and unsafe because of the potential for microleakage, cement dissolution, corrosion, and adverse effects of its toxic by-products on periapical tissues²². Clinical reports have shown that permanent paresthesia are associated with gross over-filling with paraformaldehyde material, such as N-2 cement and it too should be avoided^{23,24}.

The purpose of intracanal medicaments is to reduce bacteria, control pain, reduce inflammation, and dry wet canals²⁵. Sjögren *et al*²⁶ showed that the success rate of root canal treatment of such infected cases increases significantly if there is an inter-appointment dressing of calcium hydroxide. In this survey the use of calcium hydroxide was the most popular among the respondents in both vital and necrotic endodontic cases. A number of factors may contribute to the latter's popularity: low incidence of toxicity, being an injectable formulation, and its reported effectiveness²⁵. Formocresol and Ledermix paste were the second and third choices, though far less popular than calcium hydroxide. Formocresol is cytotoxic and can cause a painful reaction if placed in contact with periapical tissues²⁷. The mutagenic, embryotoxic, and carcinogenic potential of formocresol has been well demonstrated in animal studies²⁸. Ledermix is a paste containing a mixture of a corticosteroid and a tetracycline-based antibiotic. Despite its antibiotic content, the advisability of using a corticosteroid in the presence of infection has been questioned²⁹.

Systemic antibiotics can lead to adverse effects including drug interactions, selection and overgrowth of resistant organisms, nausea, vomiting and other gastrointestinal symptoms, antibiotics-associated colitis, as well as potentially fatal allergic reactions³⁰. Antibiotics are indicated only if there has been systemic spread of infection; the patient is unwell and has a fever. Otherwise, they may present more of a risk to the patient than the infection. There is evidence showing that antibiotics are prescribed inappropriately in general dental practices^{31,32}. Recent reviews revealed that systematic antibiotics alone offer no additional benefit in the management of acute apical periodontitis and acute abscesses in permanent dentition^{33,34}. With the increasing worldwide problem

of antimicrobial resistance, there is a need to rationalize prescription of antibiotics. This study showed that the surveyed GDPs in Hong Kong like to prescribe antibiotics in conjunction with endodontic treatment, especially when the patients present with swelling (Figure 2). The most commonly prescribed were amoxicillin, metronidazole, and penicillin V, and similar to preferred drugs reported in another study³⁵. However, due to the questionnaire's design, no information about the use of combination antibiotic regimens was obtained.

All training activities in continuing professional development have resource implications and in an assessment of cost-benefit, these costs need first to be itemized. Overall, there are two main types of costs of continuing professional development: i) provision for tuition fees, lecture fees, and physical costs (course video, textbook etc.), and ii) opportunity costs (foregone earnings and on-going practice expenses due to absence from the dental practice). Such cost considerations may explain why more respondents prefer to receive further endodontic training via short continuing education courses, which incurs much less in the way of opportunity costs than full-time structured programs.

Conclusion

Endodontics is a dynamic, evolving discipline with considerable advances in techniques and materials over the last decade. The present small-scale study may not necessarily represent the true picture in Hong Kong. However, it can be used as reference for a larger survey in the future.

The professional bodies in endodontics should embark on training programs, seminars, and workshops aimed at improving the knowledge and skills of the GDPs. Appropriately structured continuing education courses may be able to meet the demands and needs of GDPs.

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References

1. Tanitor JF, Ross PN. Interest survey for continuing education courses in endodontics. *J Dent Educ* 1977;41:737-8.
2. Cafferata GL, Goldberg HJ, Roghmann K, Fox R. Continuing education: attitudes, interests, and experiences of practicing

- dentists. *J Dent Educ* 1975;39:793-800.
3. Wiebusch FB. Two problems confronting continuing education in dentistry: local or national problems? *J Dent Educ* 1973;37:45-7.
 4. Consensus report of the European Society of Endodontology on quality guidelines for endodontic treatment. *Int Endod J* 1994;27:115-24.
 5. Zinman EJ. Records and legal responsibilities. In: Cohen S, Burns RC, editors. *Pathways of the pulp*. 8th ed. St Louis: Mosby; 2002:365-407.
 6. Silversin B, Shafer M, Sheiham A, Smales FC. The teaching and practice of some clinical aspects of endodontics in Great Britain. *J Dent* 1975;3:77-80.
 7. Cohen SC. Endodontics and litigation: an American perspective. *Int Dent J* 1989;39:13-6.
 8. Whitworth JM, Seccombe GV, Shoker K, Steele JG. Use of rubber dam and irrigant selection in UK general dental practice. *Int Endod J* 2000;33:435-41.
 9. Weine FS. Calculation of working length. In: Weine FS, editor. *Endodontic therapy*. 5th ed. St Louis: Mosby; 1996:395-422.
 10. Olson AK, Goerig AC, Cavataio RE, Luciano J. The ability of the radiograph to determine the location of the apical foramen. *Int Endod J* 1991;24:28-35.
 11. Pagavino G, Pace R, Baccetti T. A SEM study of in vivo accuracy of the Root ZX electronic apex locator. *J Endod* 1998;24:438-41.
 12. De Moor RJ, Hommez GM, Martens LC, De Boever JG. Accuracy of four electronic apex locators: an in vitro evaluation. *Endod Dent Traumatol* 1999;15:77-82.
 13. Buchanan LS. The art of endodontics: files of greater taper. *Dent Today* 1996;15:42,44-6,48-9.
 14. Reddy SA, Hicks ML. Apical extrusion of debris using two hand and two rotary instrumentation techniques. *J Endod* 1998;24:180-3.
 15. Martin B, Zelada G, Varela P, et al. Factors influencing the fracture of nickel-titanium rotary instruments. *Int Endod J* 2003;36:262-6.
 16. Kakehashi S, Stanley HR, Fitzgerald RJ. The effects of surgical exposures of dental pulps in germ-free and conventional laboratory rats. *Oral Surg Oral Med Oral Pathol* 1965;20:340-9.
 17. Moller AJ, Fabricius L, Dahlen G, Ohman AE, Heyden G. Influence of periapical tissues of indigenous oral bacteria and necrotic pulp tissue in monkeys. *Scand J Dent Res* 1981;89:475-84.
 18. Sundqvist G, Figdor D. Endodontic treatment of apical periodontitis. In: Orstavik D, Pitt Ford TR, editors. *Essential endodontology*. London: Blackwell Science; 1998:242-77.
 19. Moorer WR, Wesselink PR. Factors promoting the tissue dissolving capacity of sodium hypochlorite. *Int Endod J* 1982;15:187-96.
 20. Walton RE, Johnson WT. Obturation. In: Walton RE, Torabinejad M, editors. *Principles and practice of endodontics*. 3rd ed. Philadelphia: W.B. Saunders; 2002:239-67.
 21. DuLac KA, Nielsen CJ, Tomazic TJ, Ferrillo PJ Jr, Hatton JF. Comparison of the obturation of lateral canals by six techniques. *J Endod* 1999;25:376-80.
 22. Margelos J, Eliades G, Palaghias G. Corrosion pattern of silver points in vivo. *J Endod* 1991;17:282-7.
 23. Kleier DJ, Averbach RE. Painful dysesthesia on the inferior alveolar nerve following use of a paraformaldehyde-containing root canal sealer. *Endod Dent Traumatol* 1988;4:46-8.
 24. Neaverth EJ. Disabling complications following inadvertent overextension of a root canal filling material. *J Endod* 1989;15:135-9.
 25. Bystrom A, Claesson R, Sundqvist G. The antibacterial effect of camphorated paramonochlorophenol, camphorated phenol and calcium hydroxide in the treatment of infected root canals. *Endod Dent Traumatol* 1985;1:170-5.
 26. Sjögren U, Figdor D, Persson S, Sundqvist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. *Int Endod J* 1997;30:297-306. Erratum in *Int Endod J* 1998;31:148.
 27. Powell DL, Marshall FJ, Melfi RC. A histopathologic evaluation of tissue reactions to the minimum effective doses of some endodontic drugs. *Oral Surg Oral Med Oral Pathol* 1973;36:261-72.
 28. Friedberg BH, Gartner LP. Embryotoxicity and teratogenicity of formocresol on developing chick embryos. *J Endod* 1990;16:434-7.
 29. Abbott PV, Heithersay GS, Hume WR. Release and diffusion through human tooth roots in vitro of corticosteroid and tetracycline trace molecules from Ledermix paste. *Endod Dent Traumatol* 1988;4:55-62.
 30. Thomas DW, Satterthwaite J, Absi EG, Lewis MA, Shepherd JP. Antibiotic prescription for acute conditions in the primary care setting. *Br Dent J* 1996;181:401-4.
 31. Palmer NA, Pealing R, Ireland RS, Martin MV. A study of therapeutic antibiotic prescribing in National Health Service general dental practice in England. *Br Dent J* 2000;188:554-8.
 32. Palmer NA, Pealing R, Ireland RS, Martin MV. A study of prophylactic antibiotic prescribing in National Health Service general dental practice in England. *Br Dent J* 2000;189:43-6.
 33. Sutherland S, Matthews DC. Emergency management of acute apical periodontitis in the permanent dentition: a systematic review of the literature. *J Can Dent Assoc* 2003;69:160.
 34. Matthews DC, Sutherland S, Basrani B. Emergency management of acute apical abscesses in the permanent dentition: a systematic review of the literature. *J Can Dent Assoc* 2003;69:660.
 35. Palmer NA, Dailey YM, Martin MV. Can audit improve antibiotic prescribing in general dental practice? *Br Dent J* 2001;191:253-5.