The past 10 years have witnessed significant changes in the art and science of endodontics. The advances in the science of this specialty have allowed for better understanding of endodontic disease processes and have led to development of treatment modalities aimed at restoring health to the pulp and periradicular tissues. Technological discoveries in instruments and materials have made it possible to achieve treatment objectives that once were considered unattainable. This article reviews the advances in endodontics during the past decade, focusing on both basic and clinical research.

BASIC RESEARCH

The microbial nature of endodontic disease. While the mechanical and manual challenges of root canal débridement and obturation remain, it has become increasingly clear that the largest proportion of endodontic disease, both pulpal and periradicular, is due to the presence of microorganisms. Therefore, treatment success is related very closely to the ability to remove these irritants and to prevent reinfection.

The polymicrobial nature of endodontic infections contributes to the increased overall bacterial irritation that is associated with the development of certain virulent bacterial combinations. The presence of certain microorganisms, such as members of the black-pigmented gram-negative bacteria, in root canals of teeth with necrotic pulp has been associated with increased clinical symptoms.

Development of DNA- and RNA-based microbiological techniques has allowed researchers in endodontics to identify new species of bacteria and to develop a more elaborate description of the microbial diversity in root canal infections. Owing to increased sensitivity and the ability to detect uncultivable microorganisms, researchers identified several fastidious or uncultivable microorganisms in root canal infections, using techniques based on the polymerase chain reaction to amplify the bacterial 16S rRNA gene.

Researchers cultured gram-positive bacteria, particularly Enterobacteriaceae, which have been associated with increased clinical symptoms and poor treatment outcomes.
coccus faecalis, from the root canals of teeth with persistent periradicular lesions.11-13 Furthermore, other researchers cultured fungi—mostly belonging to the genus Candida—from nearly 7 percent of retreatment cases that have culturable microorganisms.14 It is not yet clear whether these microorganisms cause the treatment failure or are favored by the environment of previously treated root canals.

The endodontic literature has devoted much attention to the question of whether microorganisms are present within periradicular lesions. Techniques using in situ staining methods have revealed the presence of bacteria, mainly belonging to the genus Actinomyces, in some therapy-resistant cases.15 Using careful sampling techniques, researchers have detected bacteria or bacterial DNA in periradicular lesions. More recently, researchers have linked symptomatic periradicular lesions to an increased prevalence of human cytomegalovirus and Epstein-Barr virus.19

**Inflammation of the pulp.**

Inflammation of the dental pulp is a basic biological response that takes place in a unique low-compliance environment and is the result, at least initially, of bacterial toxins acting well in advance of any direct microbial invasion. The initial innate component of the response is largely vascular and due to the release, initiated by cytokines and mediators, of neuropeptides from the multitude of pulpal nerves via axon reflexes.22 A three-dimensional study has revealed widespread anastomoses and loops that help limit the potentially damaging sequelae of inflammation. In this regard, examination of a microvascular study showed clearly that mechanisms in the capillary bed limit the dangers of increasing tissue fluid pressure such that capillary collapse occurs only at a late stage in untreated inflammation. Researchers also have mapped out the immunological component of the tissue response in detail, starting with antigen-presenting cells that greet the penetrating irritants as they reach the odontoblastic layer and culminating in nonspecific and specific responses by phagocytes and lymphocytes, respectively.

Inflammation and infection of the periradicular tissues are an extension of the processes in the pulp but are not identical to them. Hard-tissue dissolution is not a characteristic of pulpal inflammation. The periradicular lesion has proven to be a productive model for the study of inflammatory resorption.26,27 Clinicians now have detailed descriptions of the inflammatory cascade of cytokines released by bacterial toxins from macrophages and neutrophils, and the recognition of a group of these cytokines (interleukin-1 alpha, interleukin-2 beta, transforming growth factor-1 alpha, transforming growth factor-2 beta) as the osteoclast-activating factor is an important advance.

For most patients, pain is the most obvious and important characteristic of inflammatory disease, and especially so when it is within the tooth. During inflammation, intrapulpal nerves sprout and gather increased amounts of neuropeptides and release transmitters in response to stimulation by cytokines. A-δ fiber terminals, in dentin responding to hydrodynamic stimuli, and C fibers, in pulp responding to inflammatory mediators, appear to have differential roles in pulpitis. A relationship between symptoms and inflammatory molecules has been demonstrated in all studies reporting the significance of substance P.29-31 Inflammation and regeneration are closely related. The repair potential of the dental pulp is well-known, and recent work using growth factors suggests that modulation of these proteins will be of great value in extending the range of pulpal repair procedures.32,33

**CLINICAL RESEARCH**

**Treatment outcomes.** The most recent data indicate that about 15.8 million primary endodontic procedures were performed in the United States in 1999.34 Maintenance of the natural dentition, aided by endodontic, periodontal and restorative procedures, is the preferred choice of patients and remains a predictable treatment plan. From the patient’s perspective, retention of a tooth in a functional and esthetic condition may be considered a favorable treatment outcome. On the other hand, endodontists use more rigorous standards to assess treatment outcomes. Successful treatment to the specialist generally is signified by clinical and radiographic absence of disease. Researchers have reported outcome data in the endodontic literature as complete healing, incomplete healing or an absence of healing. Com-
plete restoration to health may be expected in 80 percent\textsuperscript{35,36} to more than 95 percent\textsuperscript{37} of cases, depending on the observation period. It is important to note that while signs of initiated, but incomplete, healing may be visible in early follow-up periods, complete resolution of preoperative radiolucent lesions may require up to four years of healing time.\textsuperscript{38} Overall, the criteria used for reporting endodontic treatment outcomes are different from and more rigorous than those used to report the survival rates of implants.

**Evidence-based endodontics.**Clinical decision making is becoming more complex today and requires information from many sources: primary data and patient preferences, the clinician’s own clinical and personal experiences, external rules and constraints, and scientific evidence. There also has been an explosive increase in the amount and quality of laboratory and clinical evidence. Fortunately, mechanisms such as systematic reviews are emerging that will help us acquire the best, most compelling and most current evidence that addresses defined clinical questions.

In 1999, the American Association of Endodontists (AAE) Board of Directors elected to use an evidence-based approach to its decision making and embrace lifelong learning as an essential element in the practice of the highest standards of endodontics. Trained AAE members, active in education and research, conducted systematic reviews in selected topics that were reported at the 2002 AAE Annual Session in Chicago. The organization established an Evidence-based Endodontics Standing Committee to consider action on the following recommendations:

- construction of a critically approved database of identified articles;
- development of an electronic journal from the database;
- contribution to other databases such as the Cochrane Collaboration;
- continued training of reviewers to conduct systematic reviews on additional clinical questions;
- creation of a standardized report-writing format;
- revision of the standards of the American Dental Association Commission on Dental Accreditation to include instruction in conducting systematic reviews.

**CLINICAL PRACTICE**

**Diagnosis.** Accurate and efficient diagnosis is the cornerstone of endodontic therapy. Experienced clinicians long have recognized that the patient’s chief complaint and history of illness are the first, and arguably the most, important pieces of the diagnostic puzzle. Some investigators view history of moderate-to-severe pain as a good indicator of irreversible pulpal pathosis.\textsuperscript{39} Nonetheless, clinical signs and symptoms alone are unreliable predictors of pulp and periradicular diseases.\textsuperscript{40,41} Thermal (cold and heat) and electrical pulp testing (EPT) are simple tests but are not completely reliable. Heat as a pulp test has a relatively high sensitivity but is the least accurate overall of the three common pulp tests owing to low specificity.\textsuperscript{42} Cold testing with tetraflouroethane, ethyl chloride or carbon dioxide (CO\textsubscript{2}) snow is relatively reliable and generally more accurate than heat. Cold testing is presumed to be more reliable than EPT in teeth with incomplete root formation. Since thermal tests are not 100 percent accurate, EPT is especially useful for confirming a questionable pulpal diagnosis.

A major limitation of thermal testing and EPT is that these tests measure only pulpal nerve response, not pulpal blood flow. Since the true measure of pulp vitality is blood flow, laser Doppler flowmetry (LDF) and pulse oximetry devices have been adapted for experimental use in assessing pulp vitality.\textsuperscript{43-46} These devices seem particularly well-suited for evaluating the vitality of traumatized teeth and for evaluating teeth in areas that may require orthognathic surgery.\textsuperscript{47}

Some investigators have attempted to identify biological factors that may determine the health status of the pulp tissue more accurately.\textsuperscript{48,49} Identification of the 20,000 to 25,000 genes of the human genome has paved the way for association of specific genes with known pathological findings. Microarray technology has enabled researchers to identify and study a large array of genes and proteins that are affected during disease formation and healing.\textsuperscript{50,51}

**Canal instrumentation.** The goals of débride-ment are to remove irritants from the root canal system and to create a three-dimensional shape that can be obturated.\textsuperscript{52} Nickel titanium (NiTi) files have become a mainstay in most endodontic procedures. Thanks to this metal, practitioners can use rotary instruments effectively in curved canals. Many file designs and shapes can be used for débridement. Varying the taper of the instrument leads to a more efficient preparation of the root canal space. Many of these types of files fea-
ture a U-shaped groove and a radial land that helps prevent perforations and instrument locking and separation. They also usually have a noncutting tip that helps to decrease transportation of the canal space.

While it can reduce the bacterial count significantly, mechanical débridement does not disinfect the root canal system completely. Thus, a root canal irrigant is needed to aid in the débridement of the canals. Sodium hypochlorite (NaOCl) is the most commonly used root canal irrigant. However, NaOCl has some major shortcomings, including its inability to remove the smear layer and to kill all bacteria present in infected root canals. Recently, a mixture of a tetracycline isomer, an acid and a detergent known as MTAD has been introduced as a final rinse for disinfection of the root canal system. This irrigant is able to remove the smear layer safely, and it is a more effective disinfectant than NaOCl even against resistant bacteria such as E. faecalis.

**Obturation: new delivery systems and importance of coronal restoration.**

Researchers have attributed failure of root canal therapy largely to incomplete obturation of the root canal system. After proper cleaning, shaping and disinfection of the root canal system, proper filling of the canal is necessary to prevent reinfection. There are two basic methods of root canal obturation, with a number of permutations to these techniques. The lateral condensation technique requires lateral compaction of cold gutta-percha points to fill the space. Warm gutta-percha techniques, also called “vertical compaction techniques,” use warm gutta-percha that is made plastic and compacted apically. Both techniques require addition of a cementlike sealer that adheres to the dentin walls and fills any space not obliterated by the gutta-percha. Properly prepared canals—cleaned, disinfected and tapered in shape—also should be cleared of the smear layer. This can be achieved by using a combination of ethylene diamine tetra-acetic acid and NaOCl or MTAD.

Variations of the techniques described previously use newer devices, which are equipped with a heated spreader/plugger that warms the gutta-percha and acts as a plugger to compact the plasticized mass. Use of solid-core carriers such as Thermafil (Dentsply Tulsa Dental, Tulsa, Okla.) is another accepted method of obturating root canals. By this method, a central carrier coated with alpha-phase gutta-percha is warmed and plasticized in a special oven and inserted to the appropriate depth in the prepared canal.

An apical third obturator acts as a terminal plug at the apical portal of exit. The plug can be made up of dentin chips formed from the cleaned, shaped and disinfected canal walls. Not only does the plug prevent overfilling, but also dentin chips can stimulate the formation of a cementumlike cap over the apex. Calcium hydroxide and mineral trioxide aggregate (MTA) also can be packed as an apical plug. The remainder of the canal space can be filled using sealer and a gutta-percha gun such as Obtura II (Obtura Spartan, Fenton, Mo.).

The lack of a coronal seal is an important factor in the development of periradicular lesions following root canal therapy. Therefore, it is important to prevent coronal leakage after completion of root canal therapy. A number of studies have investigated the loss of the provisional restoration to determine how long it takes for coronal leakage to adversely affect the root canal seal. In one study, leakage occurred in as little as three days’ time. By day 19 in another study, more than 50 percent of the root canals were completely contaminated, and by day 30 in a third study, all canals without a coronal seal were contaminated. While the presence of a temporary restoration may retard this process, this protection is short-lasting and a substantial change occurs between 28 and 90 days after placement of a temporary restoration. The loss of a provisional coronal access restoration most likely results in a compromised root canal seal sometime during the first month of exposure to oral contaminants.

**Adjuncts. Operating microscopes.** Perhaps no area of endodontic practice has met with more
excitement and controversy in the past decade than the introduction of the operating microscope (OM) to clinical practice. In less than 10 years, the OM has progressed from a novelty item to a required training standard for specialty education in endodontics.

The OM is used most commonly to assist in retrieving separated instruments, locating and negotiating calcified canals, and providing surgical root canal treatment. Proponents of OMs feel strongly that they allow for more efficient and safe treatment of teeth that otherwise might be untreatable or treatable only with great difficulty. There is some evidence that the use of OMs in combination with operator skill, prudent case selection, and other current technology and materials may lead to improved surgical treatment outcomes and the location of additional canals. Endoscopes, orascopes and magnifying loupes with or without a supplemental light source also can be employed to enhance visualization of the operative field.

**Ultrasonic devices.** Ultrasonic devices have become essential tools for assisting in the removal of posts and separated instruments, as well as root-end preparation during surgical treatment of root canals. Since heat is a byproduct of the energy generated by ultrasonic instruments, it is important to use a water coolant spray and to operate at the lowest setting possible consistent with the task (root-end preparation, for example, is a delicate procedure and requires a lower setting than do post removal applications). Many specially designed ultrasonic tips are available and suitable for specific situations such as preparing root ends, removing posts, removing instrument fragments and searching for calcified canals. Ultrasonic tips specially designed for root-end preparation allow for conservative and precise preparation of the root end during apical surgery.

**Electronic apex locators.** The task of determining canal length has moved into a new and more precise era with the rapid evolution of electronic devices that measure the length of the root canal. The first- and second-generation apex locators were more difficult to use and more prone to erroneous readings than are the third-generation devices now available.

Research and clinical experience support the claim that apex locators can assist accurately in determining canal length in the majority of cases. Apex locators also can be used to detect perforations and root fractures. The use of electronic apex locators is contraindicated in patients with cardiac pacemakers, although the actual risk to these patients is uncertain.

**Lasers.** Lasers have various applications in endodontics such as measuring pulp vitality, treating dentinal hypersensitivity, preparing and disinfecting root canals, and performing apical surgery. Reports about these applications are conflicting, owing to the use of different types of lasers, energy levels and specimens used. LDF has the most promising application in endodontics. LDF was developed to assess blood flow in microvascular systems. The reliability of conventional pulp tests can vary in newly erupted and traumatized teeth, owing to incomplete formation or trauma to the neural pulpal component, respectively. LDF techniques are sensitive and accurate for pulp vitality testing because they reflect vascular rather than nervous responsiveness when compared with other methods. LDF is a useful research instrument, but a practical clinical device still is lacking.

The neodymium:yttrium-aluminum-garnet (Nd:YAG) laser is the most popular system for cleaning and shaping the root canal system, because the device offers a thin fiber-optic delivery system for entering narrow root canals. Lasers can remove the smear layer and debris; however, it is difficult to clean all root canal walls with these devices, because the linear emission of the laser beam makes it almost impossible to irradiate the lateral canal walls and leaves them rough and uneven. Root canal spaces rarely are straight; more often, they are curved in at least two dimensions. For lasers to be useful in endodontics, it is necessary to improve the fiber tip and the method so that the laser irradiates all areas of root canal walls. Several studies have evaluated the sterilization of root canal systems by means of CO₂ and Nd:YAG lasers. Although lasers used at high power have a bactericidal effect, that effect is dependent on each laser. Furthermore, using lasers to disinfect root canals is problematic, since it can inflict thermal injury on periodontal tissues.

Despite lasers’ approval for dental procedures by the U.S. Food and Drug Administration, more research is required to develop lasers for use in endodontics and to compare their efficacy with that of present treatment modalities.
SPECIAL CASES

Nonsurgical retreatment (indications versus surgery). Despite the availability of advanced technological tools and better understanding of the biology of pulp and periradicular diseases, clinicians often need to address posttreatment endodontic disease. Before commencing with any treatment, clinicians must consider all interdisciplinary treatment options in terms of time, expense, prognosis and patient satisfaction. If the choice is endodontics, then the goal of nonsurgical retreatment is to remove materials from the root canal space and to address any deficiencies or repair defects that are pathological or iatrogenic in origin. Many significant advantages result when endodontically failing teeth are re-entered nonsurgically. Endodontic access provides the opportunity to evaluate teeth for coronal leakage, fractures and missed canals—and importantly, after disassembly procedures, these root canal systems can be three-dimensionally cleaned, shaped and obturated (Figure 1). Advancements in the field of nonsurgical endodontic retreatment are related directly to the introduction of the dental OM, ultrasonic technology and related instruments, NiTi rotary shaping files and MTA. Nonsurgical retreatment of failed cases has a similar success rate to that of initial conventional treatment if the cause of failure is identified and corrected.

Perforation repairs. Historically, the occurrence of perforations during root canal treatment has reduced the long-term prognosis of the affected tooth significantly. The poor prognosis of perforations is mostly due to bacterial leakage or the lack of biocompatibility of the repair materials used. The important steps in the management of a furcal perforation are immediate treatment, adequate isolation, débridement and sealing of the defect. Discovery of new materials such as MTA has significantly improved the prognosis for what once were considered hopeless teeth.

Trauma and management of open apexes. Traumatic injuries in young patients present a special challenge during endodontic treatment in terms of diagnosis and treatment planning, as well as of managing the open apex. Whenever possible, the goal should be preservation of pulp vitality to allow continued development along the entire root length. MTA has the most desirable properties for this purpose because it provides a good seal, is biocompatible and induces hard-tissue formation. If the pulp is necrotic, the treatment of choice is root canal therapy. However, in an immature tooth, completion of root canal therapy must be delayed until root-end closure has been completed. Long-term calcium hydroxide therapy no longer is the treatment of choice because of the variability of its treatment outcomes and its adverse effects on dentin. Researchers have advocated placement of an artificial barrier as an alternative to long-term apexification procedures. More recently, MTA has been shown to induce hard-tissue formation more predictably than calcium hydroxide (Figure 2), while bioactive materials such as bone morphogenetic proteins have demonstrated no added advantage over calcium hydroxide.

Evaluation of healing of intra-alveolar root fractures in patients between the ages of seven and 17 years suggests that 77 percent of these cases heal by means of development of a hard-tissue fragment, development of periodontal ligament or a combination of the two. Pulp vitality, degree of tooth development, presence or absence of response of the pulp to stimuli, type of injury, amount of diastasis between the fragments and efforts to reposition the displaced fragments have an influence on healing. However, the efficacy of long-term splinting is questionable.

To prioritize treatment of traumatic injuries, treatment delivery has been divided into three groups: acute (treatment rendered within a few
hours), subacute (treatment rendered within the first 24 hours) and delayed (treatment rendered after the first 24 hours). A survey of the available literature suggests the following recommendations:

- crown and crown/root fractures—subacute or delayed treatment;
- root fractures—acute or subacute treatment;
- concussion and subluxation—subacute treatment;
- extrusion and lateral luxation—acute or subacute treatment;
- intrusion—subacute treatment;
- avulsion—acute treatment if the tooth is not replanted at the time of injury, subacute treatment otherwise;
- primary tooth injury—subacute treatment, unless the primary tooth is displaced into the follicle of the permanent tooth or occlusal problems are present, in which cases acute treatment is necessary.

**Surgical root canal therapy.** Endodontic surgery is not oral surgery in the traditional sense. Rather, it actually is endodontic therapy performed through a surgical flap. The main purpose of performing periradicular surgery is to remove a portion of a root with undederived canal space or to seal the canal when a complete seal cannot be accomplished through a coronal approach. With recent improvements in surgical instruments, materials and techniques, endodontic surgery can provide a second chance to retain a tooth that otherwise would be extracted. Endodontic surgery may be necessary to address anatomical complexities and procedural complications associated with difficult nonsurgical cases.110-113 The OM is the latest addition to this armamentarium, providing up to ×32 magnification of the surgical field.114,115 The quantity and quality of light in the working field is as important as magnification. The coaxial lighting and improved optics of an OM provide better distinction between tooth and bone. Identifying minute canal openings, incipient fracture lines and other important anatomical findings becomes routine with the OM. For example, an isthmus frequently runs between two canals in the mesiobuccal root of the maxillary first molar.116,117 These small communications contain pulp tissue remnants and should be included in root-end cavity preparations and fillings during endodontic surgery.118 The magnification and illumination afforded by the OM facilitates identification of these ramifications, allowing them to be prepared and filled with the main canals (Figure 3).

Enhanced magnification necessitates miniaturization of endodontic surgical instruments. Microscalpels, piezoelectric ultrasonic handpieces, surgical micromirrors and microsurgical irrigators, together with miniature carriers, condensers and pluggers, have been developed to accommodate the high level of magnification used routinely in endodontic surgical procedures.

The miniaturized instruments allow more precise performance of surgical procedures. For instance, the root-end preparation is aligned parallel to the long axis of the root using specially designed ultrasonic tips to a depth of 3 mm.119 A variety of root-end filling materials can be used, which include Super EBA (Harry J. Bosworth, Skokie, Ill.), intermediate restorative material, dentin bonding agents and, most recently, MTA.118,120,121 The materials should be biocompat-
MTA provides a superior apical seal compared with other root-end filling materials and is not adversely affected by blood contamination. In several studies, histologic sections demonstrate the regeneration of new cementum over the MTA root-end filling (Figure 4), a phenomenon that is not seen with other commonly used root-end filling materials.

Clinical controversy: the smear layer. Studies have shown that current methods of cleaning and shaping root canals produce a smear layer that covers the instrumented walls. The smear layer contains inorganic and organic substances that include fragments of odontoblastic processes, microorganisms and necrotic materials.

Proponents of smear layer removal claim that the presence of a smear layer can inhibit or significantly delay penetration of antimicrobial agents such as intracanal irrigants and medications into the dentinal tubules. Furthermore, removal of the smear layer may significantly improve adhesion of obturation materials to the canal walls and reduce microleakage.

While some investigators have reported that the removal of the smear layer does not have any significant effect on microleakage of root canals, the opponents of smear layer removal have shown an increased level of leakage through the obturated root canals with a 10- to 80-micrometer depth of penetration.

Despite controversy regarding the effect of the smear layer on the quality of instrumentation and obturation, it should be noted that the smear layer itself may be infected and may protect the bacteria already present in the dentinal tubules. Because of these concerns, it may be prudent to remove the initially created smear layer from infected root canals and allow penetration of intracanal medications into the dentinal tubules of these teeth. After disinfection of the root canal system, the smear layer can be recreated. Chemical, mechanical and laser means can be used to remove the smear layer.

Management of pain, infection and anxiety. Considerable advances have occurred in the management of pain, infection and anxiety in the endodontic patient.

Pain. Survey studies indicate that only about 40 percent of patients report pain after nonsurgical root canal therapy, with about 20 to 25 percent reporting moderate-to-severe pain. Thus, the clinician should tailor pain management strategies to each patient. A survey of endodontic clinical trials indicated that the presence of preoperative pain or a positive response to percussion is a consistent predictor of patients most likely to report postendodontic pain. A systematic review of nonsteroidal anti-inflammatory drugs used to treat pain in endodontic patients reported good analgesic responses in patients treated with either 100 milligrams of flurbiprofen or the combination of flurbiprofen with 100 mg of tramadol.

In the classic case of the difficult-to-anesthetize mandibular molar, several studies have demon-
strated that intraosseous anesthetics are effective for enhancing the incomplete anesthesia that occurs after inferior alveolar nerve block injection.152,153

Infection. Considerable progress has been made with respect to the use of antibiotics in endodontic patients. Susceptibility testing studies have indicated that 80 to 95 percent of cultivable endodontic microorganisms remain sensitive to penicillin, supporting the selection of penicillin as an antibiotic of first choice when indicated.154,155 Clindamycin is a good alternative for patients who are unable to take penicillin, since approximately 87 to 100 percent of cultivable endodontic microorganisms are sensitive to this antibiotic.154,156 Although antibiotics are effective for treating endodontic infections, they appear to have little effect on reducing pain.156 In addition, antibiotics have no effect when prescribed to treat pain due to irreversible pulpitis.157

Anxiety. Researchers have evaluated several approaches for treating anxiety associated with endodontic care. In general, both behavioral and pharmacological methods have proven to be effective. Oral triazolam (0.25 mg) may be superior to oral diazepam (5 mg) for reducing anxiety associated with endodontic treatment.158

CONCLUSIONS AND FUTURE DIRECTIONS

The art and science of endodontics have undergone significant advances in the past decade. These changes have resulted in improved treatment outcomes and an opportunity to preserve the natural dentition. These objectives can be achieved with less morbidity and more predictability. The specialty of endodontics is dedicated to the preservation of healthy natural dentition. Compilation of more current clinical data that are based on procedures performed with more advanced techniques will provide a more accurate rate of healing after nonsurgical and surgical endodontic therapy. The future holds the promise of continued growth of the body of research knowledge, and systematic reviews will provide the most valuable thread of evidence connecting the patient, the clinician, the educator, the researcher, the policy-maker, the editor, the benefit purchaser and the benefit provider in the decision-making process.

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