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Modern endodontic practice: instruments and techniques

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The specialty of endodontics has evolved and changed over the years like many other dental and medical specialties. The changes that have occurred in the last 10 years, however, have been of great magnitude and profundity. The microscope, ultrasonic units with specially configured tips, superbly accurate microchip computerized apex locators, flexible nickel-titanium files in rotary engines, and greater emphasis on microscopic endodontic surgery have totally changed the way endodontics and endodontic surgery are practiced. Comparing these changes with formocreosol medication, K-file and radiographic determination of working length are truly dramatic. These changes are bringing the specialty of endodontic practice into the twenty-first century with greater precision, fewer procedural errors, less discomfort to the patient, and faster case completions.

Seven key advancements in endodontics were made in the last decade. In-depth discussion of each of these advancements is found in articles elsewhere in this issue. In this article, the advancements and their applicability to everyday practice are discussed (Fig. 1).

The microscope

The previous issue of the *Dental Clinics of North America* was devoted to the use and advantages of the microscope. Briefly, the microscope provides great magnification and illumination and functions as an extension of loupes (Fig. 2). The proper use of the microscope in endodontic therapy provides an advantage over any other tools. The question of why we need loupes or microscopes can be answered quite simply: loupes provide 2× to 4× magnification. Although small, this magnification has such an impact that

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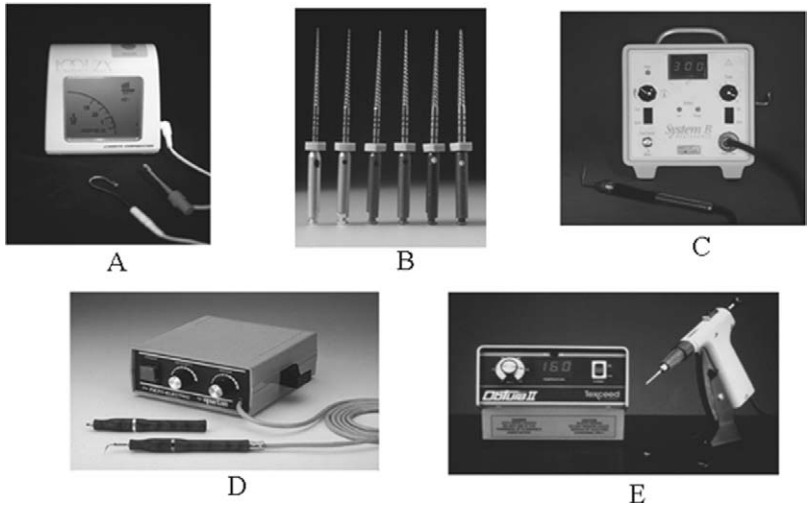

Fig. 1. Key instruments for the modern practice. (*A*) Electronic apex locator. (*B*) Nickel-titanium rotary ProFiles. (*C*) System B. (*D*) Spartan Piezo ultrasonic instrument. (*E*) Obtura II.

Fig. 2. The bright focused light and high magnification provided by the microscope results in endodontics of the highest, most accomplished level.

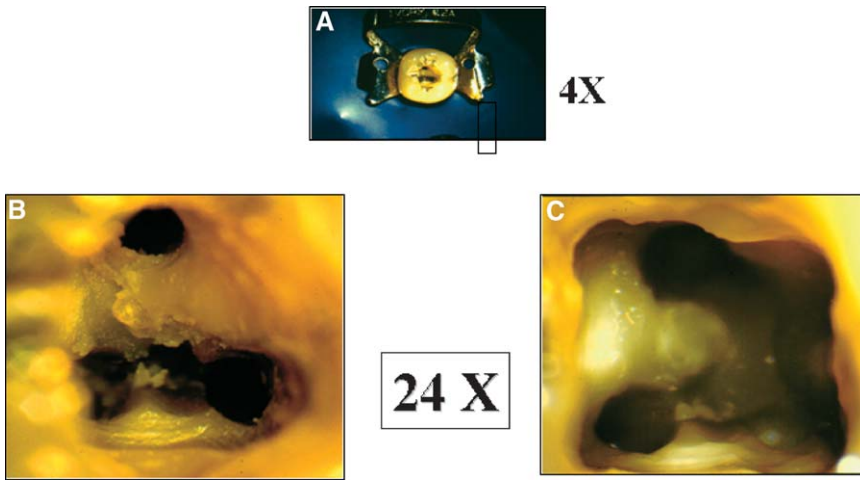

Fig. 3. A completely instrumented madibular first molar at 4× magnification (*A*). The same tooth at 24× magnification (*B*) that shows dentin covering the pulpal floor. After removal of the dentin, another canal is located and instrumented (*C*).

anyone who is used to loupes cannot practice without them. The microscope provides 4× to 25× magnification. The questions here are, Do we need magnification that great? and, in extension, What is the optimum magnification for endodontic procedures? In the author's opinion, the optimum magnification for endodontic practice ranges from 8× to 24× magnification (Fig. 3). The high magnification is needed to locate hidden canals, detect microfractures, distinguish between the chamber floor and dentin, and identify isthmuses and other small anatomic entities, of which recognition and treatment are so important for endodontic therapy success.

In conventional endodontics, the microscope is most useful for locating canals after the access is made. It is extremely useful for post removal using ultrasonic instruments and for perforation repair. These are procedures that previously were done largely by "feel." The advent of the microscope in modern endodontic therapy facilitates a primarily visually guided, secondarily sensory-aided endodontic procedure (Fig. 4).

Ultrasonic instruments

There are two types of ultrasonic tips on the market: surgical and nonsurgical.

Surgical tips are for root canal retropreparation, and there are many types available (see the Obtura/Spartan Company Web site, Fenton, Misssouri). Nonsurgical tips come in two categories. First, the Buc tip is used for conventional cases such as cleaning the chamber so that endodontists can visualize the chamber without dentin debris (see the article by Kim elsewhere

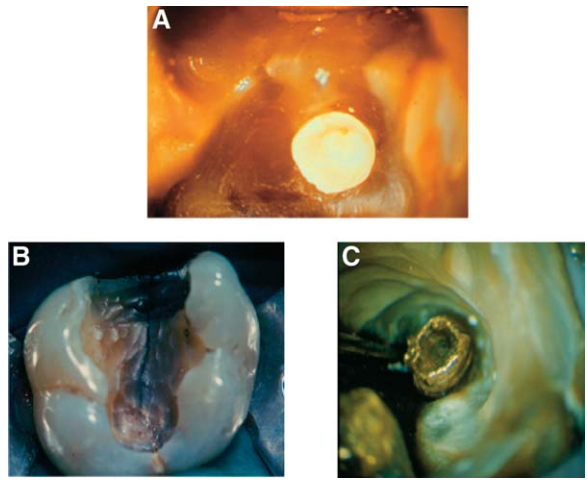

Fig. 4. The microscope is best used for repair of perforation (*A*), identification or detection of microfractures (*B*), and removal of posts and/or separated files (*C*).

in this issue, [Fig. 8]). The sharp-ended tips allow clinicians to pick and explore the chamber floor to identify canals. This ultrasonic instrument is a lifesaver when calcified canals are encountered. High- or low-speed burs are much too large to "catch" the minute, sometimes microscopic, openings to calcified canals. A second type of nonsurgical ultrasonic tip is the CPR tip. These tips are used mainly for post removal. Although posts can be removed with burs, even the smallest burs unnecessarily remove large amounts of dentin compared with CPR tips. Over 90% of the post can be removed by CPR tips driven by a Piezo ultrasonic instrument, with much less gouging or damaging the dentin structure around the post than with burs.

Cleaning the pulp chamber is also an important prerequisite for inspection of the chamber for anatomic details. This cleaning can be done best with a diamond-coated small microburner tip (eg, Buc tip size 2). Microscopic observation is not effective when the chamber floor is full of dentin debris that is created by burs.

Electronic apex locator

If asked what the most important advancement in endodontics in the recent decade is, the author's unequivocal answer would be the electronic apex locator (see Fig. 1A). After the microscope, the electronic apex locator has become the most important and essential instrument in endodontic practice. Advancements in microchip technology led to the design of a better apex locator, making the radiographic determination of root canal length nearly obsolete. The correct use of the locator always identifies the root end

correctly. This precision is needed to minimize intervisit flare-ups, overfillings, and underfillings. In the author's department, postgraduate students rely more on their apex locators than on radiographs. This practice has contributed greatly to pain-free treatments without flare-ups and with long-term healing success—almost impossible 10 years ago.

System B or "Touch'n Heat"

In the "old" days—only 10 years ago—a torch or open flame was used to sear or melt the gutta percha. This technique is now called "Flintstone-age endodontics." The System B and "Touch'n Heat" (SybronEndo, Orange, California) allow a safer means to heat the gutta percha (see Fig. 1C). Specially designed tips of varying sizes are connected to the System B and are heated instantly to the desired temperature by touching a sensor on the handle. A tip is inserted into the obturated canal, the sensor to heat the tip is activated, and the gutta percha is thermoplastesized. This thermoplastesized gutta percha is then condensed (eg, with S-Kondensers) to obturate the canal. It has been shown that the resulting temperature elevations within the canal do not damage the periodontal ligament. The obturation technique using System B is gaining popularity among endodontists and is gradually replacing the old technique.

Obtura compactor

The Obtura compactor is another innovation in modern endodontic practice that has become a "must have." Thermoplastesized gutta percha was used in endodontics before the invention of this compactor; however, the procedure was done in the canal using hot instruments. With the advent of this instrument, gutta percha is thermoplastesized in a specially designed gun that is connected to an electronically controlled unit (see Fig. 1E). Varying tip sizes determine the depth of penetration (ie, the thinner the tip, the deeper the penetration). In this manner, the canal is more homogeneously and densely filled. The use of the compactor is especially useful when dealing with internally resorbed canals that cannot properly be filled, even with the lateral condensation technique.

Nickel–titanium files

The nickel–titanium (NiTi) revolution took place in the mid-1990s. Now there are numerous NiTi rotary file systems available (see Fig. 1B). At the time of this writing, there are over 20 different types of NiTi rotary file systems available, with new ones being introduced every year. This development is similar to the titanium implant development some years ago. In 1980, there was only one system; now there are so many. One salient

question is, Will NiTi file systems replace the stainless steel K-file system? The answer is definitely not. The NiTi file systems are very convenient for "milling" the canal but not for cutting the canal dentin. Cutting the dentin is usually done with Gates–Glidden burs or K files in combination with NiTi rotary files. By using these instruments, the canals can be prepared more easily and uniformly. Some clinicians avoid the NiTi rotary systems due to breakage of the file tip inside of the canal. This breakage can be minimized greatly by light-handed and careful use. The author considers the NiTi file system not a must-have instrument, but rather a convenient instrument.

There are basically two types of NiTi systems: the LightSpeed (LightSpeed, San Antonio, Texas) and the non-LightSpeed types. The LightSpeed type is a miniaturization of the Gates–Glidden bur, with a 0.02-type handle with varying file tip diameters. The non-LightSpeed types include active systems with a positive rake angle that cut the dentin, and others that are passive with a negative rake angle that mill the dentin. For instance, the most popular type is the ProFile (Dentsply, Tulsa, Oklahoma) with a negative rake angle. Each of these systems offers files ranging from 0.02 to 0.12 taper with smaller tip diameters.

Although there are many pitfalls on the road to consistent results, with proper use of the NiTi systems, endodontists will be able to improve the quality and esthetics of their endodontic obturations quickly.

Mineral trioxide aggregate

Mineral trioxide aggregate (MTA) is a reliable new endodontic material initially designed as a retrofilling material. More recently, it also has been advocated for pulp capping, perforation repair, and even as an endodontic filling material for apexification. MTA is a mixture of many oxides and looks like grayish-brown sand. In fact, it handles like sand and some clinicians have compared it to Portland Cement. In a moist environment, it sets in about 7 hours. In conventional endodontics, it has proved to be the best material for most types of perforation. Its unique physical property is its compatibility with bone. It has been shown in numerous studies and in clinical practice that it is the only material into which bone and cementum cells actually grow, thereby creating a perfect seal and an ideal barrier. This is a material that has long been on the endodontic wish list because perforations during endodontic procedures or during post preparation are not that uncommon.

Anatomy of modern endodontic practice

Excellent and consistent endodontic outcomes are still very difficult to obtain. With the incorporation of the new generation instruments, along with a thorough knowledge of the root canal anatomy and endodontic practice, however, far better and more consistent results can be obtained

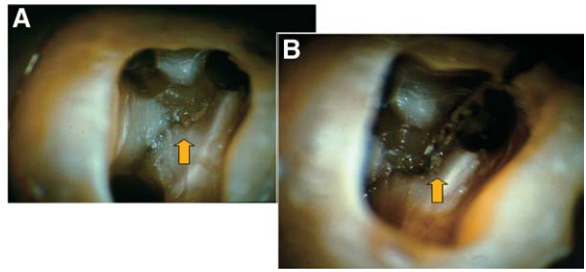

Fig. 5. At high magnification, a fourth canal (MB2) of a maxillary first molar can easily be detected (*A*) and is shown with a size 10 file in the canal entrance (*B*). (Courtesy of F. Maggiore, DDS, Rome, Italy.)

than in the past. To illustrate the modern endodontic procedural sequence of a normal case of a maxillary first molar, an itemized sequence follows:

1. The diagnosis indicates that endodontic treatment is needed and the tooth is anesthetized.
2. Following placement of the rubber dam, access is made. The microscope is not needed for this step, although some clinicians may prefer to use it.
3. Using the microscope at low to mid magnification, the pulp chamber is thoroughly prepared using a Buc tip size 2 for inspection.
4. Under high magnification (16–24×), the floor of the chamber is examined for additional canals because more than 50% of molar teeth have a fourth canal (Fig. 5).
5. After the canal entrance is identified, the microscope is not needed until a later stage. The apex is negotiated with a size 10 K file and is then enlarged with size 15 or 20 files.
6. Gates–Glidden burs are used in reverse order to enlarge the coronal one half or two thirds using the crown down technique. During this enlargement, it is important to use irrigants (2.5%–5% sodium hypochlorite and 17% EDTA solution) to penetrate deep into the canals.
7. An apex locator is used to determine the canal length at this stage. In this manner, a more accurate canal length measurement is possible because coronal interference has been eliminated.
8. NiTi rotary instruments are now employed to prepare the remaining one half or one third of the apical canal in the crown down manner. The final apical preparation or determination of the master apical file is done by hand instruments or LightSpeed, depending on the original canal width or estimate of working width.
9. The microscope is used to check the preparation and to check again for an additional canal or canals (the author has found up to six canals in molars)(Fig. 6).
10. A master gutta percha cone is selected; the canal length and solid ''tug back'' is assured.

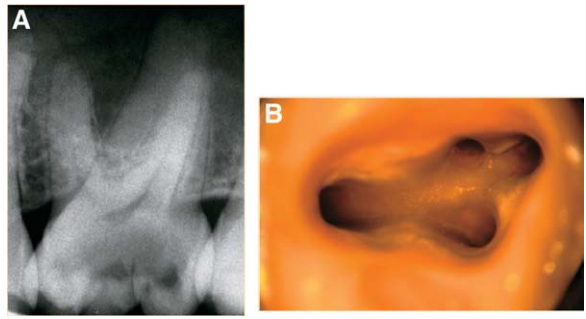

Fig. 6. Radiograph of the maxillary first molar prior to endodontic therapy (*A*) and microscopic examination of the prepared four canals at 24× magnification of the same tooth (*B*).

11. This master cone, coated with root canal cement, is inserted into the canal, and the coronal part of the point is seared off using System B. The gutta percha in the apical 3 to 4 mm is packed with S-Kondensers.
12. The Obtura gutta percha compactor with an appropriate tip is inserted into the canal up to where the master gutta percha was seared off. The thermoplastesized gutta percha fills the canal as the tip is slowly withdrawn.
13. The microsocpe is used again for a final check. Finally, the canal is sealed with temporary cement.

This brief sequence shows the use of modern endodontic instruments. The purpose of incorporating these advanced instruments is to perform endodontic procedures more accurately, thus experiencing less postoperative discomfort, fewer procedural errors, and a more efficient procedure. Although the ultimate criteria (ie, whether the incorporation of these

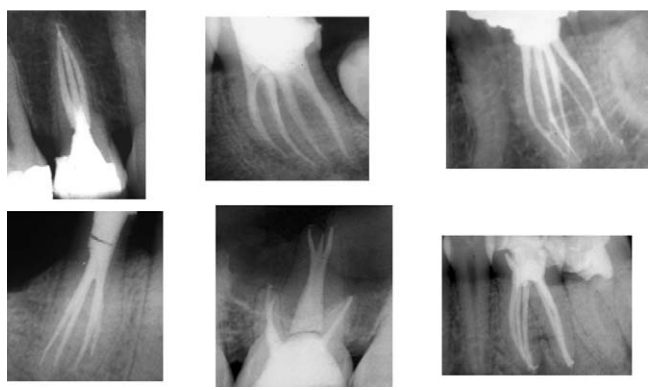

Fig. 7. Multicanal cases done by endodontic graduate students at the University of Pennsylvania using the modern instruments and techniques described in this article.

instruments provides greater treatment results and success) has still not been established in a formal study, the author's clinical experience of the last 10 years has shown that the procedures are more predictable, efficient, and reliable, and result in fewer flare-ups and less discomfort for patients. In addition, the radiographic results are far better, with a significant increase of over 40% in locating fourth canals in molars (Fig. 7). These improvements are truly significant.