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The microscope and endodontics

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It may seem surprising that the microscope is not a high-tech instrument. It has been used in the medical field for over 50 years. According to the Zeiss Company, the microscope was first introduced to otolaryngology around 1950, then to neurosurgery in the 1960s, and to endodontics in the early 1990s. Dentistry, therefore, is about 40 years behind medicine in this respect. As in medicine, the incorporation of the microscope in clinical endodontics has had profound effects on the way endodontics is done and has changed the field fundamentally. For this reason, the 1998 American Dental Association accreditation requirement change states that all accredited United States postgraduate programs must teach the use of the microscope in nonsurgical and surgical endodontics. This was a giant step forward in the advancement of endodontics.

This article outlines the key prerequisites for the use of the microscope in nonsurgical endodontic procedures. There are many microscopes on the market; the three most popular ones are presented in Fig. 1.

Prerequisites for the use of the microscope in nonsurgical endodontics

Rubber dam placement

The placement of a rubber dam prior to any endodontic procedure is an absolute requirement for sterility purposes. This technique is taught at all dental schools. In endodontics, however, the purpose is greater. Here, the rubber dam placement is necessary because direct viewing through the canal with the microscope is difficult, if not impossible. A mirror is needed to reflect the canal view that is illuminated by the focused light and magnified by the lens of the microscope. If the mirror were used for this purpose without a rubber

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Fig. 1. The three most popular microscopes in endodontics.

dam, then the mirror would fog immediately from the exhalation of the patient. Thus, the powerful microscope magnification and illumination would be rendered totally useless for the necessary visualization of the chamber floor and the canal anatomy. To absorb reflected bright light and to accentuate the tooth structure, it is recommended to use blue or green rubber dams (Fig. 2).

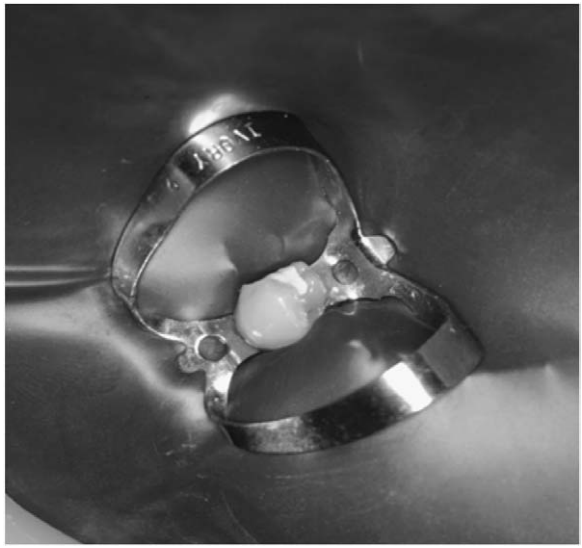

Fig. 2. The use of a rubber dam is essential for effective microscope use.

Indirect view and patient head position

As mentioned previously, it is nearly impossible to view the pulp chamber directly under the microscope. Instead, the view seen through the microscope lens is a view reflected by way of a mirror. To maximize the access and quality of the view by this indirect means, the position of the patient (especially the head position) is important (Fig. 3). The optimum angle between the microscope and the mirror is 45°, and the clinician should be able to obtain this angle without requiring the patient to assume an uncomfortable position. The maxillary arch is rather easy for indirect viewing. Basically, the patient's head is adjusted to create a 90° angle between the maxillary arch and the binocular (Fig. 4). In this position, the mirror placement will be close to 45° for best viewing.

Mouth mirror placement

It is always a good idea to use the best mirror for this purpose. If a rubber dam has been placed, then the mirror must be placed away from the tooth within the confines of the rubber dam. If the mirror is placed close to the tooth, then it will be difficult to use other endodontic instruments. Readjusting the mirror will necessitate refocusing of the microscope, making the entire operation time-consuming and, at times, frustrating. This is especially true during a lengthy perforation repair. With practice, however, the "correct" placement of the mirror will become automatic.

Some key instruments

The ability to locate hidden canals is the most important and significant benefit gained from using the microscope. To do this effectively and efficiently, clinicians must use specially designed microinstruments. An explorer can pick the entrance of a canal under the microscope, but negotiating the canal with

Fig. 3. Patients should wear protective dark glasses and have support for the neck, such as a moldable pillow.

Fig. 4. Positioning the microscope. Notice the ergonomics of the clinician and comfortable patient position.

a file can be challenging because there is only a tiny space between the mirror and the tooth for a finger with a file to move around. Files specially designed by Maileffer, called microopeners, have with different sized tips and can be extremely useful (Fig. 5). These hand-held files allow the clinician to initially negotiate the canal, verifying that the ''catch'' is truly a canal. After the canal is located in this manner, clinicians can instrument the canal normally without the microscope. The use of Gates–Glidden burs to enlarge the canal entrance prior to full instrumentation, however, can be easily achieved under the microscope, facilitating the subsequent steps of canal instrumentation.

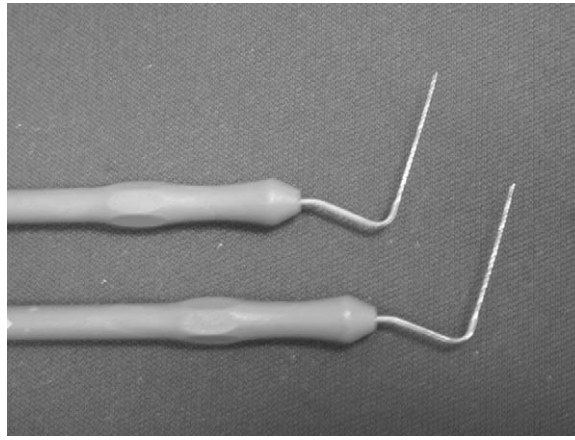

Fig. 5. Micro-openers by Maillefer are ideal instruments for exploration of hidden canals at high magnification.

For what procedures is the microscope really essential?

Some enthusiasts claim that the microscope must be used for all steps of nonsurgical endodontic procedures. This may a noble idea, but in reality, it is not needed or desired. A clinician must consider the benefit/risk ratio when using the microscope. The following procedures are those that benefit from the use of the microscope.

Diagnosis

The microscope is an excellent instrument to detect microfractures that cannot be seen by the naked eye or by loupes. Under 16× to 24× magnification and focused light, any microfracture can be easily detected (Fig. 6). Methylene blue staining of the microfracture area assists this effort greatly.

A persistently painful tooth after endodontic therapy may be due to an untreated missing canal (eg, MB2 in a maxillary molar). Re-examination of the chamber at high magnification under the microscope may locate the missing canal (see the article by Kim elsewhere in this issue [Fig. 5]). It has been the author's experience at the University of Pennsylvania Graduate Endodontic Clinic that the main cause of a symptomatic tooth following radiographically satisfactory endodontic therapy is an untreated canal.

Locating hidden canals

As discussed in many sections in this issue, the most important utility of the microscope in nonsurgical endodontics is locating hidden canals. The canal anatomy is extremely complex. All endodontic textbooks have information on molar teeth with three canals, premolars with two canals, and anterior teeth with one canal. Often, dental anatomy is not that predictable. Following the introduction of the microscope to the Graduate Endodontic Program at the University of Pennsylvania in 1992, it has been

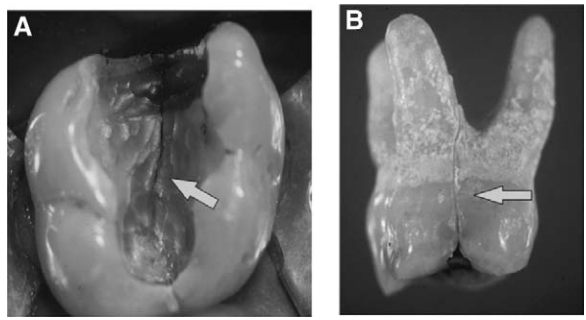

Fig. 6. Microfracture detected under the microscope (*A*) and the same tooth after extraction (*B*). Arrows identify the fracture line.

found that nearly an astounding 50% of all molars (maxillary and mandibular) have a fourth canal, more than 30% of all premolars have a third canal, and close to 25% of all anterior teeth have two canals. What was considered a rare exception in the past has become a routine finding when using the microscope. Considering this as the benefit of using the microscope for endodontic procedures is obvious.

There are teeth where the canal bifurcates at 3 to 5 mm into the canal and in the maxillary second molar, where the MB and DB are in very close proximity of each other; the microscope is an invaluable tool in clearly detecting the bifurcation and the two separate canals.

Management of calcified canals

With normal vision or low-power loupes, calcified canal in the pulp chamber is not detectable. When the calcified canal is looked at through the microscope at high magnification, however, the difference in the color and texture between the calcified canal and the remaining dentin can be easily seen. Careful probing and ultrasonication using CPR or Buc tips (Obtura/Spartan, Fenton, Missouri) will allow clinicians to detect and negotiate the calcified canal easily (Fig. 7). Sometimes in these cases, the ultrasonic preparation of the canal or canals has to go as far as a couple of millimeters short of the apex. Again, the microscope allows the clinician to detect and prepare conservatively, and not to gouge the healthy dentin structures (Fig. 8).

Perforation repair

Perforation does occasionally occur no matter how carefully the tooth is accessed for endodontic therapy. When a perforation occurs, the microscope is the key instrument to identify and evaluate the damaged site. The results of a careful inspection will be the basis for which the preparation of the

Fig. 7. Buc tips (Obtura/Spartan) are ideal ultrasonic instruments for cleaning the pulp chamber and floor for clear viewing of the canals.

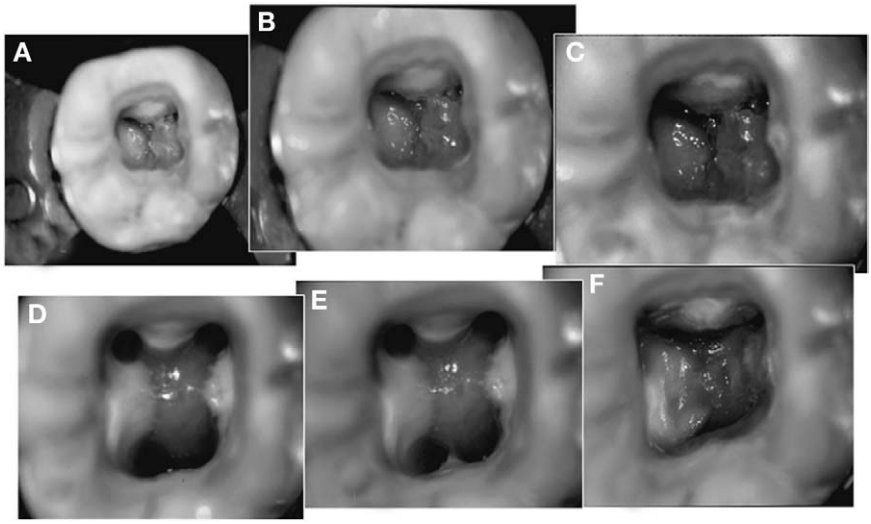

Fig. 8. Access preparation and management of calcified canals at a high magnification under the microscope (*A–F*). (Courtesy of F. Maggiore, DDS, Rome, Italy)

perforation repair will be made (see the article by Kratchman elsewhere in this issue). Briefly, the microscopic procedure is to place a matrix precisely, just outside of the perforation site (ie, just exterior of the root substance). The matrix can be calcium sulfate or resorbable collagen. After the matrix is placed, mineral trioxide aggregate is packed against the matrix. This procedure requires delicate and careful handling of the materials so as not to extrude, overfill, or underfill. The microscope is essential for this procedure.

Retrieval of broken files

With the more frequent use of nickel-titanium rotary files in general dentistry, the incidence of file separation within the canals has increased. When the file is broken at the apex, the microscope cannot be of help. If the file breaks within the coronal half of the canal, however, then the microscope is essential to guide the clinician to retrieve the broken files. In this manner, the broken file can be removed while minimizing the damage to the surrounding dentin.

Final examination of the canal preparation

It takes a simple step to see whether a canal is completely cleaned. Under the microscope, a small amount of sodium hypochlorite, a popular irrigation solution, is deposited into the canal and observed carefully at high magnification. If there are bubbles coming from the prepared canal, then there is still remnant pulp tissue in the canal. In short, the canal needs more cleaning.

Cost versus patient benefit

Many of the practitioners who perform endodontic procedures and do not yet own a dental microscope are still evaluating the benefits of its use. Practicality is the key concern. How does one recoup the cost of the capital expenditure and the cost and time associated with training? Are the clinical benefits worth the expenditure of time and money?

To address the critical cost and efficiency issue, clinicians should take an intensive training course at the very beginning to make them comfortable with handling the microscope and with working underneath it. Clinicians should also become totally committed to using the microscope in each of their treatment cases, not just selected ones. This practice is the fastest route toward proficiency and the best way to maximize the return on investment.

In addition to clinical benefits associated with the use of the microscope in endodontics, after the initial learning curve, endodontic procedures can be done in less time because of the greater visibility of the root canal anatomy. Procedural errors can be greatly reduced, if not eliminated, and complicated cases become less so under the microscope.

Another benefit of the microscope is the flexibility with documentation. Compared with intraoral video cameras, microdental images can be captured on computer or digital camera. The information can then be shared with referring dentists or patients and the images are, of course, also required information for the patient record.