Locating Canals
Strategies, Armamentarium, and Techniques

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About the Author

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During the past decades, many technologies have come to market to help dentists better perform each procedural step that comprises start-to-finish endodontics. Yet many of these technological advancements are irrelevant if a clinician cannot identify any given orifice, underlying canal, and its related root canal system. As such, there is great value in those technologies that promote diagnostics and vision, which serve to improve the probability of identifying mineralized or aberrant canals, or in the retreatment situation, a previously missed canal.

Predictable endodontic treatment begins with an effective access preparation that enables locating any given orifice, which in turn promotes negotiating, securing, and shaping the canal; 3-D disinfection; and filling this root canal system. Missed canals hold pulp tissue, and at times bacteria and related irritants, which oftentimes contribute to clinical symptoms and lesions of endodontic origin (Figure 1). This article will look at the anatomical considerations within the various tooth groups, then focus on strategies for locating canals.

ANATOMICAL CONSIDERATIONS

Teeth may be categorized as to whether they are maxillary versus mandibular, anterior versus posterior, or single- versus multirotted. Further, harbored within root structure is what Dr. Herbert Schilder referred to as the root canal system. The following is a review of root canal morphology within the various tooth groups.

Maxillary central and lateral incisors—On occasion, maxillary incisors may contain more than one canal. Further, these teeth can also radiographically display an anomaly, termed dens invaginatus or dens in dente, which is a tooth within a tooth (Figure 2).

Maxillary first and second bicuspids—Maxillary first bicuspids generally have separate buccal and lingual roots. However, the first bicuspid can, at times, radiographically exhibit mesiobuccal (MB), distobuccal (DB), and palatal roots (Figure 3). Maxillary second bicuspids generally have a single broad root, measured buccal to lingual. Although the orifice is commonly ribbon-shaped, clinicians must appreciate that broad canals oftentimes exhibit deep canal divisions.

Maxillary first and second molars—Maxillary first molars have at least 2 systems in the MB root more than 90% of the time.

Figure 1a. A preoperative radiograph of this second molar bridge abutment demonstrates 3 posts, previous endodontics, and apical pathology.

Figure 1b. The access preparation is shown following disassembly and 3-D cleaning, shaping, and obturation procedures. Note the displaced more mesiolingual-2 (ML2) orifice.

Figure 1c. A recall radiograph demonstrates the revisional endodontic treatment, the displaced ML2 system, and the new restorative effort.
According to the literature and clinical experience, the MB1 and MB2 systems can communicate via an isthmus, merge, or have their own individual apical portals of exit (Figure 4). Maxillary second molars should be suspected of having a second canal in the MB root until proven otherwise.

**Mandibular incisors**—The mandibular incisors have broad roots measured facial to lingual. These broad roots hold a second, more lingual canal approximately 45% of the time. Access cavities should be carried more lingual at the expense of the cingulum to locate and treat this potential system (Figure 5).

**Mandibular bicuspids**—This group of teeth typically exhibits one root that notoriously holds complex root canal systems. The anatomical variations include displaced orifices, deep divisions, loops, branches, and multiple apical portals of exit (Figure 6). Infrequently, but on occasion, extra roots are noted.

**Mandibular first and second molars**—These teeth routinely have significant anatomical variations. On occasion, the mesial root may hold a third system that may be located within the groove between the MB and mesiolingual (ML) orifices (Figure 7), or a third mesial root canal may be displaced (Figure 1). The typically broad distal root commonly contains a second canal that may be separate along its length or become contiguous following shaping procedures. Infrequently, but on occasion, a separate distolingual (DL) or DB root is detected radiographically, termed radix entomolaris or radix paramolaris, respectively.8

**C-shaped molars**—Dentists need to be familiar with this aberrant tooth form, typically found in mandibular second molars. C-shaped molars exhibit distinct features, and their incidence within population groups is well known (Figure 8). Radiographically, this tooth exhibits a fused root, a deep pulp chamber, and a cul-de-sac furcation that opens toward the lingual aspect. Clinically, the ML orifice is isolated; however, the MB orifice is connected to the distal orifice by a thin ribbon-shaped communication that ultimately extends along the pulpal floor from the MB to the DL aspect, making a C-shaped configuration.

**STRAATEGIES FOR LOCATING CANALS**

With a greater appreciation of the endodontic anatomy within the various tooth groups, let’s look at specific methods that may be utilized to identify more mineralized, aberrant, or previously missed canals. The following represents, in no particular order, the more important strategies for locating any given orifice, canal, and its related root canal system.

**Anatomical familiarity**—Any dentist can become a serious student of endodontic anatomy by visualizing the historic work of Walter Hess or visualizing state-of-the-art μCT images (ehuman.com). Knowledge and understanding of root canal system anatomy serve to influence and guide predictably successful endodontic treatment outcomes.
Radiographic diagnostics—Even the best angulated film is a 2-dimensional representation of a 3-dimensional object. As such, well-angulated periapical images should be taken in 3 different horizontal planes: straight-on, mesioblique, and distoblique. For example, another canal is suspected when a file or obturation material is radiographically positioned asymmetrically within the long axis of any given root. Importantly, CBCT imaging is a major advancement in radiographic diagnostics, revealing anatomy and promoting the conservation of tooth structure during the access preparation.

Vision—Magnification plus lighting equals vision. Traditionally, magnification glasses, headlamps, and transilluminating devices have been used to enhance vision. However, the dental operating microscope has become the benchmark for unsurpassed lighting and magnification, which in turn facilitates identifying orifices (Figure 9). Recently, Dr. Assad Mora, a Santa Barbara prosthodontist, developed a dual 3-D camera system called MoraVision. This system affords a remarkable depth of field where the clinician is able to see at 8x anterior and posterior teeth in focus simultaneously. The MoraVision technology allows the operator to sit relaxed, move comfortably, and view 3-D images in an interactive manner on a large 3-D monitor.

Surgical length burs—Surgical length burs move the visually obstructive head of the handpiece further away from the occlusal table. Long-length cutting instruments improve the line of sight along the shaft of the bur, promoting safety while encouraging the preservation of tooth structure when searching for canals.

Access cavities—The finished access cavity should, more or less, enable the operator to look in a mouth-mirror into a furcated tooth and visualize all of the orifices without moving the mirror. Importantly, axial walls should be flared, flattened, and finished to enhance vision, improve diagnostics, and provide straight-line access to the orifice(s) (Figures 1, 4, 7, and 10).

Piezoelectric ultrasonomics—The ultrasonic handpiece eliminates the bulky head of the conventional handpiece, which notoriously obstructs vision. The working ends of specific ultrasonic insert tips have abrasive surfaces to precisely sand away dentin and to chase and uncover hidden orifices (Figure 11). In combination, the microscope and ultrasonic insert tips have led to microsonic refinements in instrumentation.

Micro-openers—Micro-openers are flexible, stainless steel hand files attached to an ergonomically designed offset handle. As an example, micro-openers provide unobstructed vision for initially penetrating and enlarging an offshoot that divides deep within a canal.

Dyes—Methylene blue is a water-soluble dye that can be irrigated into a dry pulp chamber. The pulp chamber is subsequently rinsed with water, dried, and visualized. The dye is absorbed into orifices, fins, and isthmus areas. This technique serves to visually “map” hard-to-find orifices, fins, and grooves, or certain coronal fractures.
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**Bubble test**—When sodium hypochlorite (NaOCl) is flooded into the access cavity, it dissociates into Na+ and OCl− ions and liberates free oxygen. The hypochlorite ion has a superior tissue-dissolving capacity. A positive “bubble” or “champagne” test signifies a reaction between OCl− and pulpal tissue within a canal; or, bubbles signify a reaction between NaOCl and a residual viscous chelator that is oftentimes utilized in a canal when manually performing glide path procedures.

**Transillumination**—A fiber-optic wand may be positioned cervically so that light is directed perpendicular to the long axis of a tooth. During transillumination, identifying an orifice is, at times, improved by turning off any overhead light source.

**Explorer pressure**—The endodontic handheld explorer should be strong, thin, and have a durable pointed tip. The JW 17 Micro-Explorer (CliniMed) provides a safe way to firmly sound or punch through a thin layer of secondary dentin in order to locate a hidden, receded, or more mineralized orifice of a canal.

**White line test**—When performing ultrasonic procedures without water in necrotic teeth, dentinal dust frequently settles into any available anatomical space. This can form a white dot within a hidden orifice or a white line within an anatomical fin, groove, or isthmus. This observation can provide a visible anatomical roadmap on the pulpal floor (Figure 10, left).

**Red line test**—In vital teeth, blood frequently emanates from an orifice, a fin, or an isthmus area. Like a dye, blood serves to map and visually aid in the identification of the underlying anatomy. At times, a red dot is noted on the lateral aspect of a paper point, which may be associated with an offshoot or secondary canal within a canal (Figure 10, right).

**Restorative disassembly**—Removing any given dental restoration provides direct visualization of the underlying tooth preparation. Coronal disassembly improves vision, orientation, and the predictability of safely identifying any given orifice (Figures 1 and 4).

**Perio-probing**—Circumferentially probing the sulcus of a tooth is another important strategy for locating canals. Intersulcular probing provides information as to the emergence profile of the clinical crown and the orientational alignment of the underlying root.

**Symmetry**—Any single root has a single canal when its orifice is positioned an equal distance from the external cavosurface of the root. In multirooted teeth, the orifices on the pulpal floor should exhibit symmetry between and/or among each other. The rules of symmetry will help to confirm that all the orifices and underlying canals have been identified (Figure 12).

**Color**—A dark, narrow line on the pulpal floor of a multirooted tooth provides a visual color-map that is helpful to locate a canal orifice. Visually, an orifice or fin will generally appear darker in color compared to the surrounding lighter-colored dentin (Figures 4 and 7).

**CLOSING COMMENTS**

Whether you are endodontically accessing a maxillary versus a mandibular tooth, an anterior versus a posterior tooth, a single-versus a multirooted tooth through a single-unit restorative versus a bridge abutment, or performing initial treatment versus endodontic retreatment—if you can see it, you can do it. The strategies outlined can help virtually any dentist perform more predictably successful treatment. However, if a missed canal is suspected but cannot be identified, then an endodontic referral may be prudent to avoid a complication. Murphy’s Law of Committee states, “If more than one person is responsible for a miscalculation, no one will be at fault.”

**References**

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1. The first bicuspid can, at times, radiographically exhibit mesiobuccal, distobuccal, and palatal roots.
   a. True   b. False

2. The mandibular incisors have narrow roots measured facial to lingual.
   a. True   b. False

3. C-shaped molars exhibit distinct features; however, their incidence within population groups is not well known.
   a. True   b. False

4. Well-angulated periapical images should be taken in 3 different horizontal planes: straight-on, mesioblique, and distoblique.
   a. True   b. False

5. The MoraVision technology allows the operator to view 3-D images in an interactive manner on a large 3-D monitor, but the operator has to sit in an uncomfortable position.
   a. True   b. False

6. Micro-openers are flexible, stainless steel hand files attached to an ergonomically designed offset handle.
   a. True   b. False

7. Coronal disassembly improves vision, orientation, and the predictability of safely identifying any given orifice.
   a. True   b. False

8. A dark, narrow line on the pulpal floor of a multirooted tooth provides a visual color-map that is helpful to locate a canal orifice.
   a. True   b. False
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Please check the correct box for each question below.

1.  ☒ a. True.  ☒ b. False
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