Minimally invasive and biomimetic endodontics: The final evolution?

By David J. Clark, DDS

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raditional endodontics has been based on feel, not sight. Tactile proprioreception was the only guide as burs and files were blindly inserted into pulp chambers and root canal systems. Together with radiographs and electronic apex locators, this blind approach has produced surprising success that, in the words of Dr. Eric Herbransen, “the endodontics succeeds often in spite of us.”

There is, however, a significant failure rate, especially long-term failure to close driving mainstream dentistry to aggressively extract natural teeth in favor of implants. The sting of clinical failure is a powerful motivator for change. In this article, I will describe the rationale and techniques involved in minimally traumatic endodontic access and shaping (Part I). In my upcoming Webinar I will discuss obturation techniques for smaller and non-round endodontic systems, which will also appear as a follow-up article in this publication (Part II).

Ribbons, sheets & banners

One of the most distressing “hangovers” of the era of blind endodontics and endo-restorative is the belief that canal systems are straight, exit at the radiographic apex and are round in cross section. In reality, most canal systems curve and exit short of the radiographic terminus. A very large number, at least 50 percent, are ovoid or super-ovoid in cross section. Figure 1 demonstrates that of the three roots and canal systems shown, only one is round. As these canal systems mature, they narrow into a variety of unpredictable ovoid shapes, often with smaller anastomosing canal systems (Figs. 4-6).

The evolution of endodontic shaping

The original endodontic shape was established based on mostly hand filing and filling with either silver points or cold lateral condensation of gutta-percha. Sargenti later introduced a more rapid approach that involved machine-driven instruments (rotary files) creating larger shapes with significantly more dentin removal. As of late, a crown-down approach is now popular. The roots are rapidly and blindly machined. This can result in better obturation of the apical half because of improved penetration of irrigation during instrumentation and improved hydraulics during obturation. But at what cost (Fig. 2)?

Is crown-down endo actually better than lateral condensation?

The outcome studies are inconclusive, but what we do know is that the success rate today is no better than it was 40 years ago (Fig. 5). The advantages of crown down are often offset by the weakening caused by Gates-Glidden burs and orifice shapers. The short-term thrill of the radiographic “puff of sealer” at the apex is lost when the tooth implo-des a few years down the line. Residual dentin is directly related to long-term strength and has indisputably been shown as the key to long-term tooth retention.

In contrast, the supposed strengthening of the root from a “monoblock” of bonded resin obturation, bonded core and fiber post is proving to be inconsistent.1 Another startling revelation is that the dentin in an endodontically treated tooth is not more brittle than in a vital tooth.2 In short, preservation of peri-cervical dentin and ferrule girth trump all other factors.

Ovoid canal systems & roots are non-round for a reason

Rotary instruments and obturating points of gutta-percha are round because of the limitations of their mechanical nature. They create anatomically appropriate shapes in round roots, but fail in ovoid roots. Over the ages, the dynamics of occlusion and arch form have guided the development of human tooth roots such that at least half have ovoid roots.

Smaller and/or ovoid shaping: Why and how?

Why? Biomimetics is a treatment approach that has, as its ultimate goal, to retain as much of the natural tissue as practical, and to mimic the physics and structures of the human body. There is nothing biomimetic about a stiff, round rod (prefabricated post) running through the center of an ovoid root.

The natural ovoid root is essentially a semi-rigid pipe deriving its strength from without, not within. The endodontic and endo-restorative goal should be to mimic the pulp space that was present when the tooth was young. From that point, it can be argued that any secondary dentin that is deposited adds little additional strength because of the amorphous and irregular deposition pattern. This point is supported by the robust strength of young teeth with large pulp chambers and large radicular pulp spaces.

If a small round access that does not disturb primary dentin can allow instruments to engage potentially significant complex anatomy (e.g., a second or third major system and corresponding portals of exit), then the round access is acceptable. The See ENDODONTICS, Page 8

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Clinical  7
realistic portrayal of ovoid roots would seem to disagree with this approach.

Creating a large round access that results in removal of primary dentin of the delicate, narrow portion of the root is the common approach today. While this can allow access to complex branching of systems that occurs further apically, it does not satisfy the more appropriate goals of anatomic, biomimetic dentistry. Additionally, the single large round endodontic shaping pattern often encroaches upon a fluting in the center of the root.

How? Visually shaping ovoid systems. The three components of ovoid shaping are:
1) the operating microscope with powerful coaxial shadowless lighting,
2) ultrasonic instruments, and
3) an understanding of the anatomic, biomimetic dentistry.

Anatomic, biomimetic shaping cannot occur safely “by feel” (Figs. 7, 8a, 8b).

Summary
Although no two roots are the same, general anatomic patterns allow the microscope-equipped clinician to search for major pulpal regions that will yield a high probability of cleaning and shaping the clinically available pulpal zones. The three components of ovoid systems branch into five systems in the coronal third. (Image courtesy Dr. John Vanars)

Figs. 7, 8a, 8b: Several renderings contrast current endodontic shapes versus new biomimetic microscope enhanced shapes. Figure 7 shows the preservative pulpal space of the root, sectioned at the orifice, then shows lateral condensation shape that does not weaken the root but does not address the potential complex anatomy. The third image shows the new aggressive crown-down shape that weakens non-round roots. Figure 8b shows two potential shapes that are anatomic and address the complex anatomy, yet do not weaken the tooth. Figure 8b shows the obliterated anatomic shapes in the second axis.

Attend Dr. David Clark’s Webinar!
On March 14 at 1:45 p.m. E.S.T., Dr. Clark will present a one-hour Webinar, “World Class Obturation for General Dentists,” followed by a live question-and-answer session with the online audience.

Can endodontics be minimally invasive? Biomimetic? Last as long as implants?

The implant era has raised the bar for endodontics serendipitously as new tools and techniques allow for the next level of endodontic excellence. Instead of “blindly poking around” the pulp chamber and “machining” the delicate root with Gates-Glidden and large rotary files, there are other options! Once we have created the new shapes, then how can we perform ideal obturation? Join us to find out!

This is one Webinar in a five part Webinar series that will be running over the course of the entire day to launch the brand new Dental Tribune Study Club. Participants will receive C.E. credits and attendance is free for the first 100 registrants. After the first 100 spaces are filled, the cost of the full-day symposium is only $49. Live attendees have 30-day access to the recorded Webinars to review at their convenience. Attendees require the full-day symposium is only $49. Live attendees have 30-day access to the recorded Webinars to review at their convenience. Attendees require

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Fig. 7: One variation of potential anatomy in an ovoid root; system branches in apical third of a C-shaped second molar.

Fig. 8a: Another variation of ovoid root; system branches in apical third of a C-shaped second molar.

Fig. 8b: Shows two potential shapes that are anatomic and address the complex anatomy, yet do not weaken the tooth. Figure 8b shows the obliterated anatomic shapes in the second axis.

Fig. 9: A new model for lower incisor access is depicted, along with the new CK endodontic access bur. Note that the access has been moved away from the cingulum and toward the initial edge. The delicate tip size of the bur and its conical shape are helpful for both visual (dentists using microscopes) and tactile (little or no magnification) endodontics.

Fig. 10a: Extracted bicuspid is shaped to follow the pattern of secondary dentin that has been described by Gurr as resembling “glacial ice” in appearance under the microscope. One border of secondary dentin and primary dentin is outlined with arrows. Guttapercha is one of the many terms used to describe the many color and translucency features of secondary and tertiary dentin. CPR 2D (Odonto-Spartan) ultrasonic tip is pictured at 16x.

Fig. 10b: Depicts the much finer CPR 5D as the oval system is explored further apically with combined microscope visualization. Note the ideal visual environment that is the hallmark of the microscope-ultrasonic combination. It allows for identification of dentin maps for the ultimate in dentin preservation.

Fig. 5, 6: Another variation of ovoid roots, non-round canal systems branch into five systems in the coronal third. (Image courtesy Dr. John Vanars)

Fig. 7: Shows the preservative pulpal space of the root, sectioned at the orifice, then shows lateral condensation shape that does not weaken the root but does not address the potential complex anatomy. The third image shows the new aggressive crown-down shape that weakens non-round roots. Figure 8b shows two potential shapes that are anatomic and address the complex anatomy, yet do not weaken the tooth. Figure 8b shows the obliterated anatomic shapes in the second axis.
While these systems go by many different names, the best way to describe the system is that it’s a cross between a digital pan/ceph and a CAT scan machine. The most popular model right now in the United States is the i-Cat by Imaging Sciences. While I could describe the system in detail, this excerpt from an i-Cat user does the best job of explaining why they are becoming so popular:

“Compared to medical scanners, cone beam scanning is 10 times more accurate while reducing a patient’s exposure to radiation by more than 97 percent. Pre-surgical implant treatment planning, preparing to remove impacted third molars, determining how sinus grafts and ridge augmentation heal, discovering the ideal position for a single-tooth replacement are just some of the benefits of cone beam scanning technology. Because cone beam scanning permits multiple slices through the axial, sagittal and coronal views, the guesswork is removed when it is critical to determine the width of edentulous ridges, whether or not cancellous bone exists between cortical plates, the position of supernumerary and developing tooth buds, if sockets have filled with bone, if irregularities exist to the condyles, where the mandibular nerve is relative to an impacted tooth and implant sites, or to visualize the borders of a cyst or tumor. Cone beam scanning has an added benefit in that it can take the maxilla and mandible in a single scan.

Probably the biggest drawback to these systems is the initial cost: they average around $170,000 to $200,000 each, although new units from Kodak and Carestream are now below $100,000. I’m seeing many dentists group together to create imaging centers to share the costs of the machines, and these centers are sprouting up all over the country. While the cone beam may someday be the standard of care for many procedures, it will be quite some time before that happens.