Interestingly, in endodontics, we have and restoratively, are a very big deal. Evidence to our profession’s desire to improve dental health and delivery of care, we have seen many advances in the art and science of dentistry. Even during my relatively short 24 years of practice, I have adopted many new materials and techniques to offer my patients the best possible care. My observations, after years of clinical microscope dentistry and study of past research, have led me to conclude that despite our best intentions, we are falling short. Some of our techniques are incompatible with our most common procedures leading to avoidable failures. We need to reassess and recalibrate our endodontic and restorative techniques to best suit the way that we practice today. At the same time, we need to preserve essential tooth structure to routinely achieve a 50-year, not a 5-year, successful outcome. In this article, I will address how restorative dentists can reclaim endodontics and reinvent direct restorative techniques for clinical success.

The shapes we cut, both endodontically and restoratively, are a very big deal. Interestingly, in endodontics, we have embraced a radical change in the shapes that we cut for root shaping (big versus small) in spite of the outcome studies that do not validate this aggressive removal of precious dentin. Meanwhile, in restorative dentistry, we cling to modified G. V. Black preparations, namely retentive Class I and Class II preparations that do not serve the clinician, composites, or the tooth. As I look to the future, I see a daunting task in reversing the massive inertia of the dental industry that has created materials, instruments, and techniques to serve 2 perverse masters. Let’s begin with endodontics.

**PART I: RECLAIMING ENDO DONTICS**

**Endodontic Design**

Endodontic design refers to access preparation and canal shaping. For decades restorative dentists have deferred to endodontists to determine endodontic design. It is imperative that restorative dentists reclaim endodontic design and work in concert with endodontists (Figure 1). We need to move away from round bur access preparations which tend towards parallel-sided access, as is so frequently shown in texts. This invariably results in gouging of the all-important peri-cervical dentin (PCD) (Figure 2). The PCD is the zone of dentin extending 4 mm coronal to 4 mm apical of the crestal bone. Round-bur access also makes discovery and negotiation of calcified canal systems difficult. In contrast, when an infinity edge cavosurface margin merges with a conical access, a whisper of pulp can be more easily discovered with the file tip; the new Endoguide Precision Micro Endodontic Burs (SS White), available in November, do just that. These new burs have a polished carbide conical shape that is self-centering to create a beautifully smoothed dentinal surface that simplifies finding calcified canals by virtue of these 3 important attributes (Figures 3 and 4).

When we take a round bur and rammerge around the calcified tooth, the tip of the round bur typically becomes slightly misdirected. When the file is inserted, it clunks into the bottom of the well. We continue to drill deeper and go back and forth, burrowing and then clunking files into the fruitless bottom, when in reality the tiny trace of pulp is along the lateral wall. With conical access, the tip of the file can trace up and down the converging walls of the cone of dentin and the file is nicely directed into the pulp chamber, even when the tip of the cone is off-center. I have been pleasantly...
surprised to find pulp very early on, often far coronally to where the pulp begins to appear on the radiograph (Figure 5).

Big Endodontic Root Shapes: A Step Backward?
The big, aggressive canal-flaring party is officially over. The movement away from conservative endodontic shaping to large, flared endodontic shapes was well intentioned. At Boston University, Dr. Herb Schilder’s vision of modern endodontics was the pursuit of 3-dimensional (3-D) obturation of complex canal systems; this was done in the hope that the warm compaction of gutta-percha and sealer out the lateral and apical extents of the system would create better outcomes (Figure 6). Well, these hollowed teeth are much more prone to fracture.4,5 Whereas endodontic design that is biomimetic and extremely conservative would probably not weaken the tooth. This is because the dentin in the endodontically treated tooth is not more brittle or with a lower moisture content than a natural untreated tooth.4,6 We may have created a generation of dentists and patients who have seen so many endodontically-treated teeth fracture that they now understandably view endodontically treated teeth fracture as “weak.” Besides fracturing, one of the last nails in the “big shapes” coffin is the recent study published in the Journal of Endodontics.7 It suggests that aggressive canal shaping and 3-D obturation may not result in a better seal.7 In this study, 493 human endodontically treated teeth were extracted and examined for histopathologic and histobacteriologic status of tissue in lateral canals. They found that “lateral canals that appeared radiographically filled were not obturated,” and “Overall the belief that lateral canals (and apical ramifications) must be injected with filling material was not supported by literature review or by our histopathologic observations.”8 In other words, we can’t predictably fill all of the lateral canals, even when the radiograph shows all of those “sexy puffs of sealer.” In the cases where the lateral canals appeared radiographically obturated, the histologic serial sections showed the lateral canals to be more like a garage sale of bacteria, chaotic chunks of filling material, inflammatory cells, etc. We should default back to small endodontic design because: (1) the tooth will be stronger and (2) there is insufficient evidence that big shapes provide a better seal and thus fewer endodontic failures.

What dismays endodontists is the confusion between small and sloppy. Endodontists tend to see failing cases with “small shapes” like this central incisor case (Figure 7a) and understandably make the link between small shapes, sloppy work, and failure. This does not necessarily follow. To demonstrate the shape Dr. Khademi and I are recommending, the case in Figure 7a with a lateral lesion is first delicately shapped and obturated to the apices with calcium hydroxide (Figure 7b), and carefully sealed with no cotton pellet and a combination of Cavit (3M ESPE), and flowable composite directly over the Ca(OH)2 (Ultra Cal [Ultradent Products], Cavit, and Filtek Supreme Ultra flowable composite [3M ESPE]). The canal system is allowed to disinfect and begin to heal for 8 weeks. Although the lateral canal was not radioographically obturated, the lateral lesion has healed nicely. (Figures 7c and 7d) In contrast, another case (Figures 8a to 8c) had a beautiful radiographic fill of the lateral canal and yet is not healing to my satisfaction. Both of these cases were treated by me with careful calcium hydroxide therapy before the obturation appointment.

So If Mainstream Dentistry Cannot Adequately Seal Lateral Canals, Why Do We Not See More Endodontic Failures?
Case spectrum is important. Some gifted and committed microdentists exist who may actually succeed in sealing the majority of lateral canals and apical ramifications. They accomplish this by committing additional time, massaging precurved hand files into multiple orifices, and so on. While these procedural nuances may be important in a small spectrum of cases, it’s not reasonable to expect this in mainstream dentistry treating vital or recently necrotic cases. It’s probably not even necessary (in a vital case). The good news is that the above mentioned study showed that, for vital (nonlesion, noninfected) cases, the histology looked a lot like a deep pulp cap; with happy pulp and periodontal tissue nestled next to gutta-percha. In other words, the lateral canals and apical ramifications were filled with healthy tissue supported by the vascular supply of the surrounding bone. Sealer may not be all that important. Go figure!

Uniform Wall Thickness
Uniform wall thickness of the residual root dentin is a casualty of the aggressive use of Gates Glidden burs, rotary files, and old school straight-line access. In Figure 9 we see a sectioned immature root that has a large pulp space but naturally absolute uniform wall thickness. Studies need to be performed on the merits of this attribute. Restorative dentists do not typically see root fractures of these naturally “hollow” teeth in their adolescent patients. We also intuitively understand that a thin area of dentin is a liability in so many ways. The photoelastic studies of stressed root canal-treated roots definitely show that uneven flexure occurs in endodontically-treated roots when a round shape is cut in a nonround root.9 In continued on page xx
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addition, very few roots are actually round in cross section. The potential of an endodontically-treated tooth to fracture increases proportionally to the amount of dentin removed. This risk is even higher in ovoid roots (Figure 10).

Can We, Should We, Machine Only the Apical 2 mm of the Root?

Interestingly, the cross sections in the apical 3 mm of most roots become round and without flutings; regardless of the ovoid shape and flutings that are present in the remainder of the root. Most clinicians and researchers will agree that some apical shaping and taper is of benefit from both a disinfection and obturation standpoint. From a strength and fracture resistance perspective, this is one place, perhaps the only place, where the root can be milled without deleterious long-term affects.

What is the Ideal Endodontic Shape and Technique?

In a unique and novel approach, Dr. Fred Barnett guest authored an endodontic edition of Dental Clinics of North America. He requested that Dr. John Khademi (a restoratively-aware endodontist) and I (a general dentist) co-author chapters on modern access and shaping. The 2 chapters we wrote for the textbook are now available from Elsevier publishing. The following are some highlights of the text:

- Visual endodontics (using a microscope and modern instruments to find all of the major canal systems without mutilating the tooth).
- Biomimetic and minimally invasive shapes (shaping of the canals with constant microscopic visualization to match the root form, not milling arbitrary big round tapering shapes).
- Vital cases and lesion cases are almost unrelated.

Figure 9. Extracted immature maxillary molar is sectioned and viewed from the apical. Uniform wall thickness of root dentin is nearly always present naturally in both young and old teeth.

Figure 10. A relatively conservative arbitrary round endodontic shape in an ovoid root combined with inevitable noncentered enlargement allows mesiodistal flexure and consequent buccolingual crack initiation.

Figure 11. Postoperative report from the endodontist (left 4 radiographs) shows a preoperative view and three postoperative views of my tooth No. 19. It is a textbook Schilder Shape. Note the careful the shapes and that 4 canals were filled with matching puffs of sealer. Seven years later (right single radiograph) there are significant lesions on the mesial root highlighted by the green arrows.

- For lesion cases, we can expect a 3 times higher failure rate, and those cases should be treated in a special manor. Follow articles are planned.
- Vital cases (no lesion) should be kept as small as possible.
- A generous 45° cavosurface cut through etchable substrates (enamel and some porcelains) allows a better restorative seal and aids in preservation of PCD.
- For nonlesion cases, continuous taper in small delicate roots and active irrigation in any canal shape in the hope to clean and obturate lateral canals is not warranted.

I Just Had My No. 19 Extracted…and I’m Not Happy

Yes, I feel like an old man. Seven years ago the pulp died in tooth No. 19 and a committed endodontist did a beautiful Resilon endo (Figure 11). It never felt quite right and recently developed a stoma on the facial. The endodontist and I faced the agonizing decision of retreatment or extraction. One of the tipping points for extraction for me was the weakened coronal half of these delicate roots. Sure, we could try a re-treatment, but would the tooth last a lifetime even if we deflated the cysts on the mesial root? Photographs of my extracted tooth No. 19 and cone beam computed tomography (CBCT) will be featured in future articles. Suffice it to say that the mesial had a very large cyst attached.

The CBCT looked far worse than the periapical radiograph, so I opted for extraction. I now have a hole in my mandible where I used to have a beautiful molar. What are the morals of this sad story? Resilon obturation, large tapering shapes, and a hermetic root seal are not panaceas. Great endodontics fails, and it fails far more often than not.

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An Endodontist’s Perspective

John Khademi DDS, MS

The treatment philosophies presented here are not an update of the traditional endodontic technique. Dr. Clark and I believe that the traditional round-bur, tactile-based approach to endodontic access is fundamentally flawed. We are proposing a new approach of site-specific dentin conservation. Central to the philosophy is a titration of the treatment protocol to the given case from what we know about the histology, the presenting pulpal and periapical diagnosis, the endodontic-anatomic issues and radicular-morphological form.

We know that we cannot completely debride the canal system. Decades of literature with multiple instrumentation techniques and the attendant shaping endpoints, varied irrigants and intracanal medicaments consistently show this. Consistent with this understanding of the real results of our woeful attempts at debridement is the impartial evaluation of the truly long-term 20-plus-year-old cases. As a group, these cases have obvious missed anatomy, are short, under-shaped and poorly obturated by today’s standards.

Yet, looking past the endodontic shortcomings of these 20-plus-year-old cases, one finds they invariably share this characteristic: adequate peri-cervical-dentine (PCD) has been maintained. Violation typically occurs in 3 key areas: (1) gouged access, (2) aggressive, obturation-driven shaping protocols, and (3) deep axial reduction during crown preparation. Violation of the PCD in 3 or more areas portends a drastically shortened lifespan for the tooth. This is evidenced by the dearth of radiographically “good looking” 20-plus-year-old cases.

Balance needs to be restored to the treatment process that respects: (1) The operator needs in accomplishing the treatment objectives appropriate given what we know about the given case (above); (2) The tooth needs for long-term retention; 3) The restoration needs from a fabrication and mechanical perspective.

Dr. Khademi is an endodontist and pioneer of Restoratively Driven Micro-Endodontics. He can be reached at jakhademi@gmail.com.
of patients who had a root canal by their general dentist would return to him/her for the treatment!). My recommendations are: to first find an endodontist who uses a microscope for every step of every case; and second, take him/her to lunch to discuss our concerns (as restorative dentists) regarding the long-term weakening effects of some current accepted philosophies of root canal access and shaping. (You might want to bring along a copy of this article.)

**CLOSING COMMENTS**

Question yourself whenever you cut tooth structure. Very few of the endodontic techniques that we perform have sufficient evidence to support the dogmas that are the foundations of such techniques.◆

**References**


Dr. Clark is a general dentist and pioneer in biomimetic microendodontics and minimally traumatic restorative microdentistry. He can be reached at drclark@microscopedentistry.com or visit the Web site lifetimeaccentdentistry.net.

Disclosure: Drs. Clark and Khademi receive a royalty from the sales CK Endodontic Access burs and CK Endo-Exploration burs. For further information regarding these burs, contact SS White Burs at sswhiteburs.com.