

Bio-Minimalism: Trends and Transitions in Endodontics

by Dr. Martin Trope

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and Dr. Kenneth Serota

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Course description

This article is an overview of the essentials that accept that the endorestorative continuum is not a concept. Rather, it is a de facto treatment approach. “Clean, shape and pack,” with hindsight, should have been “shape, clean and pack”—but even that was a somewhat simplistic approach. Debridement, disinfection and microstructural replication due to the introduction of adaptive bioceramic technologies for root filling are increasingly being recognized as the standard for optimal endodontic therapy.

Objectives

1. To have a better understanding of the dynamic changes in mainstream endodontic instrumentation.
2. To have a better understanding of latest and most advanced obturation techniques.
3. To understand the synergism between the endodontic and restorative

continuum of tooth rehabilitation.

4. To dispel the myths of past “concepts” and evaluate the shifts in treatment protocols with better evidentiary understanding.

History

The recent history of endodontics has been an evolution through several transitional stages: nickel-titanium (NiTi) instruments for sculpting and debridement; microscopes for illumination and magnification—indispensable for detection and exploration of the inner space of teeth (Figs. 1a–1d); and, of late, the inclusion of cone-beam computed tomography for diagnosis and treatment planning.

The clinician can thus anticipate, visualize and treat with unprecedented levels of accuracy and safety. However, the failure to overcome all potential mechanical and pathologic vectors that negate treatment success continues in spite of these technologic

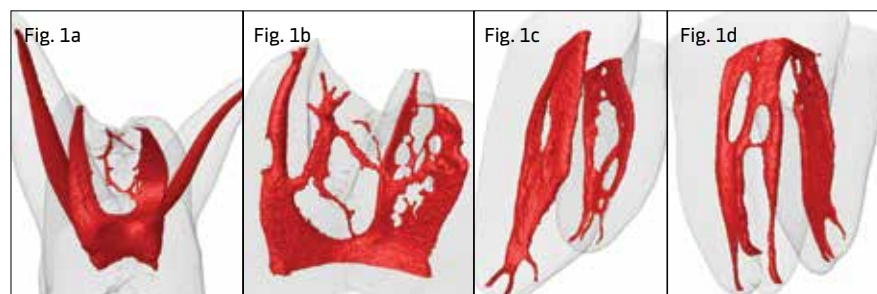


Fig. 1a
Four-rooted
maxillary molar

Fig. 1b
Maxillary molar
fused roots

Fig. 1c
Mandibular molar A

Fig. 1d
Mandibular molar B

Figs. 1a–1d provided by Dr. Marco Versiani, Jesus D. Pécora and Manoel D. Sousa Neto

The root-canal system is an arborizational, anastomotic, byzantine, labyrinthine complexity, morphologically comparable to the passages of a maze. While primary canals exist, the tributaries, accessory branches and luminae of the dentinal tubuli harbor extensive tissue and microflora, which if left untreated remain vectors for persistent and refractory pathology.

advances. The most current evolution is a minimalistic approach to access design by shifting the outline configuration toward greater dentin preservation and idealizing the endodontic-restorative interface (Figs. 2a–2d). This article will address aspects of the access, treatment and restorative paradigm shifts underway.

Original healthy tissue has the best biologic value. Minimally invasive dentistry (MID) is all about tissue preservation. By removing pathology in a way that preserves as much healthy tissue as possible, one hopefully can not only prevent disease but also stop disease that is occurring from getting worse.¹

These aims are logical if taken in the appropriate context. They do not suggest that respect for original tissue is more important than preventing or treating disease, only that disease prevention or elimination should be performed without sacrificing unnecessary native tissue.

The aspects in clinical endodontics that are essential for biological success in the absence of periradicular disease and paramount for the survivability of the tooth are:

- the eradication of microbial presence, particularly in the apical 3–4mm of the root-canal space
- minimal removal of native tissue in the coronal two-thirds of the root to enhance long-term success
- optimal access to the root-canal space, both in the coronal two-thirds and apical 3–4mm segment.

Before addressing the question, “How are we doing at the moment?” it is wise to reflect upon the value derivative from clinical impact factors and scientific impact factors.² The many variables in clinical dental research make it unlikely that they will have the same scientific potentials as, for example, a laboratory study. In this aspect we are at an impasse because traditional in vitro studies, from a clinical practice point of view, are essentially of little or no value, and anecdotal empirical protocol changes based on extrapolation may seem valid but lack the substantiation of a controlled study.

Biological success

Assessment of university-based studies shows that endodontic treatment outcome success ranges from 80 percent for infected teeth to 96 percent for uninfected teeth. This suggests that even when the clinician has limited experience (dental students), the (biological) success rate for root-canal treatment can be extremely high.

Unfortunately, cross-sectional cohort studies in general dentistry practices in a practice-based research network (PBRN) show that the success rate ranges from 40 percent to 73 percent for myriad reasons.^{3,4} Of them, caries, periodontal disease and fracture are most prominent. The perception that the incidence of fracture in endodontically treated teeth is intrinsically related to the amount and quality of remaining dentin is valid, in a generic sense.^{5,6} However, it discounts the many restorative factors and design scenarios causing unfavorable biomechanical shear stresses that must be held to account.^{7–9}

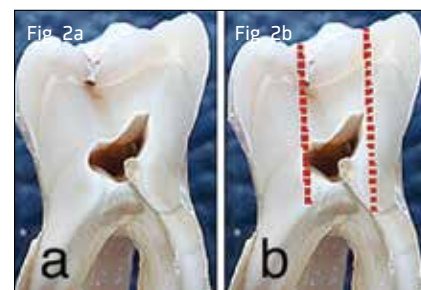
Functional success

The majority of studies on functional success have been performed to justify root-canal versus implant (partial edentulism) survival rates. The functional success of root-treated teeth ranges as high as 97 percent and is actually more favorable than implants de facto, if length of time and post-treatment complications are taken into account.¹⁰

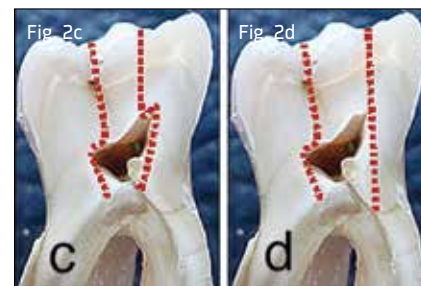
It must be acknowledged, however, that many of these studies on functional success were performed on teeth treated with stainless-steel files with 0.02 tapers. In vitro studies using NiTi files with larger tapers have shown that microcracks develop in the tooth structure as the taper increases, leading to possible fractures and thus a decrease in the reported functional success rates.¹¹

Cone-beam computed tomography

The scope of this article prevents an elaborate discussion of CBCT. However, as the cliché goes, a picture is worth a thousand words, and the value of the sagittal, coronal and axial images obtained from small



Figs. 2a, 2b: Traditional access preparations were slightly divergent to enable convenience form in the era before the introduction of super-elastic metallurgy into the instrumentation armamentarium. The more constrained, constricted or preferably conservative access cavity encourages the retention of “soffits,” ostensibly to minimize cuspal flexure during mastication. Modification of the access design is predicated on planar geometry of the roots and factors such as limitation of interocclusal distance.



Figs. 2c, 2d: Drs. Clark and Khademi¹ have described a revisionist concept of conservative endodontic access that prioritizes the removal of restorative materials before tooth structure; of enamel before dentin; and of occlusal tooth structure before cervical dentin. It negates the traditionalist straight-line access protocol and the totality of deroofting the pulp chamber. The biologic mandate of greatest imperative is the preservation of the critical region of pericervical dentin (PCD)—4mm above and below the crestal bone—to the paramount achievable degree without compromising debridement or inducing iatrogenic misadventure. (With sincere appreciation to Dr. Hany Mohamed Aly Ahmed of the Universiti Sains Malaysia.)

field-of-view (FOV) scans is a quantum leap forward in diagnosis and treatment planning. As demonstrated in Fig. 1, we have been treating three-dimensional teeth with two-dimensional images—something we’ve done for decades.

Axial slices assist in the identification of the number of canals (Figs. 3a–3c). They

are an aid in determining the location of external root resorptions, bifidities, diametral width and curvature at various levels along the length of the root.

Coronal slices offer an evaluation of the many configurations characteristic of premolars and molars, predominantly in the mandible. They assist in guiding the clinician to avoid removing hard tissue in exploring for canal angulation and orientation (Fig. 4).

Sagittal slices assist in eliminating the anatomical noise of overlapping structures, particularly in the maxilla, and enable a clarity of a Y-axis perspective in both orthograde and retrograde treatment that has been previously unobtainable (Fig. 5).



Fig. 3 provided by Dr. William Nudera

The traditional flat film used to preoperatively assess the number of roots, the degree of calcification and the planar geometries of the roots along their length has now been augmented by axial slices which assist in identification of the number of canals and various anatomical configurations and aberrations.

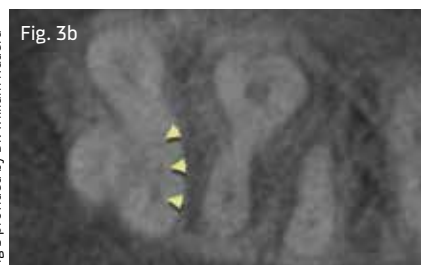


Fig. 3 provided by Dr. William Nudera

Three canals untreated in MB root of tooth #2.



Fig. 3 provided by Dr. William Nudera

Canals obturated.

The challenges and changes

Bio-minimalism recognizes that the pericervical dentinal (PCD) zone is crucial for buttressing the residual coronal tooth structure during functional loading stress, and ostensibly acts to minimize cuspal flexure during mastication. The challenge to the clinician is to negotiate all canals, debride residual pulp tissue from all loci and avoid iatrogenic complications while working through a restricted access without “convenience form.”¹² This begs the question: “How can we remove as many microbes as possible while still maintaining the strength of the tooth?”

Fortunately, there are technological advances in the instrumentation armamentarium that bring us closer to the aims of minimally invasive endodontics. We are in a new era in endodontics, with the introduction of disinfection systems that do not require changing the nonround canal to a round shape. This previous formulistic alteration

meant that sculpting the inner space was overly minimized, or that too much native tissue was removed.

We now have files and finishers that adjust to the original shape of the canal, scrape biofilm in a manner similar to periodontal scalers, and facilitate irrigants to act upon exposed microbes. These systems will continue to iterate, enabling the clinician to retain more native root structure while more effectively removing inflammatory vectors.

From the standpoint of survivability, the future looks increasingly bright, not only due to bio-minimalistic technical changes, but also to the introduction of new obturation materials. Until recently, the preparation of the coronal two-thirds of the canal was designed to facilitate plugger placement to within 4mm of the apical terminus to generate the hydraulic forces necessary to deform thermolabile gutta-percha in the apical capture zone



The coronal view can assist in determining branching otherwise undetectable and assist in access orientation to ensure optimal preservation of pericervical dentin.

Fig. 4 provided Dr. Charles Boveida

The clinician can thus anticipate, visualize and treat with unprecedented levels of accuracy and safety. However, the failure to overcome all potential mechanical and pathologic vectors that negate treatment success continues in spite of these technologic advances.

with optimal gravitometric density. This necessitated large tapers destructive to the native root structure with minimal benefit to microbial removal.

The introduction of bioceramics brings a material with antimicrobial potential (high-alkaline pH), biocompatibility, bio-activity and no evidence of shrinkage upon setting. The myriad applications—from orthograde to retrograde to resorptive treatment—facilitate enhanced sealing without the need for removal of excess inner or outer root structure.¹³

Unfortunately, minimally invasive access design has dominated the discussion of bio-minimalism in endodontics. Traditional endodontic access design adhered to the restorative axiom “extension for prevention,” which manifested as straight-line access, including deroofing the pulp chamber and preflaring the canal orifice to facilitate the subsequent shaping of the entire root-canal system to negotiate the apical terminus.

However, optimal diametral retention of coronal/radicular dentin and maintenance of the planar geometry of the root-canal

anatomy essential for the structural integrity of endodontically restored teeth was unduly compromised.¹⁴

Preparing the cavity

There are many limitations to what is preached as the perfect minimally invasive cavity design (conservative access preparation). In teeth requiring root-canal treatment, the shape and size of the access opening is invariably dictated by caries, or failing or lost restorations. It is imprudent and unlikely that a clinician would leave diseased tooth structure intact to configure a textbook-access cavity. Removal of unnecessary dentin during access preparation was never the biologic mandate of access design. Even in the Schilderian era, the goal was to retain as much of the cervical dentin as possible, while still achieving straight-line access to the apical termini. (The greater the curvature in the canal, the greater the relevance for a glide path to achieve a straighter-line access.)

Perhaps the aim of conservative cavity preparation should be reframed from “removal of as little tooth structure as possible” to “removal of as little as necessary.” As discussed previously, clinicians now have a multitude of technologies at their disposal to assist in the execution of this redefined objective. Restoratively in the adhesion era, we are now blessed with an abundance of riches to move away from the post/core and full-coverage paradigm of the past, which only further compromised the retention of foundational tooth structure, to a truly bio-minimalistic restorative template.

One can barely skim the surface in a publication of this brevity; however, the purpose is to create an energy dynamic analogous to the ripples produced by dropping a stone in a pool of water. With minimal

resistance, they can expand concentrically in greater and greater diameters. Or one could be a curious octopus and go off in all directions. That will be forthcoming in the online curriculum under development for Dentaltown.com.

Perhaps the answer to all of the issues that remain to be corrected in endodontics was articulated eloquently more than 100 years ago by the man who predicted waves in the gravitation fields of the universe, Albert Einstein. “We cannot solve our problems with the same thinking we used when we created them,” he said. ■

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Fig. 5
Sagittal views provide the clinician with the z-axis perspective to identify the distance between splits in roots and the orientation of the roots about themselves. This is of paramount importance particularly in microsurgical treatment.

Fig. 5 provided by Dr. William Nudera

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1. Which of the below statements are true?

- A) G.V Black's principles are an intriguing premise for addressing the restorative needs of the tooth. However, in endodontics, there is no rationale for removal of the restoration, eradication of decay and assessment of structural fractures, until the root-canal treatment is completed.
- B) Ninja access, mousehole access, soffits and trusses have long-term studies that verify their validity in the transition of access-preparation design shapes and configuration.
- C) Residue in the pulp chamber is entombed within the final core restoration and of no infective concern.
- D) None of the above.

2. Which of the below is true?

- A) Calcification occurs apical to coronal in the root-canal space.
- B) Calcification occurs coronal to apical in the root-canal space.
- C) As long as you can access the canal orifice, residual pulp stones are not an impediment to root-canal success.

3. Which of the below is true?

- A) Preservation of pericervical dentin or "girth" is not relevant to ensuring the structural integrity of residual tooth structure.
- B) Post placement reinforces the structure and ensures elimination of the potential for stress fractures.
- C) The use of Gates Glidden drills or Peezo reamers will not compromise dental girth.
- D) All of the above.
- E) None of the above.

4. Which of the below is true?

- A) Gates Glidden drills should be used to the interface of the coronal and middle thirds of the root-canal space to enable straight-line access.
- B) Peezo reamers are a better alternative than Gates Glidden drills in anterior teeth.
- C) Any nickel-titanium instrument can go around any curve, because the metal is super-elastic.
- D) None of the above.

5. True or False?

- Irrigants present little or no concern in regard to the biochemical composition of residual structural dentin after root canal therapy.
- A) True
 - B) False

6. True or False?

- A) To establish conservative access, it is reasonable to allow loci of infective organic material to remain in the pulp chamber and the isthmus areas of the root-canal space.
- B) Conservative access implies that we no longer need worry about glide path before the use of nickel-titanium instruments.
- C) Residue in seams between orifices and canal isthmi can be completed cleared with irrigants and passive ultrasonic irrigation or sonic activators.
- D) All of the above are true.
- E) All of the above are false.

7. Which of the below is true?

- A) The ideal obturation material adapts to, but does not adhere to, the root-canal walls. Sealer ensures that no leakage can occur once it has set.
- B) Gutta-percha is the ideal root filling material.
- C) Gutta-percha will not shrink on cooling.
- D) Gutta-percha's gravitometric density is enhanced on cooling.
- E) Bioceramic sealers are hydrophilic and will penetrate dentinal tubuli.

8. Which of the below is true?

- A) Full coverage of the endodontically treated teeth is more likely to result in long-term success rather than the use of inlay/onlay adhesive restorations.
- B) Occlusal coverage of the endodontically treated tooth is not required.
- C) In the absence of a suitable ferrule of more than 1.5mm in anterior teeth, a feather-edged preparation is acceptable.
- D) All the above statements are false.

9. Preservation of the tooth structure 4mm above and 4mm below the CEJ is not desirable nor essential to a positive treatment outcome.

- A) The above statement is true.
- B) The above statement is false.

10. Which of the below is true?

- A) The greater the taper in a funneling canal, the better the apical seal.
- B) Regardless of the root curvature, the condenser must be accommodated to within 4mm of the apical terminus.
- C) The above statements are true.
- D) The above statements are false.

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Bio-Minimalism

by Dr. Martin Trope and Dr. Kenneth Serota

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