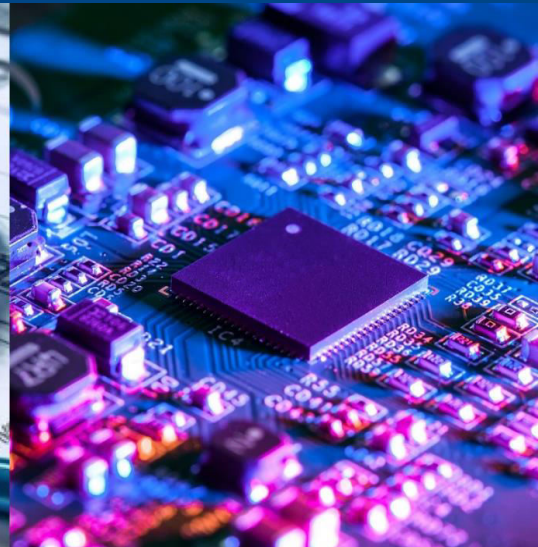
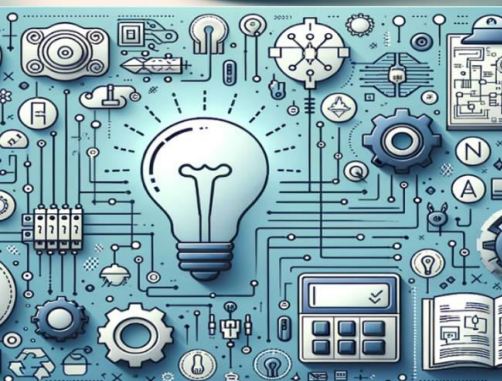




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Armamentarium for Minimal Invasive Endodontic Access Cavities (MIEC): A Review

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ABSTRACT: Minimally invasive endodontic access cavities (MIEC) aims to preserve maximum tooth structure while providing adequate access for effective root canal treatment. The selection of appropriate armamentarium plays an important role in achieving conservative access preparation without compromising canal location, cleaning, shaping and obturation. Modern endodontic armamentarium includes burs, Ni-Ti system, magnification devices like loupes and operating microscope and ultrasonic tips. This review describes the commonly used armamentarium for MIEC and highlights their role in achieving precise, conservative and clinically effective endodontic access while maintaining structural integrity of the tooth.

KEYWORDS: Minimally invasive endodontic access cavities, Armamentarium, Magnification devices, Loupes, Operating microscope, Ultrasonic tips.

I. INTRODUCTION

MID is based on a preventive and conservative philosophy that focuses on preserving as much as healthy tooth structure as possible and maintaining the functional integrity of teeth throughout life. The concept of 'Minimal Treatment' for dental caries was initially proposed by Mount, while the term "Minimal Intervention Dentistry" was subsequently introduced into the dental literature by Dawson and Makinson. The growing recognition of minimal invasive approaches led to the first International Association for Dental Research (IADR) symposium dedicated to minimal intervention techniques for dental caries in 1995.¹ Minimal Invasive Endodontics is a conservative treatment philosophy that emphasizes maximum preservation of sound dental tissues by limiting the dimensions of access cavity, reducing canal preparation taper and maintaining a smaller apical preparation size. Minimal invasive endodontic access cavities are conservative access openings designed to facilitate entry into the root canal system while maximizing the preservation of healthy, structurally important tooth tissue.² Minimal invasive access cavity (MIEC) designs have been introduced to conserve the pericervical dentin, which plays an important role in distributing functional stresses within the tooth. Maintaining this critical dentin may help to preserve the structural integrity of the tooth and potentially increases its resistance to fracture.³ Clark and Khademi were the first authors to describe the application of minimally invasive principles to endodontic access cavity preparation, publishing their work in 2010.⁴ Various MIEC includes Conservative Access Cavity, Ultra conservative Access Cavity, Truss Access Cavity, Caries driven Access Cavity, Restorative driven Access Cavity, Straight Line Furcation and Straight Line Radicular.⁵ The success of MIECs depends not only on the access cavity designs but also on appropriate case selection, knowledge of root canal anatomy, operator experience and proper selection and application of instruments. Therefore, understanding the available armamentarium is essential for achieving conservative access cavity treatment. This review discusses the contemporary armamentarium used for MIECs with emphasis on their clinical applications and role in preserving tooth structure.



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II. ARMAMENTARIUM

- **Burs-** Traditional round burs rely on tactile feedback to identify entry into the pulp chamber but may cause excessive dentine removal and overextended cavity walls. Newer instruments, such as CK and EndoGuide burs, have smaller tips—less than half the diameter of conventional round burs—allowing more precise and conservative access preparation.⁶ These instruments facilitate the identification of root canal orifices with non-linear access and help detect calcifications or canal obliteration. They also minimise procedural errors such as gouging and strip perforation while promoting preservation of pericervical dentine.⁷
- **Mirrors-** High-quality rhodium-coated mirrors are used as they enhance visibility and light transmission through small access cavities while reducing distortion and double images. Magnifying mirrors are generally avoided due to increased distortion; loupes or dental operating microscopes are preferred when magnification is required. Effective visualisation depends on adequate magnification, illumination, and reflection.⁸
- **Endodontic Explorers-** Endodontic explorers aid in locating root canal orifices and determining their direction. Although standard explorers are commonly used, specialised instruments such as DG-16 and JW-17 explorers provide greater precision during canal identification.⁸
- **Nickel-Titanium Instruments-**
Endo EZE TiLOS Anatomic Endodontic Technology – The Endo-Eze Anatomic Endodontic Technology (AET) system (Ultradent Products Inc., USA) was introduced as a minimally invasive canal preparation system. It uses stainless-steel shaping and apical files with conservative dimensions. The shaping files are operated with a reciprocating/oscillating handpiece for coronal canal preparation, while the apical files are used manually with a clockwise turn-and-pull motion. The system is designed to provide controlled preparation while preserving more natural tooth structure, particularly in irregularly shaped canals.⁹

XP ENDO FILES- The XP-endo Finisher system (FKG Dentaire SA, Switzerland) is a heat-treated Ni-Ti instrument designed to enhance three-dimensional cleaning of the root canal while preserving dentine. Its flexible, snake-shaped file has a 0.01 taper in the martensitic phase and expands to approximately 0.04 at body temperature due to its shape-memory properties. The instrument adapts to canal irregularities and reaches areas that may be difficult to contact with conventional files. Its main functions include enhancing debris removal, improving canal-wall contact, and facilitating conservative three-dimensional cleaning, while its flexibility and fatigue resistance support safe instrumentation.¹⁰

TruNatomy- The TruNatomy system (Dentsply Sirona, Switzerland) is a heat-treated Ni-Ti system with a slim design and regressive taper, developed to maximise dentine preservation. It includes the Orifice Modifier, Glide Path File, and Shaping Files, which facilitate conservative orifice enlargement, smooth glide-path preparation, and efficient canal shaping. Its off-centred parallelogram cross-section and heat-treated alloy provide enhanced flexibility and fatigue resistance. The system is available in different sizes, including Small (20/.04), Prime (26/.04), and Medium (36/.03), allowing its use in a range of canal anatomies.¹¹

SAF system 3D cleaning- The Self-Adjusting File (SAF) is a hollow, flexible Ni-Ti lattice instrument with a rough abrasive surface. Its compressibility allows it to adapt three-dimensionally to the canal's cross-sectional shape, including oval canals, while preserving dentine. Unlike conventional rotary files, the SAF is operated using gentle in-and-out vibrational movements with a specialised handpiece rather than continuous rotation.¹²

- **EndoActivator system-** This technology uses sonic energy (2–3 kHz) to activate a selected tip and intracanal irrigants, generating hydrodynamic agitation that enhances cleaning of well-shaped root canals.¹³
- **Multisonic Gentle wave system-** The GentleWave system (Sonendo, USA) is an advanced irrigation technology designed to clean and disinfect the root canal system following minimal instrumentation. It uses a closed-loop system that generates negative pressure, facilitating effective delivery and activation of irrigants throughout the canal.¹³
- **Photon induced photoacoustic streaming-** The Photon-Induced Photoacoustic Streaming (PIPS) technique, developed by Dr. Enrico DiVito and his team, uses an Er:YAG laser to activate intracanal irrigants and generate three-dimensional hydrodynamic streaming, enhancing root canal cleaning and disinfection.¹³
- **Photodynamic therapy in endodontics (PDT)-** Light-Activated Disinfection (LAD) combines a photosensitizing agent with a specific light source to target and eliminate bacteria within the root canal system.¹³



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- **EndoVac system-** The EndoVac system (Discus Dental, USA) uses apical negative pressure to draw irrigant from the pulp chamber towards the apical third, where a microcannula facilitates effective irrigation while reducing the risk of apical extrusion.¹³
- **Dental Loupes-** Magnifying loupes, typically available in 2x–6x magnification, enhance visualisation during endodontic procedures. They include single-lens, Galilean, and Keplerian (prism) loupes, with increasing optical complexity and image quality. Loupes may also be flip-up, allowing adjustment of the viewing angle, or through-the-lens (TTL), which offers a wider field of view, lighter design, and customised positioning.¹⁴
- **Endodontic Operating Microscope-** The introduction of the endodontic operating microscope (EOM) is one of the major developments in endodontics. It provides magnification (approximately 3x–30x) and enhanced illumination, improving visualisation during both conventional and surgical endodontic procedures. The microscope also promotes ergonomic working positions, commonly ranging from the 9 o'clock to 12 o'clock positions, helping reduce operator strain.¹⁴

The EOM consists of three basic components:

- Supporting structure: Provides stability and may be floor-, wall-, or ceiling-mounted.
- Microscope body: Includes:
 - Eyepieces: Usually 10x–20x magnification with adjustable diopter settings.
 - Binoculars: Straight, inclined, or inclinable tubes that hold the eyepieces.
 - Magnification changer: Provides multiple magnification levels or continuous zoom.
 - Objective lens: Determines the working distance; a 200-mm focal length is commonly suitable for endodontics.
- Light source: Provides intense illumination of the small and deep operative field. The coaxial illumination aligns the light with the line of sight, reducing shadows and improving visibility within the root canal system.¹⁴
- **Ultrasonic Tips-** Ultrasonic cutting employs piezoelectric oscillations to selectively remove dental hard tissues and restorative materials without rotary movement. Ultrasonic tips are available in various shapes, sizes, and angulations, allowing precise cutting in restricted areas. Due to the small operative field, adequate magnification and illumination are essential for effective use.
- “4” series tips: Used for troughing around posts and locating calcified canals.
- EndoSuccess™ ultrasonic tips: Include CAP1, CAP2, and CAP3 micro-blade tips. EndoSuccess™ Canal Access Prep kit is designed for locating and opening buried or calcified canals and for refining and completing the access cavity.¹⁵
- **Obturation Materials-** Bio-minimalism in root canal preparation requires a filling material that adapts closely to the canal walls, interacts with dentin, and provides a durable seal. This can be achieved using hydraulic bioceramic cements, which are highly hydrophilic and utilise the natural moisture present within dentinal tubules.¹³

Common hydraulic endodontic cements/sealers include:

1. BioRoot RCS (root canal sealer)- Septodont, SaintMaur-desFosses Cedex, France
2. Endosequence BC (bioceramic) sealer Brasseler, Savannah, GA, USA
3. TotalFill (bioceramic sealer)- FKG Dentaire, La-Chaux-De-Fonds, Switzerland
4. iRoot SP (sealer)- Innovative BioCeramix Inc., Vancouver, Canada
5. Tech biosealer Endo-Isasan, Como, Italy
6. EndoSeal MTA-Maruchi, Wonju, Korea
7. MTA Fillapex-Angelus Industria de Produtos Odontologicos S/A, Londrina, Brazil
8. TheraCal LC (light cured)- Bisco Inc., Schaumburg, IL, USA¹³

- **Restorative Strategies-** The long-term success of endodontic treatment depends on an effective coronal restoration that prevents microbial penetration through the restorative margins. Composite restorations and onlays provide conservative, biomimetic options for restoring minimally prepared endodontically treated teeth.¹³

III. CONCLUSION

The armamentarium for Minimally Invasive Endodontics (MIEC) combines advanced magnification, instrumentation, irrigation, obturation, and restorative technologies. These tools facilitate precise treatment, improved visualisation, preservation of sound tooth structure, and effective root canal disinfection and sealing. Proper selection and skilled use of the armamentarium are essential for achieving predictable outcomes while maintaining the structural integrity of the tooth.



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