Minimally invasive endodontics - Part 1: From endodontic access to shaping of root canals

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Endodontics is constantly evolving. Modern technology has a significant impact on the success rate of endodontic treatment, which is between 87-97% over a 10-year period [1, 2, 3]. Failure in endodontics is often related to fractures, which range from 3.69% up to 25% in endodontically treated teeth and are connected with the substantial loss of hard dental tissues (HDT) during root canal treatment [4-11]. The success of endodontics is a delicate balance between eliminating bacteria and preserving the maximum strength of the tooth so it resists structural deformation and remains functional over the years [12, 13].

With advancements in technology and science, there is a paradigm shift in endodontics – minimally invasive endodontics (MIE). This concept aims for the maximum preservation of healthy tooth structures from the crown to the root apex [14]. Several advancements have made this possible: magnification, CBCT (small field of view, high resolution), ultrasonic devices and tips, new heat-treated alloys of Ni-Ti files, evolution of irrigation techniques, development of biocompatible materials and techniques for root canal obturation, and static and dynamic guidance [15].

Tooth structure preservation: the importance of peri-cervical dentin (PCD)

Preserving as much hard dental tissues as possible during endodontic treatment is a key factor for success as it is directly related to the function of the tooth in the future. Preservation of peri-cervical dentin (PCD) is crucial for maintaining structural integrity and long-term survival of the teeth, especially in molars [16]. PCD is the area about 4 millimeters above and below the orifice (fig. 1) [17].

MIE: access cavity preparation

The traditional endodontic access cavities are related to big loss of hard dental tissues in the crown, which reduces the strength of the tooth. Opposite to it is the

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Dr. Dimitar Kosturkov graduated with honors from the Faculty of Dental Medicine in Sofia, Bulgaria, in 2014. Since then, he has been an endodontist and restorative dentist at Uzunov Dental Clinic in Sofia. From 2016 to 2019, he was a full-time PhD student in the Department of Conservative Dentistry at FDM-Sofia. In 2017, he began teaching students at FDM-Sofia. In 2019, he successfully defended his dissertation on the topic: "Pulse Oximetry in Dental Medicine" and obtained his PhD degree. In 2020, he obtained a specialty in operative dentistry and endodontics from FDM-Sofia. Since 2021, he has been a chief assistant professor in the Department of Conservative Dentistry at FDM-Sofia. He is author of numerous publications in Bulgarian and international journals and scientific projects.

Dr. Kosturkov's main interests are in the fields of endodontics, treatment of dental caries, dental photography and digital dental medicine. He is a member of the Bulgarian Dental Association (BDA), the Control Commission of the Sofia Region Body of BDA and the Bulgarian Scientific Society of Dental Medicine. He is a speaker at Inspire Dental Academy and Dentstore Bulgaria and an international endodontics speaker for Kerr Endodontics and Carl Zeiss.

ultra-conservative access, which is maintaining as much as possible of the pulp chamber roof [18]. In order to prepare that access the operator usually has to create a small, rounded opening in the center of the tooth with long-shank diamond rounded bur (usually 1.2 mm), reaching the pulp, then use ¾ stainless steel bur (1.2 mm) to remove coronal pulp, diamond burs with non-cutting tips, ultrasonic tips to refine the cavity and magnification to visualize the orifices (fig. 2).

One of the biggest difficulties created by the constricted access cavities is the location of the root canal orifices due to the limited view of the pulp chamber floor (fig. 3). The access to the root canals is not straight line, but the new Ni-Ti alloys (such as in ZenFlex™ files) allow safe shaping through this small coronal opening [19].

MIE: coronal flaring – trends

For many years preliminary coronal enlargement of the root canals used to be made by gates-glidden burs. This is associated with very extensive preparation in PCD region, chance of creating a ledge or blockage of narrow/curved canals and perforation. Special rotary instrument for opening of the orifices like Traverse™ Orifice opener (size 25/08) is more suitable. It removes less HDT, it is always centered in the root canal (minimum risk of blockage and ledge), it is used with brushing motion towards the thicker wall (no chance of perforation) and it creates smooth tapered space for negotiating and shaping of the root canal.

MIE: working length

In order to perform MIE the clinician must shape, disinfect and obturate within the limits of the root canal, which ends in the zone of apical constriction. It is very important to measure this point precisely. Inaccurate working length (WL) measurement might lead to failure of the root canal therapy related to poor (unintentional) disinfection and obturation. Modern highly accurate and advanced electronic apex locators (EAL) such as Apex Connect (Kerr) make this process easier and more reliable. Safety features of Apex Connect include automatic self-calibration that activates every time the device is switched on to ensure accurate measurements during operation; smart light apex indicator and audible indicator for real-time working length information.

A step further in accuracy is the integration of EAL Apex Connect with the endodontic motor elements™ Connect (Kerr). This is a big advancement in MIE concept as it provides opportunity for real-time working length measurement during root canal preparation. This reduces dramatically the chance for procedural errors such as overpreparation or blockage, ledge, via falsa and perforation. In addition, elements connect maintains all existing shaping techniques based on

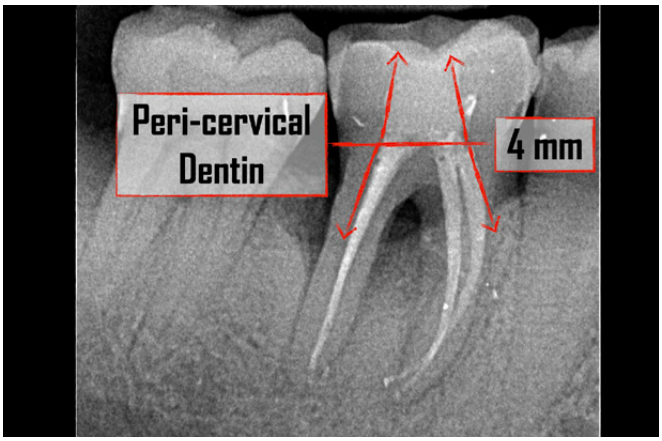

Fig.1 GPDM monomer bonds onto the metal and ceramic surface through metal chelation process.

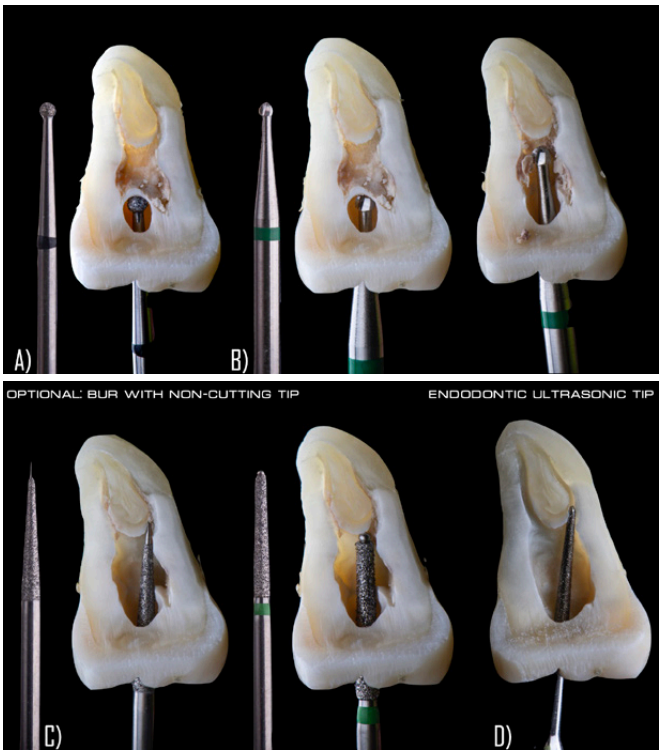

Fig.2 Conservative access cavity preparation. A) Long-shank diamond rounded bur used to reach the pulp; B) ¾ stainless steel bur for removal of coronal pulp; C) Diamond burs with non-cutting tip and D) endodontic ultrasonic tip for cavity refinement.

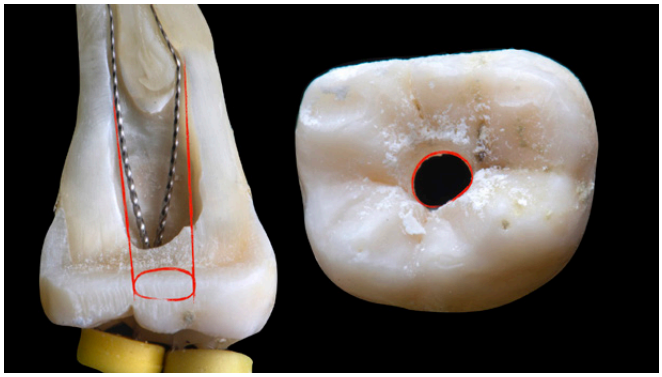

Fig.3 Constricted endodontic cavity access – usually a very small, rounded opening in the center of the tooth.

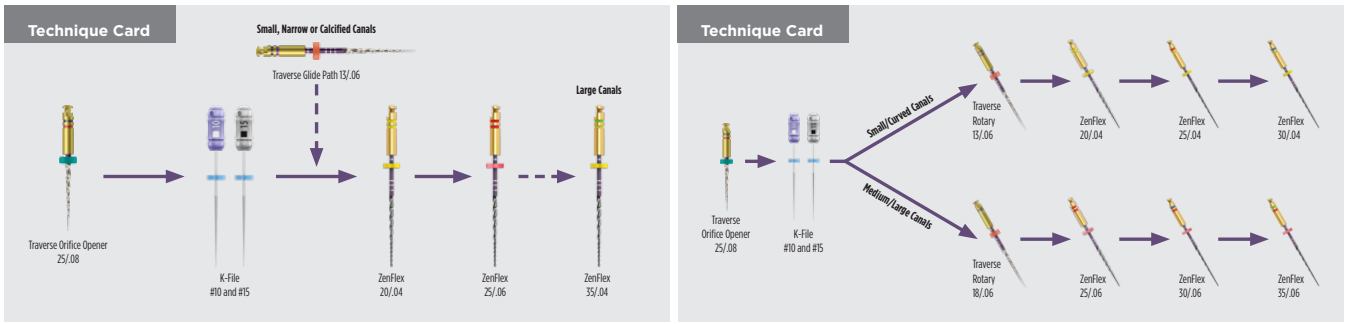

Fig.4 ZenFlex technique card – different approaches.

full rotation, reciprocation and even adaptive motion. When connected with Apex Connect, there is a smart light indicator on the motor for real time working length. elements™ Connect has very small head of the contra angle covered with dark anti-reflexive material, which makes more easier the shaping of root canals under microscope, especially when ultra conservative access cavities are performed.

MIE: Shaping

The concept of MIE related to shaping of root canals has two different aspects – minimal removal of HDT and maximum preservation of the original root canal anatomy. The first is function of the diameter of the tip and taper of the files. It has been proved that when the canal is prepared with small apical diameter and taper (25/04) it can be disinfected and obturated adequately, without weakening of the root canal [20-26]. Preserving the original anatomy depends on the design and alloy of the file. ZenFlex™ is Ni-Ti file system that is based on MIE concept. Some of its characteristics make this possible:

- Non-cutting tip with special design for prevention of ledges and transportation
- Variable heat treatment optimized for each size that prevents derangement of canal path and makes the files highly resistant to breakage
- More austenite structure for small files, which provides more cutting efficiency, whereas big sizes have more martensic structure, meaning higher flexibility
- Triangular cross section, which on one hand means smaller core and bigger flexibility and on another provides 57% greater chip space for debris evacuation compared to square files
- Variable pitch flute angles which decrease the risk of threading and breakage
- Maximum flute diameter limitation (MFD) - smaller diameter at d16 and much more conservative preparation with less removal of PCD

Before shaping of the root canals, glide path should be created. It makes the shaping process easier and with less chance of complications. Glide path can be created manually, but rotary instruments will follow the natural anatomy better without modifying it. Traverse™ is glide path system used in combination with ZenFlex™ files. It comprises an orifice opener with a size of 25.08 and glide path files with sizes 13.06 and 18.06.

MIE: Shaping techniques

ZenFlex™ files can be used with standard multi step technique.

For small canals (the one where initial file is #10) shaping can be done in the following sequence: Traverse™ Orifice Opener (25.08) and Glide path (13.06), then Zenflex™ 20.04, 25.04;30.04.

For large canals (where the initial file is #15 or more) - Traverse™ Orifice Opener (25.08) and Glide path (18.06), then Zenflex™ 25.06, 30.06; 35.06. A hybrid approach can be used as well, which is simple, cost effective and fits most of the cases. The orifices are opened with Traverse™ Orifice Opener (25.08), after that Glide Path (13.06) file is used only in cases of small, narrow or calcified canals, then shaping continues with Zenflex™ 20.04 and 25.06. In large canals the preparation can be completed with 35.04. (fig. 4)

Conclusion

MIE concept requires maximum preservation of hard dental tissues in order to preserve the tooth in long term. Although yet there is no clear scientific evidence concerning the impact of MIE on the success rate in the modern era of endodontics root canal therapy should be practiced in minimally invasive way. This can be achieved only by using special instruments, tools and techniques and requires certain clinical experience.

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Disclosure: Dr. Dimitar Kosturkov is a consultant for Kerr. The opinions and technique expressed in this article are based on the experience of Dr. Dimitar Kosturkov. Kerr is a medical device manufacturer and does not dispense medical advice. Clinicians should use their own professional judgment in treating their patients.

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