

Minimal Invasive Endodontics: The New Revolution

¹Limsha Nath V.P. , Postgraduate Student, Department of Conservative Dentistry and Endodontics, Yenepoya Dental College, Mangalore, India

²S. Vidhyadhara Shetty , Professor , Department of Conservative Dentistry and Endodontics ,Yenepoya Dental College , Mangalore , India

³K. Harish S. Shetty , Professor and Head of the Department, Department of Conservative Dentistry and Endodontics, Yenepoya Dental College , Mangalore , India

⁴Vivian Flourish D’Costa, Reader, Department of Conservative Dentistry and Endodontics ,Yenepoya Dental College , Mangalore , India

Corresponding Author: Limsha Nath V.P. , Postgraduate Student, Department of Conservative Dentistry and Endodontics, Yenepoya Dental College, Mangalore, India

Citation of this Article: Limsha Nath V.P. , S. Vidhyadhara Shetty , K. Harish S. Shetty , Vivian Flourish D’Costa, “Minimal Invasive Endodontics :The New Revolution”, IJDSIR- February - 2020, Vol. – 3, Issue -1, P. No. 199 – 206.

Copyright: © 2020, Dr. Sinjana Jana, et al. This is an open access journal and article distributed under the terms of the creative commons attribution noncommercial License. Which allows others to remix, tweak, and build upon the work non commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Preserving the natural tissue for the extended survival of tooth is the principle of minimal invasive dentistry. Minimal invasive endodontics(MIE) aims at salvaging the tooth structure during the endodontic treatment and its post endodontic restoration phase . The dentist need to preserve the tooth structure during access cavity preparation, cleaning and shaping of the canal, post space preparation and post endodontic restoration of the teeth. Innovations in the field of optics , instrumentation , materials , robotics and computer systems have given hopes for a challenging future.This review throws light on achieving the goal of minimal invasive endodontics.

Keywords: Minimal Invasive Endodontics, Post Endodontic Restoration, Instrumentation

Introduction

Preserving the mother nature promises our longer survival .Similarly preserving the natural tooth tissue is gifted with its extended survival.This is the principle of minimal invasive endodontics (MIE) . MIE refers to the minimally removal of dentin during the all three phases of a root canal procedure: (1) Coronal access preparation; (2) radicular apical preparation; and (3) flaring of the canal that connects the coronal to the apical preparations.^[1] Utilizing advanced imaging modalities and computer software for understanding the complexities of the root canal system, employing increased magnification, and lighting for visualizing the pulpal space ,working with new instruments, irrigants for cleaning and shaping the canal system and applying newer materials that increase

the prognosis for restoring structure and retaining the natural dentition are the various stepping stone to minimal invasive endodontics..

Going forward, the question that should be scientifically answered is, how conservatively can be prepared any given access cavity or root canal, and most importantly - still enable the root canal system to be both 3D cleaned and filled? Until, this question is answered by collaborative research, it would be better to continue to practice utilizing the most proven treatment concepts and techniques. Long-term endodontic treatment success must integrate respect for the concept of MIE while fulfilling treatment objectives by mechanically and biologically. Dr. Herb Schilder, in 1974, precisely described the mechanical objectives for the preparation of a canal that, when filled, would ensure the biological goals for long-term success.^[2]In the goal of destroying the microorganism from the root canal ,we have been increasing the apical width and taper of the canal which result in destruction of the remaining tooth structure. Eliminating the maximum microorganism with minimal invasion is a challenge. Preservation of what remains matters .This article highlights on the various minimal invasive strategies during the endodontic procedures and its restoration.

Iminimal Invasive Endodontics: Advantages

The less invasive treatment approach ('Endolight')has the following advantages: ^[3]

- Preservation of immunological functions and retaining structural integrity of the tooth.
- Simplifying treatment procedures and avoiding treatment complications associated with difficult root canal anatomy.
- Suggested procedures cause little pain (Simon et al. 2013).

- Reducing cost and inconvenience for patients and society.

Diagnosis and Treatment Planning

A new classification was introduced in pulpal diagnosis based on clinical symptoms (Hashem et al. 2015). Hashem and co-workers classified pulpitis as: ^[3]

- Mild reversible pulpitis: patients' descriptions of sensitivity to hot, cold and sweat lasting up to 15–20 s and settling spontaneously.
- Severe reversible pulpitis: increased pain for more than several minutes and needing oral analgesics.
- Irreversible pulpitis: persistent dull throbbing pain, sharp spontaneous pain and tenderness to percussion or pain exacerbated by lying down.

Proposal for new clinical pulp diagnosis terminology and associated treatment modalities: ^[4]

Initial pulpitis

Heightened but not lengthened response to the cold test, not sensitive to percussion and no spontaneous pain.

Therapy: Indirect Pulp Therapy (van der Sluis et al. 2013, Asgary et al. 2015)

Mild pulpitis

Heightened and lengthened reaction to cold , warmth and sweet stimuli that can last up to 20 s but then subsides, possibly percussion sensitive. According to the histological situation that fits these findings, it would be implied that there is limited local inflammation confined to the crown pulp.

Therapy: Indirect Pulp Therapy (van der Sluis et al. 2013, Asgary et al. 2015)

Moderate pulpitis

Clear symptoms, strong, heightened and prolonged reaction to cold, which can last for minutes, possibly percussion sensitive and spontaneous dull pain that can be more or less suppressed with pain medication. According to the histological situation that fits these findings, it

would be implied that there is extensive local inflammation confined to the crown pulp.

Therapy: Coronal pulpotomy – partly/completely

Severe pulpitis

Severe spontaneous pain and clear pain reaction to warmth and cold stimuli, often, sharp to dull throbbing pain, patients have trouble sleeping because of the pain (gets worse when lying down). Tooth is very sensitive to touch and percussion. According to the histological situation that fits these findings, it would be implied that there is extensive local inflammation in the crown pulp that possibly extends into the root canals.

Therapy: Coronal pulpotomy – if there is no prolonged bleeding of pulp stumps in the orifices of the canals, these will be covered with MTA in mature teeth, followed by restoration (Alqaderi et al. 2014). If one or more of the pulp stumps keeps bleeding after rinsing with 2 mL 2% NaOCl, a superficial pulpotomy can be carried out, whereby more inflamed tissue is removed from the canal up to 3–4 mm from the radiographic apex. If bleeding ceases, then the root canal up to the vital pulp tissue is filled with gutta-percha and sealer at this working length. If bleeding persists, a full pulpectomy needs to be performed in order to remove all inflamed tissue from the canal

(Matsuo et al. 1996).

Structural Integrity

Preserving the remaining tooth structure plays an important role in the structural integrity of tooth. Reeh et al., in 1989, did a study to assess the stiffness of cusps when comparing conventional cavity preparations to endodontic access openings on bicuspid teeth. It was shown that endodontic procedures reduced the relative cuspal stiffness of premolar teeth by only 5%, in contrast to an occlusal cavity preparation (20%) and an MOD

cavity preparation (63%) . Marginal ridges are a key factor in retaining tooth strength as per above studies^[4]

There is a perception that endodontically treated teeth becomes desiccated and are prone to fracture. While Rosen described the dentin of endodontically treated teeth as "desiccated and inelastic," Johnson et al. additionally speculated that the elasticity of dentin decreased with time following endodontic treatment. Alternatively, it has been suggested that, rather than endodontic treatment, loss of tooth structure associated with restorative procedures was the major factor in weakening teeth.^[5] Collectively, various studies show minimum dehydration effects due to pulpal removal and demonstrate biomechanical behaviors in strength and toughness testing that are similar to vital dentin.^[5-7] Factors which can cause the dentinal fatigue resulting cracks are chemical factors such as irrigants and medicaments on dentin; the bacterial effect on the matrix of dentin; structural loss due to the effect of post and core restorations and the results of age changes in dentin.^[8]

Failed endodontic tooth has mainly two causes:

- 1.How much stress a tooth under load experiences
- 2.The biomechanical properties that help the remaining tooth structure to resist fracture

Three ways to attain biological success are:

- 1.By removal of canal microbes from the apical 3 mm
- 2.Long term survivability of the tooth is achieved by minimal tooth tissue removal from the coronal two thirds of the root.
- 3.Access to the root canal is difficult.

Minimally Invasive Access Strategies

The main features to be aware in minimal invasive endodontics are:

- a.Pericervical dentin
- b.3D ferrule
- c.3D Soffit

Pericervical dentin

It is the dentin present 4 mm above the alveolar crest and 4 mm below the crest. Preservation of this area is important as it reinforces the tooth.

3D Ferrule

Axial wall of dentin covered by axial wall of crown. 3D refers to the components of ferrule namely:

It has

1. Vertical component - around 1.5 to 2.5 mm
2. Dentin thickness (Girth) - Absolute minimum thickness – 1-2 mm
3. Total occlusal convergence/ Net Taper-Total draw of 2 opposing axial walls to receive a fixed crown which is 10° in 3mm of vertical ferrule, 20° in 4mm, possible in the traditional stainless-steel crowns whereas the newer porcelain crowns demands 50° or more taper owing to its deep chamfer marginal zones.^[9]

Soffit/Banking

A small border of the chamber roof is maintained where it curves 90° to the wall. In the tooth, this tiny “lip” or “cornice” could be as small as 0.5 mm, or as large as 3.0 mm in some cases (where extra strength is needed, or when the anatomy allows it)(Fig.1.) . The primary reason to maintain the soffit is to avoid the collateral damage that usually occurs, namely the gouging of the lateral wall.^[10]

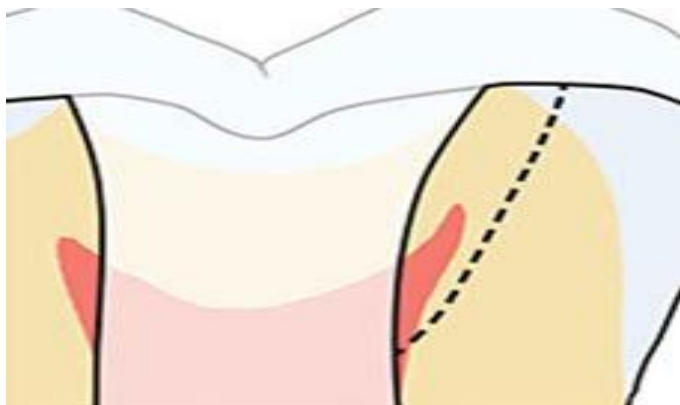


Fig. 1: Dotted line shows the typical cut made to remove the entire pulp horn. Area between the lines is referred to as the soffit.^[9]

Newer access designs include

- 1) Conservative Endodontic Access Cavity
- 2) Ninja Endodontic Access Cavity
- 3) Orifice-Directed Dentin Conservation Access Cavity
- 4) Incisal Access
- 5) Cala Lilly Enamel Preparation

Conservative Endodontic Access Cavity (CECs)

John Khademi and David Clark modified traditional access cavities and developed the constricted or conservative endodontic access cavities to minimize the tooth structure removal while maintaining the mechanical stability of the tooth for long-term survival and function of the endodontically treated teeth. Here, teeth are accessed at central fossa and extended only as necessary to detect canal orifices, thus preserves the pericervical dentin and part of the chamber floor.

Ninja Endodontic Access Cavity (NECs)

An access with a ‘Ninja’ outline, the oblique projection is towards the central fossa of the root orifices in an occlusal plane. It is parallel with the enamel cut of 90° or more to the occlusal plane, making it easier to trace the root canal orifices from the varying visual angulations.

Orifice-Directed Dentin Conservation Access Cavity / ‘Truss’ Access Cavity

Purpose of this design is to preserve the dentin i.e. Leaving a truss of dentin between the two cavities that has been prepared. Separate cavities are made to approach the canals.^[11] Mandibular molars, two separate cavities are made to approach the mesial and the distal canals where as in maxillary molars, the mesiobuccal and the distobuccal cavities is approached in one cavity and a separate cavity for the palatal canal is made.

Incisal Access

In contemporary access cavity preparation access is shifted from centre of the lingual to incisal edge to increase the accessibility.

Blind Tunnelling: Gouging commonly observed with round burs which are aggressive in nature and cingulum access. Buccal-lingual gouging (not easily seen in x-rays) occurs in nearly every traditionally-accessed case.^[11]

The Inverse Funnel: As the access grows internally, an inverse funnel is created.^[11]



Fig. 2: Incisal access preparation^[10]



Fig. 3: Traditional parallel-sided access (left), compared with the Cala Lilly enamel preparation (right).

Cala Lilly Enamel Preparation

Traditional parallel-sided access compared with the Cala Lilly enamel preparation. Unfavourable C factor and poor enamel rod engagement are typically present when removing old amalgam or composite restorations or with traditional endodontic access 90 degree to the occlusal table. The enamel is cut back at 45 with the Cala Lilly shape.^[11]

Dynamically Guided Access

Dynamic guidance used for dental implants. In endodontics - first introduced by **Dr. Charles M.** It uses information from the patient's CBCT volume to plan an access cavity. Overhead tracking cameras relate the position of the patient's jaw and the clinician's bur in 3-dimensional space. The clinician, by looking at the software interface, gets immediate feedback about the position of the bur as it relates to the position of the planned access and the tooth.^[10]

Microguided Endodontic Access

With the help of special software (coDiagnostix™, Dental Wings Inc., Montreal, Canada), alignment with a CBCT and surface scan allows virtual planning of an ideal access cavity.^[12] Subsequently, a template can be produced by means of a 3D printer. This template guides a minimally invasive drill to the calcified root canal.^[10]

Modern Endodontic Burs

Traditionally used round bur technique relied on tactile feedback as the round bur drops into pulp chamber. Round burs are aggressive in nature, the walls are overextended and gouged in other areas. Newer burs like ck and endoguide burs has a tip size less than half as wide as round bur available from SS White Burs.^[10]

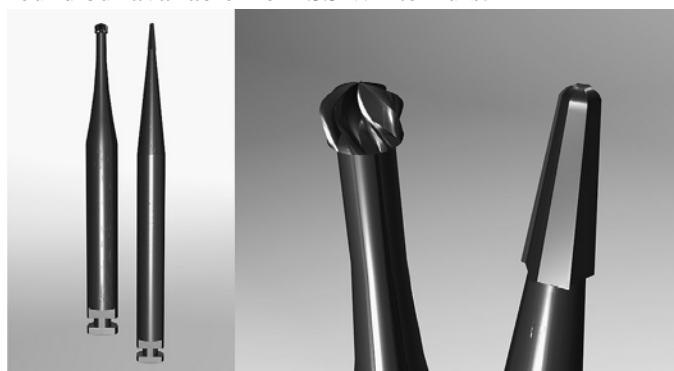


Fig.4.CK endodontic access burs (right) is shown and contrasted with the corresponding surgical length round bur (left).^[11]

Shaping The Root Canal Space

A 3 D cleaning and shaping by minimal invasion can be achieved through a thorough irrigation protocol.

A. Apical Preparation Geometry: Significant difference was not found in intracanal bacterial reduction used with or without apical enlargement preparation, stating it is not necessitated to remove excessive dentin in the apex if sufficient coronal taper is present which allows enough irrigation.^[13]

B. Self-Adjusting File System: Hollow file - compressible, thin-walled, pointed cylinder of 1.5 mm or 2.0 mm diameter and composed of 120- μ m-thick Ni-Ti lattice. File adapts itself to the three-dimensional canal morphology both longitudinally and cross-sectionally. Effectively shapes up to 92% of the of root canal walls, while allowing for the continuous flow of fresh NaOCl through the hollow file by using a peristaltic irrigation device.^[14]

C. TruNatomy rotary file:

Recently, TruNatomy (Dentsply Sirona), a new generation of rotary files was launched. TruNatomy files are pre-packaged, pre-sterilised rotary instruments, designed to shape root canal systems to a continuously tapering preparation with maximum preservation of peri-cervical dentine. This new file system offers the clinician more simplicity, safety, improved cutting efficiency and mechanical properties compared to previous generations of rotating instruments.^[15]

D. Endo-Eze anatomic endodontic technology:

Introduced as a minimally invasive endodontic preparation system. Used in a special reciprocating/ oscillating handpiece for instrumentation of the coronal part of the root canal about 3 mm short of the apex.^[16] Apical files are hand files with shortened cutting flutes to cut only in the apical region of the canal and are used in a clockwise turn and pull motion .

Disinfection

Endoactivator system

In a root canal system, Endoactivator activates the intracanal reagents thereby produces a vigorous hydrodynamic phenomenon utilizing sonic energy.^[17]

Ultrasonic

Acoustic streaming creates sufficient shear forces to dislodge debris in instrumented canals. Files activated with ultrasonic energy acoustic streaming was sufficient to produce significantly cleaner canals compared with hand filing alone. The flushing action of irrigants is enhanced. Improves the efficacy of irrigation solutions in removing organic and inorganic debris from root canal walls.^[17]

Photon Induced Photoacoustic Streaming (PIPS)

Requires any given canal which is prepared upto size 20 files. Striped and tapered tip of PIPS is placed still in the pulp chamber alone. Upon activation of the tip, it creates non-thermal photoacoustic shockwaves, that travel 3 Dimensionally, also into the complex apical regions. It eradicates both biofilm and planktonic contaminates, sterilizing more than 1000 μ m depth into the dentinal tubules.^[10]

GentleWave

It is a multisonic technology with a specific wide spectrum wavelength with different frequencies. The reagents flow through the closed system. With this a 3-dimensional cleaning of canal is achieved including the complex areas like isthmuses, lateral canals and dentinal tubules.^[18] Moreover, it has the technological capabilities to debride and disinfect these integral complex anatomies which are often inaccessible through standard endodontic therapies.^[19]

Post Endodontic Restoration Strategies For Minimal Invasion

Post

Traditional post space preparation resulted in excessive tooth preparation with the use of peeso reamers which in turn leads to loss of structural integrity. The newer posts like Ribbond and Everstick increases the flexibility and requires minimal tooth preparation. Fibre-reinforced resin posts are more elastic support to core.^[10]

Endocrown

The limitations to the use of intraradicular posts, such as calcified root canals, narrow canals, or a fracture of an instrument, have led dentists to think of other alternatives, as the use of endocrowns, an adhesive endodontic crown.^[20] It prevents inadvertent destruction of dental tissues.

Magnification

The resolution of human eye is 0.2mm. This can be enhanced upto 6 micrometre with the help of Surgical Operative Microscope.^[21] Loupes and microscopes have led to another era of minimal invasion.

5 catalyst forces that will change the future of endodontic access and coronal shaping are:

1. Implant success rates
2. Operating microscopes and micro-endodontics
3. Biomimetic dentistry
4. Minimally invasive dentistry
5. Esthetic demands of patients.

Conclusion

Minimal invasive endodontics plays a great role in preservation of what remains. It reinforces and improves the mechanical behavior of a tooth. This review should instill in the reader that endodontically treated teeth are not weak by itself but it is the various procedures carried out that contributes to it. So as a dentist it is our duty to

follow and provide ethical treatment to the patients for the extended survival of the tooth.

References

1. Tang W, Wu Y, Smales RJ. Identifying and reducing risks for potential fractures in endodontically treated teeth. *J Endod* 2010;36:609-17.
2. Mukherjee P, Patel A, Chandak M, Kashikar R. Minimally Invasive Endodontics a Promising Future Concept: A Review Article. *Int J Sci Stud* 2017;5(1):245-251.
3. Wolters WJ, Duncan HF, Tomson PL, Karim IE, McKenna G, Dorri M, Stangvaltaite L, van der Sluis LW. Minimally invasive endodontics: a new diagnostic system for assessing pulpitis and subsequent treatment needs. *Int Endod J.* 2017 Sep 1;50(9):825-9.
4. Reeh ES, Messer HH, Douglas WH. Reduction in tooth stiffness as a result of endodontic and restorative procedures. *J Endodon* 1989;15:512-6.
5. Sedgley CM, Messer HH. Are endodontically treated teeth more brittle? *J Endod* 1992;18:332-5.
6. Huang TJ, Schilder H, Nathanson D. Effects of moisture content and endodontic treatment on some mechanical properties of human dentin. *J Endod* 1992;18:209-15.
7. Nazari A, Bajaj D, Zhang D, Romberg E, Arola D. Aging and the reduction in fracture toughness of human dentin. *J Mech Behav Biomed Mater* 2009;2:550-9.
8. Kishen A. Mechanisms and risk factors for fracture predilection in endodontically treated teeth. *Endod Top* 2006;13:57-83.
9. Clark D, Khademi J, Herbranson E. The new science of strong endo teeth. *Dentistry today.* 2013 Apr;32(4):112-4.

10. Arbiya Anjum S, and Sylvia Mathew SH. Minimally Invasive Endodontics-A Review.
11. Clark D, Khademi J. Modern molar endodontic access and directed dentin conservation. *Dental Clinics*. 2010 Apr 1;54(2):249-73.
12. Connert T, Zehnder MS, Amato M, Weiger R, Kühl S, Krastl G. Microguided Endodontics: a method to achieve minimally invasive access cavity preparation and root canal location in mandibular incisors using a novel computer guided technique. *International endodontic journal*. 2018 Feb;51(2):247-55.
13. Coldero LG, McHugh S, MacKenzie D, Saunders WP. Reduction in intracanal bacteria during root canal preparation with and without apical enlargement. *International endodontic journal*. 2002 May;35(5):437-46.
14. Metzger Z. The self-adjusting file (SAF) system: An evidence-based update. *Journal of conservative dentistry: JCD*. 2014 Sep;17(5):401.
15. Peet J. van der Vyver, Martin Vørster , Ove A Peters. Minimally invasive endodontics using a new single-file rotary system. *INTERNATIONAL DENTISTRY – AFRICAN EDITION 2019: VOL.9(4)* :6-20.
16. Paqué F, Barbakow F, Peters OA. Root canal preparation with Endo Eze AET: changes in root canal shape assessed by micro computed tomography. *International Endodontic Journal*. 2005 Jul;38(7):456-64.
17. Gu LS, Kim JR, Ling J, Choi KK, Pashley DH, Tay FR. Review of contemporary irrigant agitation techniques and devices. *Journal of endodontics*. 2009 Jun 1;35(6):791-804.
18. Ruddle CJ. Endodontic triad for success: the role of minimally invasive technology. *Dent Today*. 2015 May;34(5):76-80.
19. A. Bindl and W. H. Mörmann, “Clinical evaluation of adhesively placed cerec endo-crowns after 2 years: preliminary results,” *The Journal of Adhesive Dentistry*, vol. 1, no. 3, pp. 255–265, 1999.
20. Ford MW. Utilizing the GentleWave® System for Debridement of Undetected Apical Anatomy. *J Contemp Dent Pract* 2018;19(3):345-351.
21. Carr GB, Murgel CA. The use of the operating microscope in endodontics. *Dental Clinics*. 2010 Apr 1;54(2):191-214.