

Clinical Practical Guidelines On Minimally Invasive Endodontics

Review Article

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Abstract

This review comprises various methods of minimally invasive treatment approaches along with traditional approaches that are used in Endodontics. Searches were based on MEDLINE, PubMed databases and bibliographies of all relevant articles and textbooks. The main focus should be on perpetual preservation of what remains rather than meticulous replacement of what is missing which is achieved by the form extension for prevention to the minimal invasion. Minimally invasive approach requires knowledge about the root canal anatomy, diagnosis, decision making, along with preservation of structural integrity of tooth, alternate access designs, image guided endodontic access, dynamically guided endodontic access, microguided endodontic access, modern bur designs, cleaning and shaping, 3D irrigation and disinfection, root strengthening and magnification aids like the loupes and surgical operative microscope. With the help of the following methods mentioned in this article one can preserve the structural integrity of the tooth with minimal invasion and maximum appropriateness.

Keywords: Dynamically Guided Endodontic Access; Image Guided Endodontic Access; Magnification; Micro Guided endodontic Access; Minimally Invasive Endodontics.

Introduction

The objective of root canal treatment is to eliminate microorganisms and pathologic debris from the root canal system, to seal the root canal three dimensionally and to prevent any reinfection [1]. Herbert Schieler in 1974, listed certain mechanical objectives of cleaning and shaping to promote the success of the root canal therapy. During root canal therapy, with the aim of eliminating the microorganisms pathologic debris from the root canal system one should also make sure that there is no extensive loss of tooth structure during the process. Correct diagnosis, decision making, minimal access openings depending on anatomical challenges, minimal removal of dentin, cleaning and shaping of the root canal by retaining as much sound dentin as possible, performing a crown lengthening procedure to establish sound tooth margins for core/crown restorations rather than planning for a tooth extraction and implant or bridge placement

helps in preserving the structural integrity of the tooth structure. [2-7]. Previously our team has a rich experience in working on various research projects across multiple disciplines [8-22] Now the growing trend in this area motivated us to pursue this project.

The article lists out a few approaches of Minimally Invasive Endodontics (MIE) which can preserve the structural integrity of the tooth with minimal invasion and maximum appropriateness.

Diagnosis And Treatment Planning

Many factors favor caries progression such as endodontic and restorative factors and should be considered while treating caries lesions [23-26]. Proper endodontic diagnosis plays an important role for the success of treatment [27-29]. Mature teeth with irreversible pulpitis or apical periodontitis require root canal treatment, during which excessive loss of dental hard tissue can

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lead to weakening the tooth and thus more prone to fracture.[30] Clinical research on vital pulp therapy provides more options for new biologically driven treatment protocols.[31] Minimally invasive endodontics treatment modalities include preservation and maintaining physiological and defensive functions along with minimal removal of hard tissue which preserves structural integrity of tooth. Avoiding full pulpectomies which involves complete removal of the pulp to the apical constriction, wherever possible the biological response of immune system could be enhanced by even a partially retained pulp thus improving the treatment outcome and also helps in preventing further infection of the apical area. A study done by Seltzer & Bender 1963, Garfunkel et al. 1973, Dummer et al. 1980 stated that conventional treatment approaches was thought to have a poor relationship between the histological state of the pulp and clinical signs and symptoms in mature teeth,[32] the recent histological study have shown that there is a good correlation between clinical symptoms of pulpitis and the histological state of a diseased pulp.[33]

Irreversible pulpitis cases have shown morphological changes indicating presence of inflammation or necrosis of coronal pulp while the radicular pulp is viable. This paves way of preserving radicular pulp thus preventing the need for a pulpectomy. This minimally invasive treatment approach is called the Endolight,[31] and helps in preservation of the immunological functions and retaining the structural integrity of tooth, simplify treatment procedures and to avoid treatment complications related with the varying root canal anatomy, reduce cost and inconvenience of patients and the society and is a less painful procedure.[34]

Newer proposal for pulp diagnosis and related treatment modalities

New proposals have been advocated for pulp diagnosis and re-

lated treatment modalities.[35-37] (Figure 1)

Structural Integrity Of Tooth

Remaining structural integrity of the tooth is an important factor that determines the prognosis as it relates to the post endodontic survival rate of the tooth. Maintenance of strength along with stiffness that resists structural deformation becomes the goal of all restorative procedures, mainly in endodontics.

A study compared the impact of endodontic versus restorative procedures on tooth strength and they found that endodontic access openings by themselves have only 5% impact on tooth stiffness in comparison to any restorative preparation that removes the tooth's marginal ridges which also reduces the cuspal stiffness by 63%. Marginal ridges are a key factor in retaining the strength of the tooth. Widely held clinical perception is that endodontically treated teeth are more brittle and hence they are more vulnerable to fracture. Endodontic treatment is the major etiologic factor for tooth fracture, Brittleness of teeth due to loss of moisture,[38] insignificant difference in the moisture content between endodontically treated teeth and teeth with vital pulp.[39]

More Emphasis has been given on the importance of conserving the bulk of dentine to maintain the structural integrity of post-endodontically restored teeth. When endodontically treated teeth fail under function, that outcome is determined by two etiologies- such as degree of stress experienced by the tooth when under load and Inherent biomechanical properties of the remaining structure responsible for resisting the fracture.

Attempts made to prevent fracture rates are by Preservation of peri cervical dentin, 3D ferrule and 3D soffit.[40] Figure 2)(Figure 3)

Figure 1. Represents Flowchart showing strategies for pulp diagnosis and treatment planning.

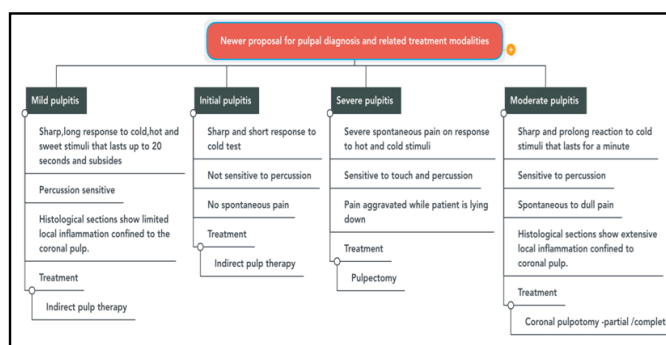
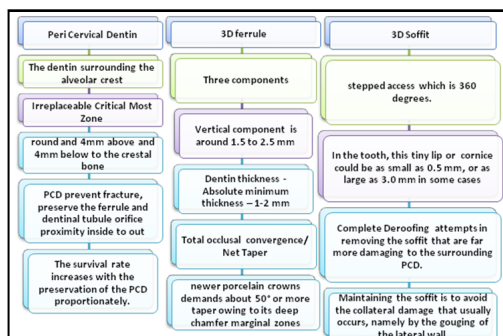


Figure 2. Represents Methods To Prevent Fracture Rate.



Figure 3. Represents Flowchart Explaining Pericervical Dentin, 3D Ferrule And 3D Soffit.



Alternate Access Designs

Traditional access designs (TECs) aim at a straight line access into the root canals which increases the biomechanical preparation efficacy and also helps in reducing the procedural errors. New instruments have round-ended tapers that help to increase the radii of the gouges and nicks that can act as stress concentration points. The flat sides help to create smoother, flatter walls and minimize gouges. Newer access designs include Conservative Endodontic Access Cavity, Ninja Endodontic Access Cavity Orifice-Directed Dentin Conservation Access Cavity/Truss Access Cavity, Incisal Access, Cala Lilly Enamel Preparation and Caries driven Access.[41](Table 1)

CECs, TECs and NECs found that TECs presented lower fracture strength than CECs and NECs in maxillary and mandibular premolars and molars and no statistical significance was found in the fracture resistance mean values of CECs and NECs.[42]

Conservative endodontic access was associated with the risk of compromised canal instrumentation only in the molar distal canals, and it conserved coronal dentin and has a benefit of increased fracture resistance in both the mandibular molars and premolars.[43] Traditional endodontic access may lead to a better preservation of the original canal anatomy during shaping compared with conservative, at the apical level.[44] Instrumentation efficacy and biomechanical responses in conservative and traditional preparations in maxillary molars and found that there was no significant

difference.[45] The MB2 detection rate of CEC (53.3%) and TEC (60%) are higher than that of statistically that of NEC (%31.6). There was no significant difference between CEC and TEC in terms of determining the MB2 canals.[46] No significant difference was seen in the fracture strengths of teeth prepared using the TEC and CEC methods, the types of fractures were less serious with CEC preparation.[47] Both traditional and conservative access designs have their own pros and cons as concentrating on too many conservative designs can lead to inefficient cleaning and shaping and also inability to get the extra canals can in turn lead to failure of the treatment.[48] Hence, one must know when to use based on the right tooth and situation in order to avoid failures. Various other means of conserving the tooth structure through a minimal invasive approach include the use of image guided endodontic access, dynamically guided access, micro guided access and the use of modern endodontic burs.[49](Figure 4)

Cleaning And Shaping

Negotiating and a complete shaping of the canal is the primary goal. A 3D cleaning and shaping ensures minimal mechanical shaping and thorough an irrigation protocol.[50-53]. Combination of mechanical instrumentation, use of irrigating solutions and intracanal medicaments should be used to remove and dissolve organic and inorganic debris, remove the smear layer and maintain dentin permeability.[54] Important things to be included during cleaning and shaping are: Small apical terminal diameters but wide tapers apically, while ensuring sufficient dentin remaining within the body of the root canal. Studies vary on which size diameter

Table 1. Represents Alternate Access Cavity Designs.

ALTERNATIVE ACCESS DESIGNS					
Conservative Endodontic Access Cavity (CECs)	Ninja Endodontic Access Cavity (NECs)	Orifice-Directed Dentin Conservation Access Cavity/‘Truss’ Access	Incisal Access	Cala Lilly Enamel Preparation	Caries driven access
<ul style="list-style-type: none"> Developed by John Khademi and David Clark 	<ul style="list-style-type: none"> An access with a Ninja outline, the oblique projection is towards the central fossa of the root orifices in an occlusal plane. 	<ul style="list-style-type: none"> Purpose -preserve the dentin by leaving a truss of dentin between the two cavities that has been prepared. 	<ul style="list-style-type: none"> Blind Tunnelling: Gouging is observed with round burs which are aggressive in nature and cingulum access. Buccal-lingual gouging (not easily seen in x-rays) occurs in almost every traditionally-accessed case. 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Caries driven access is made either through the mesial or distal wall following the caries process.
<ul style="list-style-type: none"> Traditional access cavities were modified and developed into constricted or conservative endodontic access cavities 		<ul style="list-style-type: none"> Separate cavities are made to approach the canals 			
<ul style="list-style-type: none"> Minimizes removal of the tooth structure while maintaining the mechanical stability of the tooth for long-term survival and function of the endodontically treated teeth 	<ul style="list-style-type: none"> The design is parallel with the enamel cut of 90 or more to the occlusal plane, which makes it easier to trace the root canal orifices from the varying visual angulations. 	<ul style="list-style-type: none"> Mandibular molars, two separate cavities are made to approach the mesial and the distal canals and maxillary molars, the mesio-buccal and the distobuccal cavities is approached in one cavity and a separate cavity for the palatal canal is made. 	<ul style="list-style-type: none"> Inverse Funnel: As the access cavity grows internally, an inverse funnel is created and the precious peri-cervical dentin is lost each time when the bur enters the tooth. 	<ul style="list-style-type: none"> The enamel is cut back at 45 degrees with the shape of a Cala Lilly. 	

Figure 4. Represents Various Methods That Can Be Followed To Conserve The Tooth Structure Through A Minimal Invasive Approach.

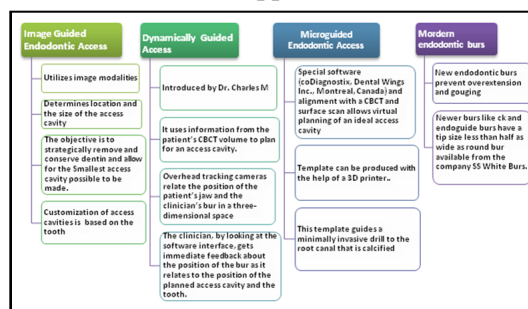


Figure 5. Represents Methods That Enable Minimal Invasiveness and Maximum Effectiveness During Cleaning And Shaping.

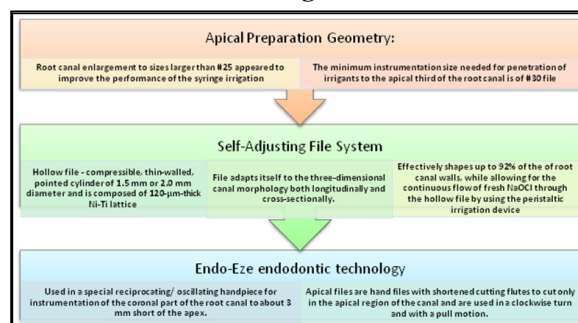
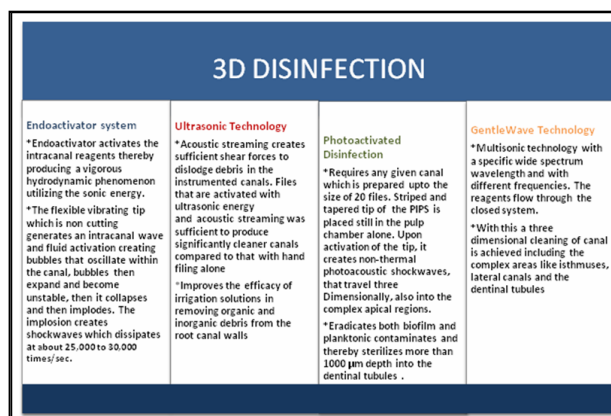


Figure 6. Represents Depicting Various Types of 3D Disinfection that Can Used During Cleaning and Shaping.



will accomplish the maximum cleaning. Apical overpreparation can cause fracture of tooth as it weakens tooth structure. Apical preparation geometry [55-57], the use of self adjusting file [58], the use of Endo-Eze technology, [59] 3D disinfection by means of endoactivator system, ultrasonics, [60] photoactivated disinfection and the use of gentle wave technology [61] are various means by which minimal invasiveness and maximum effectiveness can be achieved. (Figure 5)(Figure 6)

Root Strengthening

Minimally invasive therapy directs the usage of resin in the endodontically treated teeth. Tooth structure is more valuable than the use of a post in every circumstance where adequate structure exists for a ferrule. [62] Adhesive materials can be used and are minimally invasive.

Posts: Traditional post space preparation resulted in excessive tooth preparation with the use of peeso reamers which in turn leads to loss of structural integrity of the tooth. The use of newer posts like Ribbond and Everstick increases the flexibility and

requires minimal tooth preparation. Fibre-reinforced resin posts provide a more elastic support to the core.

Magnification

Magnification magnifies the look in endodontics to the extent that one sees it clearer which has made it possible to look through the difficulties of the root canal treatment. The resolution of the human eye is around 0.2mm. This can be enhanced upto 6 micrometre with the help of a Surgical Operative Microscope. [63] Surgical microscopes are no longer a luxury but it is a necessity in the field of dental practice.

Our institution is passionate about high quality evidence based research and has excelled in various fields. [12, 64-73] The tooth structure has a great influence on fracture resistance of the tooth. This aspect has led us to focus on this current research.

Conclusion

Minimally invasive endodontics helps in preserving the tooth

structure and requires optical magnification aids (surgical microscope), ultrasonic-assisted preparation techniques, modern file systems, and in-depth knowledge of the tooth and the root canal anatomy and is in the interest of the patient. The clinician should strike the right balance between minimal preparation and the traditional endodontic preparation with their own pros and cons and thus achieve the objectives of endodontic treatment.

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