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Minimal Endodontics: A Paradigm Shift Towards Preserving Natural Tooth Structure

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Abstract

Minimal endodontics is a contemporary approach emphasizing preservation of the natural tooth structure during root canal treatment. This review article will tell about the on the theories, methods, and technologies used for minimal endodontics, as well as its clinical benefits, challenges, and future possibilities.

Keywords: Minimally invasive endodontics, Conservative access, Bioceramics, NiTi files, Regenerative endodontics.

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INTRODUCTION

A shift from conventional treatment that focused on extensive instrumentation and tooth structure removal is characterised by minimal endodontics, known as as minimally invasive endodontics (MIE). The main objective of this method is to protect vital dentin structures, especially the pericervical dentin, to help to maintain tooth biomechanics. This conservative approach has become easier and effective in clinical practice due to advancements in imaging methods like flexible rotary files, enhanced magnification tools, and cone-beam computed tomography (CBCT).

Philosophy and Principles

The philosophy of MIE revolves around minimizing intervention while ensuring treatment efficacy some key principles like conservative access cavities preparation to minimize loss of tooth structure while providing adequate access to the root canals. The main goal doing this is to retain as much natural tooth structure as possible, use of heat-treated nickel-titanium files is very good as it increased flexibility, enabling better navigation through curved canals thus it cause minimal loss of dentin. Since there is mini mal loss of dentin, the chemical disinfection becomes very crucial. Irrigants like sodium hypochlorite and EDTA, are frequently used. Post-Op restoration is very important to mimic the natural tooth properties & appearance, thus improving both functional and longevity of the tooth structure.

Access Cavity Designs

Innovative designs in access cavities are important for Minimal Invasive Endodontics: like minimal access cavity preparation which is done by small access openings in the tooth, the main objective of this preparation is to preserve the maximum dentin to provide more strength to the tooth by providing the enough access to locate and proper instrumentation within the canal (Figure 1). Ninja Access cavity preparation is an even more conservative design which helps in preservation of maximum roof of the pulp, but also requires proper magnification. For locating the canals. To maintain the marginal ridges while doing the separate canal accesses truss access is done also. Guided endodontics also used for ultraconservative access cavity preparation while using 3D-printed guides which are by using CBCT and intraoral scans, thus to improve the accuracy while doing treatment and thus reducing the risk of iatrogenic errors [1,2].

Instrumentation Techniques

For Minimal Invasive Endodontic preparation several instrument are used like NiTi Rotary Systems which include many heat-treated files systems like ProTaper Gold (Dentsply), Blueflex files, Hiflex (Coltene). The files have very high flexibility and chances of less fracture [3]. Also Single-File Systems: Systems like WaveOne Gold are very useful as they reduce the procedure time [4]. Self-Adjusting Files (SAF) are also very helpful while doing minimal endodontics as they easily adapts to the canal morphology, which gives three-dimensional cleaning & shaping while preserving canal shape [5]. XP-Endo Shaper files are also very important as they expands within the canal of the tooth, which allows it to do the effective shaping with minimal structural loss [6].

Figure 1: Figure Showing Access Cavity Preparation

Irrigation and Disinfection

Chemical disinfection is essential in MIE since mechanical debridement is limited. Chlorhexidine, sodium hypochlorite (NaOCl), and EDTA are frequently used to breakdown tissues, remove smear layers, and disinfect canals [7].The efficiency of irrigants is greatly increased by passive ultrasonic irrigation (PUI), sonic activation, negative pressure systems such as EndoVac, and laser-activated irrigation (e.g., PIPS, SWEEPS) [8,9].Without the need for harsh instruments, devices such as GentleWave clean intricate canal anatomy using multisonic energy and optimised fluid dynamics [10]. Ozone therapy provides extra disinfection advantages [12], whereas photodynamic therapy (PDT) employs light-activated photosensitisers for antibacterial action [11].

Obturation Strategies

Obturation in MIE prioritizes effective sealing while respecting conservative canal preparations (Figure 2): Bioceramic Sealers are highly flowable, biocompatible, and capable of bonding chemically with dentin. They are well suited for narrow or minimally flared canals [13]. Single-Cone Technique is a very good option: in this a master gutta-percha cone coated with bioceramic sealer is inserted with hydraulic pressure to fill the canal [14]. Traditionally used Warm Vertical Compaction technique can be modified for minimal access by using smaller pluggers and improved heating devices for a good obturation [15].Thermoplasticized gutta-percha (eg.obtura) can also be used by injected directly into the canal space, which adapts well and there is less chances of mistakes [16].

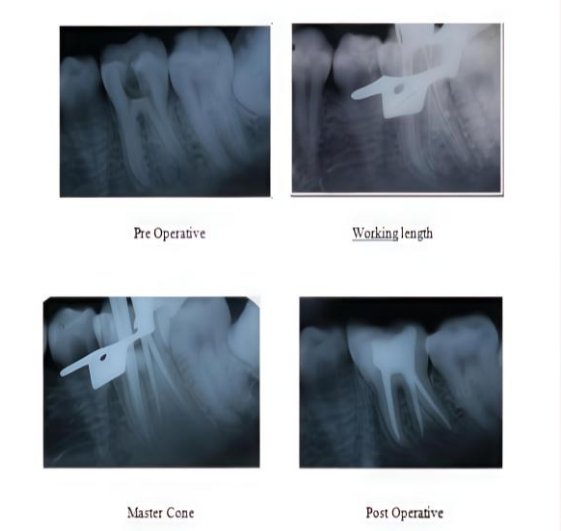

Figure 2: Figure Showing Obturation

Restorative Considerations

For a Long-term success of MIE depends on excellent restoration: Conservative Restorations like Inlays, onlays (Figure 3), and overlays preserve more natural tooth tissue than full crowns. Endocrowns are used to protect the pulp chamber for a good retention and is very good for posterior teeth with excessive coronal damaged tooth structure[17]. Universal adhesives and techniques like Immediate Dentin Sealing (IDS) improve bond strength and minimize leakage [18]. Fiber Posts can be used in cases with insufficient coronal structure, fiber posts provides more strength to the tooth [19]. CAD/CAM can be used to ensure esthetic restorations with minimal material wastage [20]

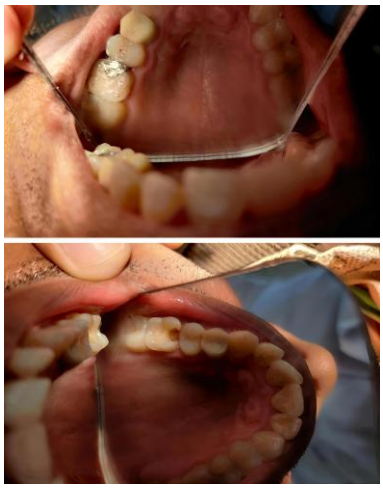

Figure 3: Figure Showing Inlay Cavity Preparation and Inlay Insertion

Advantages

Minimal endodontics offers several key benefits like Enhanced Tooth Strength by preserving the pericervical dentin thus reduces the risk of fracture [21]. Less invasive procedures result in decreased postoperative pain [22]. Patients prefer minimally invasive approaches for comfort and longevity [23]. With improved imaging and guided techniques, there are the less chances of perforation or missed canals [24]. Long-term outcomes are improved thus reduces the chances of endo failure.

Challenges and Limitations

Despite its benefits, MIE faces few challenges too like ideal conservative techniques requires training and practice and patience. Smaller access cavities preparation, identification & working without proper magnification tools is a difficult task. Retreatment can be difficult due to restricted access. CBCT, microscopes, and specialized files are costly thus increase the treatment cost too [25].

Future Directions

The field of MIE is advancing rapidly: AI is very helpful in the diagnosis and treatment plannings [26]. The use of nanoparticles in sealers and irrigants has increased its antimicrobial properties [27]. Augmented and Virtual Reality: AR/VR is used today for many guided procedures and professional training in many countries [28]. Combining MIE with the tissue engineering to regenerate the pulp-dentin complex (Figure 4), especially in immature teeth [29]. Material selection and personalised treatment plans may be guided by genetic analysis [30].

Figure 4: Figure Showing Regeneration after MTA apexification & obturation

CONCLUSION

Since minimal endodontics focuses on accuracy, preservation, and patient-centered outcomes, it is considered an important advancement in dental care. This method could one day become the standard of endodontic therapy due to continuous developments in materials and technology.

Conflicts of Interest

The author reports no conflicts of interest.

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