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Minimally invasive endodontics: A Review

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Abstract
The concept of Minimally invasive endodontics (MIE) involves preservation of maximum healthy coronal, cervical as well as radicular tooth structure during endodontic procedures. MIE can be incorporated in various phases of endodontic treatment, namely access opening, cleaning and shaping of the root canal and surgical endodontics.
This review article discusses various procedures that can be incorporated at each step of endodontics to achieve minimal intervention, which is the goal of the new-age endodontics.

Keywords: minimally invasive endodontics, endodontics, minimally invasive dentistry

Introduction
In the field of cariology there has been tremendous advancement over the past 30 years. Most of these advancements are based on scientific knowledge involving prevention and treatment using minimally invasive approaches. This 'rational' model of care is known as minimal intervention dentistry [1-3].
During early times, surgical model dominated dentistry. But, with inventions of etching and adhesion lead to the era of minimally invasive preparations [4] .

Need for Minimally Invasive Endodontics
The structural integrity of the remaining tooth plays the key role in determining prognosis of the tooth after restoration [5, 6] .
Various studies have shown that the dentin properties of endodontically treated teeth do not differ from vital dentin [7-9] . So, the predominant reason for failure of endodontically treated teeth can be attributed to the increased susceptibility to fracture due to loss of structure.
This makes the concept of minimal intervention highly significant in the field of endodontics.

Procedures used in Minimally Invasive Endodontics (MIE)
MIE can be incorporated into various phases of endodontics, i.e., access opening, biomechanical preparation of root canals as well as surgical endodontics. All these will be further discussed, keeping in mind, the concept of MIE.

(a) Minimally Invasive Access Cavity Preparation
The mail goal of endodontics is to access, shape and clean the root canal system and allow efficient and total filling of the root canal space, leaving the tooth with maximum strength to function successfully [10]. The access preparation should not be too small or big as too small access obstructs the view of the operator, whereas too big preparation leads to unnecessary removal of vital tooth structure.
However, in this era where lighting and magnification are so enhanced, we can make minimally invasive preparations with much more ease and comfort, compared to the earlier times when these were not available.
During minimally invasive access cavity preparation, it is vital to conserve the pericervical dentin (PCD) as it plays a crucial role in maintaining the long-term survivability and function of the tooth. The philosophy of minimal invasion discourages the use of round burs and Gates-

Glidden burs as these instruments lead to the gouging of endodontic access and the coronal third of the root canal, especially around the PCD, which must be avoided to preserve maximal resistance to structural flexure and ultimate failure [10] .

The following minimally invasive access cavity designs can be incorporated, namely-

i. Conservative endodontic access cavity,
ii. Ninja endodontic access cavity, and
iii. Truss access cavity

Conservative endodontic access cavity (CEAC)

This cavity design has been advocated in order to minimize the removal of unnecessary tooth structure [11, 12] .

In conservative endodontic access cavity, the teeth are accessed at the central fossa and the outline is extended only if required to detect the canal orifices. This helps in the preservation of the pericervical dentin and also a part of the floor of the pulp chamber. The pericervical dentin is located 4 mm above and 4 mm below the crestal bone and it play a major role in distributing functional stresses of the teeth. Thus it is vital to preserve this pericervical dentin in order to maintain the biomechanical response of the radicular dentin. [11, 12].

Ninja endodontic access cavity

To obtain an access 'ninja' outline, an oblique projection is made towards the central fossa of the root orifices in an occlusal plane. As the endodontic access is parallel with the enamel cut of 90º or more to the occlusal plane, it is easier to locate the root canal orifices even from different visual angulations [13] .

Truss Access Cavity

It is also called the orifice-directed design. In this, two different cavities are prepared in order to approach the canals.

In case of mandibular molars, two separate cavities are prepared; one for the mesial canals and the other one for the distal canals. In case of maxillary molars, the mesiobuccal and the distobuccal canals are approached through a single cavity and another separate cavity is made to approach the palatal canal. Such conservative cavities are prepared to preserve the dentin i.e. to leave a truss of dentin between the two cavities that have been prepared [14] .

(b) Cleaning and Shaping of the Root Canal Space

This is another critical step in the process of endodontics, and various techniques and instruments can be incorporated to make this step minimally invasive.

Taper of Endodontic files

The old concept of big, aggressive canal-flaring is no more in practice. More conservative designs leave the tooth much stronger and moreover, there is a very limited evidence that wider canal shapes provide a better seal and fewer endodontic failures [7, 8] .

Enhanced instrumentation in the apical area and larger apical diameters weakens the root due to loss of apical dentin and also a loss of control over the obturation component of treatment. Hence, smaller apical preparations and continuous taper are preferred. This kind of preparation preserves root dentin and promotes resistance form and provides a tight apical seal to create sufficient shape for adequate disinfection [15-17] .

Self-Adjusting File (SAF) system

The SAF or the Self-adjusting file system has gained popularity due to its minimally invasive approach.

The design of the SAF produces minimal stress concentrations in the apical root dentin during shaping of the curved canal, which leads to an increase in the chance of preservation of root dentin integrity with a reduced chance of dentinal defects and apical root cracking [18] .

Photon Induced Photo-Acoustic Streaming (PIPS)

The traditionally used laser applications required a conventional preparation for atleast up to size 30 and the laser tip needed to reach up to the apical third of the root. But on the other hand, the PIPS tip can be placed into the coronal reservoir of the root canal. Therefore, this technique allows for minimally invasive preparation of the root canal [19] .

Photodynamic therapy in endodontics (PDT)

PDT is an effective adjunct to standard antimicrobial intracanal cleaning and shaping for the treatment of periapical lesions. When this technique is used efficiently, disinfection of the canals can be obtained without inadvertent instrumentation and removal of excessive dentin [20] .

Minimally Invasive Preparation in Primary Teeth

Kedo-S File System for Primary Teeth

Kedo-S pediatric rotary instrumentation (Reeganz dental care Pvt. Ltd. India) was developed for cleaning and shaping in primary teeth. They are designed specially for biomechanical preparation of primary teeth having shorter, thinner, curved roots, and ribbon-shaped morphology. They can efficiently be used in primary teeth without over instrumentation of the thin root canal wall [21] .

Non-Instrumental Endodontics or LSTR for primary teeth

The lesion sterilization and tissue repair (LSTR) technique was developed by the Cariology Research Unit of Niigata University School of Dentistry, Japan. This technique uses a combination of antibiotics at the exposure site to sterilize the endodontic lesion [22] .

Since excessive instrumentation of root canals leads to inadvertent removal of tooth structure, this Non-Instrumental Endodontic Techniue or LSTR leads o preservation of tooth structure.

The LSTR therapy aims to eliminate causative bacteria from lesions, and after sterilization, the lesions are repaired or regenerated by the host's natural tissue recovery process and is simple, painless, time-saving, and lessens physical and mental burden for patients [23] .

(c) Surgical Endodontics

Traditionally, Apicectomy was performed in teeth with periapical lesions. This is a highly invasive procedure and hence, in the recent years, newer techniques that are less invasive are gaining popularity which include microsurgery and Apexum.

Microsurgery in Endodontics

Endodontic microsurgery is a minimally invasive technique that results in less postoperative pain and edema and faster wound healing. It offers a significantly higher success rate than traditional apical surgery technique [24] .

The use of light and magnification through the surgical microscope offer the greatest advantage to achieve a minimally invasive approach [24] .

Apexum (a non-surgical approach)

This method allows removal of periapical tissues without using scalpels, periosteal elevators or sutures.[25] It is based on a device that removes the chronically inflamed periapical tissues through a root canal access using a procedure that is minimally invasive (Apexum Ablator; Apexum Ltd, Or-Yehuda, Israel) [26] .

Conclusion

Thus, with the advancements in endodontics, a plethora of options are available to preserve tooth structure and vital tissue. Be it access opening, biomechanical preparation of canals, or surgical endodontics, at any level, multiple techniques can be adopted towards achieving a Minimally Invasive Endodontic approach.

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