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Modern Concepts in Endodontic Access Preparation: A Review

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Abstract: ***The aim of every endodontic treatment is to eradicate all organic substrates from the complex root canal system and to obturate the root canal system. After the establishment of diagnosis and treatment plan, the part of the treatment directly applied to the tooth is the access cavity preparation. Access cavity preparation is of paramount importance as it is the vital stage that governs the success or ease of the subsequent treatment stages. Endodontics has seen an unparalleled advancement in technology and materials in the past couple of decades. This period has witnessed remarkable development in endodontic technologies which has brought about various modifications in all phases of endodontic treatment including access opening.***

Keywords: Access preparation, Truss access**,** Ninja access

1. Introduction

In this era of enhanced magnification coupled with the availability of increasingly more flexible nickel-titanium rotary instruments, there has been a paradigm shift in endodontics from conventional to conservative access preparation. Within the last 10 years, the goal of access preparation is towards reducing size of access preparation to the natural dimensions of the pulp chamber aiming at yielding improved survival outcomes. The application of traditional or conventional access cavity preparations became questionable as it is invasiveand may lead to structural failure of a tooth [1].Structural loss of tooth is one of the risk factors for fracture predilection in endodontically treated teeth [2]. Traditional access cavity preparation is found to be one of the largest causes of failure of root canal treatment. So, a reduced endodontic access design would reduce the failure of root canal treatment. Improved prognosis of root canal treated teeth is seen in conservative endodontic cavity, or ultraconservative "endodontic cavity". Clark and Khademi [3], initially proposed an approach for accessing tooth structure and dental material so as to gain access to the root canal system by leverage of caries, missing tooth structure and existing restorations.

2. Preservation of Tooth Structure

Endodontic access should be considered as the key to endodontic success, as well as restorative success and to the long-term retention of endodontically treated teeth and fracture resistance of tooth which are related to the amount of residual tooth structure [4],[5]. The long-term retention of tooth can be ensured by the preservation of the following:

2.1 Pericervical dentin (PCD)

Pericervical dentin is the dentin near the alveolar crest which is roughly 4 mm above the crestal bone and extending 4 mm apical to the crestal bone. This critical zone of dentin is irreplaceable as it plays a critical role in the maintenance of long-term survivability and optimum function of endodontically treated tooth [6].Pericervical dentin is crucial for the transfer of occlusal load to the root. Pericervical dentin preservation is of utmost importance as it helps in the prevention of fracture, preservation the ferrule.

2.2 Banking of tooth structure (Soffit)

In architecture, a soffit is described as the underside of an architectural feature such as the ceiling, the corner of the ceiling, and the wall [7].According to Clark and Khademi, a small piece of roof of pulp chamber is retained around the pulp chamber to preserve pericervical dentin, which is known as the soffit. Maintenance of soffit is a perfect example of banked tooth structure. Attempts at removing soffit which is a small piece of roof around the entire coronal portion of the pulp chamber may alsodamages the surrounding Pericervical dentin [3],[8]. The primary reason to maintain the soffit is to prevent the occurrence of the gouging of the lateral walls. This conservative approach of banking tooth structure thus aids in the long-term retention and fracture resistance of tooth.

2.3 Three-dimensional ferrule (3DF)

Ferrule is the axial wall dentin covered by the axial wall of the crown and has been described as the backbone of prosthetic dentistry. Three-dimensional ferrule is an

evaluation of the available dentin that will buttress the crown which has 3 components [8]:

- Vertical component - around 1.5 to 2.5 mm[5],[7]
- Thickness of dentin (Girth)-Absolute minimum thickness-1-2 mm
- Total occlusal convergence or Net Taper that is the total draw of 2 opposing axial walls to receive a fixed crown which is 10 degree in 3mm of vertical ferrule, 20 degree[9] in 4mm, possible in the traditional stainlesssteel crowns.However, the newer porcelain crowns demand 50 degree or more taper due to its deep chamfer marginal zones.

3. Newer access preparation designs

Traditional endodontic access design has given superior importance to the clinician's convenience for access preparation above the restorative and structural needs of the tooth. Contrary to this, in conservative access, during the endodontic treatment there is maximum preservation of the healthy coronal, cervical and radicular tooth structure to improve the short-term and long-term success of the tooth. According to these new access preparation designs, the elimination and prevention of the disease should be performed without sacrificing tissue unwantedly. The aim of conservative access preparation can be redefined from "removal of as little tooth structure as possible" to "removal of as little as necessary" [10]. It is with the technological advances in the armamentarium that this newer concept of minimally invasive endodontics evolved. Minimally invasive dentistry includes "a systematic respect for the original tissue" and "preventing or treating disease with as little loss of original tissue as possible" according to Ericson [11]. The newer access preparation designs which focuses on dentin preservationwith the aid of the newer advancements in magnification and armamentarium are:

- Truss access
- Ninja Endodontic Access Cavity
- Caries leveraged access
- Cala Lilly Enamel Preparation
- Guided endodontic access
- Dynamic Guided access

3.1Truss access

Truss access is an approach of contracted endodontic cavity which is an orifice directed design in which separate cavities are prepared to approach the canal systems [12]. The main objective of these access cavity designs is the preservation of dentin by leaving a truss of dentin between the two cavities thus prepared. Truss access approach mainly emphasizes on the preservation of the healthy tooth structure with the minimally invasive approach. This minimal invasive approach avoids the need for conventionally placed crowns after endodontic treatment.

Figure 1: The microscopic view of Truss access cavity (Courtesy: Auswin et al, 2017)

3.2 Ninja endodontic access cavity (Orifice-Directed Dentin Conservation Access)

To obtain outline for "ninja" access, the oblique projection during access preparation is madein an occlusal plane towards the central fossa of the root orifices [13]. It is easier to locate the root canal orifices even from the different visual angulationsas the endodontic access is made parallel with the enamel cut of 90º or more to the occlusal plane.

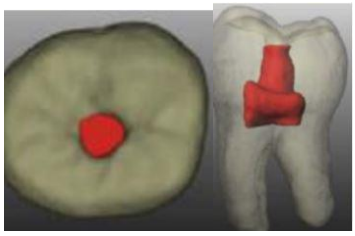

Figure 2: Ultraconservative ''ninja'' access cavity (red) segmented on CBCT reconstructions. (Courtesy: Kanchan et al, 2018)

3.3 Caries leveraged access

According to this concept described by Clark and Khademi, low or zero value tooth or restorative structures i.e., existing restorative materials, decay and less strategic tooth structure are removed for access preparation. This access design thus allows for direct conservation of healthy dentin by removing discontinuities in tooth structure [14].

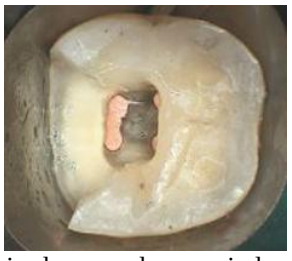

Figure 3: Caries leveraged access in lower first molar (Courtesy: Clark and Khademi, 2010)

3.4 Cala Lilly enamel preparation

In Cala Lilly enamel preparation, shape of the access preparation resembles calalilly flower. In this preparation a bevel (45 degree) is given on the enamel portion of access cavity to remove undermined enamelwhich resembles a calalilly flower [8]. This helps to cover the access preparation within the restorative and to involve the entire enamel and dentinal wall in the restoration, thereby improving the overall resistance and strength of the access preparation.

3.5 Guided endodontic access preparation

'Guided Endodontics' method utilizes 3D printed templates to gain minimal invasive access to root canals. Intraoral scanning is done followed by CBCT scanning. Virtual drill path is then planned on the computer screen which is designed by combining the data from intraoral scanning and CBCT and virtual sleeve is made for the guiding the bur. Templates are prepared based on this and their fitting is checked. Marks are then set through the template sleeves to indicate the region of access cavity. Access is then prepared in this area using specific bur to gain access to the root canal [15].

3.6 Dynamic Guided access

Dynamic guidance which was used for implants was recently introduced as an alternative to milled drill guides. Dynamic guidance was recognised by Dr. Maupin as a solution for the difficulties faced during the use of static drill guides in guided endodontics. It uses an overhead three-dimensional camera system (X-NAV System) which helps to relate the position of the handpiece and the jaw of the patient during the clinical procedure. Thus, this helps the operator in assessing the position of the bur during access preparation [16].

Despite the advancements in technologies that have enabled dentin conservation procedures in modern access cavity preparation designs, the evidence for an increase in fracture resistance remains limited and controversial. A recent study has found that the conservative endodontic access cavity results in conservation of coronal dentin and increased resistance to fracture, especially of posterior teeth but it compromised the instrumentation of the distal canals in the mandibular molars [17]. When fracture strength of endodontically treated teeth with various access cavity designs were compared, increased fracture strength was seen in contracted access and ninja access compared with traditional access preparation [18]. According to a study, there was no significant difference between truss access and traditional access cavity in debridement of pulp chamber and mesial root canal systems in mandibular molars [19]. Further clinical studies are to be conducted to evaluate the influence of this conservative access preparation strategies on the long-term prognosis of endodontically treated teeth.

4. Conclusion

Inspite of successful endodontic therapy, there are cases of failures that necessitates the retreatment of an endodontically treated tooth. Although cone beam computed tomography imaging, operating microscopes, newly-designed endodontic access burs and less tapered engine-driven nickel-titanium root canal instruments are able to preserve the natural tooth structure, challenges faced by clinicians include working effectively and minimizing or avoiding procedural errors while working in confined spaces due to lack of convenience form. There are high chances that small access openings result in undercleaned, undershaped, or underfilled root canal systems. There are additional challenges faced during irrigation as well such as limited irrigant penetration, needle wedging, vapor lock effect, and challenges associated with sonic or ultrasonic or apical negative pressure irrigation. So, further research is required in this area to clarify the benefits and possible risks of minimal access cavity designs and their possible effects on the outcome of root canal treatment before these newer concepts are practised routinely.

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