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Modern Concepts in Endodontic Access Preparation: A Review

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ABSTRACT
The primary objective of any endodontic procedure is to remove all organic substrates from the intricate root canal system and seal the root canal. The access cavity preparation is the portion of treatment that is immediately applied to the tooth once the diagnostic and treatment plan has been established. Preparing the access cavity is a crucial step that determines whether subsequent phases of therapy will be easy or successful. Over the past few decades, endodontics has witnessed an unmatched advancement in technology and materials. The field of endodontics has advanced significantly throughout this time, leading to changes in all areas of endodontic treatment, including access opening.

KEYWORDS - Access cavity design, minimally invasive access cavity, Peri cervical dentin, Soffit, traditional endodontic access cavity.

I. INTRODUCTION

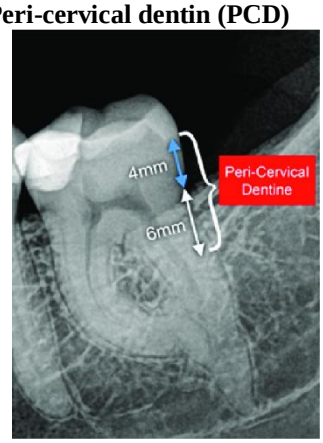
The primary goal of endodontic therapy involves the removal of pathologic debris and germs from the root canal system as well as preventing the possibility of reinfection. Endodontic therapy comprises three factors and they are cleaning and shaping, disinfection, and three-dimensional obturation of the root canal system. One of the most important aspects of the entire root canal treatment process is access cavity preparation, which is essential to the successful outcome. [(1)]One of the major reasons root canal therapy fails is conventional access cavity preparation. Therefore, the failure rate of root canal therapy would be lower with a restricted endodontic access design. Improved prognosis of root canal-treated teeth is seen in the conservative endodontic cavity, or ultraconservative "endodontic cavity." [(2)]

Preservation of Tooth Structure

Since the quantity of residual tooth structure determines the fracture resistance of teeth, endodontic access should be viewed as the key to both endodontic and restorative success as well as the long-term retention of endodontically treated teeth. The following can be preserved to ensure the long-term retention of teeth.

A) Peri-cervical dentin (PCD)
B) Tooth structure banking (Soffit)
C) Ferrule in three dimensions (3DF)

A) Peri-cervical dentin (PCD)



This is the portion of the dentin that surrounds the root canal junction between the clinical crown and the root region. Composite resins and ceramics are just two examples of materials that can be used to rebuild lost tooth structure in the coronal part of the tooth. Currently, a variety of biomimetic materials can be used to substitute dentin in root canal therapy. The peri-cervical dentin, which is located near the alveolar crest, cannot be reversed. This area, which is 4 mm above and 4 mm below the crestal bone, is crucial. The thickness of PCD is directly correlated with the tooth's long-term retention and fracture resistance.
The significance of PCD can be attributed to three main factors-
1. Ferrule 2. Fracture resistance 3. Dentinal tubule proximity

1. Ferrule

The ferrule is a band that encircles the residual tooth structure and prevents the tooth from splitting or wearing. It's been suggested that maintaining at least 2 mm of dentin is crucial for preventing fracture lines. To overcome the tooth's biomechanical response to masticatory stresses, preservation of this is crucial.

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2. Fracture resistance

The preservation of PCD results in the ability of the tooth to withstand both excessive shear and compressive forces during mastication. Insufficient PCD thickness can lead to crown root separation and horizontal tooth fractures.

3.Dentinal tubule orifice proximity

Dentinal tubules are arranged in a way that the tooth's cervical portion has the shortest tubule length. Furthermore, the cementum and enamel have significantly lesser thicknesses. Wear of teeth, particularly following endodontic therapy, causes the cervical cementum and enamel to erode even further. Microorganisms and microbial toxins can enter the root canal space through the open dentinal tubules. These toxins are unable to enter the canal space when the PCD is preserved.[3]

B) **BANKING OF TOOTH STRUCTURE(SOFFIT).** According to Clark and Khademi, the soffit—a small portion of the roof of the pulp chamber is preserved in place encompassing the pulp chamber to protect the pericervical dentin. One excellent illustration of a banked tooth structure is soffit maintenance. Attempts to remove the soffit, a little section of roof that encircles the pulp chamber's coronal portion, may also cause harm to the dentin that surrounds the pulp chamber. Maintaining the soffit is mostly necessary to stop the lateral walls from being gouged.This conservative approach of banking tooth structure thus aids in the long-term retention and fracture resistance of tooth .[2]

C) 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:

·**Vertical component** - around 1.5 to 2.5 mm ·

. Thickness of dentin (Girth)-Absolute minimum thickness-1-2 mm

· **Total occlusal convergence or Net Taper** which is the total draw of 2 opposing axial walls to receive a fixed crown which is 10 degrees in 3mm of vertical ferrule, 20 degrees in 4mm, possible in the traditional stainless-steel crowns. However, the newer porcelain crowns demand 50 degrees or more taper due to their deep chamfer marginal zones.[2]

Traditional endodontic access cavity

For a long while, conventional endodontic access cavity G.V. Blacks preparation was accepted as the standard. Traditional access cavities (TAC) suggest the removal of dental caries and restorations, hence preserving the tooth's structural integrity. The roof of the pulp chamber is eliminated to discover all orifices of the root canal & give direct access to the apical foramen or the initial curvature of the canal by eliminating cervical dentin protrusions & enlarging the canal orifices. The three main objectives of a typical endodontic access cavity are root canal filling, chemo-mechanical preparation, and localization.

However, consistent with some authors, traditional endodontic access eliminates more layers of dentin structure which can weaken the tooth structure. The conventional access cavity designs have recently been reexamined and modified.[2,5]

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. On the other hand, with conservative access, the maximum amount of the tooth's healthy coronal, cervical, and radicular structure is preserved during the endodontic treatment, improving the tooth's success both in the short and long term. These novel concepts for access preparation dictate that the illness should be eradicated and prevented without unintentionally harming tissue.

"Removal of as little tooth structure as possible" can be rephrased as "removal of as little as necessary" in the context of conservative access preparation. The notion of minimally invasive endodontics is a more recent one, arising from technological advancements.

Truss access

Truss access is an approach to a contracted endodontic cavity which is an orifice-directed design in which separate cavities are prepared to approach the canal systems. 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. The truss access approach mainly emphasizes the preservation of the healthy tooth structure with the minimally invasive approach. This minimally invasive approach avoids the need for conventionally placed crowns after endodontic treatment.[2]

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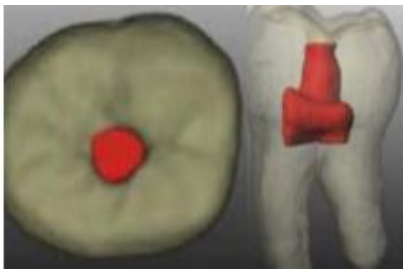
The microscopic view of the Truss access cavity

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

To obtain an outline for "ninja" access, the oblique projection during access preparation is made in an occlusal plane towards the central fossa of the root orifices. It is easier to locate the root canal orifices even from the different visual angulations as the endodontic access is made parallel with the enamel cut of 90^0 or more to the occlusal plane.2



Ultraconservative ninjaaccess cavity (red) segmented on CBCT reconstructions.

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 structures are removed for access preparation. This access design thus allows for direct conservation of healthy dentin by removing discontinuities in tooth structure.

Cala Lilly enamel preparation

In Cala Lilly enamel preparation, the shape of the access preparation resembles a Cala Lilly flower. In this preparation, a bevel (45 degrees) is given on the enamel portion of the access cavity to remove undermined enamel which resembles a calla-lily flower. 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.

Guided endodontic access preparation

The Guided Endodontics method utilizes 3D-printed templates to gain minimal invasive access to root canals. Intraoral scanning is done followed by CBCT scanning. A virtual drill path is then planned on the computer screen which is designed by combining the data from intraoral scanning and CBCT and a virtual sleeve is made for 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 the access cavity. Access is then prepared in this area using a specific bur to gain access to the root canal.

Dynamic Guided Access

Dynamic guidance which was used for implants was recently introduced as an alternative to milled drill guides. Dynamic guidance was recognized 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.[(2,6)]

Effect of Modern Access Cavity Designs on Fracture Resistance of Endodontically Treated Teeth

Endodontically treated teeth have a reduced long-term survival rate and thus reduced fracture resistance when compared to non-treated teeth. Consequently, several clinical studies have brought to light the possibility that root canal therapy is a contributing factor in tooth fractures brought on by loss or reduction in tooth structure. In the universal testing machine, teeth fracture resistance is regularly evaluated under simulated functional stresses until fracture occurs. The loading point, force, and direction may all be adjusted, as well as the load at fracture. The amount of dentin removed and the parts of the canal wall that the instruments did not touch can be measured by micro-computed tomography (CT) analysis of pre-andpostoperative images. Micro CT imaging allows for high-resolution imaging of inside structures.

Endodontically treated teeth require a final restoration that retains esthetics and function, protects residual tooth structure, and prevents microleakage. With the fast advancement of

adhesive technology and the development of stronger adhesive materials, it is now possible to manufacture Cons, extremely esthetic restorations that are connected directly to the tooth structure and reinforce it. Modern therapeutic concepts encourage a minimally prepared approach to endodontic therapy that preserves as much of the tooth structure as possible while maintaining the quality of the endodontic treatment, which improves the fracture resistance of teeth that have had endodontic treatment. On the other hand, compared to alternative access techniques, conventional access has been demonstrated to have a higher percentage of irreversible tooth fractures, which have been connected to greater coronal tooth structural loss.[4,7,8]

II. CONCLUSION

Despite successful endodontic therapy, there are cases of failures that necessitate the retreatment of an endodontically treated tooth. The natural tooth structure can be preserved with the use of cone beam computed tomography imaging, operating microscopes, newly designed endodontic access burs, and less tapered engine-driven nickel-titanium root canal instruments. However, clinicians still face challenges in minimizing or avoiding procedural errors when working in confined spaces due to a lack of convenience. Small access openings can lead to root canal systems that are inadequately formed, cleaned, or filled. Limited irrigant penetration, needle wedging, the vapor lock effect, and difficulties with acoustic, ultrasonic, or apical negative pressure irrigation are some of the additional difficulties encountered during 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 practiced routinely.

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