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Future of Minimially Invasive Access Cavities: A Review

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Abstract

In the recent years, minimally invasive endodontic access cavities in the root canal treatment have gained a lot of popularity. It depends on a lot of factors such as appropriate case selection, amount of remaining tissue and preparation of tooth structure. Many studies have shown an improved fracture resistance of endodontically-treated teeth accessed with a minimally invasive access cavity design. However, it has certain limitations. The aim of this review is to present a brief overview of the development of the minimally invasive endodontic access cavity and its future.

Keywords: *Minimally invasive, conservative endodontic access cavity, access cavity, fracture resistance, root canal treatment, tooth preservation*

Introduction

In the recent times, preserving tooth structure has become the prime focus in the contemporary practice of endodontics and restorative dentistry. Minimally invasive endodontics refers to a concept that advocates the preservation of as much natural tooth structure as possible by minimal invasive access cavity preparation, the taper of prepared canals, and the prepared apical size1 This technique requires specific tools such as ultra-flexible instruments, visual magnification, superior illumination, and three-dimensional imaging technology like cone beam computed tomography (CBCT).**[**2**]**

Minimally invasive tooth preparation helps in retaining more of a tooth structure which would determine the prognosis of the treatment and the fate of the tooth in the long run. Conservative approach with reduced removal of tooth structure helps to reduce the risk of tooth fracture as well as increased service life. It is highly recommended to prepare the tooth structure with preservation of the Peri Cervical Dentin, 3D ferrule and 3D Soffit, all of which helps to enhance the prognosis and increase the longevity of the tooth.

The first articles describing how to apply the minimally invasive concept to access cavity preparation were published by Clark and Khademi.3,4 Amongst the several concepts introduced by the researchers, the core aspect concentrates in maintaining the pulp chamber roof – the so-called soffit – and the pericervical dentine as much as possible in order to ultimately improve the tooth's survival. In their conceptual, but non-evidence–based narrative, the researchers refutes the basic concepts of

endodontics by using analogies such as “this 360° soffit or roof-wall interface can also be compared with the metal ring that stabilizes a wooden barrel” and also emphasize that “research will certainly need to be done to validate the strength attributes of the roof strut or soffit”.

Newer access designs include

A. Conservative Endodontic Access Cavity (CECs)
B. Ninja Endodontic Access Cavity (NECs)
C. Orifice-Directed Dentin Conservation Access Cavity.
D. Incisal Access
E. Cala Lilly Enamel Preparation

Conservative Endodontic Access Cavity (CECs)

Success of endodontic treatment largely depends upon the endodontic access preparation to the pulp chamber and the root canal system which further enables localization, mechanical measurement and preparation and obturation. The traditional endodontic cavity (TEC) approach has long remained the same, with only a few adjustments. However, modifications are required to conserve shape of the access cavity and conserving more tooth structure.

In a systematic review by Silva et al, many studies have shown, according to which insufficient restoration of the dental structure of the endodontically treated teeth leads to extraction.**[**5**]** Thus, to improve the prognosis of endodontically treated teeth, it is essential that healthy dental substance be preserved. In conservative endodontic cavities (CECs), a type of minimal invasive access cavities, there is an emphasis on preserving an adequate part of the pulp chamber roof and pericervical dentin.**[**3**]**

This technique was advocated by John Khademi and David Clark keeping in mind the longevity of the tooth by upholding the mechanical stability of the tooth.**[**3**]** The approach for the cavity preparation begins at the central fossa and is comprehensively drawn out as to spot and access the canal orifices, all of which would help in the salvation of the pericervical dentin as well as the part of the floor of the chamber.

Ninja Endodontic Access Cavity (NECs)

The outline of the cavity is based on its name a 'Ninja', wherein there is an oblique projection headed in direction of the central fossa of the root orifices in an occlusal plane. It runs in a line which is parallel in direction with enamel cut of 90º or more in regard to the occlusal plane, providing better visualization of the root canal orifices when seen from capricious angulations.**[**6**]**

Orifice-Directed Dentin Conservation Access Cavity.

Orifice-directed dentin conservation access cavity design is unique technique and requires a more diagnostic image as well as an experienced and skilled operator. This is said because here we will have multiple accesses into the coronal portion of the tooth which are in line with the root canal orifices. This helps to retain a significant amount of tooth structure which would help in preserving enamel as well as dentin, which is also called as a truss of dentin between the two prepared cavities that. This technique aims at the removal of dentin just above the orifice, thereby maintaining the maximum amount of sound tooth structure.**[**3,4**]** This technique has several disadvantages such as difficulty in curved canals, requires enhanced imaging techniques, time-consuming and requires a straight-line access.

Incisal Access

Gouging is mostly seen when we use round burs with access from the cingulum. As the access grows internally, an inverse funnel is created.3 A continuous recurrent approach into the canal with the bur leads to the loss of peri-cervical dentin which reflects indirectly onto the tooth longevity.**[**5**]**

Cala Lilly Enamel Preparation

In this technique enamel is cut back at 45 degree in the shape of the Cala Lilly.**[**3**]** This altered preparation encompasses almost the complete occlusal surface during preparation. Even though this preparation may not be as favorable as the other preparations but still it is considered during preparations which have previous amalgam fillings and other large restorations.**[**5**]**

New Nomenclature of Access Cavity Designs

The proposal for different designs of access cavity preparation is a relatively new trend in endodontics, and specific nomenclature has yet to be established. The numerous abbreviations proposed in the literature are characterized by mismatching and overlapping terms, leading to challenges around comprehension and readability. Hence, the new classification proposed by Silva et al in 2020. (Figure 1 and 2)

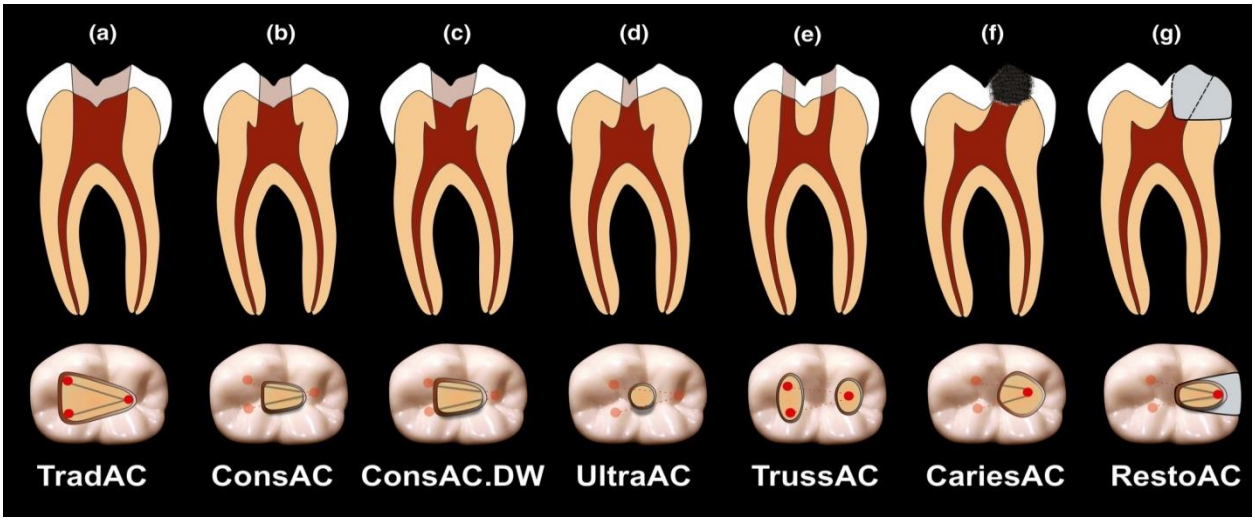

Figure 1- Posterior Teeth

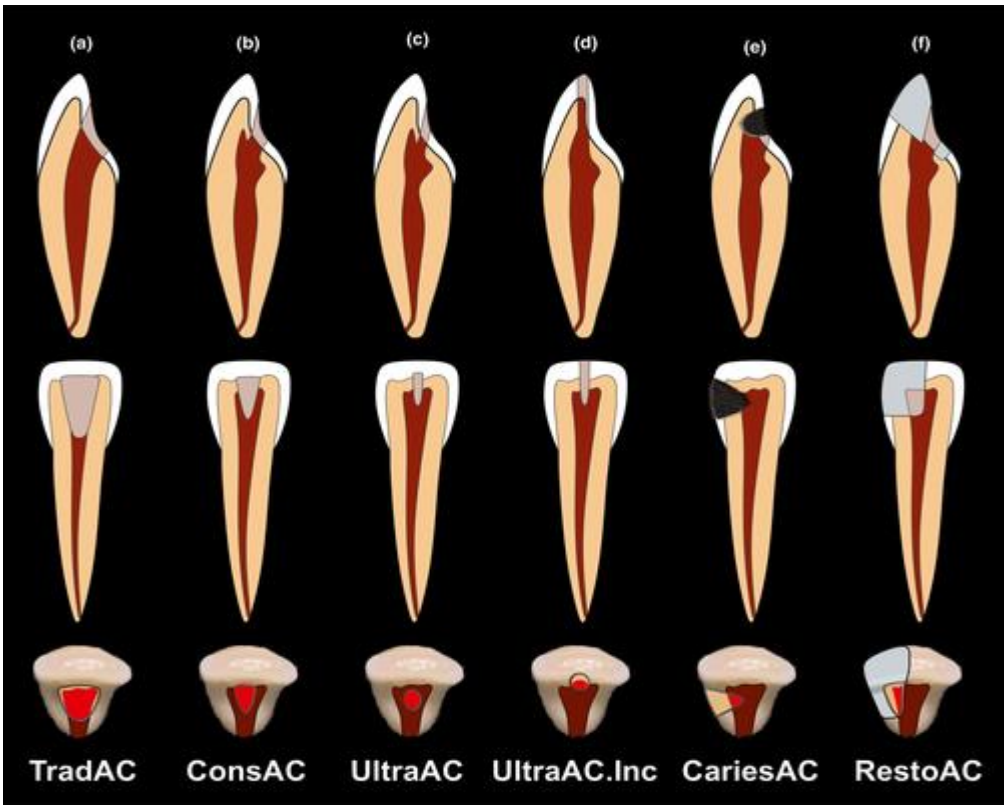

Figure 2 – Anterior teeth

Traditional Access Cavity (TradAC)

If followed in posterior teeth, complete removal of the pulp chamber roof followed by achieving straight-line access to the canal orifices, with smoothly divergent axial walls, so that all orifices can be seen within the outline form. (Figure 1)

In anterior teeth, the straight-line access is obtained by removing the pulp chamber roof, the pulp horns, the lingual shoulder of dentine, and further extending the access cavity to the incisal edge. (Figure 2)

Conservative Access Cavity (ConsAC)

In posterior teeth, preparation usually starts at the central fossa of the occlusal surface and extends, with smoothly convergent axial walls to the occlusal surface, only as far as necessary to detect the canal orifices, preserving part of the pulp chamber roof.3 (Clark & Khademi 2010b)This access type can be also performed with divergent walls (ConsAC.DW) (Roperto et al. 2019)8 (Figure 1)

In anterior teeth, this access involves moving the entry point away from the cingulum towards the incisal edge, on the lingual or palatal surface, by creating a small triangular-shape or oval-shape cavity, conserving the pulp horns and the maximum pericervical dentine (Vieira et al. 2020).9 (Figure 2)

Ultra-Conservative Access Cavity (UltraAC)

Its known as 'ninja' access, such cavities start out as described in the ConsAC, but with no further extensions, maintaining as much of the pulp chamber roof as possible (Plotino et al. 2017)**[**10**]**

In anterior teeth, when there is attrition or a deep concavity in the lingual aspect of the crown, the access can be performed in the middle of the incisal edge, parallel to the long axis of the tooth. (Figure 2)

Truss Access Cavity (TrussAC)

This technique aims to preserve the dentinal bridge between two or more small cavities prepared to access the canal orifices in each root of multi-rooted teeth. In mandibular molars, for example, two or three individual cavities can be created to access the mesial and distal canals (Neelakantan et al. 2018)**[**11**]** (Figure 1)

Caries-Driven Access Cavity (CariesAC)

The access to the pulp chamber is performed by removing caries and preserving all remaining tooth structures including the soffit structure, described as the underside of an architectural feature such as the ceiling, the corner of the ceiling and the wall (Clark et al. 2013).**[**12**]**

Restorative-Driven Access Cavity (RestoAC)

In restored teeth with no caries, access to the pulp chamber is performed by totally or partially removing existing restorations and by preserving all possible remaining tooth structures.

Advanced access Techniques

These procedures unlike other normal procedure requires specialized equipment which would assist the operator as well as guide them to reduce any minor to major errors producing a more favorable result with a much better prognosis.

Advantages of advanced techniques

1. Conservation of tooth structure
2. Better idea of the anatomy
3. Less working time
4. Better prognosis
5. Less errors

Demerits

1. It requires specialized equipment like cone beam computed tomography (CBCT).
2. It’s expensive
3. Highly technique sensitive
4. Less commonly used
5. Requires four-handed dentistry
6. Needs more customization.

Image Guided Endodontic Access

This technique requires additional pre-imaging methods, which are already available either with the operator or at the nearest diagnostic center, which are easily accessible. These imaging procedures can be used for all patients and can be categorized into "one size fits all". These diagnostic imaging procedures will help in determination of location as well as the size of the access cavity.

The objectives of this technique include

1. Small access cavity preparation
2. Minimal dentin removal
3. Preservation of maximum tooth structure
4. Minimial error

Dynamically Guided access

This technique was introduced by Dr. Charles M and most commonly used to place dental implants. Patient CBCT volumetric data helps in determining the location of the access cavity. Furthermore, overhead tracking cameras relate to the position of the patient's jaw and the clinician's bur in 3-dimensional space. At the same moment with the help of the software the clinician makes use of the software interface and with active responsive feedback is about to get the precise location with a depth determination in respect to the planned access and the tooth

Microguided Endodontic Access

Micro-guided access cavity aims at combining CBCT and 3-D printer technology, a bur is specially designed according to the design of the tooth as seen by the CBCT image. A virtual bur is first made and then superimposed on the tooth, and then the 3D printer is used to make the specific bur, which then helps in making the endodontic access.**[**13**]**

Special software which works in corrugation with CBCT and a surface scan provides us with a virtual outline of the access cavity. Another technologically added feature to such a procedure is the printing of a template accomplished by the use of a 3D printer. It helps to direct a minimally invasive drill into the calcified root canal which is useful in conserving the tooth structure and avoid/reduce the errors possible.**[**14**]**

Conclusion

Minimally invasive access cavity designs are followed to provide the patient with the best possible treatment. One should be well versed with the anatomy of the tooth, the operating technique, new addendums, latest machinery available, the costs involved, the feasibility, the experience, and the required expertise. Even though we have a high focus on the conservative approach, the clinicians anticipate that procedural challenges, such as canal location, instrumentation, and disinfection. And this should also be kept in mind that there is always a chance of errors which is caused due to inadequate access to the canals. It is ultimately the clinicians call to decide between the benefit to the risk ratio and its feasibility, all of which should result in good prognosis as well as qualitative treatment outcome for the patient.

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