



TRENDS IN ACCESS CAVITY PREPARATION: A REVIEW

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ABSTRACT

The term 'access cavity preparation' often refers to the part of the cavity from the occlusal table to the canal orifice. One of the common causes of failure in endodontics is missed/eluded canals which hold tissue, and at times bacteria and their related irritants. With the advent of modern endodontic techniques which includes dental operating microscope or loupes for better magnification, illumination and visualization of the 'ideal access cavity preparation' has evolved from being based on individual tooth type to the preparation based on the shape of the pulp chamber morphology of tooth being treated. The present review would discuss the various aspects and trends in access cavity preparation focusing on both the traditional as well as the modern concepts.

KEYWORDS: Cavity, Access, Preparation, Endodontic.

INTRODUCTION

A successful endodontic treatment requires correct access cavity preparation, adequate cleaning and shaping and a complete three-dimensional obturation. Amongst the various steps of the root canal treatment, access is the first and arguably one of the most important phase. However, it can be the most challenging and frustrating aspect of endodontic treatment too.^[1]

The term 'access cavity preparation' often refers to the part of the cavity from the occlusal table to the canal orifice (Stephen Cohen et al). However, its design, which includes location, shape and size, depends on the internal pulp anatomy, position of the canal orifices as well as the curvature of the canal throughout its entire length.^[2]

One of the common causes of failure in endodontics is missed/eluded canals which hold tissue, and at times bacteria and their related irritants.^[3] There are several strategies to decrease the possibility of missed root canals starting with good preoperative radiographies, newer armamentarium and instruments that are useful to locate canals including ultrasonics, dyes, DG-16 etc and the latest advancement of CBCT. Apart from this, another issue is loss of fracture resistance of tooth due to access cavity preparation. Factor such as maintenance of marginal ridge integrity and width of isthmus region also appear to be important in reducing tooth fracture.^[4]

In the past, access cavities were standardized mainly depending on the tooth type. However, with the advent of modern endodontic techniques which includes dental operating microscope or loupes for better magnification, illumination and visualization of the 'ideal access cavity preparation' has evolved from being based on individual tooth type to the preparation based on the shape of the pulp chamber morphology of tooth being treated¹. The present review would discuss the various aspects and trends in access cavity preparation focusing on both the traditional as well as the modern concepts.

Endodontic principles about access cavity preparation

I. Outline form: It is the recommended shape for access of a normal tooth with radiographic evidence of pulp chamber and canal space. External outline form evolves from internal anatomy of the tooth established by the pulp. Therefore, external outline form is established by mechanically projecting the internal anatomy of the pulp onto the external surface.

II. Convenience form: Establishing a straight line access to the apical one-third of the canal for preparation and canal filling instruments. Too narrow access cavity leads to limited visual access and also creates friction of the instrument shaft against the coronal obstruction which in turn leads to application of increased forces by

the operator to overcome the obstruction which contributes to fracture of the instrument. Also, the access cavity should provide positive support for temporary filling material between appointments.^[5]

III. Removal of remaining carious dentin and defective restorations: Caries remaining in the endodontic access cavity must be removed for three reasons.

1. To eliminate mechanically as many bacteria as possible from interior of the tooth
2. To eliminate the discoloured tooth structure, that may ultimately lead to staining of tooth especially of concern in the anteriors.
3. To eliminate the possibility of any bacteria-laden saliva leaking into the access cavity.

IV. Toilet of the cavity: Removal of residual caries, necrotic tissue, soft and calcified debris should be done before radicular preparation is begun. Sterilize the access cavity with antimicrobial agents like Sodium hypochlorite.^[5]

What should these principles mean to endodontist?

The first & foremost thing to do should be to recollect the normal anatomy of the tooth in question. This gives a clear picture of the number of roots, canals, the position of the tooth in relation to the dental arch etc. A good, undistorted radiograph taken using the right technique would aid in making this assessment easier. While preparing the outline form three important factors to be considered are:

- Size of the pulp chamber
- Shape of the pulp chamber
- Number of individual root canals, curvature & their position.

The studies conducted by Krasner & Rankow have provided the following Laws

1. Law of Centrality: The pulp chamber is always located in the center of the tooth at the level of the CEJ.
2. Law of Concentricity: the walls of the pulp chamber are always concentric to the external surface of the tooth at the level of the CEJ.
3. Law of CEJ: The CEJ is the most consistent, repeatable landmark for locating the position of the pulp chamber. Visualize and identify the CEJ. Do not go beyond the CEJ during access preparation with a bur. Over penetration with the bur beyond the level of the CEJ leads to damage of the pulpal floor especially in the furcal area of posterior teeth.
4. Law of Symmetry 1: It states that except for the maxillary molars, canal orifices are equidistant from a line drawn in mesiodistal direction through the pulp chamber floor.
5. Law of Symmetry 2: It states that except for the maxillary molars, canal orifices lie on a line perpendicular to a line drawn in a mesiodistal direction across the center of the pulp chamber floor.
6. Law of Color change: It states that the pulp chamber floor is always darker in color than the walls. A dip in

the bur is usually encountered when the pulp chamber is penetrated. However, this may not be the case always. In certain conditions like attrition, abrasion, pulp stones, and secondary dentin formation - a 'dip' is not encountered. Therefore, one can rely on the Law of Color change in such conditions.

7. Law of Orifice location 1: It states that the orifices of the root canal are always located at the junction of the walls and the floor.

8. Law of Orifice location 2: It states that the orifices of the root canals are always located at the angles in the floor-walls junction.

9. Law of Orifice location 3: It states that the orifices of the root canals are always located at the terminus of the root's developmental fusion lines.^[5]

Armamentarium for access cavity preparation: The access armamentarium should be simple, yet sufficiently versatile, to achieve the preparation goals. The most common armamentarium required is bur and X-Gates. Burs used for access cavity preparation were Diamond Round Bur, Transmetal Bur, Carbide Round Burs, Endo Z Bur, Tapered Diamond Bur. One X-Gates is comprised of four Gates Glidden (GG) drills. Together, the X-Gates and surgical length diamond bur are the burs of choice for finishing the preparation and providing easy access to the underlying root canal space.^[6]

Aids used for access cavity: Dyes, Sodium hypochlorite Champagne bubble test, Transillumination⁷, DG-16 endodontic explorer⁸, Endodontic spoon excavators, Endodontic Micro-orifice opener, Endodontic Micro-debriders, Pathfinder files instruments.^[7]

Modern aids in access cavity preparation: One of the most common problem that compromise the success of endodontic therapy is missed canals. There are many methods that can be employed to prevent this unfortunate event.^[7]

a. Dental loupes: Magnifying loupes were developed to address the problem of proximity, decreased depth of field, and eyestrain occasioned by moving closer to the subject. Dentists can increase their resolving ability without using any supplemental device by simply moving closer to the object of observation. This can be accomplished in dentistry by raising the patient up in the dental chair to be closer to the operator or by the operator bending down to be closer to the patient. This method is limited, however, by the eye's ability to refocus at the diminished distance. The disadvantage of loupes is that the practical maximum magnification is only about 4.5 diameters. Nevertheless, such loupes require a constrained physical posture and cannot be worn for long periods of time without producing significant head, neck, and back strain.^[7]

b. Dental operating microscope: enhances clinician's ability to remove dentin with greater precision. Magnification allows endodontists to better identify

anatomical landmarks, within the pulp chamber-including the sides, overhanging remnants of the pulp chamber roof, initial perforations into the pulp, dentinal map, canal orifices and to differentiate between the pulp horns and the main body of pulp within the chamber.^[7]

c. Ultrasonics tips: in endodontics has enhanced the quality of treatment and represents an important adjunct in the treatment of difficult cases. The use of ultrasonic tips with abrasive coatings helps remove dentine conservatively. The working end of these tips are typically about ten-times smaller than the smallest available round burs and consequently they can be used on the walls and/or floor of the pulp chamber to look for canal orifices. Ultrasonic devices are particularly advantageous when attempting to locate the mesio-palatal canal in maxillary molars due to the cavitation effect.^[6]

d. Geometric Techniques: Complete dependence on the occlusal anatomy may explain the occurrence of procedural errors like missed canals, perforation etc. Krasner and Rankow utilized geometric techniques to formulate a set of laws to set guidelines for easier location of canal orifices as previously discussed. Another technique which is specifically utilized for location of canal orifices in maxillary molars was given by Beer and Bauman.^[7]

Beer And Bauman Technique for maxillary molars

- LINE 1: connects mesiobuccal canal to palatal canal
- LINE 2: line drawn perpendicular to LINE 1, at a point one third the inter canal distance from the palatal canal such that this line passes over the disto buccal canal.
- Fourth canal lies somewhere on LINE 3 which deviates approximately 10°.40

e. Radiographs serves as a good predictor to root canal anatomy and its variations which guide the operator towards access cavity preparation. Radiographic techniques to assist locating the canals were Conventional radiography and Cone-beam computed tomography, Computerized axial tomography (CT), CBCT scanning.

Modern concept of access cavity preparation

Features of Traditional endodontic cavity (TEC)

1. Traditional endodontic cavities are geometrically predesigned shapes.
2. The outline form in a TEC determines the occlusal extent of the prepared cavity.
3. The convenience form is dictated by the degree of dentin to be removed at specific locations so as to achieve a straight-line access to the root canal orifices or to the first curvature of the root canal.
4. The extension for prevention in the endodontic cavity involves the removal of dentin obstructions to extend the straight-line access to the apical foramen or to the primary curvature of the root canal.

5. Employing the concept of extension for prevention facilitates the treatment procedures and avoids procedural errors. None the less this occurs at the expense of crucial structural dentin, which may compromise the biomechanical integrity of tooth.^[9]

Concept of conservative access cavity: Following the trend of minimally invasive dentistry, According to these authors, the current model of endodontic accesses does not lead to long-term success, since they structurally compromise the tooth by removing an excessive amount of dentin, which predisposes to tooth fracture. From this, some concepts have been disclosed in an attempt to improve the resistance of endodontically treated teeth.^[9]

Traditional versus contracted endodontic cavity (TEC vs CEC): Both the concepts have their pros and cons.

1. Effect on fracture resistance of teeth (TEC v/s CEC): CEA preparation in molars has been shown to provide a 2.5+ fold greater fracture resistance.⁴⁵ Furthermore, the fracture resistance of premolars and molars that received a contracted endodontic cavity was comparable to that of intact teeth whereas teeth prepared with a traditional endodontic cavity had less fracture resistance than intact teeth.^[10]

2. Effect on clinical outcomes of RCT (TEC v/s CEC): It is of general consensus that CECs affect tooth structure preservation including pericervical dentin. However, this type of access design does not reflect the clinical daily routine as it can mainly be performed on sound teeth, which does not occur frequently. Nonetheless, CECs might enhance the possibility of missing some root canal orifices and also may have negative impact on the instrumentation efficacy.^[10]

3. Pulpal debridement/canal instrumentation: When comparing the instrumentation efficiency between CEA and TEA, the percentage of untouched-walls was significantly higher in only the distal canals of molars with CEA and not significantly different in maxillary incisors, mandibular premolars and other canals of molars when a “contracted endodontic cavity was performed”. However, with the advances of modern endodontics technology, including ultrasonics, microscopes and irrigation systems, the concern of inadequate debridement in CEA prepared teeth may be overcome.^[11]

Truss concept: This truss access approach mainly emphasizes on the preservation of the healthy tooth structure with the minimally invasive approach. For this approach, it is essential to know the anatomical structures and variations so that the sound tooth structure from caries removal to root canal enlargement can be preserved. It is important not to gouge cervically, laterally, and into the floor while preparing the access. For this, careful evaluation of pre-operative x-ray and even advanced imaging techniques like CBCT may be

helpful. Complete justification with this concept can be done only if the root canal treatment is attempted after CBCT evaluation and with the aid of magnification.

CBCT guided access cavity: CBCT technology can better guide CEA preparation by providing relevant information for pre-access analyses. Clinical implications of CBCT in CEA preparation are: a) to enhance the accuracy of CEA; b) to enhance the efficacy of CEA for inexperienced operators; c) to reduce procedural errors during CEA preparation. CBCT has a strong tendency to guide more consistent preparation. CBCT images also provide additional advantages preventing procedural errors including perforation and missing canals.^[12,13]

CBCT technology can help guide CEA preparation through the valuable information it provides for pre-access analyses. Additional information such as the presence of complex anatomy (i.e isthmus presence, broad canals buccolingually, developmental anomalies, etc.) can be planned for and taken into consideration with the goal of increasing the efficacy and accuracy of CEA preparation.^[13]

Technique for CT-GEA: A cone beam computed tomography (CBCT) and an intra-oral surface scan was performed and matched using software. After planning, the position of the drill for the root canal location, a virtual template was designed, and the data exported as an STL file and sent to a 3D printer for template fabrication. The template was positioned on the specific teeth and a specific drill was used to penetrate through the obliterated part of the root canal and obtain minimally invasive access to the apical part. The record has been used successfully to gain access in maxillary incisor 9mm distance for apex.^[14]

Cone-beam computed tomography (CBCT) and computer-aided design/3D printing technology was used to design and fabricate a drill guide template for access cavity preparation that was performed on two permanent maxillary first molars that was extracted due to periodontitis. Based on the scans, guide templates of access cavities can be designed and this concept was introduced by Hu Chen *et al.*^[15] The angle of the guiding cylinders was used to determine the direction of the long axis of the tooth. A 3D resin printer with high resolution was used to print the guide templates. The printed guide templates were used by the dentist with specialized clinical experience to perform access cavity preparation in a dental simulator. Then the prepared access cavities were scanned again by CBCT, and scan data compared to the design data.

Disadvantages of CT-GEA

1. Increased cost of treatment.
2. More time required for access cavity preparation.
3. More exposure to radiation because of CBCT and optical surface scan.⁵¹

Therefore, clinicians should be cautious and focus on performing a minimally invasive endodontics, aiming to preserve the maximum of tooth structure during root canal therapy but without compromising the treatment outcomes judiciously and do careful selection of the cases for CBCT guided contracted access cavities.

Modifications of access cavity preparation

Shamrock preparation for maxillary molars: In access cavity preparation, enough tooth structure should be removed to allow instruments to be placed easily into the orifice of each canal without interference from overhanging walls. Luebke has made the important point that an entire wall need not be extended in the event that instrument impingement occurs due to a severely curved root or an extra canal. In extending only that portion of the wall needed to free the instrument, a clover-leaf appearance may evolve as the outline form. Hence, Luebke has termed this as 'Shamrock preparation'.^[16]

Incisal access in mandibular incisors: On the basis of anatomical considerations, the 'incisal' access cavities have been recommended as optimal by Zillich *et al.*^[17] It was hypothesized that even in maxillary anterior teeth, only a limited proportion of the root canal surface is instrumented regardless of access cavity design. The design and location may, however, influence the extent of instrumentation.

Factors should also be considered in selection of the appropriate access cavity. Lack of straight-line access compromises apical control of instruments and may result in ledge formation, perforation and, due to fatigue, possible instrument separation. The coronal binding of instruments may also predispose to tooth fracture. Delivery of an irrigant may be affected by inadequate access as it has been shown that fluids reach very little further than the needle tip itself and the straighter the access to the apical portion of the root, the more likely the needle is to reach further into the canal.^[18]

The lingual conventional access cavity provides a design which falls between the other two, leaving the incisal edge intact but allowing reasonably good contact of the file with the canal walls. This more conservative design may prove to be comparable with the straight line access when combined with the added effects of chemical cleansing, and therefore may be considered more appropriate if aesthetics of the remaining tooth structure are a consideration.

CONCLUSION

Conservative access design requires a thoughtful implementation by endodontists in order to achieve higher rates of success and longevity of root canal therapies.

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