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## Decision tree analysis on management of calcified canals

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**Abstract**--Calcific metamorphosis is also called pulp canal obliteration. Canals can be partially or fully obliterated. Most common reasons for calcified canals are trauma and aging. These calcific deposits can cause a considerable challenge to the dental practitioner in locating the canals, reaching the working length and also cleaning and shaping the canals. Attempt to negotiate the canals and perform biomechanical preparation without proper and thorough knowledge on management of calcified canals can lead to iatrogenic errors caused by the clinician such as perforation, fracture of instrument, transportation etc. Most important thing before attempting to negotiate such calcified canals is to have a thorough knowledge on the normal anatomical form and morphology of the root canal system of the particular tooth. Practicing under dental loupes or microscope can add to the clear vision and aid in locating and negotiating the canal. Different armamentarium is available for this purpose like basic small size k file, c pilot files, Endo guide burs, ultrasonic, chelating agents, endodontic surgery to advanced Guided Endodontics. For proper understanding, based on the extent of calcification, whether One third canal is calcified, two third or fully calcified canals, the decision tree has been made. Though negotiating and managing calcified canals can be challenging, they can be managed if a proper protocol is followed. Positive approach with patience along with Operator's skill, attitude, and a proper armamentarium are the requisites to overcome the difficulties posed by these calcified and obliterated canals for their successful treatment.

**Keywords**---decision, tree analysis, calcified canals.

## Introduction

Calcific metamorphosis is also called pulp canal obliteration or also as pulp canal calcification. Calcified tissues get deposited along the walls of the canal, and as a result partial or complete obliteration of root canal space occurs. Calcified canals can be caused due to trauma, deep caries, old restorations, extensive pulp therapy procedures, and most importantly, the aging process can cause the deposition of secondary dentin causing decreased pulpal space.(1). Calcification of the root canal is frequently observed in luxation type injuries associated with displacement(2). Teeth with calcified canals usually remain symptomless for a number of years except for their radiographic appearance and in some instances discoloration of the crown(3) (4,5). Calcified bodies in the dental pulp have been classified on the basis of their structural characteristics. The classification by Kronfield is as follows.

- "true" denticles (composed of tubular (ortho) dentin),
- "false" denticles (composed of concentric layers of calcified material not resembling dentin),
- 3. "diffuse calcifications" (small calcified deposits scattered throughout the pulp tissue)(6,7)

Dental trauma to the permanent dentition can lead to clinical complications and its management may considerably challenge a practitioner.

## Clinical findings

- Colour changes:  
Pulp canal obliteration can be clinically detected in a few cases as early as 3 months whereas in the majority of the cases, for it to appear clinically evident, takes about 2 or more years (8). The pulp canal obliterated tooth is usually darker in colour than the adjacent tooth. There is an increase in thickness of dentine in pulp canal obliteration cases, therefore reducing the translucency compared to adjacent normal teeth, thereby giving a darker appearance. The tooth may also be gray or yellow in color (9,10).
- Pulp Sensibility Test:  
An accurate diagnostic aid is a prerequisite in attaining a proper treatment. Pulp sensibility tests can often act as an important initial diagnostic aid. Electric pulp testing, heat pulp testing and cold pulp testing are the most commonly used. Cold pulp testing can be used as a reliable initial diagnostic aid (11). Teeth undergoing pulpal obliteration usually do not show any symptoms, however there is every possibility that such teeth can respond to pulp sensibility tests after a certain period of time. So follow-up of such cases is very important.

## Radiological findings

Radiographic assessment often leads to proper identification of calcified canals. Radiologically, the pulp chambers and root canals may either be presented as partial obliteration or complete obliteration. Periapical changes and periapical pathosis can also be evaluated using radiographs and treatment can be planned

accordingly. CBCT can be considered as an important and accurate method of analysis of such teeth.

### **Histological findings**

The presence of mineralized tissues in the pulp is generally related to the process of aging. However, they can also be found in young pulp. (12,13) They present in different ways as follows.

- True Denticles
- False denticles
- Diffuse calcifications

True denticles - are the type which is rarely found:

- They are usually located near the apex and are composed of dentin and dentin type of calcifications with tubules that are covered or surrounded by odontoblast-like cells.

False denticles can be histologically divided into two types, (14,15):

- Round or ovoid with concentric layers of calcification and with smooth surfaces.
- Amorphous and rough surfaces.

Diffuse calcifications:

- The incidence of this type of calcification increases with age
- They follow the path of the nerves, blood vessels and collagen fiber bundles.

Denticles usually predominate in the pulp chamber whereas diffuse calcifications are predominantly found in root canals. (16,17). Based on the extension of calcification in the root canals, they can be categorized as follows:

- One third of the canal is calcified.
- Two thirds of the canal is calcified.
- Canal is fully calcified

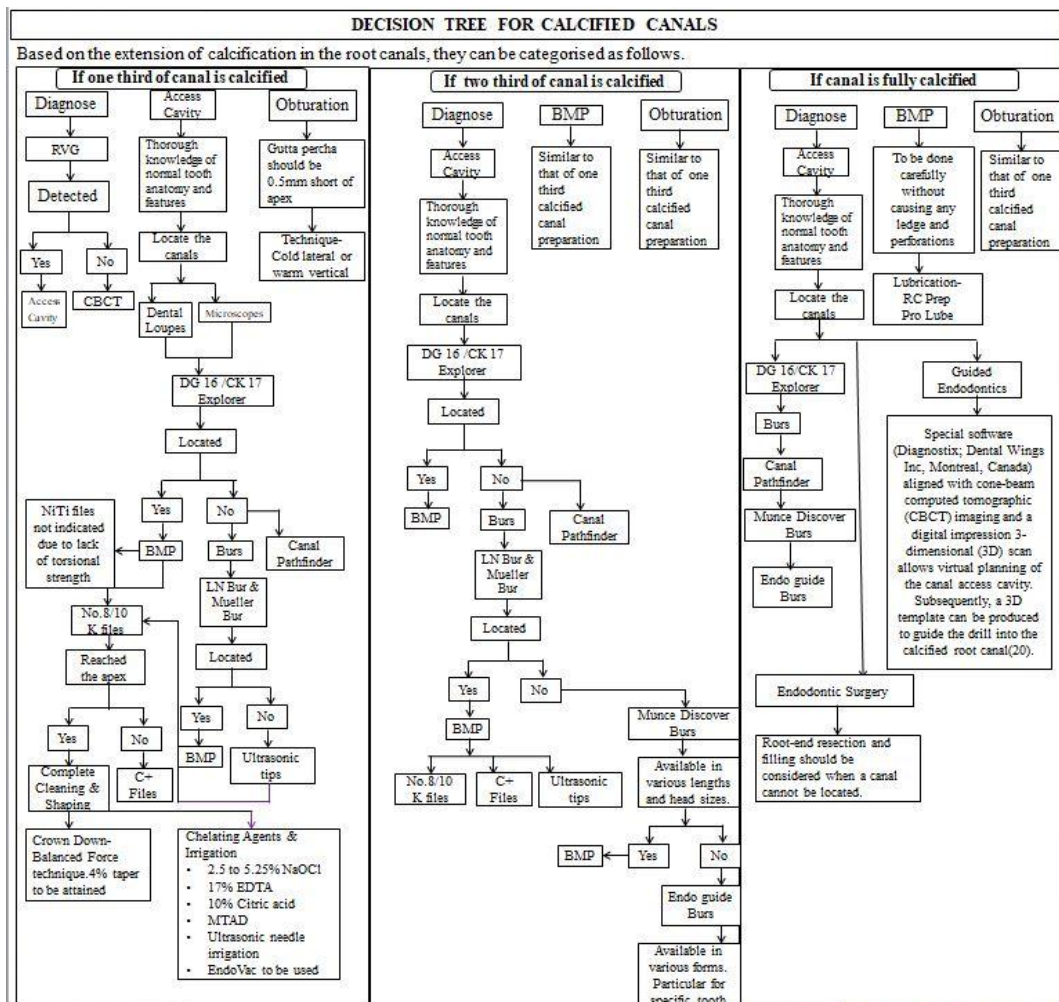


Figure 1. Decision tree for management of calcified canal

## Management of calcified canals

Management of pulp canal obliteration can pose a big challenge to dentists. Thorough knowledge of root canal morphology is of utmost importance before calcified canals can be managed.

## Negotiation of canals

### Use of files

- K files of size 8 or 10 can be used to negotiate the canals. Recently a modified technique has been employed for locating constricted canals. The tip of size 10 k file is sliced diagonally and the tip is made thinner. Because of the fine tip, it could penetrate into constricted and sharply curved canals.
- Use of c+ files is also another important method of locating calcified canals. They have greater taper and can be used to negotiate calcified canals.

- Pathfinder: Pathfinder instruments feature a minimal taper and are used for negotiating difficult or calcified canals.(18)
- DG16 and CK14 explorer is a very useful instrument for location of root canal orifice.

### **Use of burs**

- Mueller bur:  
It is an extended length round bur which improves deep vision,small size encourages safe access and slow speed rotation promotes control.
- LN bur:  
Long neck round bur can be used for location of orifice in calcified canals.
- Munce Discovery Burs:  
They facilitate deep troughing for locating separated instruments and hidden canals, calcified canals, stiff shafts provide positive control for deep troughing procedures in contrast with flexible shafts of Mueller burs.1mm shaft diameter prevents shaft impingement on deep access cavity walls.They are available in different head sizes.
- Endoguide burs:  
They provide straight line access to canals. They are set of eight carbide burs for non surgical root canal treatment. Offers precision guidance for efficient identification of calcified canals.Facilitates increased tactile sensation of dentin and calcified canals.

### **Dental loupes and microscopes**

In recent times, there has been an explosion of novel technologies, instruments, and materials for both surgical and nonsurgical endodontics.These developments have improved the precision and the accuracy with which the treatments is performed in endodontics(19).The most important revolution is the introduction and widespread adoption of the operating microscope (OM) in endodontics.Its introduction into dentistry, particularly in endodontics, has revolutionized how endodontics is practiced throughout the world(20).Therefore, the use of dental microscopes improves the accuracy and ease of location of obliterated canals. However, microscopes cannot be considered as a cost effective approach. Instead, dental loupes which are cost effective must be at least considered as routine practice to improve the precision and accuracy of the treatment offered.(21).Different types of loupes are available in the market(21,22).

### **Ultrasonic tips and irrigation**

Ultrasonic tips can be used in complicated cases like calcified canals, constricted canals, broken instruments (23).Irrigation is the process of activating irrigant through introduction of instrument in the canal and oscillating and rotating action(24).Copious irrigation is to be done to prevent the accumulation of debris.(25)Various irrigation devices can be used, syringe irrigation with needle, manual dynamic agitation, sonic and ultrasonic irrigation devices, EndoVac etc.Lubrication with RC Prep and ProLube can be considered(26).

### **Chelating agents**

Chelating agents are known to be useful in calcified canal negotiation(27). Most commonly used agents are 17%EDTA, 2.5 to 5.25% sodium hypochlorite, 10% citric acid, MTAD etc(28).Liquid EDTA is the most commonly suggested method as it causes removal of the smear layer.EDTA as an irrigant is employed by depositing liquid EDTA drops into the pulp chamber with a syringe and carefully pumping the solution into the root canal with fine instrument (29). In case it is difficult to introduce a file into the root canal, due to intracanal calcifications, EDTA gel coated onto the instrument can serve as a method of negotiation.Better to pulp EDTA into the canal and wait for 1 minute before attempting instrumentation. Once the working length is reached, the canal can be irrigated in the usual manner.

### **Cleaning and shaping of canals**

After locating the canal and reaching the working length, cleaning and shaping has to be done. Balanced force technique is mostly recommended. Crown Down technique can be employed. First patency of the canal is established using an 8 or 10 size k file.

### **Endodontic surgery**

Endodontic surgery can be considered as an option in severely calcified canals. Literature supports use of retrograde method of filling in such cases as an option.Retrograde surgical procedures emphasize on creating an apical seal limited to the remaining resected apical one third of the root canal space(30).However, this treatment modality can be only considered where non surgical approaches fail repeatedly or when retreatment has resulted in periapical lesions.

### **Guided endodontics**

Guided endodontics is the recent addition to the field of endodontics. This is a novel approach in management of partially or fully calcified canals(31).Special software is used which is aligned with cone-beam computed tomographic (CBCT) imaging and a digital impression 3-dimensional (3D) scan allows virtual planning of the canal access cavity. A 3D template is produced which can act as a guide for the drill into the access cavity.Conservative access or minimally invasive access can be used in this approach (32). However, one disadvantage stated is that during the access cavity preparation of anterior teeth, the incisal edge is removed in an attempt to maintain straight line access. To avoid this, a modification to the template was proposed,in which access is attained in the center of the palatal surface of the anterior tooth buccolingually and inciso gingivally, thereby preserving the incisal edge(33). Use of guided endodontics can show better results than the conventional method (34). The planned and minimally invasive guided access to calcified roots may help to preserve tooth structure and prevent mishaps such as deviations and perforations. This may lead to an improved long-term prognosis of the tooth.

## Decision making

- If one third of the canal is calcified:  
As given in figure 1 decision tree, based on the extent of calcification present in the root canal, a proper protocol can be planned. If only about one third of the canal appears to be calcified as seen in radiograph, based on the normal morphology of tooth, minimal access cavity is prepared. It is of utmost importance to have a thorough knowledge of the anatomy of the tooth and the most common anomalies present in that particular tooth. Canal can be located using DG16 or CK17 explorer, attempt is made to enter canal using initial #8 or #10 size k file. In case not located, c+ pilot files can be used as the next option. Once the orifice is located, burs like Mueller bur and LN burs can be used for troughing into the canal. Canal pathfinder can serve as an option too in the management of calcified canals. Ultrasonic tips with copious irrigation can clear up the debris. Use of liquid or gel EDTA coated instruments further adds to the ease of management.
- If two thirds of the canal is calcified:  
If two thirds of the canal is calcified, an initial attempt is made by using DG 16 or CK17 explorers. Then, #8 or #10 size k files should be tried as an approach. If attempt is failed in locating a calcified canal, mueller bur or LN bur or even pathfinder can be used. Ultrasonic tips and EDTA coating instruments can be tried. If canal is not located in any of these approaches, Munce Discovery burs or Endoguide burs can be used. They are available in various head sizes and shapes of the tips for different access prepared in different teeth.
- If the canal is fully calcified,  
If the canal is fully calcified, it is a great challenge to the dentist. Patience, proper armamentarium, positive approach of the dentist can definitely lead to success in locating the canal and final obturation. If all the above attempts do not help much in locating the orifice and reaching the working length, then two other approaches are to be considered. Guided endodontics in recent times showed promising results. Proper straight line access and visualisation using CBCT can definitely be considered as an approach. One more approach is considerable, that is endodontic surgery. This approach can be planned only if orthograde filling is not successful and repeated periapical lesions occurred in spite of retreatment. The apical third of the tooth is resected and retrograde filling is done.
- In the majority of the cases, any of the above mentioned approaches definitely will lead to successful orifice location of calcified canals. Further cleaning and shaping has to be done, preferably using crown down balanced force technique. Copious irrigation has to be done at every step. Obturation has to be 0.5 to 1mm short of the apex. Recall and review of the patients can help in quality assessment and outcomes of the treatment.

## Conclusion

Though negotiating and managing calcified canals can be challenging, they can be managed if a proper protocol is followed. Positive approach with patience along with Operator's skill, attitude, and a proper armamentarium are the requisites to

overcome the difficulties posed by these calcified and obliterated canals for their successful treatment.

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