ENDODONTIC THERAPY: TECHNIQUE & PROTOCOL

Basic guide for predictable endodontics

Universiti Kebangsaan Malaysia
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Content:

PREFACE

Endodontology is an important part of undergraduate dental curriculum of the teaching institution. In Malaysia, the national requirements identified endodontic skill as one of the clinical procedures that need to be mastered by the students, who would eventually be a general dental practitioner by the end of the programme. As endodontic disease remains prevalent, in their acute forms, pulpitis and apical periodontitis continue to be the most frequent dental emergency conditions.

This book was published to provide a guide for dental students who wish to understand all the technical aspect of endodontic treatment prior to starting their preclinical endodontic module. It was written in a "Question and Answer" type with easy to read style to give the students new knowledge and insight can be immediately applied to the clinical practice.

We hope that the readers will find this book relevant and informative.

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INTRODUCTION TO ENDODONTOLOGY AND ENDODONTICS

CHAPTER 1

Safura Anita Baharin, Dalia Abdullah

What is the definition for endodontology and endodontic?

Endodontology is concerned with the study of the form, function and health of, injuries to, and diseases of the dental pulp and periradicular region, their prevention and treatment. The aetiology and diagnosis of dental pain and diseases are integral parts of endodontic practice. (European Society of Endodontology, 1997)

Endodontics is the clinical treatment, comprising of any procedure to maintain the vitality and health of the pulp and periapical tissues. When the pulp is infected or traumatized, endodontic treatment mainly aims to maintain or restore the health of the periapical tissues.

What can be considered as endodontic treatment procedures?

1) Vital pulp therapy. This includes, pulp capping (direct or indirect) or pulpotomy that aim to preserve the health of all or part of the pulpal tissues. Regeneration therapy can be included as part of vital pulp therapy, as well as apexogenesis and apexification.

2) Root canal treatment and pulpectomy. These treatments aim to restore teeth where its pulpal tissues are irreversibly inflamed or are now necrotic so that the teeth could remain functional in the mouth. In simpler words, root canal treatment saves tooth!

3) Root canal retreatment and surgical endodontic are treatment that aim to restore the tooth with apical lesions that fail to heal after the root canal treatment.

Biological aspect of endodontic disease/infection

What is pulpal tissue and the tissue that supports it?

Pulpal tissue comprises of connective tissue, tissue fiber, ground substance, nerves and blood supply/vessels. This pulpal tissue is confined in a canal space which is connected with the periodontium through apical foramen. Sometimes, accessory and/or lateral canal is present within the tooth and connected to the periodontium. The root is surrounded by periodontal support which consists of cementum, periodontal fiber and supporting bone.

How does the pulpal tissue become infected?

The presence of caries, traumatic injury to the tooth, restorative procedure, faulty restoration and presence of periodontal disease can be harmful / injurious / damaging to the pulpal tissue. Prolonged exposure to these stimuli can results in pulpal inflammation and its healing rate depends on the degree of injury experienced / imposed to the pulpal tissue. Total pulpal healing is possible if the pulpal injury is minor and immediate treatment is provided, thus preventing additional bacterial infection and contamination of the injured pulp.

In a situation where the pulp is unable to heal due to irreversible pulpitis (pulpal inflammation), the pulp tissue dies and subsequently become necrotic. Previous researchers have shown that if the necrotic pulp is sterile, it would not cause further inflammation of the supporting tissue of the root. Apical periodontitis will only occur when there is bacterial contamination of the necrotic pulp.

What is apical periodontitis?

Apical periodontitis refers to inflammation of the supporting periodontium around the root apices. This inflammation could cause intense pain, swelling and pus formation from the affected tooth. Intraoral radiographic assessment will show the present of periapical radiolucency near or surrounding the root apices due to bone destruction and resorption.

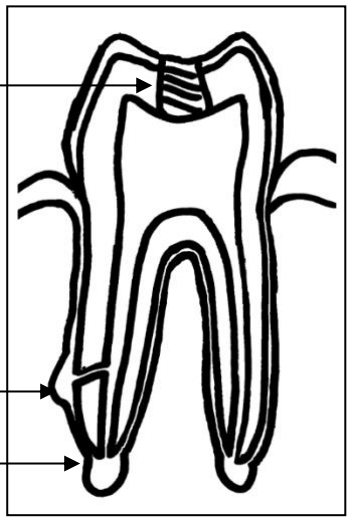
How does apical periodontitis develop?

When the pulpal tissue becomes infected, bacteria and their products will accumulate within the root canal space. Prolonged and persistent bacterial infection would result in spreading of the infection apically until it reaches the apical foramen. Bacteria toxin will be released through the apical foramen or lateral canal, which starts to irritate the periodontal tissue around the root apices. This insult will cause inflammation of the periodontium and subsequently bone resorption will develop (Diagram 1).

In summary, apical periodontitis is developed as a result of propagation/dissemination of the infection of the pulpal tissue. This can be prevented if the infected pulpal tissue is removed and treated before it affected the periapical tissue.

Diagram 1 –
Bacteria invading the pulp chamber through occlusal caries. Pulpal tissue was infected with bacteria and its byproducts. Production and accumulation of bacterial toxin spread apically and exude through apical foramen, producing apical periodontitis.

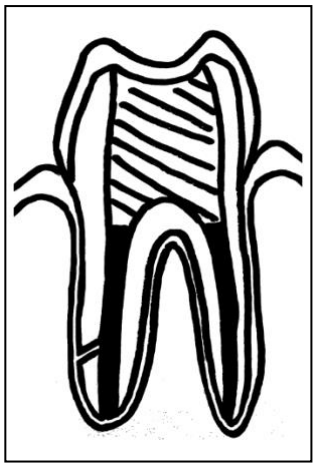
Apical lesion develops around root opening (such as apical foramen or lateral canal) which communicates with the periodontium.



What is the management / treatment for apical periodontitis?

Root canal treatment is performed to treat apical periodontitis, to regain the health of the surrounding supporting tissue (Diagram 2). Complete healing of the supporting tissue will occur when the causative agent i.e. bacteria, is eliminated and a good restoration is placed to prevent bacterial recontamination of the root canal.

Diagram 2
Tooth which have received root canal treatment should heal and the condition of the periodontium will return to normal.



PULP AND PERIAPICAL DISEASES

Dalia Abdullah

CHAPTER 2

The structures of the oral cavity are safe havens for microbial populations. From these areas, microbes of varying virulence emigrate and cause infections such as tonsillitis, gingivitis, pericoronitis, marginal periodontitis, dental caries, pulpitis and apical periodontitis.

What is pulpitis?

Pulpitis is inflammation of the pulp tissues caused by various forms of irritation to the pulp. This inflammation will result in tooth pain. The most common cause of pulpitis is dental caries.

What is an apical periodontitis?

Apical periodontitis is inflammation and destruction of periradicular tissues caused by the interaction of microbes, predominantly bacteria and microbial products of endodontic origin.

How do the microorganisms cause pulp and periapical disease?

There are several routes through which microorganisms can reach the dental pulp space. Breaches in the hard tissue wall, resulting from caries, dental surgical procedures or trauma-induced cracks and fractures are the most frequent pathways of pulpal infection. Even though the teeth may appear clinically intact, microcracks could occur and these provide portals of entry for bacteria. It has also been suggested that bacteria from the gingival sulci or periodontal pockets may reach the root canals through severed blood vessels of the periodontium. Bacteria remaining in the infected dentinal tubules can be a potential reservoir for endodontic reinfection.

How does the pulp react to the irritation?

As microorganisms progress deep towards the pulp, chronic inflammatory cells such as lymphocytes, macrophages and plasma cells increase. As a defence mechanism to prevent bacteria from infiltrating the pulp, tertiary dentin is formed at the affected area. The increase in dentin thickness is accompanied also by a reduced permeability of dentinal tubules.

How to diagnose pulpal disease?

There is no clear association of signs and symptoms with pulpal disease. Clinical studies suggest that pain is present in 40% of teeth classified as saveable pulp and the pain incidence increased to 89% with non-saveable pulp. Teeth with necrotic pulp are usually symptomless. Therefore, it is difficult to accurately classify the pulp condition of all painful teeth or to differentiate between a saveable and non-saveable pulp.

Attempts have been made to correlate the clinical diagnosis of normal pulps, reversible pulps and irreversible pulpitis with histologic findings. A high correlation between clinical and histologic diagnosis of pulp conditions is demonstrated only in cases of normal pulp and

reversible pulpitis. The diagnosis of pulp conditions as normal pulp or reversible pulpitis (saveable pulp) and irreversible pulpitis (non-saveable pulp) have high chances of directing the correct therapy in the large majority of cases. Thus, as much information as possible should be collected from clinical signs and symptoms and diagnostic test to enable formulation of an empirical pulpal diagnosis.

What causes apical periodontitis?

The role of microorganism in the aetiology of apical periodontitis has been extensively demonstrated in the literature. A classic report was by Kakehashi et al. (1965) who carried out his animal study in which 36 inbred Fisher rats were divided into 21 germ-free group and 15 conventional control group. The pulp tissues of the maxillary right first molars of all the rats were exposed to the oral cavity and left untreated. In the conventional or normal rats, pulpal inflammation occurred and progressed leaving only the apical half of the root remained vital by the eighth day. Complete pulpal necrosis with granulomas and abscess formation were seen in all older specimens. In contrast, there were only minimal inflammatory reactions and evidence of reparative dentine formation was observed, with no devitalized pulps, apical granulomas, or abscesses found in germ-free rats.

How do the microorganisms survive in the root canal?

The necrotic pulp offers a selective habitat for endodontic microflora. The microbes could exist in the form of adhesive biofilms, aggregates, co-aggregates, and as planktonic cells suspended in the fluid phase of the canal. A biofilm is an extracellular matrix-embedded community of microorganisms that adhere to each other and/or to a moist surface, while the planktonic organisms are free-floating single microbial cells in an aqueous environment.

How do the microorganisms initiate the periapical inflammation?

In the infected root canal, any microbe has the potential to initiate periapical inflammation. In the biofilm form, microorganisms are protected where they have the remarkable ability to resist biocides several hundred times that of the same organisms in planktonic form. Bacterial biofilms are expected to be present in association with longstanding pathologic processes, including large lesions and cysts, and a very high prevalence of bacterial biofilms found in the apical root canals of both untreated and treated teeth associated with apical periodontitis. The microbes in the root canal or their products can egress into the periapex.

In response, the host mounts an array of defences consisting of several classes of cells, intercellular messengers, antibodies, and effector molecules; some of which act primarily to protect the pulp and the periapical region, whereas others mediate tissue destruction, particularly bone destruction. The dynamic encounter between root canal microbes and host defence results in the formation of various categories of apical periodontitis lesions, and the equilibrium at the periapex, in favour of or against the host defence.

What are the clinical signs of apical periodontitis?

In general, apical periodontitis can develop and persists without clinical signs. Acute inflammatory apical periodontitis lesions usually are recognizable through their clinical signs and symptoms; whereas, the more common type of lesion, which is the chronic (asymptomatic) apical periodontitis is detected mainly or exclusively by its radiological features. The radiographic changes could range from a widening of the apical part of the periodontal ligament to distinct periapical radiolucency. Therefore, radiographic findings are of high importance for diagnosis.

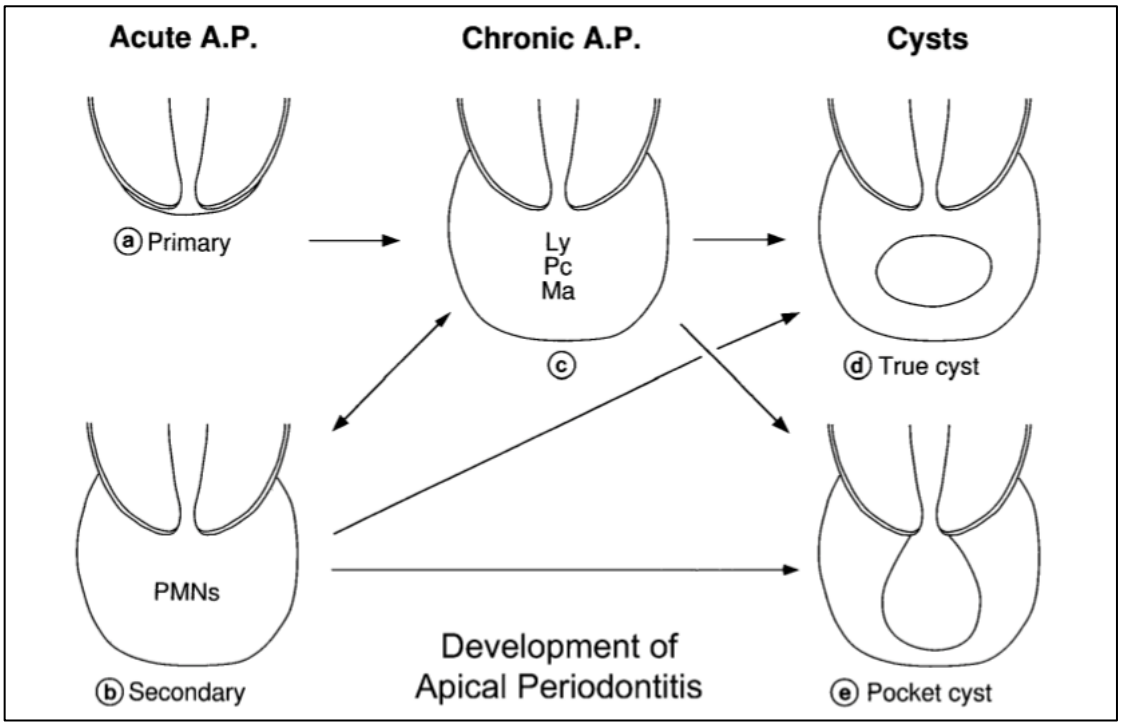


Figure 2-1. Pathogenesis of apical periodontitis (AP) lesions. The acute lesion may be primary (a) or secondary (b) and is characterized by the presence of a focus of neutrophils (PMNs). The major components of chronic lesions (c) are lymphocytes (Ly), plasma cells (Pc), and macrophages (Ma). Periapical cysts can be differentiated into true cysts (d), with completely enclosed lumina, and pocket cysts (e), with cavities open to the root canal. Arrows indicate the direction in which the lesions can change. Source: Nair 2004

Can the apical periodontitis heal on its own?

In spite of the formidable defence, the body is unable to destroy the microbes well entrenched in the sanctuary of the necrotic root canal, which is beyond the reaches of body defences. Therefore, apical periodontitis is not self-healing. The treatment of AP consists of eliminating infection from the root canal and preventing re-infection by a hydraulic seal of the root canal space.

CHAPTER 3

RADIOGRAPHS

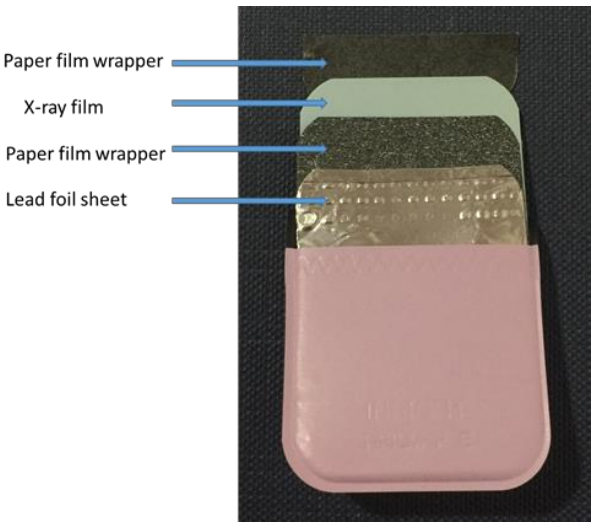
Safura Anita Baharin

Radiograph plays an important role in root canal treatment. Conventional radiograph commonly used is known as periapical radiograph (PA). The radiation produced has the ability to penetrate the human tissues hence able to capture the image on a *screen*. Although the x-ray procedure is safe, the students' needs to know how the x-ray being used, its production and radiation protection measures to follow when using this machine.

ALARA principles: ***A***s ***L***ow ***A***s ***R***easonably ***A***chievable

What are the components in an intraoral periapical film packet?

1. Paper film wrapper – is a protective sheet of black paper that covers the film and shields the film from a light leak.
2. X-ray film – a double-emulsion film, raised dot in one corner used for film orientation
3. Lead foil sheet – protects the film from backscatter, reduces patient's exposure, strengthens packet
4. Outer package wrapping – is a soft vinyl wrapper that hermetically seals the film packet, protects against exposure to light and saliva,



What is the structure and components of the radiograph film?

The intraoral X-ray film is a double-emulsion film. A double-emulsion film requires less radiation exposure to produce an image compared to a single-emulsion film.

Radiograph film consists of 4 basic components:

1. **Protective layer**
   - The protective gelatine layer is a thin, nonabrasive, transparent super coat placed over the emulsion. It protects the emulsion surface from handling as well as mechanical damage (scratching).

2. **Film emulsion**
   - The film emulsion is a coating on both sides of the film base to give the film greater sensitivity to X-ray radiation.
   - The emulsion is a homogenous mixture which consists of two principal components: the silver halide (bromide and iodide) crystals and gelatine matrix.

   - When the X-ray photons interact these silver halide crystals, the crystals will be sensitized.

- During the developing process, the sensitized crystals will be reduced, and a radiolucent image is produced.

3. **Adhesive layer**
   - This layer is a sub-coating of a thin layer of adhesive material, which aids the attachment of the emulsion to the base.

4. **Film base**
   - Is a flexible, transparent piece of polyester plastic of 0.2mm in thickness. It exhibits a slight blue tint which acts to intensify contrast and enhance image quality.
   - Its primary purpose is to strengthen and provide stable support for the delicate emulsion.

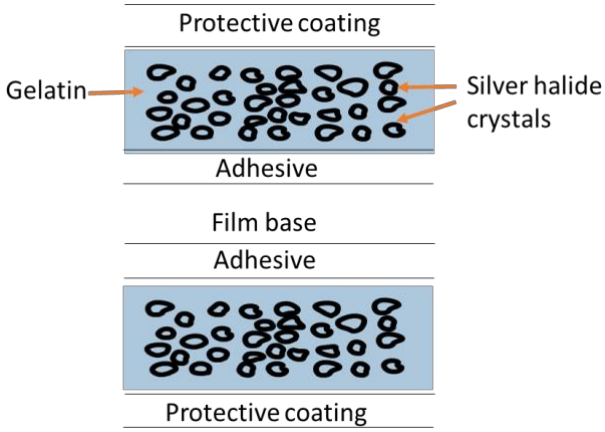


Figure 3-1: Schematic cross-section drawing of intraoral x-ray film

Why is radiograph important in endodontic treatment?

Radiographs are essential to all phases of endodontic therapy. It assists with diagnosis and provides information regarding various treatment phases and helps evaluate the success or failure of treatment. Since root canal treatment relies on accurate radiographs, it is necessary to acquire the essential skills in radiographic techniques in order to achieve films of maximum diagnostic quality. Such skills minimize the retaking of films and avoid additional exposure to patients. Additionally, expertise in radiographic interpretation is crucial for recognizing deviations from the norm and for understanding the limitations associated with endodontic radiography.

What do you need to view a radiograph?

1. X-ray viewer
2. Magnifying glass
3. Good source of light/darkroom
4. A correctly mounted radiograph

How to take the radiograph with the least distortion and maximum diagnostic quality?

For endodontic purposes, the paralleling technique produces the most accurate radiograph whereby the film is placed parallel to the long axis of the teeth, and the central beam is directed at right angles to the film. In order to achieve this position sometimes it is necessary to position the film away from the tooth toward the middle of the oral cavity especially when the rubber dam clamp is in position. With the use of the long cone aiming device the focal spot-to-object distance is increase. This has an effect of directing only the most central and parallel rays of the beam to the film and teeth, thus reducing size distortion. Hence this technique allows more accurate reproduction of the tooth's dimensions and therefore enhances the determination of the tooth's length and its relationship to the surrounding anatomic structures. Furthermore, this technique reduces the possibility of superimposing the zygomatic processes over the apexes of the maxillary molars, which often occurs with more angulated films such as in bisecting-angle technique. Moreover, the paralleling technique when used properly could produce films with the least distortion, minimal superimposition, and of the utmost accuracy.

In endodontics, Endo-Ray® is the most suitable instrument to use when taking radiographs during root canal treatment. This is to ensure that the film is correctly placed inside the mouth with minimal distortion and magnification of the image. The clinician must also make sure that the film is placed parallel to the tooth and the tooth of interest is positioned in the centre of the film. This is to minimize error and prevent cone cutting of the film.

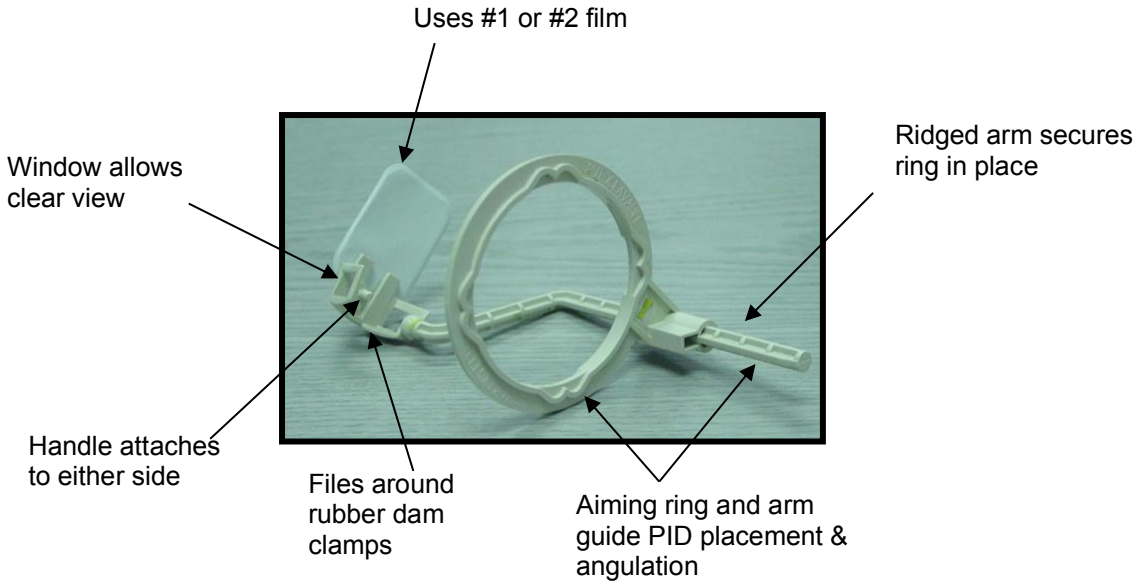


Figure 3-2: Component of Endo-Ray kit with film

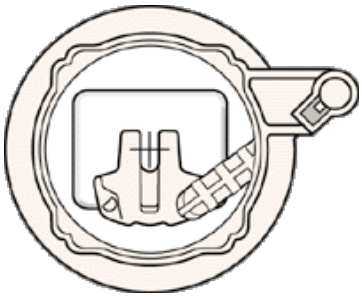


Figure 3-3: Film placement

Two techniques can be used to take the radiograph:
1. Paralleling technique – the most accurate technique to use
2. Bisecting angle technique – used under certain circumstances only

Paralleling technique

The basic principles are:
a. The film is placed parallel to the long axis of the teeth being radiographed.
b. The central ray is directed at right angles to both the film and teeth.

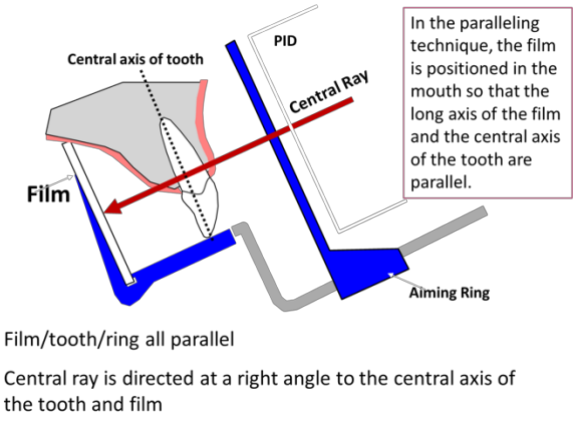


Figure 3-4: Principles of paralleling

Figure 3-5: Correct placement of film holder

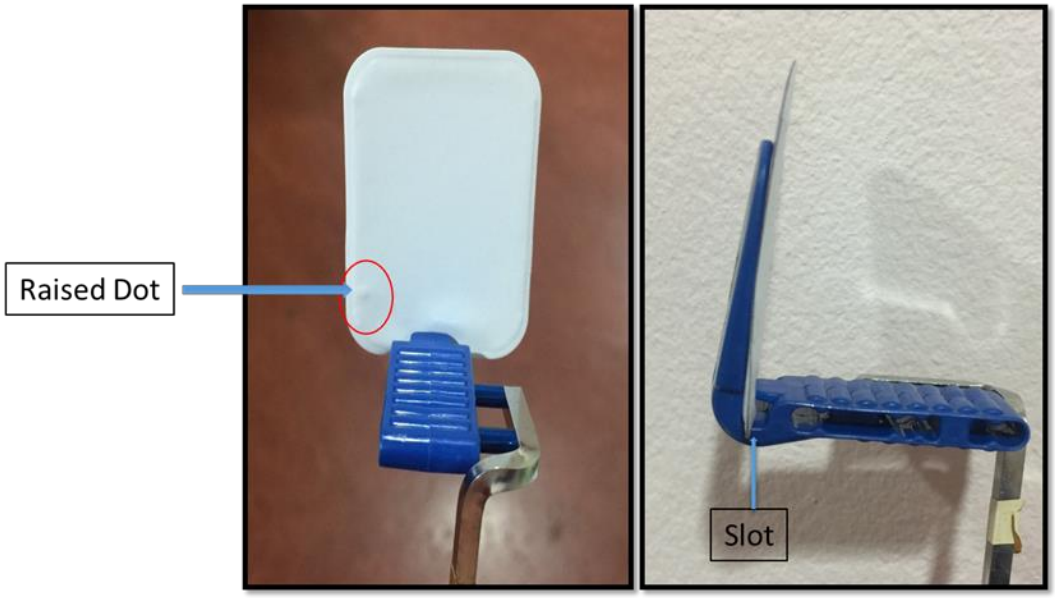


Figure 3 -6a & 6b

Make sure the 'dot' on the film is positioned in the slot of the x-ray film holder. This is to ascertain that the dot is not superimposed with the radiographic apex (Figure 3-6a & b).

2. Bisecting angle technique

The bisecting angle technique is used when the Endo-Ray® film holder cannot be used to take the radiograph. This technique is used particularly for patients that have a tooth with extremely long roots, gagging, unable to tolerate the film holder inside their mouth or when the patient has a shallow palatal vault. This technique requires good clinical skills and experience. This technique is not recommended for endodontic radiography; however, when a modified paralleling technique cannot be used, there may be no choice because of difficult anatomic configurations or patient management problems.

The basis of this technique is to place the film directly against the teeth without bending the film. This causes distortion because the film is not parallel with the long axis of the tooth. If the x-ray beam is directed at a right angle to the film, the image on the film is shorter than its actual length, or foreshortened; if the beam is directed at a right angle to the long axis of the teeth, the image is much longer than the tooth, or elongated. Additional error potential is when the clinician must imagine the line bisecting the angle, an angle in itself is difficult to assess.

This technique produces greater image distortion than the paralleling technique and makes it difficult for the clinicians to reproduce radiographs at similar angulations to assess healing following root canal treatment.

What is periapical radiograph (PA)?

A periapical radiograph is an intraoral radiograph that shows the whole teeth and its surrounding tissue. It is taken to assess the conditions of the teeth and its surrounding tissue.

What are the criteria of an acceptable periapical radiograph?

Ideally, for endodontic purposes, a periapical radiograph should show the tooth of interest in the centre of the film. Consistent film placement in this manner will minimize errors in interpretation, as this is the area of the film where distortion is the least.

In summary, the criteria for an acceptable radiograph in endodontics are:

1. The whole length of the tooth including the crown and also the surrounding periapical tissues are visible with at least 3 mm of bone beyond the apex
2. Good diagnostic quality radiograph i.e. good contrast and density radiograph
3. Minimal distortion and magnification
4. No error in the positioning, radiation exposure dose, and processing of radiograph

Figure 3-8: An acceptable radiograph

What useful information that you could gather from a periapical radiograph?

Useful information that we can gather from a good periapical radiograph in root canal treatment are:

1. Assessment of the status of the coronal part of the tooth i.e. the crown – the presence of restoration (size, depth, location), presence of caries (location, size).
2. Assessment the morphology of the pulp chamber in terms of depth from the occlusal surface, the size of the chamber, presence of pulp stone obscuring the chamber.
3. Determination of the numbers, location, size, shape, and direction of roots and root canals.
4. Estimation and confirmation the length of the canals prior to instrumentation procedure.
5. Assessment of the surrounding periapical tissues – normal, pathology (bone resorption).
6. Evaluation of the quality of root filling material inside the root canal – length, quality, material (GP, paste, Ag point, post).
7. Aids in the diagnosis of fractures, dislocation and other injuries to the hard tissues following trauma.

8. Determination of the relative positions of structures in the mesiodistal direction.
9. Aids in the examination of soft tissues such as lips, cheeks, and tongue from fractured tooth fragments and other foreign bodies following trauma.
10. Evaluation of the success or failure of endodontic treatment by using recall radiographs.

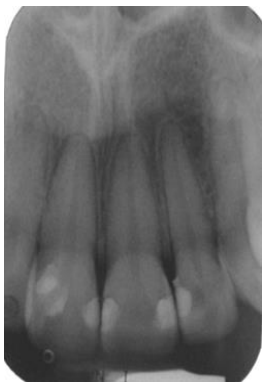


Figure 3-9a

Figure 3-9b

Figure 3-9c

Figures 3-9a to 3-9c showed radiographs of anterior teeth. Figure 3-9a shows the normal anatomy of upper anterior teeth, Figure 3-9b shows lower anterior teeth which has been root treated and there was a fractured instrument present in tooth 41 and periapical radiolucency was present associated with root apex of tooth 41 and 42. Figure 3-9c shows upper central incisors which has been root treated and post was placed inside the root canal but the angulation of the post was incorrect for tooth 11.

When to take radiographs for root canal treatment?

A radiograph is required during the following stages:

1. Pre-operative or diagnostic stage
2. Working length determination stage
3. Obturation stage – master gutta-percha (MGP) adaptation
4. Mid-obturation stage
5. Final post-operative stage after placement of long term temporary or permanent restoration

1. Pre-operative radiograph

A pre-operative radiograph is important before the commencement of any root canal treatment. This radiograph is used to assess the restorability of the tooth and most importantly to ascertain the anatomy and morphology of the root canal system. The presence of root curvature, multiple root canals in a single root or presence of an obstruction in the root canal such as root filling material, post, and fractured instrument may hinder

thorough and adequate root canal treatment. Therefore, the clinician's will be able to decide the complicatedness of the treatment prior to the commencement of treatment and perhaps refer cases that are beyond their clinical capability.

The pre-operative radiograph is also used to estimate the working length of the tooth by measuring the length of the tooth from the incisal edge or cusp height to the radiographic root apex. This measurement is important to ascertain that all instrumentation is confined within the root canal system because extrusion beyond the root apex could compromise the treatment outcome. Therefore, it is crucial that at least 3 mm of bone must be visible beyond the apex of the tooth. Failure to do so may result in misdiagnosis, incorrect interpretation of the apical extent of the root or incorrect determination of file lengths for canal cleaning and shaping.

Other information that can be gained from a good preoperative radiograph is:

1. Depth and position of the pulp chamber and its roof
2. Root morphology i.e. the number, shape, and size
3. Root canal morphology – number of canals, the appearance of the canal (wide, thin, sclerosed), orientation, depth, and angulation
4. Morphological changes that can make entry difficult (pulp stones, filling material)
5. Periradicular status – root resorption, bone resorption
6. Other associated pathology – root fracture, root perforation

How to estimate the working length from a pre-operative radiograph?

Estimated working length (EWL) can be determined from the pre-operative radiograph. A metal ruler is placed on the radiograph and measurement is taken from the incisal or occlusal tip (reference point) to the radiographic apex.
The calculation for EWL is:

Estimated working length (EWL) = tooth length – 0.5 to 1.00mm

Figure 3-10a

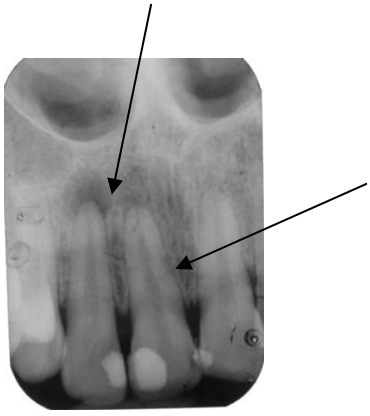


Figure 3-10b

Figure 3-10a &10b shows extracted teeth and the anatomical apex. Figure 5- shows the radiographic apex and the morphology of the root canal. There is a periapical radiolucency present associated with tooth 12.

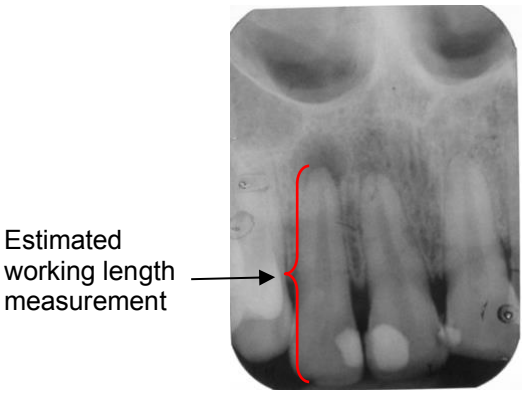


Figure 3-10c: Measurement of estimated working length from a pre-operative radiograph

Figure 3-10c

2. Working length radiograpn

In root canal treatment, the whole length of the root canal must be debrided and cleaned from bacterial infection, followed by placement of an obturation material. The obturation must be within the canal length and not extruded beyond the apical foramen due to its potential irritation to the periapical tissue. Working length radiograph is taken after the canal is accessed and working length is confirmed with an apex locator. To attain a confirmed WL (CWL), endodontic file(s) is inserted into the canal and the file that can reach the estimated working length with a snug fit is used to take the radiograph. File(s) less than size #15 is not suitable to be used to take the radiograph as it is too small, and the tip may not be clear on the radiograph. The clinician must ensure that the radiographic apex is visible on the radiograph as it is used to establish whether the working length is long, short or just at the apex. The working length can be adjusted after this radiograph has been developed and assessed.

Correct technique is essential when taking this radiograph because visibility is reduced (due to rubber dam) and the bows of the clamp often restrict precise film positioning.

Figure 3-11a

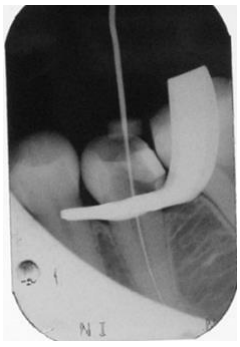


Figure 3-11b

Figure 3-11a shows the working length radiograph taken with the smallest file that can reach to the estimated working length. Figure 3-11b shows unacceptable working length radiograph as the radiographic apex is not visible, thus an accurate decision cannot be made.

How to take a working length radiograph?

<u>The working length radiograph is taken with all the files placed in the designated root canals.</u> This is to reduce the number of radiographs taken for the patient. Once the working length is confirmed (re-check the working length again after placement of files in the root canal), removed the rubber dam frame and prepares the patient for taking the radiograph. Without removing the rubber dam, the x-ray holder and film is gently positioned inside the patient's mouth and make sure that the tooth is centred on the film. Exposed the radiograph using the correct exposure dose (Figures 3-12a to 3-12c).

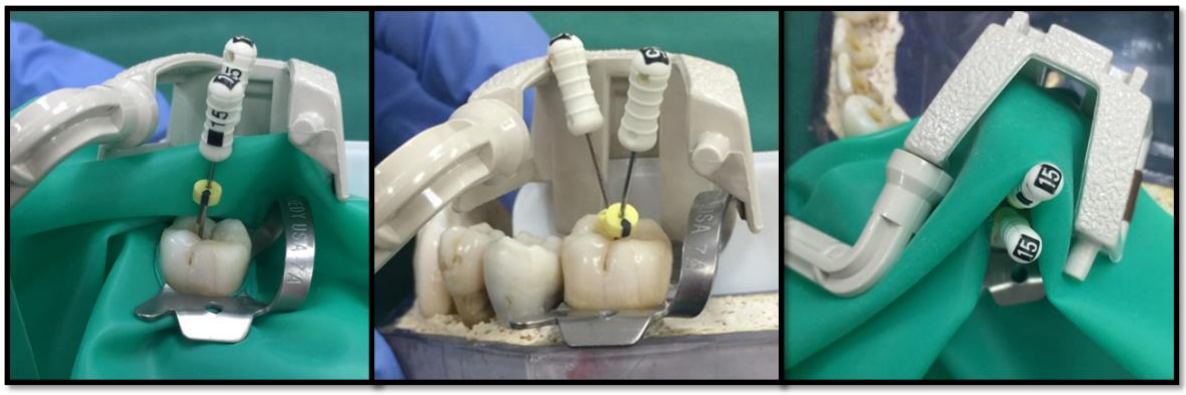


Figure 3-12a Figure 3-12b Figure 3-12c

How to ensure the estimated working length radiograph is acceptable?

The length of the endodontic file is measured to the estimated working length, inserted into the canal. Subsequently, a working length radiograph is taken and developed. Assess this radiograph under sufficient lighting and magnification. If the tip of the endodontic file in the radiographic image is within 0.5 mm from the radiographic apex, then the working length is correct and accepted (Figures 3-13a & b). Any necessary adjustment to the working length can be done according to this radiograph.

DO NOT adjust the working length before taking this radiograph.

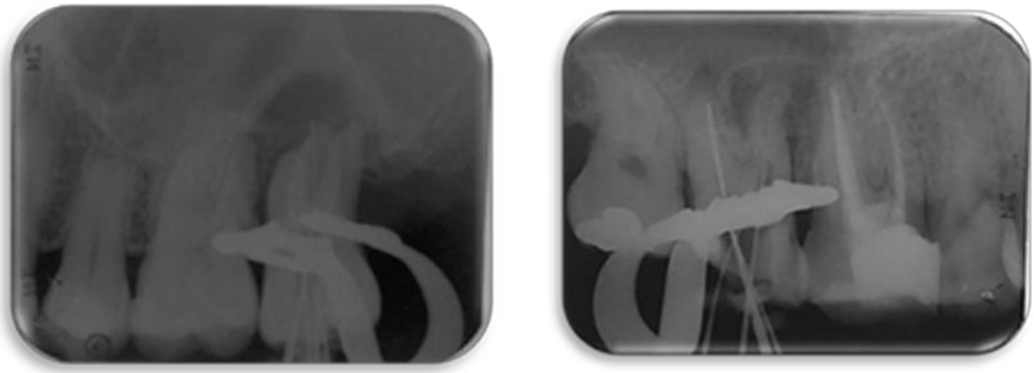


Figure 3-13a Figure 3-13b

What are the disadvantages/limitations of using radiograph to determine the working length?

There are several disadvantages of using radiograph solely to determine the working length such as:

1. It only shows the tooth in two-dimension hence any canal curvature or abnormality that occur in the same plane with the direction of the x-ray beam would not be visible.
2. The apical foramen does not always end at the root apex. It can exist on the lateral side of the root (*radiographic apex and anatomical apex may not be at the same location*).
3. The radiograph can be distorted or magnified therefore the length may not be accurate.
4. Superimposition with anatomical structure or roots could prevent the correct assessment of the file.

<u>3 & 4. Master GP (MGP) adaptation and obturation radiographs</u>

Master GP radiograph is taken after the canal preparation is completed and the tooth is ready for obturation. This radiograph helps to establish that the canal preparation is adequate, and the root canal can be obturated to the desired length (Figure 3-14a). If the root canal preparation is not enough or inadequate, the MGP would not go to the desired working length hence the MGP will appear short of the radiographic apex. Or it can also appear long if the canal is over-prepared. If the MGP radiograph is acceptable, then the clinician can proceed with the obturation procedure and before the gutta-percha points are cut to the orifice level another obturation radiograph is taken (Figure 3-14b). This is to ensure that there are no voids within the obturated canals thus the quality of the root canal obturation can be established. Inadequacy in canal obturation will render the treatment to fail as it does not seal the root canal 3-dimensionally. On the contrary, early detection of poor quality obturation will help the clinician to determine whether to re-do the obturation procedure again or to modify the obturation technique.

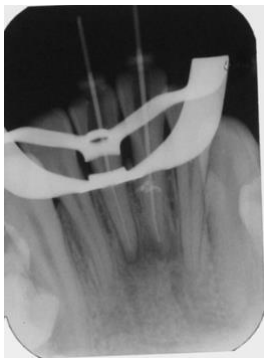


Figure 3- 14a

Figure 3-14b

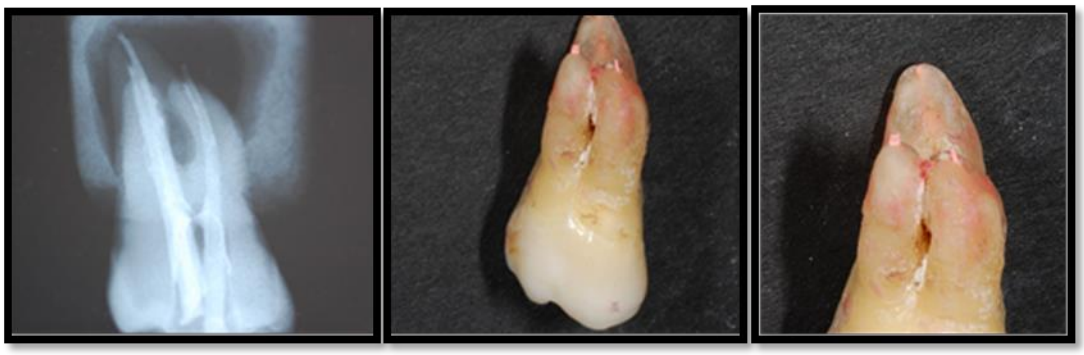


Figure 3-15a to 3-15c demonstrate a radiograph showing extruded MGP in the MB and DB canals, and it is confirmed when the tooth is removed from the resin block. The MGP in the palatal canal is slightly extruded although the radiograph shows it is just at the radiographic apex.

5. Post-operative radiograph

The postoperative radiograph acts as a baseline whereby it is compared with the recall radiograph in order to determine the treatment outcome. Likewise, the quality of the final restoration can also be evaluated (Figure 3-16a). In a successful treatment, the radiolucent lesion will completely heal (disappear) or decrease in size. If the lesion appears larger than the initial size, then the treatment is considered failed (Figure 3-16b). Therefore, recall radiographs taken at similar angulations enhances assessment of the success or failure of treatment.

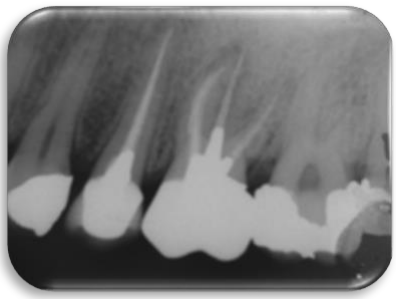


Figure 3-16a

Figure 3-16b

How to take a radiograph in a tooth with multiple roots or root canals?

Since this intraoral radiograph is a two-dimensional image, which is a major limitation, it is often advantageous to take additional radiographs at different horizontal or vertical angulations when treating multi-rooted or multi-canals teeth and those with severe root curvature. Often, superimposition of roots/canals occurs when the roots in the same radiographic plane. It is common to see superimposition of the root canals of the maxillary

first premolar, mesial root of mandibular molar and mesio-buccal canals of maxillary molar. To resolve this situation, the Parallax technique can be used to take the periapical radiograph. This technique uses the buccal object rule to determine the position of the canal. This supplemental radiograph enhances visualization and evaluation of the three-dimensional structure of the tooth.

How to determine the correct position of the buccal and lingual canals?

Image produced using this Parallax technique will show two separated canals. Using the SLOB rules (Same Lingual, Opposite Buccal), the image in the radiograph that is in the same position as the direction of the cone shift is the Lingual canal (the word 'SAME" refers to the shift direction and position of the canal's image). Meanwhile, the canal that is further from the cone is the buccal canal (Refer to Figure 3-).

When taking a pre-operative radiograph, the x-ray cone is usually placed at the right angle (90^o) to the film to minimize distortion of the image. If both canals were in the same plane, both canals will be superimposed and appear as one canal (Diagram A).

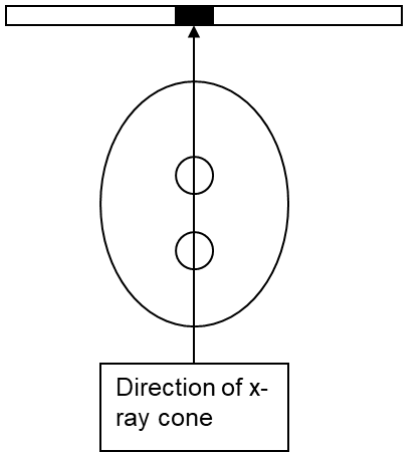
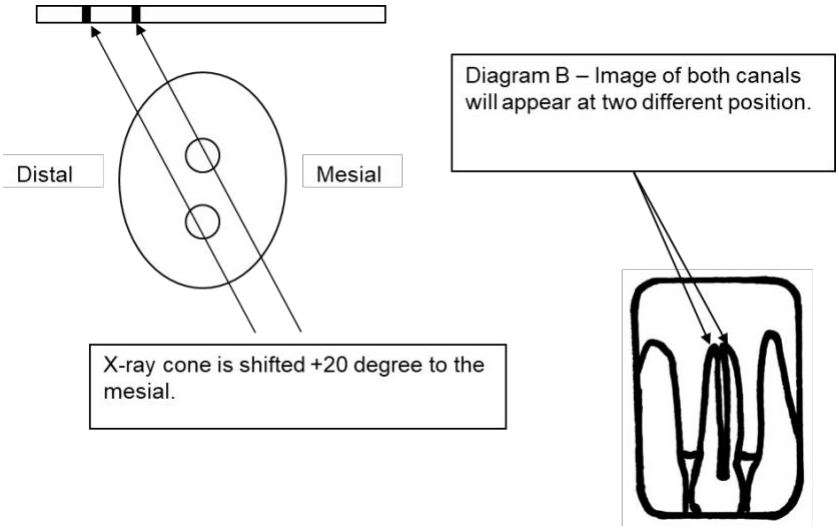


Diagram A illustrate that when the x-ray cone is directed at right angle to the film, superimposition of both canals occurs and the working length is difficult to determine.

The Parallax or cone-shift technique refers to shifting of the x-ray cone in a horizontal plane either mesially or distally so that the canal image is not overlapped (Diagram B). The cone must be shifted at + 20 to 30 degree horizontally. Shifting the cone too much (> 30^o) can result in the superimposition of the canals with the adjacent tooth.



How to mount the film after processing?

After the film has completely dried, use the mounting plastic to mount the film. Make sure the film is mounted in sequential order, dated and the stage of root canal treatment and tooth of interest is written clearly (Figure 3-17).

These films will be useful for future references when reviewing the patient or if retreatment is required.

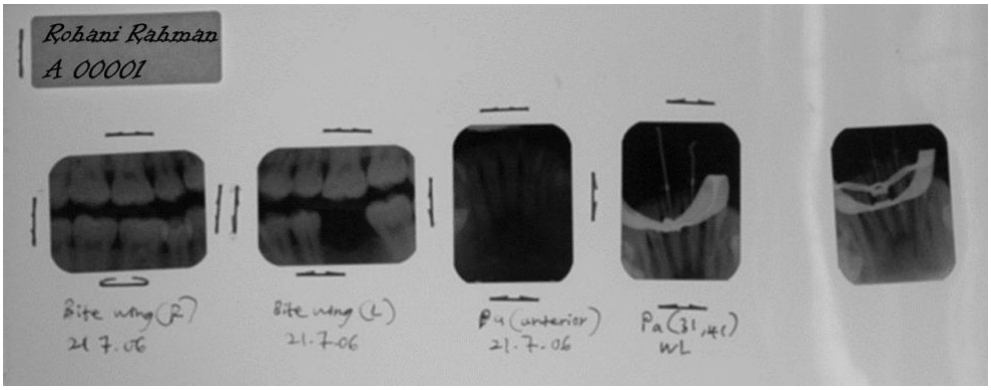


Figure 3-17: Correct mounting of the films in sequential manner

What are the limitations of radiographs in endodontic treatment?

There are several limitations of radiograph in endodontic treatment. Firstly, the radiograph represents a 2-dimensional image of a 3-dimensional object. Therefore, any features of the object that are parallel to the direction of the x-ray beam are not visible on the radiograph. Secondly, detection of bony destruction or pathosis is often late especially when it is limited to the cancellous bone. Studies have proven that radiolucencies usually do not appear unless there is external or internal erosion of the cortical plate. This factor must be considered in evaluating teeth with symptoms but show no radiographic changes.

What are the problems encountered during the taking and processing of the radiograph?

1. Problems during the taking of a radiograph
   - placement of film in the mouth - elongation or foreshortening of radiograph
   - the film is too big/small mouth
   - patient inability to withstand the discomfort during the placement of film
   - wrong angulation of x-ray beam (Figure 3-18) / placement of film in relation to the long axis of the tooth.

Figure 3-18: Incorrect angulation of x-ray cone

2. Problems during processing
   - radiographs too light or too dark (Figure 3-19a)
   - film is damaged during processing (Figure 3-19b)
   - dot in the wrong place – superimposed with the root apex of the tooth of interest – placement of x-ray clip at the wrong place (Figure 3-19c)
   - radiograph become brownish / darker due to improper processing time

Figure 3-19a: Brown film

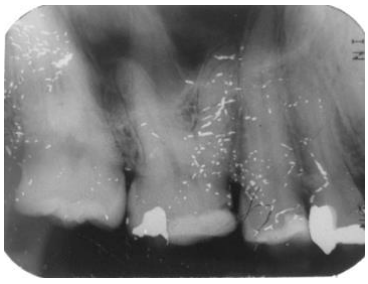


Figure 3-19b: Scratched film during processing or mounting

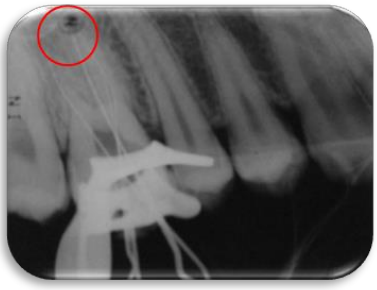


Figure 3-19c: The raised dot is not placed in the slot of x-ray holder

CHAPTER 4

DIAGNOSING PULP AND PERIAPICAL DISEASE

Dalia Abdullah

Both pulpal and periapical diseases have been subject to so many diagnostic schemes, classification systems and terminologies.

How do we classify pulp and periapical disease?

The American Association of Endodontics (AAE) in 2013 standardised the endodontic diagnosis and terminology. The classification aims to aid the communication and better research development between educators, researchers and clinicians. The recommended endodontic diagnosis comprises of both pulpal and periapical diagnosis and the diagnosis is based on patient's symptoms, clinical examination and special investigations such as pulp tests and radiographic analysis. Each diagnosis has its own features which represents the pulpal and periapical status and treatment needs.

Diagnosis of Pulpal Conditions based on AAE (2013)

Diagnosis	**Normal Pulp**	**Reversible Pulpitis**	**Irreversible Pulpitis (Asymptomatic)**	**Irreversible Pulpitis (Symptomatic)**	**Pulp Necrosis**
Patient History	No history of spontaneous pain	No history of spontaneous pain	None	Spontaneous pain	No pain to severe pain
Cold Test	Quick response to cold and does not linger.	Quick and sometimes sharp response discomfort does not linger.	Quick and sometimes sharp response, discomfort does not linger.	Exaggerated response to cold with lingering pain	No response
Percussion Sensitivity	Negative	Negative	Negative	May be positive	No response to exaggerated response.
Radiographic periapical findings	Normal	Normal	Normal PDL or thickening of PDL Caries present	Normal PDL or thickening of PDL	Normal periapex to large periapical radiolucency

Abbreviation: PDL, periodontal ligament

Are diagnostic tools able to conclusively determine the pulpal status?

There are some limitations in the current pulp testing modalities as well as clinical and radiographic examination techniques. To utilized only case history, hot and cold tests to come to a clinical diagnosis is difficult as there is poor correlation between the pulp status and the histologic analysis. For example, in 106 cases studied, of the 20 pulps diagnosed as suppurative pulpitis, only six of them showed abscess histologically. Similarly, in 26 cases diagnosed as hyperaemia which is the first state of pulpal involvement, only six of them had the initial inflammation of hyperaemia while 14 of the other pulps showed histologically signs of abscess

formation. There is also coexistence of different conditions in various parts of the same pulp. For example, micro abscess in a carious lesion exposing the posterior pulpal horn is evident while the other parts of the pulp show sign of initial inflammation only.

Diagnosis of Periapical Condition based on AAE (2013)

Diagnosis	Normal Apical Tissues	Symptomatic Apical Periodontitis	Asymptomatic Apical Periodontitis	Acute Apical Abscess	Chronic Apical Abscess
Patient History of Symptoms	None	Pain when biting	None	Extreme pain when biting	Usually none
Vitality Tests	WNL	Usually no response to vitality tests.	No response	No response	No response
Percussion	None	Positive	None to slight	Positive	None to slight
Palpation	None	May or may not be positive	WNL	Positive	None to slight with sinus tract present
Radiographic Findings	Normal	Widened PDL space to PAR	PAR	Widened PDL space to PAR	PAR

Abbreviations: PAR periapical radiolucency; PDL, Periapical ligament; WNL, within normal limits

How to diagnosis 'normal apical tissue' ?

The diagnosis of normal apical tissues is when the periradicular tissues of a tooth is at the state of health. On percussion and palpation, tooth will not have any pain and radiographically, lamina dura surrounding the root is intact and the periodontal ligament space is uniform. It is of good practice to percuss a clinically sound tooth first to allow patient to gauge the sensation of a normal tooth before proceeding to percuss the suspected tooth of complaint.

How about symptomatic apical periodontitis?

Symptomatic apical periodontitis represents inflammation and destruction of the apical periodontium. The most common metric associated with this diagnosis is pain on biting, teeth coming into contact and percussion testing. The positive percussion test usually correlates with presence of a partial or total necrotic pulp. The reason behind this condition was theorized to be due to oedema, build-up of pressure and the presence of inflammatory mediator.

The response of teeth in symptomatic apical periodontitis varies when tested with palpation, electric pulp tests and thermal tests. The results with those tests are not consistent. This is also true with radiographic findings. Radiographic findings vary from no observable change to only widening of the PDL space at the apex of the roots.

How to diagnose asymptomatic apical periodontitis?

As the term asymptomatic apical periodontitis suggests, the metric associated with this diagnosis are asymptomatic tooth with necrotic pulp and the presence of periapical radiolucency. There may be altered or slight sensitivity to percussion or palpation tests. Radiographically, images may vary from a break in the lamina dura to periapical radiolucency. Histologic analysis of these lesions will usually reveal the presence of lymphocytes, plasma cells, and macrophages denoting the chronic nature of the lesion. To date, no studies have

attempted to relate their histological findings to the metrics used for the classification of this clinical diagnosis.

What are the differences between acute and chronic apical abscess?

One of the differences between acute and chronic apical abscess as the terminology dictates is the duration and onset of the formation of pus. The histologic features of abscess show localized liquefaction necrosis with abundant polymorphonuclear (PMN) leukocytes, debris, and accumulation of purulent exudates. Acute apical abscess is an inflammatory reaction to endodontic infection and necrosis is characterized by rapid onset, spontaneous pain, extreme tenderness of the tooth to pressure, pus formation and swelling of the associated tissues. Patient may be presented with malaise, fever and lymphadenopathy. The radiographic signs of destruction may vary.

Chronic apical abscess has a slower, gradual onset where patient may feel no or slight discomfort with intermittent pus discharge. Sinus tract can be detected at the tissue which offers the path of least resistance. Radiographically, this condition will show signs of bone destruction and radiolucency. A gutta percha point can be used to trace the origin of the sinus tract.

How to diagnose acute apical abscess?

The metrics for acute apical abscess includes symptoms of increasing pain, localized or spreading swelling, sensitivity to percussion, palpation and varying degrees of mobility. Teeth with this diagnosis also have varying degrees of mobility and presence of elevation from the socket. Radiographic features also vary from widened PDL space to radiolucent lesion.

What is condensing osteitis?

A variant of asymptomatic apical periodontitis is condensing osteitis which has radiopaque lesion representing a localized bony reaction to a low grade chronic inflammatory stimulus at the apex of the tooth. Teeth with this condition may or may not have sensitivity to percussion or palpation. Also, there may or may not be a positive response to electric and thermal pulp tests.

CHAPTER 5

ENDODONTIC INSTRUMENTS

Eason Soo

The common endodontic instruments consist of:

1. Front surface mirror
2. Explorer – DG 16 probe
3. Endodontic locking tweezer
4. Endodontic excavator
5. Endodontic plugger/Mortonson plugger
6. Hand plugger
7. Metal ruler
8. Scissors
9. Endo box – contains files, gates glidden burs, finger spreader.

Each instrument has its own function.

Instrument	Function
Front surface mirror	It gives a clear image. (No double image if compared with the rear-surface mirror).
Endodontic explorer – DG 16 probe	To find the canal orifices, to remove the pulp stone. DG 16 probe is long, so it is easier to access into the pulp chamber.
Endodontic excavator	The spoon excavator is used to gain access into pulp chamber
Endodontic locking tweezer	It has a lock "latch" to secure the materials such as paper points, gutta percha points without continuous finger pressure. The grooved tip is to enhanced gripping of materials
Endodontic plugger (in different sizes) Mortonson plugger	1. To compact the GP vertically at the below orifice level 2. To compact the GP vertically at the orifice level
Metal ruler	To measure up to 0.5mm
A 3 mL Syringe and 27G needle	For root canal irrigation
Finger spreader	For lateral compaction technique in obturation

Bur

Bur	Function
1. Round diamond or pear-shaped high speed (size 010/012)	Used as the first bur to gain access into the pulp chamber
2. End non-cutting high-speed bur	Used to enlarge the access to follow the shape of the pulp chamber
3. Goose neck (Long) round bur – slow speed size 010/012) 18mm (extra-long)	To be used in the pulp chamber only, not in the canal. To remove sclerotic dentine overlying the orifices, to remove attached pulp stone in the pulp chamber.
4. Gates Glidden bur (size 1, 2, 3, 4) Length - 18mm and 24mm	To be used in the canal to enlarge the coronal part.

Hand Files

Files are used to clean the canal. The endodontic files can be broadly divided into two groups i.e. standardized files (K-files, Hedström files) and non-standardized files. Non-standardized files are also known as greater taper files.

Standardized Hand Files

Standardized files are made according to the specifications by the International Organization for Standardization (ISO). Examples of files include the K-files and Hedström files. Standardization of the files is on:

1) The diameter and taper of the file
   For a set of K-files,
   - The diameter and taper of the files are fixed with the smallest diameter of 0.06 mm (size 06 file) and the biggest diameter of 1.20 mm (size 120 file).
   - The diameter increases 0.05 mm for every file size from file size 10, 15, 20 – 60 and increases 0.10 mm for file size 70 to 120.
   - The taper of all the files is fixed at 0.02 mm (or 2% taper).

2) The numbering of the file according to the diameter of the file at the tip
   - The file size refers to the number representing diameter of the file at the tip. For example, file size 30 has a tip diameter of 0.30 mm, file size 35 has a tip diameter of 0.35 mm etc.

3) The gradual increase in taper along the length of the file
ISO normed hand files have a standardised taper of 2% that equates to 0.02 mm increase in diameter per mm of file. This standardised taper allows you to calculate the diameter of any given stainless-steel file at any given point. Where the 2% taper means that there is an increase in diameter by 0.02 mm every 1 mm of file (moved in a coronal direction). The most apical point of any file is D_0, so moving coronal on the file by 1 mm brings you to D_1 and so on, up to D_{16} as there is a 16mm cutting surface on all files.

4) For example, an ISO K-file size 30 has a D_0 value of 0.30 mm diameter at its tip. If you were to move 5 mm coronally on this file from D_0, the cross-sectional diameter for D_5 would be: 0.30 mm + (5 mm x 0.02 mm) = 0.40 mm

The standardized files come in 21 mm, 25 mm and 31 mm in length. The length of the active cutting blade/flute is 16 mm.

Characteristics of K-files and K-flexofiles

- K-file are the oldest and most common type of manual intracanal file used today.
- It was first introduced in the early 1900s and received the name K-type file (or K-file) from the holder of the original patent, the Kerr Manufacturing Company (Romulus, Michigan, USA)
- The standardized files we use in the simulation lab and clinics are the K-Flexofiles (size 06 to 30) and K-files (size 30 - 120).
- They are made from stainless steel. There are K-files in the market that are made from nickel titanium.
- For stainless steel file, it is made by twisting a rod that have been grinded to a triangular/square cross section. The sharp edges of the rod will become the cutting flutes.
- The flexofiles are triangular in cross-section (except for size 6, 8 & 10 are square in cross-section), which makes it flexible. This flexibility is important to ensure the file can negotiate curved canals.
- The K-files are square in cross-section and more rigid than the flexofiles. Therefore, these files are mainly used in straight canals.
- The file tip is blunt and non-cutting to prevent formation of ledges on the wall.

How to use the K-files?

- **Watch-winding movement** – Use this rotational movement (clockwise and anti-clockwise/right and left) as you insert the file into the canal. The clockwise movement will engage the file into the dentinal canal wall and the cutting of the dentine occurs when the file rotates anti-clockwise. This rotational movement will ensure that the file follows the canal curvature and reduces the formation of ledges on the canal wall. The file is removed from the canal with a clockwise twist; this will help to load the flutes with debris.
- **Balance force technique (Roane et al 1985)** – This is a specific rotational movement similar to watch-winding technique. The file is turned one-quarter clockwise rotation so that it engages/binds into the dentinal wall. Then, with maintaining a slight apical pressure, the file is turned half- to three-quarter anti-clockwise rotation to cut the dentine. It is recommended to use the first two movements repeatedly, progressing more

apically. Then the third movement pulls the file gently out of the canal in clockwise rotation. This technique will ensure that the file follows the canal curvature and reduces the formation of ledges on the canal wall.

- **Filing movement** – This is an up-down filing movement where the file is gently pressed onto the wall. This movement must be carried out with caution especially in curved canals. Make sure it is limited to the straight part of the canal only.

Characteristics of Hedström-files (H-file)

- Made by machining round stainless steel, thus producing the spiralling cutting edge and taper in a single process.
- It is sharp and aggressive, smaller sizes tend to break easily.
- Ineffective in cutting dentine when used in watch-winding or rotational movement, they would engage and lock into the dentine much like a screw into a piece of wood.
- It is commonly used in retreatment cases to remove old root filling materials
- How to use the H-files? By filling movement – debride root canal wall by up and down filing movement

Non-standardized Hand Files

Non-standardized files do not follow the specification design by ISO. These files are usually designed with a taper much greater than 2% (these files are sometimes called greater taper files). The file system you will be using in the simulation lab and clinics is ProTaper Universal files for hand use.

Characteristics of Hand ProTaper Files

- The hand ProTaper files is a file system consisting of 2 types of file: shaper files and finishing files.
- It is made from nickel-titanium. Nickel-titanium metal is flexible (shape-memory alloy) and has the ability to flex even with larger diameter. This is useful when negotiating curved canals. As such, the files are designed with larger diameter than the K-files and with multiple and progressive greater tapers (2 – 19% taper).
- It has a triangular convex cross section (for better flexibility), sharp cutting edges and the flutes are in variable helical angle.
- The tip of the file is non-cutting.
- The files are designed following the 'crown-down' concept.
    - The shaper files (S1, SX and S2) are used to flare/enlarge the coronal part of the canal. The upper part of the flutes acts to cut the dentinal wall. These shaper files engage a smaller area of dentine at the coronal part and therefore reduces the torsional loads and file fatigue.
    - A unique feature of the ProTaper Universal Shaping files is each instrument has multiple "increasing" percentage tapers over the length of its cutting blades. This progressively tapered design serves to significantly improve flexibility, cutting efficiency, and safety.
    - This design feature allows each shaping file to perform its own "crown down" work. One of the benefits of a progressively tapered shaping file is that each instrument

engages a smaller zone of dentin which reduces torsional loads, file fatigue and the potential for file breakage.

- The finishing files are used to enlarge the apical part of the canal. However, unlike the Shaping files, the Finishing files have "decreasing" tapers from D_4 - D_{14}. This design feature serves to improve flexibility, reduce the potential for dangerous taper-lock, and prevent the needless over-enlargement of the coronal two-thirds of a root canal.

File	Tip Diameter	Taper	Colour
Shaper files			
S1	0.17 mm	2% - 11% (D_1 to D_{14})	Purple
SX	0.19 mm	3.5% - 19% (D_1 to D_9) 2% (D_{10} to D_{14})	Orange
S2	0.20 mm	4% - 11.5% (D_1 to D_{14})	White
Finishing files			
F1	0.20 mm	7% (D_1 to D_3) Decreasing Taper (D_4 to D_{14})	Yellow
F2	0.25 mm	8% (D_1 to D_3) Decreasing Taper (D_4 to D_{14})	Red
F3	0.30 mm	9% (D_1 to D_3) Decreasing Taper (D_4 to D_{14})	Blue
F4	0.40 mm	6% (D_1 to D_3) Decreasing Taper (D_4 to D_{14})	Black
F5	0.50 mm	5% (D_1 to D_3) Decreasing Taper (D_4 to D_{14})	Yellow

How to use the ProTaper Universal files?

The files are used with **Balance-force Technique**. The file is turned one-quarter clockwise rotation so that it engages/binds into the dentinal wall. Then, with maintaining a slight apical pressure, the file is turned half- to three-quarter anti-clockwise rotation to cut the dentine. It is recommended to use the first two movements repeatedly, progressing more apically. Then the third movement pulls the file gently out of the canal in clockwise rotation. This technique will ensure that the file follows the canal curvature and reduces the formation of ledges on the canal wall.

Tips on using the files:

- Always measure the full length of the file before inserting it into the canal. Never use a broken file in the canal.
- Always estimate the working length when you first insert the file into the canal. This is to prevent over-instrumentation and minimize the trauma to the periapical tissue.
- Glide path must be established first after confirmation of working length prior to canal shaping and apical preparation. Glide path can be achieved with K-files size 10 up to 20 using Balance forced technique.
- Never force the file into the canal. Gently insert into the canal as far as the file can go.

- Never perform canal instrumentation in a dry root canal wall. Always use a root canal lubricant (such as RC Prep, Glyde, File-Eze) with the files to reduce the occurrence of file breakage. The lubricant enhances the cutting ability of the files and the chelating agents in the lubricant clumps up the debris to facilitate its removal during flushing with sodium hypochlorite irrigation. This will result in cleaner canals.
- Clean the file flutes often to remove the debris. A file full of debris will not cut so efficiently. This debris may be pushed into the periapical tissues and could cause post-operative flare-up.
- Check the flutes for any defects and untwisting of the flutes.
- Irrigate the canals often to flush out the debris.
- Always use the files in a wet canal.

Materials used in endodontics

1. Irrigation Solution
   Irrigation solution of choice to be used during root canal treatment is sodium hypochlorite solution (NaOCl). In the faculty, the domestic bleach is used for this purpose. The bleach solution has a 5.25% concentration. Clinically, 1 – 5.25% concentration could be used. The usual concentration used in the clinic is 2.5% (by adding 1 part of water to 1 part of 5.25% NaOCl).

   NaOCl has these advantageous properties:
   a) It has an anti-bacterial property.
   b) It dissolves the soft tissues especially in the root canal system where the area is inaccessible by the files (lateral canals, ramifications between the main canals).
   c) It flushes the debris out of the canal efficiently.

   Dental dam placement is **mandatory** for all endodontic and restorative works. This will ensure that the irrigation solution does not leak in the patient's mouth and subsequently into gastro-oesophagus and respiratory tract.

2. Lubricant
   Lubricant is a material that usually contains 15-17% ethylene diamine tetra-acetic acid (EDTA). Lubricant is useful to lubricate the canals so that the resistance between the file and canal wall is reduced. There will be less force used to cut the dentine, and there will be less fatigue to the files.
   EDTA acts as a chelating agent whereby it clumps the dentine chips/debris together and therefore facilitating its removal from the canal during irrigation.
   Frequent use of the lubricant reduces the occurrence of canal blockage and file breakage/separation during root canal instrumentation.

3. Obturation Materials
   Gutta percha (GP) cones have been the material of choice for root canal obturation. The GP cones consist of 19-22% gutta percha, 59-75% zinc oxide, wax, colouring, antioxidant and radiopaque material.

The GP cones are supplied in various forms; standardized GP cones, non-standardized GP cones and accessory GP cones. The standardized GP cones have similar specifications to match the standardized files, whilst non-standardized GP cones match the files of greater taper. ProTaper GP, for example, is produced to match the canal prepared with ProTaper Universal files system. It is called “single-matched cone” technique.

The accessory GP cones are used to fill in the spaces between the canal wall and the main GP and follows the sizes of the finger spreaders.

CHAPTER 6

ACCESS CAVITY

Dalia Abdullah

What is the purpose of creating an access cavity?

The first step in performing a root canal treatment is to create an access cavity to gain access in the pulp chamber and into the canals. This process involves the removal all caries and also the sound tooth structure that makes up the pulpal roof. All defective restorations must be removed, followed by caries removal before entering the pulp chamber. Total caries removal is essential to prevent contamination of caries debris that contain millions of bacteria into the chamber and the canals. If pulpal exposure is present after caries removal, the exposure can be used as the initial point of entry.

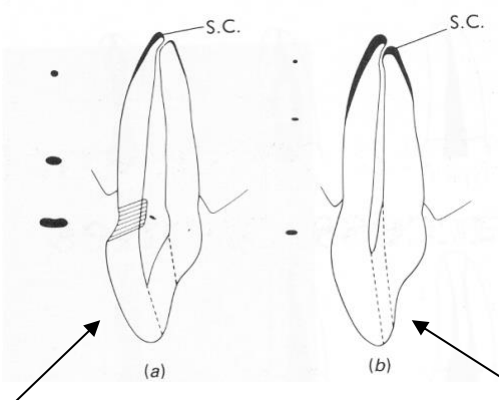
What basic principles should be kept in mind when creating an access cavity?

The design of an access cavity is crucial to ensure that the objectives of root canal treatment are met. When creating an access cavity, ensure that:

1) All pulpal roof over the pulp chamber is removed. Under prepared cavity due to incomplete removal of pulpal roof may result in difficulty to locate all the root canals.
2) Removal of sound tooth structure is limited and is only to facilitate access into the canal orifices with no overextension. The removal is considered necessary to allow complete removal of pulp tissues, hard tissues such as pulp stones that could block the canal orifices, and to allow straight-line access into the canals. Unnecessary removal of sound structure may cause a decrease in fracture resistance of the tooth.
3) Walls of the access cavity would give retention to the temporary filling.

Are the shapes of access cavity for all teeth similar?

The shape of an access cavity depends on the shape of its pulp chamber. An access cavity of a tooth of the same type may have a similar shape. For example, the shape of an access cavity for an anterior tooth might be triangular. However, this shape is dependent on the age and presence of pathological condition on that particular tooth. The size of an access cavity of a young patient is usually bigger compared to an older patient and therefore, its shape may also differ. In the presence of caries, the formation of secondary and tertiary dentine will make the pulp chamber and canal becoming narrower.



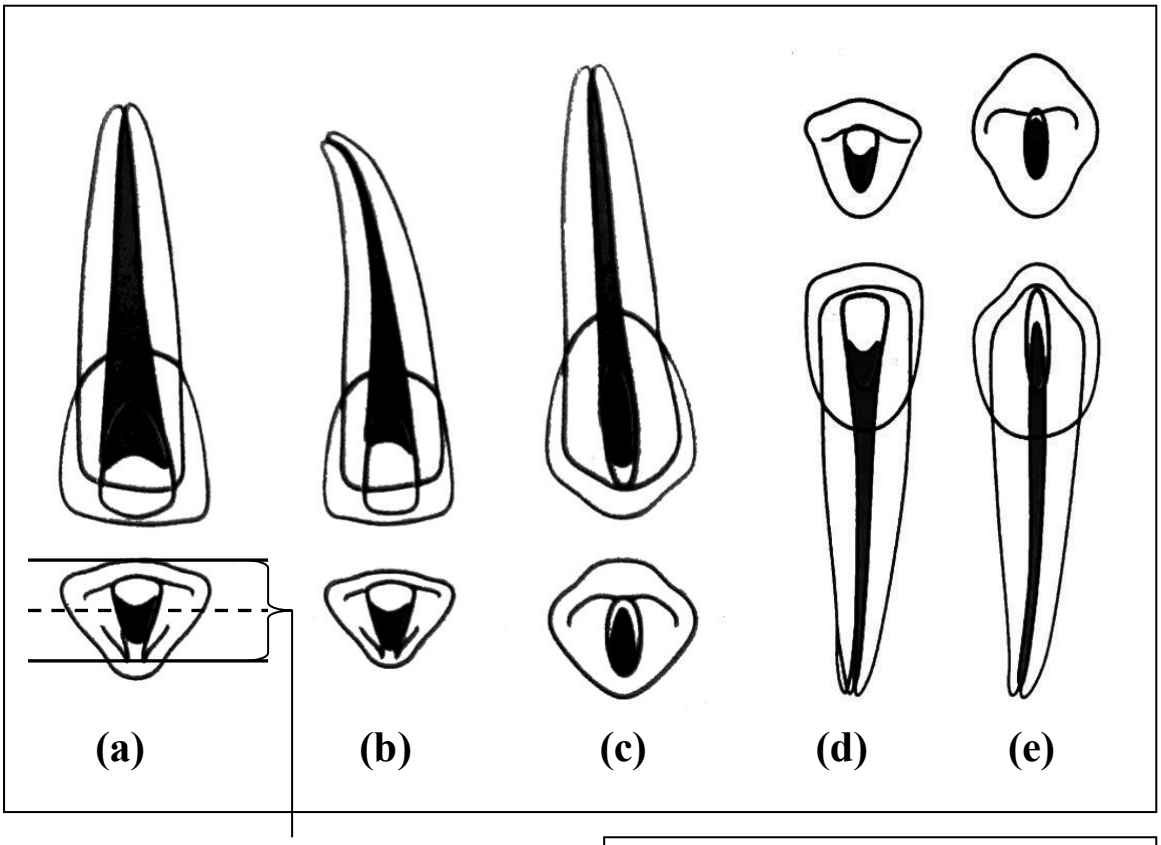
Size of pulp chamber in young patient

Size of pulp chamber in old patient or tooth with caries

What are the common shapes of the access cavity in different types of teeth?

a) Anterior teeth

The access cavity of the maxillary and mandibular anterior teeth is usually triangular or oval, depending on the shaped of its pulp chamber. The access cavity is placed between the incisal and the cingulum. (Diagram 6.1).



The initial vertical access is made by putting the bur in the middle of the palatal surface.

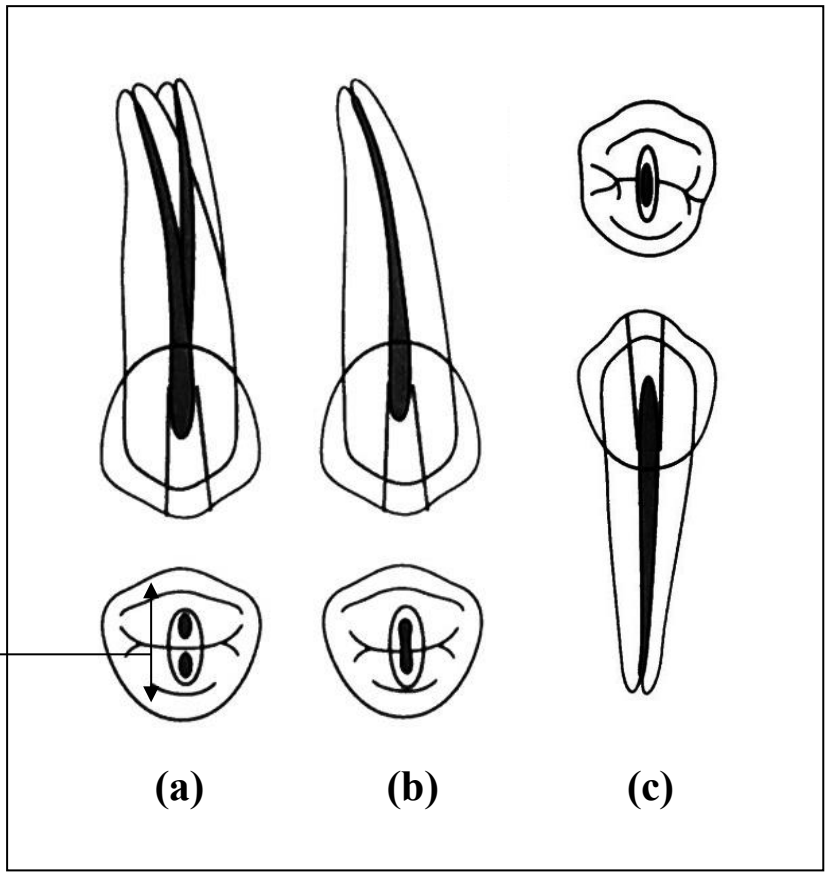
Diagram 6-1 – Shape of the access cavity for:
(a) Maxillary central incisor
(b) Maxillary lateral incisor
(c) Maxillary canine
(d) Mandibular incisor
(e) Mandibular canine

All the pulpal tissues in the pulp chamber must be removed as the remnants left in the canal could cause coronal discoloration. It is imperative to remove the entire pulpal roof especially at the pulpal horn for the anterior teeth as incomplete removal will prevent proper cleaning of tissue remnants as well as root canal cements at this area.

b) Premolars

The shape of an access cavity for premolars is oval. At the initial vertical access, the bur is placed in the middle of the tooth at the central groove in the direction of the most coronal pulpal horn. After the bur penetrates the pulp chamber, the subsequent horizontal preparation bucco-palatally is required to remove the roof completely forming the oval-shaped cavity. All effort must be made to prevent mesial or distal extension especially for upper premolar as the pulp chamber area at the neck of the crown is very narrow. Over-preparation at this area could cause perforation.

Diagram 6-2 – Shape of access cavity for:
a) First maxillary premolar
b) Second maxillary premolar
c) Mandibular premolar



For premolar tooth that contain one canal orifice, the orifice is usually located in the centre of the tooth and the orifice diameter is usually larger than two canal orifices (diagram 6.2b). For premolar tooth that contain 2 canal orifices, the orifices are located more towards the buccal and palatal. The shape of the access cavity for this tooth may look like figure of 8 (diagram 6.2a).

c) Molars

The shape of access cavity for molars usually is triangular or squarish. The pulpal roof is completely removed to allow maximum visibility into the pulp chamber and all orifices. The preparation of the cavity must also allow straight line access into the orifices.

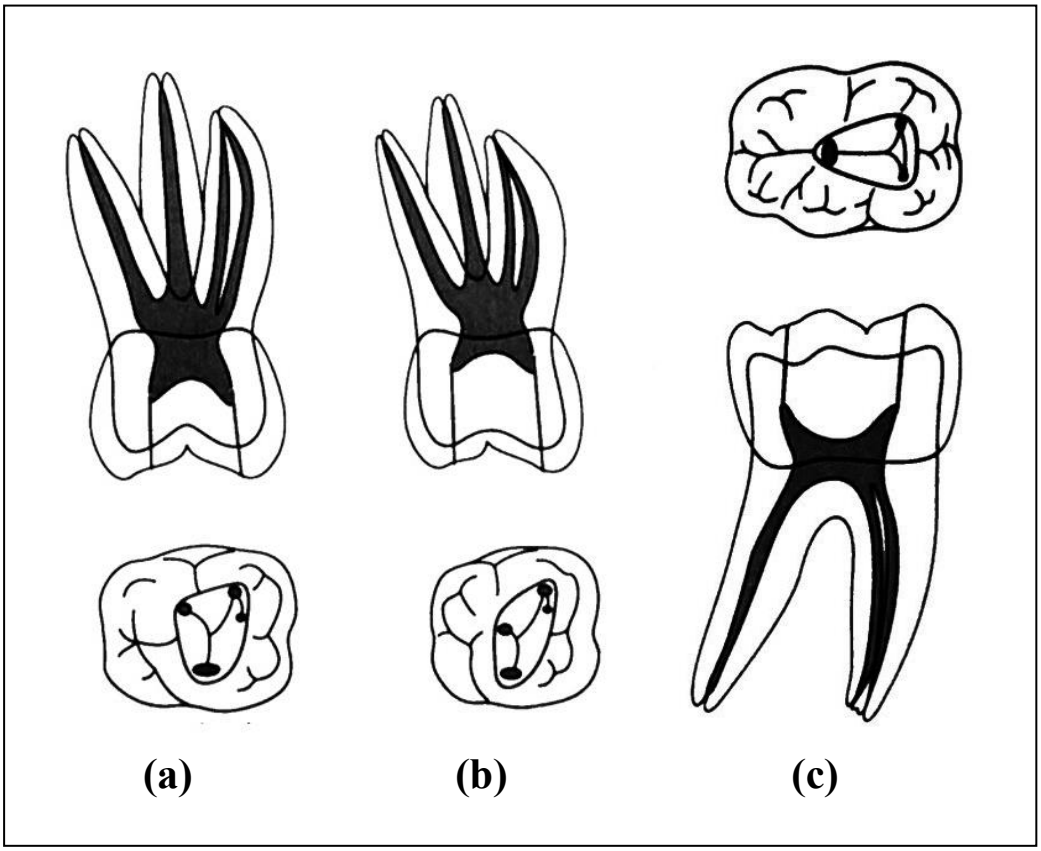


Diagram 6-3 – Shape of access cavity for:
(a) First maxillary molar
(b) Second maxillary molar
(c) Mandibular molar

How to gain access into narrow and calcified pulp chamber?

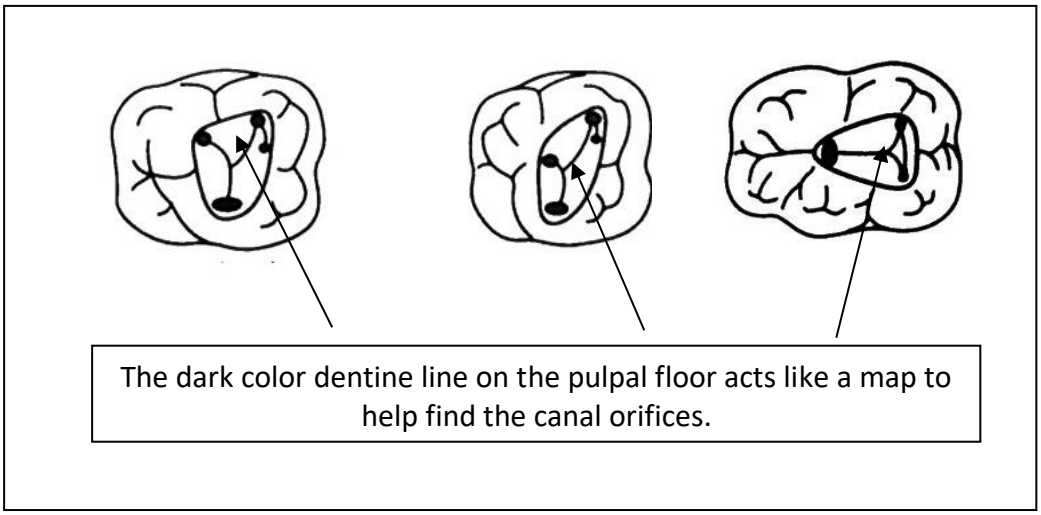
Teeth requiring root canal treatment are usually carious or had repetitive restoration being placed, which act as stimuli to incite the formation of secondary or tertiary dentine in the pulp chamber. This calcification process will lead to narrowing of the pulp chamber and canals. Sometimes from the radiograph, it appears as if the roof and floor fused in the middle the pulp chamber.

The best way to penetrate into the pulp chamber in this case is to place the bur for initial penetration in the centre of the tooth and to direct the bur towards the biggest canal. For lower molar, the biggest canal is the distal canal and for upper molar, it is the palatal canal.

After the initial vertical penetration, the preparation needs to be extended to follow the shape of the pulp chamber by removing the roof using an end non-cutting bur.

How to find the canal orifices?

After access cavity preparation, the pulp chamber should be irrigated with sodium hypochlorite to dissolve any pulp tissue remnants and disinfect the area. The cleaned pulpal floor is dome-shaped with the dentine floor slanting into the canal orifices. On the pulpal floor, there is usually the dark colour dentine line (that looks almost like a groove). The orifice is usually located at the end of this line at the floor-wall junction. Use the DG 16 probe to scout and locate the orifice.



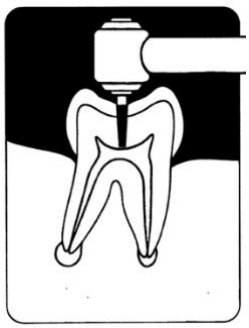
The dark color dentine line on the pulpal floor acts like a map to help find the canal orifices.

Each canal for molar is named according to its position in the arch. For example, the upper maxillary molar consists the two buccal canals which are called mesiobuccal (MB) and distobuccal (DB) canal and the other palatal (P) canal. If there is a fourth canal presents, it is called the mesiobuccal 2 (MB2) as it is usually located at the mesiobuccal position.

What are the step-by-step techniques of an access cavity preparation?

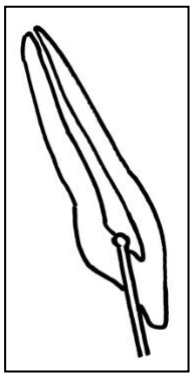
Method:

1. From the pre-operative radiograph, estimate the depth of the initial vertical penetration into the pulp chamber by measuring the distance from the occlusal surface to the roof of the chamber. Use a rule to measure or put the bur against radiograph to estimate the depth.



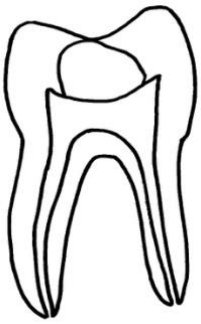
2. The initial vertical access is made by using any small high-speed bur.

3. For anterior tooth, ensure that the bur is in the direction of long axis of the tooth and parallel to the labial surface. This direction is necessary to prevent perforation on the labial.

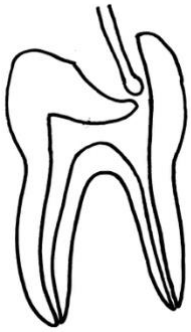


Bur is placed parallel to the labial surface of the crown

For upper molar, place bur in the centre of the tooth and direct the bur towards the likely position of the palatal canal while for lower molar, direct the bur towards the likely position of the distal canal.

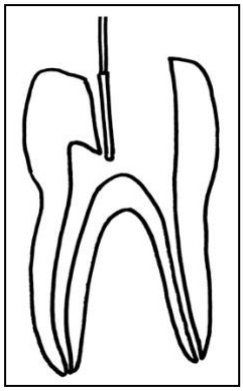


Remove caries completely before making the penetration into the pulp chamber. If there is pulp exposure, enter the pulp chamber through the exposure.



Direct the bur towards the distal canal

4. After the initial penetration, use the end non-cutting bur to make the horizontal extension/preparation by removing the pulpal roof completely. The end non-cutting bur is used to prevent damage to the pulpal floor.



Horizontal extension to remove pulpal roof using the end non-cutting bur

5. Use the DG 16 probe to ensure the pulpal roof is completely removed. Remove any overhanging roof with the end non-cutting bur.

6. Remove the pulp tissues in the pulp chamber then clean the pulp chamber with sodium hypochlorite to dissolve any remnants and disinfect the chamber.

7. Use the DG 16 to locate the canal orifices. Use the grooves on the floor as a guide to locate the orifices.

8. Any calcification (pulp stone etc) that maybe present in the pulp chamber can be removed by using the ultrasonic tip or scalers. The ultrasonic tip will chip off the calcification so ensure chamber is frequently washed to remove the debris.

9. After finding the canals, establish the estimated working length from the pre-operative radiograph for each canal. First, measure the tooth length (distance from the coronal such as the cusp tip or incisal edge to the radiographic apex). Then subtract 0.5-1mm from the tooth length to give the estimated working length.

10. Next is to establish the glidepath. Use K-file #10 (dipped in lubricant such as RC Prep) in a watch-winding motion to enter the canal. Gently advance the file in the canal until the estimated working length. Check if there is straight line access into the canal.

Straight line access – the file is not bent when inserted in the canal.

How many canals are there for each type of tooth? What about the variation of canal morphology?

Typical anatomy of the pulp chamber for maxillary teeth:

Tooth	Maxillary central and lateral incisor	Maxillary canine	Maxillary first premolar	Maxillary second premolar	Maxillary first molar	Maxillary second molar	Maxillary third molar
No of root	1	1	2	1	3	3	
No of canal	1	1	2	1	4	3	
Average root length	23 mm	26.5 mm	21 mm	21.5 mm	22 mm (Palatal canal maybe slightly longer)	21 mm	
Canal variation	Dens invaginatus, rarely extra root	-	Maybe 1 rooted (Mongoloids) or 3rooted (6%)	-	-	-	Varied root morphology Pulp space anatomy unpredictable
Root curvature	Apex of lateral incisor curved distally	-					

Typical anatomy of the pulp chamber for mandibular teeth:

Tooth	Mandibular central and lateral incisor	Mandibular canine	Mandibular premolar	Mandibular first molar	Mandibular second molar	Mandibular third molar
No of root	1	1	1	2	3	-
No of canal	1	1	1 or 2	3, sometimes 4 (especially in Mongoloid)	3	-
Average root length	21 mm	22.5 mm	21 mm	21 mm	20 mm	-
Canal variation	Prevalence of 2 main root canals that merge in the middle into a single apical foramen (41 %)	2 canals (14%)	Wide variation of canal morphology	Mesial canals merge together with one apical foramen 38% has 2 distal canals	33-52% fused roots in Chinese population (giving a C shaped canal)	Varied root morphology Pulp space anatomy unpredictable
Root curvature	-	-		Mesial roots tend to curve mesially at the apical part, Ramifications between mesial canals		

How about the canal configuration in the root canal system?

Canal system can be classified into Type I – VIII as illustrated in the diagram below:

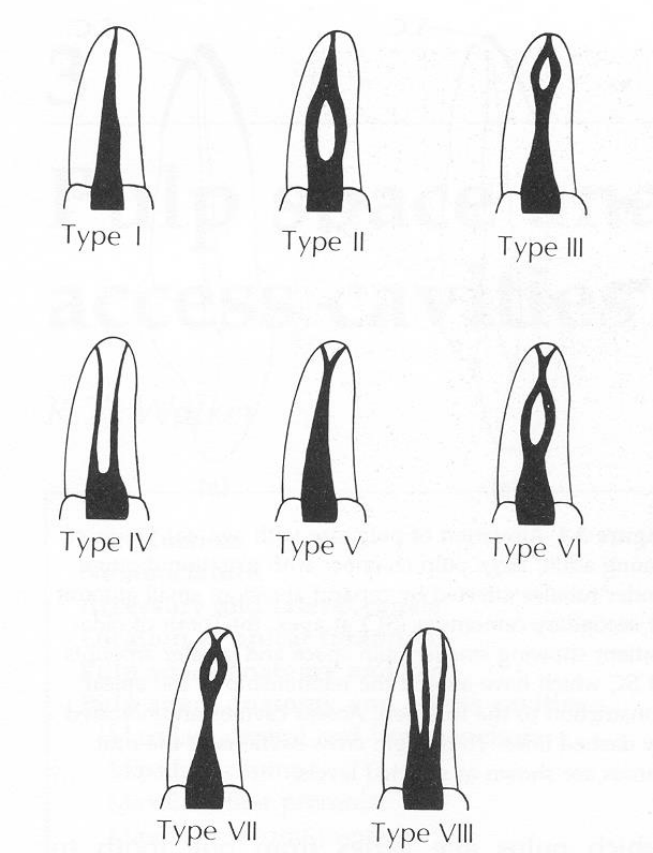


Figure 3.2 Types of canal configuration.

What are the errors that can occur during an access cavity preparation?

1) Perforation on the labial of the anterior teeth
   This perforation occurs due to incorrect orientation of the bur during the initial vertical penetration into the pulp chamber whereby the bur is angulation 45^{o} from the labial surface of the crown. This angulation will cause the bur to damage and perforate the canal wall.

   The bur should have been directed parallel to the long axis of the tooth and to the labial surface of the crown.

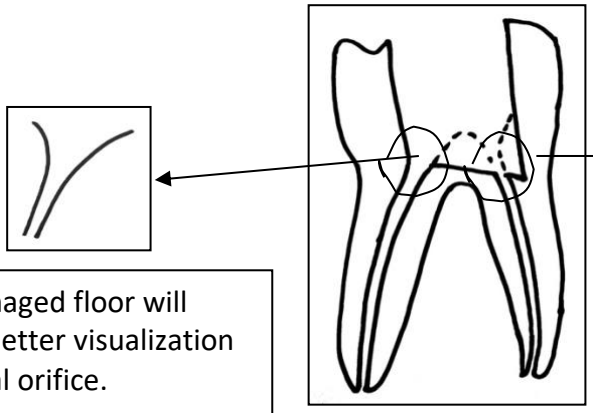
Bur directed 45^{o} from the labial surface – risk of perforation

Bur should be directed parallel to the labial surface of the crown

2) Incomplete removal of pulpal roof (overhangs)
   Pulp chamber roof overhangs should be removed to prevent accumulation of (infected) pulp tissue debris and root canal cements underneath it. Incomplete cleaning underneath the overhangs may cause dentine discolouration and makes the crown appears dark and discoloured (especially for anterior teeth).

3) Overpreparation involving the incisal edge for anterior tooth
   Most access cavity for anterior teeth can be prepared without involving the incisal edge to gain straight line access into the canal. Extension of preparation to the edge of the incisal is not aesthetic and can weaken the tooth structure.

4) Damage to the pulpal floor
   Damage to the pulpal floor usually occurs due careless use of high-speed burs in the pulp chamber. Use of good illumination and magnification may help to prevent this error. Pulp calcification should be removed carefully using the ultrasonic tip. Damage to the floor may result in failure to locate the canal orifice.



Undamaged floor will allow better visualization of canal orifice.

If the floor is damaged due to overcutting, canal orifice will be smaller and difficult to find

5) No straight-line access into the canal
Access cavity should allow the file to enter the canal without deviation and restriction. Restriction could occur due to dentine shelves at the coronal part.

The file is bent when is inserted un the canal due to the presence of pulpal roof that is not completely removed.

If inflexible file is inserted in the canal that has no straight-line access, ledge could be formed causing difficulty in cleaning the canal.

CHAPTER 7

CANAL PREPARATION

Dalia Abdullah

Endodontics is the clinical procedure to prevent or treat the root canal system of the infection. The objective of the treatment is to provide an environment that allows healing of the periradicular tissues so that the tooth can remain functional within the dental arch.

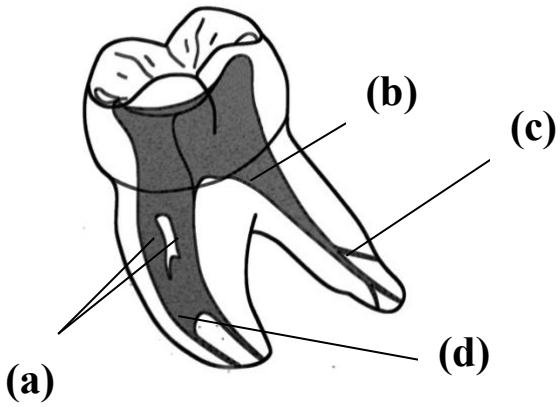
What are the biological objectives of canal preparation?

Two biological objectives are:
1) To eliminate the pulp tissues and debris from the root canal system.
2) To eliminate bacteria from the root canal system.

It is impossible to eliminate completely both pulp tissues and bacteria from the canal. In most cases, with the use of anti-bacterial irrigation solutions, the root canal treatment can only manage to reduce the number of bacteria (especially the virulent species that are usually anaerobes) and alter the environment in the canal to make it unsuitable for further bacterial proliferation.

Why is it impossible to eliminate the bacteria in the canal?

In single-rooted teeth, it may be possible to render the canals to be bacteria-free. In this situation, the canal is usually single, large and tube-like which makes it easy to clean the dentinal wall with the files and flush the debris out with irrigant. Most root canal system of the multi-rooted teeth however exhibit a complex morphology. It usually consists of main canals that are connected to each other. There are many communications between the main canals in the form of fins and isthmuses. Root ramifications and presences of lateral canals are common at the apical areas of most canals. Endodontic files can be used to clean the main canals since they are easily accessible but not in these communications and ramifications.



Root canal system:
(a) Main canal –mesial
(b) Main canal – distal
(c) Lateral canal
(d) Isthmus dan fins

For example, mesiobuccal and mesiolingual canal of the mandibular mesial root are usually connected by the isthmuses and fins.

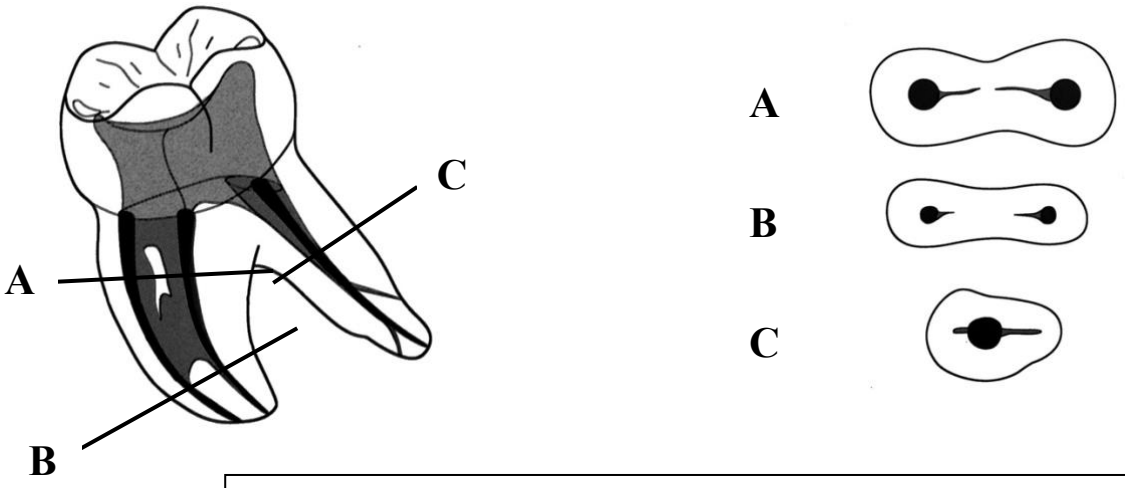
Bacteria have also been shown to be able to travel and reside in the dentinal tubules. Mechanical removal of the dentine on the canal wall is not able to remove the bacteria in this area completely.

In the root canal system, bacteria co-exist in a layer on the canal wall called biofilm. They are clumped in the layer surrounded by a matrix, which is quite resistant to the irrigation solution. It is important to disrupt this layer during the mechanical filing in order to remove the layer.

How do we make sure we achieve an effective canal cleaning?

The key to successful endodontics depends on effective canal cleaning. This includes:
1) The use of a bactericidal irrigation solution
2) Adequate enlargement of the root canal system to allow efficient action of irrigation solution

Chemo-mechanical debridement refers to the use of the endodontic files and an anti-bacterial irrigation solution to clean the canal. The files are used to mechanically remove the tissues from the main canal and destroy the biofilm whilst the chemical solution will flow into those areas inaccessible by the files.



A, B dan C shows the cross-section of the root. The dark area indicates the main canal in which files are able to access. The grey areas indicate the areas that could only be accessed by irrigation solution.

Why do we need to enlarge the canals? Why is canal preparation a must?

Cleaning of the canal relies heavily on the use of irrigation solution. In order to ensure good delivery of irrigant into the canal especially at the apical part, canals need to be enlarged from its original size. Canal preparation is a stage during the root canal cleaning whereby the files are used to shape the canals to create space to allow the

irrigation needle to penetrate as deep as possible into the canal. The deep penetration will allow effective delivery of the irrigation solution into the apical part of the canal, where the intricate root canal morphology is usually present. The enlargement of the canal will also provide better exchange of irrigant at the apical area for effective dissolution and flushing of the debris.

Removal of dentine wall along the canal during canal enlargement will also ensure removal of the biofilm and bacteria that could remain deep in the dentinal tubules.

Canal enlargement must be done without removing too much of the dentine. Excessive removal could eventually result in the weakening of the tooth and may lead to fracture.

What is the right shape to enlarge the canal?

According to Schilder in his published paper in 1970, the canal preparation must:

1) Create a shape of continuous taper whereby the canal is flared coronally and it tapers down to the apex
2) Ensure the original curvature of the canal is maintain
3) Maintain the original location of apical foramen
4) Maintain the original size of the apical foramen

The shape of the continuous taper is recommended as it follows the original shape of the canal, allows removal of the dentine without weakening the root structure and allows for the efficient delivery of the irrigant into the apical area.

How do we achieve this shape?

There are many ways and techniques described in the literature on how to do canal preparation. Traditionally, the technique of canal preparation advocates enlarging the apical part first before flaring the coronal part of the canal (this technique is usually referred to as step-back technique). This technique is no longer in use because it produces a lot of procedural complications.

The crown-down approach is a newer technique whereby the canal is first flared coronally, followed by the enlargement of the apical part of the canal.

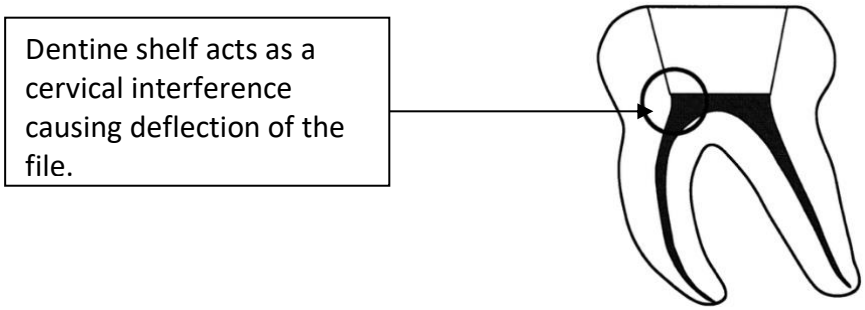
What are the advantages of crown-down techniques?

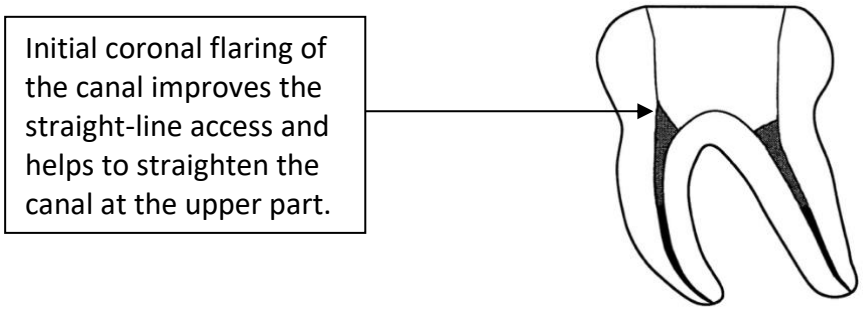
1) Most microorganisms and necrotic tissues are situated at the coronal part of the canal. Initial enlargement at the coronal part first will ensure bulk removal of these infected tissues and reduces the risk of accidental pushing of the debris into the periapical tissues.

2) Initial enlargement of coronal part will create space for the solution to escape out from the canal and reduces the build-up of hydrostatic pressure in the canal. The

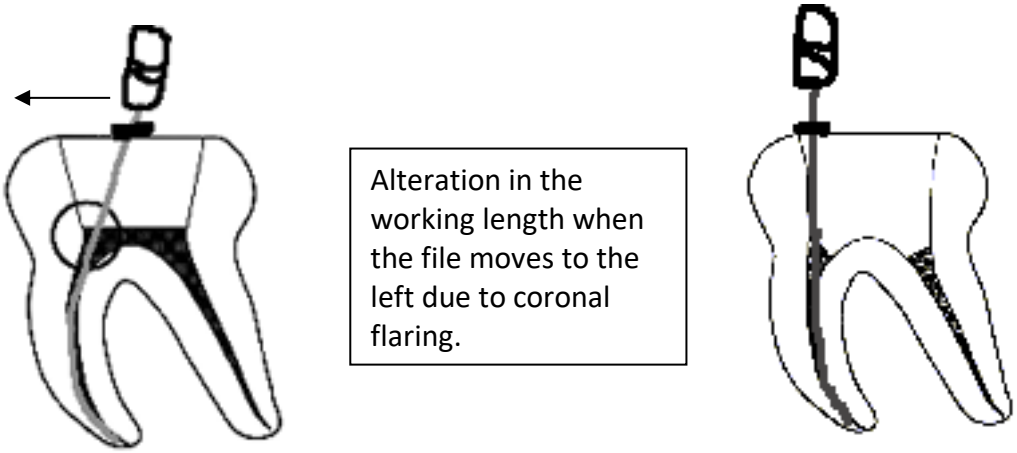
hydrostatic pressure could cause the extrusion of debris into the periapical tissues that increases the risk of post-operative pain.

3) In multirooted teeth, presence of dentine shelf acts as a cervical interference that could cause difficulty in inserting the file especially in curved canal. If it is not removed, the file will bend at an angle during insertion. Without the straight-line access into the canal, the tip of the file could accidentally cut the canal wall at the curvature that will eventually form a ledge. Initial enlargement of the coronal portion of the canal removes this cervical interference, improves the straight-line access into the canal and facilitates the insertion of file into the canal.





4) Initial coronal flaring prevents alteration of the working length.



5) Coronal flaring allows the irrigating needle to penetrate right away into the 2/3rd of the canal to deliver the solution. This will effectively flush the debris and produce cleaner canal. Efficient removal will also prevent accumulation of debris at the apex and reduces the incidence of canal blockage.

CROWN-DOWN APPROACH

Crown-down approach refers to the procedure of canal enlargement to produce a continuous taper canal as the final shape. The canal is first flared at 2/3rd coronally before the enlargement of the apical part of the canal.

The steps in crown-down approach include:

1) Coronal flaring
2) Determining working length
3) Gauging the canal size at the apex
4) Apical preparation

There are many techniques of canal preparation described in the endodontic literature. In this chapter, two methods of crown-down using 2 types of hand files will be described i.e.:

1) Canal preparation using Hand Protaper
2) Modified double flare technique using K-files

Protaper hand files have the advantages whereby the files are designed to produce the tapered shape in a crown down manner (please read the section on the instruments).

With Modified Double Flare technique, you need a series of hand files and rotary burs (GG burs mainly) to produce the tapered shape.

Description of the technique:

Steps	Hand Protaper	Modified Double Flare
1) Estimate the working length from pre-operative radiograph	• Measure the tooth length from preoperative radiograph. • Estimation of working length (EWL) = Tooth length minus 0.5 - 1mm	
2) Establish the glide path	• Take a #10 K-file and insert into the canal to EWL. • Use a lubricant such as RC Prep with the file. Use the watch-wind motion to insert the file into the canal. • Never force the file into the canal. • If the file could not go down all the way into the canal, do not worry. Work the file to that length only (take note of the length). Do not force the file to proceed further. The file probably binds at the coronal dentine. Once the coronal flaring is complete, you may find the file will go to the EWL.	
3) Determine 2/3rd of canal	• Estimate the length of 2/3rds from the EWL. E.g. 2/3rd of 18mm working length = 12mm	
4) Coronal Flare	• Use file S1 to enlarge the 2/3rd of canal with lubricant. • Once S1 is at 2/3rd, use S2 to 2/3rd. • Then use the Sx to open the canal orifice. Alternatively, you could also use GG burs to replace Sx as described in Modified Double Flare technique.	• Use K-files #15 – 40 to enlarge the 2/3rd of canal with lubricant. • Once the #40 file is at 2/3rd, use GG bur #1 to 2/3rd. • Use GG bur #2 at ½ canal. • Use GG bur #3 at the orifice of the canal
5) Confirm working length	• Take the biggest file that could be inserted to the EWL – file must bind to the canal wall and not loose. [This file size refers to the size of the canal at the apex before apical enlargement = initial apical file (IAF)]. • Take the radiograph with this file in the canal to confirm the length. • **The WL is considered acceptable if the tip of the file is ±0.5mm from the radiographic apex.** Note: • In clinic, use apex locator to determine WL before confirming it with the radiograph. • In multirooted teeth, insert all the files in the canals to confirm the length. • In multirooted maxillary premolar and mandibular molar, use parallex technique to take the radiograph (i.e. angulate the x-ray cone) in order to split the superimposed canal images so that both canals are visible in the radiograph.	

Steps	Hand Protaper	Modified Double Flare
6) Canal preparation (Coronal 2/3)	• Use S1 to the confirmed WL. • Use S2 to WL • Use F1 to WL	• Enlarge the canal 2x more than the IAF at the WL. E.g. – if IAF is 20, enlarge it to #30. <u>Note:</u> With the curved canal, do not enlarge the canal at the WL beyond size 30. The rigidity of file #35 will straighten the curved canal. Maintain the size of the apex of the curved canal at #30.
	Note: • Use lubricant at all times. • Irrigate as often as possible. • Confirm canal patency with #10 K-file (refer page 37)	
7) Determine size at the apex i.e. Master Apical File (MAF)	• Gauge the size of the canal at the apex with the use of K-Files (start with #20). • The biggest K-file that could be inserted to WL will determine the size of the apex. E.g. If #20 binds to the wall, the MAF (apex size) is 20. If #20 does not bind to the wall, insert K-file size #25 to WL. If #25 binds to the wall, the MAF (apex size) is 25 and so on.	• After enlarging the canals 2x than the size of IAF, the size of the file after the canal enlargement is the MAF. <u>Note:</u> • For narrow curved canal with IAF #10, prepare the canal to the minimum MAF size of #25.
8) Apical preparation	• Choose the finishing Protaper file matched to the MAF to prepare the canal: MAF #20 – finish with F1 MAF#25 – finish with F2 MAF#30 – finish with F3 MAF#40 – finish with F4 MAF#50 – finish with F5 <u>Note (Modified ProTaper technique):</u> If F4 and F5 are not available, the apex may be prepared using the step-back technique described in the Modified Double Flare column. For example, if the MAF for the tooth is #45, use finishing file up to F3 then step-back file #50 1mm short from WL, #55 2 mm short of WL.	• Prepare the apical part by using step-back technique. Step-back: • Use the next file size bigger than the MAF to prepare the apical third 1mm short of the WL. • Step back for at least another 2mm using the subsequent bigger file. • E.g. If the MAF is 30 and WL is 20mm: Use file #35 to enlarge canal at 19mm Use file #40 at 18mm Use file #45 at 17mm • Every time you step back with a bigger file, make sure to use

		MAF to WL to ensure WL is not lost.

How do you prevent canal blockage?

During canal enlargement, a lot of dentine chips are produced in the canal. Failure to irrigate the canal frequently will result in canal blockage. The debris need to be flushed out of the canal often, preferably after the use of every file to maintain apical patency.

What is apical filing?

Apical filing refers to the use of a #10 file inserted in the canal 1mm beyond the apical foramen. This is to ensure that canal remains patent and not blocked by the dentine chips. The #10 file is called a patency file.

Working Length

What is the definition of working length?

Working length is the length of the canal that needs to be instrumented with the file. It is usually the length measured from a fixed reliable point at the crown (either the tip of the cusp or tooth margin) to the root apex. It is important to get an accurate length so that the entire canal could be cleaned with the instruments.

Over-instrumentation (using the file to clean beyond the root) will cause:
1) Damage to the apical constriction and may result in failure to contain the obturation material in the canal
2) Trauma to the periapical tissues which will lead to post-operative pain
3) Infected materials to be pushed into the periapical tissues and will result in an acute episode of inflammatory reaction.

Under-instrumentation (using the file short of the actual canal) will leave a part of the canal filled with bacteria that could remain and cause apical periodontitis.

Where do you end the apical preparation?

Anatomically, the narrowest diameter of the canal is at the apical constriction. The opening at the apical constriction is also called a minor apical foramen.

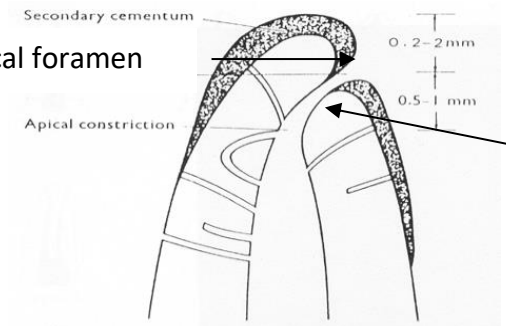
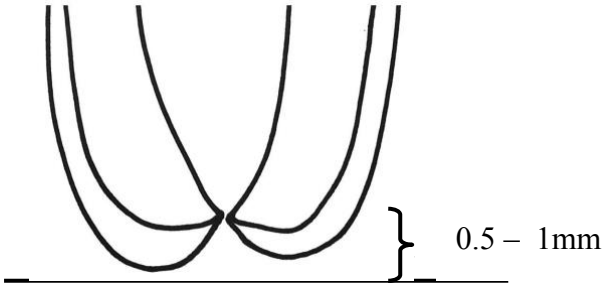


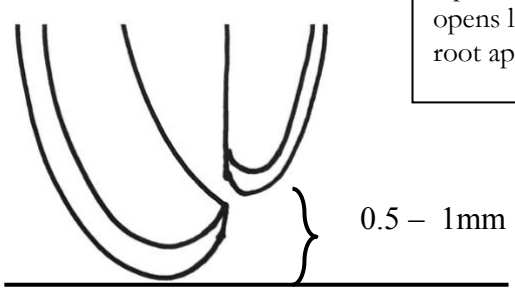
Figure 3.6 Diagrammatic section through apical third of root. The position of the apical foramen varies with age and may be 0.2–2.0 mm from the anatomical apex. The apical constriction may be 0.5–1.0 mm from the foramen.

This minor apical foramen is the ideal part to end the canal preparation as it is actually the terminal point of the pulp tissues before it continues into the periodontal tissues. The narrow opening will also create a 'stop' and help to contain the obturating material from being pushed into the periapical tissues.

The apical constriction could be found most often at about 0.5 – 1mm from the anatomical apex. The distance from the apex could increase with the deposition of secondary cementum as the age advances (picture).

The major apical foramen refers to the main opening that is usually situated at the end of the root and this opening could be bigger in diameter than the minor apical foramen. It is worthy to note that more often, the apical foramen opens laterally (either lingually or buccally) at the root apex rather than at the end of the apex (see diagram).





Apical foramen opens lateral to the root apex.

How do we determine the position of apical constriction?

The most accurate method of determining the apical constriction is with the use of apex locator. The device will be able to detect the end point of the periapical tissues and will reliably give the length repeatedly.

Without apex locator, the preoperative radiograph could be used to estimate the working length.

How do we estimate the working length from pre-operative radiograph?

First, it is very important to take the pre-operative radiograph using a parallel technique (use film holder) to get an accurate image (an image without too much of a distortion or elongation). Remember that even with the use of paralleling technique, there is still be magnification of the image of at least 0.5mm.

Measure the tooth length from the pre-operative radiograph with a metal ruler (accuracy to 0.5mm) i.e. from the tip of the cusp to the radiographic apex. To get the working length, it is customary to minus 0.5 – 1mm from the tooth length (taking into account that the apical constriction is usually situated 0.5mm from apex and with the magnification of 0.5mm of the image). This is an estimation of the working length and as it is a very crude method, it is important to verify the length by the taking another radiograph with the file in the canal.

What file do you use in the canal to confirm the working length radiographically?

Use the biggest file that could be inserted into the canal (file that binds to the wall) to take the working length radiograph. This file is called the initial apical file, which refers to the size of the canal before apical preparation. For upper anterior incisor teeth, the initial apical size could be as large as #50. File smaller than the actual canal will be loose in the canal and could move during the taking of the radiograph.

Never take a radiograph with a #10 file in the canal. This file is too small, and it is very difficult to see where the tip of the file ends in the radiograph. The canal should be enlarged at the estimated working length to at least a #15 or #20 file before taking a radiograph.

The working is considered acceptable if the tip of the file is situated about 0.5mm from the radiograph.

How do you choose the reference point?

Choose a fixed reference point such as the tip of a cusp, flat marginal ridge nearest to the canal for a reliable measurement.

APEX LOCATOR

How does an apex locator work?

Apex locator uses the impedance and resistance of electric to detect periodontal tissues at the end of the apex. It calculates the measurement of impedance of the mucosal tissues which has similar value to the periodontal tissues. When the tip of the file touches the periapical tissues, the device will compare the value with that of the mucosa and indicate that the apex has been reached.

How do you use an apex locator?

1. Estimate the working length from a preoperative radiograph.
2. Use the lip clip to complete the circuit.
3. Use a small and suitable file (#10 or 15) and attach the clip to the file.
4. Insert the file into canal to the estimated working length until the device beeps at zero or it indicates apex.
5. Adjust the stopper and measure file.

Always take the measurement at '0" for the most accurate reading. You may minus a 0.5mm if you are not comfortable working all the way at the apex.

What are problems you may face during the use of the apex locator?

Inaccuracy could occur:

1) In blocked canals
2) In wet canals – canals full of sodium hypochlorite could cause inaccurate reading. Aspirate out the fluid with the syringe and try again. Do not take the reading in a dry canal that is too dry.
3) When the file touches metal such as amalgam filling.
4) If the file used to take the reading is too small for the canal. E.g. Using #10 file for a #50 canal
5) Lip clip is loose
6) Battery is weak

PREVENTING PROCEDURAL ERRORS

File breakage

Endodontic files are prone to shear and fatigue fracture. Shear fracture refers to the fracture due to the twisting of the metal during instrumenting. Fatigue fracture occurs due to repeated use of files.

When using the file, always measure the file before inserting it into the canal. To prevent incidental fracture,

1) Always check the file after removal from the canal. Look for sign such as untwisting of the flutes, which means that the file should be discarded.
2) Smaller sized file should be discarded after a few uses.
3) Use a lot lubricant with the files.
4) Do not force the file in the canal.
5) Always work in a wet canal

Canal blockage

To prevent canal blockage:

1) Irrigate often. It is recommended to use at least 50ml of sodium hypochlorite to get clean canal in the clinic.
2) Use patency file often

Ledges

Ledges often occur in curved canal. To prevent formation of a ledge:

1) Pre-curve the file before inserting it in the canal
2) Do not use K-file of more than #30 in curved canal
3) Do not force the file in the canal
4) Use watch-winding movement to enlarge canal and not filing movement.

Apical transport

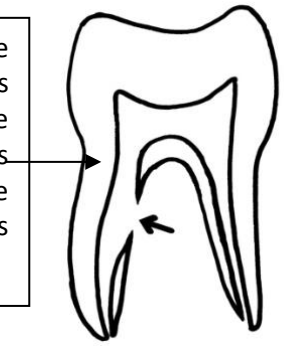
Apical transport refers to the alterative of the apical foramen from its original position. Prevention of an apical transport is similar to that of a ledge formation.

Strip perforation

Strip perforation usually occurs in multi-rooted teeth where excessive removal of dentine causes perforation at the inner curvature of the root e.g. in curved mesial root of a mandibular molar. It often occurs in thin and slender roots. To prevent strip perforation,

1) Examine the root morphology carefully before canal preparation
2) Do not flare the coronal portion excessively. Remove more dentine on the outer wall of the canal.
3) Use watch-winding motion to get a centred canal preparation.

Mesial root of the mandibular molar is usually curved to the distal. The outer wall is thicker and more dentine should be removed at this area.



The arrow indicates 'strip perforation' occurring due to excessive removal of dentine at the inner dentine.

Loss of apical stop

Loss of apical stop is usually due to damage of the apical constriction. It occurs more often in the large canals. To prevent loss of apical stop:

1) Always measure the file to working length accurately
2) Use reliable and reproducible reference points
3) In large canal with open apex, consider working length of >1mm from apex
4) Make sure the stopper is not loose. Change stopper if it keeps moving.

CHAPTER 8

CANAL OBTURATION

Eason Soo

What are the objectives of root canal obturation ?

1) To entomb remaining microorganisms that was left after root canal instrumentation and preventing it from proliferation.
2) To seal the entire pulp canal system hermitically and to prevent future recontamination in the root canal.

Root canal has to be obturated in 3-dimensionally. When is the appropriate time for obturation ?

1) After completion of root canal cleaning and shaping.
2) If the tooth is asymptomatic and periapical lesion is not present, obturation can be done after root canal preparation in the same visit.

What are the contraindications for canal obturation ?

1) Tooth that has been ongoing treatment is still symptomatic and swelling associated with the offending tooth is still present.
2) Persistent wet canal, evidence of oozing of exudates/transudates from the root canal.
3) Continuous suppuration from intracanal during canal instrumentation.

What are the pre-requisites prior to canal obturation ?

Root canal must be irrigated thoroughly prior to obturation. Any remnants of the non-setting calcium hydroxide (interappointment root canal medicament) must be flushed out completely by irrigation. Final rinse should follow these sequences in order: 2.5% sodium hypochlorite, 17% EDTA then 2.5% sodium hypochlorite solution. Canal should be dried with sterile paper points. In this faculty, AH Plus root canal sealer is provided in the clinics. Make sure only thin layer of AH Plus root canal sealer is applied to the root canal wall before commencing the obturation with GPs. Most GPs are supplied in a not sterile packaging unless stated otherwise. Therefore, you have to soak the GPs in a 2.5% sodium hypochlorite or 0.12% chlorhexidine solution (Oradex mouth rinse) for 30 seconds to 1 minute prior to use.

How many radiographs do I need to take for obturation ?

1) Master cone radiograph – to proceed with this stage only when you have checked the master cone is placed to its full working length with a “tug-back”.

2) Obturation radiograph – to proceed with this stage once you have obturated the canal with GPs and root canal sealer prior to do the cutting of the excess GPs. The GP should look homogenous along the root canal space and voids free. If the obturation is more than 2 mm short of working length or having massive voids in

the middle third and/or apical third of the root (observed from the obturation radiograph), remove the GP immediately and rectify the reasons. If the voids are mainly limited to coronal third of the root and below orifice level, soften the GP with a heat carrier at the orifice and use an endodontic plugger to compact it apically.

3) Post-op radiograph – to proceed with this stage only when you have completed the permanent filling or permanent core e.g. composite resin, or fibre-post with composite resin core for tooth that is indicated for post-and-core supported crown***** after completion of root canal treatment.

   **Important ! : ***The decision if a tooth need a post-and-core supported crown or not following completion of a root canal treatment MUST be planned ahead in the E&D stage and MUST be written clearly in the E&D Form (Treatment Plan section) and verified by a Specialist in Prosthodontics/Specialist in Restorative Dentistry.

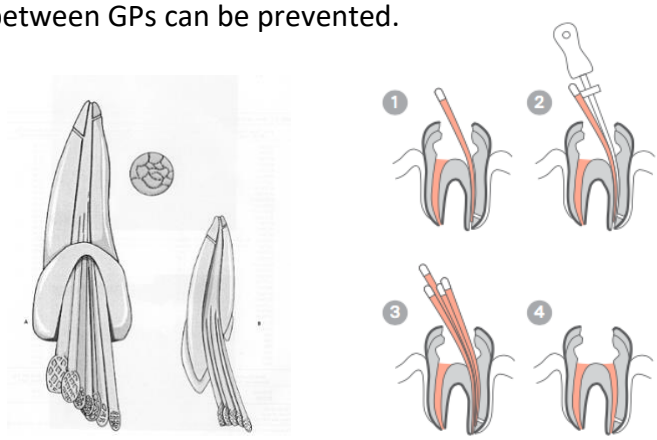
What are techniques for canal obturation ?

Basically, there are three techniques for canal obturation :

1) Lateral compaction technique
2) Single matched-cone technique
3) Warm vertical compaction technique

Lateral Compaction Technique

This is the commonly used technique in canal obturation. Master gutta-percha (GP) cone is fitted into the canal after completion of root canal instrumentation and verified radiographically. Then accessory GPs are placed and compacted laterally so that voids/spaces in between GPs can be prevented.



This technique can be improved by using a heated finger spreader. It is call “warm lateral compaction”. It will help to warm the surrounding GPs so that the GP compaction can be more efficient. Furthermore, the heated GPs will be able to flow into difficult-to-reach area e.g. canal isthmuses and lateral canal.

Radiographic assessment of a root canal obturation is done routinely prior to placement of a permanent radicular composite core foundation. GP should be homogenous and no voids/spaces in between GPs radiographically.

Lateral compaction technique - Master GP cone selection

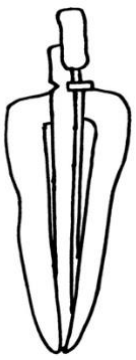
1. For canal instrumentation done by using "modified double flare technique", select the master cone on the largest file use based on the Master Apical File (MAF) size.

2. Place the master cone into the canal.

3. Check for apical "tug-back". "Tug-back" is a slight resistance to pull of the master cone when it is removed from the canal.

4. If the master cone has reached to its full working length but it is loose in the canal, cut 1 mm at the end of the GP point and re-insert back to the canal to its full working length. If the master cone is till loose, choose another GP but one size larger (and to repeat this step) until it can fit into full working length with the "tug-back" at the apex.

5. If the master cone is extruded beyond full working length, the master cone might be too small or there is no "apical constriction/stop". Choose another GP but one size larger or repeat the apical preparation until the master cone can fit into full working length with the "tug-back" at the apex without extrusion.



6. Once the master cone is placed into canal to its full working length, then gently insert a finger spreader into the canal between the master cone and root canal wall, and make sure it is 2 mm shorter than the working length. Usually finger spreader with MF size will be used.

7. Take a master cone radiograph to verify if the master cone fitting is good.

Lateral compaction technique - Obturation

1. Prepare some accessory GPs with the corresponding size of the finger spreader used. Size FF/MF for small canal, while MF/F for large canal.

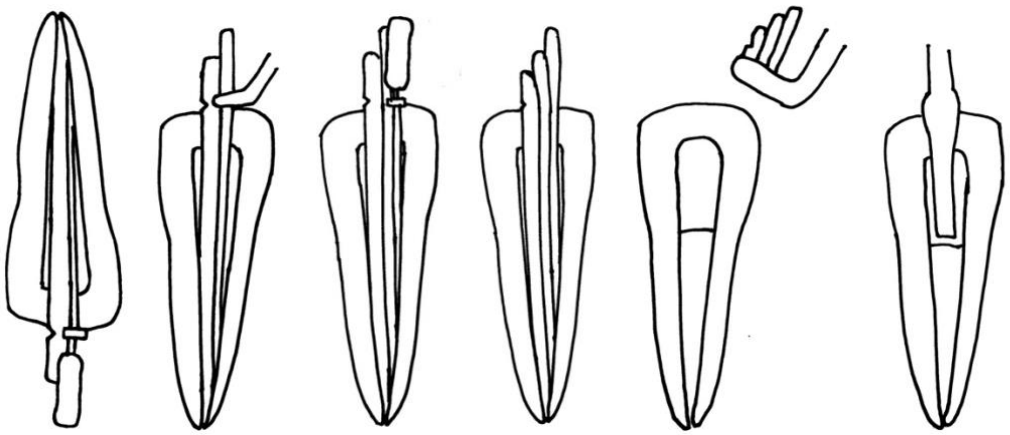
2. Mixed AH Plus root canal sealer into a "condensed milk" like consistency. Use a sterile paper point to coat the root canal sealer onto the root canal wall (thin layer).

3. Then coat the master cone (thin layer) with the root canal sealer and then place it into canal to its full working length.

4. Gently insert the finger spreader into the apical third of the canal and start compacting the master cone laterally under light vertical pressure. There should be no lateral rocking or forcing of the finger spreader, as this will increase the risk of root fracture.

5. Remove the finger spreader slowly by gently rotating it out from the canal. Do not pull the finger spreader abruptly from the canal. Slide the accessory GP fully into the canal space created by the previous finger spreader.

6. Repeat the previous step (in No. 5) as long as you can fit an accessory GP until the canal is fully occupied with GPs.



7. Take an obturation radiograph to verify if the canal is well compacted and the GPs are homogenous without any voids or spaces.

8. Once the obturation is completed, cut the excess GPs at the coronal part using a heated carrier e.g. Touch & Heat. Make sure the GPs are removed slightly below the cemento-enamel junction (CEJ) for anterior tooth and slightly below canal orifices for posterior tooth.

9. Compact the GPs vertically using an endodontic plugger. Clean the pulp chamber and excess root canal sealer with alcohol or Oradex (it contains 0.12% Chlorhexidine and alcohol) prior to orifice sealing with flowable composite follow by a composite restoration.

10. If the tooth is indicated for a post-retained crown restoration after completion of endodontic treatment, the GPs has to be removed immediately at the same session while the GPs are still soft and not hardened yet, and you still able to visualize the existing root canal outline and anatomy. Use the heated carrier e.g. Touch & Heat to remove the GPs and left about 4 - 5 mm (depending of each individual clinical cases) of GPs at the apical third of the root.

11. Only use prefabricated “tapered” fibre post for post-retained crown restoration. Unnecessary enlargement of root canal post space will cause root crack propagation and root fracture after some time.

12. If you remove the GPs after 24 hours post-obturation, there will be a higher risk of iatrogenic procedural error e.g. root canal perforation. Therefore, please plan ahead with the prosthodontic supervisor during E&D; and treatment planning phase if a root canal post is needed after root canal treatment.

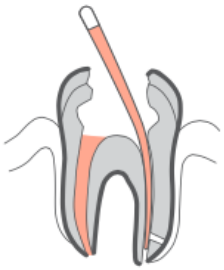
What are the common mistakes found during lateral compaction procedure?

Most common mistake is the GPs may look nicely compacted at the coronal third, but voids/spaces can be clearly seen at the apical and middle third of the canal.

It is mainly due to wrong selection of accessory GPs. Those accessory GPs is too large compare to the finger spreader used for lateral compaction. Hence, the accessory GPs cannot be fully placed into the canal space created by the finger spreader. To overcome this mistake, make sure the accessory GPs has the similar size or slightly smaller than the finger spreader.

Single Matched-cone Technique

1. For canal instrumentation done by using ProTaper Universal system, select the master cone corresponding to the size of the last finishing file used. For example, if the last finishing file is F2, the corresponding master cone will be F2 GP. Insert it into canal to full working length, check for “tug-back” and verify the fitting with a master cone radiograph.

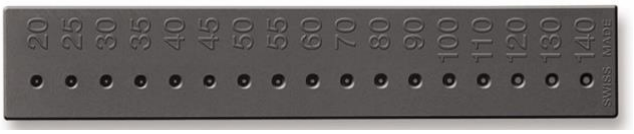


2. Coat the entire root canal wall and the master cone with a small amount of AH Plus root canal sealer.

3. Insert the master cone into the canal to its full working length. Often there are some spaces found in oval shaped canal e.g. distal canal of mandibular molars and maxillary/mandibular canines/premolar after placement of the master cone. Additional accessory GPs cone can be inserted and compacted as in lateral compaction technique to prevent void/spaces in the aforementioned oval shaped canal configuration.

4. Cut the excess GP at the coronal part using a heated carrier e.g. Touch & Heat. Then compact the GP vertically with an endodontic plugger. Clean the pulp chamber and excess root canal sealer with alcohol or Oradex (it contains 0.12% Chlorhexidine and alcohol) prior to orifice sealing with flowable composite follow by a composite restoration.

5. If the apical terminus size is more than #30, use the ProTaper Universal F3 GP and put the GP cone into the appropriate hole size (according to the apical terminus size) on the "gutta-percha gauge", and use a scalpel blade to cut the excess GP tip protruded on the other side of the GP gauge.



Gutta-percha gauge

6. Modified ProTaper Technique is the canal instrumentation method used in this faculty for apical terminus size more than #30.

Warm Vertical Compaction Technique

1. Select a master cone corresponding to the last file used (depending on which instrumentation system is used to prepare the canal), and it is suggested to adjust the master cone 0.5 – 1 mm short from the apex to prevent extrusion of the obturation material into periapical tissue.

2. Prepare 3 sizes of endodontic pluggers (small, medium and large).

3. Coat the entire root canal wall and the master cone with a small amount of AH Plus root canal sealer.

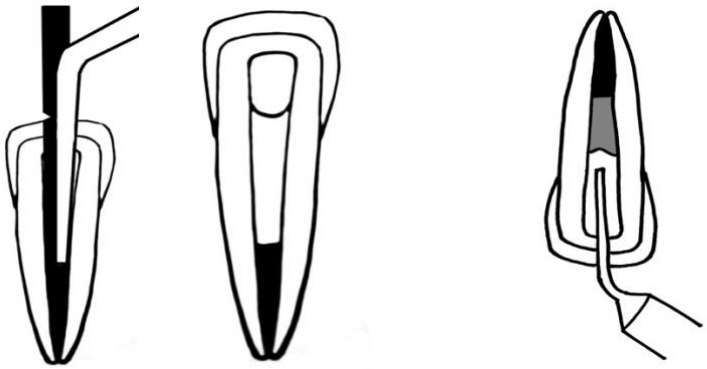
4. Place the master cone into the canal and cut the coronal end with the heat carrier e.g. Touch 'n Heat

5. Heat the GP cone in the canal with the heat carrier with a light apical pressure. Take away the upper part of the GP by gentle pulling out the heat carrier. Compact the GP cone vertically and gently with the large endodontic plugger.

6. Repeat the same step (in No. 5) with the heat carrier; and medium and the small endodontic pluggers, until the apical 3 – 4 mm segment of the canal is filled (this step is called the down-pack).

7. Coat the remaining portion of the root canal (middle and coronal thirds) with the AH Plus root canal sealer. It is then filled with a heated GP up to the orifice level in one single step (this step is called the backfill with continuous wave), and then follow by compacting the heated GP with a medium or large endodontic plugger

vertically in a light apical pressure. Source of the heated GP can be from any specific device that able to dispense sizeable amount of heated GP by command e.g. Calamus® Dual Device, Dentsply Sirona and Obtura Spartan.



Down-pack

Backfill

Gutta-percha removal from the root canal

When an endodontic retreatment is indicated in failed root canal treatment cases, old root filling materials i.e. gutta-percha and root canal sealer have to be removed prior to root canal cleaning and shaping. Retreatment procedure is usually complex compare to primary root canal treatment as the removal of old root filling materials is more technique sensitive and possess higher risk of iatrogenic procedural error e.g. canal perforation if it is not being done carefully.

Selection of technique for GP removal depending on :

1) Obturation quality – canal that looks well compacted with GP (radiographically) might need solvent for removal, while GP that is poorly compacted can be removed by mechanical means

2) Length of the root filling material – the use of solvent to remove GP at the apical third of the root canal might cause root filling material to be extruded into periapical area. If the existing GP cone is already “overextended” into periapical area, do not use solvent.

3) Tooth morphology, size and canal shape, and curvature of the root – GP can be removed from a straight and large canal mechanically. Solvent should be used to remove GP in a curved canal.

Methods for GP removal :

1. Make sure the access cavity is correct and adequate.

2. Mechanical removal – use appropriate sizes of Gates Glidden burs to remove GP at the coronal part (as in coronal flaring). Use only light apical pressure and remove the GP toward the outer wall of the root canal. Alternatively, special retreatment rotary files e.g. ProTaper Universal Retreatment Files, Dentsply Sirona can also be used.

3. If the GP is hardened, use heat carrier e.g. Touch 'n Heat, to soften the GP and remove it at the orifice level.

4. Once the coronal part of the GP has been removed, insert K-file size 20 or 25 into the canal using watch-winding and filing (push-pull) movement to further remove the remaining GP at the middle and apical thirds of the root. Do not force the K-file into the canal. Do irrigate the canal with copious amount irrigation solution so that the remnants of the GP chips will not being pushed into periapical tissue.

5. GP removal with solvent – chloroform is the solvent commonly used and it is available in the clinics. This solvent will liquefy any plastic-based materials. Therefore, make sure it is not placed into plastic container. Aspirate about 0.5 mL of this solvent into the 3 mL irrigation syringe. Use a 27G needle and carefully deposit 1 – 2 drops solvent into the canal. Put a K-file size 25 or 30 into the canal and remove the GP in repetitive manners using watch-winding and filing (push-pull) movement. Change to K-file size 20 as you approach the apical third of the canal. Alternatively, you may use H-Files (minimum size 35) to remove the coronal and middle third portion of the GP with gentle watch-winding and filing (push-pull) movement, as extreme force will cause breakage of the H-Files. If excessive solvent is being deposited into the canal, the GP will become very messy and sticky, hence the GP removal will be difficult. Excess solvent can be removed by placing absorbent paper points into the canal. Once the GP is completely removed from the canal, irrigate the canal with 17 % EDTA solution (with mechanical rubbing with micro brush) will further enhance the removal of small fragments and remnants of the remaining GP attached on the canal wall.

CHAPTER 9

RESTORATION OF ENDODONTICALLY TREATED TOOTH

Safura Anita Baharin

Introduction

The ultimate goal of restorative treatment of endodontically treated tooth (ETT) is to restore the form, the function and the aesthetics of the dentition whilst preserving as much tooth structure as possible. Minimization and optimum stress distribution in function should be indistinctly linked with these aims and the long-term goal must be to maintain health. Evidence is accumulating for the quality of the coronal seal as an important prognostic marker for outcomes of root canal treatment.

Thus, it is important to advice the patient on the importance of having a permanent coronal restoration done immediately after root canal treatment to ensure a successful treatment.

How would you assess the restorability of a tooth indicated for root canal treatment?

Assessment of the restorability of a tooth must be performed before commencing root canal treatment. This is essential to ensure that the tooth is restorable and permanent restoration can be placed immediately following completion of root canal treatment. Factors that need to be assessed in determining tooth restorability are:

1. *Periodontal status*

The periodontal probing profile should be determined. Presence of deep pocketing either localized or generalized may compromised the long-term prognosis of the tooth.

Figure 9-1 shows the presence of deep localized pocket on tooth 21.

2. *Prosthodontic status*

The amount and location of remaining sound dentine should be assessed as it determines whether the tooth can be restored to its function, and subsequently, the

type and design of the coronal restoration. A minimum of 2 mm sound coronal dentine around the tooth circumference is necessary to provide a ferrule effect for cuspal coverage restoration (crown or onlay). Preferably, the entire existing restoration should be completely removed to allow the assessment of sound dentine for subsequent coronal restoration prior to start of endodontic treatment. This procedure will also enable the clinician to remove any secondary caries (if present), identify existence of coronal tooth fracture, and ensuring that there is enough tooth structure for placement of functional and aesthetic restoration.

Figure 9-2 shows tooth 17 with all ceramic crown with presence of secondary caries and tooth fracture underneath the crown upon its removal. The tooth is deemed not restorable.

Figure 9-3 shows tooth 47 with all ceramic crown with presence of secondary caries underneath the crown upon its removal.

3. *Endodontic status*

The status of the root canal i.e. the capability to identify and negotiate the canals to the estimated working length followed by subsequent preparation, disinfection and obturation will determine its prognosis. Ability to achieve satisfactory root canal treatment will give an excellent prognosis. Presence of canal sclerosis, perforation, root resorption and procedural error may compromise the restorability of the tooth and its prognosis.

Figure 9-4 shows periapical radiograph of tooth 31 and 41. The root canal is visible and not obstructed.

Figure 9-5 shows periapical radiograph of tooth 25. The tooth is heavily restored and root canal is visible.

How do endodontically treated teeth differ from vital teeth?

It was suggested that ETT seem to be more predisposed to fracture compared with teeth with vital pulps. Initially, it was beliefs that these ETT were mechanically weakened due to the difference in moisture content (becoming more brittle due to moisture loss). However, recent study has showed that endodontic access and treatment only reduces the stiffness of these teeth by 5% compared to a 63% reduction following MOD cavity preparation.

Unfortunately, once a tooth has undergone endodontic treatment, it loses its proprioceptive ability which results in potentially over-loading of this tooth. Additionally, ETT also loss a great amount of tooth structure during access preparation and canal preparation. A combination of these factors makes the ETT more susceptible to fracture especially when the marginal ridges on posterior teeth were lost, thus decreases its structural stability.

What are the objectives of restoring an endodontically treated teeth?

It is essential to protect the underlying tooth structure subsequent to root canal treatment. The longevity of a root treated tooth is directly related to the amount of remaining sound tooth structure.

Therefore, the objectives for restoring an endodontically treated teeth are to:

1. provide a coronal seal to prevent microbial contamination of the root canal system;
2. restore form, occlusal stability, and adequate contact points with the adjacent teeth;

3. restore function;
4. protect residual tooth structure against further tissue loss;
5. ensure health of the marginal periodontal tissues;
6. provide optimal aesthetics.

What are the options available for restoring an endodontically treated tooth?

Restoration of endodontically treated teeth can be either direct or indirect. If the tooth has intact coronal tooth structure with minimal tooth loss, direct restoration such as composite resin restoration or amalgam is indicated. Restoration of an ETT immediately after obturation whilst under dental dam isolation is preferable as it can prevent recontamination of the root space and risk of coronal leakage is lessened.

Anterior teeth often need immediate restoration due to aesthetics. If most of the tooth is intact, the lingual cavity can be restored with a composite restoration. If there is significant discoloration or realignment is required, porcelain or composite veneers may be appropriate. If the coronal tissue is severely compromised, the placement of a post for retention of a crown becomes necessary.

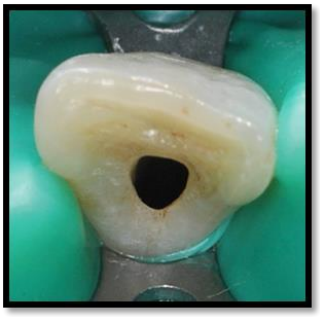


Figure 9-6 shows an anterior tooth with access cavity palatally. This tooth can be immediately restored with composite restoration upon completion of root canal treatment.

In the case of posterior teeth, the choice of restoration will be governed by the size and shape of any existing restoration or cavity preparation in the tooth. A relatively intact tooth may be restored with amalgam or composite [Figure 9-7(a)]. In a proximo-occlusal cavity, the choice of restoration will depend on the width and depth of the proximal box and occlusal loading. Where minimal, a plastic restoration will suffice but where there is heavy occlusal loading, cast metal cuspal coverage is indicated [Figure 9-7(b)]. In cases of teeth with MOD cavities, cuspal coverage is mandatory unless there is no opposing occlusion or a denture in the opposing arch. The choice of restoration materials include amalgam which may be difficult to contour and require the removal of unnecessary tooth tissue to provide for enough bulk of material to sustain loading. Alternatively, cast partial veneer restorations (indirect/direct porcelain or composites), partial veneer inlays, full gold crowns or full coverage ceramo - metal restorations are other possible alternatives [Figure 9-7(c)].

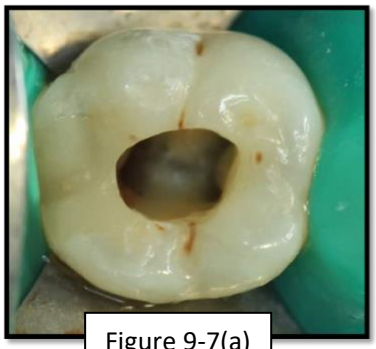


Figure 9-7(a)

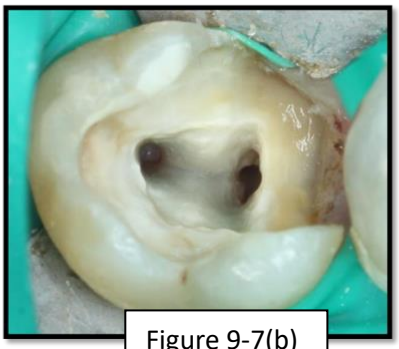


Figure 9-7(b)

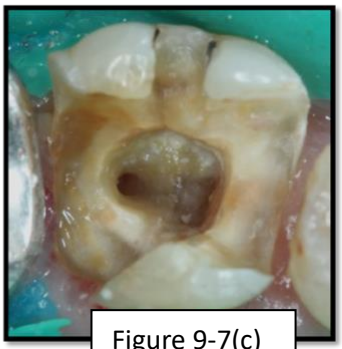


Figure 9-7(c)

Figure 9-7(a) showing minimal tooth structure loss on a molar tooth. This tooth can be restored using direct restoration following canal obturation. Figure 9-7(b) showed moderate loss of tooth structure which involves the MB cusp. An onlay or full coverage crown is required. Figure 9-7(c) showed extensive loss of tooth structure and a post-core and full cuspal coverage crown is necessary.

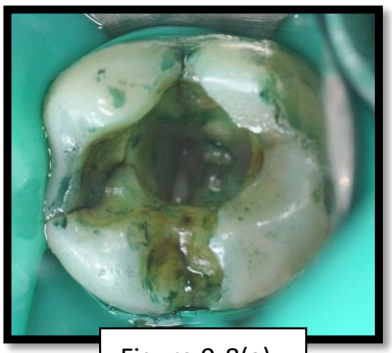


Figure 9-8(a)

Figure 9-8(b)

Figure 9-8(c)

Figure 9-8(a) showed a lower molar tooth with presence of cracks extending from the lingual to mesial marginal ridge. The tooth was deemed restorable. A molar band was cemented on the tooth to prevent propagation of the fracture and to support the remaining tooth structure [Figure 9-8(b)]. The tooth was restored with a full ceramic crown following completion of root canal treatment [Figure 9-8(c)].

Are there any situations when a cuspal coverage restoration is not indicated for restoring an endodontically treated teeth?

A tooth with an occlusal access cavity with intact marginal ridges may be restored with a direct restoration (Figure 9-9). If there is signs of heavy occlusal loading (attrition, tooth wear) or tooth loss due to hyperfunction (e.g. bruxism) then a cuspal coverage restoration should be considered.

Figure 9-9 showed tooth with intact marginal ridges with only occlusal access cavity present.

When should the tooth be restored with a cuspal coverage restoration?

It was showed that cuspal deflection and thickness of the residual walls and cusps are important factors in preventing tooth fracture. If a maxillary premolar tooth has loss one of its marginal ridge, a cuspal coverage restoration is essential to prevent tooth fracture (Figure 9-10). It was recognized that this type of tooth is prone to fracture especially when one of its marginal ridge is loss. Therefore, placement of cuspal coverage restoration is recommended. For a molar tooth, occlusal analysis should be performed to determine the susceptibility of the tooth to heavy occlusal loading.

Figure 9-10 of a maxillary premolar with loss of the distal marginal ridge. This tooth is prone to fracture if not protected with a cuspal coverage restoration.

How long do you have to wait before placing a cuspal coverage restoration after completion of root canal treatment?

If the root canal treatment has been carried out to the standard of care (i.e. canal identification, negotiation, preparation and obturation to the ideal working length), the tooth may be restored with a cuspal coverage restoration after 1 – 2 weeks. However, if the prognosis of the root canal treatment is doubtful / questionable, then the provision of a cuspal coverage restoration should be delayed until there are signs of healing (e.g. improvement in clinical sign and symptoms or reduction in periapical radiolucency radiographically). During the interim period, the tooth should be restored with a well-adapted temporary crown or plastic restoration.

When do you need post retention?

Posts are required when there is insufficient tooth structure to support the coronal restoration. The purpose of a post is to facilitate the retention of a core, as the core will be the foundation for the crown retention.

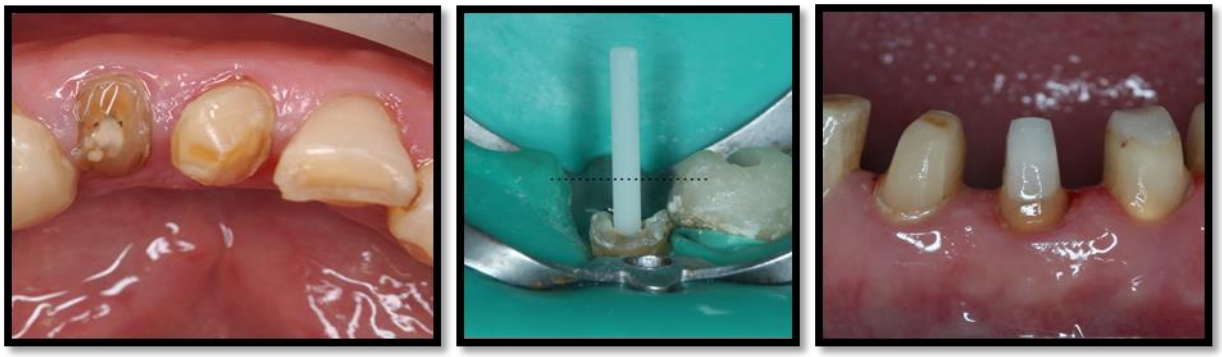


Figure 9-11 shows a lower incisor with minimal remaining tooth structure. This tooth was subsequently restored with a fibre post, core and crown.

What are the advantages of placing the post immediately after completion of endodontic treatment?

Immediate placement of the post has several advantages:

- minimized the risk of iatrogenic accidents (e.g. perforation, disorientation of the canal axis) during post space preparation as the canal anatomy and orientation is known;
- reduced the risk of microleakage, as good coronal restoration is achieved immediately. Additionally, temporary post crown is prone to leakage and may become decemented between appointments;
- allows immediate crown preparation to be carried out, thus reducing the overall treatment time and number of appointments.

Precaution should be taken when preparing a post space under dental dam isolation. The orientation of the tooth must be assessed and determined as to prevent iatrogenic accidents from occurring during the procedure. This is more crucial when treating a misaligned tooth.

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