DENTAL PULP

Endodontics translates to the "knowledge of what is within teeth". It is the field of dentistry concerning dental pulp and surrounding tissues of tooth roots. Studying endodontics grants clinicians an understanding of the etiology, diagnosis, and treatment of pulpal and periradicular conditions.

1 Pulp & Dentin

Composition

Dental pulp contains a variety of cells and connective tissues.

- Loose connective fibrous tissue
- Neuromuscular elements
  - Blood vessels
  - Lymph vessels
  - Nerves
- Cells types
  - **Odontoblasts** - produce primary and secondary dentin
    - **Primary dentin** - before complete root formation
    - **Secondary dentin** - after complete root formation
  - **Mesenchymal cells** - can differentiate into secondary odontoblasts to produce tertiary dentin (response to injury)
  - **Fibroblasts**
- Lack of collateral circulation = difficulty fighting infection

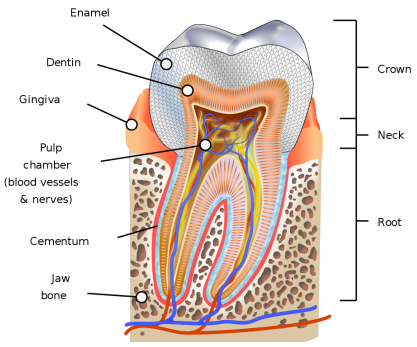

Figure 1.01 Tooth Anatomy

Dentin

Tooth pulp is surrounded by dentin. This hard dentin has limited expansion ability, thus creating an increase in pressure when infection occurs and the pulp and inflamed. There are different reactions that occur in dentin and pulp in response to damage.

- **Secondary dentin/Reactionary dentin** - produced in response to minor damage
- **Tertiary dentin/Reparative dentin** - produced in response to major damage

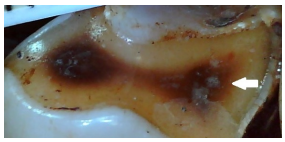

Figure 1.02 Tertiary dentin

INBDE Pro-Tip:
Pulp capping involves placing a calcium hydroxide liner that irritates odontoblasts, causing them to lay down secondary/tertiary dentin

- **Sclerotic dentin** - calcification of dentinal tubules
  - Due to aging or a response to slowly advancing caries
- **Pulp necrosis** - occurs in rapid caries or severe damage

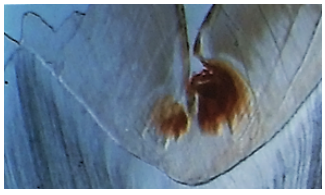

Figure 1.03 Sclerotic Dentin

Histological Zones of Pulp

Layer	Characteristics
Predentin	Unmineralized, inner dentin layer, directly adjacent to pulp
Odontoblastic Layer (1)	Location of odontoblasts, considered part of the pulp
Cell-free zone of Weil (2)	No nuclei/cells present, often seen with nerve bundles
Cell-rich zone (3)	Nuclei and cells present
Pulp Core (4)	Central part of pulp

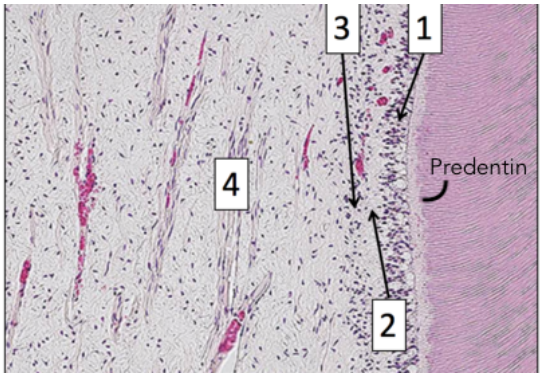

Figure 1.04 Pulp Histology

2 Pain

Altered Sensations

- **Hyperalgesia** - abnormal increase in sensitivity
- **Anesthesia**- numbness
- **Dysasthesia**- unpleasant, abnormal sensation
- **Allodynia** - pain due to stimulus that does not normally cause pain
- **Referred pain** - pain perceived to come from a location other than where it actually originates

INBDE Pro-Tip:
In dentistry, referred pain from mandibular molars is often felt in the pre-auricular region (both have V3 innervation)

Pain from Pulpitis

- Pain conducted from **C-fibres**
  - Afferent nerve
  - Small diameter
  - Unmyelinated
- Dull throbbing lingering pain
- Sensitive to heat
- Travel centrally through pulp

Pain from Dentin

- Pain conducted from **Aδ-fibres**
  - Afferent nerve
  - Large diameter
  - Myelinated
- Sensitive to cold
- Sharp transient pain
- Travel coronally in the pulp
  - Hence, more easily provoked for pain sensation than central C-fibers

Figure 2.01 Nerve Bundles

DIAGNOSIS

Every tooth can be given a pulpal and periapical diagnosis. **Pulpal diagnosis** concerns the pulp of the tooth, whereas **periapical diagnosis** involves the tissues surrounding the tooth.

1 Pulpal Diagnosis

Possible Diagnosis

1. **Normal**
   i. Normally asymptomatic
   ii. Mild-moderate transient (short-lasting) response to thermal and electrical pulp test
2. **Reversible pulpits**
   i. Symptomatic
   ii. Cause = pulp irritant
      a. Reversed by removal of irritant
      b. No removal = may progress to irreversible pulpitis
   iii. Not considered disease
   iv. Positive cold test = hypersensitivity + transient, sharp pain
   v. No spontaneous pain
3. **Asymptomatic irreversible pulpitis**
   i. Asymptomatic
   ii. Physiologically and microscopically comparable to symptomatic irreversible pulpitis, but without symptoms
4. **Symptomatic irreversible pulpits**
   i. Symptomatic = spontaneous pain (intermittent or constant)
   ii. Irreversible damage to pulp, will not fully heal with irritant removal
   iii. Cold test = lingering pain
   iv. EPT not useful
   v. Radiographs usually insufficient
   vi. Posture changes (bending, lying down) may exacerbate pain due to increased blood pressure
5. **Necrotic pulp**
   i. Rarely symptomatic
   ii. Often, occurs from long term lack of blood supply to the pulp
   iii. Includes partial or total necrosis
   iv. Anterior teeth may appear with crown discolouration
   v. Untreated leads to PDL thickening, sensitivity to percussion and periapical disease
6. **Previously treated pulp**
   i. Natural pulp tissue has been removed due to pulp therapy

Pulp Vitality Tests

1. **Cold Test** - application of cold substance on tooth to cause stimulation
   i. Uses **endo-ice** (dichlorodifluromethane, -30°C) sprayed onto a cotton pellet and applied onto the dried mid-facial surface of the tooth for 5s
   ii. Pulpal diagnosis based on intensity and duration of response

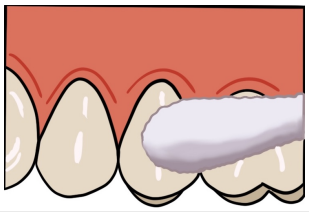

Figure 1.01 Cold Test

2. **Electric Pulp Test**
   i. Determines presence of vital sensory fibres in the pulp
   ii. Can only indicate if the tooth is vital or non-vital (no severity)
   iii. Least reliable pulp vitality test
      i. False results (positive and negatives)
      ii. No indication of vascular supply of pulp
      iii. Cardiac pacemaker contraindicated

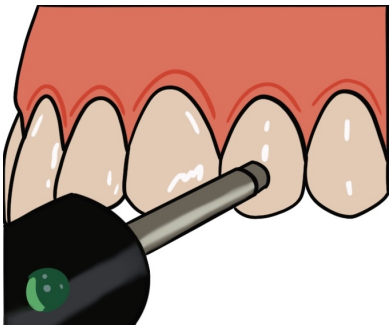

Figure 1.02 Electric Pulp Test

2 Periapical Diagnosis

Apical lesions that arise from pulpal origin is extension of pulpal disease into the apical tissues. Other causes include trauma, iatrogenic damage, and periodontal disease.

Possible Diagnosis

1. **Normal**
   i. Asymptomatic = no pain on palpation and percussion
2. **Asymptomatic Apical Periodontitis**
   i. Asymptomatic
   ii. Radiographs useful = visualization of **apical radiolucency**
      a. Confirms necrotic pulp

Figure 2.01 Apical Radiolucency

3. **Symptomatic Apical Periodontitis**
   i. Symptomatic = pain on percussion (intense and throbbing)
   ii. Inflammation around tooth apex
   iii. PDL contains localized inflammatory infiltrate
   iv. If tooth is vital → occlusal adjustment
   v. If necrotic tooth → endodontic therapy
      a. Due to belief that infection originated from pulp spreading to apical tissues
4. **Acute Apical Abscess**
   i. Acute = rapid swelling + severe pain
   ii. Apex contains purulent exudate/ liquefaction necrosis of tissue
5. **Chronic Apical Abscess**
   i. No/less swelling or discomfort (than acute) due to the presence of draining **sinus tract**
      a. Path and source of sinus tract can be located by inserting gutta percha cone into the tract until resistance is felt. Then, take a periapical radiograph

Tests for Periapical Diagnosis

1. **Percussion Test**
   i. Done by tapping the tooth along its long axis using the end of the mirror handle
   ii. Normal response should not have pain

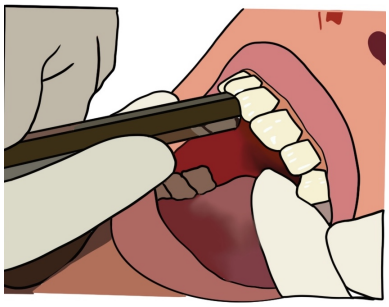

Figure 2.02 Percussion Test

2. **Apical Palpation**
   i. Palpation of gums/vestibular area around the area of the root apex of tooth
   ii. Normal response should not have pain or feel swollen or bumpy

DENTAL TRAUMA

1 Dental Trauma Types

Fractures

- **Uncomplicated fracture**
  - Fracture that does not involve the pulp
  - Enamel only → smooth the edges of the tooth to prevent future damage
  - Enamel and dentin involved → tooth restoration

Figure 1.01 Uncomplicated Fracture

- **Complicated fracture**
  - Fracture that involves pulp
  - Treatment according to timing
    - Less than 24h → direct pulp cap
    - ±24h → partial pulpotomy (Cvek)
    - ±72h → pulpotomy

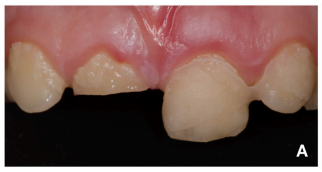

Figure 1.02 Complicated Fracture

- **Horizontal root fracture**
  - Apical segment remains in place
    - Necrosis is rare
  - Displacement of coronal segment
    - 25% of necrosis
  - Minimum 3 periapical + 1 occlusal radiograph
    - Fracture along one plane will need several radiographs at different angulations to visualize the fracture
  - Healing
    - Calcific metamorphosis can fuse close fragments through calcification
  - If tooth is necrotic perform root canal
  - If tooth is vital, splint teeth immediately based on fracture site on root
    - Apical → flexible splint, 4 weeks
    - Middle → flexible splint, 4 weeks
    - Coronal → flexible splint, 4 months

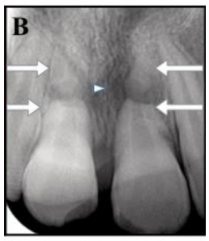

Figure 1.03 Apical Root Fracture

Luxation Injuries

- **Concussion** - minor injury, no tooth displacement or mobility
  - PDL inflamed and sore
  - No treatment needed, let tooth rest

- **Subluxation** - no tooth displacement, slight mobility
  - PDL inflamed, may rip and bleed
  - Closed apices = 6% chance of necrosis
  - Open apices have better prognosis
  - Treatment → flexible splint for up to 2 weeks

- **Extrusion** - displacement of tooth from socket in an extrusive direction
  - Closed apices = 65% of necrosis
  - Treatment
    - Closed apices → reposition, flexible splint for up to 2 weeks, follow-up

    - Open apices → reposition, flexible splint, root canal treatment if necessary

- **Lateral Luxation** - tooth displaced from its long axis with apical end usually displaced labially and coronal end palatally
    - Fracture of alveolar bone may occur in severe cases
    - Close apices = 80% chance of necrosis
    - Treatment → flexible splint, 4 weeks

- **Intrusive Luxation** - tooth pushed into socket/ apical displacement of tooth
    - Closed apices = 95% chance of necrosis due to severing of blood vessels
    - Treatment
        - Closed apices → reposition, flexible splint or root canal
        - Open apices → monitor and wait for tooth to re-erupt on its own

- **Avulsion** - tooth completely displaced from the alveolus
    - Most serious of all dental injuries
    - **Extra-alveolar dry time (EADT)** should be monitored
        - Time the tooth has been dry and out of the mouth
        - Prognosis is worse the longer the time
    - Treatment (General)
        - Re-implant tooth as soon as possible
        - Flexible splint for up to 2 weeks

INBDE Pro-Tip:
The INBDE will most often ask questions regarding treatment when it comes to dental trauma injuries.

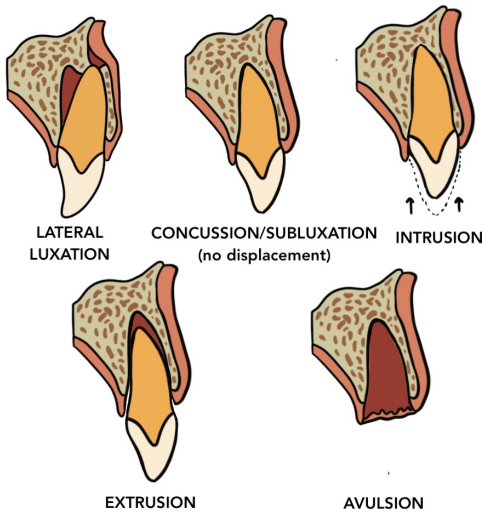

Figure 1.04 Luxation Injuries

2 Long-term Response to Trauma

Internal Resorption

- Damage to **odontoblastic layer** initiates resorption in root canal system
- Inflammatory response to bacteria and their byproducts traveling from necrotic pulp to dentinal tubules, causing internal resorption
- Radiograph
    - Does not move with radiograph angle change
    - Margins well defined, sharp
- Better prognosis and easier treatment than external resorption
- Treat with root canal therapy to obturate and seal the canal

External Resorption

- Damage to **cementoblastic layer** initiates resorption in the periodontium
- Radiograph
    - Radiographically moves with radiograph angle change
    - Margins poorly defined & irregular
- Three subcategories
    1. **Replacement resorption** - PDL replaced with bone (ankylosis)
        i. Can result from splints being too rigid or being placed too long

2. **Inflammatory root resorption** - in response to bacteria and their byproducts traveling from necrotic pulp to dentinal tubules
3. **Cervical resorption** - due to trauma or non-vital bleaching causing subepithhelial sulcular infection

Figure 2.01 Internal & External Resorption

Calcific Metamorphosis

- Odontoblasts producing large amount of reparative dentin into the pulp space, induced by trauma
- Results in canal obliteration
- Yellow-orange
- Increased risk
  - Open apices
  - Intrusion
  - Severe crown fractures

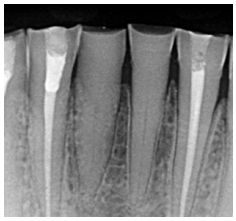

Figure 2.02 Calcified Canals

3 Dental Management

Classification

The **Ellis Classification** is commonly used to signify which traumatic injury has occurred.

- Class I = enamel only involved
- Class II = enamel + dentin involved
- Class III = enamel, dentin & pulp involved
- Class IV = tooth is non-vital from trauma
- Class V = avulsion
- Class VI = root fracture +/- crown structure loss
- Class VII = displacement without crown or root fracture

Protocol

The acronym "**TRAVMA**" can be used to remember to the appropriate steps in response for recent traumatic tooth injury

1. Tetanus booster
   i. Within 48h
   ii. For avulsions only, if tooth gets contaminated
2. Radiographs
   i. At least 1 periapical radiograph
   ii. Panoramic recommended for general trauma or suspected fracture
3. Antibiotics
   i. For avulsion, only if the tooth is contaminated
4. Vitality tests
   i. May give false negatives since sensory nerves can be disrupted for 2-8 weeks, but vascular supply is still in tact
5. More Appointments
   i. Follow-up appointments recommended at 3 weeks, 3-, 6-, and 12-months after traumatic injury

Avulsion

An avulsed tooth should not be kept dry and should be kept in appropriate **storage media** before arriving to the dentist. The following are considered appropriate storage media:

- Milk
- Saline
- **Hank's balanced salt solution** - best option
- Saliva
  - Person can also hold the tooth in the area of the vestibule where the tooth is from
- Avoid storage in water!
  - Hypotonic, incorrect balance of ions

Avulsion (continued)

Dental protocol for avulsion of permanent tooth is more complicated, depending on apices and EADT.

Apices, EADT	Treatment
Closed, EADT < 1h	Reimplant + splint
Open, EADT < 1h	Reimplant + splint Apexification if pulp infected No root canal
Closed, EADT > 1h	Reimplant + splint Root canal
Open, EADT > 1h	Options - Reimplant + splint - Root canal - Implants

VITAL & NON-VITAL PULP THERAPY

1 Introduction

Options for Vital pulp Therapy

Vital pulp therapy refers to treatment options that are suited for pulp that is still vital, but has some sort of damage. There are several different options.

- Indirect pulp cap
- Direct pulp cap
- Partial (Cvek) Pulpotomy
- Pulpotomy
- Apexogenesis

Options for Non-Vital pulp Therapy

- Pulpectomy
- Root Canal Therapy
- Apexification
- Extraction

Common Materials

- **Calcium hydroxide -** $Ca(OH)_2$
  - pH = 12.5 → bactericidal and cauterizes tissue
  - Can stimulate mesenchymal cells to differentiate into **secondary odontoblasts**, which will create a dentin bridge (tertiary dentin) as a barrier to protect pulp
- **MTA -** mineral trioxide aggregate
  - Stimulates **cementoblasts** to make hard tissue
  - Contains
    - Calcium, silicon & aluminum
    - Bismuth oxide (opacifier) = radiopaque, but can leak and stain tissue
  - Properties
    - Can sets in moisture
    - 3h setting time
    - Nonresorbable & biocompatible - good sealant
    - Antimicrobial

2 Vital Pulp Therapy

Indirect Pulp Cap

- Indicated for deep caries, pulp is healthy and not exposed
- Dentin covering pulp lined with $Ca(OH)_2$ or RGMI
  - RGMI can also layer on top of $Ca(OH)_2$

Direct Pulp Cap

- Indicated for healthy pulp that is exposed
  - From caries of mechanical exposure <2mm
  - From trauma that occurred within 24h
- $Ca(OH)_2$ placed directly on top of exposed pulp
  - Hard tissue barrier can form as early as 6 weeks

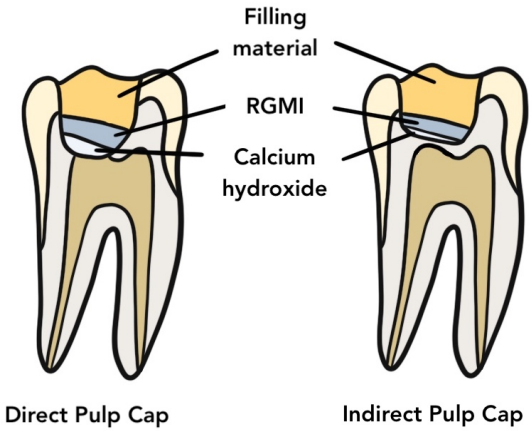

Figure 2.01 Pulp Capping

Partial (Cvek) Pulpotomy

- Indicated when there is a small amount of coronal diseased pulp
  - From caries or mechanical exposure > 2mm
  - From trauma that occurred more than 24h ago
- Removal of diseased pulp only as a means of reserving the remaining healthy coronal and radicular pulp
- Aka **shallow pulpotomy**

Full Pulpotomy

- Indicated for
  - Trauma that occurred more than 72h ago
  - For vital primary tooth with pulp exposure, but is restorable
  - Traditionally place a ZOE crown and formocresel
- Removal of coronal diseased pulp as a means of preserving healthy radicular pulp tissue

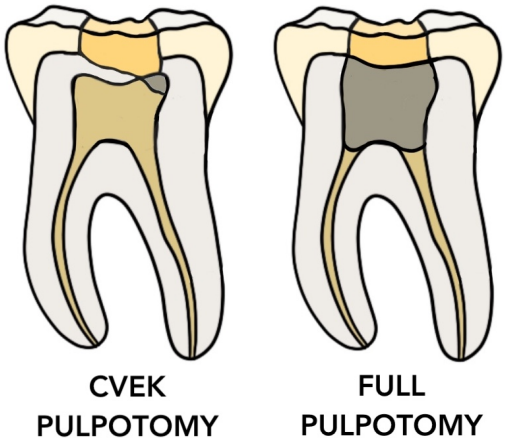

Figure 2.02 Pulp Pulpotomy

Apexogenesis

- Performed to maintain pulp vitality and encourages root end closure by physiologic development of root end
- Occurs when $Ca(OH)_2$ or MTA is placed on healthy or diseased pulp
- Contraindications
  - Nonrestorable tooth
  - Severe horizontal fracture
  - Avulsed tooth
  - Necrotic tooth
- Is a process that occurs when an indirect or direct pulp cap, Cvek of full pulpotomy is performed in an immature permanent tooth

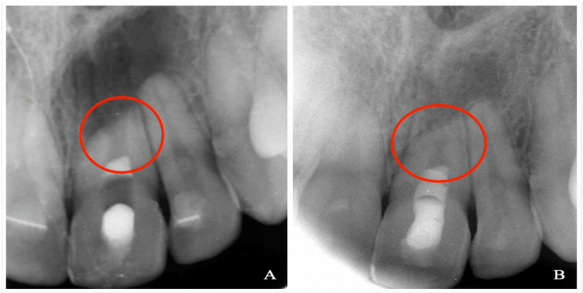

Figure 2.03 Apexogenesis

INBDE Pro-Tip:
Buckley's Formocresol is the form of formocresol that is asked about on the exam. It has bactericidal properties and is a fixative for pulp tissue to resist enzymatic breakdown. It can be toxic if used in large amounts, but should not be if used appropriately in the correct dilutions. The formulation is as follows:

- Formaldehyde - 19%
- Cresol - 35%
- Water - 31%
- Glycerine - 15%

3 Non-Vital Pulp Therapies

Pulpectomy

- Involves removing coronal and radicular pulp that is dead or dying
- Similar to root canal treatment, but filling with ZOE (instead of gutta percha)
- Indications
  - Temporary treatment for irreversible pulpits (pain relief) until full RCT can be performed
  - For asymptomatic non-vital primary tooth with exposed pulp, but the tooth is restorable
    - ZOE in crown and $Ca(OH)_2$ in root (allows for resorption when the underlying permanent tooth erupts)

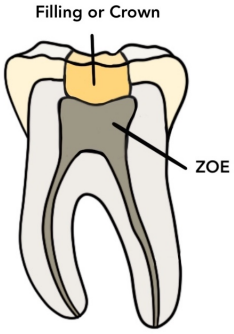

Figure 3.01 Pulpectomy

Root Canal Treatment

- Pulp is diseased or dead
- Involves complete removal of pulp, followed by cleaning, shaping and filling with gutta percha
- More detail in root canal section (page 12)

Apexification

- Induction of calcific barrier/artificial barrier of an open root apex to achieve root end closure
- Dead or dying pulp removed, followed by CaOH or MTA is placed at base of canal (artificial barrier)
- Occurs in any pulpectomy in an immature permanent tooth

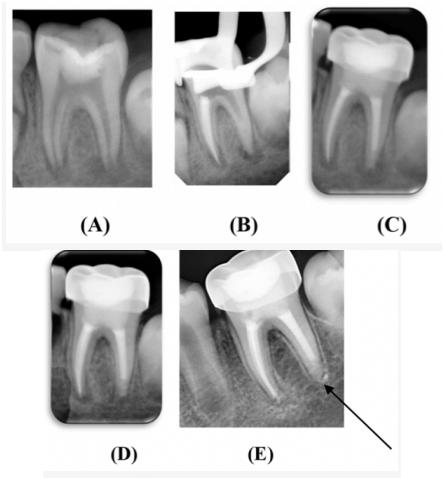

Figure 3.02 Apexification

Extraction

- Complete removal of tooth with dead or dying pulp
- Extract primary teeth
  - When it is non-restorable
  - When tooth is symptomatic and exhibits root resorption
  - Extract molars when anatomy is too complex for pulpectomy

ROOT CANAL

1 Introduction

Root canal treatment is usually performed when a tooth has necrotic or dying pulp. Steps for a root canal can be divided into the following:

1. Access Prep
2. Cleaning & Shaping
3. Filling/ Obturation

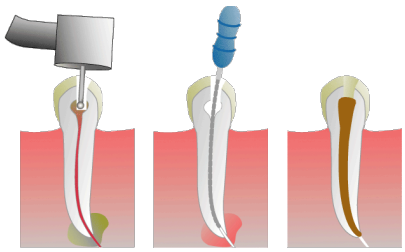

Figure 1.01 Root Canal Steps

Microbiology

A common cause for necrotic pulp comes from endodontic infection.

- **Primary endodontic infection** - the first time a tooth had infected pulp
  - Predominantly **Bacteroides** (gram negative obligate anaerobe)
- **Secondary endodontic infection** - re-infection due to failed endodontic treatment
  - Predominately **Enterococcis faecalis**

2 Sequence of Treatment

Access Cavity Preparation

- Tooth prep that allows access to the pulp chambers and canals
- Must de-roof the pulp chamber → exposed pulp horns and canal opening (orifice), while trying to conserve as much tooth structure as possible
  - Try to avoid prepping cusp tips and marginal ridges
- Most important step of root canal treatment for technique
- Aim to create straight line access to orifice and root apex
- Usually performed with high-speed round bur or tapered bur
- Patient should be wearing a **rubber dam** before pulp tissue is exposed
  - Prevents infection

Tooth	Access Prep Shape
Incisors	Triangular or Ovoid on lingual surface
Canines	Ovoid
Premolars	Ovoid (narrow)
Maxillary Molars	4 canals (2 in MB root) → Blunted triangle/ rhomboidal 3 canals → Triangular
Mandibular Molars	4 canals (2 canals/root) → Rectangular 3 canals (more common, 2 canals in M root) → Trapezoidal

INBDE Pro-Tip:
A common question on the exam is which premolar is the most common to have 2 roots and 2 canals. The answer is the maxillary first premolar.

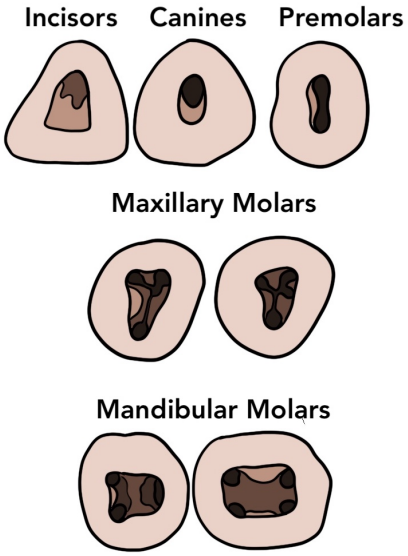

Figure 2.01 Access Cavity Prep

Working Length

The goal for a root canal is to clean, shape and obturate the root canal up until 0-2mm from the root apex. This can be achieved by measuring the working length. **Working length** is the length of the tooth from a reference point (ex. cusp tip) to the tooth apex. It can be determine using the following:

- Radiograph of hand file in the canal
- Electronic apex locator

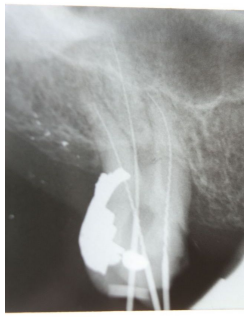

Figure 2.02 Radiograph for Working Length

Cleaning & Shaping

Using files and rotary instruments, cleaning and shaping can be done primarily through either of two methods.

1. **Step-back** - shape coronal third → apical third → middle third of canal (small to big)
   i. Usually use hand instruments
   ii. Shaping coronal third allows access for a file to reach the apical third, at which the operator can then shape from apical to coronal

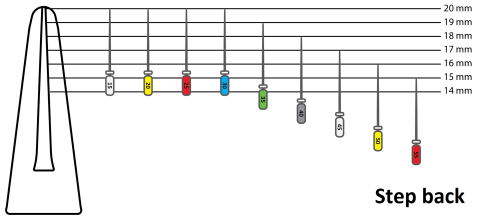

Figure 2.03 Step-back Example

2. **Crown-down** - coronal to apical direction
   i. Usually use rotary instruments
   ii. Use progressively smaller files as you reach more apical
      a. Change files when you feel resistance

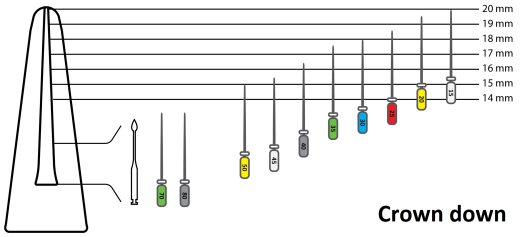

Figure 2.04 Crown-down Example

Filling

Obturation refers to filling and sealing the cleaned and shaped canal system with

- Often gutta percha filler + ZOE sealant
- Compaction techniques
   1. **Cold Lateral** - using a finger spreader for placement of multiple gutta percha cones to working length until spreader can no longer penetrate the coronal part of the canal

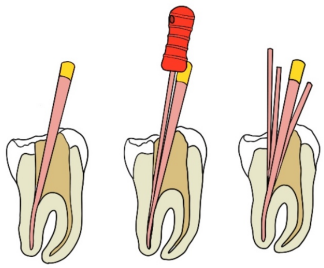

Figure 2.05 Lateral Compaction

2. **Warm Vertical** - seating gutta percha cone to working length and using a heated plugger instrument to compress the gutta percha

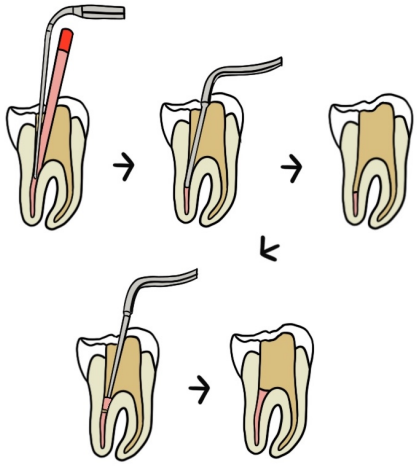

Figure 2.06 Vertical Compaction

3 Cleaning and Shaping (continued)

Instruments for Canal Prep

Specific instruments are used to remove pulp from the canals in a controlled and conservative manner and shape and the canals.

1. **NiTi rotary instruments**
   i. 0.04 or 0.06mm taper
   ii. Uses an electric hand piece that rotates according to rpm

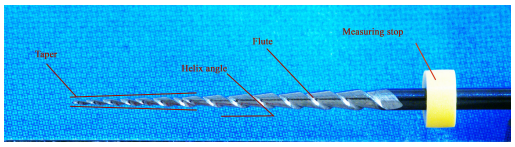

Figure 3.01 NiTi Rotary File

2. **Stainless steel (SS) hand files**
   i. 0.02 taper
   ii. Often colour coded (ISO colour coding)
      a. Small to large: pink, grey purple, white, yellow red, blue, green, black (then repeats from white to black)
   iii. **K-files (Kerr)** - twisted-square in cross section
      a. Rotate clockwise-counterclockwise
   iv. **H-files (Hedstrom)** - spiral grooves
      a. Agressive
      b. Cuts in retraction
3. **Gates-Glidden drill** - used to open 1/3 of canal
   i. Used in straight-line access

Figure 3.02 Gates Glidden

4. **Reamer** - twisted-triangle cross section
   i. Rotated clockwise
5. **Barbed broaches** - to remove entangled and difficult to remove substances

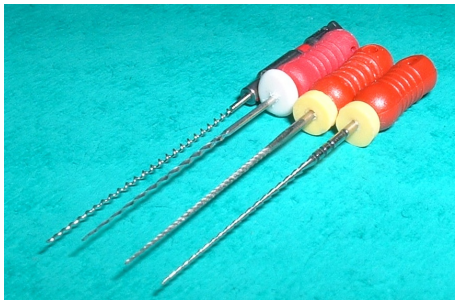

Figure 3.03 From Left - Lentulo (applies sealant), Reamer, K-file, & H-file

File Diameter

Files are usually chosen based on their diameters. Specific notation of diameters are used in the following manner:

- **D0** = tip diameter (end of file)
  - Size 10 K-file = 0.10mm at the tip
- **D16 or D2** - diameter at the location of the file 16mm from the tip (where the cutting flutes end)
  - For every 1mm up the file, the diameter increase 0.02mm
  - Therefore for a size 10 K-file, D16= 0.1 + 0.02*16) = 0.42mm

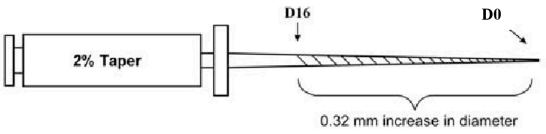

Figure 3.04 File Diameter

Irrigation

During the cleaning and shaping phase, it is important to irrigate the canal system between the changing of files. **Irrigation** cleans the canal system of its constituents.

1. **Sodium hypochlorite (NaOCL)**
   i. Irritant
   ii. Dissolves tissue (organic matter)
   iii. Antibacterial
2. **EDTA**
   i. Dissolves in inorganic material = smear layer
   ii. Lubrication
3. **Choloform**
   i. Used in re-treatment to dissolve gutta percha

4 Complications

Different complications can arise during root canal treatment due to poor technique and instrumentation. It should be noted that these types of errors can occur in surgical endodontic procedures as well (next section).

Perforation

- When a pathway is created and allows communication between the root canal and periodontium
- Signs of perforation
  - Sudden pain
  - Immediate hemorrhage
- Treat using internal repair with MTA
- Perforation locations
  - **Furcal** - through pulp floor
  - **Coronal** - through the crown
  - **Strip** - from too much coronal flaring
    - Commonly occurs in mandibular molars on the distal surface of the mesial root
    - Mesial side of mandibular molars has thicker dentin (always favour this side)
  - **Root** - through the root surface
    - Better prognosis the more apical the perforation is

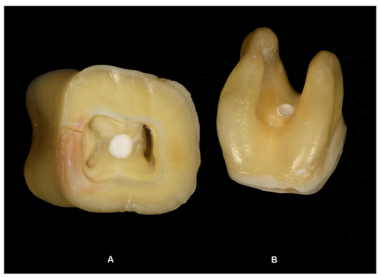

Figure 4.01 Filled Furcal Perforation

Ledges

- Irregularity, created by the operator, on the root canal wall
- Occurs when original pathway of canal is lost during instrumentation
  - Often occurs in longer and smaller diameter canals
  - Files naturally tend to straighten out in curved canals, hence NiTi files are less likely to created ledges due to their flexibility
- **Renegotiation** - bypass the ledge by using a smaller instrument/file
- Can also bypass the ledge by slightly curving the file

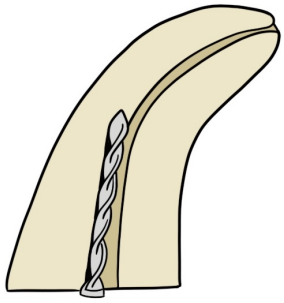

Figure 4.02 Ledge Formation

INBDE Pro-Tip:
The later the complication/error occurs in the the root canal process, the better the prognosis is compared to if it occurred earlier in the process. This is because more instrumentation and disinfection occurred prior to the fracture = greater proportion of bacteria removed and killed.

Endodontic Instrument Fractures

- Also known as **instrument separation**
- When an instrument breaks and remains within the canal
- Occurs when
  - Inadequate irrigation to allow instrument to move in and out
  - Files are too big and get lodged in canal
  - Used, weak files and more prone to fracture
  - Flexible NiTi files more prone to fracture
- Can bypass the fractured instrument using a smaller instrument/file
  - Often times, removal is too difficult

Figure 4.03 Broken File in Mesial Root

SURGICAL ENDODONTICS

1 Types of Procedures

Surgical root canal treatment occurs when there is persistent infection of the tooth around the apex despite previous root canal treatment.

INBDE Pro-Tip:
If a root canal fails, there are the two options of re-treatment or surgery depending on where the problem is located.
Canal → Re-treatment
Apex → Surgical root canal

Drainage

- Done for localized and fluctuant swollen areas
- **Incision** to open soft tissue to drain exudate and relieve pressure
- **Trephination** - surgical access into hard tissue (drilling into bone) for the release of exudate and pressure

Periapical Microsurgery

Periapical microsurgery is used in surgical root canal therapy, where access to the pulp is through the apical aspect of the tooth. This contrasts with conventional root canal treatment, where access to the pulp is through the coronal aspect of the tooth. Steps for periapical microsurgery are as follows:

1. Anesthesia
2. Soft tissue flap to reveal underlying bone
3. Drill through the bone to access tooth apex
   i. Trephination may occur
4. **Apicoectomy** - resect 3mm of the root apex
   i. Traditionally done with round bur at an 45° bevel (more chance of leakage)
   ii. Modern-technique uses ultrasonic tip at 0-10° (less chance of leakage)
5. Prepare 3mm of the canal from the root end with an ultrasonic instrument
6. Fill the root end of canal with MTA
   i. Biocompatible
7. Suture the soft tissue and allow the bone to heal

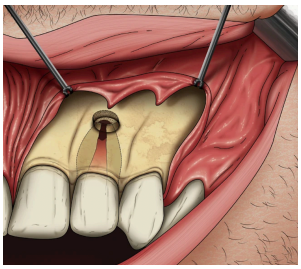

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Figure 1.01 Flap and Drill

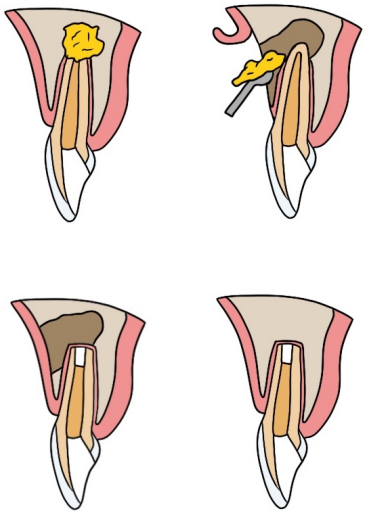

Figure 1.02 Surgical Root Canal