

Review lecture

Endodontics

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Endodontics is the branch of dentistry which is concerned with the morphology, physiology and pathology of the human dental pulp and periradicular tissues. Its study and practice encompass the basic clinical sciences including biology of the normal pulp, the etiology, diagnosis, prevention and treatment of diseases and injuries of the pulp and associated periradicular conditions

Objectives of Endodontics treatment

- ◆ to create a biologically acceptable environment within the root canal system which allows the healing and continued maintenance of the health of the peri-radicular tissue by eliminating the bacteria (source of infection) from within the root canal system, and Sealing the root canal and tooth to prevent re-infection.

Indications and contraindications

1. An irreversibly damaged or necrotic pulp with or without clinical and/or radiological findings of apical periodontitis'
2. Elective devitalization, e.g. to provide post space, prior to construction of an overdenture, doubtful pulp health prior to restorative procedures' likelihood of pulpal exposure when restoring a (misaligned) tooth and prior to root resection or hemisection
1. Teeth that cannot be made functional nor restored
2. Teeth with insufficient periodontal support'
3. Teeth with poor prognosis' uncooperative patients or patients where dental treatment procedures cannot be undertaken'
4. Teeth of patients with poor oral condition that cannot be improved within a reasonable period.

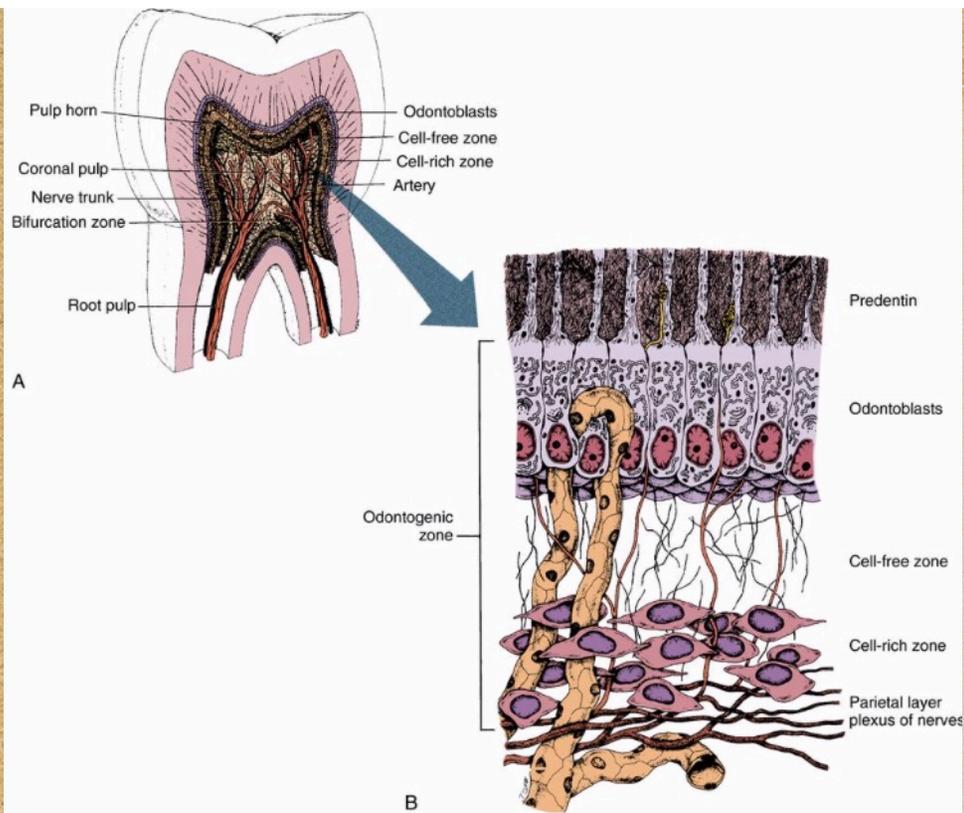


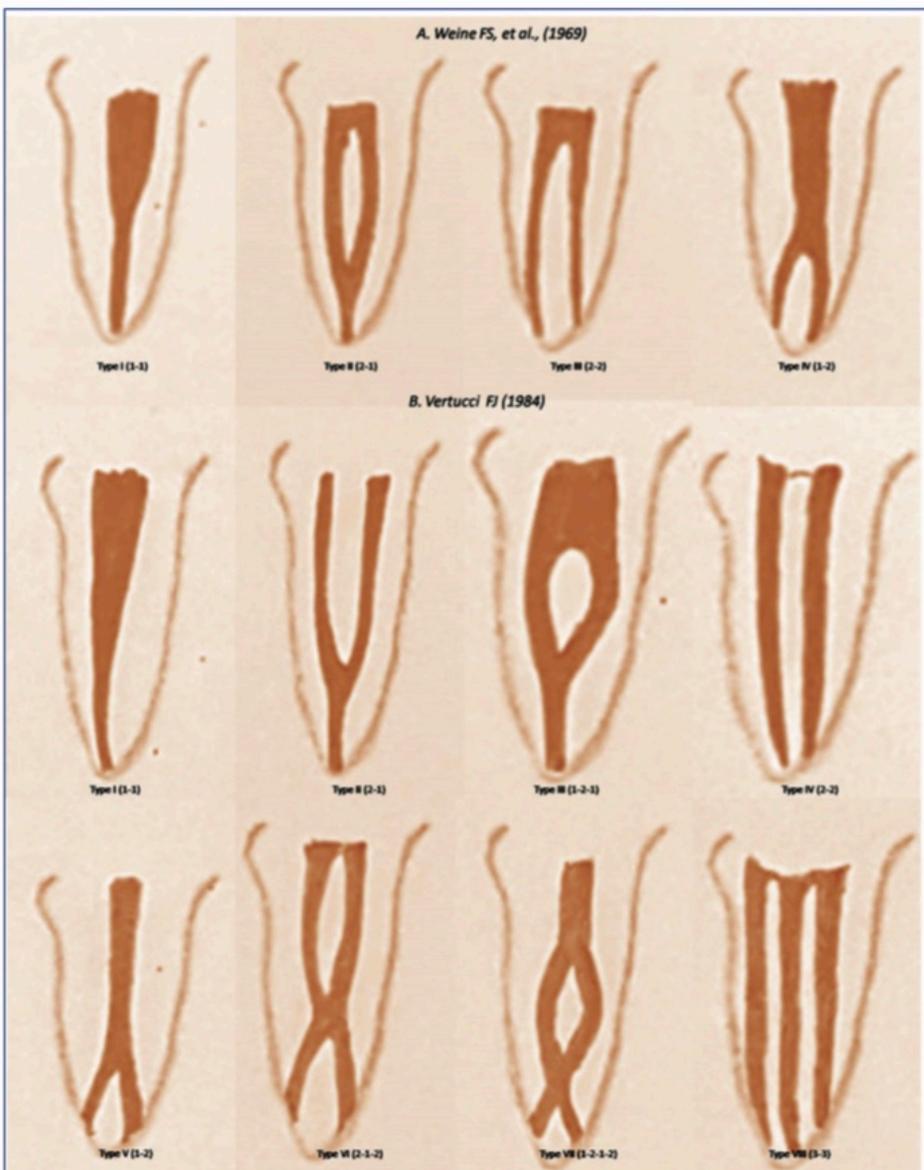
FIG. 9.5 Diagram of pulp organ illustrating pulpal architecture. **A**, There appears high organization of the peripheral pulp and the appearance of centrally located nerve trunks (*dark*) and blood vessels (*light*). **B**, Odontogenic zone of pulp. *Top to bottom*: Predentin, odontoblasts, cell-free and cell-rich zones, and parietal layer of nerves. (Modified from Bhaskar SN, editor: Orban's oral histology and embryology, ed 11, St. Louis, 1991, Mosby.)

◆ Functions of the pulp:

Pulp performs four basic functions:

1. Formation of dentine
2. Nutrition of dentine
3. Innervation of tooth
4. Defense of tooth

Pocket dentistry



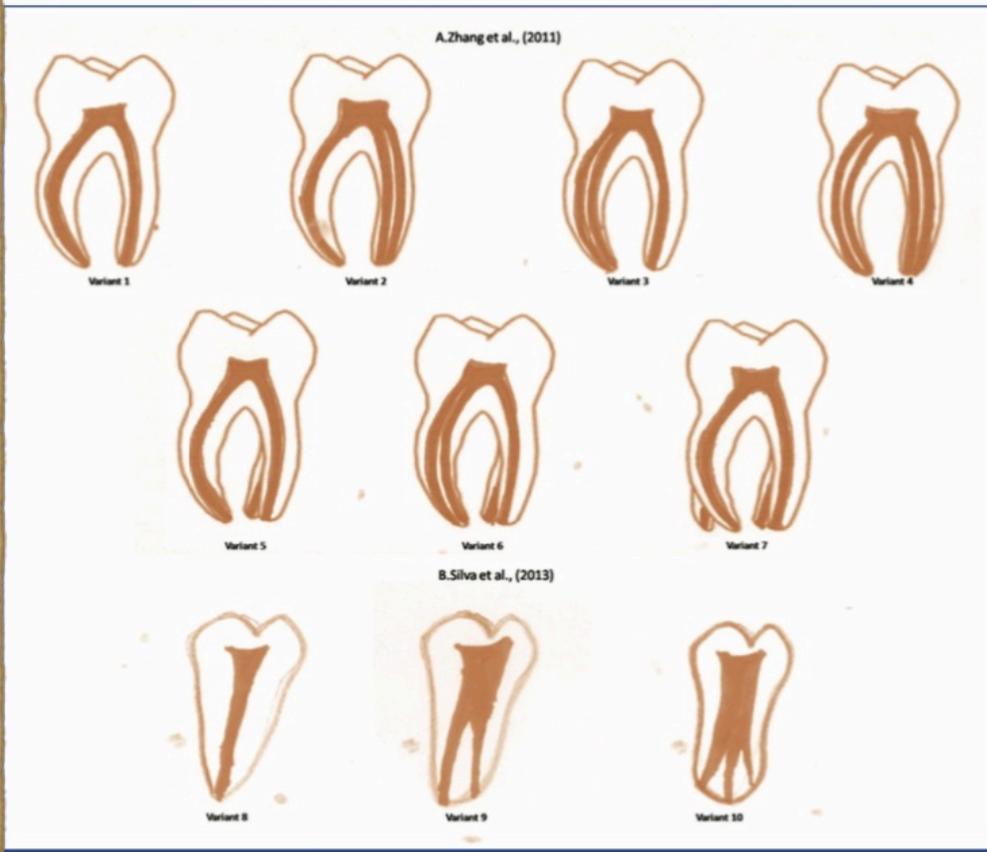
[Table/Fig-1]: The root canal configurations from the pulp chamber to the root apex according to Weine FS et al., (A) and Vertucci FJ (B).



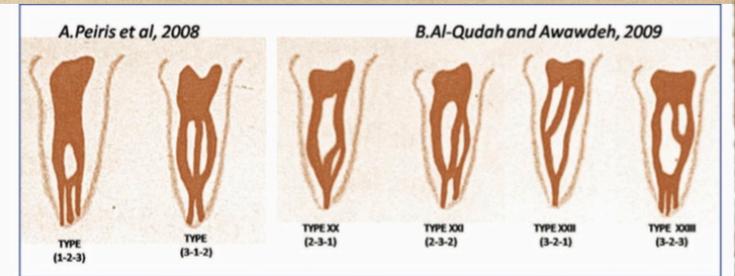
[Table/Fig-2]: The root canal configurations from the pulp chamber to the root apex according to Kartal N et al., (A) and Gulabivwala K et al., (B).



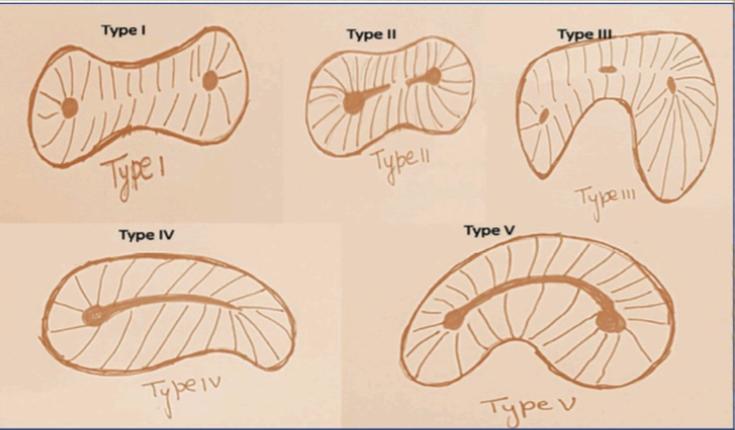
[Table/Fig-3]: The root canal configurations from the pulp chamber to the root apex according to Sert S and Bayirli GS.



[Table/Fig-5]: The root canal configurations from the pulp chamber to the root apex according to (A) Zhang R et al., (B) Silva EJNL et al.,.



[Table/Fig-4]: The root canal configurations from the pulp chamber to the root apex according to Peiris H et al., (A) and Al-Qudah AA (B).



[Table/Fig-6]: Classification according to isthmus by Kim SY

Pulpal Diagnosis

1. Normal Pulp is a clinical diagnostic category
 - ◆ pulp is symptom-free
 - ◆ normally responsive to pulp testing.
 - ◆ “clinically” normal pulp results in a mild or transient response to thermal cold testing lasting no more than one to two seconds after the stimulus is removed.
 - ◆ It is best to test the adjacent teeth and contralateral teeth first so that the patient is familiar with the experience of a normal response to cold.

Pulpal Diagnosis

2. Reversible Pulpitis

- ◆ the inflammation should resolve and the pulp return to normal following appropriate management of the etiology.
- ◆ Discomfort is experienced when a stimulus such as cold or sweet is applied and goes away within a couple of seconds following the removal of the stimulus.
- ◆ Typical etiologies may include exposed dentin (dentinal sensitivity), caries or deep restorations.
- ◆ There are no significant radiographic changes in the periapical region of the suspect tooth and the pain experienced is not spontaneous.

Pulpal Diagnosis

3. Symptomatic Irreversible Pulpitis

- ◆ the vital inflamed pulp is incapable of healing and that root canal treatment is indicated.
- ◆ sharp pain upon thermal stimulus, lingering pain (often 30 seconds or longer after stimulus removal), spontaneity (unprovoked pain) and referred pain.
- ◆ Sometimes the pain may be accentuated by postural changes such as lying down or bending over and over-the-counter analgesics are typically ineffective.
- ◆ Common etiologies may include deep caries, extensive restorations, or fractures exposing the pulpal tissues.
- ◆ no pain or discomfort to percussion. In such cases, dental history and thermal testing are the primary tools for assessing pulpal status.

Pulpal Diagnosis

4. Asymptomatic Irreversible Pulpitis

- ◆ the vital inflamed pulp is incapable of healing and that root canal treatment is indicated.
- ◆ These cases have no clinical symptoms and usually respond normally to thermal testing but may have had trauma or deep caries that would likely result in exposure following removal.

Pulpal Diagnosis

5. Pulp Necrosis

- ◆ indicating death of the dental pulp, necessitating root canal treatment.
- ◆ The pulp is non-responsive to pulp testing and is asymptomatic.
- ◆ Pulp necrosis by itself does not cause apical periodontitis (pain to percussion or radiographic evidence of osseous breakdown) unless the canal is infected.
- ◆ Some teeth may be non-responsive to pulp testing because of calcification, recent history of trauma, or simply the tooth is just not responding. As stated previously, this is why all testing must be of a comparative nature (e.g. patient may not respond to thermal testing on any teeth).

Pulpal Diagnosis

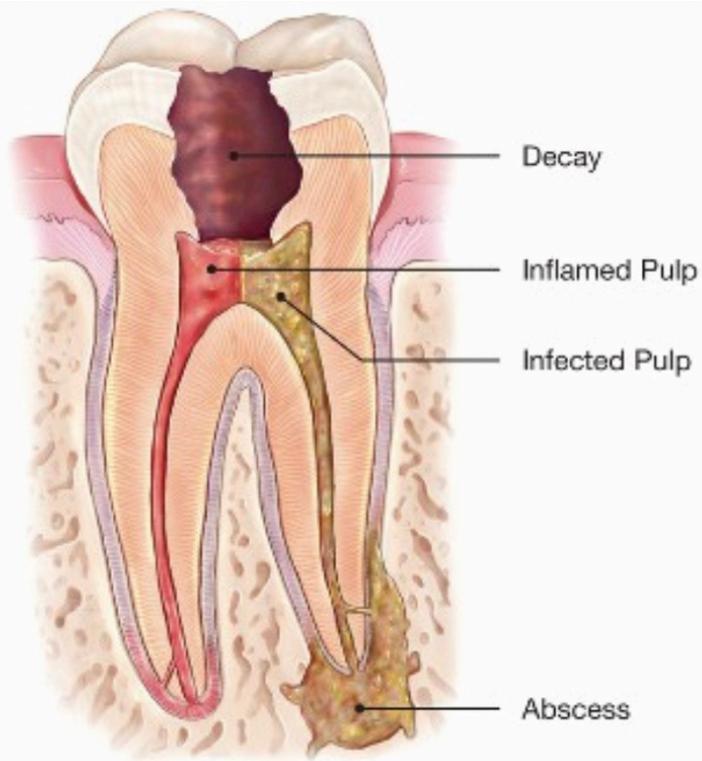
6. Previously Treated is a clinical diagnostic category indicating that the tooth has been endodontically treated and the canals are obturated with various filling materials other than intracanal medicaments. The tooth typically does not respond to thermal or electric pulp testing.
7. Previously Initiated Therapy is a clinical diagnostic category indicating that the tooth has been previously treated by partial endodontic therapy such as pulpotomy or pulpectomy. Depending on the level of therapy, the tooth may or may not respond to pulp testing modalities.

Apical Diagnosis

1. Normal Apical Tissues are not sensitive to percussion or palpation testing and radiographically, the lamina dura surrounding the root is intact and the periodontal ligament space is uniform. As with pulp testing, comparative testing for percussion and palpation should always begin with normal teeth as a baseline for the patient.
2. Symptomatic Apical Periodontitis represents inflammation, usually of the apical periodontium, producing clinical symptoms involving a painful response to biting and/or percussion or palpation. This may or may not be accompanied by radiographic changes (i.e. depending upon the stage of the disease, there may be normal width of the periodontal ligament or there may be a periapical radiolucency). Severe pain to percussion and/or palpation is highly indicative of a degenerating pulp and root canal treatment is needed.
3. Asymptomatic Apical Periodontitis is inflammation and destruction of the apical periodontium that is of pulpal origin. It appears as an apical radiolucency and does not present clinical symptoms (no pain on percussion or palpation).

Apical Diagnosis

4. Chronic Apical Abscess is an inflammatory reaction to pulpal infection and necrosis characterized by gradual onset, little or no discomfort and an intermittent discharge of pus through an associated sinus tract. Radiographically, there are typically signs of osseous destruction such as a radiolucency. To identify the source of a draining sinus tract when present, a gutta-percha cone is carefully placed through the stoma or opening until it stops and a radiograph is taken.
5. Acute Apical Abscess is an inflammatory reaction to pulpal infection and necrosis characterized by rapid onset, spontaneous pain, extreme tenderness of the tooth to pressure, pus formation and swelling of associated tissues. There may be no radiographic signs of destruction and the patient often experiences malaise, fever and lymphadenopathy.
6. Condensing Osteitis is a diffuse radiopaque lesion representing a localized bony reaction to a low-grade inflammatory stimulus usually seen at the apex of the tooth.



Guide to Clinical Endodontics

Sixth Edition

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Pulp test

- ◆ pulp test (pulp sensibility test) — A diagnostic procedure to determine pulpal status; can be performed with electric, mechanical or thermal stimuli or by the assessment of the blood supply to the tooth.
1. electric pulp test (EPT) — A pulp test that utilizes an electrical current to stimulate sensory nerves of the dental pulp; modes of testers include both bipolar and monopolar.
 2. laser Doppler flowmetry — A pulp test that assesses pulpal blood flow by the detection of light scatter generated by moving erythrocytes; effective in young traumatized pulps and large pulps that do not respond dependably to other forms of sensitivity testing.
 3. pulse oximetry — A pulp test to assess vascular integrity by measuring the oxygenation of blood. test cavity — A diagnostic procedure in which a small cavity is prepared w

4. Test cavity: a diagnostic procedure in which a small cavity is prepared without anesthesia into the dentin to test for pulpal responsiveness.
5. thermal pulp test — A pulp test using a hot or cold stimulus to induce dentinal tubule fluid movement and resultant stimulation of sensory receptor elements within the pulp.
 - cold test — Usually conducted with an ice stick, a frozen stick of carbon dioxide or a cotton pellet sprayed with 1,1,1,2 tetrafluoroethane.
 - heat test — Usually conducted with hot liquid, heated temporary stopping material or devices specifically designed to administer heat of a specified temperature.

Scope of Endodontics

1. Vital pulp therapy (pulp capping' pulpotomy)
2. Diagnosis and differential diagnosis of oro-facial pain'
3. Root canal treatment of teeth with or without periradicular pathology of pulpalorigin
4. Surgical management of pathology resulting from pulpal pathosis
5. Management of avulsed teeth (replantation)
6. Endodontic imPlants
7. Root end resections, hemisections and root resections
8. Retreatment of teeth previously treated endodontically
9. Bleaching of discolored teeth'
10. Coronal restorations of teeth using post and core

Vital pulp therapy.

1. Apexogenesis

Indications for Treatment

Apexogenesis is indicated on permanent teeth with immature apices if *all* the following conditions exist:

- a. Tooth has a deep carious lesion that is considered likely to result in pulp exposure during excavation.
- b. No history of subjective pretreatment symptoms.
- c. Pretreatment radiographs should exclude periradicular pathosis.
- d. Mechanical exposure of a clinically vital and asymptomatic pulp occurs.
- e. Bleeding is controlled at the exposure site.
- f. Exposure occurs when the tooth is under dental dam isolation.
- g. Adequate seal of the coronal restoration can be maintained.
- h. Exposure permits the capping material to make direct contact with the vital pulp tissue.
- i. Patient has been fully informed that endodontic treatment may be indicated in the future.

Procedure

Apexogenesis is vital pulp therapy performed to allow continued physiological development and formation of the root. It involves the removal of a portion of pulp and application of a medicament with the aim of maintaining the vitality of the remaining pulp and to encourage continued physiological development and formation of the root.

Objectives

- a. To prevent adverse clinical signs or symptoms.
- b. To develop contact of a radiopaque capping material with the pulpal tissue.
- c. To prevent breakdown of the periradicular supporting tissue.
- d. To obtain radiographic evidence of root development.

2. Pulpotomy

Indications for Treatment

A pulpotomy may be indicated if any of the following clinical conditions exist:

- a. Exposed vital pulps or irreversible pulpitis of primary teeth. Primary teeth with insufficient root structure, internal resorption, furcal perforation or periradicular pathosis that may jeopardize the permanent successor are not indicated for pulpotomy procedures.
- b. As an emergency procedure in permanent teeth until root canal treatment can be accomplished. Pulpal debridement should be encouraged (*see section C3*).
- c. As an interim procedure for permanent teeth with immature root formation to allow continued root development (apexogenesis). (*see section D4*).

Procedure

Pulpotomy is the surgical removal of the coronal portion of vital pulp tissue. A biologically acceptable material is placed in the pulp chamber, and the tooth is restored.

Objectives

- a. To prevent adverse clinical signs or symptoms.
- b. To obtain radiographic evidence of sufficient root development for endodontic treatment. An increase in root length may be evident.
- c. To prevent breakdown of the periradicular supporting tissues.
- d. To prevent resorptive defects or accelerated canal calcification as determined by periodic radiographic evaluation.

3. Pulpal Debridement

Indications for Treatment

Pulpal debridement (pulpectomy) is indicated for the relief of acute pain prior to conventional root canal treatment when complete root canal treatment cannot be accomplished at this appointment. This procedure cannot be submitted for reimbursement when endodontic treatment is completed on the same day.

Procedure

Surgical removal of the entire pulp tissue.

Objectives

Relief of acute pain until complete treatment can be accomplished.

4. Indirect Pulp Capping

Indications for Treatment

Indirect pulp capping is indicated on permanent teeth with immature apices if *all* the following conditions exist:

- a. Tooth has a deep carious lesion that is considered likely to result in pulp exposure during excavation.
- b. No history of subjective pretreatment symptoms.
- c. Pretreatment radiographs should exclude periradicular pathosis.
- d. Patient has been fully informed that endodontic treatment may be indicated in the future.

Procedure

Treatment consists of two visits approximately six to eight months apart. At the first visit, caries biomass is excavated, leaving affected dentin adjacent to the pulp. Calcium hydroxide or other biologically compatible material is placed over the dentin followed by a base, and the tooth is soundly restored. At the second visit, the restorative material and residual caries mass is removed, and the tooth is restored.

Objectives

- a. To prevent adverse clinical signs and symptoms.
- b. To obtain radiographic evidence of root development.
- c. To prevent breakdown of the periradicular supporting tissues.
- d. To prevent resorptive defects or accelerated canal calcification as determined by periodic radiographic evaluation.

5. Direct Pulp Capping

Indications for Treatment

Direct pulp capping is indicated when *all* of the following clinical conditions exist:

- a. Mechanical exposure of a clinically vital and asymptomatic pulp occurs.
- b. Bleeding is controlled at the exposure site.
- c. Exposure permits the capping material to make direct contact with the vital pulp tissue.
- d. Exposure occurs when the tooth is under dental dam isolation.
- e. Adequate seal of the coronal restoration can be maintained.
- f. Patient has been fully informed that endodontic treatment may be indicated in the future.

Procedure

A radiopaque capping material is placed directly onto the surface of vital pulp tissue at the exposure site. The final restoration is placed over the base. The status of the pulp and periradicular tissues should be assessed through periodic recall examinations.

Objectives

- a. To prevent adverse clinical signs or symptoms.
- b. To develop contact of a biocompatible radiopaque capping material with the pulpal tissue.
- c. To maintain normal responsiveness to electrical and thermal pulp tests.
- d. To prevent breakdown of the periradicular supporting tissue.

Non surgical Endodontics.

1- permanent teeth root canal treatment

- a. Symptomatic or asymptomatic irreversible pulpitis, with or without evidence of periapical disease
- b. Necrotic pulp with or without evidence of periradicular disease.
- c. Teeth with a pulp that would be compromised during dental procedures, including but not limited to caries removal, overdenture abutments, malposed teeth and root resection.
- d. Restorative reason when a placement of a core and possibly a post is necessary for retention of a fixed restoration.
- e. Cracked or fractured teeth with pulpal involvement (with or without clinical symptoms) that can reasonably be expected to maintain satisfactory periodontal health.
- f. Teeth with thermal hypersensitivity that significantly interferes with normal function, when alternative methods have failed in relieving hypersensitivity.

Objectives

- a. To alleviate present and prevent future adverse clinical signs or symptoms.
- b. To debride and shape the root canal system.
- c. To create the radiographic appearance of a well-obtured root canal system where the root canal filling extends as close as possible to the apical constriction of each canal. Gross overextension, underfilling in the presence of patent canals, ledges and perforations should be avoided.
- d. To maintain health and/or promote healing and repair of periradicular tissues:
 - i. If a tooth had a normal periodontal ligament space and an intact lamina dura surrounding the root(s) at the time of obturation, the subsequent postoperative radiographic appearance should remain unchanged after a suitable period of time for resolution of any transitory radiographic changes.
 - ii. If a tooth had a preoperative periradicular radiolucency, the follow-up radiographic examination should optimally demonstrate an intact lamina dura and a normal periodontal ligament space around the root(s) under observation.
 - iii. If the radiolucent area is decreasing in size or is not enlarging and the tooth is asymptomatic additional follow-up visits with radiographic examination are indicated.
 - iv. There may be periradicular bone healing without reformation of a normal periodontal ligament space.

2- Regenerative Endodontics

I. Pulpal regeneration (regenerative endodontics)

Indications for Treatment

- a. The primary indication at this time is incomplete root development (length) as well as incomplete apical closure
- b. Treatment options other than extraction are limited to apexification or pulpal regeneration. An apexification may provide an apical barrier; however this would result in less than ideal root length and dentinal wall thickness, making the root more prone to fracture.
- c. Apexogenesis is not a choice because the pulp is necrotic.

Procedure

This is a biologically-based procedure designed to physiologically replace damaged tooth structures, including dentin and root structures, as well as cells of the pulp-dentin complex. Treatment is initiated by isolating the tooth with a rubber dam and gaining access to the root canal system followed by copious, gentle irrigation. Necrotic tissue is extirpated, and the canal is irrigated and dried. Antibacterial medication is placed in the canal to the apex and access is closed with temporary filling material. The patient is recalled in three to four weeks, and this step is repeated until there are no clinical signs or symptoms of infection. The final phase of treatment is initiated by anesthetizing without vasoconstrictor followed by rubber dam isolation. Access is gained followed by copious gentle irrigation. After the canal is dried, apical bleeding is induced by overinstrumentation to create a clot in the canal. Three to four millimeters of mineral trioxide aggregate or similar material is placed in contact with the clot, ending apical to the CEJ. The access is closed with a permanent filling material. Patient is recalled to assess continued development of the root.

Objectives

- a. To treat apical periodontitis
- b. To induce radiographic evidence of apical closure without breakdown of supporting tissues.
- c. To retain dentition, especially during craniofacial development
- d. To promote root development

3- Apexification

II. Apexification

Indications for Treatment

This procedure can be done if pulpal generation has failed or there are other reasons not to attempt to regenerate the pulp.

Procedure

Treatment is initiated by cleaning and shaping the canal and packing the area with biologically appropriate material to create an apical barrier. The patient is reappointed, and the root canal treatment is completed.

If there are concerns about patient compliance or long term follow-up, a second method is to use Ca(OH)_2 to induce hard tissue formation as an apical stop. It may be necessary to change the intracanal medication several times during a six- to 18-month period before root canal treatment can be completed.

4- Recalcification

III. Recalcification

Indications for Treatment

Treatment or prevention of external and internal resorptive defects perforating to external tooth surface.

Procedure

Treatment may be done either before or after completed root canal treatment, depending on size and location of resorptive defect. If defect is coronal, root canal treatment can be completed before addressing resorptive defect. If resorptive defect is in roots, root canal treatment is not completed until resorptive healing is complete.

Treatment is initiated by cleaning and shaping the canals (and possibly obturating the canals) and packing the area with appropriate material to create resorptive repair. The patient is reappointed for monitoring. Treatment is completed when resorptive repair is observed.

These procedures may involve several treatments (medication changes) over an extended period of time. Biologically acceptable materials should be used.

Objectives

Encourage biological root repair.

5- Perforation repair

5. Perforation Repair

Indications for Treatment

Nonsurgical repair is indicated if *any* of the following clinical conditions exist:

- a. A perforation of tooth structure has occurred during nonsurgical root canal treatment or post space preparation, and the perforation is within alveolar bone.
- b. A communication between the pulp space and external root surface as a result of root resorption or dental caries.

Procedure

The perforation defect is repaired using a biologically acceptable material to seal the communication between the pulp canal space and external root surface.

Objectives

- a. To seal the root canal space from the external surface of the root.
- b. Minimize extrusion of the repair material.
- c. Promote healing of the periodontal structures at the site of the perforation.

6- Non Syrgical root canal retreatment

3. Nonsurgical Root Canal Retreatment

Indications for Treatment

Nonsurgical root canal retreatment is indicated if *any* of the following clinical conditions exist:

- a. Continued periradicular pathosis, with symptoms.
- b. Radiographic evidence of a deficiency in the quality of the root canal obturation when periradicular pathosis or symptoms continue after endodontic treatment.
- c. Persistent symptoms.
- d. Anticipated restorative or prosthetic procedures that could compromise any pre-existing root canal obturations.
- e. Anticipated restorative or prosthetic procedures on a tooth where the previous treatment quality is questionable.
- f. Salivary contamination when bacterial leakage into the root canal system is suspected.

Procedure

Nonsurgical root canal retreatment is a procedure to remove the previously placed root canal obturating material and re-obturate the tooth. Cleaning, shaping, disinfection and obturation of all canals are accomplished using an aseptic technique with dental dam isolation. Root canal sealers are used in conjunction with a biologically acceptable semi-solid or solid obturating material to establish an adequate seal of the root canal system.

Additional procedures may be required to remove posts and manage canal obstructions, radicular defects, aberrant canal morphology, ledges or perforations.

Retreatment cases may vary greatly in complexity, requiring greater effort, time and skill, and should be undertaken with due regard to the ability and experience of the practitioner. Retreatment may require augmentation by other treatment modalities, such as apexification, recalcification or surgical intervention to provide optimal treatment.

6- Non Syrgical root canal retreatment

Objectives

- a. To alleviate present and prevent future adverse clinical signs or symptoms.
- b. To create the radiographic appearance of a well-obtured root canal system where the root canal filling extends as close as possible to the apical constriction of each canal. Gross overextension, underfilling in the presence of patent canals, ledges and perforations should be avoided. To maintain health and/or promote healing and repair of periradicular tissues:
 - i. If a tooth had a normal periodontal ligament space and an intact lamina dura surrounding the root(s) at the time of obturation, the subsequent postoperative radiographic appearance should remain unchanged after a suitable period of time for resolution of any transitory radiographic changes.
 - ii. If a tooth had a preoperative periradicular radiolucency, the follow-up radiographic examination should optimally demonstrate an intact lamina dura and a normal periodontal ligament space around the root(s) under observation.
 - iii. If the radiolucent area is decreasing in size or not enlarging and the tooth is asymptomatic, additional follow-up visits with radiographic examination are indicated.
 - iv. There may be periradicular bone healing without reformation of a normal periodontal ligament space.

Syrgical endodontics

1. Incision and Drainage/Trephination

Indications for Treatment

Incision and drainage of soft tissues is indicated if *any* of the following clinical conditions exist:

- a. If a pathway is needed in soft tissue with localized fluctuant swelling that can reasonably be expected to provide necessary drainage.
- b. When pain is caused by accumulation of exudate within soft tissues.
- c. When necessary to collect samples for bacteriologic analysis.

Trephination of hard tissues is indicated in any of the following clinical situations:

- a. If a pathway is needed from hard tissue that can reasonably be expected to provide necessary drainage.
- b. When pain is caused by accumulation of exudate within the alveolar bone.
- c. When necessary to collect samples for bacteriologic analysis.
- d. When adequate drainage cannot be established through the tooth.

Procedure

Incision and drainage is a surgical opening created in soft tissue for the purpose of releasing exudate or decompressing the area of swelling.

Trephination is the surgical perforation of the alveolar cortical bone to release accumulated intraosseous exudate.

These procedures may include the placement and subsequent timely removal of a drain.

Antibiotics may be indicated if there is diffuse swelling (cellulitis), systemic symptoms or in patients who are immunocompromised.

Objectives

- a. To alleviate present and prevent future adverse clinical signs or symptoms.
- b. To reduce localized soft tissue swellings.
- c. To promote acceptable repair of hard and soft tissues.
- d. To prevent damage to teeth or anatomical structures.

2. Periradicular Curettage

Indications for Treatment

Periradicular curettage is indicated if *any* of the following clinical conditions exist:

- a. Symptomatic periradicular pathosis following endodontic treatment.
- b. A periradicular lesion that enlarges after endodontic treatment, as noted on follow-up radiographic examination.
- c. A periradicular lesion that may involve soft tissue swelling.
- d. A marked overextension of obturating materials interfering with healing.
- e. A biopsy is deemed necessary.
- f. A periradicular lesion associated with intractable discomfort in spite of orthograde endodontic treatment.

Procedure

Periradicular curettage is a surgical procedure to remove diseased or reactive tissue and/or foreign material from the alveolar bone in the apical or lateral region surrounding an endodontically treated tooth. By definition, the root is not resected.

A mucoperiosteal flap is surgically elevated and, when necessary, bone is removed to allow direct visualization of and access to the affected area. Thorough removal of all targeted tissue and/or foreign material is performed. Guided tissue regeneration techniques and/or bone replacement may be used if, at the time of surgery, the clinical condition warrants their use. Primary closure of the surgical site is desired.

Objectives

- a. To alleviate present and prevent future adverse clinical signs or symptoms.
- b. To promote repair of hard and soft tissues.
- c. To minimize damage to adjacent teeth or anatomical structures.

3. Root-End Resection (Apicoectomy)

Indications for Treatment

A root-end resection (apicoectomy) in conjunction with periradicular curettage is indicated if *any* of the following clinical conditions exist:

- a. Symptomatic periradicular pathosis following endodontic treatment.
- b. A periradicular lesion that enlarges after endodontic treatment, as noted on follow-up radiographic examination.
- c. A marked overextension of obturating materials interfering with healing.
- d. Access for periradicular curettage, biopsy or to an additional root is necessary.
- e. Access for root-end preparation and root-end filling is necessary.
- f. When the apical portion of the root canal system of a tooth with periradicular pathosis cannot be cleaned, shaped and obturated.

Procedure

Root-end resection (apicoectomy) is the preparation of a flat surface by the excision of the apical portion of the root and any subsequent removal of attached soft tissues.

A mucoperiosteal flap is surgically elevated and, when necessary, bone is removed to allow direct visualization of and access to the affected area. Thorough removal of all targeted tissue and/or foreign material is performed. Guided tissue regeneration techniques and/or bone replacement may be used if, at the time of surgery, the clinical condition warrants their use. Primary closure of the surgical site is desired.

Objectives

- a. To alleviate present and prevent future adverse clinical signs or symptoms.
- b. To promote repair of hard and soft tissues.
- c. To minimize damage to adjacent teeth or anatomical structures.
- d. To preserve as much root length as possible.

4. Root-End Filling (Retrofilling)/Root Repair

Indications for Treatment

Root-end filling (retrofilling) and root repair, when anatomically feasible, are indicated if *any* of the following clinical conditions exist:

- a. Persistent periradicular pathosis resulting from an inadequate apical seal that cannot be corrected nonsurgically.
- b. Periradicular pathosis and a blockage of the root canal system that could not be obturated by nonsurgical root canal treatment.
- c. Root perforations and transported canals.
- d. Resorptive defects.

Procedure

Root-end filling (retrofilling) is an additional procedure following root-end resection (apicoectomy). A biologically acceptable restorative material is placed into a root-end preparation. Root resorptive defects and perforations are repaired with a biologically acceptable filling material.

Following root-end resection, a preparation is made and a biologically acceptable repair material is placed. Guided tissue regeneration techniques and/or bone replacement may be used if, at the time of surgery, the clinical condition warrants their use. Primary closure of the surgical site is desired.

Objectives

- a. To alleviate present and prevent future adverse clinical signs or symptoms.
- b. To promote acceptable repair of hard and soft tissues.
- c. To minimize damage to adjacent teeth or anatomical structures.
- d. To preserve maximum root length possible.
- e. To limit root-end filling and root repair materials to the confines of the preparation.
- f. To seal the root canal system or defect.

5. Biopsy

Indications for Treatment

A biopsy is indicated if *any* of the following clinical conditions exist:

- a. When an adequate amount of tissue or foreign material can be removed from the periradicular surgical site for histopathologic examination.
- b. Persistent pathosis or pathosis inconsistent with endodontic disease is noted on clinical or radiographic examination.
- c. Medical history indicates the merits of biopsy.

Procedure

A biopsy is the surgical removal of a soft and/or hard tissue specimen for histopathologic examination.

Objective

To establish a diagnosis by histopathologic examination.

6. Root Resection (Root Amputation)

Indications for Treatment

A root resection procedure is indicated if at least one root of the tooth is structurally sound and *any* of the following conditions exist:

- a. Periodontal furcation defect with a severe infrabony defect .
- b. Vertical root fracture confined to the root to be separated and removed.
- c. Carious, resorptive root or perforation defects that are inoperable or cannot be corrected without root removal.
- d. Persistent periradicular pathosis where nonsurgical root canal treatment or periradicular surgery is not possible.

Procedure

Root resection (root amputation) is a surgical procedure for the removal of a root or roots of a tooth. There are two methods of resection: the vertical cut technique and the horizontal root resection.

In the vertical cut technique, the tooth is sectioned vertically through the furcations, allowing for separation of the affected root and crown from the remaining root structure. This method is referred to as a hemisection when used on mandibular molars.

A horizontal root resection involves surgically amputating the root and preserving the crown portion of the tooth. This technique is often used to preserve an existing prosthesis.

When possible, it is preferable to complete the root canal procedure and place a permanent restoration that extends into the canal orifices prior to the root resection procedure.

Objectives

- a. To alleviate present or prevent future adverse clinical signs or symptoms.
- b. To eliminate or reduce significant periodontal defect(s).
- c. To perform acceptable root canal obturation(s) in the remaining root segment(s).
- d. To perform proper contouring of remaining tooth structure.
- e. To seal all external openings into the pulp chamber.
- f. To provide a portion(s) of the tooth that is/are restorable and that can be maintained by the patient.
- g. To preserve an existing prosthesis where one root of an abutment requires removal (horizontal root resection).

7. Intentional Replantation (Extraction/Replantation)

Indications for Treatment

Intentional replantation is indicated when *all* of the following clinical conditions exist:

- a. Persistent periradicular pathosis following endodontic treatment.
- b. Nonsurgical retreatment is not possible or has an unfavorable prognosis.
- c. Periradicular surgery is not possible or involves a high degree of risk to adjacent anatomical structures.
- d. The tooth presents a reasonable opportunity for removal without fracture.
- e. The tooth has an acceptable periodontal status prior to the replantation procedure.

Guide to Clinical Endodontics

Procedure

Intentional replantation is the insertion of a tooth into its alveolus after the tooth has been extracted for the purpose of accomplishing a root-end filling or root repair. Stabilization of the replanted tooth may or may not be necessary. When possible, root canal treatment is performed prior to intentional replantation.

Objectives

- a. To alleviate present and prevent future adverse clinical signs or symptoms.
- b. To properly orient the tooth in the socket.
- c. To eliminate periradicular pathosis.
- d. To minimize periodontal pathosis.
- e. To preserve the maximum root length possible.
- f. To place root-end filling(s) or root repair material(s).
- g. To maintain the tooth as a functional member of the dentition.

8. Surgical Removal of the Apical Segment of a Fractured Root

Indications for Treatment

When a root fracture occurs in the apical portion and pulpal necrosis results, the fractured segment may be removed surgically following or in conjunction with nonsurgical root canal treatment. Surgical removal of the apical segment of a fractured root is indicated when *all* of the following clinical conditions exist:

- a. Root fracture in the apical portion of the root.
- b. Pulpal necrosis in the apical segment as indicated by a periradicular lesion or clinical signs or symptoms.
- c. Coronal tooth segment is restorable and functional.

Procedure

A mucoperiosteal flap is surgically elevated and, when necessary, bone is removed to allow direct visualization of and access to the affected site. The apical portion of the affected root and all of the targeted tissue are removed. A root-end resection and/or root-end filling may be necessary. Guided tissue regeneration techniques and/or bone replacement may be used if, at the time of surgery, the clinical condition warrants their use. Primary closure of the surgical site is desired.

Objectives

- a. To alleviate present and prevent future adverse clinical signs or symptoms.
- b. To remove the fractured root segment.
- c. To promote acceptable repair of hard and soft tissues.
- d. To maintain a favorable crown-to-root ratio.
- e. To prevent damage to adjacent teeth or anatomical structures.
- f. To maintain the tooth as a functional member of the dentition.

Use of Antibiotics

- ◆ Antibiotics should only be used as adjuvant therapies in cases with evidence of :
 - ◆ systemic involvement (fever, malaise, cellulitis and/or lymphadenopathies)
 - ◆ following adequate endodontic disinfection and abscess drainage if swelling is present (8, 19).
- ◆ In addition, patients who are immunocompromised or have predisposing conditions such as previous endocarditis should be medicated as a prophylactic measure.

Administration of antibiotics in the absence of the above-mentioned reasons has no evidence of therapeutic benefit

Use of Antibiotics

Amoxicillin 500mg tid

Amoxicillin (500 mg) and clavulanic acid (125 mg) tid

Clindamycin 300 mg every 6 h

Alternative drugs (macrolides, quinolones or tetracyclines.) have less effect on Endodontics pathogens.

Signs and Symptoms	Possible Condition	Management Strategies
Continued pain and/or swelling	Bacterial resistance to antibiotic or presence in inaccessible areas	Supplementing antibiotic regimen with another oral drug such as Metronidazole
Trismus, dyspnea and dysphagia	Spread to poorly vascularized fascial spaces such as submandibular, sublingual, masseteric, parapharyngeal and retropharyngeal spaces	Hospitalization, culture and sensitivity, together with IV antibiotics
Vision problems, headache	Cavernous sinus involvement	Hospitalization, culture and sensitivity, together with IV antibiotics
Fever over 102°F, malaise, lethargy and increased erythrocyte sedimentation rate	Massive systemic involvement, potential septic shock	Hospitalization, culture and sensitivity, together with IV antibiotics

Table: Unfavorable response to empirically prescribed antibiotics following root canal debridement, and incision for drainage.

Prophylactic use of antibiotics for endodontic surgery

- ◆ Decision depends on:
 1. the type and site of surgery,
 2. the morbidity associated with potential infection.
 3. the systemic health of the patient.

			Regimen: Single Dose 30 to 60 min. Before Procedure
Situation	Agent	Adults	Children
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin	2 g IM* or IV+	50 mg/kg IM or IV
	OR Cefazolin or ceftriaxone	1 g IM or IV	50 mg/kg IM or IV
Allergic to penicillins or ampicillin—oral	Cephalexin ϕ δ	2 g	50 mg/kg
	OR Clindamycin	600 mg	20 mg/kg
	OR Azithromycin or clarithromycin	500 mg	15 mg/kg
Allergic to penicillins or ampicillin and unable to take oral medication	Cefazolin or ceftriaxone δ	1 g IM or IV	50 mg/kg IM or IV
	OR Clindamycin	600 mg IM or IV	20 mg/kg IM or IV

*IM: Intramuscular
 +IV: Intravenous
 ϕ Or other first- or second-generation oral cephalosporin in equivalent adult or pediatric dosage.
 δ Cephalosporins should not be used in an individual with a history of anaphylaxis, angioedema, or urticaria with penicillins or ampicillin.

Regimens for a Dental Procedure*

*Source: ADA Division of Legal Affairs, An Updated Perspective of Antibiotic Prophylaxis, *Journal of American Dental Association*. 2008; 139:10-21

