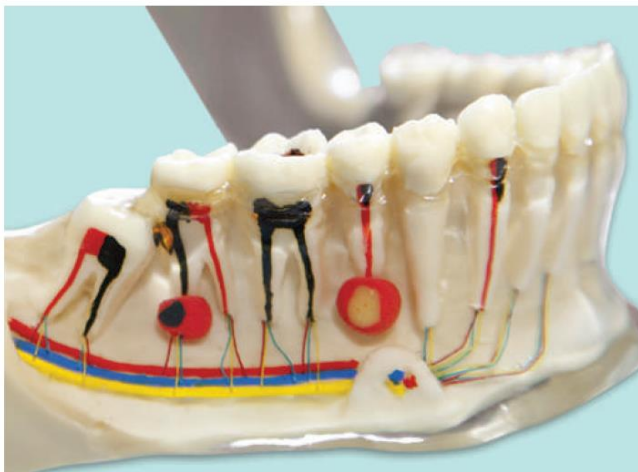


# Endodontics

## Lecture 1

### **Introduction and Scope of Endodontics**

The word "En" is of Greek origin, meaning "Inside," and "Odont" is derived from the Greek word for "Tooth." Endodontic treatment specifically focuses on the interior of the tooth. This specialized branch of clinical dentistry concerns itself with the prevention, diagnosis, and treatment of pathological conditions affecting the dental pulp and the tissues surrounding the tooth roots. In-depth knowledge of pulp biology, etiology, diagnosis, treatment, and prevention of pulp and periradicular tissue conditions is essential for studying Endodontics.



**Fig. 1.1** Model of teeth showing pulp along with endodontic lesions of the teeth.

*Figure 1: Anatomy of the root canal system*

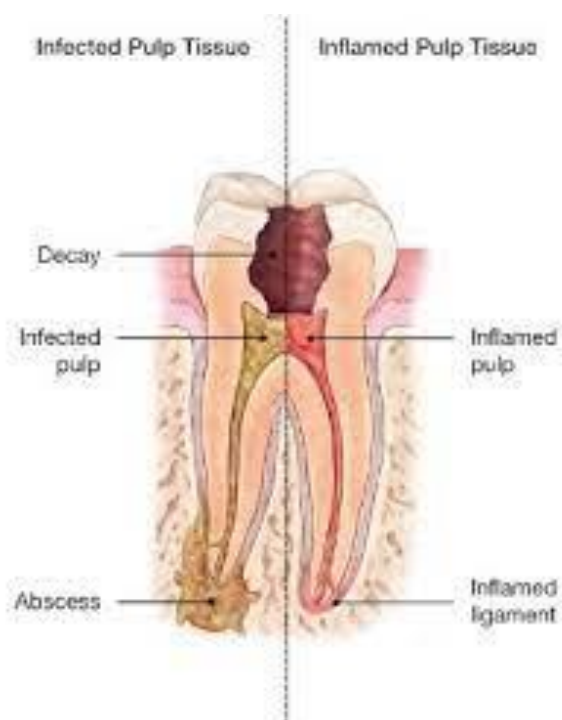
The main aim of endodontic therapy involves the prevention and treatment of periapical pathosis through the following processes:

- i. Maintain the vitality of the compromised pulp in vital teeth.
- ii. Preserve and restore the tooth with a necrotic pulp.
- iii. Preserve and restore the tooth with a periapical lesion.
- iv. Conserve and repair teeth that have not responded well to previous endodontic treatment (retreatment option), to maintain the tooth's functionality within the dental structure.

### **OBJECTIVE OF ENDODONTIC TREATMENT**

The primary objective of endodontic therapy is to create a biologically acceptable environment within the root canal system which allows for the healing and continued maintenance of the health of the peri-radicular tissue. This crucial objective can be effectively achieved by employing a comprehensive approach that involves the meticulous elimination of bacteria, which serve as the primary source of infection, from within the root canal system. This process encompasses thorough disinfection, targeting not only the coronal pulp chamber but also the intricate radicular part of the root canal system. Additionally, it is imperative to ensure the complete and reliable seal of the root canal and tooth, effectively preventing any potential re-infection.

It is important to note that the primary source of bacteria is typically attributed to dental caries initially. These carious lesions, deeply penetrating the tooth structure, progressively extend until they reach the pulp chamber, ultimately resulting in the dreaded infection of the pulp. Failing to promptly address and treat this infection would inevitably lead to the necrosis of the pulp. Consequently, the infection would then indiscriminately spread throughout the entire root canal space. This unchecked progression, if allowed to continue without intervention, would further advance into the periapical tissue. Ultimately, this sequence of events culminates in the infection of the bone in the periapical area, which is clinically referred to as apical periodontitis.



**Figure 2: Source of infection**

Endodontic treatment involves procedures that aim to preserve the health of the dental pulp and surrounding periapical tissues. When

the dental pulp is compromised, the goal is to maintain the normal peri-radicular tissues. Treatment also focuses on restoring peri-radicular tissues to health in cases of apical periodontitis, typically through root canal treatment, often combined with surgical endodontics.

## **SCOPE OF ENDODONTICS**

The scope of endodontics includes the following procedures:

1. Vital pulp therapy (pulp capping, pulpotomy)
2. Diagnosis and differential diagnosis of oro-facial pain.
3. Non-surgical Root canal treatment of teeth with or without periradicular pathology of pulpal origin.
4. Surgical Root canal treatment of teeth with or without periradicular pathology of pulpal origin.
5. Regenerative endodontics
6. Apexogenesis, and apexification
7. Management of avulsed teeth (replantation)
8. Endodontic implants
9. Root end resections, hemisections, and root resections
10. Retreatment of teeth previously treated endodontically
11. Bleaching of non-vital discolored teeth.
12. Coronal restorations of endodontically treated teeth using post and cores

## **INDICATIONS FOR ROOT CANAL TREATMENT**

Root canal treatment may be carried out on all patients where other dental procedures may be undertaken. Specific indications include:

1. Teeth that have irreversibly infected or necrotic pulp with or without apical periodontitis.
2. Elective devitalization is performed in cases where post space is needed before the construction of an overdenture when there is uncertainty about the health of the pulp before the restorative procedures, the potential for pulpal exposure when restoring a misaligned tooth, or before root resection or hemisection.

## **CONTRAINDICATIONS FOR ROOT CANAL TREATMENT**

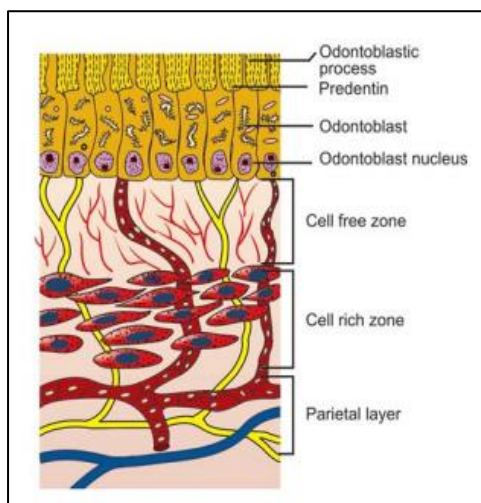
1. Teeth that cannot be made functional nor restored.
2. Teeth with insufficient periodontal support (loss of supporting bone due to periodontal infection).
3. Teeth with poor prognosis, uncooperative patients, or patients where dental treatment procedures cannot be undertaken.

4. Teeth of patients with a poor oral condition that cannot be improved within a reasonable period.

## **HISTOLOGY OF DENTAL PULP**

The dental pulp is the soft, mesenchymal tissue located at the center of the tooth. It is made up of specialized cells, including odontoblasts, which are arranged around the edges in direct contact with the dentin matrix. This close interaction between odontoblasts and dentin is referred to as the “pulp-dentine complex.” The pulp is a connective tissue system that includes cells, ground substance, fibers, interstitial fluid, odontoblasts, fibroblasts, and other cellular elements. It functions as a microcirculatory system with arterioles and venules serving as the major vascular components. Histologically, the pulp can be divided into four distinct zones, which are organized from the periphery to the center of the pulp, as illustrated in the figure below. The zones are:

- A. The odontoblastic layer at the pulp periphery:** Odontoblasts consist of cell bodies and cytoplasmic processes.
- B. Cell-free zone of Weil:** Central to odontoblasts is sub-odontoblastic layer, which contains plexuses of capillaries and small nerve fibers
- C. Cell-rich zone:** It contains fibroblasts, undifferentiated cells which maintain the number of odontoblasts by proliferation and differentiation
- D. Pulp core:** It contains large vessels and nerves from which branches extend to peripheral layers.



Contents of the pulp	
I. Cells	<ol style="list-style-type: none"> <li>1. Odontoblasts</li> <li>2. Fibroblasts</li> <li>3. Undifferentiated mesenchymal cells</li> <li>4. Defense cells <ul style="list-style-type: none"> <li>- Macrophages</li> <li>- Plasma cells</li> <li>- Mast cells</li> </ul> </li> </ol>
II. Matrix	<ol style="list-style-type: none"> <li>1. Collagen fibers <ul style="list-style-type: none"> <li>- Type I</li> <li>- Type II</li> </ul> </li> <li>2. Ground Substance <ul style="list-style-type: none"> <li>- Glycosaminoglycans</li> <li>- Glycoproteins</li> <li>- Water</li> </ul> </li> </ol>
III. Blood Vessels	- Arterioles, Venules, Capillaries
IV. Lymphatics	- Draining to submandibular, submental and deep cervical nodes
V. Nerves	<ul style="list-style-type: none"> <li>- Subodontoblastic plexus of Raschkow</li> <li>- Sensory afferent from Vth nerve and Superior cervical ganglion</li> </ul>

*Figure 3: Zones of the pulp*

## **ANATOMY OF DENTAL PULP**

The pulp is situated in the center of the tooth and takes on a miniature version of the tooth's shape. This area, known as the pulp cavity, is divided into two main parts: the pulp chamber and the root canals, which extend from the orifice to the apical foramen. Additionally, there may be accessory and lateral canals present. The roof of the pulp chamber is formed by dentin, which covers the pulp chamber from the occlusal surface. Canal orifices are openings in the floor of the pulp chamber that lead into the root canals. The configuration of the root canals varies depending on the size, shape, and number of the roots in different teeth.

## **FUNCTIONS OF PULP**

The pulp performs four basic functions:

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

## **ROOT CANAL CONFIGURATION**

The configuration of root canals is divided into four types:

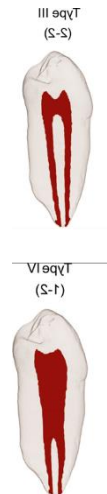
**Type 1:** A single canal leaving the pulp chamber and continuing as a single canal to the root apex and opening in a single apical foramen. It refers to **1-1**



**Type 2:** Two canals leave the pulp chamber and then join each other at the apical third to open in a single apical foramen. It refers to **2-1**



**Type 3:** Two canals leave the pulp chamber and continue as two canals to be opened in two separate apical foramina. It refers to **2-2**



**Type 4:** A single canal leaving the pulp chamber, bifurcating at the apical third into two canals and opening in two apical foramina. It refers to **1-2**

## **BASIC PHASES OF TREATMENT**

There are three basic phases of treatment:

- 1- The Diagnostic phase in which the disease to be treated is “determined “and the treatment plan developed.
- 2- The Preparatory phase in which the contents of the root canal are removed and the canal is prepared to receive a filling material.
- 3- The obliteration Phase in which the canal is filled or obliterated with an inert material to obtain an adequate seal as close as possible to C.D.J. (cemento-dentinal junction).

If there is a defect in any phase, the endodontic treatment will not be succeeded.

## **PULP AND PERI-RADICULAR PATHOLOGY**

The etiology of pulpal diseases can be broadly classified into:

### **I. Bacterial irritant**

Bacteria, usually from dental caries, are the main source of injury to the pulpal and periradicular tissues and they enter either directly or through dentine tubules.

Modes of entry for bacteria to the pulp are as follows (Figure 4):

- 1- Through the carious cavity.
- 2- Through the dentinal tubules as in contamination during cavity preparation, through exposed root surface, and surfaces with erosion, abrasion and attrition.

- 3- Through the apical foramen as in advanced periodontitis where microorganisms reach the apical foramen and then the pulp.
- 4- Through the bloodstream (anachoresis: it is a process by which microorganisms get carried by the bloodstream from another source and localize on inflamed tissue).
- 5- Through faulty tooth restoration.
- 6- Through the extension of a periapical infection from the adjacent infected tooth.

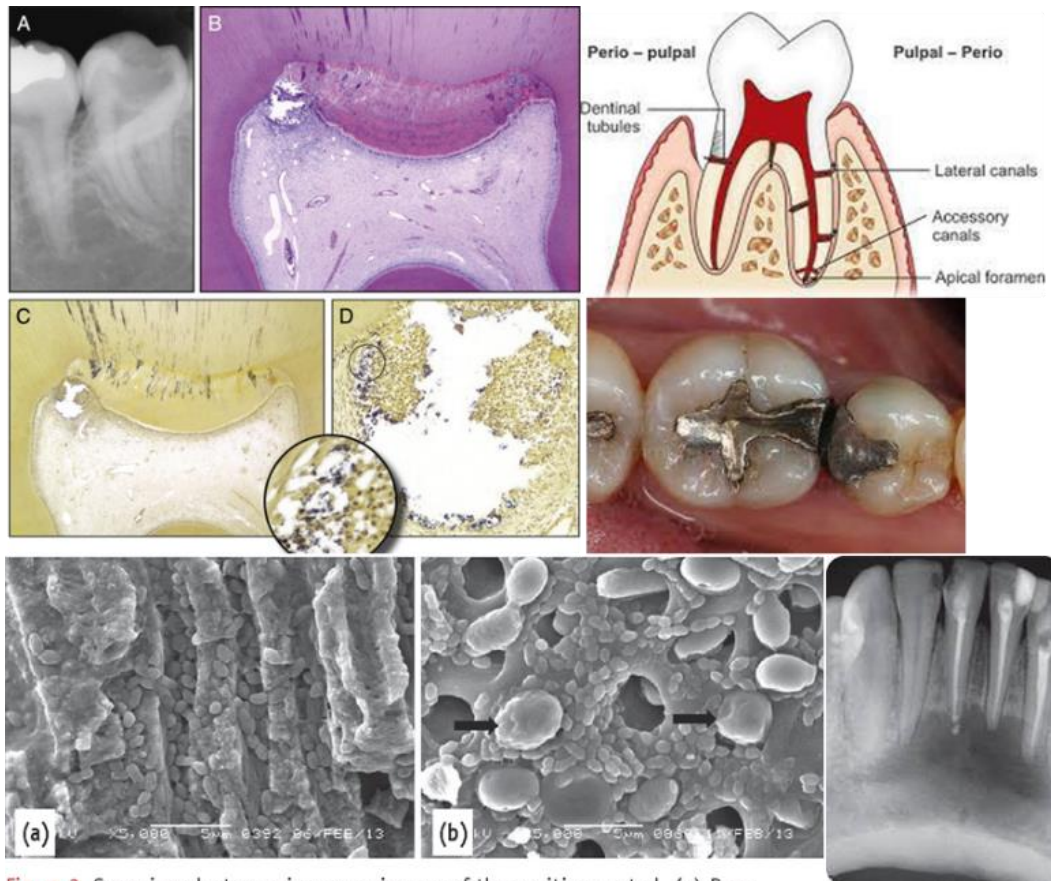


Figure 3: Scanning electron microscope images of the positive control. (a) Deep

Figure 4: Modes of entry of Bacteria

Bacteria most often recovered from infected vital pulps are:

- Streptococci
- Lactobacillus
- Fusibacterium, etc.

## II. Mechanical irritants

Examples of mechanical irritation include trauma, dental procedures, excessive orthodontic forces, subgingival scaling, and over-instrumentation with root canal tools.

### **III. Chemical irritants**

Pulpal irritation can be caused by bacterial toxins or certain restorative materials and conditioning agents. Peri-radicular irritation may arise from irrigating solutions, phenol-based intra-canal medicaments, or the extrusion of root canal filling materials.

### **IV. Radiation injury to the pulp**

Radiation therapy affects the pulps of fully formed teeth in patients exposed to radiation therapy. The pulp cells exposed to ionizing radiation may become necrotic, and there may occur vascular damage and the interference in mitosis of cells.

## **Diagnosis in Endodontics**

### **Chief Complaint**

Patient usually complains of pain on biting, pain with swelling, pus discharge, etc.

### **Dental History**

Patient gives history of recurring episodes of pain and sometimes swelling with discharge.

### **Extraoral examination**

General appearance, skin tone, facial asymmetry, swelling, extraoral sinus, sinus tract, tender or enlarged cervical lymph nodes.

### **Intraoral examination**

It includes examination of soft tissues and teeth to look for discoloration, abrasion, caries, restoration, etc.

### **Clinical Tests**

- 1- **Percussion** Indicates inflammation of periodontium. Palpation Determines how far the inflammatory process has extended periapically.
- 2- **Pulp vitality** Thermal tests which can be heat or cold, Electrical pulp testing
- 3- **Probing**: Determines the level of connective tissue attachment. Probe can penetrate into an inflammatory periapical lesion that extends cervically.
- 4- **Mobility**: Determines the status of periodontal ligament.



- 5- **Radiography:** help to illustrate the loss of lamina dura apically. And Radiolucency at apex.
- 6- **Palpation:** help detect the spread of infection from periapical area into the cortical bone and soft tissue.

### **Classification of Pulp and periapical Diseases**

Diagnosis of pulp and periapical disease is usually based on patient symptoms and clinical findings.

### **Pulpal disease**

Pathological conditions of the pulp can be classified into the following:

- 1- ***Reversible pulpitis (Pulpal Hyperaemia):*** A mild-to-moderate inflammatory condition of the pulp, induced by harmful stimuli, where the pulp can return to a normal state after the removal of these stimuli, is known as reversible pulpitis. Determining whether the pulp is reversible involves clinical judgment, taking into account the patient's history and clinical evaluation. Causes of reversible pulpitis include dental caries, trauma, deep restorations, and thermal or chemical injuries.

#### **Symptoms:**

- Sharp momentary pain caused by cold.
- Pain is not a spontaneous and needs an external stimulus and it subsides immediately after the removal of the stimulus.
- Normal periradicular radiographic appearance on X-ray radiograph.
- Teeth are not tender to percussion but sensitive to a cold stimulus.

**Treatment** involves covering up exposed dentine, removing the stimulus, or dressing the tooth.

- 2- ***Irreversible pulpitis:*** Irreversible pulpitis is a persistent inflammatory condition of the pulp, either symptomatic or asymptomatic, caused by harmful stimuli. It can present in both symptomatic and asymptomatic stages. This condition typically results from more severe insults than reversible pulpitis and may develop as a progression from a reversible state. Histologically, pulp with irreversible inflammation is distinguished by the presence of liquefaction necrosis, in contrast to pulp with reversible inflammation. Irreversible pulpitis is classified into:

a) Symptomatic Irreversible pulpitis (previously known as acute irreversible pulpitis).

This condition is usually associated with acute symptoms which include

- Severe pain develops spontaneously or from stimuli that may last from minutes to hours after exposure to cold or hot stimuli. which is sharp, throbbing, intermittent, or continuous
- Pain exacerbated on bending down or lying down due to change in intrapulpal pressure from stand to supine.
- Pain is so severe that it keeps the patient awake at the night.
- Presence of referred pain
- In later stage, Heat stimulus increases pain due to the expansion of blood vessels, therefore, increasing pressure in the pulp.
- Cold stimulus decreases pain due to contractile action on the blood vessels, therefore, lowering intrapulpal pressure
- Not tender to percussion and normal radiographic apical region in early stage.
- a widened periodontal ligament may be seen radiographically in the later stages.

**Treatment** involves either pulpectomy (removal of the infected pulp) followed by a root canal filling or extraction of the tooth.

b) Asymptomatic irreversible (previously known as chronic irreversible pulpitis).

After the acute phase, the pulp **might** enter the chronic phase. The symptoms experienced are:

- Mild to moderate intermittent pain may be tolerated by the patient for a long period.
- Thermal tests are of little value.
- Tenderness to percussion and radiographic changes are not seen until infection reaches the periapical region.

Treatment involves either root canal therapy or extraction of the tooth.

c) Hyperplastic pulpitis: Hyperplastic pulpitis is a form of irreversible chronic pulpitis and is also known as a **pulp polyp**. It is an inflammatory response of pulpal connective tissue due to extensive carious exposure to young pulp. It shows the overgrowth of granulomatous tissue into the carious cavity. It is commonly seen in the teeth of children and adolescents because this pulp

tissue has high resistance and large carious lesions permit a free proliferation of hyperplastic tissue.

Symptoms include: It is usually asymptomatic, and fleshy pulpal tissue fills the pulp chamber. It is less sensitive than normal pulp but bleeds easily due to a rich network of blood vessels. Sometimes this pulpal growth interferes with chewing.

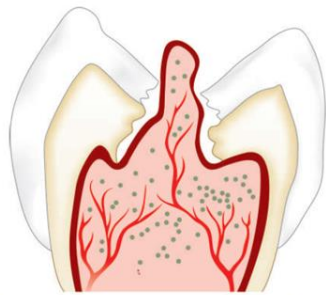


Fig. 3.16 Schematic representation of hyperplastic form of chronic pulpitis.



d) Internal resorption: Internal resorption begins within the pulp cavity and leads to the loss of dentinal tissue. While the exact cause is often unknown, pulpal inflammation can sometimes trigger changes that stimulate dentinoclastic activity, resulting in dentin resorption. Clinically, internal resorption is usually asymptomatic unless it leads to root perforation. In advanced cases, a pink spot may become visible on the crown of the tooth. Radiographic examination typically shows a radiolucency that appears continuous with the pulp cavity. Root canal therapy can halt the resorptive process, but if the damage is extensive, extraction may be necessary.

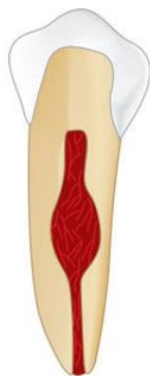


Fig. 3.18 Schematic representation of ballooning of pulpal cavity showing internal resorption of the tooth.



**3- Pulp necrosis:** Pulp necrosis, or the death of the pulp, occurs as a consequence of untreated pulpitis. In this condition, the pulpal tissue becomes nonvital, and if left untreated, harmful substances can leak from the pulp space, leading to the development of an endodontic lesion. Symptoms may include:

- The tooth might be asymptomatic.
- Discoloration of the tooth due to bleeding from the pulp into the dentin.
- Radiographic findings may show a large cavity or restoration, or appear normal unless accompanied by apical periodontitis or condensing osteitis.

Treatment options include root canal therapy or extraction.

**4- Pulp calcification:** In which part of the pulp tissue is replaced by calcific material,  
Mainly three types of calcifications are seen in pulp:

- **Dystrophic calcifications:** the foci of these calcifications can begin in dead and degenerated tissue, blood clots, connective tissue walls of blood vessels, and nerves of the pulp because of the inflammation. They occur in minute areas of young pulp affected by minor circulatory disturbances, in blood clots, or around a single degenerated cell. They can also begin in the connective tissue walls of blood vessels and nerves and follow their course.
- **Diffuse calcifications:** these are usually linear calcification present in the root canal.
- **Denticles/pulp stones:** they are present in the pulp chamber and can be classified according to location as either a freestone, embedded stone in dentin, or an attached stone. Also, pulp stones can be classified according to structure into:
  - ✓ True denticle: It is composed of dentin formed from detached odontoblasts or fragments of Hertwig's enamel root sheath which stimulates the undifferentiated cells to assume dentinoblastic activity.
  - ✓ False denticle: Here degenerated tissue structures act as a nidus for deposition of concentric layers of calcified tissues.



Fig. 3.22 Radiograph showing pulp stone in pulp chamber of mandibular first molar.

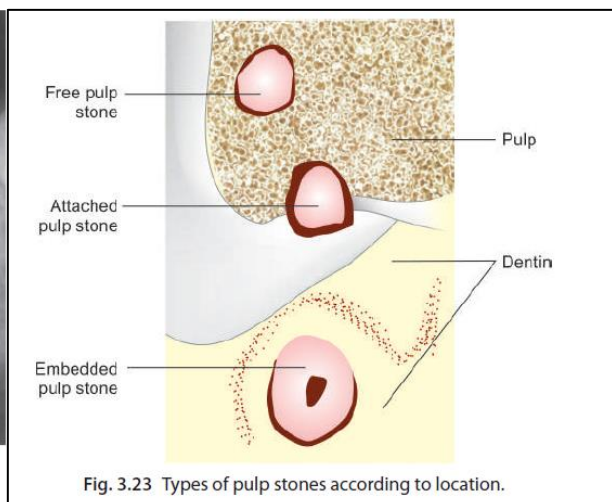


Fig. 3.23 Types of pulp stones according to location.