Oral Histology

Lect 8 **The Pulp** **Dr. Enas Fadhil Kadhim**

The dental pulp occupies the center of each tooth and consists of soft connective tissue. The pulp is housed in the pulp chamber of the crown and in the root canal of the root. The pulp present in the crown is called coronal pulp and the pulp present in the root is called radicular pulp. The shape of the pulp therefore resembles the shape of the tooth in which it is housed.

Coronal pulp

The coronal pulp in young individuals resembles the shape of the outer surface of the crown dentin. The coronal pulp has six surfaces: the roof or occlusal, the mesial, the distal, the buccal, the lingual, and the floor. It has pulp horns, which are protrusions that extend into the cusps of each crown. The number of these horns thus depends on the cuspal number. The cervical region of the pulp organs constricts as does the contour of the crown, and at this zone the coronal pulp joins the radicular pulp. Because of continuous deposition of dentin, the pulp becomes smaller with age.

Radicular pulp

The radicular or root pulp is that pulp extending from the cervical region of the crown to the root apex. In the anterior teeth the radicular pulps are single and in posterior ones multiple. They are not always straight and vary in size, shape, and number. The radicular portions of the pulp are continuous with the periapical connective tissues through the apical foramen or foramina. The dentinal walls taper, and the shape of the radicular pulp is tubular. During root formation the apical root end is a wide opening limited by an epithelial diaphragm .

As growth proceeds, more dentin is formed, so that when the root of the tooth has matured the radicular pulp is narrower. The apical pulp canal becomes smaller also because of apical cementum deposition.

Apical foramen

The location and shape of the apical foramen may undergo changes as a result of functional influences on the teeth. A tooth may be tipped from horizontal pressure, or it may migrate mesially, causing the apex to tilt in the opposite direction. Under these conditions the tissues entering the pulp through the apical foramen may exert pressure on one wall of the foramen, causing resorption. At the same time, cementum

is laid down on the opposite side of the apical root canal, resulting in a relocation of the original foramen .
Sometimes the apical opening is found on the lateral side of the apex, although the root itself is not curved.
Frequently, there are two or more foramina separated by a portion of dentin and cementum or by cementum only.

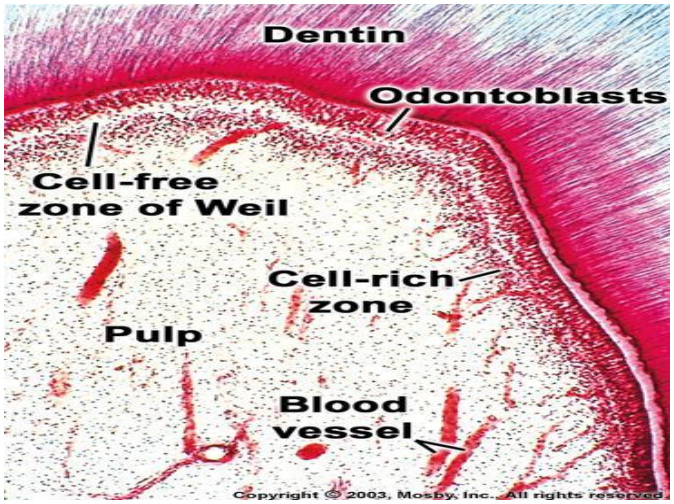
Accessory canals

Accessory canals leading from the radicular pulp laterally through the root dentin to the periodontal tissue may be seen anywhere along the root but are most numerous in the apical third of the root. They are clinically significant in spread of infection, either from the pulp to the periodontal ligament or vice versa. It is likely that they occur in areas where there is premature loss of root sheath cells because these cells induce the formation of the odontoblasts which form the dentin. Accessory canals may also occur where the developing root encounters a blood vessel. If the vessel is located in the area where the dentin is forming, the hard tissue may develop around it, making a lateral canal from the radicular pulp.

STRUCTURAL FEATURES

The central region of both the coronal and the radicular pulp contains large nerve trunks and blood vessels. Peripherally, the pulp is circumscribed by the specialized odontogenic region composed of

(1) the odontoblasts (the dentin-forming cells).
(2) the cell-free zone (Weil's zone):is a space in which the odontoblast may move pulpward during tooth development
(3) the cell-rich zone : composed principally of fibroblasts and undifferentiated mesenchymal cells is restricted to the coronal regions, as it is formed during the pre-eruptive phase of the tooth. During early dentinogenesis there are also many young collagen fibers in this zone.
(4) pulp core which is characterized by the major vessels and nerves of the pulp.



Intercellular substance

The intercellular substance is dense and gel like in nature, varies in appearance from finely granular to fibrillar, and appears more dense in some areas, with clear spaces left between various aggregates. It is composed of both acid mucopolysaccharides and protein polysaccharide compounds (glycosaminoglycans and proteoglycans).

The cells of Pulp

1-Fibroblasts

The pulp organ is said to consist of specialized connective tissue because it lacks elastic fibers. Fibroblasts are the most numerous cell type in the pulp. They functionin collagen fiber formation throughout the pulp during the life of the tooth. They have the typical stellate shape and extensive processes that contact and are joined by intercellular junctions to the processes of other fibroblasts.

2-Odontoblasts

the second most prominent cell in the pulp,
reside adjacent to the predentin with cell bodies in the pulp and cell processes in the dentinal tubules. The number of odontoblasts corresponds to the number of dentinal tubules.
They have a constant location adjacent to the predentin, in what is termed the “odontogenic zone of the pulp”. The cell bodies of the odontoblasts are columnar in appearance with large oval nuclei, which fill the basal part of the cell. Immediately adjacent to the nucleus basally is rough-surfaced endoplasmic reticulum and the Golgi apparatus. The cells in the odontoblastic row lie very close to each other. Between odontoblasts gap, tight and desmosomal junctions exist. Further toward the apex of the cell appears an abundance of rough-surfaced endoplasmic reticulum. Near the pupal-predentin junction the cell cytoplasm

is devoid of organelles. Focal junctional complexes are present where the odontoblast cell body gives rise to the process. During the early period of active dentinogenesis it does contain occasional mitochondria and vesicles. During the later stages of dentinogenesis these are less frequently seen.

3-Undifferentiated mesenchymal cells

Undifferentiated mesenchymal cells are the primary cells in the very young pulp, but a few are seen in the pulps after root completion. They are found along pulp vessels, in the cell-rich zone and scattered throughout the central pulp.

They appear spindle shaped. They are believed to be a totipotent cell and when need arises they may become odontoblasts, fibroblasts, or macrophages. They decrease in number in old age.

4-**Defense cells**

These are histiocytes or macrophages, dendritic cells, mast cells, and plasma cells.

In addition, there are the blood vascular elements such as the neutrophils, eosinophils, basophils, lymphocytes, and monocytes. These latter cells emigrate from the pulpal blood vessels and develop characteristics in response to inflammation.

5-Pulpal stem cells

Among the numerous stem cells that have been identified from dental tissues and characterized, those from the pulpal tissues include dental pulp stem cells (DPSCs) and stem cells from human exfoliated deciduous teeth (SHED). The stem cells were shown to undergo proliferation and migrate to the site of injured odontoblasts and produce dentin.

Blood vessels

The pulp organ is extensively vascularized. It is known that the blood vessels of both the pulp and the periodontium arise from the inferior or superior alveolar artery and also drain by the same veins in both the mandibular and maxillary regions. The communication of the vessels of the pulp with the periodontium, in addition to the apical connections, is further enhanced by connections through the accessory canals. These relationships are of considerable clinical significance in the event of a potential pathologic condition in either the periodontium or the pulp, because the infection has a potential to spread through the accessory and apical canals.

Small arteries and arterioles enter the apical canal and pursue

a direct route to the coronal pulp . Along their course they give off numerous branches in the radicular pulp that pass peripherally to form a plexus in the odontogenic region

Nerves

The abundant nerve supply in the pulp follows the distribution of the blood vessels. The majority of the nerves that enter the pulp are nonmyelinated. Many of these gain a myelin sheath later in life. The nonmyelinated nerves are found in close association with the blood vessels of the pulp and many are sympathetic in nature. They have terminals on the muscle cells of the larger vessels and function in vasoconstriction .

Thick nerve bundles enter the apical foramen and pass along the radicular pulp to the coronal pulp where their fibers separate and radiate peripherally to the parietal layer of nerves.The large myelinated fibers mediate the sensation of pain that may be caused by external stimuli. The peripheral axons form a network of nerves located adjacent to the cell-rich zone. This is termed the parietal layer of nerves, also known as the plexus of Raschkow.

FUNCTION OF PULP

1-Inductive

The primary role of the pulp anlage is to interact with the oral epithelial cells, which leads to differentiation of the dental lamina and enamel organ formation. The pulp anlage also interacts with the developing enamel organ as it determines a particular type of tooth.

2-Formative

The pulp organ cells produce the dentin that surrounds and protects the pulp. The pulpal odontoblasts develop the organic matrix and function in its calcification. Through the development of the odontoblast processes, dentin is formed along the tubule wall as well as at the pulp–predentin front.

3-Nutritive

The pulp nourishes the dentin through the odontoblasts and their processes and by means of the blood vascular system of the pulp.

4-Protective

The sensory nerves in the tooth respond with pain to all stimuli such as heat, cold, pressure, operative cutting procedures, and chemical agents. The nerves also initiate reflexes that control circulation in the pulp. This sympathetic function is a reflex, providing stimulation to visceral motor fibers terminating on the muscles of the blood vessels.

5-Defensive or reparative

The pulp is an organ with remarkable reparative abilities.
It responds to irritation, whether mechanical, thermal, chemical, or bacterial, by producing reparative dentin and mineralizing any affected dentinal tubules.

REGRESSIVE CHANGES (AGING)

1-Cell changes

In addition to the appearance of fewer cells in the aging pulp, the cells are characterized by a decrease in size and number of cytoplasmic organelles.

The fibroblasts in the aging pulp exhibit less perinuclear cytoplasm and possess long, thin cytoplasmic processes.

2-Fibrosis

In the aging pulp accumulations of both diffuse fibrillar components as well as bundles of collagen fibers usually appear.
Fiber bundles may appear arranged longitudinally in bundles in the radicular pulp, and in a random more diffuse arrangement in the coronal area. Any external trauma such as dental caries or deep restorations usually causes a localized fibrosis or scarring effect.

3-Vascular changes

Vascular changes occur in the aging pulp organ as they do in any organ. Atherosclerotic plaques may appear in pulpal vessels.
In other cases the outer diameter of vessel walls becomes greater as collagen fibers increase in the medial layer.
Also calcifications are found that surround vessels .
Calcification in the walls of blood vessels is found most often in the region near the apical foramen. The capillary endothelium shows changes due to age. The endothelium in the elderly shows numerous pinocytic vesicles, microvesicles and microfilaments.
In addition lipid like vacuoles and glycogen granules are present.
Blood flow decreases with age.

Pulp stones (denticles)

Pulp stones, or denticles, are nodular, calcified masses appearing in either or both the coronal and root portions of the pulp organ. They often develop in teeth that appear to be quite normal in other respects. They usually are asymptomatic unless they impinge on nerves or blood vessels. They have been seen in functional as well as embedded unerupted teeth.

Pulp stones are classified, according to their structure as true denticles or **false denticles**.

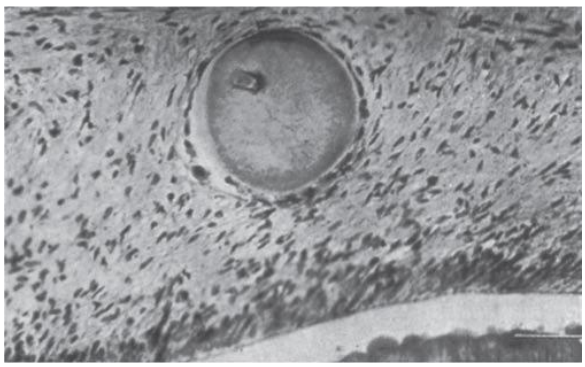
1-True denticles are similar in structure to dentin in that they have dental tubules and contain the processes of the odontoblasts that formed them and that exist on their surface . True denticles are comparatively rare and

are usually located close to the apical foramen. A theory has been advanced that the development of the true denticle is caused by the inclusion of remnants of the epithelial root sheath within the pulp. These epithelial remnantsinduce the cells of the pulp to differentiate into odontoblasts, which then form the dentin masses called true pulp stones.

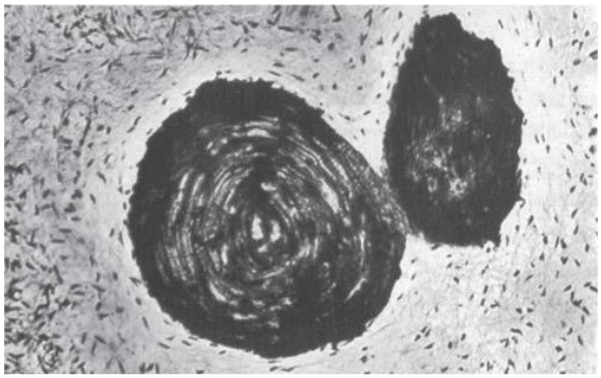
2-False denticles do not exhibit dentinal tubules but appear instead as concentric layers of calcified tissue. In some cases these calcification sites appear within a bundle of collagen fibers . Other times they appear in a location in the pulp free of collagen accumulations . In the center of these concentric layers of calcified tissue there may be remnants of necrotic and calcified cells. Calcification of thrombi in blood vessels, called phleboliths, may also serve as nidi for false denticles. All denticles begin as small nodules but increase in size by incremental growth on their surface. The surrounding pulp tissue may appear quite normal. Pulp stones may eventually fill substantial parts of the pulp chamber.

3-Diffuse calcifications

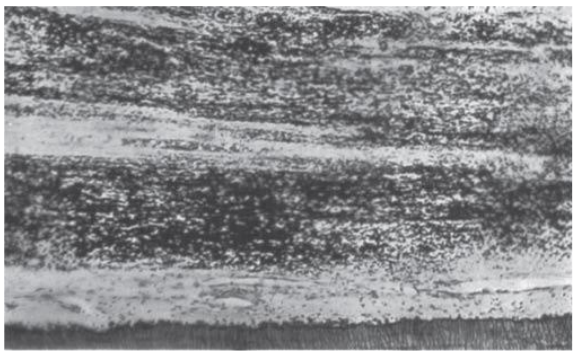
Diffuse calcifications appear as irregular calcific deposits in the pulp tissue, usually following collagenous fiber bundles or blood vessels . Sometimes they develop into larger masses but usually persist as fine calcified spicules. The pulp organ may appear quite normal in its coronal portion without signs of inflammation or other pathologic changes but may exhibit these calcifications in the roots. Diffuse calcifications are usually found in the root canal and less often in the coronal area, whereas denticles are seen more frequently in the coronal pulp. Diffuse calcification surrounds blood vessels.



True Denticles



False Dentricles



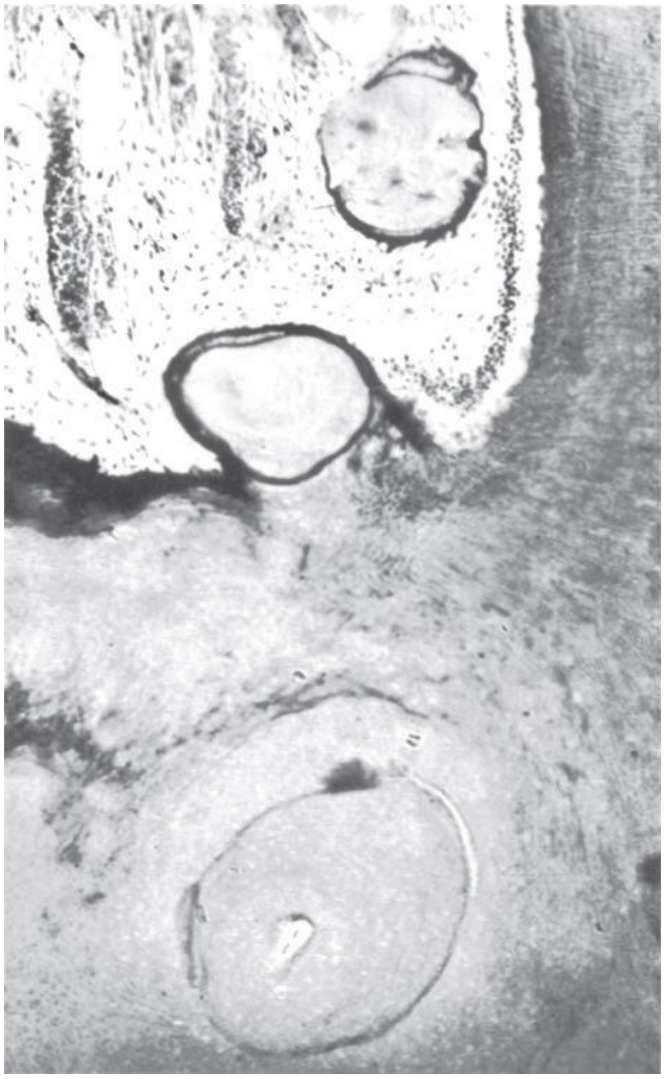
Diffuse Calcification

Pulp stones may also be classified according to their location as **free**, **attached**, or **embedded**, depending on their relation to the dentin of the tooth.

1-The free denticles are entirely surrounded by pulp tissue,

2-attached denticles are partly fused with the dentin**,**

3-embedded denticles are entirely surrounded by dentin.



Free Denticles

Attached Dentricles

Embbedd Denticles