Periodontics

Lec. 2

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Junctional epithelium

The junctional epithelium is that epithelium which lies at, and in health also defines, the base of the ging.sulcus. It attaches to the surface of the tooth by way of the *(EA) epithelium attachment* with hemidesmosomes and is, on average, roughly 1 mm in width in theapicocoronal dimension, constituting about one half of the biologic width. The attachment of the JE to the tooth surface can occur on enamel, cementum, or dentin. The position of the EA on the tooth surface is initially on the cervical half of the anatomical crown when the tooth first becomes functional after tooth eruption.
The junctional epithelium, a nonkeratinized stratified squamous epithelium, lies imme diately apical to the Sulcular epithelium, which lines gingival sulcus from the base to the free gingival margin , where it interfaces with the epithelium of the oral cavity.
Cells in the junctional epithelium tend to have wide intercellular spaces and fewer desmosomal junctions, to allow the transmission of white.blood.cells from lamina properia's bloodvessels to the bottom of the gingival sulcus, to help prevent disease.
In addition, the JE is alsothinner than the sulcular epithelium, ranging coronally from only 15 to 30 cells thick at the floor of the gingival sulcus, and then tapering to afinal thickness of 3 to 4 cells at its apical part. The superficial, or suprabasal, cells of the JE serve as part of the EA of gingiva to the toothsurface. These superficial, or suprabasal, epithelial cells of the JE provide the hemidesmosomes and an internal basal lamina that create the EA, because this is a cell to no cellular type of intercellular junction.
The structure of the EA is similar to that of the junction between theepithelium and subadjacent connective tissue; the internal basal lamina consists of a lamina lucida and lamina densa.\Nor does JE mature on a lesser level like nonkeratinized tissue of the sulcular gingiva and throughout the rest of the oral cavity, whichenlarges its cells as they mature and migrate superficially. The JE cells do not mature and form into a granular layer or intermediate layer.Without a keratinizing superficial layer at the free surface of the JE, there is no physical barrier to microbial attack. Other structural and functional characteristics of the JE must compensate for the absence of this barrier.
The JE fulfills this difficult task with its special structural framework and the collaboration of its epithelial and nonepithelial cells that provide very potent antimicrobial mechanisms, such as the whiteblood cells. However, these defense mechanisms do not preclude thdevelopment of extensive inflammatory lesions in the gingival tissue,and, occasionally, the inflammatory lesion may eventually progress to the loss of bone and the connective tissue attachment to the tooth.
The JE cells have many organelles in their cytoplasm, such as rough endoplasmic reticulum, Golgi complex, and mitochondria, indicating ahigh metabolic activity. However, the JE cells remain immature or undierentiated until they die and are shed or lost in the gingival sulcus.Lysosomes are also found in large numbers in JE cells; enzymes contained within these lysosomes participate in the destruction of bacteria contained in dental biofilm.

Characteristic features of junctional epithelium:

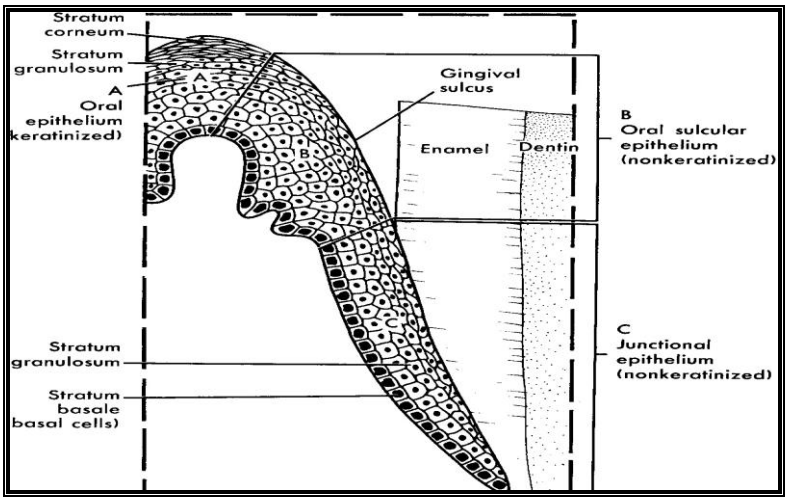
1) The JE has a free surface at the bottom of gingival sulcus.

2) Like the OE and SE the JE is continuously renewed by cell division in the basal layer.
3) The cells of JE are flattened with their long axis parallel to the tooth surface

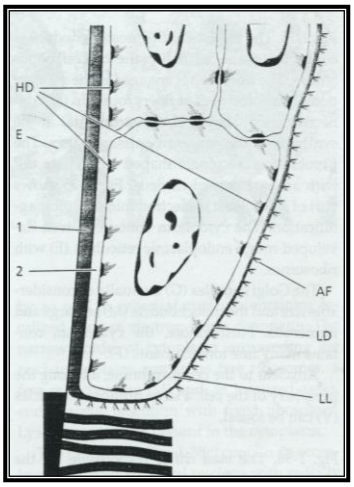
The attachment of JE to the tooth is reinforced by the gingival fibers, which brace the marginal gingiva against the tooth surface. For this reason, the JE and the gingival fibers are considered a functional unit, referred to as the dentogingival unit.

***<u>There are differences between the SE, OE and JE</u>*:**

1) The size of the cells of the JE is larger than in the oral epithelium.
2) The intercellular space in the JE is wider than in the OE.
3) The number of desmosomes is smaller in JE than in the OE.
4) The SE and JE are not thick as OE, because they are not keratinized and in health have no rete pegs.
5) JE turnover is very high (4-6 days) compared to OE that has longest turnover rate (6-12 days or up to 40 days).
6) JE forms the attachment of the gingiva to the tooth surface while OE and SE have no attachment to the tooth surface.

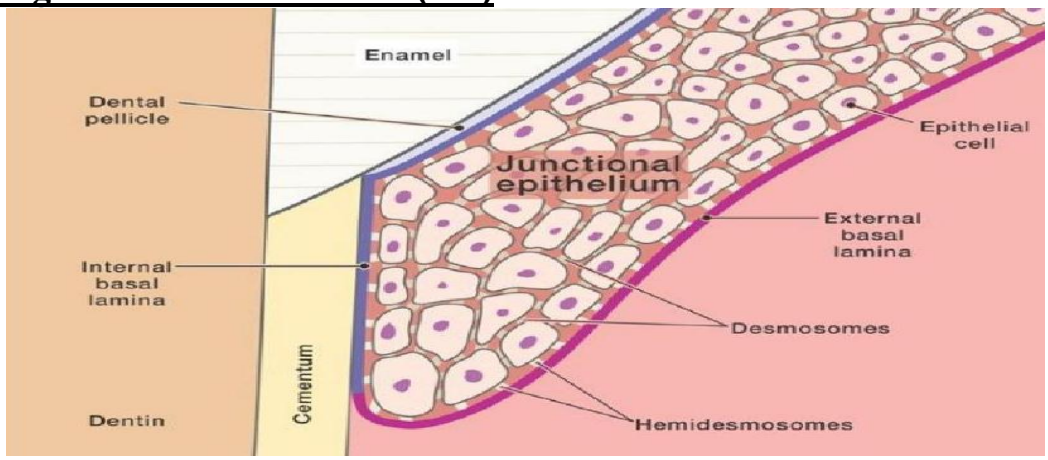


Under higher magnification, the basal cells of the JE are not in direct contact with enamel. Between the enamel and JE there are two zones; electron- dense zone and electron-lucent zone. The electron- lucent zone is in contact with the cells of JE. These two zones have a structure very similar to that of the lamina densa and lamina lucida in the basement membrane area at the epithelium (JE-CT interface).



The cell membrane of the JE harbors hemidesmosomes towards the enamel as it does towards the connective tissue so that the interface between the enamel and JE is similar to the interface between the epithelium and C.T

Gingival Connective tissue. (CT):



The predominant tissue component of the gingiva and periodontal ligament is the CT. Collagen fibers constitute the major components of the CT (around 60%), fibroblasts (around 5%), vessels, nerves and matrix (around 35%).

Cells of the CT:

1) ***Fibroblast****: is the most predominant cell. It's engaged in the production of various types of fibers of CT and synthesis of CT matrix.*
2) ***The mast cell****: produces certain components of the matrix and produces vasoactive substances that control the blood flow through the tissue.*
3) ***The macrophage****: has a phagocytic and synthetic function, macrophage is derived from blood monocytes and present particularly in inflamed tissue.*
4) ***Inflammatory cells****: include neutrophilic granulocytes (polymorphoneuclear leukocytes), lymphocytes and plasma cells. All these cells are involved in defense mechanism.*

Fibers of CT:

1) **The collagen fibers**: predominate in the gingival CT and constitute the major components of the periodontium.Collagen fibers are produced mainly by fibroblasts but they are also may be produced by cementoblasts and osteoblasts. The collagen fibers are bundles of collagen fibrils and these fibers in the tissue arranged in bundles.
2) **Reticulin fibers**: they are numerous near the basement membrane and surround the blood vessels.
3) **Oxytalan fibers**: present in gingiva and PDL and composed of long thin fibrils parallel to the long axis of the tooth in PDL. The function of these fibers is as yet unknown.
4) **Elastic fibers**: in the gingiva and PDL are only present in blood vessels.

The gingival fibers have the following functions:
1. To brace the marginal gingiva firmly against the tooth
2. To provide the rigidity necessary to withstand the forces of mastication without being deflected away from the tooth surface
3. To unite the free marginal gingiva with the cementum of the root and the adjacent attached gingiva.

Classification of gingival fibers:

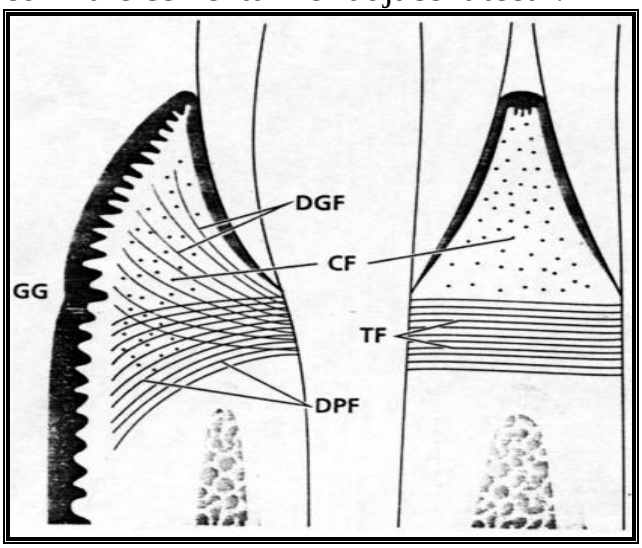
According to their insertion and course in the tissue the gingival fibers can be divided into the following groups:

1) **Circular fibers** (CF): are fibers encircling the tooth and run their course in the free gingiva.

2) **Dentogingival fibers** (DGF): are embedded in the cementum of supra- alveolar portion and project in a fan-like configuration out into free gingival tissue of the facial, lingual and interproximal surfaces.

3) **Dentoperiosteal fibers** (DPF): are embedded in the cementum (the same portion of DGF) but run apically over the crest of the bone and terminate in the tissue of the attached gingiva.

4) **Transseptal fibers** (TF): run straight across the interdental septum and are embedded in the cementum of adjacent teeth.



Matrix of the CT:

Matrix is produced by fibroblast, but although some constituents are produced by mast cells and blood. The matrix is the medium in which the CT cells are embedded and the transportation of water, electrolytes, nutrients, etc, to and from the individual CT cells occurs within matrix.

Periodontal ligament (PDL):

Is the soft, richly vascular and cellular CT which surrounds the roots of the teeth and joins the root cementum with the lamina dura or alveolar bone proper. Coronally the PDL is continuous with the lamina

properia of the gingiva and separated from the gingiva by the collagen fiber bundles which connect the alveolar bone crest with the root (the alveolar crest fibers). The PDL space has a narrowest area at the mid-root level. The width of PDL is approximately 0.25 mm.

Fibers of PDL:

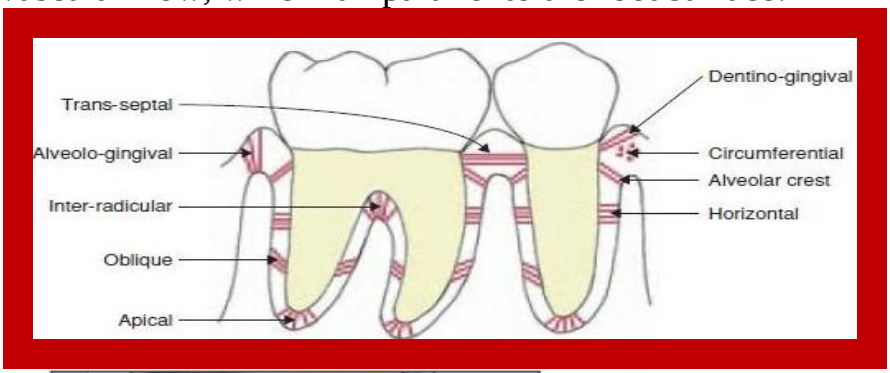
A. Majority of fibers in PDL are **collagen fibers** and are called "Principals fibers of PDL" which arranged in bundles and follow a wavy or **S** – shaped course

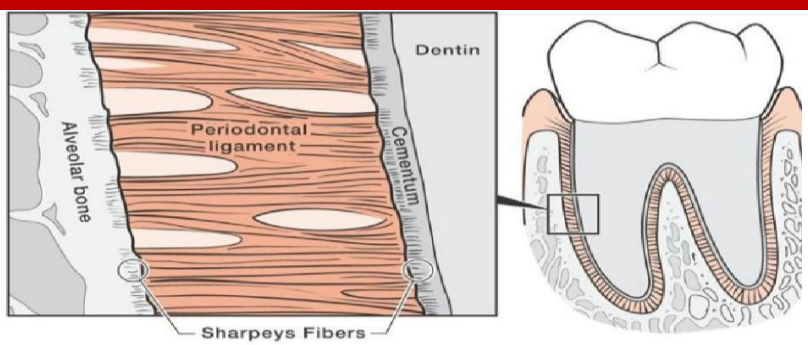
The principals fibers of PDL are arranged in five groups as follow:

1. ***Alveolar crest fibers (ACF):*** run obliquely from the cementum to crest of alveolar bone below the JE and function prevent the extrusion of the toot and resist lateral tooth movements
2. ***Horizontal fibers (HF):*** extend at right angle with the long axis of the tooth from cementum to the alveolar bone. The function is resistance to lateral forces.
3. ***Oblique fibers (OF):*** run obliquely from the cementum to the alveolar bone. They represent the largest group of PDL fibers. They withstand the vertical masticatory force.
4. ***Apical fibers:*** they extend from cementum to the bone at the apical region of the socket.
5. ***Interradicular fibers:*** they fan out from the cementum in the furcation areas of multirooted teeth.

B.Elastic fibers: are relatively few and associated with blood vessels

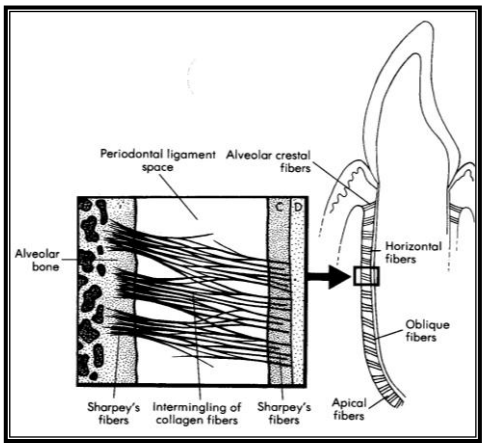
C. Oxytalan fibers: immature forms of fibers are thought to regulate vascular flow, which run parallel to the root surface.





Sharpey's fibers: Are the portions of the principal fibers which are embedded in the root cementum and in the alveolar bone.

Intermediate plexus: In the mid- section of PDL the fibers bundles arising from both sides of cementum and AB joined together by small, thick strands of collagen fibers.



<u>Cellular elements of the PDL</u>:

*1. **Connective tissue cells:*** Include fibroblasts, Cementoblast and osteoblasts. Fibroblasts synthesize collagen and possess the capacity to phagocytosis "old" collagen fibers by enzyme hydrolysis.

*2. **The epithelial rests of malassez:***

Which considered being remnants of Hertwig's root sheath. Epithelial rests are distributed close to the cementum mostly in the apical and cervical areas. These epithelial rests are either degenerated or become calcified to form (cementicles) which are calcified masses adherent to or detached from root surfaces. Epithelial rests proliferate when stimulated and participate in the formation of periapical cysts and lateral root cysts.

*3. **The defense cells:*** Include macrophages, mast cells and eosinophils.

<u>Functions of PDL</u>:

A) **Physical functions**:

1) Provision of a soft tissue "casing" to protect the vessels and nerves from injury by mechanical forces.
2) Transmission of occlusal forces to the bone.
3) Attachment of the teeth to the bone.
4) Resistance of impact of occlusal forces (shock absorption).

B) **Formative and remodeling function**:

Cells of PDL participate in the formation and resorption of cementum and bone. Formative cells are (fibroblasts, Cementoblast and osteoblasts).

C) **Nutritional functions**:

The PDL supplies nutrients to the cementum, bone and gingiva by way of the blood vessels.

D) Sensory functions:

The PDL is supplied with sensory nerve fibers which transmit "tactile - pressure- pain sensation by the trigeminal pathway, in addition the PDL is supplied with mechanoreceptors that transmit sense of localization which is done through proprioceptive nerve endings unlike the pulp do not have mechanoreceptors so the sense of localization is not present in the pulp.

Root cementum:

Is a specialized mineralized tissue covering the root surfaces and occasionally, small portions of the crown of the teeth.

It has many features similar to bone tissue, however, the cementum contains no blood or lymph vessels, has no innervation, does not undergo physiologic resorption or remodeling, but it characterized by continuing deposition throughout the life. Like other mineralized tissues, it consists of collagen fibers embedded in organic matrix. Its mineral contents, which is mainly hydroxyapatite, is about 65% by weight.

Fibers of cementum:

There are two sources of collagen fibers in C.:

A. **Extrinsic fibers** represented by Sharpey's fibers, which are embedded portion of principal fibers of PL and are formed by fibroblasts. These fibers are arranged in perpendicular direction to the long axis of the tooth.

B. **Intrinsic fibers** which are belong to the C. matrix and produced by cementoblasts and composed of fibers oriented more or less parallel to the long axis of the tooth.

Functions of cementum:

1) It attaches the PL fibers to the root.
2) It contributes to the process of repair after damage to the root surface.
3) Anchorage of the tooth the alveolus.

Types of cementum:

1. ***Acellular cementum*** *(AC):* is the first to be formed and covers approximately the cervical third or half of the root.

It does not contain cells, and it is formed before the tooth reaches the occlusal plane.

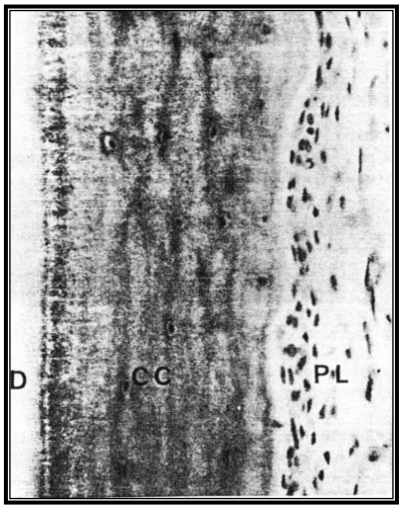
Sharpey's fibers make up most of the structure of AC, which has a principal role in supporting the tooth.

The size, number and distribution of these fibers increase with function.

Sharpey's fibers are completely calcified with the mineral crystals (hydroxyaptite crystals) oriented parallel to the fibrils, except in a zone near the cementodentinal junction, where they are only partially calcified.

The peripheral portions of Sharpey's fibers tend to be more calcified than interior regions.

AC also contains other calcified collagen fibrils that are irregularly arranged or parallel to the surface.



2. ***Cellular cementum*** *(CC):* formed after the tooth reaches the occlusal plane, is more irregular and contains cells (cementocytes) in

individual spaces (lacunae) that communicate with each other through a system of anastomosing canaliculi. Cellular C. is less calcified than AC. Sharpey's fibers occupy a smaller portion of CC and are separated by other fibers that are arranged either parallel to the root surface or at random.
Sharpey's fibers may be completely calcified or partially calcified or have a central, uncalcified core surrounded by a calcified border.
Both CC and AC are arranged in lamellae separated by incremental lines parallel to the long axis of the root. These lines represent rest periods in cementum formation and are more calcified than the adjacent cementum.
Intermediate cementum is an ill-defined zone near the cemento-dentinal junction of certain teeth that contains cellular remnants of Hertwig's sheath embedded in calcified ground substance.
The inorganic content of C. (hydroxyapatite) is 45% to 50%, which is less than that of bone (65%), enamel (97%), or dentin (70%).

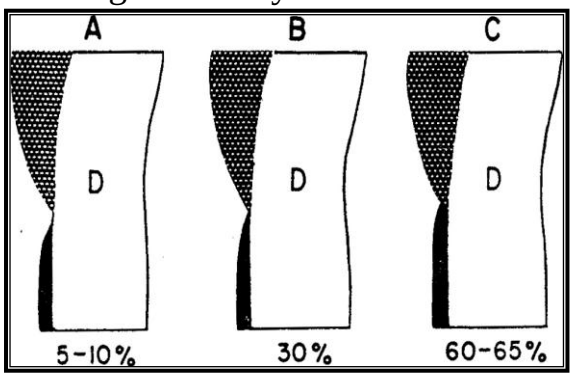
Permeability of cementum:

In young animals both CC and AC are very permeable and permit the diffusion of dyes from the pulp and from the external root surface.

In CC, the canaliculi in some areas are continuous with dentinal tubules. With age, the permeability of C is diminished.

Cemento-enamel junction:

There are 3 types of relationships involving the C may exist at the CEJ:



1- In about 60% to 65% of cases C. overlaps the enamel.
2- In about 30% there is an edge-to-edge relationship.
3- In 5% -10% the C. fails to meet enamel.
The last instance has a clinical importance because in case of gingival recession may be accompanied by an accentuated sensitivity due to exposure of dentin.

Thickness of cementum:

C. deposition is a continuous process that proceeds at varying rates throughout life. C. formation is most rapid in the apical regions, where it compensates for tooth eruption which itself compensates for attrition.
The term hypercementosis (cementum hyperplasia) refers to the prominent thickening of the C. It may be localized to one tooth or generalized to the entire dentition. Hypercementosis also appears in the form of spike-like excrescences (cemental spikes) created by either

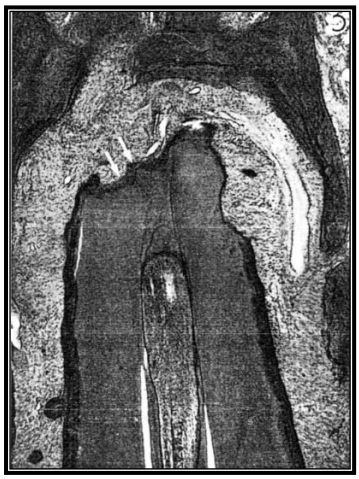
coalescence of cementicles that adhere to the root or the calcification of PD fibers at the site of insertion into the C.

Cementum resorption:

The C. of erupted and unerupted teeth is subjected to resorption which may be of microscopic proportion or extensive and detected radiographically.

C. resorption is extremely common and may be due to local and or systemic causes or may be without apparent etiology (idiopathic).

Among the local causes of resorption:



1. Trauma from occlusion.
2. Orthodontic movement.
3. Pressure form malaligned erupting teeth.
4. Cysts and tumors.
5. Teeth without antagonists.
6. Periapical disease.
7. Periodontal disease.

Among systemic conditions:

1. Calcium deficiency.
2. Hypothyroidism.
3. Paget's disease.

Ankylosis:

Is fusion of C. and alveolar bone with obliteration of PL. Ankylosis occurs in teeth with cemental resorption, which suggests that it may represent a form of abnormal repair. Ankylosis may occur after chronic periapical inflammation, tooth replantation and occlusal trauma and around embedded teeth.

Alveolar process (AP):

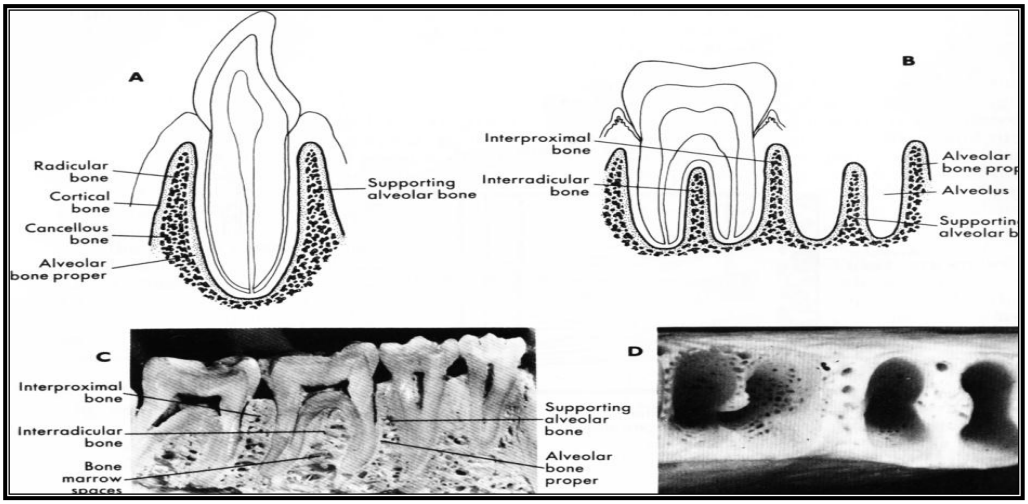
The alveolar process is the portion of the maxilla and mandible that forms and supports the tooth socket. It forms when the tooth erupts to provide osseous attachment to the forming PL.

The AP consists of:

1-External plate of cortical bone formed by compacted bone lamellae.

2-Inner socket wall of thin, compact bone called alveolar bone proper (also known as cribriform plate or lamina dura), which appears radiographically as a radio-opaque line surrounding the roots of the teeth.

3-Cancellous trabeculae, between these two compact layers, which act as supporting alveolar bone. The AP is formed of separate areas anatomically, but it functions as a unit in supporting the teeth. Occlusal forces that are transmitted from the PL to the inner of the alveolus are supported by the cancellous trabecullae, which in turn are buttressed by the labial and lingual cortical plates.



<u>Cells and intercellular matrix</u>:

-Osteocytes are the cells of the bone; they are enclosed within spaces called lacunae. The osteocytes extend processes into canaliculi that radiate from the lacunae. The canaliculi form an anastomosing system which brings O_2 and nutrients to the osteocytes.

-The other cells of bone are osteoblasts which are responsible for bone formation.

-Osteoclasts are the performing bone resorption.

<u>Periosteum and endosteum</u>:

All bone surfaces are covered by layers of differentiated osteogenic connective tissue. The tissue covering the outer surface of bone is termed (periosteum), whereas the tissue lining the internal bone cavities is called endosteum. The periosteum consists of an inner layer composed of cells that have ability to differentiate into osteoblasts and an outer layer that is rich in blood vessels and nerves and is composed of collagen fibers and fibroblasts.

<u>Fenestrations and dehiscences</u>:

Isolated areas in which the root is denuded of bone and the root surface so covered only by periosteum and overlying gingiva are termed (fenestrations).

In these instances, marginal bone is intact. When the denuded areas extend through the marginal bone, the defect is called a dehiscence.

These defects occur on approximately 20% of the teeth, they occur more often on the facial bone than on the lingual, and are more common on anterior teeth than on posterior.

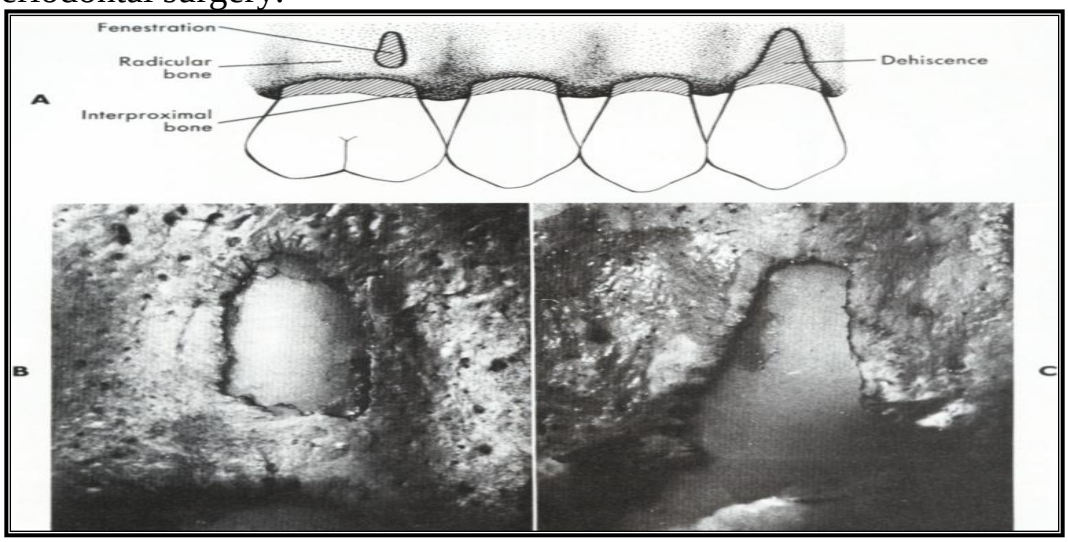
The predisposing factors for these defects are:

1-**prominent root contours**

2-malposition

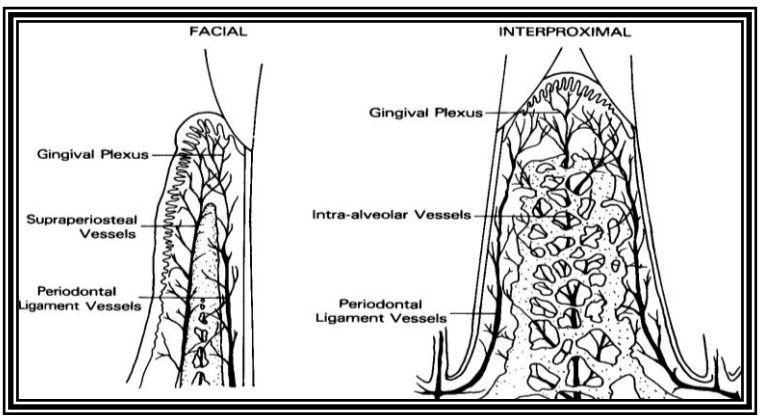
3-labial protrusion of the root combined with a thin bony plate.

These defects are important because they may complicate the outcome of periodontal surgery.



The blood supply to the periodontium:
is derived from the following branches of the superior and inferior alveolar arteries:
1- Supraperiosteal arteries on the facial, lingual and palatal surfaces of the alveolar bone.
2- Interdental arteries located within the interproximal bone that exit at the crest of the interproximal alveolar processes to supply the gingiva.
3- Periodontal ligament arterioles.

Nerves of the periodontium:
The periodontium contains receptors which record pain, touch and pressure (mechanoreceptors). The PL contains properioceptors sensitive to the movements and positions. Nerve supply is brought to the periodontium via the trigeminal nerve and its end branches.



Due to the presence of receptors in the PL, small forces applied on the teeth may be identified. For example, the presence of a very thin metal foil between the teeth during occlusion can be identified. The movement which brings the upper teeth in contact with the lower teeth is arrested reflexively and altered into an opening movement if a hard object is detected in the chew.