PERIODONTAL LIGAMENT(PDL)

The periodontium is defined as those tissues supporting and investing the tooth and consist of cementum , periodontal ligament, bone the lining alveolus (socket) and that part the of gingival facing the tooth.

PERIODONTAL LIGAMENT(PDL)

define as is the dense fibrous connective tissue that occupies the periodontal space between the root of the tooth and bone forming the socket wall.

Ranges in thickness between 0.15 and 0.38 mm and is thinnest in the middle portion of the root.

Origin and Development Of Periodontal ligament

PDL is derived from the dental follicle that envelops the developing tooth germ. Some delicate fiber bundles of the forming **PDL** appear as root formation begins. The inner most cells near the forming root differentiate into cementoblasts and lay down cementum, while the outermost cells differentiate into osteoblasts and furnish the lining of the bony socket. The more centrally located cells are differentiated into fibroblasts which synthesize the fibers and the ground substance of the **PDL**. The fibers of the **PDL** become embedded in newly developed cementum and alveolar bone (Sharpey's fibers).

Histological structure ofthe periodontal ligament

The PDL consist of fibers , cells , ground substance, and other structures such as blood vessels and nerves.

A.fibers of the periodontal ligament

(1) Collagen fibers

Collagen of the periodontal ligament

- The periodontal collagen is mostly type I, collagen Type III collagen (about 20%).
- Much of the collagen is gathered together to form bundles which are approximately 5μm in diameter.
- These bundles are termed the principal fibers of the periodontal ligament.

- The principal fibers appear more numerous at their attachments to cementum than at the alveolar bone.

The principal fibers of the periodontal ligament which are embedded in cementum and inthe bone lining the tooth socket are termed Sharpey's fibers.

The horizontal lines in the bone and cementum represent the Sharpey's fibers.

The principal fibers: They are formed of collagen bundles, which are wavy in course and are arranged in three groups

a) Gingival fibers:

1- Dento-gingival fibers:-2- Alveolo-gingival group:3- Circular group: 4- Dento-periosteal fibers.

b) The trans septal ligament: It connects two adjacent teeth. The ligament runs from the cementum of one tooth over the crest of the alveolus to the cementum of the adjacent tooth.

Function: Resists mesial and distal tooth separation.

c) The alveolodental ligament:

1-Alveolar crest group: attached to the cementum just below the cement enamel junction and running down ward and out ward to insert into the rim of the alveolus.

Function: resists vertical and intrusive forces.

2-Horizontal group: just apical to the Alveolar crest group and running at right angles to the long axis of the tooth from cementum to bone just below the Alveolar crest

Function: resists horizontal and tipping forces.

3- Oblique group: the most numerous in the pdl and running from the cementum in an

oblique direction to insert into bone coronally.

Function: Performs the main support of the tooth against masticatory forces.*Resists vertical and intrusive forces.

4- Apical group: The bundles radiating from the cementum around the apex of the

root to the bone forming the base of the socket.

Function: resists vertical force.

5- Inter radicular group: found only between the roots of the multi rooted teeth. And running from cementum into the bone forming the crest of the inter radicular septum.

Function: resists vertical and lateral forces.

(2) Oxytalan fibers

The oxytalan fibers are often terminate around blood vessels.

The oxytalan fibers vary in size from 0.5-2.5mm in diameter and constitute no more than about 3% of the extracellular fiber composition. They need special stains to be demonstrated These are elastic fibers run in oblique direction one end being embeddedin bone or cementum and the other in the wall of blood vessels. At the apical region they form acomplex network.

Function has not been determined fully they are thought to**1.** regulate vascular flow in relation to tooth function because they are elastic, **2**.support the bloods vessels in the periodontal ligament. **3-** Help fibroblasts migration.

B.The cells of periodontal ligament are

1. Synthetic Cells a) Fibroblasts b) Osteoblasts c) Cementoblasts

2.Resorptive Cells a) Osteoclasts b) Cementoclasts c) Fibroblasts

3.Undifferentiated mesenchymal cells (Progenitor Cells)

4.Epithelial Cell rests of malassez

5.Connective Tissue cells

a) Mast cells b) Macrophages

(1) Synthetic cells:

a)Fibroblasts cell s

Periodontal fibroblasts, being active cells, have low nuclear-cytoplasmic ratios, and each nucleus contains one or more prominent nucleoli.

Fibroblasts are the most common cells in periodontal ligament. They constitute about 65% of total population.

They appear as ovoid or elongated cells with pseudopodia like process.

They are usually found parallel to collagen fibers.

Function they help in synthesis and resorption of extracellular connective tissue.

b) Osteoblasts cells

A layer of osteoblasts lining the alveolar bone.

They are bone forming cells.

C) Cementoblasts cells

They help in formation of cementum.

(2) Resorptive cells

a) Cementoclasts cells

As cementum not remodel these cells are not normally found in ligment. These cell occur only in certain pathological conditions,during resorption of deciduous teeth and during orthodontic therapy.

b) Osteoclasts cells

They are bone resorbing cell . An increase in number of Osteoclasts are seen where bone is under going active resorption.

(3) Undifferentiated mesenchymal cells (Progenitor cells)

Can undergo mitotic division, Can differentiate to different types of cells, have small, closed- face nucleus, little amount of cytoplasm, found close to blood vessels.

(4) Epithelial rest of Malassez's these groups of epithelial cells become located in

the mature PDL after the disintegration of Hertwig epithelial root sheath during the formation of **the root.**

(5) Connective cells

Defence cells: Mast cells, Macrophages that derived from monocytes are present in ligament.

C. Ground substance

The ground substance is an an amorphous back ground material that bind s tissue and fluids.itconsists mainly of proteins and poly saccharides. ground substance contain s about 70% water.All components of the periodontal ligament ground substance are presumed to be secreted by fibroblasts.The ground substance is thought to have many important **functions** :**1.**helps in transporting ion and water bring and exchange and also helps in carring the wast products from cell to blood vessels,**2**. control of collagen fibrillogenesis and fiber orientation.

D.Interstitial tissue

they are found between the fibers of the PDL

They are areas that contain some of the blood vessels, lymphatic, and nerves . They surrounded by loose C.T

E.Blood vessels

The blood vessels travel from apical to occlusal.

Main blood supply is from superior and inferior alveolar arteries. The blood vessels are derived from the following:

1. Branches from apical vessels: vessels that supply the dental pulp.

2. Branches from intra-alveolar vessels:- Vessels run horizontally and penetrate the alveolar bone to enter into the periodontal ligament

3. Branches from gingival vessels:- The arterioles and capillaries ramify and form a rich network. Rich vascular plexus is found at the apex and in cervical part of ligament. .

A dense venous network is particularly prominent around the apex of the alveolus.

F.Lymphatics

A network of lymphatic vessels following the path of the blood vessels provides the lymph drainage of the periodontal ligament.

G.Nerves of periodontal ligament

The nerves are the branches of second and third division of fifth cranial nerve (trigeminal nerve) and follow same path as blood vessels. These nerve fibers provide sense of touch, pressure, pain and proprioception during mastication. The nerve fibers entering the periodontal ligament are derived from two sources. Some nerve bundles enter near the root apex and pass up through the periodontal ligament. Others enter the middle and cervical portions of the ligament as finer branches through opening in the alveolar walls. Periodontal nerve fibers are both myelinated and unmyelinated.

Functions of periodontal ligament

1. Supportive function

by attaching the tooth to the surrounding alveolar bone proper. This function is mediated primarily by the principal fibers of the periodontal ligament that form a strong fibrous union between the root cementum and the bone. The periodontal ligament also serves as a shock-absorber by mechanisms that provide resistance to light as well as heavy forces. Light forces are cushioned by intravascular fluid that is forced out of the blood vessels. Moderate forces are also absorbed by extra vascular tissue fluid that is forced out of the periodontal ligament space into the adjacent marrow spaces. The heavier forces are taken up by the principal fibers. Blood vessels and all the components of the ligament act together as a hydaulic damperor shock absorber with the ground substance and the tissue fluid. the ground substance present between the fibers of pdl is rich in water content and there fore add up to the support .

2. Remodeling function

by providing cells that are able to form as well as resorb all the tissues that make up

the attachment apparatus, i.e. bone, cementum and the periodontal ligament Undifferentiated ectomesenchymal cells, located around blood vessels, can differentiate into the specialized cells that form bone (osteoblasts), cementum (cementoblasts), and connective tissue fibers (fibroblasts). and resorbing cells (osteoclasts andcementoclast).

3- Sensory function: The periodontal ligament provides an excellent proprioceptive mechanism which helps in estimating the amount of pressure on mastication and elicits even the mildest force acting upon atooth.

4- Nutritive function: The blood vessels in the periodontal ligament has agood blood supply which provide nutrient for cells of the ligament .

5- Protective function The protective function of the periodontal ligament is achieved by:

a- The principal fibers.b- The blood vessels.c- The nerves .

a- The principal fibers: The arrangement of the fiber bundles in the different groups is well adapted to fulfill the functions of the periodontal ligament.The alveolodental ligament transforms the masticatory pressure exerted on the tooth into tension or traction on the cementum and bone .If the exerted force on a tooth is transmitted as pressure this will lead to differentiation of osteoclasts in the pressure area and resorption of bone.

b- The blood vessels:The capillaries form a rich network, they are arranged in form of a coil and attached to bone and cementum through the oxytalan fibers. This arrangement makes it possible when pressure is exerted on the tooth, the blood does not escape immediately from the capillaries and thus buffering the pressure action before it reaches the bone. The behavior of the blood in the capillaries may be simulated to a hydraulic brake

c- The nerves: By its mechanoreceptors nerves.

Clinical considerations

1. The ligament is thicker in functioning than in non-functioning teeth, and in areas of tension than in areas of compression .

2. Excessive forces can cause localized necrosis (cell death) of the ligament by cutting off the normal blood supply to the cells. This situation immediately results in stoppage of remodeling at the affected site. Therefore, orthodontic tooth movement is no longer possible. Repair occurs via emigration of cells from adjoining vital periodontal ligament.

In the event the ligament continuity is not restored, localized resorption and ankylosis may occur.

3. Accidentally exfoliated teeth can be replanted. Complications include external root resorption and ankylosis may occureif portions of the ligament are permanently damaged. These can be minimized by avoiding excessive handling of the torn ligament prior to replantation.

The Age Changes of periodontal ligament

*The periodontal ligament through aging shows vasuclarity ,cellularity, thickness.

*It may contain cementicles.