Lec.3 **Alveolar process** د.سحر غانم القزاز

Bone: specialized hard connective tissue of a complex structure and function.

Alveolar process (alveolar bone): is bone of the jaws containing the sockets or alveoli (alveolus) for the teeth. In humans, the tooth-bearing bones are the maxillae and the mandible.

Development of Alveolar process:

Near the end of the 2nd month of fetal life, mandible and maxilla form a groove that is opened toward the surface of the oral cavity as tooth germs start to develop, bony septa form gradually. The alveolar process starts developing strictly during tooth eruption. Alveolar bone develops from the dental follicle .The ectomesenchymal cells of the dental follicle differentiate into osteoblasts and lay down the matrix called osteoid. Some osteoblasts become embedded in the matrix and are called osteocytes.

Physical Properties of Alveolar process :

Yellow in color. Softer than dentin.

Compositions of Alveolar bone:

Chemical composition :

mature alveolar bone is by weight 60% mineralized or inorganic material, 25% organic material, and 15% water.(in organic materials) In the form of hydroxy apatite crystals .The mineral content of alveolar bone is mostly calcium. The minerals of potassium, manganese, magnesium, and others are also present but in smaller amounts.

(Organic materials)Type I collagen, ground substance of glycoproteins and proteoglycans with small amount of proteins and lipids.

Structure of the bone:-

Histologically: bone consist of cells and inter cellular matrix. In developing and adult bone tissue four type of cell are seen:-

1.Osteoprogenitor cells:- these cells are located in the deepest layer of the periosteum and lining the vascular canals of the compact bone. They drived from mesenchymal tissue. They have the capacity to divide and give rise to any of the other three bone cells. Morphologically they resemble mesenclymal cells (pale staining large nucleus and eosinophilic).

2.Osteoblasts:- they are the cells that form bone tissue. They are drived from osteoprogenitor cells. The osteoblast secret at first the organic matrix of the bone which is called (ostoid tissue)and is stained pink with hematoxyaline and eosin Stain. Later the osteoid tissue will be mineralized also by the osteoblast to form the bone tissue .The osteoblast are found in relation to the surface of bone where bone matrix is being deposited.

3.osteocyte s: they are the principle cells of bone. it is an osteoblast trapped in bone matrix.

The cell process in canaliculi. Canaliculi open into certain canals that contains capillaries. maintain bone tissue and play important role in it's mineral storage.

Mature bone is formed in thin layers called lamellae.

Lamellae are arranged in concentric circles called haverison system .

Haverison system consist of a concentric lamellae around a central canal called haversain canal which contain capillary blood vessles .

4.osteoclasts:they are located on the surface of bone tissue where resorption is taking place . the cells are multi nucleated giant cells and are found in a shallow excavation known as how ships lacuna. osteoclasts are derived from Osteoprogenitor cells cells or probably form circulation blood cells(monocytes).

Three distinct types of bone lamellae are found they are:

1.circumferential lamellae:

They are bony lamellae that surround the entire bone, forming its outer perimeter

2.concentric lamellae :

Form the bulk of the bone and formed the basic metabolic unit of bone called osteon. osteon is a cylinder of bone found oriented along the long axis of the bone.

3.interstitial lamellae: they are lamellae found between adjacent concentric lamellae. they are filters that fill the space between the concentric lamellae. number of canals are found in this bone . these canals called Volkmann's canals.

Branches of blood vessels from these canal may enter smaller haversain canals.

Structure of Alveolar bone

Bone: consist of cells and intercellular matrix of fibers and ground substance. Bone can be examined histologically by decalcification in the acid solution to examine cellular and organic components and it could be examined in ground bone section to examine the details of matrix structure and lacuna of the bone cells.

The alveolar bone or process is divided into:

1.alveolar bone proper 2. The supporting alveolar bone

Microscopically, both the alveolar bone proper and the supporting alveolar bone have the same components: fibers, cells, intercellular substances, nerves, blood vessels, and lymphatic.

1.alveolar bone proper:

is that part of alveolar bone that lines the sockets It is a thin lamella of compact bone in which periodontal fibres are embedded . Although the alveolar bone proper is composed of compact bone, called the cribriform plate because it contains numerous holes where Volkmann canals pass from the alveolar bone into the PDL.

The alveolar bone proper consist of two types of bone:

A. Bundle Bone:

The alveolar bone proper is also called bundle bone because Sharpey fibers, a part of the fibers of the PDL, are inserted here. Similar to those of the cemental surface, Sharpey fibers in alveolar bone proper are each inserted at 90 degrees, or at a right angle, but are fewer in number, although thicker in diameter than those present in cementum. As in cellular cementum, Sharpey fibers in bone are generally mineralized only partially at their periphery.

Radiographically alveolar bone proper is referred to as lamina dura Lamina dura appears more dense and hence radio-opaque. In a radiograph the widening of lamina dura indicates periodontal pathology.

The alveolar crest is the most cervical rim of the alveolar bone proper. In a healthy situation, the alveolar crest is slightly apical to the cementoenamel junction (CEJ) by approximately 1.5 to 2 mm. The alveolar crests of neighboring teeth are also uniform in height along the jaw in healthy situation.

Histologically the bundle bone contains fewer fibrils than lamellated bone therefore it appears dark in hematoxylin and eosin stain .these fibrils arranged at right angles to Sharpey s fibers.

B. lamellated bone: Lamellar bone (compact bone next to bundle bone). Some lamellae are arranged parallel to the surface and others form Haversian systems.

2.The supporting bone: The remainder of the alveolar process below the alveolar bone proper is called the supporting bone It is attached to the alveolar bone proper. The Supporting bone includes the compact cortical plates on the outer surface and the spongy bone between the cortical plates and the alveolar bone proper the supporting bone gives support to the socket.

2.The supporting bone: It consist of two parts:

A. **Cortical plates (Compact supporting bone)**: The compact supporting bone of the alveolar process extends from the alveolar crest to the lower border of the socket on the outside surface of the maxilla and mandible It is also called the cortical bone/plate .The cortical bone has Haversian systems, radiating lamellae with lacunae and canaliculi. The cortical plates of the molar regions are thicker than those of the incisor regions. The thickness of the cortical plate varies depending upon the location.

B. Spongy bone: (Cancellous supporting bone): is located apically between the alveolar bone proper and the cortical bone It is also called as spongy bone contain marrow space and is continuous with spongiosa of the body of the jaws.

Two types spongy of bone are seen:¬

1) interdental bone: the bone between the roots of adjacent single-rooted or multi-rooted teeth is called inter dental bone.

2) interradicular bone: the bone between the roots of multi-rooted teeth is known as interradicular bone.

The spongy bone consist of bone trabacule (spongiosa) which can classified according to its appearance in the x-ray film two types

Radiographically:

Type I : in which inter dental and inter radicular trabaculea are regular and horizontal and arranged in A sparse ladder-like arrangement (in the mandible). It more resistance to the force of mastication.

Type II : in which inter dental and inter radicular trabaculea are irregular arranged . An apparent haphazard arrangement (in the maxilla).

Interradicular bone and interradicular septum consist entirely of Spongy bone. These septum transmit blood vessles and radiolucent lines of these on radiographas are called hirshfeld's canals. The spongiosa is absent in the regions of the incisors, where the alveolar bone proper is fused with the cortical plate.

The spongiosa is adapted to support the alveolus proper, since its trabeculae are arranged in such a fashion as to resist occlusal force. Transmits the masticatory forces from alveolar bone proper to Cotrical plates It supports and strengthens the alveolar bone proper.

2. basal bone

apical to the roots of the teethforms the body of the maxilla and mandible alveolar bone can be resorbed with age.

3.bone marrow

the marrow spaces contain usually fatty tissue but it may contain red blood cells forming hematopoietic marrow.this red marrow will be transformed into fatty marrow by age ,but it persist only in the angle of the mandible ,in the condylar process and in the maxillary tuberosity.

4.Periosteum: dense CT surrounding bone important in bone repair
o Outer fibrous layer
o Inner layer with bone cells, precursors, and blood vessels
5. Endosteum : thin layer of CT lining inner surface of bone, facing marrow
o Contains osteoblasts and their precursors

Bone resorption

Bone resorption is associated with the appearance of osteoclast .
During bone resorption three process take place:
1.decalciation
2.degredation of organic matrix
3.transport of the products.
1.Decalciation:this is achieved at the ruffled border of osteoclasts by the secretion of organic acids (citric and lactic acids)that chelate bone and by H^+ which increase the solubility of hydroxyl out side the ostoclast.
2.degredation of organic matrix :this achieved by the activity of cathepsin b-1(lysosome)acid
Destroy this activity take place outside the osteoclast.
3.transport of the soluble product s:to the extra cellular fluid and to the blood vascular syetem.the details of mechanism of transport is not yet known.

Bone Remodeling:

Bone is sensitive to pressure and to tension which will cause bone remolding which means resorption in certain areas and deposition of new bone else were. the bone remolding in the socket occurs normally during eruption of teeth(mesio-occlusally). Bone remodeling allows the teeth to be moved orthodontically. most orthodontic movements in which the tooth responds by tipping around an axis of rotation mid way down the length of the root. The alveolar bone reacts to this movement by resorption in the pressure side and at the bottom of socket at the tension side .
while bone deposition will occur on the alveolar crest of the tension side and at the bottom of the socket.

Bone healing

During healing of fractures or extraction wounds, an embryonic type bone is formed which is charactised by great number ,great size and irregular arrangement of osteocytes, also course irregular fibers ,reduced volume of in organic substance. and great amount of organic substance ,and decrease of in organic substance makes this bone more radio lucent than mature bone that is why the socket of the extracted tooth appear in the x-ray film empty at when it is almost filled with immature bone. The emberoynic bone (woven bone)will be resorbed and replaced by lamellate bone, so it could be seen on x-ray film 2-3 weeks after actual formation of new bone.

Incremental lines of bone:

1.Resting lines

Are smooth straight lines consist of inter cellular substance with less collagen and relatively more ground substance ,and because of this they stained dark blue with hematoxylin and eosin. they represent the resting period of the osteoblast during bone formation.

2.Reversal lines

They are lines that stain dark like the resting lines reversal lines are scalloped not smooth. They represent the outline of how ship's lacunae with their convexity to toward the old bone. following bone resporation new osteoblast differentiated and deposited bone tissue leaving these lines separating between old and new bone.

Vascular supply of alveolar bone:

1. alveolar process of the maxilla: anterior & posterior alveolar arteries (branch from the maxilla & infra orbital arteries)

2. alveolar process of the mandible:

a)inferior alveolar arteries(internal)

b) periosteal branches of submental & buccal arteries (external).

Functions of alveolar bone:

1) protection: alveolar bone forms and protects the sockets for the teeth.

2) attachment: it gives the attachment to the pdl fibers, which are the principle fibers. these fibers which enter the bone are regarded as sharpey's fibers.

3) support: it supports the tooth roots on the facial & on the palatal/lingual sides.

4) shock-absorber: it helps absorb the forces placed upon the tooth by disseminating the force to underlying tissues.

Age changes in alveolar bone:

The alveolar sockets appear Jagged and scalloped.The bone marrow appears to have a fatty infiltration.Osteoporosis indicates loss of some bony elements.The internal trabecular arrangement is more open, which indicates bone loss.

Clinical considerations

Resorption and regeneration of alveolar bone this process can occur during orthodontic movement of teeth, Bone is resorbed on the side of pressure and opposed on the site of tension.

If you draw a line connecting the CE junctions of adjacent teeth, this line should be parallel to the alveolar crest. If the line is not parallel, then there is high probability of periodontal disease.