Al Rasheed College of Dentistry
Oral Histology

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Lecture 5

Dentin structure

By weight, 70% of dentin consists of the mineral (hydroxyapatite crystallites), 20% is organic material (which include 90% collagen fibers and 10% ground substances) and 10% is water. Dentin makes up the bulk of the hard tissue in the tooth. Usually, it is covered by enamel on the crown and cementum on the root and surrounds the entire pulp. Yellow in appearance, it greatly affects the color of a tooth due to the translucency of enamel. Dentin, which is less mineralized and less brittle than enamel, is necessary for the support of enamel. Unlike enamel, dentin continues to form throughout life and can be initiated in response to stimuli, such as tooth decay or attrition. Because dentin is softer than enamel, it wears away more quickly than enamel.

Dentin structural units:

1- Dentinal tubules (D.T.):

Dentin consists of microscopic channels, called **dentinal tubules**, which radiate outward through the dentin from the pulp to the exterior cementum or enamel border. The characteristic features of D.T. are:

- D.T. are fine canals that contain tissue fluid and odontoblastic process (Tome's fiber).
- The course of D.T. is somewhat curved, resembling an **S shape** known as primary curvature. Starting at right angles from pulpal surface, the first convexity of this doubly curved course directed toward the apex of the root ending perpendicular to D.E.J, this configuration indicates the course taken by odontoblasts during dentinogenesis.
- in the root and in the area of incisal edge or cusps, the tubules are almost straight.
- The ratio between surface areas at the outside and inside of the D. is about **5:1**, so the tubules are farther apart in the peripheral layers and are more closely packed near the pulp. In addition, they are larger in diameter near the pulpal cavity **(3-4µm)** and smaller at their outer ends **(l µm).**
- The terminal part of D.T. branched into 2-3 branches near D.E.J resulting in the increase number of tubules in this area. Also there are lateral branches of D.T. which called **canaliculi**.

- D.T. make the D. permeable and providing a pathway for entrance or invasion of bacteria caused dental caries and also play an important role in D. sensitivity.

2-Peritubular D.:

- It's the D. that surrounds the D.T. and form **l µm** thick sheath around each tubule. Peritubular D. is missing in D.T. in interglobular D. indicating that this is a defect of mineralization in this area.
- Peritubular D. is highly calcified and its about **40%** more calcified than adjacent intertubular D.

3-Intertubular D.:

- It's the D. located between the D.T., and its formed the most bulk of the body of D.
- Its less mineralized than the peritubular D., and it consist of network course of collagen fibers in which apatite crystals deposited on it.

Types of D.:

1.Primary dentin (Mantle and Circumpulpal D.)

Primary dentin, the most prominent dentin in the tooth. The outer layer of this primary D. which closest to enamel in the crown and closest to the cementum in the root is known as **mantle dentin**. This layer is unique to the rest of primary dentin. Mantle dentin is formed by newly differentiated odontoblasts and forms a layer approximately **150 µm** wide, and its less mineralized. Below it lies the circumpulpal dentin, a more mineralized dentin which makes up most of the dentin layer and is secreted after the mantle dentin by the odontoblasts.

Circumpulpal dentin is formed before the root formation is completed. Newly secreted dentin is un-mineralized and is called **predentin**. It is easily identified in haematoxylin and eosin stained sections since it stains lighter than dentin. It is usually **10-47 µm** and lines the innermost region of the dentin. It is un-mineralized and consists of collagen (type I and type III), and glycoproteins.

2-Secondary dentin:

Secondary dentin is formed after root formation is complete, normally after the tooth has erupted and is functional. It grows much more slowly than primary dentin. It has a similar structure to primary dentin, although its deposition is not always even around the pulp chamber. It is the growth of this dentin that causes the decrease in the size of the pulp chamber with age**.**

3-Tertiary dentin (pathological type):

Tertiary dentin formed as a reaction to external stimulation such as cavities. It is of two types, either **reactionary**, where dentin is formed from a pre-existing odontoblast, or **reparative**, where newly differentiated odontoblast-like cells are formed due to the death of the original odontoblasts, from a pulpal progenitor cell. Tertiary dentin is only formed by an odontoblast directly affected by a stimulus; therefore, the D. structure depend on the intensity and duration of the stimulus, e.g., if the stimulus is a carious lesion, there is an extensive destruction of dentin and damage to the pulp, due to the differentiation of bacterial metabolites and toxins. Thus, tertiary dentin is deposited rapidly, with a sparse and irregular tubular pattern and some cellular inclusions of odontoblasts in its matrix because of rapid formation; in this case it is referred to as "**osteodentin**".

Stimuli of different nature not only induce additional formation of reparative D. but also lead to changes in the D. itself, calcium salts may be deposited in or around degenerated odontoblastic processes and may obliterate the tubules. This type of D. called **transparent or sclerotic D.**, and can be demonstrated only in ground sections. It appears light in transmitted light and dark in reflected light, because the light passes through the transparent D. but reflected from the normal D.

In ground section of D., the odontoblastic process disintegrated as a result of severe stimuli to the pulp like caries, attrition or abrasion, and the empty tubules are filled with air. They appear dark in transmitted light and white in reflected light, this type of D. called **dead tracts** and its area of decreased sensitivity. Reparative D. seals these dead tracts at their pulpal end.

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Incremental lines in D.

1.Imbrication or von Ebner lines:

It appears as fine lines, which in cross section run at right angles to the D.T. The course of the lines indicates the growth pattern of the D. The distance between the lines corresponds to the daily rate of opposition, which in crown varies from 4-8μm and becomes decreasingly less as root formation progress.

2.Counter lines of Owens:

Its hypocalcified line, it distinguishes in longitudinal ground section as accentuated few lines. These lines arise due to disturbances in D. matrix and mineralizing process.

3.Neonatal lines:

This line separating between prenatal and postnatal D., and mostly found in deciduous and first permanent molar. This line is the result of incomplete calcification, due to metabolic disturbances at the time of birth to the abrupt changes in environment and nutrition.

Interglobular D.:

Mineralization of the D. sometimes beings in small globular areas that normally fused to form a uniformly calcified D. layer. If fusion does not take place, unmineralized or hypomineralized regions remain between the globules, which termed **interglobular D.** This type of D. is found in the crown in both sections (decalcified and ground sections) near the D.E.J. and in the root near C.D.J. In ground sections is sometimes lost and replaced by air, so it appear black.

Tomes' granular layer:

In the ground sections a thin layer of D. adjacent to the cementum almost appears granular and only found in the root, this is known as Tomes' granular layer. It's thought to represent an interference with mineralization of the entire surface layer of the root D. prior to the beginning of cementum formation.

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Clinical consideration:

- The rapid penetration & spread of caries in the dentin is the result of the tubule system in the dentin.
- The dentinal tubules form a passage for invading bacteria that may thus reach the pulp through a thick dentinal layer.
- Air driven cutting instruments cause dislodgement of the odontoblasts from the periphery of the pulp & their aspiration within the dentinal tubule.