

Biologic Considerations of Dentin Its Clinical Significance in Operative Dentistry

DENTIN:

Function: the coronal dentin (crown) provides both color & elastic foundation for enamel. Together with radicular dentin (root); dentin forms the bulk of the tooth & protective encasement for the pulp. As a vital tissue without vascular supply or innervation, it is nevertheless able to respond to thermal, chemical or tactile external stimuli.

Support: tooth strength & rigidity are provided by intact dentinal substrate. Resistance of tooth to fracture is significantly lowered with increasing depth & width of cavity preparation. Therefore a conservative initial approach that combines localized removal of carious tooth structure, placement of a bonded restoration & placement of sealant is recommended. If large preparations are required, the dentist should consider placement of onlay or crown.

Morphology: dentin is composed of small apatite crystals embedded in cross linked organic matrix of collagen fibrils. The extended cytoplasmic processes of the formative cells (the odontoblasts) form channels or tubules traversing the full thickness of the tissue. Dentin contains 45% to 50% inorganic apatite crystals, about 30% organic matrix, & about 25% water.

During tooth preparation, dentin is distinguished from enamel by:

1-Color: dentin is normally yellow-white and slightly darker than enamel, in older patients dentin is darker and become brown or black in cases in which it has been exposed to oral fluids, old restorative materials or slowly advancing caries.

2-Reflectance: dentin surfaces are more opaque and dull, being less reflective to light than enamel surfaces, which appear shiny.

3-Hardness: dentin is softer than enamel, sharp explorer tends to catch and hold in dentin.

4-Sound: when moving an explorer tip over the tooth, enamel surfaces provide a sharper, higher pitched sound than dentin surfaces.

Two main type of dentin are present:

1. **Intertubular dentin**: the primary structural component of the hydroxyapatite- embedded collagen matrix between tubules.

2. **Peritubulardentin**: the hypermineralized tubular walls.

These component ratios vary according to depth of dentin, age & traumatic history of the tooth.

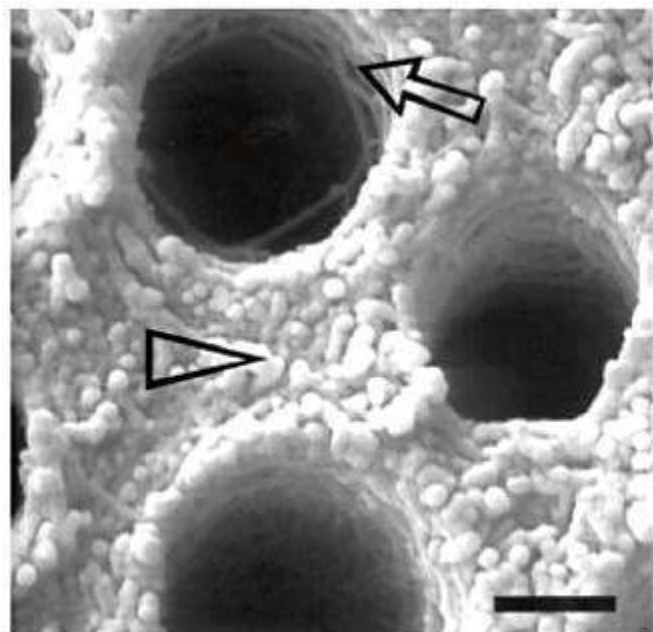
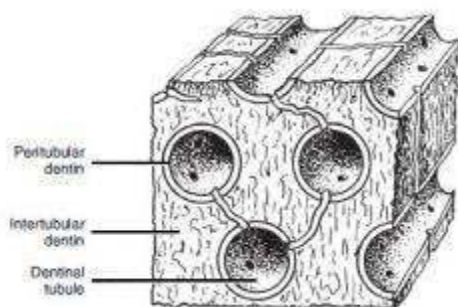


FIGURE 3- Cross-sectioned tubules showing exposed outer peritubular (arrow) and intertubular collagen fibrils (arrowhead) for a tooth from a 29 year-old patient (Bar = 1 μm / 10,000 X)

Depth of dentin:

Outer dentin: the dentin near the DEJ, the tubules of the outer dentin are relatively far apart & the Intertubular dentin makes up 96% of the surface area.

Inner dentin: the dentin near the pulp differs from that near DEJ, these differences affect the permeability & bonding characteristics of inner dentin. In the inner dentin the tubules diameters are larger & the distance between tubule centers is half that of tubules at DEJ. Thus the Intertubular matrix area is

only 12% of the surface area, & the permeability of inner dentin is about eight times more permeable than the D. near DEJ.

Permeability of dentin:

The permeability of dentin is directly related to its protective function. When the external cap of enamel & cementum is lost from the periphery of the dentinal tubules through caries, preparation with burs or abrasion & erosion, the exposed tubules become conduits between the pulp & the external oral environment. Restored teeth are also at risk of toxic seepage through the phenomenon of microleakage between the restorative material & the cavity wall, through capillary action differential thermal expansion, & diffusion, fluids containing various acidic & bacterial products can penetrate the gap between the tooth & restoration & initiate secondary caries of the internal cavity walls. Bacterial substances can continue diffusion through permeable dentinal tubules to reach the pulp. putting the tooth at risk for pulpal inflammation & sensitivity. So restorative techniques with varnishes, liners or dentin bonding resin adhesives are effective to provide reliably sealed margins & sealed dentinal surface.

The remaining dentin thickness is the key determinant of the diffusion of gradient.

Sensitivity of dentin:

Although dentin is sensitive to thermal, tactile and osmotic stimuli across its (3-3.5 mm) thickness. Dentin is neither vascularized nor innervated, accept for about 20% of tubules that have nerve fibers penetrating inner dentin by few microns. Therefore odontoblast & its process is the possible stimulus receptor.

Physiologic dentin

1. Primary dentin: formed relatively quickly until root formation completed by odontoblasts.
2. Secondary dentin: This slowly formed dentin continues to constrict the dimensions of the pulp chamber. In response to mild occlusal stimulus, secondary dentin mainly deposited in the pulp horns & on the roof & floor of the pulp chamber so after many decades the chamber becomes quite narrow occluso- gingivally. The dentist must pay attention for the size & location of the pulp chamber to decide the design of the preparation & placement of retentive features such as pins.

Sclerotic dentin (transparent or peritubular dentin)

Results from aging or mild irritation (such as slow caries) and cause a change in the composition of the primary dentin. The tubular content appears to be replaced by calcified material that obliterates the tubules, progressing from the DEJ pulpally. These areas are harder, denser, less sensitive & more protective of the pulp against subsequent irritation. Sclerosis resulting from aging is (physiological dentin sclerosis) and that resulting from mild irritation called (reactive dentine sclerosis).

Reparative dentin (tertiary dentin)

Intense traumatic insult (injury) to the tooth, whether caused by bacterial penetration associated with caries, or heat & trauma from a dental bur, may be severe enough to destroy the supporting odontoblasts in the affected location. Within 3 weeks, fibroblasts or mesenchymal cells of the pulp are converted or differentiated to stimulate the activities of original odontoblasts, & form irregularly organized tubules. The rate of formation & the thickness & organization of reparative dentin depend on the intensity & duration of the stimulus.

The end