Operative Dentistry

Lecture (3) **Dr. Raghad Noori**

Biologic Considerations of Enamel and their Clinical Significance in Operative Dentistry

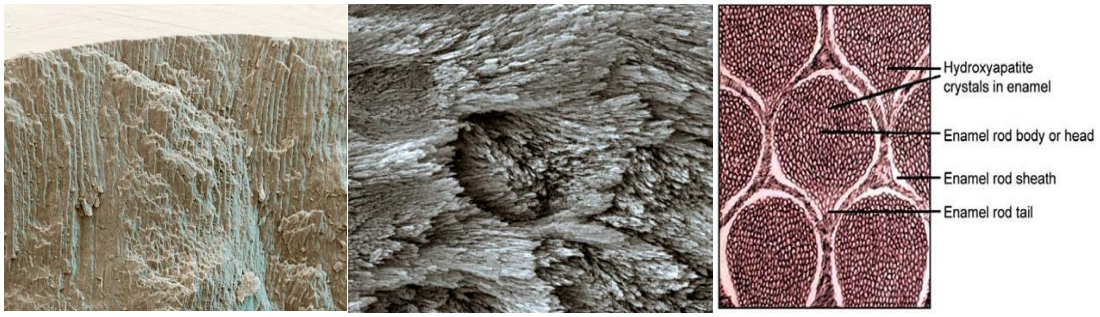
❖ Histological View

Enamel is formed by ameloblast cells. Enamel provides a hard, durable shape for the functions of teeth and a protective cap for the vital tissues of dentin and pulp. Both color and form contribute to the esthetic appearance of enamel.

Enamel is incapable of repairing itself once destroyed because the ameloblast cell degenerates after formation of enamel rod. The final act of ameloblast cell is secretion of a membrane covering the end of enamel rod. This layer is referred to as Nasmyth membrane or the primary enamel cuticle, which covers the newly erupted tooth and is worn away by mastication and cleaning. The membrane is replaced by an organic deposit called a pellicle, which is a precipitate of salivary proteins. Microorganisms may invade the pellicle to form bacterial plaque, a potential precursor to dental disease.

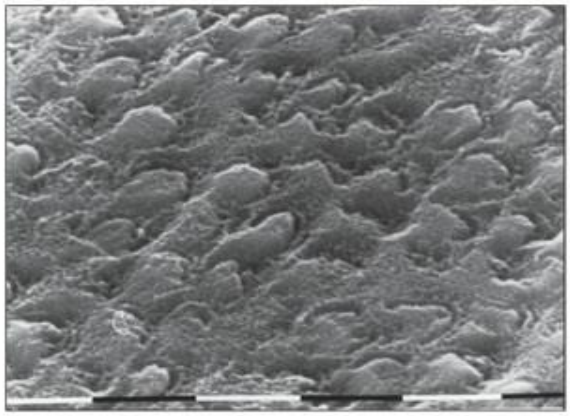
❖ Enamel Structure

Structurally enamel is composed of millions of enamel rods or prisms. The rods are densely packed and have a wavy course and each extends from the DEJ to the external surface of the tooth. The structural components of enamel prisms are millions of small elongated apatite crystal which are tightly packed in a distinct pattern of orientation that gives strength and structural identity to the enamel prisms.



An organic matrix or prism sheath surrounds individual crystal. The spacing and orientation of the crystals and the amount of organic matrix make the enamel rod boundary and the central core differentially soluble when exposed for a short time to weak acids.

The acid- treated enamel surface has an irregular and pitted surface with numerous microscopic undercuts, the etched enamel has a higher surface energy, so resin monomer flows into and adheres to the etched depressions to polymerize and form retentive resin tags. Because there are (30,000) to (40,000) enamel rods/ mm2 and acid etch penetration increases the bondable surface area to (10) to (20) folds, micromechanical bonding of resin restorative materials to enamel is significant.

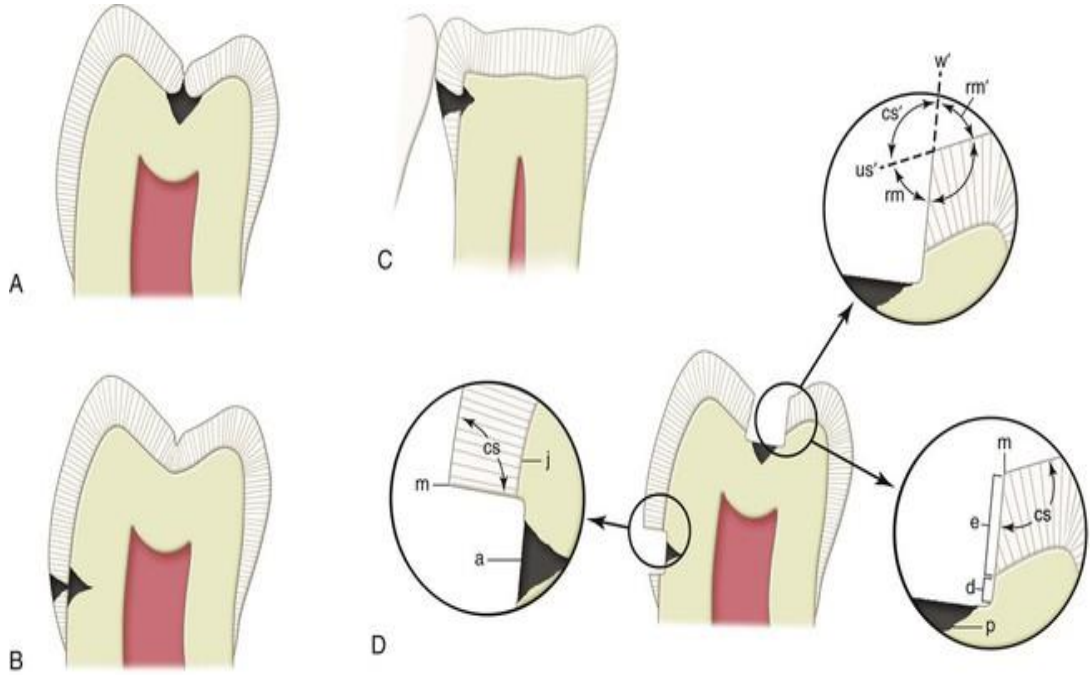


Acid-etch modification of enamel for restoration retention provides a conservative, reliable, alternative to traditional methods of tooth preparation and restorations (retentive grooves, pins, extension for prevention...).

Starting at 1mm from the CEJ, the rods on the vertical surfaces run occlusally or incisally at approximately a 60 degrees inclination and progressively incline approaching the marginal ridges and cusp tips, where the rods are parallel to the long axis of the crown. The rods beneath the occlusal fissures are also parallel to the long axis, but rods on each side of the fissure vary up to 20 degrees from the long axis.

Loss of enamel rods that form the cavity wall of cavo-surface margin of dental restorations creates a gap defect, leakage of bacteria and their products that may lead to secondary caries. Therefore, a basic principle of cavity wall preparation is to bevel or parallel the direction of enamel rods and avoid undercutting them.

In the cervical region of permanent teeth enamel rods are oriented outward in a slightly apical direction, therefore a perpendicular cut to the external surface of occlusal walls of preparation on axial surfaces compromised enamel, so an obtuse enamel cavo-surface angle is recommended to closely parallel the rod direction and preserve the integrity of enamel margin.



❖ Properties of Enamel

1. Hardness

Enamel is the hardest substance of human body. The hardness value of enamel (HV = 275) is around 4 to 5 times higher than that of dentin (HV = 65).

2. Brittleness

Enamel is very brittle; thus, it requires a base of dentin to withstand the masticatory stress. Enamel rods that fail to possess a dentin base because of caries or improper cavity design are easily fractured away from neighboring rods.

3. Permeability

At maturity, enamel is more than 90% inorganic hydroxyapatite mineral by volume. Enamel also contains a small volume of organic matrix, as well as 4% to 12% water, which is contained in the intercrystalline spaces and in a network of micropores opening to the external surface. The micropores form a dynamic connection between the oral cavity and the pulpal and dentinal tubule fluids.

Various fluids, ions and low molecular weight substance can diffuse through the semipermeable enamel. Therefore, the dynamics of acid demineralization, caries, remineralization, fluoride uptake are not limited to the surface but are active in three dimensions.

There is some evidence that the permeability of the enamel decreases with age and may be affected by various dental procedures, such as tooth whitening, acid etching, or the physical removal of the outer most layer of enamel.

4. Solubility to acids

Enamel is soluble when exposed to acid medium, although the dissolution is not uniform. Solubility of enamel increases from the enamel surface to the dentinoenamel junction. When fluorides are present during enamel formation or are topically applied to the enamel surface, the solubility of surface enamel is decreased. Fluoride concentration decreases toward the dentinoenamel junction.

Fluoride additions can affect the chemical and physical properties of the apatite mineral and influence the hardness, chemical reactivity, and stability of enamel while preserving the apatite structures. Trace amounts of fluoride stabilize the enamel by lowering acid solubility, by decreasing the rate of demineralization, and by enhancing the rate of remineralization.

5. Color

Enamel is relatively translucent. It has a glossy surface and varies in color from light yellow to grayish white. Therefore, the color of the tooth is primarily a function of the color of underlying dentin, enamel thickness and the amount of the stain in the enamel. The thickness of enamel is greater at the cusps tips (2.5mm) and incisal edges (2mm) and decreases below deep fissures and become thin cervically at the junction with cementum.

The amount of translucency of enamel is related to the variation in the degree of calcification and homogeneity.

Abnormal conditions of enamel usually result in aberrant color, anomalies of development and mineralization, extrinsic stains, antibiotic therapy, and excessive fluoride can alter the natural color of the teeth.

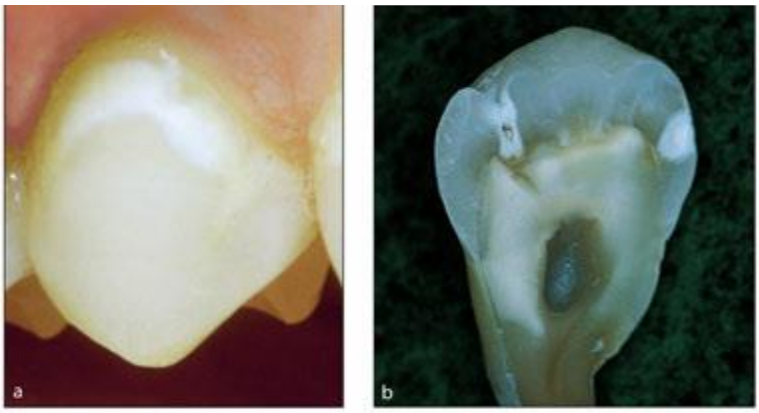
Enamel becomes temporary whiter within minutes when the tooth is isolated from the moist oral environment by rubber dam or absorbents. Thus, the shade must be determined before isolation and preparation for a tooth-colored restoration. This change in color explained by the temporary loss of loosely bonded (or exchangeable) water (less than 1% by weight).

❖ Clinical Appearance and Diagnosis:

The dentist must pay close attention to the surface characteristics of E. for evidence of pathologic or traumatic conditions. Key diagnostic sings include:

1. Color changes associated with demineralization

Color changes related to enamel demineralization and caries are critical diagnostic observation. Subsurface enamel porosity from carious demineralization is manifested clinically by a milky white opacity called (white spot lesion); when located on smooth surfaces. In later stages of caries, internal demineralization of enamel at the DEJ, subsurface cavitation imparts a blue or gray color to the overlying enamel.



2. Cavitation

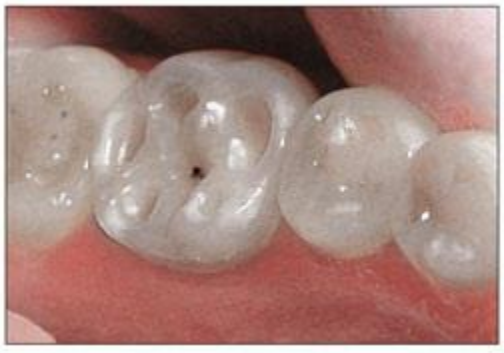
The dentin is affected until enamel breaks away to create a cavity, a restoration must then be placed. If untreated the cavitation expands to compromise the structural strength of the crown and microorganisms infiltrate into deep dentin to affect the vitality of the tooth. When the

carious lesion extends gingival to CEJ as in root caries, isolation, access and gingival tissue response complicate the restorative procedure.



3. Wear

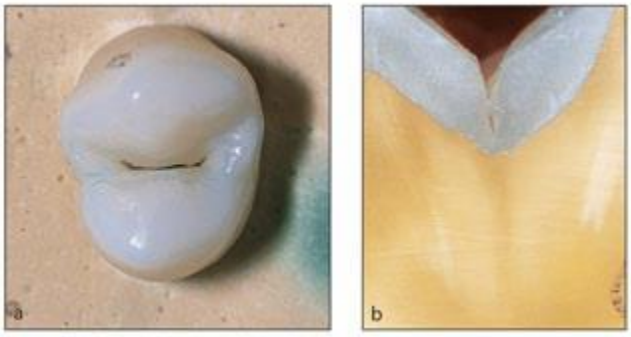
Enamel is as hard as steel. However, enamel will wear because of attrition or frictional contact against opposing enamel or harder restorative materials such as porcelain. Heavy occlusal wear is demonstrated when rounded cuspal contacts are ground to flat facets. Depending on factors such as bruxism, malocclusion, age and diet; cusps may be completely lost and enamel abraded away so that dentin is exposed. So, cavity outline form should be designed so that the margins of restorative materials avoid critical high stress areas of occlusal contact..



4. Faults and fissures

A deep fissure is formed by incomplete fusion of lobes of cuspal enamel in the developing tooth. The resulting narrow clefts provide protected area for acidogenic bacteria. Pits and fissures defects are eight times more vulnerable to caries than are smooth surfaces. Careful observation of enamel surrounding fissures for evidence of demineralization or cavitations' is necessary to determine the need for restorative intervention.

Several studies offer evidence that the physical barrier provided by an enamel bonded resin fissure sealant is an effective preventive treatment for high-caries-risk patients and for individual teeth with incipient enamel pit and fissure lesions.



5. Cracks

Pronounced cracks that extend from developmental grooves across marginal ridges to axial walls or from the margins of large restorations may cause cuspal fracture. When this crack extends through dentin or when the patient has pain when chewing; the tooth requires a restoration that provide complete cuspal coverage.

