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Operative Dentistry

Lecture (8) **Dr. Ahmed H. Ali**

Pulp Irritants

Pulp

Dental pulp consists of 75% water and 25% organic material, this organic material composed of collagen fibers and ground organic substances. Function of organic material is supporting nervous, cellular and vascular components of the vital tooth. Vascularization of the pulp is through the apical foramen which present at the root apex. Pulp tissue is enclosed in a hard dentinal structure of the tooth.

Functions of the pulp

1- Formative: Generates primary, secondary, and tertiary dentin (dentinogenesis)
2- Nutritive: Provides the vascular supply and ground substance transfer medium for metabolic functions and maintenance of cells and organic matrix
3- Sensory: Transmits afferent pain sensation (nociception)
4- Protective: Coordinates inflammatory, antigenic, neurogenic, and dentinogenic responses to injury and noxious stimuli.
5- homeostasis and clearance of noxious and antigenic substances through the vascular and lymphatic systems and through defense cells, such as macrophages and leukocytes.

Pulp irritants

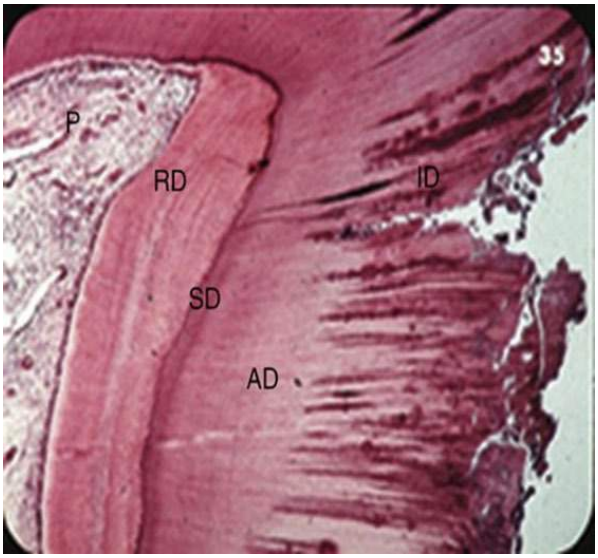
Response of the pulp to external irritation usually accompanied by changes in the dentin (such as sclerosis of dentin, reparative dentin…. etc.), therefore it has been agreed to consider the pulp and dentin as a one organ called the pulp-dentin complex which responds to tooth pathology through pulpal immune-inflammation defense systems and dentin repair/ formation.

Like other soft tissues, the pulp reacts to irritants with an inflammatory response. The pulp irritants can be classified according to the cause of irritant into:

I-Bacterial
II-Physical
III-Irradiation
IV-Chemical

I-Bacterial irritant

1-Caries



Carious enamel and dentin contain numerous bacteria such as *Streptococcus mutans*, *Lactobacilli*, and *Actinomyces*. The population of microorganisms decreases to few or none in the deepest layers of carious dentin. Microorganisms in caries produce toxins that penetrate into the pulp through the dentinal tubules. As a result of the presence of microorganisms and their by-products in the primary dentin, cells in the pulp (mainly odontoblasts)) will respond to this irritation by releasing of cytokines and chemokines that initiate inflammatory reaction and beginning of infiltration of chronic inflammatory cells primarily. As the carious lesion progresses deeper into the dentin and bacterial irritation increase, the pulpal reaction increases as well and the concentration and character of the inflammatory cells' infiltrate change to a more sever type of inflammation.

The outward flow of fluid through the dentinal tubules during the primary irritation does not prevent bacteria or their toxins from reaching the pulp and increasing the pulpal inflammation. The extent of the pulpal inflammation beneath a carious lesion depends on the depth of bacterial invasion as well as the degree to which dentin permeability has been reduced by dentinal sclerosis and reparative dentin formation as well as the duration of the irritant.

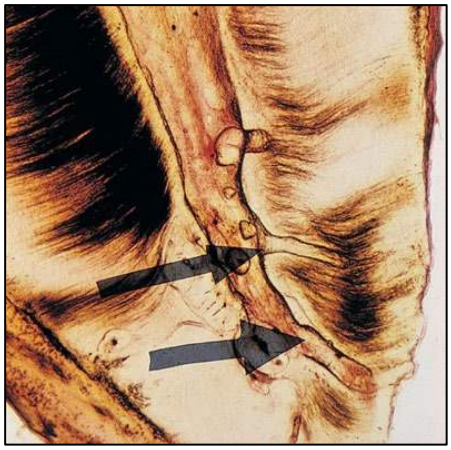
2-Contamination of an exposed pulp by microorganisms



When actual pulpal invasions by bacteria and/or their toxins occur, severe inflammation occurs and is infiltrated locally by polymorphonuclear leukocytes to form an area of liquefaction necrosis at the site of exposure. Pulpal tissue may stay inflamed for long periods and may undergo necrosis eventually or become necrotic quickly which make the tooth non-vital requiring root canal treatment.

3-Periodontal disease

Periodontal disease may extend to the pulp through the accessory canals (arrows in the figure), the apical foramen, and open dentinal tubules. The inflammatory changes of the pulp occur when teeth have many accessory canals or when periodontal disease has progressed to the apex.



Many studies concluded that the accumulative effect of periodontal disease has a damaging effect on the pulp, as indicated by the presence of pulp calcification, inflammation, or resorption, but total pulp disintegration is certainty only when the apical foramen is infected.

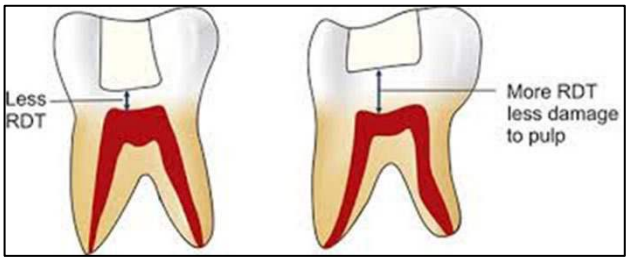
Some studies found that periodontal disease does not have a direct inflammatory effect on the pulp; the initial effect of periodontal inflammation may be degenerative. Root curettage can result in pulp devitalization. During curettage of a periodontal lesion that extends around the apex of a root, the pulp vessels may be severed and the pulp devitalized.

II-Physical irritant

1- Mechanical Irritation

A- Tooth preparation (caries removal or crown preparation)

Pulp trauma results when the pulp is closely approached or the dentin is extensively removed during cavity preparation. Over-cutting during cavity preparation, whether a pulp is exposed or not is one of the greatest damages to the pulp. Not only the depth of cavity affects the pulp, but also the width of the cavity has the same importance. Pulpal damage is roughly proportional to the amount of tooth structure removed as well as to the depth of removal. The remaining dentin thickness (RDT) after deep cavity preparation play a significant role in health of the pulp. Also, it has been noted that there is an inverse relationship between remaining dentine thickness and the pulp injury. This is very important, especially in the case of the acid etching procedure, which is important to increase the longevity of restorations. In teeth with remaining dentine thickness less than 300 μm, acid etching may lead to severe irritation to odontoblasts and persistent inflammation in the pulp due to high permeability caused by acid etching. Also, operative procedures without water coolant cause more irritation than those performed under water spray.



B- Orthodontic movement

The force of movement during orthodontic treatment creates a disturbance in the circulation of the pulp that is similar to those found in the periodontally involved teeth.

If the force is beyond the limitation of the physiologic tolerance, blood vessels in the periodontal ligaments may rupture with a resultant hemorrhage which lead to loss of the nutritional supply to some pulp cells. If hemorrhage occur from larger vessels of the pulp the entire pulp become necrotic. In addition, sometimes orthodontic movement may initiate resorption of the root apex, usually without a change in the vitality of the pulp.

C- Tooth fracture (acute trauma)

Tooth fracture occurs by either direct trauma to the tooth or indirect trauma to the jaw, in addition severe occlusal pressure on a tooth with a large filling can cause fracture of the tooth. Fracture is usually associated with a bacterial invasion that follows the accident. Untreated bacterial invasions will decrease any possibility of sustained vitality of the pulp. If the fracture occurs through the root, this will lead to a disturbance in the vascular supply that often lead to the loss of vitality of the injured pulp.

D- Attrition

Attrition is a mechanical wear of the incisal or occlusal tooth structure as a result of functional or para-functional movements of the mandible (tooth grinding, or bruxism usually due to stress). Pulp inflammation or necrosis related to the incisal wear is seldom, pulp has the ability to lay down dentin, but when a sever worn of the tooth occurs (when attrition exceed the rate of deposition of reparative dentin), pulp exposure with an observable incisal opening could be seen. the pulp may be devitalized at an earlier time and the attrition finally reach the chamber. Sometime the tooth required to be crowned to overcome this problem.



E- Abrasion (chronic trauma)

Abrasion is defined as the loss of tooth structure by mechanical or frictional forces, these lesions are commonly caused by excessive tooth brushing, but repeated and excessive forces by other materials and appliance, such as dental floss, tooth picks, or removable appliances, may also produce such defects.

These lesions can progress rapidly if they occur at the cement-enamel junction (CEJ) because the enamel is thin and the mechanical forces can wear the dentin and cementum away quickly. Also, it can be so severe that may invade the pulp space. The lesions commonly caused by horizontal brushing and appear as V- shaped notches on the labial surface.



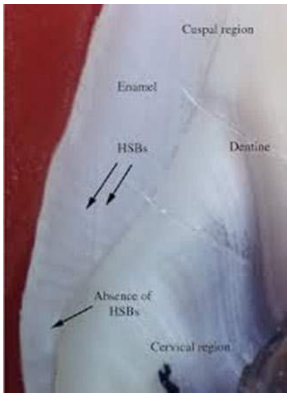
F- Abfraction

Abfraction is a type of noncarious cervical lesion characterized by the loss of tooth tissues with different clinical appearances.

The theory of abfraction sustains that tooth flexure in the cervical area is caused due to the occlusal compressive forces and tensile stresses, resulting in microfractures of the hydroxyapatite crystals of the enamel and dentin with further fatigue and deformation of the tooth structure. Abfraction lesions are also thought to be facilitated by the thin structure of the enamel and the low packing density of the Hunter-Shreger band at the cervical area.

It is important to determine and eliminate the cause (attrition, abrasion, or abfraction). If the tooth is hypersensitive, it could be relieved by desensitizing agents, topical fluoride, fluoride rinse, dentinal bonding agents, or restoration.





2- Thermal Irritation

It is commonly believed that the various dental procedures, such as tooth preparation, composite resin polymerization, finishing and polishing procedures can cause rise in the intrapulpal temperature. It was reported that an intrapulpal temperature increase of 5.5^{o}C for 10 seconds can cause histological damage in the pulp tissues (irreversible pulpitis or even pulp necrosis).

Two new methods for tooth preparation are available

-Laser

-Kinetic cavity preparation (air abrasion)

Laser device: is a device which produces beams of very high intensity light. There are several types available based on the wavelengths. Laser used for soft and hard

tissues, for soft tissue they can produce completely blood free incision followed by rapid healing. The use of a variety of lasers, including CO_2, Er:YAG, and free electron lasers (FEL) on tooth structure has demonstrated minimal pulpal response, comparable to that of high-speed rotary instrumentation.

The effect of laser depends on 1- power of beam 2- extent to which beam absorbed. When we used laser for cutting of enamel and dentin the process would generate heat, which might affect the pulp so it should be used in pulsating manner (not continuously).

-Air abrasion: this generates heat, difficult for operator to determine the cutting progress within the cavity preparation (loss of tactile sensation).

Air abrasive equipment is being used for stain removal and cleansing pit and fissure before sealing. Animal studies have shown that air abrasion cavity preparation is no more traumatic to the pulp than rotary instrumentation.

III-Irradiation irritant

The pulp of teeth is affected in-patient who is exposed to deep radiation therapy for malignant growth in head and neck region. In time odontoblasts cell and other cells will be necrotic and the salivary gland will be affected and resulting in decreasing of the salivary flow.

IV- **Chemical irritant**

1-Erosion





Erosion is being defined as the loss of tooth structure due to chemical action. Thus, erosion of facial or lingual tooth structure may create lesions. These lesions can be a prominent in patient with oral habits such as constant citrus ingestion, continues exposure to airborne acids, or gastrointestinal problems that produce repeated exposure of teeth to gastric acids. In these cases, the tooth lesions generally present a rounded, cupped-out defect initially confined to the enamel, if left untreated, the loss of tooth structure due to the chemical attack will accelerate once dentin has been reached, and deeper pattern of destruction will be seen.

Difference between dental attrition, abfraction, erosion and abrasion



Attrition Abfraction Erosion Abrasion

2-Chemical irritation of various restorative materials.

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