Endodontics

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Microbiology in Endodontics

In 1894, Miller's hypotheses stated that bacteria are the causative agent of apical periodontitis. Although there are other reasons such as chemical and physical irritation to the pulp can affect the pulp. This results in various degrees of inflammation.

More than 400 different microbial species have been found in infected root canals, usually in combinations. Fungi have been occasionally found in endodontic infections.

Change in the composition of the microbiota is due to changes in environmental conditions, particularly regarding oxygen tension and nutrient availability.

In the very initial phases of the pulpal infectious process, facultative bacteria predominate. After a few days or weeks, oxygen decrease within the root canal as a result of pulp necrosis and consumption by facultative bacteria. Oxygen supply is affected with loss of blood circulation in the necrotic pulp which develops an obligate microbiota.

Root canal microbes

The most prevalent named bacterial species detected in primary infections belong to diverse genera of

1- Gram-negative bacteria: Fusobacterium, Dialister, Porphyromonas, Prevotella, Tannerella, Treponema, Campylobacter and Veillonella

2- Gram-positive bacteria: Parvimonas, Filifactor, Pseu doramibacter, Olsenella, Actinomyces, Peptostreptococcus, Streptococcus, Propionibacterium, and Eubacterium bacteria.

Nutrition of Bacteria

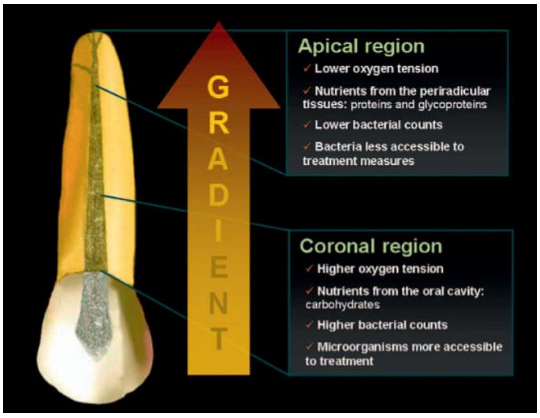
The main sources of nutrients for bacteria colonizing the root canal system include:

(1) Necrotic pulp tissue.

(2) Proteins and glycoproteins from tissue fluids and exudate that seep into the root canal system via apical and lateral foramens.

(3) Components of saliva that penetrate coronally into the root canal.

(4) Products of the metabolism of other bacteria.



Pulpal pathways

Bacteria, usually from dental caries, is the main source of injury to the pulpal and periradicular

tissues and they enter either directly or through dentine tubules.
Modes of entry for bacteria to the pulp are as follows:
1- Through the carious cavity.
2- Through the dentinal tubules as in contamination during cavity preparation, through exposed root surface, and surfaces with erosion, abrasion and attrition.
3- Through the apical foramen as in advanced periodontitis where microorganisms reach the apical foramen and then the pulp.
4- Through the blood stream (anachoresis). Following trauma or inflammation to the pulp any bacteria in the blood might be attracted to the pulp causing pulpitis.
5- Through faulty tooth restoration.
6- Through extension of a periapical infection from adjacent infected tooth.

Host-parasite interaction

This interaction depends on:

1- Microbial virulence factors

These are microbial products, structural components, or strategies (biofilm formation) in the microorganism that gives it the capability to cause tissue damage. The ability of a microorganism to cause disease is regarded as pathogenicity. Virulence indicates the degree of pathogenicity of a microorganism. Some microorganisms cause disease in a host and are called primary pathogens while other microorganisms cause disease only when host defenses are decreased which are called opportunistic pathogens.
Microbial products as endotoxins, endotoxin enzymes, metabolic end products affect the microbial virulence.

2- Host resistance factors

The reaction of the host to the presence of bacteria or their products can be effective such as:

a) Platelet factors.
b) Serum factors as antibodies (IgG, IgM)
c) Leukocytic factors as lysozymes which hydrolyzes bacterial cell wall of Gram +ve bacteria.
d) Macrophages factors.
e) Lymphocytic factors as lymphotoxin and macrophage activating factor.
f) Salivary factors as lysozyme, antibodies (IgA)

Biofilm and Bacterial Interactions

The community-forming ability is essential for microbial survival in all environments. Most of the microorganisms in nature grow and function as members of metabolically integrated communities called the biofilms. Biofilm can be defined as a multicellular microbial community embedded by cells that are firmly attached to a surface and enmeshed in a self-produced matrix of extracellular polymeric substance, usually polysaccharide. The ability to form biofilms is regarded as a virulence factor and biofilm infections account for an estimated 65% to 80% of bacterial infections. Biofilms are structurally and dynamically organized complex biologic systems. Bacterial cells in biofilms form microcolonies (±15% by volume) that are embedded

and nonrandomly distributed in the extracellular polymeric matrix (±85% by volume) and separated by water channels.
The matrix is not only important physically as part of the scaffold that determines the biofilm structure, but it is also biologically active and can retain nutrients, water, and essential enzymes within the biofilm. The matrix can also protect the biofilm community from external danger and may participate in adherence to the surface.

Spread of bacteria in the body

1- Bacteremia

Bacteria especially alpha hemolytic streptococci can enter the bloodstream during routine dental treatment. In normal person the bacteria are killed within 10 minutes by the body defense mechanism. Infective endocarditis happens in bacteremia to patients with a history of rheumatic fever with cardiac murmur or mitral valve prolapse.

2- Septicemia

It is a serious life-threatening bacterial (and their products) invasion of the bloodstream. It happens when body defense is low or when the infection overwhelming. It is associated with severe signs and symptoms.

3- Cellulitis

It is an acute infection of the alveolar and loose connective tissue and it is a diffused spread of infection. Clinically in endodontics cellelitis is called flare-up and it happens during access opening because of the environmental change of oxygen level in the root canal which enhances the action of the facultative bacteria and during instrumentation and obturation when debris or obturation material extrude the apical foramen.

Bacterial culturing in endodontics

There are three reasons for culturing root canal contents:

1- To determine the bacteriologic status of the root canal.

2- To assess the efficiency of the debridement procedure.

3- To isolate microbial flora for antibiotic sensitivity and resistance profiles in cases of persistent infections.

Intracanal medicaments

The main use of an intracanal medicament is to help destroy microbes.

1- Phenol. It is an effective medicament in root canal.

2- Camphorated phenol. It is phenol liquefied in camphor. It is less toxic of the phenolic compounds.

3- Camphorated monochlorophenol (CMCP). It is more toxic than phenol but it is also more active antiseptic but does not last for more than 3 days. It is less irritating than tricresol formalin.

4- Tri cresol formalin. The compound is a mixture of three isomers. It has a powerful antibacterial action that last for up to 7 days.

5- Calcium hydroxide. This is biocompatible and can be used to disinfect the root canal for more than one week. The antimicrobial activity of calcium hydroxide is

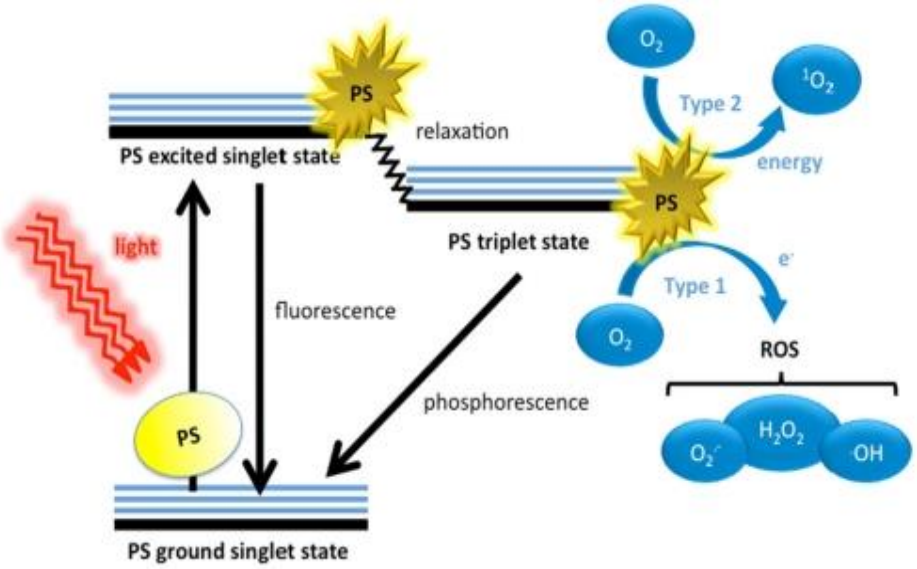
related to of (OH-) in an aqueous environment. Hydroxyl ions(OH-) are highly oxidant free radicals that show extreme reactivity, reacting with several biomolecules

6- Photoactivated disinfection (PAD)

Is a medical treatment that utilizes light to activate a photosensitizing agent (photosensitizer) in the presence of oxygen. The exposure of the photosensitizer (PS) to light results in the formation of oxygen species, such as singlet oxygen and free radicals, causing localized photodamage and cell death.

Mechanism:

PAD involves three components: light, a photosensitizer, and oxygen. A PS is administered to the root canal. Upon irradiation with light of a specific wavelength, PS undergoes a transition from a low-energy ground state to an excited singlet state. Then the PS may decay back to its ground state, with emission of fluorescence, or may undergo a transition to a higher-energy triplet state. The triplet state can react with endogenous oxygen to produce singlet oxygen and other radical species, causing a rapid and selective destruction of the target tissue.



Antibiotics in endodontics

Antibiotics are used when infection spreads to the alveolar bone with swelling of the area above the accused tooth and drainage does not relieve the swelling.

Most of the bacterial species involved with endodontic infections are susceptible to penicillins, which make them first-line drugs of choice. In more serious cases, including life-threatening conditions, combining amoxicillin with clavulanic acid or metronidazole can achieve optimum antimicrobial effects as a result of the extended spectrum of action to include penicillin-resistant strains. Erythromycin is used in cases of penicillin allergy.

As a conclusion unnecessary use of antibiotics increases the risk for developing resistant species of bacteria.