Review Article

Microbiology in Endodonitcs

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Abstract

Microbes are the main cause of caries. Once these microbes reaches pulp if the tooth has to be saved endodontic treatment is the only option. If the treatment is not initiated microbes can reach the periapical region and cause apical periodontitis and abscess. Proper understanding of the microbes that cause pulpal infection and pain will aid in bringing down the infection. This article discusses about the microbes that cause pulpal infection.

Key words*: Apical enlargement, classification, microorganisms, primary infection, secondary infection*

Introduction[1, 2, 3,4]

The main goal of endodontic treatment is to eliminate the intracanal microbes and eliminate the pathology and to prevent its reinfection so that the tooth will be free from infection and be asymptomatic. Miller was the first who explained the presence of a typical root canal microbiota. He observed that there was a difference in the bacteria in the teeth with open pulp chambers and those in the root anals. Endodontic infections can be classified according to their anatomical location (intraradicular or extraradicular infection) and to how long it took microorganisms to each the root canal (primary, secondary, or persistent infection). Usually, primary and secondary/persistent endodontic infections are located intraradicularly, and may originate in extraradicular infections if left untreated or inadequately treated. endodontic infections are polymicrobial and the development of the disease is as a result of cooperation between the microorganisms.

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Microorganisms in primary endodontic infections[1,5,6,7,8] Openings in the physical barriers of dentin (enamel and cementum) by means of caries, cracks, or traumatic injuries create pathways for bacteria into the root canal system. The most prevalent and abundant bacterial taxa/ groups occurring in primary infections include black-pigmented Gram-negative anaerobic species (Prevotella and Porphyromonas species), Fusobacterium nucleatum, streptococci, spirochetes (Treponema species), Dialister species, Pseudoramibacter alactolyticus, Propionibacterium species, Parvimonas micra, Tannerella forsythia, Filifactor alocis, Eubacterium species, and Olsenella species The apical root canal microbiota is predominantly anaerobic and the time of infection can influence this dominance, i.e. at late stages of infection, anaerobes comprise the large majority of isolates. The most commonly isolated genera include anaerobic *streptococci*, *Fusobacterium* species and the black-pigmented anaerobes such as *Prevotella* and Porphyromonas species. Facultative anaerobes belong to the viridans group *streptococci* and the anginosus group *streptococci* are commonly implicated in dental abscess. The viridans group *streptococci* includes mitis group, oralis group, salivarius group, sanguinis group, and the mutans group. The presence of bacterial flora in untreated canals is regulated by the availability of nutrients and oxygen. In necrotic tooth, untreated canals Gram-positive, Gram-negative, anaerobic and aerobic

are found. The redox potential in the necrotic root canal is very low – lower than in a deep periodontal pocket – which favors the dominance of anaerobic bacteria. Dark-pigmented anaerobic bacteria have been closely associated with acute symptoms of endodontic infections, including abscesses. Dark-pigmented anaerobic bacteria are usually found in mixed infection, which may be required for their optimal growth and contributes to a significant increase in their pathogenicity. This bacterial group comprises two genera: Prevotella (containing saccharolytic species) and Porphyromonas (containing asaccharolytic species). In the case of symptomatic apical periodontitis, when the tooth is sensitive to percussion, predominant strains of microorganisms are Parvimonas micra, Eubacterium, Porphyromonas (P. endodontalis, P. gingivalis) and Prevotella. Especially, the BPB (black – pigmented bacteria) have gained much attention. The anaerobic infection is usually polymicrobial with low virulence of the single anaerobic species. The need for cooperation and synergism between bacteria to form pathogenic combinations are characteristics of the anaerobic infection.

Persistent/secondary intraradicular infections[2, 3, 9, 10, 11] In this case, microorganisms may have tolerated the chemomechanical procedures (persistent infection) or invaded the canal via coronal leakage of the root filling (secondary infection). Facultative anaerobic and gram-positive bacteria predominated in canals with endodontic treatment failure, which may be due to increased resistance to instrumentation and to antiseptic agents. E. faecalis, a facultative gram-positive bacterium, is capable of surviving in an environment with scant availability of nutrients and minimal commensality with other bacteria. Studies have shown that bacteria can influence the outcome of the endodontic treatment in some critical situations: Bacteria are able to survive without nutrient. is capable of resistance in extreme conditions, can multiply at temperatures between 10 and 45 °C, and can withstand an alkaline pH of 10 hyperosmolar NaOCl solutions at a concentration of 6.5% [64]; it can also withstand hydrogen peroxide, ethanol, sodium hypochlorite, and ultraviolet radiation in the absence of nutrients for prolonged periods of time. They have unrestrained access to the periradicular tissues through apical/lateral foramens and Bacteria have virulence attributes that are expressed in the modified environment and reach enough concentrations to directly or indirectly induce damage to the periradicular tissues.

Effects of endodontic treatment on microflora[4, 8. 12, 13] Infected root canals can harbour between 10^2 to more than 10^9 bacterial cells. Manual instrumentation with 6–10ml of saline per canal can reduce the number of bacteria in infected root canals by 100 to 1000-fold. However, root canal preparation with hand files and saline irrigation is only moderately effective. Those bacteria cannot be completely eliminated after thorough instrumentation and irrigation regardless of the technique points to the need to follow instrumentation with an antibacterial dressing before obturation to better achieve the goal of bacteria-free root canals.

Microbial ecology in the infected root canal[9, 14, 15, 16] The microflora of infected root canal has the ability to initiate periapical inflammation through combination of species. Pathogens produce resorption and tissue destruction enzymes and also inactivate human plasma proteins. Obligate anaerobes dominate the microbial flora in root canal infections of human teeth with intact pulp chambers. Goran Sundqvist In his classical thesis on the cultivable microbiota of traumatized single-rooted teeth with an intact pulp chamber, he noticed that the presence of Bacteroides melaninogenicus (now: Prevotella melaninogenica) in all the acute cases with pus and/or tenderness, but not in counterparts diagnosed with chronic apical periodontitis. In teeth with a necrotic infected pulp, bacteria may penetrate to the most apical part of the root canal and have been observed at the apical foramen.

Classification of root canal flora[17,18]

Most prevalent groups	Gram-negative / Gram-positive anaerobes	Gram-negative anaerobes	Gram-positive facultative / anaerobes	Gram-positive facultative
Most frequent taxa	Treponema spp. Tannerela forsythia Porphyromonas spp. Dialister spp. Filifactor alocis Pseudoramibacter alactolyticus Fusobacterium nucleatum Synergistes spp. Eikenella corrodens Prevotella spp. Olsenella spp. Parvimonas micra Peptostreptococcus spp. Campylobacter spp	Treponema spp. Tannerela forsythia Porphyromonas spp. Dialister spp. Fusobacterium nucleatum Eikenella corrodens Synergistes spp. Prevotella spp. Olsenella spp. Parvimonas micra	Streptococcus mitis Other streptococci Propionibacterium spp. Fusobacterium nucleatum Prevotella spp. Pseudoramibacter alactolyticus Parvimonas micra Lactobacilli Olsenella spp. Actinomyces spp. Pseudomonas aeruginosa Enteric rods	Enterococcus faecalis Candida albicans (yeast) Streptococcus spp. Pseudoramibacter alactolyticus Propionibacterium propionicum Filifactor alocis Dialister spp. Actinomyces spp. Pseudomonas aeruginosa Enteric rods

Does apical enlargement eliminate infection?[13, 19, 20]

Once bacteria have invaded the dental pulp and root canal space, they may also invade the dentinal tubules. Bacterial infection of dentinal tubules may occur to a lesser extent in older patients compared to younger patients. This is particularly important for bacterial survival in the radicular portion of the canal, where the anatomy can be highly complex Streptococci and some Gram-positive rods such as Actinomyces and Lactobacillus spp. appear to invade the dentinal tubules better than several Gram-negative species. In another study it was demonstrated the role of the smear layer in effectively preventing bacterial invasion into the dentine. However, E. faecalis penetrated the dentine even in the presence of the smear layer. There is no consensus on the ideal apical enlargement size. All studies provide strong consensus that big apical preparation will result in reduced bacterial count and dentin debris reduction than the small apical preparation. It is possible that in the treatment of teeth with a vital pulp (pulpectomy), the size of the apical preparation is not critical because of the absence of microorganisms in the apical canal, while in the treatment of apical periodontitis, apical enlargement may be more important

Endotoxin and endodontic infections[18, 21, 22]

Lipopolysaccharide (LPS), Endotoxins are potent inflammatory agents, which activate classical and alternative pathways of complement system. Presence of endotoxin is associated with gram-negative bacteria. Primary infections had higher contents of endotoxins and more complex gram-negative bacterial community than teeth with secondary infections. Higher levels of endotoxin have been found in root canals with larger size of radiolucent (>2 mm) thus elucidating the role of endotoxins in the bone resorption present in apical periodontitis.

Conclusion: Regardless of the treatment procedure followed complete elimination of the microorganisms is needed for the success of the treatment, alleviation of the symptoms and resolution of infection. The proper diagnosis of whether the tooth is vital or necrotic, case is a primary case or retreatment case and size of the periapical lesion is important in taking the appropriate treatment protocol as the bacteria are different in these cases.

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