MICROBIAL ETIOLOGY OF ROOT CANAL TREATMENT FAILURE

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Abstract:
The objective is get a review on microbiological etiology of root canal treatment failure. Root canal treatment, the key for endodontic treatment, is needed when the pulp becomes inflamed or infected. However there is a threat of reinfection because of microorganism even after the treatment. The data on the biological causes for endodontic failures helps to achieve a comprehensive overview of the pathogenesis of root canal treatment failure. This review gives further information about the common microorganism which cause the primary and secondary infection in the root canal and cause persistent apical periodontitis.

Introduction:
Endodontics has become an increasingly routine aspect of patient care in general dental practice. The study of microbes infecting root canals and periradicular tissues has greatly increased thereby increasing our knowledge and understanding of reasons for endodontic failures. Newer information on endodontic micro flora improves our ability to effectively debride and disinfect the root canal system and manage infections of endodontic origin. Molecular methods and other research techniques have helped detect and identify many previously unknown endodontic pathogens. Primary infected root canals are untreated canals, into which the microorganisms have gained access to colonize the pulpal tissue. When failure of endodontic treatment due to persistence of bacterial infection in the root canal system occurs, it is called as secondary infection. Necrotic pulpal tissue investigated in primary root canal infections has commonly exhibited the presence of polymicrobial flora with an average of intra-canal species, which are often Gram- negative anaerobic. Obligate anaerobic bacteria are found to be the dominant species in several studies in root canal infections, which comprise 90% of all bacterial species. However, facultative bacteria such as, Enterococci, are more likely to survive chemomechanical instrumentation and root canal medication due to their ability to survive with or without oxygen in the environment (endo microflora).
Cause for root canal treatment failure:

Causes for root canal treatment failure can be majorly categorised as pre-operative, operative and post-operative causes. The preoperative reasons may be the wrong diagnosis by the clinician, systemic diseases like Pagets disease, local tissue resistance, local factors like age, sex, nutrition, hormonal factors, endoperio lesions and traumatic injury. The operative causes may include anatomical variations, infections, technical difficulties, poor debriment, broken instruments, mechanical and chemical irritants, incorrect access cavities, improper cleaning and shaping, haematoma, over extended and under extended fillings and a few iatrogenic causes also. The post operative causes are failure of retreatment and failure of surgical retreatment. In many cases errors that takes place during the time of procedure does not cause a greater impact on the failure of the treatment unless the canal is retained with pathogenic microorganisms. Procedural exposure to microorganisms during treatment of infected root canal makes it difficult to achieve the success rate of the treatment. Another major cause may be the biofilm formation in the root canal. A biofilm can be defined as a microbial population attached to an organic or inorganic substrate, surrounded by microbial extracellular products, which form an intermicrobial matrix.

2. Microbial factors

Intraradicular infection:

Microorganisms colonising the root canal system play an essential role in the pathogenesis of periradicular lesions, exposed the dental pulps of conventional and germ-free rats to the oral cavity and reported that pulp necrosis and periradicular lesions developed only in conventional rats with an oral microbiota. In a study of monkey teeth, Möller et al. demonstrated that only devitalised pulps that were infected induced periradicular lesions, whereas devitalised and uninfected pulps showed absence of pathological changes in the periradicular tissues, confirmed the important role of bacteria in periradicular lesions in a study using human teeth, in which bacteria were only found in root canals of pulp-less teeth with periradicular bone destruction. The chances of a favourable outcome with root canal treatment are significantly higher if infection is eradicated effectively before the root canal system is obturated. However, if microorganisms persist in the root canal at the time of root filling or if they penetrate into the canal after filling, there is a higher risk that the treatment will fail. How high the risk of reinfection will be is dependent on the quality of the root filling and the coronal seal. Nonetheless, in all cases where viable bacteria remain in the root canal system there is a constant risk that they may perpetuate periradicular inflammation. In most cases, failure of endodontic treatment is a result of microorganisms persisting in the apical portion of the root canal system, even in
Studies have demonstrated that part of the root canal space often remains untouched during chemomechanical preparation, regardless of the technique and instruments employed. Untouched areas may contain bacteria and necrotic tissue substrate even though the root canal filling appears to be radiographically adequate. Indeed, a radiograph of a seemingly well-treated root canal does not necessarily ensure the complete cleanliness and/or filling of the root canal system. Environmental influences operate in the root canal system during treatment, allowing certain microorganisms to survive and, depending on several factors, induce failure. Such influences are affected by intracanal disinfection measures and the low availability of nutrients within a well-treated root canal. To survive in the root-filled canal, microorganisms must withstand intracanal disinfecting measures and adapt to an environment in which there are few available nutrients. Therefore, the few microbial species that have such ability may be involved in the failure of root canal treatment.

Bacteria located in areas such as isthmuses, ramifications, deltas, irregularities and dentinal tubules may sometimes be unaffected by endodontic disinfection procedures. It is probable that the supply of nutrients to bacteria located in ramifications and deltas will remain unaltered after root canal therapy. Nonetheless, bacteria present in areas such as dentinal tubules and isthmuses may have a drastically reduced substrate. In such anatomical regions, bacteria entombed by the root filling usually die or are prevented from gaining access to the periradicular tissues. Even interred, some bacterial species will probably survive for relatively long periods, deriving residues of nutrients from tissue remnants and dead cells. If the root canal filling fails to provide a complete seal, seepage of tissue fluids can provide substrate for bacterial growth. If growing bacteria reach a significant number and gain access to the periradicular lesion, they can continue to inflame the periradicular tissues. The fact that studies have reported the occurrence of viable microbial cells in treated teeth with a persistent periradicular lesion indicates that microorganisms derive nutrition, presumably from tissue fluid which can seep into the root canal space.

The ability to survive in such conditions is important for most bacteria because periods of starvation are commonly experienced. Several regulatory systems play essential roles in the ability of bacteria to withstand nutrient depletion. These systems are under the control of determined genes, whose transcription is activated under conditions of starvation.

**Extraradicular infection:**

The development of periradicular lesions creates a barrier within the body to prevent further spread of microorganisms. Bone tissue is resorbed and substituted by a granulomatous tissue containing defence elements, such
as cells (phagocytes) and molecules (antibodies and complement molecules). A dense wall composed of polymorphonuclear leucocytes, or less frequently an epithelial plug, is usually present at the apical foramen, blocking the egress of microorganisms into the periradicular tissues. Very few endodontopathogens can advance through such barriers. However, microbial products can diffuse through these defence barriers and are able to induce or perpetuate periradicular pathosis. Recently, considerable interest has been generated regarding the potential role of extraradicular persistent microorganisms in the failure of the root canal treatment. Cultural and microscopic studies have reported the occurrence of extraradicular infections in both treated and untreated root canals. Since microorganisms established in the periradicular tissues are inaccessible to endodontic disinfection procedures, extraradicular infection may be a factor in the failure of endodontic therapy. Pathogens have developed mechanisms that allow them to survive in an inhospitable environment.

**Microbial invasion of root canal:**

The interrelationships between microbes in the disease process have been positively established by the studies of Fabricius et al. on monkeys. In the studies, bacterial isolates from the root canal of a monkey were inoculated as a separate or combined strain into the root canals of other monkeys. The study revealed that the separate strains produced only a small lesion and mild periapical reaction in comparison to the combined strains. Similar experiments involving P. Oralis revealed that it did not survive as a single isolate. However, the presence of other bacteria seemed to favour its survival and dominance within the root canal. Enterococcus faecalis and Streptococcus milleri were also found to induce weak periapical reactions when inoculated as separate strains, although they could survive in the root canal as combined isolates. The synergistic mechanisms between the various endodontic pathogens involve interplay of various factors like:

- Providing nutrition
- Inhibition of phagocytosis (i.e. preventing opsonisation and inflammation, destruction of phagocyte)
- Secretion of growth factors and enzymes
- Decrease in the local oxygen concentration
- Oxidation–reduction potential and local pH in the root canal.

These mechanisms facilitate the survival and pathogenesis of obligate and facultative anaerobes

**Non-Microbial factor:** Although most of the cases of root canal treatment failure are associated with intraradicular and/or extraradicular infections, it has been suggested that some cases can fail because of intrinsic or extrinsic non-
In these cases, no microorganisms can be found, and failures have been attributed to a foreign body reaction in the periradicular tissues. A study reported a therapy-resistant lesion, which is surgically removed and diagnosed as a periradicular cyst by light and electron microscopy. A large number of cholesterol crystals were observed in the connective tissue around the cystic epithelial lining. Since microorganisms were not detected, the investigators attributed the failure to a foreign body reaction against cholesterol crystals. Cholesterol crystals get precipitated and accumulate as they are released from disintegrating host cells, including erythrocytes, lymphocytes, plasma cells, and macrophages. These can be in large numbers in chronic periradicular lesions. Because of the characteristics of the cyst cavity, the host defence mechanisms may not be effective in eliminating microorganisms. Persisting microorganisms and their products within the cyst lumen may maintain a periradicular inflammation in well-treated root canals. This also characterises an extraradicular infection.

**Characterisation of successful RCT:**

The estimation of the RCT prognosis must be related to criteria for understanding the success. The RCT success criteria and its prevalence should be routinely reevaluated. Among the clinical and radiographic characteristics of the RCT failure there is often observed the presence of symptoms (pain) and/or the presence of a periapical radiolucent area. AP is a consequence of root canal system infection, which can involve progressive stages of inflammation and changes of periapical bone structure, resulting in resorptions identified as radiolucencies in radiographs. RCT failures may involve microbial and non-microbial factors, as discussed previously. A high rate of failure is associated with endodontically treated teeth associated with AP, overfilling, and teeth that were not properly restored after RCT. Thus, utmost care must be taken to establish criteria to define success. On this account, the life of a tooth endodontic treatment may be rely on the time and the age of the individual. In a prospective analysis, an endodontically treated tooth is expected to remain throughout the individual’s life. The analysis of the RCT success involves reversion of the inflammatory/infectious process, no symptoms, well restored, in function and no evidence of periapical radiolucency.

It is important to recognise that along people’s life, some diseases may develop and impact their health. Incidentally, an infection or re-infection may arise some time after RCT. To characterize the outcomes of endodontically treated teeth with vital pulp (healthy or inflamed pulp), infected pulp, AP and periapical abscess, must be considered the time since RCT conclusion and the definite restoration. The previous status of pulp and periapical tissue may aid in the interpretation of actual clinical conditions.
Management of RCT failure:

The bacterial biofilm is commonly seen in carious infected teeth or even in a pulp necrosis root. The most common reasons for failures in conservative root canal therapy are related to problems in instrumentation. However, occasionally, bacteria resistant to conservative therapy may also be involved. Bacteria-associated with endodontic failures together with pulp-periapical infections in conventional treatment represent the unresolved bacteriological problems in endodontics. Numerous studies have shown that persistent endodontic infections are often caused by Enterococcus faecalis.

The presence of these biofilms can be seen in scanning electron microscopy and by various culture methods. It can be seen that the rate of biofilm formation is increased when the incubation time is increased. The sterilisation of the canal with biofilms become more difficult since it’s a heterogeneous mixture with various microorganisms present in them and which are more resistant to biomechanical preparations and intracanal medicaments. There are few methods in which the irritants in the root canal can be activated those include the sonic, ultrasonic and laser activation. These new advancements help in removal of more debris from the root canals, better cleansing of the root canals with high speed oscillations and more acoustic streaming and cavitation. Lasers and optic fibres also give better results in the removal of the smear layer with usage of Ni-Ti instruments and better irrigants like ethylene diamine tetraacetic acid with cetavlon (EDTAC).

The most important intracanal medicaments used include calcium hydroxide, (metronidazole, triple ciprofloxacin antibiotic paste and minocycline), chlorhexidine, champhorated chloramphenicol. These medicaments have a sweeping action on the canal as well as some therapeutic advantages. Most of them are biocompatible and increases the success rate of the treatment.

Conclusion:

Our knowledge and understanding of the microbes infecting root canals and periradicular tissues has greatly increased. This information improves our ability to effectively debride and disinfect the root canal system and manage infections of endodontic origin. Success of any endodontic treatment is dependent on the effective elimination or maximal reduction of the involved microbiota. Modern day advances in laboratory procedures for identification of endodontic microflora, new therapeutic techniques and a clear understanding of the initiation and progression of the disease process will definitely take us a step closer to the goal of complete microbial elimination for successful root canal treatment.
Reference:


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