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Biofilms in Endodontics

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Abstract

Penetration of microorganisms into the pulp is the main reason for endodontic treatment and failure to eliminate them is the main cause of failure of endodontic treatment. Microorganisms attached irreversibly to substratum and form biofilms in the root canals. These biofilms are heterogeneously composed. This article discusses the role of biofilms and how to eliminate them.

Keywords: Biofilms; Endodontics; Microorganisms.

Introduction

Biofilm can be defined as a sessile multicellular microbial community characterized by cells that are firmly attached to a surface and enmeshed in a self-produced matrix of extracellular polymeric substance (EPS, usually a polysaccharide).[1] In a biofilm, microorganisms are wrapped in an extracellular matrix made of polysaccharides that have internal water channels. Intraradicular infection can persist in the complex apical root canal anatomy: canal irregularities, deltas and isthmus areas, and accessory canals.

Types of Biofilms[1]

1. *Intracanal:* The film is on the internal surface of dentin of the infected teeth. Most of the microorganisms survived as free collections of cocci, rods, filaments, and spirochetes.
2. *Extraradicular (cementum):* Formed on the surface of root near to root apex. SEM evaluation of root apex showed that continuous, smooth, structure less layer having various bacteria in different morphological forms. In irregular surfaces, bacteria were seen held together by an extracellular material. Seen in teeth with asymptomatic apical periodontitis also in teeth with chronic apical abscesses and a sinus tract.
3. *Periapical:* Present in the periapical region of the tooth, independent of root canal infection.
4. *Biomaterial/Foreign body centered:* Seen when bacteria adhere to an artificial biomaterial surface. It is associated with implant and prosthesis in the mouth.

Composition of Biofilm[1,2]

A fully developed biofilm is a mixture of microbial cells on a solid surface. Biofilm is made up of matrix material 85% volume and 15% cells. Surface adherent surface cells are the most important component of the biofilm.

Formation of Biofilm[3,4]

1. Deposition of a conditioning film
2. Adhesion and colonization of planktonic microorganisms in a matrix of polysaccharides and proteins
3. Coadhesion of other organisms
4. Detachment of biofilm microorganisms into their surroundings.

The EPS matrix performs the following functions in the microbial colony:[5,6]

(i) It facilitates biofilm adhesion to surfaces, commonly acting as a "biological glue";

(ii) It maintains mechanical stability of the biofilm;

(iii) It aids in extracellular enzymes to accumulate and exert important activities, which include nutrient acquisition and cooperative degradation of complex macromolecules;

(iv) It maintains biofilm cells in close proximity, thus permitting for interactions including quorum sensing, genetic exchanges, and pathogenic synergism;

(v) During time of nutrient deprivation, it can act as a source of nutrient, although few components of the matrix may be only slowly or partially degradable;

(vi) It maintains water and keeps a highly hydrated microenvironment arround the biofilm populations;

(vii) It plays a protective role against host defense cells, molecules and antimicrobial agents.

Intraradicular infection can be categorized into.[7–9]

1. *Primary infection:* In this, microorganisms enter the pulp due to caries or trauma.
2. *Secondary infection or post-treatment infection:* In this case, microorganisms gain access to the pulp between the appointments or after treatment.
3. *Reinfection (acquired or emergent)*
4. *Remnant or persistent infection:* Micro-organisms present during primary or secondary infection and survived even after the treatment.
5. *Recurrent infection (re-developed in teeth after apparent healing)*

Discussion

Endodontic disease is due to biofilm-mediated infection, and the main goal in the treatment of endodontic disease is the elimination of bacterial biofilm from within the canal. Nair discussed endodontic biofilm for the first time.[2] The three constituents involved in biofilm development are bacterial cells, a fluid medium, and a solid surface. Microorganisms progress from carious surface the process of biofilm formation starts gradually in the canal as the infectious process progresses in an apical direction to apical region.

Microorganisms survived mainly as biofilms, mostly present in uninstrumented surfaces of the main root canal, accessory canals, isthmuses and anastomoses. The bacteria in the canal are initially aerobic and facultative anaerobic. With the disease progression the ecology of the canal changes.

Enterococcus faecalis has been found as the primary cause of persistent endodontic infections. It could grow under aerobic, anaerobic, nutrient-rich, and nutrient-deprived environment.[5,10,11]

Biofilm was present along the dentinal surface and penetrated to varying depth in dentinal tubules. Microorganisms in a biofilm are much more resistant to majority of antimicrobials and the host defense.[12,13]

A good root canal irrigant should be effective against microorganisms present in biofilms while being systemically harmless and not cause damage to periodontal tissues. The thickness of the biofilm and the concentration and ability of the antimicrobial to pass through the EPS matrix will dictate the extent of exposure of cells in biofilms. Resistance to irrigants and intracanal medicaments is considerably higher in multispecies biofilms compared to single-species biofilms. Bridging, or coaggregation, amongst two or more species of bacteria is a vital process in multispecies biofilm formation. *Fusobacterium nucleatum* is commonly

found in multispecies biofilm. The goal of root canal irrigation is to eliminate vital or necrotic pulp tissues, dissolve endodontic biofilms, neutralize endotoxins and eliminate the smear layer.

Sodium hypochlorite (NaOCl); a very effective irrigant; is capable of dissolving vital or necrotic tissue along with antimicrobial activity. Tissue dissolution and biofilm disruption are concentration dependent. Warm solution and use of sonic and ultrasonic improves the effectiveness of sodium hypochlorite. Biofilms can resist antimicrobial agents in several ways.

Polysaccharide matrix present in the biofilms can retard diffusion of the antibiotics. Also, extracellular enzymes such as β-lactamase may become trapped and concentrated in the matrix, thereby inactivating β-lactam antibiotics. Chlorhexidine is less toxic when compared to sodium hypochlorite and sustained action, i.e. substantivity. A 2% concentration of chlorhexidine is recommended as a root canal irrigant.[2,5,7]

Conclusion

Elimination of biofilms is pivotal to the success of endodontic treatment. The astute practitioner must diagnose the case and use the suitable intracanal irrigant to eliminate as much infection present in the canal. The treatment for vital teeth is different compare to the necrotic teeth with periapical lesion. The treating doctor must use the suitable medicament for the complete elimination of the biofilms.

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References

1. Siqueira JF Jr, Rôças IN. Clinical implications and microbiology of bacterial persistence after treatment procedures. J Endod 2008;34(11):1291–1301.
2. Nair PN. Light and electron microscopic studies on root canal flora and periapical lesions. J Endod 1987 Jan;13(1):29–39.
3. Toral FC, Hernández LD, González CE et al. Ex vivo model for studying polymicrobial biofilm formation in root canal. Univ. Sci 2017 Jan;22(1):31–43.
4. Mohammadi Z, Palazzi F, Giardino L et al. Microbial Biofilms in Endodontic Infections: An Update Review. Biomed J. 2013 Mar-Apr;36(2):59-70.
5. José F, Siqueira JR, Isabela N, et al. Biofilms in endodontic infection. Endodontic Topics 2012;22:33–49.
6. Giuseppe Di Filippo, Sharanbir K Sidhu, Bun San Chong. The role of biofilms in endodontic treatment failure. ENDO (Lond Engl) 2014;8(2):87–103.
7. Neelakantan P, Romero M, Vera J et al. Biofilms in Endodontics—Current Status and Future Directions. Int. J. Mol. Sci 2017;18(18):1748.
8. Yoo YJ, Perinpanayagam H, Oh S, et al. Endodontic biofilms: contemporary and future treatment options. Restor Dent Endod 2019 Feb;44(1):e7.
9. Jiao Y, Tay FR, Niu Li and Chen Jh. Advancing antimicrobial strategies for managing oral biofilm infections. Int J Oral Sci 2019 Oct 1;11(3):28.
10. Wang J, Jiang Y, Chen W, et al. Bacterial flora and extraradicular biofilm associated with the apical segment of teeth with post-treatment apical periodontitis. J Endod 2012;38(7):954–59.
11. Ter GS & Bergenholtz G. Biofilms in endodontic infections. Endodontic Topics 2004;9:27–36.
12. Swimberghe RCD, Coenye T, De Moor RJ G. et al. Biofilm model systems for root canal disinfection: A literature review, International Endodontic Journal 2019 May;52(5):604–28.
13. Jhajharia K, Parolia A, Shetty KV, et al. Biofilm in endodontics: A review. J Int Soc Prev Community Dent 2015;5(1):1–12.