Review Article

Root canal biofilms: Review

Shruti Sharma[1], Varun Rajkumar[2], Sipra Sarin[3], Sahil Sarin[4], Charanpreet Singh Chugh[5], Harmeet Kaur[6]

[1]BDS, Private Practitioner, Delhi. , [2]MDS, Private practitioner, Delhi , [3]MDS, Private Practitioner, Punjab, [4]MDS, Assistant professor, Department of Prosthodontics, Genesis Institute of Dental Sciences & Research, Punjab, [5]MDS, Private Practitioner, Punjab , [6]BDS, Private Practitioner, Punjab

Abstract

The success rate of root canal therapy has tremendously increased over the years owing to various advancements in the field. One main reason is the complete understanding of the microbiology involved in the endodontic pathology. Biofilms have been implicated as the chief culprit in the etiopathogenesis of dental caries and periodontal disease. Hence; in the present review, we aim to highlight some of the important aspects of root canal biofilms.

Key words: Biofilms, Root canal, Success

Corresponding author: Dr Shruti Sharma, BDS, Private Practitioner, Delh

This article may be cited as Sharma S, Rajkumar V, Sarin S, Sarin S, Chugh CS, Kaur H. Root Canal Biofims: Review HECS Int J Com Health and Med Res 2017;3(3):93-95

INTRODUCTION

The success of infected root canal therapy is influenced by discrepancy gradients of microorganisms between the endodontic biofilm and the planktonic suspension. The phases for the microbial community to develop a biofilm and colonize the environment may sometimes be unusual, but basically occur with the same sequence of developmental steps: deposition of a conditioning film, adhesion and colonization of planktonic microorganisms in a polymeric matrix, co-adhesion of other organisms, and detachment of biofilm microorganisms into their surroundings.[1-3]

Infection of the root canal is not a random event. The type and mix of the microbial flora develop in response to the surrounding environment. Microorganisms that establish in the untreated root canal experience an environment of nutritional diversity. In contrast, well-filled root canal offers the microbial flora a small, dry, nutritionally limited space.[4, 5]

BIOFILM FORMATION

Biofilm formation is a step-wise procedure its formation occurs in the presence of microorganisms, fluid and solid surface. Biofilm is considered as community as it possesses following criteria: Autopoiesis; Haemostasis; Synergy; Communality.[6]

BIOFILMS IN ENDODONTIC INFECTIONS

Biofilm biology has become an expanding field of research in human, industrial and environmental ecosystems. The knowledge accumulated suggests that organisms growing in biofilms develop properties different to those dwelling in the planktonic state. On surveying the endodontic literature it is obvious that this realization and the fact that biofilms afford the resident microorganisms protection/resistance against harmful exogeneous influences including antimicrobial agents, is rather new to endodontology. Hence, the conditions under which biofilms occur in endodontic infections, and the measures that ought to be taken for their eradication, are not well understood.[7, 8]

Bacterial biofilm can be seen beyond the apex of the root as bacteria in biofilm survive unfavourable environmental and nutritional conditions. Infectious processes in root canal gains sufficient power to cause subsequent destruction of the pulpal tissues only after biofilm formation. Biofilm formation in root canals is probably initiated at some time after the first invasion of the pulp chamber by planktonic oral organisms after some tissue breakdown. At this point, the inflammatory lesion frontage that moves successively toward the apex will provide the fluid vehicle for the invading planktonic organisms so these can multiply and continue attaching to the root canal walls. The necrotic pulp tissue becomes a favorable environment for microbial proliferation due to the presence of organic residue or nutrients, which act as substrate or culture medium. Gram-negative bacteria are more frequent than Grampositive bacteria. Facultative or strict anaerobic microorganisms are more frequent than aerobic microorganisms, and the presence of bacilli and filaments is equivalent to that of cocci.[9]

BIOFILM AS A THERAPEUTIC TARGET IN ROOT CANAL TREATMENT

The infected root canal harbors a polymicrobial population of aerobic, anaerobic, Gram-positive, and Gram-negative bacteria in a biofilm mode of growth. Gram-positive and Gram-negative bacteria have profound differences in their three-dimensional cell architecture. The membrane barrier of a bacterial cell limits the diffusion of antimicrobials into the cytosol. The membrane barriers of a Gram-positive bacterium consist of a relatively thicker but porous cell wall made up of inter-connected peptidoglycan layers surrounding a cytoplasmic membrane. The teichoic acid residues of the cell wall contribute to the negative charge, which serves as binding sites for cationic molecules. Conversely, the cell envelope of a Gram-negative bacterium is composed of an outer membrane, a thinner peptidoglycan layer, and a cytoplasmic membrane. Movement of molecules across a Gram-negative cell wall is strictly regulated at the outer membrane, which is rich in lipopolysaccharides. Thus, the susceptibility of a bacterium to an antimicrobial will depend upon the type of cell wall it possesses. In addition to the inherent resistance to antimicrobials, bacteria are observed to demonstrate considerably high resistance to antimicrobials when they are in a biofilm mode of growth. The resistance mechanisms in a bacterial biofilm to antimicrobial agents may generally include the following: (i) resistance associated with the extracellular polymeric matrix; (ii) resistance associated with growth rate and nutrient availability; or (iii) resistance associated with the adoption of a resistance phenotype. It is recognized that no single mechanism may account for the general resistance to antimicrobials. It is apparent that these mechanisms act in concert within the biofilm, and amplify the effect of small variations in the susceptible phenotypes. Nevertheless, bacteria in a biofilm are protected from antimicrobials by unique mechanisms that are mostly due to certain peculiarities of biofilm growth and structure.[10, 11]

Advanced agents

Nanoparticles

Nanoparticles are microscopic particles with one or more particle dimensions in the range of 1–100 nm. Nanoparticles are recognized to have properties that are very unique compared to their bulk or powder counterparts. In root canal therapy, nanoparticles may be applied as slurry or in combination with sealers. They have the ability to diffuse antimicrobial components deep in dentin tissue. The successful application of nanoparticles in endodontics will depend on both the effectiveness of antimicrobial nanoparticles and the delivery method used to disperse these particles into the anatomical complexities of the root canal system.[12]

Bioactive glass

Bioactive glass (BAG) consists of $SiO2$, $Na2O$, $CaO2$, and $P2O5$ at different concentrations. It has received considerable interest in root canal disinfection due to antibacterial properties. Previous authors attributed the antibacterial mechanism of BAG to its high pH, osmotic effects and Ca/P precipitation. Another author demonstrated that compared CH, BAG showed significantly less antibacterial effects as an intracanal medicament. In addition, another author showed that BAG did not effectively prevent recontamination of instrumented root canals.[13- 15]

Laser

The nature of the laser–tissue interaction is influenced by (i) the properties of the laser such as wavelength, energy density, and pulse duration; and (ii) the optical characteristics of the tissue such as absorption, reflection, transmission, and scattering. Different types of lasers may produce different effects on the same tissue, and the same laser can have varying effects on different tissues. The nature of light absorption and transmission is wavelength dependent. It should be noted that the intensity of light will not remain constant throughout a definite volume of tissue. Therefore, laser effects will change depending upon the depth of penetration. Generally, the clinician controls the following parameters while operating a laser system: (i) applied power (power density); (ii) total energy applied over a given area of tissue (energy density); (iii) rate and duration of laser irradiation (pulse repetition); and (iv) mode of energy delivery (continuous/pulsed energy, direct/ indirect tissue contact). One of the major disadvantages of current endodontic antimicrobial irrigants is that their bactericidal effect is mostly limited to the main root canal lumen.[16, 17]

CONCLUSION

Removal of the smear layer is an essential of root canal disinfection and sealing. Contrary to the vulnerable planktonic state, bacteria are protected from the antibacterial agents in biofilms. Hence; future research is directed for better prognosis of root canal therapy.

REFERENCES

1. Narayanan LL, Vaishnavi C. Endodontic microbiology. Journal of Conservative Dentistry : JCD. 2010;13(4):233-239.
2. Jhajharia K, Parolia A, Shetty KV, Mehta LK. Biofilm in endodontics: A review. Journal of International Society of Preventive & Community Dentistry. 2015;5(1):1-12.
3. Chandki R, Banthia P, Banthia R. Biofilms: A microbial home. Journal of Indian Society of Periodontology. 2011;15(2):111-114.
4. Estrela C, Sydney GB, Figueiredo JAP, Estrela CR de A. Antibacterial Efficacy Of Intracanal Medicaments On Bacterial Biofilm: A Critical Review. Journal of Applied Oral Science. 2009;17(1):1-7.
5. Narayanan LL, Vaishnavi C. Endodontic microbiology. Journal of Conservative Dentistry : JCD. 2010;13(4):233-239.
6. Mohammadi Z, Soltani MK, Shalavi S. An Update on the Management of Endodontic Biofilms Using Root Canal Irrigants and Medicaments. Iranian Endodontic Journal. 2014;9(2):89-97.
7. Grivet JP, Delort AM, Portais JC. NMR and microbiology: From physiology to metabolomics. Biochimie. 2003;85:823–40.
8. Gu LS, Kim JR, Ling J, Choi KK, Pashley DH, Tay FR. Review of contemporary irrigant agitation techniques and devices. J Endod. 2009;35(6):791–804.
9. Huang TY, Gulabivala K, Ng YL. A bio-molecular film ex-vivo model to evaluate the influence of canal dimensions and irrigation variables on the efficacy of irrigation. Int Endod J. 2008;41(1):60–71.
10. van der Sluis LW, Versluis M, Wu MK, Wesselink PR. Passive ultrasonic irrigation of the root canal: a review of the literature. Int Endod J. 2007;40(6):415–26.
11. Distel JW, Hatton JF, Gillespie MJ. Biofilm formation in medicated root canals. J Endod. 2002;28(10):689–93.
12. Salzgeber RM, Brilliant JD. An in vivo evaluation of the penetration of an irrigating solution in root canals. J Endod. 1977;3:394–8.
13. Baker NA, Eleazer PD, Averbach RE, Seltzer S. Scanning electron microscopic study of the efficacy of various irrigating solutions. J Endod. 1975;1(4):127–35.
14. Moser JB, Heuer MA. Forces and efficacy in endodontic irrigation systems. Oral Surg Oral Med Oral Pathol. 1982;53(4):425–8.
15. Ram Z. Effectiveness of root canal irrigation. Oral Surg. 1977;2:306.
16. Chow TW. Mechanical effectiveness of root canal irrigation. Int Endod J. 1983;9(11):475–9.
17. Ahmad M, Pitt Ford TR, Crum LA. Ultrasonic debridement of root canals: an insight into the mechanisms involved. J Endod. 1987;13(3):93–101.

Conflict of Interest: None
Source of Support: None