

Review Article**ROLE OF ENTEROCOCCUS FECALIS IN ENDODONTIC TREATMENT FAILURE*****Priyanka Anand¹, Rajeshwar Reddy Kasarla²**¹Intern Doctor, Kantipur Dental College, Kathamandu, Nepal, ²Department of Microbiology, Universal College of Medical Sciences, Bhairahawa, Nepal**Submitted: 13th – September-2024, Revised: 30th – October-2024, Accepted: 26th-November-2024****DOI: <https://doi.org/10.3126/mjen.v3i2.73052>****ABSTRACT**

Endodontic treatment is generally an effective and safe treatment with a high success rate, but failure may occur in many cases. The main reason for endodontic failure is attributed to the presence of some bacteria inside the root canal system such as *Enterococcus faecalis*. This article reviews and summarizes the different conditions and attributes that make *E. faecalis* a potential threat in endodontic treatment failure.

Keywords: Endodontic treatment, *Enterococcus faecalis*, Root canal.**INTRODUCTION**

Root canal, also called tooth pulp or dental pulp is a part of the tooth made up of blood vessels, nerve tissue, and other cells that help in its development and function. Trauma, tooth decay, and bacterial infection can cause damage to the dental pulp, which requires endodontic treatment (root canal treatment). Root canal treatment is a procedure in which inflamed or infected pulp of the tooth is removed, and the inside of the tooth is thoroughly cleaned and disinfected before being filled with an inert material filling and sealed to prevent reinfection. Today, the root canal treatment has become less invasive and painless due to advanced technology.¹

NORMAL FLORA OF ORAL CAVITY

Endodontic infections are usually polymicrobial, with obligate anaerobic bacteria dominating. About a thousand bacterial species are found in the mouth.² (Table 1)

Table 1: Normal flora of the mouth³

Mouth	bacteria per gm or mL	Ratio of anaerobic and aerobic bacteria	Normal anaerobic flora	Normal aerobic flora, commensal fungi & parasites	
				Most common	Less common
Salivary juice	10 ⁸ - 10 ⁹	1:1	Anaerobic cocci Actinomyces	Viridans streptococci	Commensal parasites in oral cavity :
Tooth surface	10 ¹⁰ – 10 ¹¹	1:1	Fusobacterium Bifidobacterium	(alpha hemolytic streptococci)	<i>Trichomonas tenax</i>
Gingiva	10 ³ – 1	10 ⁸ :10 ⁹	Prevotella Spirochetes		<i>Entamoeba gingivalis</i>

CAUSES OF ENDODONTIC TREATMENT FAILURE

Endodontic treatment is generally an effective and safe treatment with a high success rate of 86 to 98%, but failure may occur in many instances.⁴ (Table 2) The most important cause for endodontic treatment failure is incomplete removal of pulp tissue, dentinal debris, and microorganisms. Persistence and survival of bacteria within the apical portion of root canal



©Authors retain copyright and grant the journal right of first publication. Licensed under Creative Commons Attribution License CC - BY 4.0 which permits others to use, distribute and reproduce in any medium, provided the original work is properly cited.

***Corresponding Author**

Priyanka Anand

Email: anandpriyanka03@gmail.comORCID: <https://orcid.org/0009-0009-6471-4508>**Citation**

Anand P, Reddy Kasarla R, Role of Enterococcus Fecalis in Endodontic Treatment Failure, MJEN. 2024 December; 3(2):27-29.



systems, even in well treated teeth may be responsible for endodontic treatment failure in most cases. Within the canal system, bacteria may be found located in areas such as isthmus ramifications, deltas, canal irregularities and dentine tubules.⁵ Depending on the circumstances present in the root canal system some bacteria are more capable to multiply and survive than others. For example, microorganisms that establish in the untreated root canal will have abundant nutrients.⁶

Table 2: The usual factors responsible for root canal treatment failure¹⁻⁶

- Inadequate debridement due to inaccessibility of infection sites
- Multiplication of bacteria in root canal
- Incomplete filling of the root canal
- Incomplete coronal seal
- Untreated root canals
- Iatrogenic procedural errors
- Complications of instrumentation

The main reason for endodontic failure is the presence of some highly resistant bacteria inside the root canal system such as *Enterococcus faecalis*.^{7,8} The composition of microbiota may vary depending on the different forms of apical periodontitis.⁹

MICROORGANISMS INVOLVED IN ROOT CANAL TREATMENT FAILURE

Enterococcus faecalis, *Actinomyces* spp., *Streptococcus anginosus*, *Streptococcus intermedius*, *Streptococcus constellatus*, *Fusobacterium*, *Propionibacterium*, *Prevotella*, *Lactobacilli*, *Staphylococci*, *Bifidobacterium*, *Candida albicans* are most commonly implicated in the failure of endodontic treatment,^{6,10-12} *Enterococcus faecalis* being the most common microorganism.¹³ A few reported that presence of herpes viruses in the root canal have a role in the pathogenesis of apical periodontitis.¹⁴

ROLE OF ENTEROCOCCUS FAECALIS IN ENDODONTIC TREATMENT FAILURE

Enterococcus faecalis is commonly detected in asymptomatic, persistent endodontic infections.³ It is able to survive in the root canal as a single organism or as a major component of the microbiota. *E. faecalis* prevalence in root filled teeth with apical periodontitis range from 24% to 77%.¹⁵

They are Gram positive cocci, observed singly, in pairs, or short chains. They were initially grouped as Group D streptococci, but later have been classified as a separate genus *Enterococcus*. It's a facultative anaerobe present in vast quantities in human intestine as normal harmless commensal flora. They are also present in oral cavity and human female genital tract. *E. faecalis* can cause urinary tract infections, chronic prostatitis, endocarditis, soft tissue infections includ-

ing wound infections and surgical-site infections and neonatal infections such as sepsis, meningitis, and pneumonia, and periodontitis. *E. faecalis* is highly resistant and can survive at extreme alkaline pH (9.6) and 6.5% NaCl. They can resist 40% bile, detergents, heavy metals, ethyl alcohol, sodium azide and desiccation. It can grow over a wide range of temperature of 10 to 45°C, and can survive at a temperature of 60°C for 30 min. At a pH of 11.5 or greater, *E. faecalis* is unable to survive.^{1,15} Enterococci have developed high resistance to antibiotics and produce several enzymes such as gelatinase, hyaluronidase, and extracellular superoxide.^{1,16} Once *E. faecalis* settles in the root canal system, it survives during large period of nutrient shortage, apart from resisting the action of antibiotics used during endodontic treatment. *E. faecalis* binds to dentin and invade dentin tubules. It produces certain virulence factors such as serine protease, gelatinase, collagen binding protein (Ace), which help it bind to dentinal tissues, collagen fibers, and human serum. *E. faecalis* resist treatment with calcium hydroxide, which is commonly used as antibacterial medication during endodontic treatment. *E. faecalis* also resists the high pH of calcium hydroxide and passively maintains pH homeostasis. The resistance to calcium hydroxide by *E. faecalis* is determined by expression of certain genes and a proton pump.^{17,18} When vancomycin resistant enterococci (VRE) are encountered, linezolid or daptomycin are treatment options.¹⁹ *E. faecalis* is able to produce calcified biofilm within the root canals, with the help of a specific cell surface protein. *E. faecalis* is hard-to-eradicate when biofilms are formed by VRE strains.^{1,20}

PREVENTION

Use of good aseptic procedure with frequent hand wash and disinfection of instruments used in treatment, increased apical preparation sizes, chlorhexidine rinse before treatment, disinfection of tooth and mouth with sodium hypochlorite is most effective methods to control *E. faecalis* infection in mouth.^{9,15}

CONCLUSION

Enterococcus faecalis is now considered as the main pathogen responsible for the failure of endodontic treatment, since it can survive extreme harsh environment, during nutrient shortage, resist antibiotic treatment, and create a biofilm. However, one thing confounding about this bacterium is that we have only associated it with endodontic failures. We have not proven that it is causative of endodontic failures. Just because we often find it with endodontically failed teeth, does not prove that it is causing the apical

disease. It might be an innocent bystander. There is a need for further research to know the micro flora involved in endodontic infections and to control them in root canal system.

ACKNOWLEDGEMENT

We are thankful to Dr. Karl Woodmansey, Assistant Professor, Department of Endodontology, Oregon Health Science University, Portland, Oregon, USA, for his valuable suggestion and input in writing this article.

REFERENCES

1. Khadijeh N, Khudaverdi G, Pourya G, Asghar T, Ahangarzadeh RM, Saad MS, Mohammad A, Samadi KH. Oral cavity infection by *Enterococcus faecalis*: virulence factors and pathogenesis. *Reviews in Medical Microbiology*. April 2020;31(2):51-60.
2. Paster BJ, Olsen I, Aas JA, Dewhirst FE. The breadth of bacterial diversity in the human periodontal pocket and other oral sites. *Periodontol*. 2000;2006;42:80-7.
3. Apurba S Sastry, Sandhya Bhat. *Essentials of Medical Microbiology*. Fourth edition, 2023. Jaypee Brothers Medical Publishers, New Delhi, India.
4. Sadia Tabassum, Farhan Raza Khan. Failure of endodontic treatment: The usual suspects. *Eur J Dent*. 2016 Jan-Mar; 10(1): 144-147.
5. Siqueira JF. Aetiology of root canal treatment failure: why well-treated teeth can fail (Literature review). *Int Endod J*. 2001;34:1-10.
6. Prada I, Micó-Muñoz P, Giner-Lluesma T, Micó-Martínez P, Collado-Castellano N, Manzano-Saiz A. Influence of microbiology on endodontic failure. Literature review. *Med Oral Patol Oral Cir Bucal*. 2019 May 1;24(3):e364-e372.
7. Alghamdi F, Shakir M. The Influence of *Enterococcus faecalis* as a dental root canal pathogen on endodontic treatment: A Systematic Review. *Cureus*. 2020 Mar 13;12(3):e7257.
8. Narayanan L, Vaishnavi C. Endodontic microbiology. *J Conserv Dent*. 2010 Oct-Dec; 13(4): 233-239.
9. Wong J, Manoel D, Näsman P, Belibasakis GN, Neelakantan P. Microbiological Aspects of Root Canal Infections and Disinfection Strategies: An Update Review on the Current Knowledge and Challenges. *Front Oral Health*. 2021 Jun 25;2:672887.
10. Pinheiro ET, Gomes BP, Ferraz CC, Sousa EL, Teixeira FB, Souza-Filho FJ. Microorganisms from canals of root-filled teeth with periapical lesions. *Int Endod J*. 2003;36:1-11.
11. Ashraf H, Samiee M, Eslami G, Ghodse Hosseini MR. Presence of *Candida Albicans* in root canal system of teeth requiring endodontic retreatment with and without periapical lesions. *Iran Endod J*. 2007 Spring;2(1):24-8.
12. Gaeta C, Marruganti C, Ali IAA, Fabbro A, Pinzauti D, Santoro F, Neelakantan P, Pozzi G, Grandini S. The presence of *Enterococcus faecalis* in saliva as a risk factor for endodontic infection. *Front Cell Infect Microbiol*. 2023;13:1061645.
13. Love RM. *Enterococcus faecalis*--a mechanism for its role in endodontic failure. *Int Endod J*. 2001 Jul;34(5):399-405.
14. Slots J. Herpes viruses in periodontal diseases. *Periodontol*. 2000. 2005;38:33-62.
15. Stuart CH, Schwartz SA, Beeson TJ, Owatz CB. *Enterococcus faecalis*: its role in root canal treatment failure and current concepts in retreatment. *J Endod*. 2006 Feb;32(2):93-8.
16. Reynaud AF, Geijerstam AH, Ellington MJ, Warner M, Woodford N, Haapasalo M. Antimicrobial susceptibility and molecular analysis of *Enterococcus faecalis* originating from endodontic infections in Finland and Lithuania. *Oral Microbiol Immunol*. 2006;2:164-168.
17. Evans M, Davies JK, Sundqvist G, Figdor D. Mechanisms involved in the resistance of *Enterococcus faecalis* to calcium hydroxide. *Int Endod J*. 2002;35:221-228.
18. Nakajo K, Komori R, Ishikawa S, Ueno T, Suzuki Y, Iwami Y, et al. Resistance to acidic and alkaline environments in the endodontic pathogen *Enterococcus faecalis*. *Oral Microbiol Immunol*. 2006;21:283-288.
19. O'Driscoll T, Crank CW. Vancomycin-resistant enterococcal infections: epidemiology, clinical manifestations, and optimal management. *Infect Drug Resist*. 2015;8:21730.
20. Sundqvist G, Persson S. Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative re-treatment. *Oral Surgery Oral Medicine Oral Pathology*. Jan 1998;85(1):86-93.