International Journal of Applied Dental Sciences 2023; 9(1): 80-83

ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2023; 9(1): 80-83

www.oraljournal.com
Received: 03-10-2022
Accepted: 13-11-2022

Ana Karen Lopez Marquez
Master's in Sciences Student, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Irene Meester
Profesor, Universidad de Monterrey, Escuela de Medicina, Ciencias Basicas, San Pedro Garza Garcia, Nuevo Leon, 66238 ZIP, Mexico

Johnny Rylander Yamada
Profesor, Universidad Veracruzana, Facultad de Odontología, Veracruz, Mexico

Teresita de Jesus Mendez Quevedo
Profesor, Universidad Veracruzana, Facultad de Odontología, Veracruz, Mexico

Rosa Isela Sanchez Najera
Profesor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Rene hernandez Delgadillo
Profesor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Gustavo Israel Martinez González
Profesor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, CP 64460, Mexico

Monica Sofia Treviño Ramirez
Dentistry Student, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Juan Manuel Solis Soto
Profesor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Corresponding Author:
Ana Karen Lopez Marquez
Master's in Sciences Student, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Streptococcus gordonii: An updated review

Ana Karen Lopez Marquez, Irene Meester, Johnny Rylander Yamada, Teresita de Jesus Mendez Quevedo, Rosa Isela Sanchez Najera, Rene Hernandez Delgadillo, Gustavo Israel Martinez González, Monica Sofia Treviño Ramirez and Juan Manuel Solis Soto

DOI: https://doi.org/10.22271/oral.2023.v9.i1b.1658

Abstract
Introduction: Streptococcus gordonii is known as an opportunistic pathogen that can cause local or systemic diseases, such as apical periodontitis and infective endocarditis.
Objective: To evaluate Streptococcus gordonii in relation to its prevalence, treatment, diagnostic methods, as well as its endodontic and systemic role.
Methodology: A search for information was carried out in databases such as PubMed, SCOPUS and Google Scholar, using logical operators AND, OR and NOT. We searched for the mention of Streptococcus gordonii bacteria related to the keywords: prevalence, treatment, identification methods, role in endodontics and systemic disease.
Results: It is found in teeth with abscesses in 11.1% and in canals with apical periodontitis in 55%. In methods of treatment of the canal system we found that the main irrigant is sodium hypochlorite, lasers and photodynamic therapy. In diagnostic methods we found matrix-assisted laser desorption ionization, Next-Generation Sequencing analysis and PCR. In the cell wall of S. gordonii they act as virulence factors, forming biofilms that can cause apical periodontitis, endocarditis and pneumonia.
Conclusion: This microorganism easily adheres to host tissues, forming biofilms that can cause apical periodontitis, endocarditis and pneumonia. It is of utmost importance to raise awareness of its role in order to select the best treatment.

Keywords: Streptococcus gordonii, endodontics, diagnosis, treatment, prevalence

1. Introduction

Streptococcus gordonii is an opportunistic pathogen that can cause local or systemic diseases, such as apical periodontitis and infective endocarditis [1].
The oral cavity contains several microorganisms associated with oral diseases [2]. Streptococcus gordonii initiates the formation of plaque [3]. In oral pathology, oral microorganisms are associated with various diseases, such as dental caries, periodontal diseases, endodontic infections and also oral cancer. One of the oral diseases is apical periodontitis, which is an inflammatory disease of the periradicular tissues of a tooth that is triggered by bacteria colonizing necrotic root canals [4]. Similarly, cardiovascular diseases and chronic degenerative diseases such as diabetes are among the most prevalent pathologies related to these same microorganisms [5]. A methodical review suggests that some systemic diseases may be correlated with endodontic outcomes [6]. Bacteria belonging to the genus Streptococcus are the first inhabitants of the oral cavity and therefore play an important role [7]. Streptococcus gordonii is commonly found in periapical endodontic lesions of patients with apical periodontitis, a condition characterized by inflammation and periapical bone loss [8].
The presence of this microorganism in the oral cavity is of commensal interaction, however, it can play an important role by affecting systemically causing other diseases. Since there is no further information on its role in endodontics, the aim of this article is to evaluate its prevalence, treatment, diagnostic methods, as well as its endodontic and systemic role.

2. Materials and Methods

Information from articles published in PubMed, SCOPUS and Google Scholar was analyzed with emphasis on the last 5 years. The quality of the articles was analyzed based on the standard guidelines, i.e., identification, review, choice, and inclusion. The quality of the review was assessed using the measurement instrument for evaluating systemic reviews. The search was performed using Boolean logical operators AND, OR and NOT. It was realized with the words “Streptococcus gordonii”, “endodontic”, “diagnosis”, “prevalence” and “treatment”, in conjunction with logical Boolean operators OR y AND.

3. Results and Discussion

3.1 Prevalence

The oral cavity of healthy individuals is inhabited by commensal microorganisms, with Streptococcus species being the most abundant and prevalent in sites not affected by periodontal diseases [9].

Being a naturally acquired organism and found as a commensal in the mouth from the first years of life, its incidence is very common; however, its harmful effects only appear when there is an imbalance in the oral cavity environment. Therefore, when analyzing its prevalence, it is based on some presence of endodontic or systemic disease.

In an analysis of 55 root canals of primary teeth with irreversible pulpitis, Streptococcus gordonii was found in 71%. In 51 root canals of teeth with pulp necrosis and apical periodontitis, S. gordonii was found in 55% [10]. In another study where samples were taken from 10 endodontically treated teeth, 125 bacterial species belonging to 68 genera and 9 phyla were found. The most represented, abundant and predominant genera in the samples were: Fusobacterium nucleatum ss. vincentii, Streptococcus oralis and Streptococcus gordonii [11]. Finally, in one trial, samples were obtained from 53 infected teeth, of which 27 cases were diagnosed as acute periradicular abscesses. Among the most prevalent species in the abscessed teeth were A. gerencseriae (14.8%), S. gordonii (11.1%), S. intermedius (11.1%), A. israelii (7.4%), S. anginosus (7.4%) and S. sanguis (7.4%) [12].

S. gordonii is found opportunistically among the most prevalent species in teeth with abscesses in 11.1%, likewise, of root canals of teeth with pulp necrosis and apical periodontitis it was counted in 55%.

3.2 Treatment

Systemic level

Antibiotic treatment is only indicated in: a) immunocompromised patients; b) acute apical abscess with systemic symptomatology; c) acute apical abscess that progresses and expands; d) In the case of cervico-facial cellulitis. Amoxicillin, with/without clavulanic acid, and clindamycin in patients allergic to penicillins are the antibiotics of choice [13].

Oral level S. gordonii is a commensal microorganism present in the oral cavity, its eradication by individual is almost impossible, however there are different elements that have been shown to inhibit the growth of biofilms. NDM (non-dialyzable high molecular mass cranberry material) selectively inhibited the metabolic activity of S. gordonii, without affecting bacterial viability. Inhibition of the metabolic activity of bacteria in the biofilm may benefit the health of the oral cavity [14]. Previous work has shown that a region of the streptococcal antigen called BAR (SspB Adherence Region) inhibits P. gingivalis/S.gordonii and biofilm formation both *in vitro* and in a mouse model of periodontitis. It is suggested that BAR-encapsulated NPs provide a potent platform to inhibit (prevent) and disrupt (treat) P. gingivalis/S.gordonii biofilms, relative to free BAR [15]. Experimental results demonstrated that D-tagatose found in saliva selectively inhibits the growth of oral pathogens S. mutans and S. gordonii [16]. Similarly, SCFA could be an effective anti-biofilm agent against S. gordonii for the prevention of oral diseases [17]. Another element is ursolic acid (UA), which has been shown to have an inhibitory effect against multi-species biofilms formed by Streptococcus mutans, Streptococcus sanguinis and Streptococcus gordonii [18].

The treatment of apical periodontitis aims to disinfect the root canal system so that the periradicular tissues are not vulnerable to attack by microbiota within the tooth [19]. Root canal infections are mediated by biofilms. Biofilm removal is achieved by a chemical-mechanical process, using specific instruments and disinfectant chemicals in the form of irrigants and/or intra-canal medications [20]. Ciprofloxacin and metronidazole and hydroxypropyl methylcellulose showed *in vitro* efficacy against E. faecalis and S. gordonii cultured in biofilm, suggesting its clinical application as an intracanal drug for both primary and persistent infections [21]. It is suggested that irrigation of this material is composed of a multitude of factors, and that effective distribution and agitation of the irrigant achieves mechanical, chemical and microbiological functions, which are prerequisites for a clean canal system [22]. Sodium hypochlorite (NaOCl) is commonly used to irrigate the root canal during endodontic treatments. It has been known for its antibacterial action, proteolytic and dissolving capacity and debridement properties [23]. Lasers and photodynamic therapy (PDT) have become the latest option to eradicate microorganisms in the root canal. PAD (diode laser) in combination with NaOCl may be an alternative and a better option for root canal disinfection for endodontic pathogens [24]. Also, light-activated disinfection (LAD) can be used as a substitute or adjunct to conventional antimicrobial treatment regimens that are implemented to combat polymicrobial biofilms [25].

Within the methods of disinfection of the root canal system, the main irrigant is sodium hypochlorite, together with mechanical shaping of the root canals. PDT are determined as the last option to eradicate microorganisms in the root canal. Likewise, when there is systemic involvement, the use of antibiotics is mentioned, the antibiotic of choice being amoxicillin, with/without clavulanic acid, and clindamycin in patients allergic to penicillins.

3.3 Diagnostic Methods

The major impetus for bacterial identification came after the advent of solid culture media. Some of the latest advances in identification include matrix-assisted laser desorption ionization. Time-of-flight mass spectroscopy (MALDI-TOF) is a state-of-the-art facility used for rapid and reliable identification of specific bacterial species [26]. Alternatively, ribosomal RNA-based Next-Generation Sequencing (NGS) analysis has been used to provide a more comprehensive view of bacteria [27]. While the endodontic microbiota has long been investigated, knowledge about the etiological factors involved in the establishment and progression of endodontic infections remains limited [28].

Culture techniques used to identify species in the oral microbiome remain difficult, as they are time-consuming to apply. In response, computerized diagnostic techniques such as polymerase chain reaction (PCR)-based DNA microarray systems have been developed to aid nucleotide sequence analysis and thus detect complex endodontic microbiota with improved specificity and sensitivity [29]. The LuxS/AI-2 quorum sensing system of S. gordonii plays a role in regulating two-species biofilm formation with S. mutans [30]. Gram-positive bacteria such as Streptococcus gordonii are recognized primarily by Toll-like receptor 2 (TLR2). Similarly, lipoteichoic acid (LTA) and lipoproteins are representative TLR2 ligands that play an important role in bacterial infection and host inflammatory responses [31].

We can conclude that the most accure diagnostic methods include matrix-assisted laser desorption ionization, RNA-based NGS analysis and PCR.

3.4 Role in Endodontics

Streptococcus gordonii is a member of the viridans streptococci and is an early colonizer of the tooth surface. Adherence to the tooth surface is made possible by proteins present on the cell surface of S. gordonii, among which SspB belongs to one of the best studied families of cell wall-anchored adhesins: the antigen I/II (AgI/II) family [32]. Microbial biofilm formation is typically seen in root canal walls, but some microbial species can invade dentinal tubules to a variable depth [33]. The invasiveness of bacteria in dentinal tubules is species-specific and may change depending on culture as a single species or culture with other bacteria. Oral streptococci can promote or inhibit capnophilic/anaerobic invasion of root dentin [34].

Microbial factors in necrotic root canals (e.g., endotoxin) can spread to apical tissue. Apical periodontitis is the result of the complex interaction between microbial factors and host defense against invasion of periradicular tissues [35]. Lipoproteins are an important component of S. gordonii for the induction of IL-8 production in PDL cells potentially contributing to inflammatory apical periodontitis [36].

Adherence to the tooth surface is made possible by lipoproteins present on the cell surface of S. gordonii. One of the best studied is SspB, which together can spread to apical tissue, potentially contributing to inflammatory apical periodontitis.

3.5 Role in Systemic Diseases

Oral streptococci produce an arsenal of adhesive molecules that allow them to efficiently colonize different tissues in the mouth. Commensal streptococci and pathogens residing in the oral cavity can eventually gain access to the bloodstream and cause systemic infections such as infective endocarditis [7]. Streptococcus gordonii is an etiologic bacterial agent of infective endocarditis. Although the mechanisms of pathogenesis are not well understood, the interaction between streptococci and phagocytes is considered important for the development of infective endocarditis [37]. It is a gram-positive commensal bacterium that also acts as an opportunistic pathogen that can cause apical periodontitis, endocarditis and pneumonia. It readily adheres to host tissues, forming biofilms and thus penetrates root canals and blood streams, subsequently interacting with various immune and non-immune cells of the host, thus its cell wall components act as virulence factors [37].

In summary, the cell wall components of S. gordonii act as virulence factors which readily adhere to host tissues, including tooth surfaces and heart valves, forming biofilms that can cause apical periodontitis, endocarditis and pneumonia.

4. Conclusions

Streptococcus gordonii microoganism easily adheres to host tissues, forming biofilms that can cause apical periodontitis, endocarditis and pneumonia. Molecular methods are the most accurate for the identification of this bacterium. It is of utmost importance to raise awareness of its role in order to select the best treatment.

5. Acknowledgement

Not available

6. Author's Contribution

Not available

7. Conflict of Interest

Not available

8. Financial Support

Not available

9. References

1. Park OJ, Jung S, Park T, Kim AR, Lee D, Jung Ji H, *et al*. Enhanced biofilm formation of Streptococcus gordonii with lipoprotein deficiency. Mol Oral Microbiol. 2020 Dec;35(6):271-278.
2. Chen T, Yan S, Wang X, Xin W, Meng F, Yang S. High-throughput sequencing analyses of oral microbial diversity in healthy people and patients with dental caries and periodontal disease. Mol. Med. 2017;16:127-132
3. Wu J, Yang Q, Jiang X, Fan Y, Zhang Y, Huang R. Oxyresveratrol promotes biofilm formation, cell attachment and aggregation of Streptococcus gordonii in the presence of sucrose. FEMS Microbiol Lett. 2020 Jun 1;367(12).
4. Bouillaguet S, Manoil D, Girard M, Louis J, Gaïa N, Leo S, *et al*. Root Microbiota in Primary and Secondary Apical Periodontitis. Front Microbiol. 2018:9:2374
5. Sampaio-Maia B, Caldas IM, Pereira ML, Pérez-Mongiovi D, Araujo R. The Oral Microbiome in Health and Its Implication in Oral and Systemic Diseases. Adv Appl Microbiol. 2016;97:171-210. DOI: 10.1016/bs.aambs.2016.08.002
6. Aminoshariae A, Kulild JC, Mickel A, Fouad AF. Association between Systemic Diseases and Endodontic Outcome: A Systematic Review. J Endod. 2017;43(4):514-519
7. Abranches J, Zeng L, Kajfasz JK, Palmer SR, Chakraborty B, Wen ZT, *et al*. Biology of Oral Streptococci. Microbiol Spectr. 2018 Oct;6(5):10.
8. Park OJ, Kim J, Kim HY, Kwon Y, Yun CH, Han SH. Streptococcus gordonii induces bone resorption by increasing osteoclast differentiation and reducing osteoblast differentiation. Microb Pathog. 2019 Jan;126:218-223
9. Ślęzak P, Śmiga M, Smalley JW, Siemińska K, Olczak T. Porphyromonas Gingivalis Hmu Y. Streptococcus gordonii GAPDH-Novel Heme Acquisition Strategy in the Oral Microbiome. Int. J Mol Sci. 2020;21(11):4150.
10. Ruviére DB, Leonardo MR, da Silva LA, Ito IY, Nelson-Filho P. Assessment of the microbiota in root canals of human primary teeth by checkerboard DNA-DNA hybridization. J Dent Child (Chic). 2007;74(2):118-123.
11. Zandi H, Kristoffersen A, Rôças I, Siqueira J, Enersen M. Microbial Analysis of Endodontic Infections in Root-filled Teeth with Apical Periodontitis before and after Irrigation Using Pyrosequencing. Journal of Endodontics. 2018;44(3):372-378.

12. Siqueira JF Jr, Rôças IN, Souto R, de Uzeda M, Colombo AP. Actinomyces species, streptococci, and Enterococcus faecalis in primary root canal infections. J Endod. 2002;28(3):168-172.
13. Asociación Española de Endodoncia (AEDE). Recommendations of the Spanish Association of Endodontics on the use of antibiotics in endodontics Endodontics (Madr.). 2020;38(1):6-12.
14. Babu J, Blair C, Jacob S, Itzhak O. Inhibition of Streptococcus gordonii metabolic activity in biofilm by cranberry juice high-molecular-weight component. J Biomed Biotechnol. 2012;2012:590384.
15. Mahmoud MY, Demuth DR, Steinbach-Rankins JM. BAR-encapsulated nanoparticles for the inhibition and disruption of Porphyromonas gingivalis-Streptococcus gordonii biofilms. J Nanobiotechnology. 2018;16(1):69
16. Mayumi S, Kuboniwa M, Sakanaka A, Hashino E, Ishikawa A, Ijima Y, *et al*. Potential of Prebiotic D-Tagatose for Prevention of Oral Disease. Front Cell Infect Microbiol. 2021 Nov 5;11:767944.
17. Park T, Im J, Kim AR, Lee D, Jeong S, Yun CH, *et al*. Short-chain fatty acids inhibit the biofilm formation of Streptococcus gordonii through negative regulation of competence-stimulating peptide signaling pathway. J Microbiol. 2021;59(12):1142-1149.
18. Lyu X, Wang L, Shui Y, Jiang Q, Chen L, Yang W *et al*. Ursolic acid inhibits multi-species biofilms developed by Streptococcus mutans, Streptococcus sanguinis, and Streptococcus gordonii. Arch Oral Biol. 2021 May;125:105107
19. Tomson PL, Simon SR. Contemporary Cleaning and Shaping of the Root Canal System. Prim Dent J. 2016;5(2):46-53
20. Neelakantan P, Romero M, Vera J, Daood U, Khan AU, Yan A, *et al*. Biofilms in Endodontics-Current Status and Future Directions. Int. J Mol Sci. 2017 Aug 11;18(8):1748.
21. Panyakorn T, Makeudom A, Kangvonkit P, Pattamapun K, Wanachantararak P, Charumanee S, *et al*. Efficacy of double antibiotics in hydroxypropyl methylcellulose for bactericidal activity against Enterococcus faecalis and Streptococcus gordonii in biofilm. Arch Oral Biol. 2021 Sep;129:105210.
22. Chubb DWR. A review of the prognostic value of irrigation on root canal treatment success. Aust Endod J. 2019;45(1):5-11.
23. Abuhaimed TS, Abou Neel EA. Sodium Hypochlorite Irrigation and Its Effect on Bond Strength to Dentin. Biomed Res Int. 2017;2017:1930360.
24. Sarda RA, Shetty RM, Tamrakar A, Shetty SY. Antimicrobial efficacy of photodynamic therapy, diode laser, and sodium hypochlorite and their combinations on endodontic pathogens. Photodiagnosis Photodyn Ther. 2019;28:265-272.
25. Haroon S, Khabeer A, Faridi MA. Light-activated disinfection in endodontics: A comprehensive review. Dent Med Probl. 2021;58(3):411-418
26. Kootallur BN, Thangavelu CP, Mani M. Bacterial identification in the diagnostic laboratory: how much is enough? Indian J Med Microbiol. 2011;29(4):336-340.
27. Simón-Soro A, Guillen-Navarro M, Mira A. Metatranscriptomics reveals overall active bacterial composition in caries lesions. J Oral Microbiol. 2014;1:1-6.
28. Yun KH, Lee HS, Nam OH, Moon CY, Lee JH, Choi SC. Analysis of bacterial community profiles of endodontically infected primary teeth using pyrosequencing. Int J Paediatr Dent. 2017;27:56-65.
29. Guven Y, Ustun N, Aksakal S, Topcuoglu N, Aktoren O, Kulekci G. Assessment of the endodontic microbiota of abscessed primary teeth using microarray technology. Indian J Dent Res. 2018;29(6):781.
30. Wang X, Li X, Ling J. Streptococcus gordonii LuxS/autoinducer-2 quorum-sensing system modulates the dual-species biofilm formation with Streptococcus mutans. J Basic Microbiol. 2017;57(7):605-616.
31. Kim AR, Ahn KB, Kim HY, Seo HS, Kum KY, Yun CH, *et al*. Streptococcus gordonii lipoproteins induce IL-8 in human periodontal ligament cells. Mol Immunol. 2017 Nov;91:218-224.
32. Schormann N, Purushotham S, Mieher JL, Patel M, Wu H, Deivanayagam C. Structural and functional analysis of the C-terminal region of Streptococcus gordonii SspB. Acta Crystallogr D Struct Biol. 2021;77(9):1206-1215.
33. Sakko M, Tjäderhane L, Rautemaa-Richardson R. Microbiology of Root Canal Infections. Prim Dent J. 2016;5(2):84-89.
34. Stauffacher S, Lussi A, Nietzsche S, Neuhaus KW, Eick S. Bacterial invasion into radicular dentine-an *in vitro* study. Clin Oral Investig. 2017;21(5):1743-1752.
35. Gomes BPFA, Herrera DR. Etiologic role of root canal infection in apical periodontitis and its relationship with clinical symptomatology. Braz Oral Res. 2018, 32.
36. Urano-Tashiro Y, Saiki K, Yamanaka Y, Ishikawa Y, Takahashi Y. Streptococcus gordonii DL1 evades polymorphonuclear leukocyte-mediated killing via resistance to lysozyme. PLoS One, 2021, 16(12).
37. Park OJ, Kwon Y, Park C, So YJ, Park TH, Jeong S *et al*. Streptococcus gordonii: Pathogenesis and Host Response to Its Cell Wall Components. Microorganisms. 2020 Nov 24;8(12):1852.

How to Cite This Article
Marquez AKL, Meester I, Yamada JR, Quevedo TDJM, Najera RIS, Delgadillo RH, González GIM, Ramirez MST, Soto JMS. Streptococcus gordonii: An updated review. International Journal of Applied Dental Sciences. 2023;9(1):xxx-xxx.