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MICROBIAL BIOCENOSIS OF APICAL PERIODONTITIS IN THE ROOT CANAL SYSTEM. (PART 2)

KHABADZE Z.S.*, NAZAROVA D.A., SULEIMANOVA Z.M., GENERALOVA YU.A., KOTELNIKOVA A.P.

Faculty of Dentistry, Peoples' Friendship University of Russia, Moscow, Russia

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ABSTRACT

The purpose of this review article is to assess systematically the available scientific evidence about the microbial biocenosis of apical periodontitis in the root canal system and its resistance to antibiotics.

The study of publications was produced in the electronic databases such as Google Scholar, PubMed during a systematic review of the literature. Included articles contain information about microbial biocenosis of apical periodontitis in the root canal system and its antibiotic sensitivity. The publication date criterion was selected from January 2012 to January 2022.

Totally 55 articles were reviewed. After analyzing the literature for inclusion criteria, the total number of publications has become 10.

Primary and secondary apical periodontitis are polymicrobial infection with predominance of gram-negative bacteria and a more diverse bacterial population found in secondary apical periodontitis. in primary apical periodontitis, the most frequently detected microorganisms are Fusobacterium, Porphyromonas, Prevotella, Pseudoramibacter and Peptostreptococcus. The most commonly occurring microorganisms in secondary apical periodontitis are E. faecalis, P. gingivalis, F. nucleatum and A. actinomycetemcomitans are the most common. No significant changes in the bacterial biocenosis of the root canal system with apical periodontitis have been detected over the past 10 years. Microorganisms of apical periodontitis are sensitive to various antibiotics, but most of them are sensitive to amoxicillin + clavulanate.

KEYWORDS: *apical periodontitis, microbiota, antibiotic sensitivity test.*

INTRODUCTION

Apical periodontitis is an inflammatory disease of the dental periradicular tissues.

The composition of microbiocenosis in the root canal determines the course of apical periodontitis. Taking into account the fact of the aggressive flora of the root canal, the task of each endodontic treatment is to achieve maximum elimination of microorganisms from the root canal system. It is important to pay attention to the evolution of the microbial agent in the long term and trends in the selection of a new antiseptic composition for root canal irrigation: This is one of the most pressing problems of modern endodontic treatment.

It usually results from bacterial accumulation and contamination occurring in the root-canal system, and extending beyond the apical foramen to involve the periapical tissues [*Tatikonda A et al., 2017*]. The advancement in microbiological study methods has allowed for the identification of new species associated with the disease process. Although this topic remains not fully explored to this day, the polymicrobial etiology of the disease is confirmed by the literature [*Aw V, 2016*].

There are two types of apical periodontitis –

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ADDRESS FOR CORRESPONDENCE:

Zurab S. Khabadze, PhD
Peoples Friendship University of Russia (RUDN University) 6 Miklukho-Maklaya Street, Moscow, 117198, Russian Federation
Tel.: (+7926) 5666602; E-mail: dr.zura@mail.ru

primary and secondary. Primary apical periodontitis results from the microbial colonization of necrotic pulp tissues. Secondary apical periodontitis results from a persistent infection of incorrectly treated root canals [*Bouillaguet S et al., 2018*]. The bacterial composition of these types of apical periodontitis differs [*Hong BY et al., 2013*].

Knowledge of microorganisms of apical periodontitis is necessary, because its treatment is based on the elimination of these bacteria.

Currently, research work is being carried out to study the taxonomic nomenclature of conditionally pathogenic and pathogenic microflora of the human body in various pathologies of the maxillofacial region and its quantitative composition, as well as to evaluate the effectiveness of candidate antimicrobial compounds. The issue of isolation and identification of pure cultures of microorganisms and assessment of the profile of their resistance (sensitivity) to antimicrobial compounds is important [*Mussano F et al., 2018*].

The purpose of this review article is to assess systematically the available scientific evidence about the microbial biocenosis of apical periodontitis in the root canal system and its resistance to antibiotics [*Chow At et al., 2019*].

MATERIALS AND METHODS

The research was written in the course of the analysis of Russian and English literature in Google Scholar and PubMed electronic databases [*Moher D et al., 2010*].

The analysis includes publications that meet the following selection criteria:

Publications dated from 2012 to 2022;

To overcome it is possible, due to the uniting the knowledge and will of all doctors in the world

Availability of studies confirming the role of microbiota in the pathogenesis of apical periodontitis;

Figuring the topic of the diversity of microorganisms of apical periodontitis [*Murad CF et al., 2014*].

The review didn't include publications, the title and abstract of which did not meet at least one of the presented inclusion criteria.

RESULTS

The publications were selected and included in the analysis in several stages. The first step was to exclude publications dated 2000 and earlier. Subsequently, the title and summary of the publications were analyzed. Further, there was an acquaintance with the content and the review of full-text versions of the selected publications. At each stage, the authors worked independently.

During the data extraction process, the risk of systematic error was evaluated using a two-component Cochrane Collaboration instrument [*Higgins J et al., 2008; Higgins J et al., 2011*]. According to Higgins et al. systematic error levels were categorized as follows: low risk if all criteria are met; moderate risk if only one criterion is missing; high risk if two or more criteria are missing; unclear risk if there were few details to evaluate the risk.

Totally 55 articles were reviewed, 15 of which were from the PubMed database, 40 were from Google Scholar. After the selection according to the exclusion criteria, the total number of articles was 10. In the selected articles, the relevant data on microorganisms present in primary and secondary apical periodontitis.

DISCUSSION

Apical periodontitis is a chronic inflammatory disorder of periradicular tissues. Microorganisms have a critical role in the etiology and pathogenesis of this disease. Bacterial biocenosis of apical periodontitis in the root canal system is very diverse. One important observation that may be derived from this high richness, is that there are virtually no species unequivocally specific to an infection type. In other words, the same bacteria tend to be detected in both types of apical periodontitis, yet with different relative abundances [*Manoil D et al., 2020; Huang Y et al., 2021; Motiwala M et al., 2021*].

Knowledge of microbial location and organization within the root canal system is important for understanding the disease process and establishing effective antimicrobial therapeutic strategies [*Lee L et al., 2017*].

Primary Apical Periodontitis

Primary apical periodontitis results from the microbial colonization of necrotic pulp tissues.

In some studies, it was shown, that strictly anaerobic bacteria dominate the microbial population of untreated necrotic root canals, with approximately 5-12 genera including Peptostreptococcus, Prevotella, Porphyromonas, Fusobacterium, Eubacterium, and Actinomyces along with facultative anaerobic streptococci. The presence of such pathogens in necrotic root canals was shown to fairly correlate with the observation of apical inflammatory lesions on intraoral radiographs [*Sato T et al., 2012; Signoretti FG et al.,2013; Bouillaguet S et al., 2018*]. This result is in agreement with another research results, where the representatives of the genera Lactobacillus, Prevotella, Fusobacterium, Actinomyces, Parvimonas, Pseudoramibacter, and Porphyromonas are often found in the root canal system with primary apical periodontitis [*Ozok A et al., 2012; Siqueira JF Jr et al., 2020; Siqueira JF Jr, Rôças IN, 2021*].

Another study shows, that most common bacteria in primary apical periodontitis are Fusobacterium (15%), Pseudoramibacter (8%), Novosphingobium (8%), Ralstonia (6%), and Bacteroides (5%) [*Manoil D et al., 2020*].

Most prevalent gram-positive bacterial species detected in primary apical periodontitis were S. intermedius (14/31), E. faecalis (13/31), P. acnes (13/31), and S. constellatus (11/31) while the most prevalent gram-negative bacterial species were P. gingivalis (14/ 31), C. sputigena (13/31), P. melaninogenica (13/31), and L. buccalis (12/31) [*Machado F et al., 2020*].

Secondary Apical Periodontitis

Secondary apical periodontitis results from a persistent infection of incorrectly treated root canals.

Microbial populations in root canal system with secondary apical periodontitis differ from those of untreated roots. Culture-based studies have rarely identified more than 1-3 genera of Gram-positive facultative anaerobes, including Streptococcus, Lactobacillus, and Enterococcus. Some of these bacteria are resistant to the action of conventional antimicrobial agents and survive in root canal system for many years [*Bouillaguet S et al., 2018; Gomes BPFA, Herrera DR, 2018; Wang Z et al., 2021*].

Most prevalent species found in secondary apical periodontitis were E. faecalis, P. gingivalis, F. nucleatum and A. actinomycetemcomitans [*Barbosa-Ribeiro M et al., 2020*].

Many studies have shown that the species E. faecalis is classically the most frequently retrieved bacterium from secondary apical periodontitis associated root canals, with prevalence values reaching up to 90%, but was rarely detected in primary apical periodontitis. Notably, E. faecalis is more commonly retrieved from teeth treated in multiple visits or temporarily left open. This may suggest that the species is a secondary opportunistic colonizer not necessarily part of the microbiota present in primary apical periodontitis before the treatment [*Manoil D et al., 2020*].

Microbiota Changes Over the Past 10 Years

In studies of 2012, the most commonly detected bacteria in root canal system with apical periodontitis were Prevotella nigrescens, Prevotella intermedia, and Tannerella forsythia [*Endo M et al., 2012*]. And also Lactobacillus, Actinomyces, Streptococcus, Fusobacterium, Porphyromonas, Eubacterium, Selenomonas and Corynebacterium [*Ozok A et al., 2012*].

A study conducted in 2014 showed, that the most frequently detected species were Firmicutes, Proteobacteria, Actinobacteria, Bacteroidetes, Fusobacteria and Spirochaetes [*Wang J et al., 2014*]. This result is an agreement with another research of the same year, in which the most numerous were Firmicutes and Bacteroidetes, but Actinobacteria, Fusobacteria, Proteobacteria, Spirochaetes, Tenericutes, and Synergistetes were also present in most of the patients [*Vengerfeldt V et al, 2014*]. E. faecalis was detected in 49% [*Stojanović N et al., 2014*].

In 2016, the most commonly detected bacteria in apical periodontitis were Proteobacteria, Firmicutes, Fusobacteria and Actinobacteria [*Siqueira J et al., 2016*]. In some studies of 2017 – Prophyromonas endodontalis, Bacteroides, Dialister invisus, Fusobacterium nucleatum, Treponema denticola, Enterococcus faecalis, Peptostreptococcus, Olsenella uli and Veillonella [*Dumani A et al., 2012; Lee L et al., 2017*].

Researches of 2019 have shown a predominance of Firmicutes, Proteroidetes and Bacterioidetes, followed by Actinobacteria, Fusobacteria, Spirochaetes, Synergistetes, Acidobacteria, Cyanobacteria, Tenericutes, Chloroflexi. Notably, a

very high abundance of Burkholderia was also found, while this was not reported in previous studies [*Qian W et al., 2019*].

In 2021 still was revealed the dominance of Firmicutes, Actinobacteria, Bacteroidetes, Proteobacteria, Fusobacteria and Corynebacterium matruchotii [*Korona-Glowniak I et al., 2021*].

Studies conducted in 2022 have also reveal the prevalence of Proteobacteria, Firmicutes, Bacteroidetes, Actinobacteria, and the genera Fusobacterium, Morganella, Porphyromonas, Streptococcus, and Bifidobacterium [*Sun X et al., 2022*].

Thus, it can be concluded that the bacterial biocenosis of root canal system with apical periodontitis has not undergone major changes over the past 10 years.

Antibiotic Sensitivity

Microorganisms with apical periodontitis are sensitive to various antibiotics. Thus, most of Campylobacter isolates were sensitive to metronidazole, chloramphenicol, and clindamycin. Streptococcus isolates were sensitive to penicillin, clindamycin, linezolid, levofloxacin, and cefepine (cephalosporin fourth generation). Staphylococcus isolates were sensitive to sulfonamide, linezolid, amoxicillin+clavulanate, and cefoxitin (cephalosporin second generation). Most of Pseudomonas and Acinetobacter isolates were sensitive to gentamicin, ceftazidime (cephalosporin third generation), ciprofloxacin and levofloxacin. Most part of Enterobacteriaceae isolates were sensitive to ceftazidime and ciprofloxacin [*Lee L et al., 2017*].

E. faecalis isolates showed varied degrees of resistance to several antimicrobial agents. Most of E. faecalis isolates were sensitive to high-level gentamicin (120 *μg/mL*) and linezolid (30 *μg/mL*) [*Lee LW et al., 2017*]. But the most effective antimicrobial agent against E. faecalis is amoxicillin + clavulanate [*Barbosa-Ribeiro M et al., 2016*].

CONCLUSION

The main role in the etiology and pathogenesis of apical periodontitis belongs to the bacterial biocenosis of the root canal system.

Primary apical periodontitis had higher contents of microbial load compared with secondary apical periodontitis. However, secondary apical periodontitis presented a more diverse microbiota compared with the primary.

The most commonly occurring microorganisms in primary apical periodontitis are Fusobacterium, Porphyromonas, Prevotella, Pseudoramibacter and Peptostreptococcus.

In secondary apical periodontitis, E. faecalis, P. gingivalis, F. nucleatum and A. actinomycetemcomitans are the most common.

Notably, E. faecalis occurs in both types of apical periodontitis, but with secondary it is much more common.

Over the past 10 years, the microbiota of root canal system with apical periodontitis has not changed significantly.

Knowledge of the bacterial biocenosis of root canals in apical periodontitis allows to choose the right tactics of antibacterial therapy. Microorganisms of apical periodontitis are sensitive to various antibiotics. However, most of them are more sensitive to amoxicillin + clavulanate, levofloxacin, clindamycin and linezolid.

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Armen A. Muradyan

Address for correspondence:

Yerevan State Medical University
2 Koryun Street, Yerevan 0025,
Republic of Armenia

Phones:

(+37410) 582532 YSMU
(+37410) 580840 Editor-in-Chief

Fax: (+37410) 582532

E-mail: namj.ysmu@gmail.com, ysmiu@mail.ru

URL: http//www.ysmu.am

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Printed in "VARM" LLC
Director: Ruzanna Arakelyan
Armenia, 0018, Yerevan,
Tigran Mec 48, 43
Phone: (+374 91) 19 29 00,
E-mail: armana6@mail.ru