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Endodontic recontamination and retreatment: the concise systematic review

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Abstract

Introduction: It is necessary to know the nature of the endodontic microbiota within the root canal system of teeth with necrotic pulp tissues. There are several methods of microbial identification, including techniques based on culture or non-predominance of facultative anaerobes and Gram-positive species, especially Enterococcus faecalis. The 16S ribosomal RNA (rRNA) gene sequencing approach has become the reference method. Polymerase chain reaction (PCR) is a molecular technique also used. A condition for successful endodontic retreatment is proper cleaning of the root canals. **Objective:** Evaluate through a systematic literature review the main contaminations, recontaminations, and endodontic retreatments in root canals. **Methods:** The present study was followed by a systematic literature review model, according to the PRISMA rules. Clinical studies included case reports, retrospective, prospective and randomized trials. The quality of the studies was based on the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument. **Results:** A total of 94 articles were found. A total of 58 articles were evaluated in full, and 34 were included and discussed in this study. The overall assessment did not result in significant risks that could compromise the science of the present study. According to the GRADE classification, the studies were of moderate quality. **Conclusion:** It was concluded that it is essential to characterize the microbiota of root canals with failed endodontic treatment through 16S ribosomal RNA (GS) gene sequencing and PCR. Furthermore, it can be stated that the root canal instrumentation system with rotating files maintains the quality of root preparation, reducing the operative time and also the risk of a torsional fracture within the root canal.

Keywords: Root canal. Recontamination. Endodontic retreatment. Microorganisms.

Introduction

It is necessary to know the nature of the endodontic microbiota within the root canal system of teeth with necrotic pulp tissues [1-3]. There are several methods of microbial identification, including culture-based and non-culture-based techniques [4-7]. The literature has shown a predominance of facultative anaerobes and Gram-positive species, especially Enterococcus faecalis [8-10]. Despite this, there is no single culture medium that allows the growth of all bacteria present in the microenvironment of root canals. Still, any factor related to the phenotype can lead to identification difficulties and even to identification errors [11].

Furthermore, molecular studies have revealed that persistent endodontic infections have an equally diverse bacterial community as primary infections, composed of Gram-positive and Gram-negative anaerobic bacteria [12-14]. Thus, the 16S ribosomal RNA (rRNA) gene sequencing approach has become the reference method, despite this it has a limited resolution and lowers sensitivity compared to metagenomic data [15].

Polymerase chain reaction (PCR) is a molecular technique used to identify difficult-to-grow endodontic pathogens without the need for cultivation [16] and it is also an important technique to monitor the effects of endodontic procedures on some microbial species [16-18]. Furthermore, the polymerase chain reaction allows the detection of difficult-to-grow bacteria without the need for cultivation.

In this context, endodontic retraction is a procedure performed on a tooth that has received a previous attempt at a definitive treatment that resulted in a condition that

requires additional endodontic treatment to obtain a successful result [19,20]. The main cause of treatment failure is insufficient cleaning and inadequate filling [21]. A condition for successful endodontic retreatment is proper cleaning of the root canals, therefore, special attention must be given to the technique used to remove the filling material [22], with cement, pastes, and gutta-percha cones being the most used [21,22].

This study aimed to evaluate through a systematic review of the literature on the main contaminations, recontaminations, and endodontic retreatment in root canals.

Methods

Study Design

The present study was followed by a systematic literature review model, according to the PRISMA rules. Access available at: http://www.prisma-statement.org/

Data sources and research strategy

Clinical studies were included as case reports, retrospective, prospective and randomized trials with qualitative and/or quantitative analysis. Also, some review studies were included. Initially, the keywords were determined by searching the DeCS tool (Descriptors in Health Sciences, BIREME base) and later verified and validated by the MeSH system (Medical Subject Headings, the US National Library of Medicine) to achieve consistent search.

Mesh Terms

The main MeSH Terms were *Root canal. Recontamination. Endodontic retreatment. Microorganisms.* The literature search was conducted through online databases PubMed, Periodicos.com, Google Scholar, Ovid, Scopus,Web of Science and Cochrane Library.

Study Quality and Bias Risk

The quality of the studies was based on the GRADE instrument, with randomized controlled clinical studies, prospective controlled clinical studies, and studies of systematic review and meta-analysis listed as the studies with the greatest scientific evidence. The risk of bias was analyzed according to the Cochrane instrument.

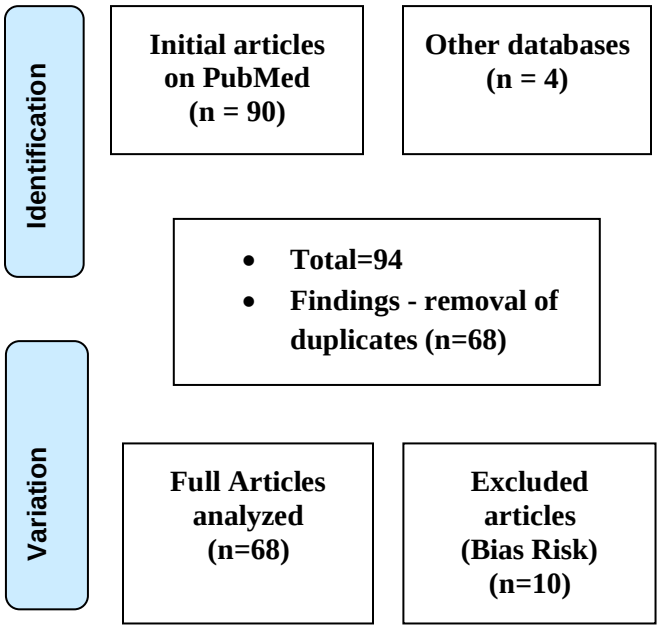
Results

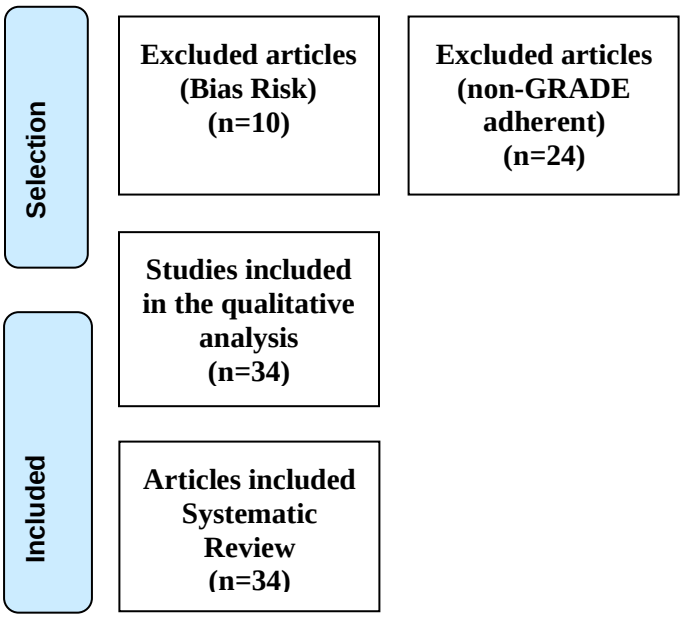
Literature Review and Discussion

A total of 94 articles were found involving root canal, recontamination, and endodontic retreatment. Initially, was held the exclusion of existing title and duplications following the interest described in this work. After this process, the summaries were evaluated and a new exclusion was held. A total of 58 articles were evaluated in full, and 34 were included and discussed in this study (Figure 1). Considering the Cochrane tool for risk of bias, the overall assessment did not result in significant risks that could compromise the science of the present study. According to the GRADE classification, the studies were of moderate quality.

Analyzing the main literary findings, it was found that it is essential to characterize the microbiota of teeth with failed endodontic treatment by genetic sequencing of 16S ribosomal RNA (GS) and PCR. In this sense, a study with twenty infected root canals of single-rooted teeth was selected. A total of 89 strains were identified using GS. Sixty-five strains were recovered in S1 and 15 strains in S2, and 9 strains remained in S3. Enterococcus faecalis was the most prevalent bacterium. Furthermore, the microbiota of persistent infection was polymicrobial, with a predominance of E. faecalis and P. gingivalis in all phases of endodontic retreatment, regardless of the method used for microbial identification. Therefore, the characterization of the bacteria present in all stages of endodontic retreatment is important to monitor the effectiveness of the techniques used and to better understand the susceptibility of these species to the disinfecting agent used during the procedures [23].

Figure 1. The selection process of scientific articles.





Furthermore, the infectious content of root canals, including bacteria and lipoteichoic acid (LTA), causes damage to periapical tissues. A clinical study quantified the levels of LTA and cultivable bacteria in the different phases of endodontic retreatment (ER) of teeth with post-treatment apical periodontitis. Twenty infected root canals of single-rooted teeth were randomly divided into 2 groups according to the chemical used for chemo-mechanical preparation (CMP) (n=10 per group): chlorhexidine (CHX) group, 2% CHX gel, and hypochlorite sodium (NaOCl) group, 6% NaOCl. Enterococcus faecalis was the most frequently isolated species in all phases of the ER. LTA and cultivable bacteria were present in all samples. CMP decreased overall levels of cultivable bacteria by 99.4% and LTA by 24.8%, while the overall reduction level of intracanal medication (ICM) in viable bacteria was 99.5% and in LTA it was 38. 6%. CMP with 2% CHX gel (CHX group, 99.3%) was more effective than 6% NaOCl (NaOCl group, 92.1%) in bacterial reduction. Likewise, ICM showed a 100% reduction in the CHX group and 98.5% in the NaOCl group. Regarding LTA reduction, CMP with 2% CHX gel (CHX group, 26.9%) was more effective than 6% NaOCl (NaOCl group, 22.6%). Furthermore, ICM showed a 43.2% reduction in the CHX group and 36.2% in the NaOCl group [24].

In addition, another clinical study investigated the microbiota of teeth with persistent secondary endodontic infection at different stages of root canal retreatment. Twenty single-rooted teeth filled with apical periodontitis were included. Cultivatable bacteria were detected in all initial samples. The chemo-mechanical preparation (CMP) reduced bacteria by 99.4% and intracanal medication (ICM) by 99.5%. The most prevalent species found in the initial samples were E. faecalis (20/20), P. gingivalis (20/20), F. nucleatum (17/20), and A. actinomycetemcomitans (10/20), while D. pneumosintes , F. alocis, P. nigrescens, and T. socranskii were not detected. After CMP, A. israelii, A. naeslundii, G. morbillorum, T. forsythia, and T. denticola were also not detected. E. faecalis and P. gingivalis had a low reduction and F. nucleatum had its DNA significantly reduced after CMP. ICM had no additional effect on microbial reduction [25].

Thus, the success rate in endodontic retreatment can be significantly increased with the use of materials that guarantee intimate adhesion to the canal walls and long-term stability. In this aspect, bioceramic cement used in root filling has interesting properties, including extraordinary sealing capabilities, an antimicrobial activity that stimulates periapical healing, and the continuous production of hydroxyapatite. Due to the ability to firmly adhere to the gutta-percha and the canal walls and to definitively seal the apical third, bioceramic cement can allow obtaining a cure in a short time [26].

In this scenario, the authors studied the Protaper Universal-Retraction system and concluded that all tested techniques left between 10.0% and 17.0% of the surface of the canals covered by the filling material. In the middle and apical thirds, samples from the Protaper group for retreatment had the lowest percentage of remnant [27]. Therefore, the benefits of using a "single-use" file system in alternative movements are shorter work time, shorter learning curve, reduction in the number of instruments needed for root canalization, simplicity (reduction in the number of steps to prepare the canal), and safety to fractures and instrument errors during the procedure [28,29].

Furthermore, Gergi and Sabbagh [30] evaluated the effectiveness of the manual files Hedströen, ProTaper, and R-Endo in removing gutta-percha from severely curved root canals. They noted that all instruments left material inside the root canal and that the ProTaper and R-Endo systems are not suitable for the complete removal of the seal material. On the other hand, other studies have demonstrated the effectiveness of rotational systems in endodontic retreatment but never producing completely obturator-free root canals.

Added to this, the authors examined the cyclic fatigue resistance of the Reciproc and WaveOne instruments through simulated root canals. Two groups of fifteen NiTi instruments with an identical size of 25.0 mm were organized, being group A composed of Reciproc R25 and group B of WaveOne Primary. All instruments were inspected and the defective one was discarded. Cyclic fatigue tests were performed in an artificial stainless steel channel, reproducing the size and taper of the instruments. The simulated root canal had a 60° angle of curvature and a 5mm radius of curvature. The center of

curvature was 5.0 mm from the tip of the instrument and the curved segment of the canal was approximately 5.0 mm long. As a result, Reciproc instruments were associated with significantly higher cyclic fatigue resistance than WaveOne instruments [31].

As a control for re-instrumentation, an x-ray of each tooth can be taken. If the radiograph showed any evidence of clogged material, the tooth was cleaned again until the radiographic examination revealed no radiopaque material in the canal. The time for retreatment and extrusion of sealing material is evaluated epically, with the cleaning of the canal walls [32].

Also, some authors compared the cyclic fatigue resistance of new endodontic instruments - ProTaper® Next X2 (M wire), OneShape® (conventional NiTi), Revo-S® Universal Shaping, and HyFlex® 25/0.6 NiTi with controlled memory) with the Revo-S® Instruments. Four groups of 20 NiTi instruments were tested in steel flutes with a radius of 3 mm and a bend angle of 60°. HyFlex® files showed greater resistance to fatigue and Revo-S® presented less resistance between groups [33].

Besides, Gavini et al. [34] evaluated the flexural fatigue strength of the reciprocal 25 mm nickel-titanium instrument and the 0.08 mm superelastic NiTi M-Wire cone, which has greater flexibility (close to 300-800%) and greater strength to Cyclic fatigue than conventional NiTi Wire using continuous rotation and/or oscillatory and rotational motion. Two groups were created according to the applied kinematics of continuous rotation (CR group) and oscillatory and rotational movement, described as reciprocal (RM group). The instruments were subjected to dynamic test devices driven by an electric motor with a speed of 300 rpm, allowing biceps movements, with 2.0 mm in each direction, through a hardened metal block simulating the instrumentation of a root canal with 40º curvature and 5mm radius. In this sense, the scanning electron microscope images showed fatigue streaks that characterize the occurrence of fatigue failure and result in spherical concavities/dimples representing a ductile fracture. Micro voids and cracks were also found. Therefore, the movement kinematics of the NiTi instruments significantly influenced the cyclic fatigue of the Reciproc R25 instrument, when the number of fracture cycles and time in seconds was almost double in the RM group compared to the CR group.

Conclusion

It was concluded that it is essential to characterize the microbiota of root canals with failed endodontic treatment through 16S ribosomal RNA (GS) gene sequencing and PCR. Furthermore, it can be stated that the root canal instrumentation system with rotating files maintains the quality of root preparation, reducing the operative time and also the risk of a torsional fracture within the root canal.

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No additional data are available

Conflict of interest
The authors declare no conflict of interest

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