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OZONE THERAPY: ADVANTAGES AND BENEFITS ASSOCIATED WITH ENDODONTIC TREATMENT

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Review Article

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Abstract. Endodontic treatment aims to restore dental form and function by eliminating root canal infections. Ozone therapy, recognized for its bactericidal properties and modulation of the immune system, is emerging as an effective alternative, promoting disinfection, tissue regeneration and less invasive treatments, overcoming the limitations of conventional approaches. In this context, this study aims to analyze the benefits of ozone therapy applied to endodontic practices, exploring the feasibility of its implementation. The study is a descriptive qualitative research, based on a literature review, which focused on articles from the last 9 years, with specific inclusion and exclusion criteria for selection. Ozone therapy, based on the use of medical ozone, stands out in endodontics for its antimicrobial, analgesic, anti inflammatory and healing properties. This treatment aims to eliminate infections and promote tissue regeneration, and is recognized by the Federal Council of Dentistry. The application of ozone, whether gaseous or in the form of ozonated water, has been shown to be effective in reducing microorganisms such as Enterococcus faecalis, contributing to apical healing and reducing the need for surgical interventions. Although ozone therapy has advantages, such as low cost and minimally invasive application, it also has contraindications and should be used as a complement to conventional treatment, respecting appropriate protocols to ensure efficacy and safety. Continuous research in endodontics is essential to ensure its efficacy and safety, highlighting the importance of innovation in dental practices for better clinical outcomes.

Keywords — Ozone therapy; Antimicrobial activity; Endodontics

1 Introduction

Endodontic treatment constitutes a spectrum of procedures within dental sciences, which aims to restore both the form and function of the tooth, while maintaining the periradicular condition at adequate levels. Thru the application of chemical and mechanical methods, the aim is, with the sanitization of the root canals, the shaping and, subsequently, the filling of these canals with a biocompatible obturating material, to resolve the infectious condition and dental inflammation [1].

With this, the main objectives of endodontic treatment include the eradication of organic debris and bacteria present in the root canals, making one of the most significant challenges in the field of endodontics the complete removal of microorganisms from the root canal system. This is due to the small diameter of the canals, their ramifications, and the presence of lateral canals and isthmuses, which often allow microorganisms to resist conventional therapies, resulting in secondary infections. In this context, the disinfection of the root canal system thru antimicrobial substances and agents that promote the dissolution of organic tissues is considered an essential step in endodontic preparation [1].

The choice of irrigating solution is crucial and must take into account the properties of the agent and the irrigation technique adopted. However, conventional irrigation has failed to meet fundamental requirements of modern endodontics, such as the ability to distribute the solution throughout the entire length of the main canal and its accessory canals. Due to this, various alternative therapies have emerged as attempts to correct the limitations of traditional approaches [1].

Among these alternatives, ozone therapy stands out, having been recognized as an alternative medicine in the United States since 1880 and applied in more than twenty countries for over 130 years. During World War I, ozone gas (O3) was used to treat infected wounds, mustard gas burns, and gangrene in German soldiers. The dentist E. A. Fisch was one of the pioneers in the application of ozone in his clinical practice, using ozonated water to aid in the disinfection and healing of dental wounds [2].

Ozone stands out as a highly effective bactericidal agent against grampositive and gram-negative bacteria, which is due to its high oxidative capacity. This property allows ozone to act directly on the fatty acids of bacterial cell membranes, resulting in an increase in cell permeability and compromising the vital functions of microorganisms. This process occurs thru the oxidation of enzymes, proteins, DNA, and RNA, thus leading to the death of bacterial cells [3].

Furthermore, ozone exerts a predominant biochemical effect on the polyunsaturated fatty acids present in the bacterial cell membrane. This interaction provides an increase in the synthesis of ATP (adenosine triphosphate) and 2,3-diphosphoglycerate, raising the oxygen supply to the tissues. Consequently, ozone acts both directly and indirectly in modulating the patient's immune system, enhancing the body's response to the etiological agent [4].

In the field of dental sciences, ozone can be applied in three distinct ways. Firstly, in gaseous form, where equipment generates ozone gas thru a suction system. Secondly, ozonated water can be used as a mouthwash, being effective in eliminating bacteria, viruses, and fungi in various conditions, such as halitosis and gum diseases. Lastly, ozonated oil is widely used in the treatment of gingivitis, periodontitis, and in post-surgical recovery [5].

The application of ozone therapy in endodontics has the main objective of enhancing the disinfection of the root canal system. This technique significantly contributes to the reduction of microbial load, especially in hardto- reach areas, such as accessory canals and isthmuses. Moreover, ozone therapy promotes biostimulation, favoring the regeneration of periapical tissues. Among the benefits of this approach, the possibility of performing less invasive treatments and the stimulation of periapical tissue recovery stand out, in addition to the reduction of symptoms presented by patients, due to the antiinflammatory properties of ozone. It is important to note that, at low concentrations, ozone is considered non-toxic to human tissues, while at the same time exerting a potent destructive effect on bacteria and other microorganisms [6].

Given this context, the present study aims to analyze the benefits of ozone therapy applied to endodontic practices, exploring the feasibility of its implementation. In this sense, the aim is to understand its molecular functioning and different forms of administration, as well as to highlight its effectiveness in eliminating microorganisms, contributing to the success of endodontic treatment.

The clinical relevance of ozone therapy in endodontic treatment is evident, as it represents a promising alternative to overcome the limitations of conventional root canal disinfection approaches. The persistence of microorganisms in hard-to-reach areas, such as accessory canals and isthmuses, often results in secondary infections, compromising the success of the treatment. This adjunctive treatment, with its bactericidal properties and ability to modulate the immune system, not only enhances the eradication of pathogens but also promotes the regeneration of periapical tissues, fostering an environment conducive to healing. Moreover, the technique provides a less invasive treatment with a lower incidence of side effects, which is crucial for the patient's experience. Thus, the investigation and implementation of ozone therapy in endodontics not only expand the available therapeutic options but also significantly contribute to the evolution of dental practices, emphasizing the importance of constantly innovating in the pursuit of better clinical outcomes and patient well-being [7].

2 Materials and Methods

The present study is characterized as a qualitative research of a descriptive nature, whose foundation will be ensured thru a rigorous literature review. Thus, the investigation was made feasible thru consultation of the SciELO, BVS, PubMed, Medline, and Science Full Text Select databases, using a combination of descriptors and the Boolean operator AND, with the aim of ensuring adequate coverage. For the selection of articles, a time frame covering the last 9 years, from 2016 to 2025, was established, prioritizing those that presented a theoretical alignment relevant to the topic in question. In this context, scientific articles were chosen that included clinical and laboratory research, systematic reviews (with or without meta-analysis), and case reports, available in the aforementioned databases, in Portuguese and English.

The defined exclusion criteria were: the elimination of duplicate works, those that contained incomplete information, that were not fully available online, or that, after complete reading, did not fit the research topic, as well as publications with a low level of review or evidence.

During the development of the research, the selection of articles was carried out respecting specific criteria. Initially, the combination of keywords was sought, followed by the application of inclusion and exclusion criteria as previously mentioned, as well as the analysis of the similarity of the article titles in relation to the topic. Subsequently, the abstracts were read, followed by the full reading of the selected texts.

3 Results and Discussion

Ozone is a molecular compound of natural origin, composed of three oxygen atoms. This gas is notable for its high reactivity, lack of color, partial solubility in water, and the intense and unpleasant odor it emits. Its discovery dates back to the year 1840, being attributed to the researcher Christian Friedrich Schönbein. In recent years, ozone therapy has stood out in both Dentistry and Medicine, being based on the use of medical ozone as a therapeutic alternative for the treatment of various pathologies. This method aims not only at the elimination of infectious foci but also at the induction of a natural healing response in the body [8, 9].

In the field of dental sciences, ozone is considered a valuable alternative therapy due to its multiple properties. Among these, the antimicrobial activity stands out, as well as its analgesic, anti-inflammatory, fungicidal, and virucidal capabilities. Moreover, ozone contributes to tissue regeneration, promotes hemostasis, activates tissue oxygenation, and exhibits healing and antioxidant effects. Given its low cost and minimally invasive application, ozone therapy proves to be advantageous in various clinical situations within Dentistry, thus demonstrating its relevance and effectiveness in contemporary dental treatment [10].

There are three different systems for generating ozone gas: the ultraviolet system, the cold plasma system used for water purification, and the atmospheric discharge system employed. In this context, it is important to highlight that the Federal Council of Dentistry, thru resolution 166/2015, officially recognized ozone therapy. This resolution establishes, in its Article 1, that ozone, derived from pure oxygen in specific concentrations, is suitable for use in dentistry. Moreover, ozone is widely recognized for its effective antimicrobial action, which includes the elimination of viruses, bacteria, and fungi. Additionally, its modulating properties exert significant influence on the systems immune and circulatory [11].

The mechanisms of action of ozone, as described in the literature, include the immediate reaction, in which the ozone molecule is oxidized, generating beneficial effects. The second mechanism, called lipid peroxidation, is a delayed reaction that results in the formation of hydrogen peroxides and a variety of aldehydes, which are oxidizing lipid products. This technique is applicable in the reduction of microorganisms during endodontic treatments, providing several benefits, although it also presents some contraindications. An additional challenge is the scarcity of material available in the literature on the subject [12].

Sushma et al.[13] confirmed the bactericidal, hemostatic, immunostimulatory, bioenergetic, analgesic, immunomodulatory, fungicidal, and anti-inflammatory effects of ozone. The effectiveness of the ozone molecule against acidogenic bacteria stands out, thus contributing to the prevention of cavities, in addition to its remineralizing properties in carious lesions.

Due to this, ozone presents great potential for endodontics, possessing antimicrobial actions, a debriding effect, stimulation of angiogenesis, an oxidizing effect, and biocompatibility [14].

When administered in appropriate concentrations and times, the antimicrobial effect of ozone can cause damage to the cytoplasmic membrane, resulting in a reduction of the periapical flora and stimulating apical bone regeneration. In this way, ozone therapy is configured as an additional proposal to conventional endodontic treatment, contributing to the decontamination process, and can be used alone or in combination with ozone gas, ozonated water, and ozonated oils [6].

In endodontics, ozone can be applied as an intracanal medication and as an irrigating agent, acting on various microorganisms, including bacteria, fungi, protozoa, and viruses present in the root canals [8]. Ozonated water, as a complementary irrigating agent, has demonstrated effectiveness in reducing the presence of Enterococcus faecalis, Streptococcus mutans, Peptostreptococcus micros, Pseudomonas aeruginosa, and Candida albicans. However, ozonated water proved to be more efficient as an irrigating agent when combined with ultrasonic agitation, significantly reducing the amount of bacteria in the root canals, although it is not as effective in neutralizing endodontic toxins [8, 15].

Concomitant with these factors, it is observed that Enterococcus faecalis, a Gram-positive and facultative anaerobic bacterium, is frequently associated with the failure of endodontic treatments, often resisting conventional therapies. However, ozone therapy has demonstrated antibacterial action against this species, showing effective results during endodontic treatment. It is essential to eliminate microorganisms during endodontic treatment to promote the healing of the apical region, and ozone has shown to be capable of reducing the periapical flora, stimulating bone regeneration, and decreasing the need for periapical surgical procedures [16].

Corroborating this premise, Moraes et al.[17] conducted an ex vivo study with the aim of evaluating the effects of gaseous ozone and ozonated water, both with and without ultrasonic activation, on the reduction of Enterococcus faecalis. For this purpose, the researchers compared these effects with the reduction provided by 2.5experiment, colonies of Enterococcus faecalis were introduced into the root canals of extracted teeth and incubated at 37º Celsius for a period of 21 days. Next, the bacterial count of the plates was performed. The results indicated that the different ozone protocols demonstrated effectiveness in reducing this species; however, there were no significant differences between the tested groups; that is, ultrasonic activation did not provide superior results compared to the use of ozone. On the other hand, the group that used 2.5hypochlorite stood out, as it was the only one that achieved total elimination of the bacteria, being, therefore, considered the most effective option compared to ozone protocols. Given these findings, the study suggests that additional tests be conducted with different ozone protocols, especially in more complex biofilms, so that its clinical application can be properly recommended.

Regarding biosafety, ozone can be used in the sterilization of instruments, as it has a biocidal effect, promoting biofilm denaturation and bacterial oxidation. However, it is essential that professionals are aware of this method and the necessary concentration for each case, individualizing the protocol for each patient. Despite the mentioned advantages, the use of ozone has contraindications and, if administered excessively, can be harmful to humans. The use of ozone in small doses for therapeutic purposes tends to minimize the occurrence of complications during treatment. However, the inhalation of ozone in large quantities can be harmful to the respiratory system and other organs. In cases of ozone poisoning, it is recommended that the patient be placed in a supine position and inhale humidified oxygen. Other measures, such as the intake of ascorbic acid and vitamin E, can be adopted to aid in detoxification [11].

The contraindications for ozone therapy include, among others, conditions such as severe anemia, recent myocardial infarction, pregnancy, hyperthyroidism, thrombocytopenia, uncontrolled diabetes mellitus, 6- phosphate dehydrogenase enzyme deficiency, and ozone allergy. Regarding ozonated oils, they exhibit effective antiseptic properties against bacteria commonly found in root canals, which allows for their use as intracanal medication. Furthermore, these oils can play an important role in the sterilization of root canal systems, as well as in the removal of necrotic debris. In certain traditional irrigation situations, the effectiveness of ozonated oils proves to be superior to that of sodium hypochlorite and sodium peroxide. To further enhance this efficacy, it is recommended to combine ozonated oil with viscous vehicles, a strategy that promotes more efficient diffusion and gradual release of the agent, thus facilitating its removal from the root canal when necessary [6, 18].

Regarding apical bone healing with ozone, it has been observed that the removal and secretion of organic matter are favored by the opening of pores, which induces the formation of granulation tissue and neoangiogenesis. This process allows the perfusion of calcium and phosphate ions, promoting the repair of apical bone tissue, being especially effective in cases of periapical lesions. This happens due to oxygen-derived free radicals, which influence the inflammatory response, causing disinfection and wound cleaning, allowing the tissue to adapt to oxidative stress [6, 18, 19].

In this way, studies demonstrate that the use of ozone in conjunction with conventional techniques results in an asymptomatic therapy, leading to favorable repair. Ozone therapy exhibits an antimicrobial action comparable to that of sodium hypochlorite at concentrations of 2.5damage, especially when applied in the form of ozonated water and agitated with ultrasound. As a complementary intracanal medication, ozonated oils demonstrate great antibacterial potential, with ozonated sunflower oil, combined with calcium hydroxide, paramonochlorophenol, and glycerin, being an option for periapical diseases [11, 20].

A comparative study was conducted with the aim of evaluating the efficacy of ozone compared to traditional endodontic treatment methods. For this purpose, 125 teeth with a single canal and bacterial infection were selected. These teeth were incubated for a period of 72 hours, allowing the formation of bacterial biofilm. Subsequently, the teeth were organized into five distinct groups: (I) ozone treatment, (II) 20(ethylenediaminetetraacetic acid), (III) 3hypochlorite), (IV) combination of 20of NaOCl with ozone. The results obtained revealed that all groups showed a significant reduction in bacterial load. However, the groups that received treatment with NaOCl alone and those that were treated with the combination of NaOCl and ozone stood out for their greater effectiveness in reducing endodontic pathogens. These findings highlight not only the antimicrobial action of ozone but also its viability as an alternative in situations where NaOCl cannot be used, as well as its potential as an adjunct to optimize treatment outcomes [21].

In this way, the use of ozone, when not combined with other drugs, still needs validation regarding its efficacy, which results in its predominant application as an adjunctive resource to already proven techniques. Although ozone therapy is recognized as a valuable tool, it is essential that its application be carried out in conjunction with other medicinal properties, respecting the appropriate concentrations for each specific situation [22].

Furthermore, it is still worth noting that a relevant aspect concerns the lack of standardization in the use of ozone therapy in endodontics, as the current theoretical framework and clinical guidelines still do not present an established protocol. In this sense, the existing studies adopt a variety of protocols, which differ both in terms of application time and ozone concentration, which can be administered in gaseous or aqueous form. Moreover, it is important to highlight a significant disadvantage: the instability of ozone concentration in aqueous state over time. This characteristic results in a relatively short lifespan, which requires the ozone to be used immediately after its generation. For the dentist to have the ability to implement this new therapeutic approach, it is essential that they complete an ozone therapy course with a minimum workload of 32 hours/class. This condition is necessary for the Federal Council of Dentistry to issue the proper certification [17, 23].

It is thus understood that the treatment of the periradicular region thru complementary therapies, such as ozone therapy, aims to significantly reduce the microbiota present in the root canals, in synergy with the conventional endodontic technique. It is important to emphasize that ozone therapy should be considered a complement to traditional endodontic treatment and a preventive strategy, not to be used alone as a therapeutic modality [15].

4 Conclusion

In summary, ozone therapy emerges as a promising alternative in the context of endodontic treatment, presenting significant advantages over conventional approaches. By acting as a potent antimicrobial agent, ozone enables the reduction of microbial load in hard-to-reach areas, such as accessory canals, contributing to the eradication of resistant microorganisms, notably Enterococcus faecalis. Moreover, the biostimulatory capacity of ozone favors the regeneration of periapical tissues, promoting an environment conducive to healing.

It is important to emphasize that, although ozone therapy offers significant benefits, its application should be considered as a complement to traditional techniques, not as a replacement. The integration of ozone therapy with conventional protocols can enhance results, minimizing invasiveness and side effects associated with treatment.

Therefore, the continuous investigation and validation of ozone therapy in endodontics are crucial, not only to ensure the effectiveness of this approach but also to guaranty the safety and well-being of patients. In summary, ozone therapy represents a significant advancement in dental practices, reinforcing the importance of innovation in the pursuit of better clinical outcomes.

References

[1] Lopes HP, Siqueira-Jr JF. Endodontia: biologia e técnica. Unknown; 2020.

[2] Sabbah F, et al. Ozone therapy in Dentistry – Where we are and where we are going to? Ozone Therapy Global Journal. 2018;8(1):37-63.

[3] Sen S, Sen S. Ozone therapy: a new vista in dentistry – integrated review. Medical Gas Research. 2020;10(4):189.

[4] Nogales CG, et al. Ozone therapy as an adjuvant for endodontic protocols: microbiological ex vivo study and cytotoxicity analyses. Journal of Applied Oral Science. 2016;24(6):607-13.

[5] Paixão LD, et al. Terapias alternativas na endodontia – ozonioterapia: revisão de literatura. Research, Society and Development. 2021;10(6):e32310615710.

[6] Silva EJNL, et al. The effect of ozone therapy in root canal disinfection: a systematic review. International Endodontic Journal. 2019;53(3):317-32.

[7] Sinha N, et al. Evaluation of Ozone Therapy in Endodontic Treatment of Teeth with Necrotic Pulp and Apical Periodontitis: A Randomized Clinical Trial. Journal of Endodontics. 2021;47(12):1820-8.

[8] Oliveira LEA, Queiroz HMA, Feitosa EA, Chagas RB, Brígido J Saldanha ADD. Ozonioterapia e odontologia: novas perspectivas. In: Conexão Fametro 2018: Inovação e Criatividade, XIV Semana Acadêmica; 2018. p. 1-7.

[9] Santos ACSV. Ozonioterapia como terapia adjunta à raspagem no tratamento periodontal de pacientes com Diabetes mellitus: série de casos. Brasília, DF, Brasil: Universidade de Brasília; 2018.

[10] Belegote IS, Penedo GS, Silva ICB, Barbosa AA, Belo MTN, Izolani Neto O. Tratamento de doença periodontal com ozônio. Braz J Surg Clin Res. 2018;23(2):101-4.

[11] Nimer HYY. O uso da ozonioterapia nas diversas especialidades da odontologia. Santa Cruz do Sul, RS, Brasil: Universidade de Santa Cruz do Sul; 2018.

[12] Indhuja RS, Sadasivan A, Koshi E. Application of ozone therapy in dentistry. International Journal of Scientific Research. 2016;5(8):21-5.

[13] Sushma. Application of Ozone Therapy in Dentistry. Indian Journal of Dental Advancements. 2011.

[14] Gupta S, et al. Applications of ozone therapy in dentistry. Journal of Oral Research and Review. 2016;8(2):86. Available from: https://jorr.org/article.asp?issn=2249-4987;year=2016;volume=8;issue=2;spage=86;epage=91;aulast=Gupta.

[15] Ajeti N, Pustina-Krasniqi T, Apostolska S, Xhajanka E, et al. The Effect of Gaseous Ozone in Infected Root Canal. Open Access Macedonian Journal of Medical Sciences. 2018;6(2):389-96.

[16] Estrela C, et al. Characterization of successful root canal treatment. Brazilian Dental Journal. 2014;25:3-11. Available from: https://www.scielo.br/j/bdj/a/RRLW7WLZjxY3gWSHVwSqFyM/abstract/?lang=en.

[17] Moraes MM, et al. The antimicrobial effect of different ozone protocols applied in severe curved canals contaminated with Enterococcus faecalis: ex vivo study. Odontology. 2021;109(3):696-700.

[18] Fernandes KGC, Andreani DIK, Tim CR, Bazan LG, Moreti LCT, Simonato LE, et al. Ozoniotherapy as a coadjuvant in the irrigation of the radicular channels system. Research, Society and Development. 2021;10(1):e40210111855.

[19] Barbosa PBMP, Alcalá MH, Castro FBL. Major clinical findings on the safety and effectiveness of ozone therapy in endodontic treatment: a concise systematic review. MedNEXT Journal of Medical and Health Sciences. 2023;4(S4).

[20] Moreira MJF, Reis AB, Dietrich Martins LHB, Barros DV. Ozonioterapia - tratamento complementar ao tratamento endodôntico: revisão de literatura. Revista Odontologia Contemporânea. 2019;3(1):73-80.

[21] Boch T, et al. Effect of gaseous ozone on Enterococcus faecalis biofilm: an in vitro study. Clinical Oral Investigations. 2016;20(7):1733-9.

[22] Smith AJ, et al. Ozone therapy: a critical physiological and diverse clinical evaluation with regard to immune modulation, anti-infectious properties, anti-cancer potential, and impact on antioxidant enzymes. OJMIP. 2015;5:37-48.

[23] CFO – Conselho Federal de Odontologia. Resolução n.166, de 08 de dezembro de 2015. Brasília; 2015. Diário Oficial da União, Seção 1, p. 95.