Journal of Dental Sciences 19 (2024) 1909–1910

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jds.com

Letter to the editor

Using photodynamic therapy for root canal disinfection during root canal therapy

Root canal disinfection is among the key factors in improving root canal therapy. However, achieving complete disinfection of the root canal during therapy is not an easy task. In this respect, incomplete disinfection can lead to apical periodontitis (which can cause long-term pain and discomfort for patients) or even tooth loss. PDT consists of a photosensitizer, light (i.e., lasers or LEDs) with a specific wavelength, and oxygen, which leads to the formation of singlet oxygen and free radicals that cause the elimination of microorganisms.[1–3] This brief letter focuses on the effect of photodynamic therapy during root canal disinfection.

PDT demonstrates an essential role for root canal disinfection. In this context, the antibacterial efficacy of various techniques on *Enterococcus faecalis* (*E. faecalis*) in 53 single-root teeth was examined in an in vitro study. After access cavity, the root canals were prepared and rinsed. The canals were then dried, and the samples were contaminated with *E. faecalis*. To confirm the success of the construction of the root canal infection model, a bacterial culture and a scanning electron microscope were performed on three teeth. Afterwards, the samples were divided into 5 groups (n = 10) and disinfected as follows: Group 1) as the control group (no treatment), Group 2) 2.5% NaOCl, Group 3) 2.5% NaOCl + Er:YAG, Group 4) methylene blue + irradiated with a 660 nm laser, and Group 5) methylene blue + Er:YAG. The results showed that Groups 3 and 5 were superior in eliminating microorganisms. Therefore, PDT (i.e., a photosensitizer (50 μmol/L methylene) and Er:YAG with a wavelength of 2940 nm for 1 min) is recommended for disinfecting root canals.[4]

Another research evaluated the efficacy of two PDT protocols in eliminating *E. faecalis* from infected root canals. In this respect, 60 root canals infected with *E. faecalis* were included in the study. The samples were divided into 4 groups (n = 15) and disinfected with the following procedures: Group 1) 2.5% NaOCl, Group 2) NaOCl + PDT (toluidine blue + 630 nm LED), Group 3) NaOCl + PDT (indocyanine green + 808 nm diode laser), and Group 4) control group (no treatment). The findings showed that Group 3 was more effective compared to other groups. Hence, employing indocyanine green with laser irradiation is recommended to improve the effect of NaOCl against microorganisms.[1]

In line with the previous study, Wang et al. investigated the effect of PDT protocols on 65 extracted premolar teeth infected with *E. faecalis*. For this intended purpose, the samples were divided into 5 groups (n = 13) and disinfected as follows: Group 1) 5.25% NaOCl (positive control), Group 2) NaCl (negative control), Group 3) sonic-assisted methylene blue mediated antimicrobial photodynamic therapy (MB-aPDT), Group 4) 3% NaOCl + MB-aPDT, and Group 5) 3% NaOCl + sonic-assisted MB-aPDT. The positive control group and Group 5 exhibited the highest antimicrobial effect (i.e., >90%). The NaOCl concentration can be reduced to a safe level (i.e., from 5.25% to 3%) while maintaining its antibacterial efficacy through the synergism with sonic-assisted MB-aPDT in this research study. Thus, it is recommended for root canal disinfection, particularly for disinfecting the lateral canals.[5]

To evaluate the antimicrobial properties of PDT in endodontic therapy, the efficacy of PDT for eliminating microorganisms was examined in a case series. Teeth Nos. 47, 46, and 41 of three patients were included in the study for treatment. Access cavities and root canals were prepared, followed by irrigation of the canals with NaOCl. After the last irrigation step, 5% $Na_2S_2O_3$ was also used to neutralize the adverse effect of NaOCl. Finally, a photosensitizer (0.1 mg/mL toluidine blue) was injected into each canal and irradiated via a light-emitting diode lamp (wavelength of 630 nm) for two 30-s periods. The results of a 6-month follow-up examination through this protocol showed satisfactory outcomes. Also, applying PDT was found to be an effective method for root canal disinfection.[6]

de Vasconcelos Neves et al. evaluated the efficacy of PDT with different irrigation protocols. To achieve this objective, 90 extracted premolar teeth were selected and enrolled in this study. The samples were prepared and contaminated with *E. faecalis*. The teeth were then divided into 6 groups

https://doi.org/10.1016/j.jds.2024.03.018

(n = 15), including 5 treatment groups and a negative control group. The treatment was performed based on the following disinfection procedures: Group 1) conventional needle irrigation with 2.5% NaOCl, Group 2) PDT (i.e., 0.005% methylene blue + diode laser of 660 nm for 90 s), Group 3) NaOCl + PDT, Group 4) passive ultrasonic irrigation with NaOCl + PDT, and Group 5) XP Endo Finisher with NaOCl + PDT (XP Endo + PDT). The results showed that PDT, in combination with other irrigation protocols, especially the XP-Endo protocol, is more effective in eliminating microorganisms. Thus, PDT with various final irrigation protocols could be chosen for root canal disinfection.[7]

In a literature review based on 51 studies, the effect of antimicrobial PDT was evaluated as an additional approach in cases of antibiotic resistance of microorganisms in endodontic therapies. The results revealed that PDT can significantly eliminate microorganisms from infected root canals (including antibiotic-resistant species) and is effective in destroying biofilms. Moreover, PDT can be used as an alternative to local intra-canal antibiotic therapy, thereby avoiding possible antibiotic resistance. Hence, the use of PDT could be considered to increase the success rate of conventional and surgical endodontic procedures.[8]

In a laboratory study, Sharifzadeh et al. investigated the penetration depth of three photosensitizers, namely curcumin, indocyanine green, and methylene blue, in the lateral wall of the root canal for endodontic disinfection. To reach this goal, 30 extracted single roots were enrolled. The root canals were prepared and rinsed with 2.5% NaOCl, followed by 17% EDTA. After drying the canals, the samples were divided into 3 groups (n = 10), each filled with curcumin, indocyanine green, and methylene blue. Subsequently, the samples were incubated for 10 min and dried again with a paper cone. The samples were grooved longitudinally and divided into two parts using a chisel. The penetration of photodynamic substances was evaluated under a microscope. According to the results, curcumin has a high penetration depth into dentinal tubules, making it suitable for disinfecting root canals.[9]

In line with the above study, a case report described the outcome of endodontic therapy (i.e., retrograde procedure) using curcumin as a photosensitizer based on PDT in the tooth No. 26. The results showed that applying a novel mixture of curcumin and 2% chlorhexidine gel with an irradiating blue LED at a wavelength of 440—480 nm showed a reduction of microorganisms followed by periapical healing. In addition, PDT contributed to accelerating cell recovery and reducing postoperative discomfort.[2]

According to the explanations provided in this brief letter, applying photodynamic therapy as a supplementary safe technique for root canal disinfection could be considered to enhance the success rate of endodontic therapy.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

None.

References

1. Asnaashari M, Veshveshadi O, Aslani F, Hakimiha N. Evaluation the antibacterial efficacy of sodium hypochlorite in combination with two different photodynamic therapy protocols against Enterococcus faecalis in infected root canals: an in-vitro experiment. *Photodiagnosis Photodyn Ther* 2023;43:103722.
2. de Araújo LP, Marchesin AR, Carpena LP, et al. Outcome of curcumin-based photodynamic therapy in endodontic microsurgery: a case report. *Photodiagnosis Photodyn Ther* 2024;45:103994.
3. Nasiri K, Wrbas KT. Successful root canal therapy during COVID-19 pandemic. *J Dent Sci* 2022;17:1079—80.
4. Yang G, Chen W. In vitro effects of Er: YAG laser-activated photodynamic therapy on Enterococcus faecalis in root canal treatment. *Photodiagnosis Photodyn Ther* 2024;45:103992.
5. Wang Y, Lei L, Huang J, Cai Z, Huang X. Sonic-assisted antibacterial photodynamic therapy: a strategy for enhancing lateral canal disinfection. *BMC Oral Health* 2024;24:5.
6. Shahbazi S, Esmaeili S, Feli M, Asnaashari M. Photodynamic therapy in root canal disinfection: a case series and mini-review. *J Laser Med Sci* 2022;13:e19.
7. de Vasconcelos Neves G, Dos Santos KSA, de Souza Sales Rocha EAL, et al. Antibacterial effect of photodynamic therapy on root canal disinfection combined with different irrigation protocols. *Iran Endod J* 2020;15:90—5.
8. Abdelkarim-Elafifi H, Parada-Avendaño I, Arnabat-Dominguez J. Photodynamic therapy in endodontics: a helpful tool to combat antibiotic resistance? a literature review. *Antibiotics (Basel)* 2021;10:1106.
9. Sharifzadeh SS, Gerami Amin M, Moezzi Ghadim N, Fazlyab M, Azizi A. Comparative analysis of photosensitizer penetration depth in root canal debridement for endodontic disinfection. *Iran Endod J* 2024;19:35—8.

Kaveh Nasiri*
Independent Researcher, Essen, Germany

Karl-Thomas Wrbas
Department of Operative Dentistry and Periodontology, Faculty of Medicine, Center for Dental Medicine, Medical Center, University of Freiburg, Freiburg i. Br., Germany
Faculty of Medicine and Dentistry, Danube Private University, 3500 Krems, Austria

Maya Doychinova
Department of Conservative Dentistry and Oral Pathology, Faculty of Dental Medicine, Medical University of Varna, Bulgaria

*Corresponding author. Independent Researcher, Koenigraetzstrasse 13, Essen 45138, Germany.
E-mail address: DDS.Nasiri@web.de (K. Nasiri)

Received 17 March 2024
Available online 25 March 2024