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# Antimicrobial Photodynamic Therapy associated with long term success in endodontic treatment with separated instruments: A case report

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ABSTRACT

This paper describes a case with a 5- year follow-up of Antimicrobial Photodynamic Therapy (aPDT) associated with long-term success in endodontic treatment in a tooth with separated instruments. The patient presented with a tooth exhibiting a periapical lesion, slight swelling, and severe pain. A radiograph revealed the presence of two separated files in the middle and apical thirds of the mesial root on a lower first molar. Attempts at bypassing were not successful. In the mesial root, instrumentation was limited to the coronal ends of the separated instruments. The apical patency could not be achieved due to the blockage of the separated files. aPDT was performed in two visits, at a 660-nm wavelength and 100 mW of power, for 90 s to a total energy of 9.0 Joules. Methylene blue solution was used as photosensitizer at concentration of 0005%. A 300-μm light diffusor was coupled to the diode laser and was inserted into the root canal 2 mm short of WL, where it was set to allow better diffusion of light. Each root canal was sealed with gutta-percha by warm vertical compaction and Pulp Canal Sealer™. After 5 years of follow-up, clear evidence of remineralization of the radiolucency and bone healing was observed. This case report suggests that the addition of aPDT to conventional endodontic treatment improved microbial disinfection leading to a successful long-term outcome.

## 1. Introduction

Over the last decades, successful endodontic treatment has become more predictable with the development of new technologies and materials. Effective root canal disinfection is one of the main goals and a fundamental component of successful root canal treatment. The quality of endodontic treatment has constantly improved, and the time required to accomplish it has been substantially reduced.

Most therapeutic failures are associated with the persistence of microorganisms that are able to survive chemomechanical preparation and/or intracanal medication. The complexity of the root canal system and the polymicrobial nature of primary endodontic infections consisting primarily of anaerobic bacteria makes complete debridement and bacterial eradication with instrumentation, irrigation or intracanal medicaments almost impossible [1]. Intracanal separation of instruments is one of the most troublesome incidents during endodontic therapy. It may hinder cleaning and shaping within the root canal system. Although some studies state that the prognosis for endodontic treatment is not significantly reduced when a fractured instrument fragment is left within a root canal [2] when a periapical lesion is present at the time of instrument separation, the treatment outcome may become highly questionable [3].

Antimicrobial Photodynamic Therapy (aPDT) has emerged as a promising approach to eradicate oral pathogenic bacteria. PDT involves the use of a photosensitizer (PS) that is activated by light at a specific wavelength; it absorbs photons from the light source, and their electrons enter an excited state, also known as triplet state. In the presence of a substrate, such as oxygen, the photosensitizer, when it returns to its basic state, transfers the energy to the substrate, thus forming free radicals of high cytotoxicity, such as superoxides, free radicals and singlet oxygen. These oxygen species are highly reactive and harm proteins, lipids, nucleic acids, and other microbial cellular components [4].

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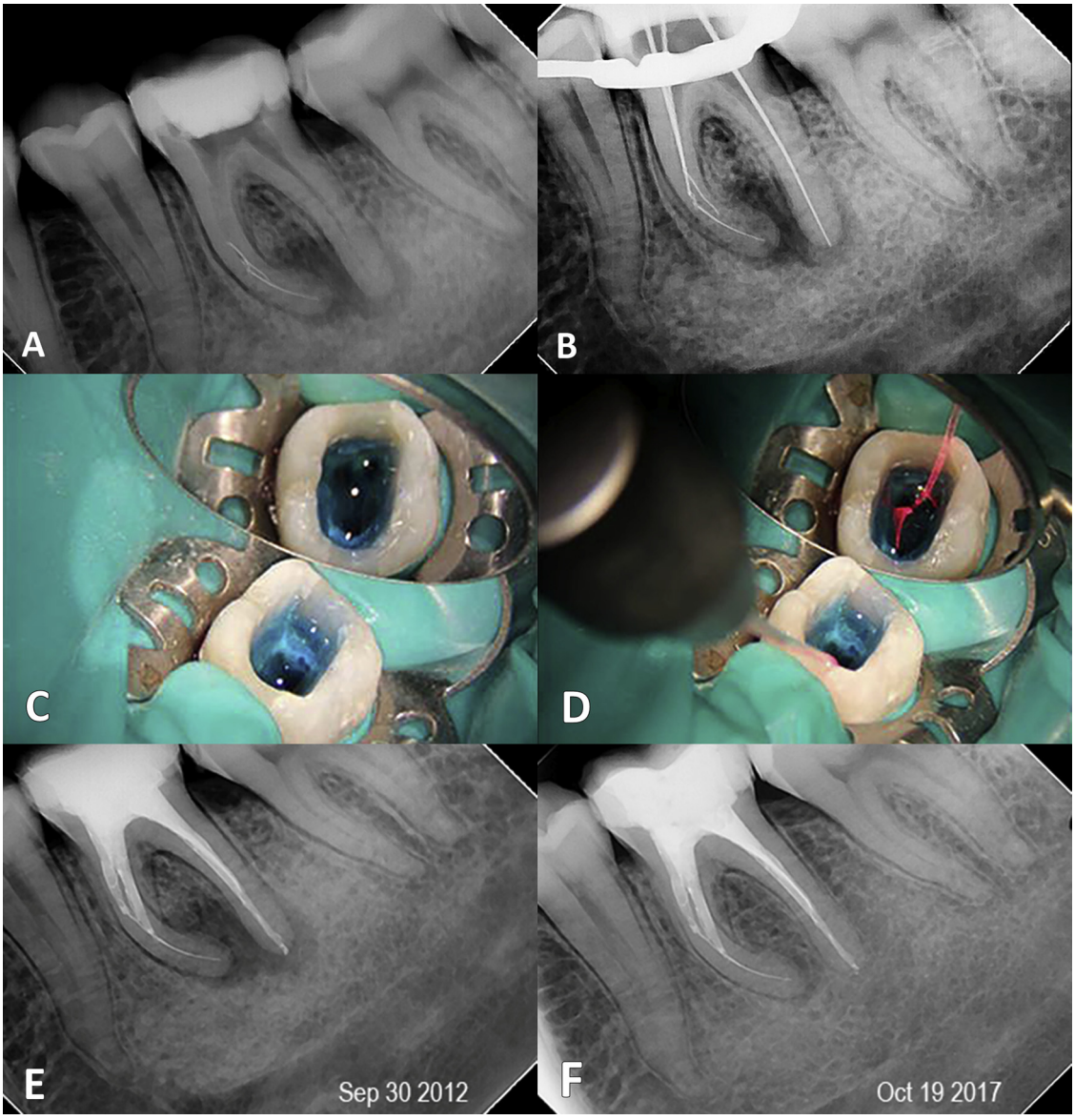


**Fig. 1.** Radiograph revealed a periapical lesion and two separated files within the mesial root and Attempt at bypassing the separated instrument (A and B). Irrigation with methylene blue solution 0.005% (C). A 300-μm light diffusor was inserted into the root canals (D). Post-op radiograph (E). Follow-up after 5 years (F).

## 2. Case report

A 25- y.o. Brazilian female was referred to a private dental office in Belo Horizonte, Minas Gerais, Brazil, in order to have a root canal treatment with an endodontist. The patient's medical history was remarkable, no medications or allergies were reported. No previous medicaments were used by the patient before the endodontic treatment. Periodontal evaluation was satisfactory with no periodontal socket. The patient reported that a week earlier a general dentist had attempted root canal therapy and the most recent periapical radiograph revealed 2 separated instruments in the M-canals of a first left lower molar (Fig. 1A). An intra-oral exam revealed a slight swelling but no associated sinus tract. The tooth had no caries and was restorable. The periapical status of the tooth was diagnosed as an acute apical abscess. Prior to retreatment the patient was informed about the presence of the two separated instruments and that these instruments might hinder complete cleaning and shaping of the root canal system resulting in a compromised prognosis. The patient was made aware that periradicular surgery would be indicated if there was no radiographic evidence of bone remineralization. The patient preferred to have the tooth retained and restored and signed the informed consent form. Local anesthesia was administered and a rubber dam was applied. The coronal temporary restoration was removed. After establishment of a straight line access, the pulp chamber was irrigated with 3 mL of 5.25% of NaOCl solution. Stainless steel K-files size 10 and 15 (Dentsply Maillefer, Ballaigues, Switzerland) were used to establish the glide-path and reach the working length. The endodontic treatment was done with the use of dental microscope. Despite many attempts it was not possible to remove both separated instruments in the mesial root because they were located apical to the root canal curvature. Bypassing was not successful either. All root canals were instrumented sequentially up to a working length (WL) achieved in the mesial and distal roots by means of a rotary instrumentation technique using ProGlider (Dentsply Maillefer, Ballaigues, Switzerland) and reciprocal instrumentation using WaveOne Gold Primary (Dentsply Maillefer, Ballaigues, Switzerland). In the mesial root canals instrumentation was limited to the coronal ends of the separated instruments (Fig. 1B), whereas the sections of the mesial canals apical to the separated instruments remained uncleaned and unshaped. The distal root was cleaned and shaped completely. Irrigation with 3 mL of 5.25% NaOCl solution was performed after each enlarging

instrument throughout the preparation using a sterile disposable plastic syringe. Upon completion of cleaning and shaping the root canals were irrigated with 3 mL of 17% EDTA solution, pH 7.4, for three minutes followed by a final irrigation with 3 mL of 5.25% NaOCl solution. Afterwards, irrigation with 3 mL of 3% hydrogen peroxide was performed inside the root canal and left inside for one minute to eliminate residual NaOCL solution, which would interfere with the photosensitizer. Then the root canals were irrigated with 0.005% methylene blue solution (Chimiolux, DMC, São Carlos, Brazil) (Fig. 1C) used as a photosensitizer (PS) and Twin Flex laser equipment (MMOptics, São Carlos, Brazil) at a 660-nm wavelength and 100 mW of power, during 90 s to a total energy of 9,0 Joules. A 300-μm light diffusor (MMOptics, São Carlos, Brazil) was coupled to the diode laser and was inserted into the root canal 2 mm short of WL, where it was set to allow better diffusion of light (Fig. 1D). Between the application of the PS and the laser activation, a 5 min waiting period was taken. After laser irradiation was performed, the root canals were irrigated with 3 mL of 17% EDTA solution to remove residual methylene blue solution and dried with paper points (Dentsply Latin America, Petrópolis, RJ, Brazil). A 2% chlorhexidine (CHX) gel (Endogel, Itapetininga, São Paulo, Brazil) was placed inside the root canals along with a sterilized cotton pellet placed in the pulp chamber. The access opening was sealed with a temporary restorative material (IRM; Dentsply Latin America, Petrópolis, RJ, Brazil). At the second appointment 1 week later, aPDT was performed following the same procedures as described previously. Each root canal was sealed with gutta-percha by warm vertical compaction and Pulp Canal Sealer (kerr Corp., Orange, USA). The patient had the tooth restored after two weeks and the follow-up was performed along five years. No symptomatology after the procedures or during the follow-up period was reported by the patient. The tooth is firm and functional and clear evidence of remineralization of the radiolucency and bone healing was observed after 5 years of follow-up (Fig. 1E and F).

## 3. Discussion

Effective root canal disinfection is one of the main goals and a foundation for successful root canal treatment. Mechanical debridement and shaping of the root canal system with various nickel-titanium rotary and reciprocal instruments, intracanal irrigation with antimicrobial dissolving agents are important for effective root canal disinfection. Nevertheless, several studies reported that complete eradication of microorganisms from the root canal system cannot be effectively achieved with any of the currently used techniques and combinations [5,6].

When an endodontic instrument separation occurs during root canal shaping it might impact the prognosis of the treatment [7,8]. When a periapical lesion is present at the time of instrument separation, the treatment outcome might be even more questionable [7]. In this case, efficient cleaning and shaping with endodontic instruments was not achieved in the apical third of the mesial root. Previous studies [7,8] reported that the presence of a lesion, stage of canal preparation when instrument fracture occurred and separated fragment position will likely reduce the success rate considerably. Bypassing is certainly the first choice to remove both separated instruments, but it was not successful in this case. The risks of removal (e.g., root perforation) were balanced against modest benefit [9]. Before recommending periradicular surgery, the treatment with (aPDT) was performed.

aPDT is based on the application of a PS and a light source resonant with the emission peak of the PS that generates singlet oxygen and free radicals, which results in bacterial cell damage. This technique is minimally invasive, non-resistant, repeatable, and economically beneficial for the patient [4,7,10].

Different PS and light sources can be performed during aPDT and one of the most used is methylene blue (MB) with red lasers with a wavelength between 630 nm and 660 nm. Methylene blue was selected because of its hydrophilic nature, low molecular weight and its proven effectiveness to generate reactive oxygen species, such as singlet oxygen and free radicals (superoxide, hydroxyl radicals, hydrogen peroxide) [10,11].

The use of a light diffusor promotes a more uniform light distribution along the root canal enabling better irradiation approaching the root apex which would probably lead to better results in endodontic photodynamic therapy [12]. Because of the impediment presented by two broken files beyond the root canal curvature, the light diffusor was used to not only irradiate the lumen of the medial root but also beyond the separated instruments. Methylene blue has a low molecular weight and high hydrophilic nature which may enable it to bypass the separated instrument, reach the apical third of the root and penetrate the dentin tubules beyond the separated files [13].

The pre-irradiation time of 5 min that was used is important to allow the perfusion of the PS inside the root canal walls [14].

Intracanal medications had been used to eradicate remaining bacteria after canal instrumentation and irrigation. In this case, 2% CHX gel was placed inside the root canals because it is an effective root canal disinfectant [15]. Calcium hydroxide dressing was not used because it might have blocked the PS infiltration and the uniform light distribution along the root canal. The root canal treatment was not performed in one visit due to symptomatology including slight swelling, and pain.

Research studies reported the use of aPDT in-vivo and ex-vivo using animal models and clinical trials [4,7,8,12]. A systematic review investigated the effect of aPDT on bacterial load reduction and all included studies showed a positive effect in reduction of microbial load ranging from 91.3%–100% [16].

The purpose of this case report is to show that the combination of aPDT as an adjunct with the endodontic treatment procedures were successful. The tooth is firm and functional and extraction or implant was not accomplished.

## 4. Conclusion

In conclusion, this case report illustrates that the use of aPDT as an adjunct in non-surgical endodontic treatment with separated files obstructions promoted sufficient microbial reduction enabling clear evidence of remineralization of the radiolucency and bone healing after 5 years of follow-up.

## Conflict of interest

The authors deny any conflicts of interest related to this case report.

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