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Management of a Sinus Tract of Endodontic Origin Using Ultrasonically-Activated Photodynamic Therapy and Photobiomodulation: A Case Report

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Abstract

Introduction: Odontogenic extraoral sinus tracts are rare conditions that can be misdiagnosed as skin lesions and lead to unnecessary treatments. They are caused by dental infections spreading through bone and draining externally. Conservative nonsurgical endodontic treatment should be pursued first. However, conventional instrumentation and irrigation techniques cannot fully decontaminate root canal systems. New disinfection techniques, including ultrasonic activation of irrigation, photodynamic therapy (PDT), and lasers, have been developed as adjunctive techniques. Photobiomodulation (PBM) (also known as low-level laser therapy) has also demonstrated beneficial effects on tissue healing.

Case Presentation: This report presents a case of an extraoral sinus tract associated with a necrotic mandibular molar that was treated successfully with nonsurgical endodontic therapy using ultrasonically-activated PDT, PBM, and high-intensity laser therapy (HILT). Six- and 12-month follow-ups showed resolution of the sinus tract and healing of the apical lesion radiographically. The extraoral lesion had diminished significantly.

Conclusion: Combining nonsurgical endodontic treatment with PDT with ultrasonic activation, PBM, and HILT allowed successful management of an odontogenic extraoral sinus tract without surgical intervention. Using PDT combined with ultrasonic activation enhanced disinfection while PBM and HILT improved wound healing. This report demonstrates a conservative approach to treating these lesions.

Keywords: Photobiomodulation therapy; Photodynamic therapy; Ultrasonics; Root canal therapy.

Introduction

The sinus tract is defined as an abnormal communication pathway surrounded by epithelium between an enclosed area of inflammation and an epithelial surface. It is a drainage duct for suppuration produced by chronic apical abscess.[1] Depending on the location of the sinus tract opening, it may be intraoral or extraoral. Sinus tracts are primarily identified intraorally, while extraoral sinus tracts are very rare. The extraoral sinus tract may exist in every region of the face and neck. However, it is usually located on the chin, cheek, angle of the mandible, submental area, and rarely in the nasal area.[2] An odontogenic extraoral sinus tract is the consequence of prolonged infection. Common dental cause of the extraoral sinus tract is chronic peri-radicular abscess due to dental caries, endodontic infections, trauma, and rarely periodontal infections. The most common cause of peri-radicular abscess is pulp infection. The odontogenic extraoral sinus tract may be confused with a variety of dermatologic lesions. Since patients have no dental symptoms and because of esthetic concerns, patients may be referred to a dermatologist or plastic surgeon and rarely a dentist. It may cause unnecessary treatment, such as surgical interventions and antibiotic therapy. There are surgical and nonsurgical treatment options to treat such cases. If an extraoral sinus tract is associated with endodontic origin, conservative nonsurgical endodontic treatment should initially be done.[3]

The outcome of root canal treatment depends on creating a bacteria-free environment. There are various limitations to a successful endodontic treatment, including untreated canals, anatomic complexities, coronal leakage, and bacterial persistence in the root canal system due to poor root canal disinfection.[4] Although chemo-mechanical techniques are accepted for decontamination purposes during root canal treatments,

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they do not provide a wholly sterile and bacteria-free root canal system.[5] One of the challenges in recent years is to develop new methods to eliminate bacterial persistence. Various adjuvant techniques have been proposed to assist root canal debridement and decontamination.

Photodynamic therapy (PDT) is a minimally invasive approach suggested as an effective adjunct to conventional root canal treatment. PDT involves the combination of a photosensitizer and a low-level laser or light-emitting diode (LED) energy. PDT is based on activating a nontoxic photosensitizer by low-intensity visible light. The interaction between the photosensitizer and light produces singlet oxygen which can damage bacterial membranes.[5] Photobiomodulation (PBM) is used as an adjunctive technique that provides satisfactory wound-healing results.[6]

This study aims to report a case of nonsurgical endodontic management using ultrasonically-activated PDT, PBM, and high-intensity laser therapy (HILT) of an extraoral sinus tract with a 12-month follow-up.

Case Report

A 15-year-old female with a low socioeconomic status was referred to the Department of Endodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences. The patient's chief complaint was pus drainage from a skin lesion on her lower left jaw region (Figure 1A). The patient's health status through the guidance of the American Society of Anesthesiologists (ASA) was ASA1. Her medical history revealed no significant findings. She had no allergies and took no medication. The dental history revealed localized dull pain, initiated spontaneously and by chewing on the left side of the lower jaw. Extraoral examination revealed a parulis with pus drainage in the mandibular region. No apparent facial swelling or asymmetry was observed. Normal palpation of the cervical and submandibular lymph nodes was observed. Intraoral examination revealed that tooth #19, the lower left first molar, had a deep carious lesion. The sensibility tests, including electric pulp tests (SybronEndo, CA, USA), cold tests, and heat tests, elicited non-responsiveness from the suspect tooth. The suspect tooth was tender to percussion and palpation. No signs of periodontal pocket or mobility were present in tooth#19. Discoloration of the mentioned tooth was observed.

Gutta-percha tracing was performed by using a size 30 gutta-percha cone (Figure 1B). An intraoral periapical radiograph showed a well-defined periapical radiolucency associated with the mandibular left first molar (Figure 1C). The CBCT scan demonstrated a periapical radiolucency, perforating the buccal cortical plate. The tooth (#19) contained two roots (mesial and distal) and three root canals (Figure 1D-G). Based on clinical and radiographic examinations, a diagnosis of pulp necrosis with chronic apical abscess and a cutaneous sinus tract associated with tooth #19 was established. The treatment plan included: (1) non-surgical root canal treatment, (2) HILT to remove parulis, (3) PBM to improve the healing of parulis, and (4) follow-up. The alternative treatment was the extraction of tooth number #19.

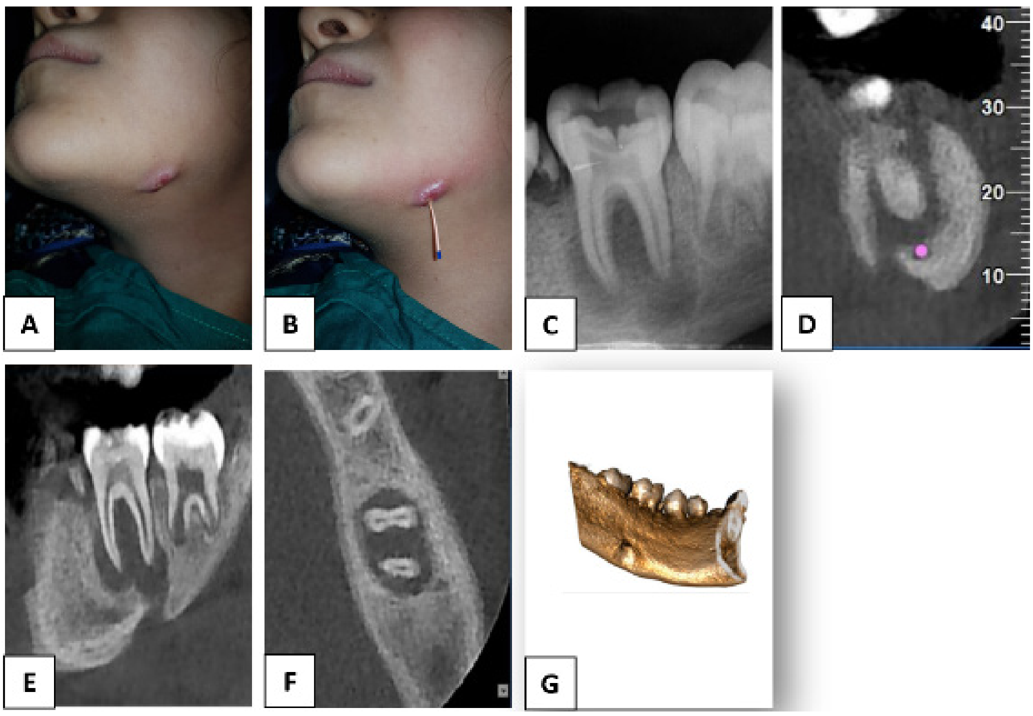

Figure 1. Examination procedures. (A) An extraoral cutaneous sinus tract in the lower jaw region; B) Gutta-percha tracing; C) Diagnostic radiograph showing a periapical lesion related to tooth#19; D) CBCT image (coronal view); E) CBCT image (sagittal view); F) CBCT image (axial view); G) 3-Dimensional Reconstruction

During the first visit, informed consent was obtained, and local anesthesia of Lidocaine 2% plus epinephrine 1:80 000 (Darou Pakhsh Co., Tehran, Iran) was achieved via Inferior Alveolar Nerve Block and Infiltration (lidocaine 2% with epinephrine1/80000). Tooth #19 was isolated with a rubber dam, and an access cavity was prepared (Figure 2A). Working length was determined by using Root ZX II apex finder (J Morita, Tokyo, Japan). The working length was confirmed radiographically. Root canals were cleaned and shaped using the crown-down method by stainless steel K-file (Mani Co, Tokyo, Japan) and rotary nickel-titanium file ProTaper NEXT X3 30.07 (Dentsply Sirona) up to MAF #30 for mesial canals and #35 for the distal canal (Figure 2B). The canals were irrigated with normal saline and 2.5% sodium hypochlorite (NaOCl) during the preparation. For the passive activation of NaOCl, an ultrasonic Ultra-X with a blue tip (Eighteeth; Medical Technology Co., Changzhou, China) was used. An XP-Endo® Finisher file (FKG Dentaire, La-Chaux-de-Fonds, Switzerland) was used as an adjunctive technique for efficient cleaning. After drying canals, PDT was carried out. Methylene blue (Sigma, St. Louis, MO) was inserted as a photosensitizer within each canal and remained for five minutes. After that, passive ultrasonic irrigation was performed for 1 minute (Figure 2C). The photosensitizer was irradiated by an LED lamp (FotoSan®; CMS Dental, Denmark) with a wavelength of 630 nm and 2000 mW/ cm^2 intensity. The endodontic tip of the LED lamp was inserted into the root canal. Two 30-second irradiation treatments were performed in each canal by using up and down motions (Figure 2D, E). Canal spaces were filled with calcium hydroxide (Golchai, Tehran, Iran), and then they were temporarily sealed for two weeks.

Two weeks later, on the second visit, the sinus tract was closed. After achieving local anesthesia, the temporary filling was removed under rubber dam isolation. The calcium hydroxide dressing was removed with a hand file and irrigated. Root canals were prepared by using ProTaper NEXT and irrigated with normal saline, 0.2% chlorhexidine, and 2.5% NaOCl. Adjunctive techniques were carried out in the same manner as the first session. Gutta-percha master cones were placed and were confirmed radiographically (Figure 2F). The canals were irrigated with 17% EDTA for smear layer removal and 2.5% NaOCl as a final irrigator. The canals were obturated with gutta-percha (Meta) and AH26 sealer (Dentsply Sirona) by using the lateral condensation technique. The tooth was restored by Filtek Supreme composite by 3M (Figure 2G, H).

HILT (diode laser, Ga-Al-As, Dr. Smile, Italy) was performed to remove parulis. The laser settings were as follows: 2.5-watt diode laser, infrared spectrum (808 nm), and continuous wave output (Figure 3A, B).

The fiber was inserted approximately 1-2 mm into the fistula tract. It was then withdrawn laterally from the fistula while rotating in a gentle twisting motion. This action effectively removed the epithelial lining cells from the walls of the fistula tract.

To improve the healing of parulis, we used PBM (diode laser, Ga-Al-As, Dr. Smile, Italy). A 0.3-W diode laser was used, with an infrared wavelength (808 nm) and continuous wave mode (Figure 3C, D). The treatment was performed on intra-oral and extra-oral sites. PB was applied in a contact mode with a spot size of 1 cm^2 and an energy density of 1 J/ cm^2. Each part of the lesion was

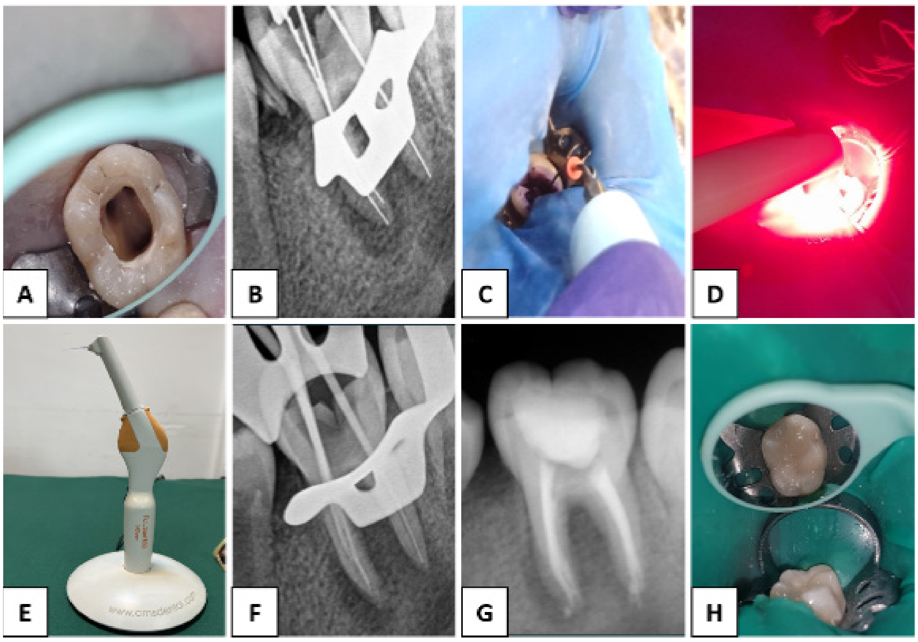

Figure 2. Treatment procedures. A) Access cavity; B) Instrumentation; C) Ultrasonic activation of the photosensitizer; D) Irradiation of the photosensitizer with an LED; E) FotoSan LED device; F) Master apical cone radiograph; G) Post-operative radiograph; H) Direct composite restoration

exposed to the laser for 30 seconds.

The patient was followed at 6 months and 12 months, and clinical photographs (Figure 4A, B) and intraoral radiographs (Figure 4C, D) were taken. Radiographs demonstrated the healing of the periapical lesion. The extraoral lesion had diminished.

Discussion

The correct diagnosis of the extraoral cutaneous sinus tract is challenging because the odontogenic extraoral sinus tract may be confused with a variety of diseases, including dermatological diseases, traumatic injuries, furuncles, pustules, osteomyelitis, bacterial infections, draining cysts, neoplasms, pyogenic granulomas, tuberculosis, actinomycosis, and foreign objects.[7] The location of the sinus tract depends on the site of the perforation in the cortical plate by the inflammatory process, the location of the affected tooth, and its relationship with the attachment of facial muscles.[8] Most odontogenic extraoral sinus tracts are associated with infected mandibular teeth (80%-87%). In some cases, the sinus tract can be located far from the source of infection.[9]

The success of endodontic therapy depends on many factors, including adequate elimination of bacteria from the root canal system.[4] Kouchi et al demonstrated that microbial contamination of the root canal can penetrate the dentinal tubules up to a depth of 1100 µm.[10] Zou et al found that 6% NaOCl achieved a maximum penetration depth of 300 microns when applied for 20 minutes at 45 °C.[11] On the basis of Ghorbanzade and colleagues' study, the average penetration depth of NaOCl in the coronal third, middle third, and apical third was 249.93, 163.9, and 42.07 micros, respectively.[12] Therefore, conventional techniques may not be able to clean the root canal system entirely, and various adjuvant techniques have been proposed to overcome this issue.

Ultrasonics in endodontics can be used for access refinement, locating calcified canals, removing obstructions (fractured instruments, posts, silver points), and enhancing irrigant solutions. Passive ultrasonic irrigation enhances irrigant penetration, flow, and disinfection when used as a supplement to conventional irrigants.[13] Ultrasonic irrigation improves the disinfection and cleaning of difficult-to-reach areas of the root canal system such as accessory canals, isthmuses, and apical regions.[14] The influence of ultrasonic activation on PDT was initially proposed by Ghinzelli et al prior research has indicated that the use of ultrasound to activate a photosensitizing agent leads to a greater reduction of *Enterococcus faecalis*.[15] Niavarzi et al showed that the ultrasonic activation of the photosensitizer enhanced its depth of penetration, with an average of 325 microns reached in the apical region and 456 microns reached in the coronal region.[16]

In a study by Bumb et al, scanning electron microscopy showed that E. faecalis was not present deeper than 890-

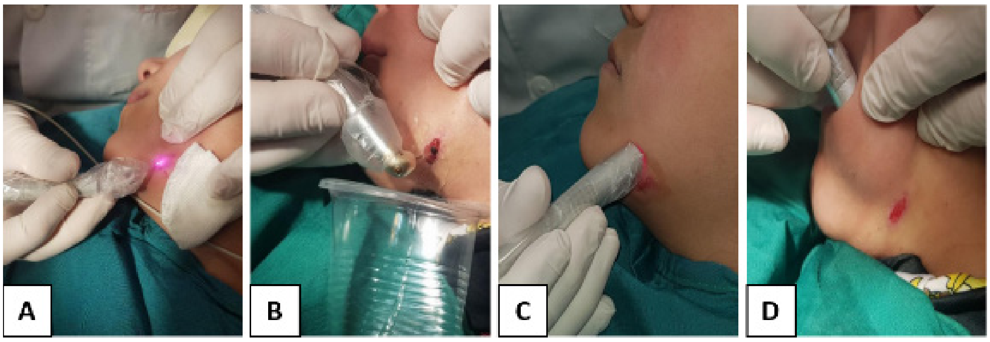

Figure 3. Laser therapy. A, B) High-intensity laser therapy; C, D) Low-level laser therapy

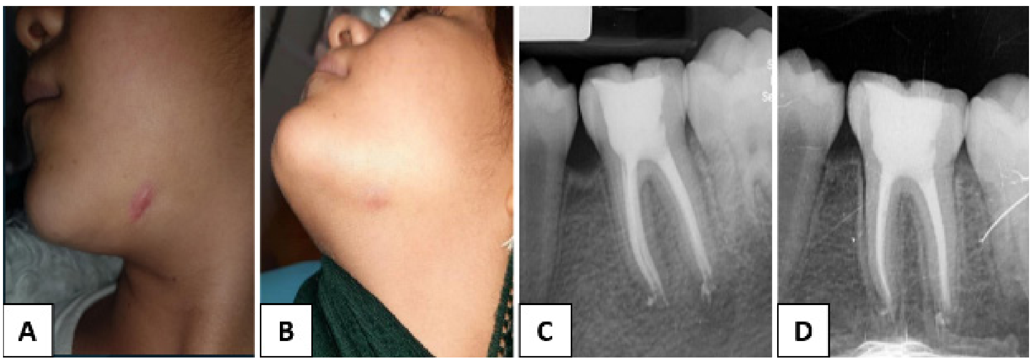

Figure 4. Follow up. A) 6-month follow-up extra-oral photograph; B) 12-month follow-up extra-oral photograph; C) 6-month follow-up radiograph; D) 12-month follow-up radiograph

900 microns within dentinal tubules after antimicrobial PDT, while in the control group, the bacteria were found at depths up to 890 microns.[17] The application of PDT has significant advantages, such as reaching inaccessible canals, one-visit application, minimally invasive procedures, no thermal damage, no bacterial resistance, and no long-term side effects when used correctly.[18] According to Chrepa et al, PDT positively reduced the bacterial load, ranging from 91.3% to 100 %.[19] Arneiro et al compared the efficacy of PDT and NaOCl in E. faecalis load reduction in the root canal system. The study showed PDT was more effective in reducing E. faecalis when used along with NaOCl.[20] Nowadays, several laser systems are used in endodontic therapy. Lasers can penetrate up to 1000 µm into the dentin and sterilize accessory canals and the apical complex anatomy.[21] Asnaashari et al compared the antibacterial efficacy of an 810 nm diode laser and PDT. The study showed that both techniques were effective, and there were no significant differences between the two methods.[22] Lasers have some limitations, including thermal damage, risk of burning, and high costs of laser devices.[23] As a solution, the current study utilized the PDT method as an adjuvant technique to improve the debridement of root canals. It is a more conservative, low-cost, and less risky alternative to lasers. Additionally, it is easier to use and more accessible.

PBM is a minimally invasive adjuvant medical treatment that assists in wound healing, nerve injury, pain relief, inflammation modulation, and edema reduction. PBM speeds up the healing process without a warming effect on tissue. In a systematic review, Tchanque-Fossuo et al compared the efficacy of low-level laser therapy and the standard of care in healing diabetic foot ulcers. All reviewed studies demonstrated positive outcomes using low-level laser therapy for diabetic wound healing.[24]

Conclusion

This study demonstrated successful non-surgical management of an extraoral sinus tract associated with a necrotic mandibular molar. Combining conventional endodontic treatment with adjuvant techniques such as PDT with ultrasonic activation, PBM, and HILT allowed for the resolution of the sinus tract and periapical lesion without surgical intervention.

Authors' Contribution

Conceptualization: Mohammad Asnaashari.
Data curation: Mohammad Asnaashari, Navid Nasrabadi.
Investigation: Mohammad Asnaashari.
Methodology: Navid Nasrabadi.
Project administration: Navid Nasrabadi, Yasaman Daghighi.
Resources: Yasaman Daghighi.
Supervision: Mohammad Asnaashari.
Validation: Mohammad Asnaashari, Navid Nasrabadi.
Visualization: Mohammad Asnaashari.
Writing–original draft: Yasaman Daghighi.

Competing Interests

The authors declare no conflict of interest.

Ethical Approval

Written informed consent was obtained from the patient's parents.

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