Case Report

Two-Step Endodontic and Surgical Treatment of Large Periapical Lesions in the Maxilla: A Case Report

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The aim of this article was to present a two-step procedure for treating two large periapical lesions located near the maxillary sinus. The first lesion measuring 7.1 mm by 6.1 mm by 5.9 mm was located around the apices of both upper right premolars and was perforating the alveolar bone. The second lesion, measuring 13.7 mm by 16.3 mm by 12.5 mm, was located around all the roots of the first upper right molar. The first step of the procedure involved single-session endodontic treatment. The second step involved endodontic microsurgery. To plan the microsurgery, a Cone Beam Computed Tomography image and an intraoral scan were taken, and a surgical guide was printed to enhance the outcome of the surgery. During the surgical procedure, a 3D-printed guide for the window preparation in the alveolar bone was created with a piezosurgery unit. Next, a microsurgical procedure under magnification with a microscope, retro-preparation, and retrofilling with bioceramic material and platelet rich fibrin were placed in the chamber after the apicectomy. A control cone-beam computed tomography (CBCT) taken 8 months after the treatment revealed full healing in the treated areas. Proper planning, novel technologies, biological approach and precise treatment allowed clinicians to successfully heal both periapical lesions.

Keywords: endodontic surgery; regeneration; guided oral surgery; dental biomaterial; platelet rich fibrin; apicoectomy; CBCT 3D; piezosurgery

Introduction

Periapical periodontitis is an inflammatory disease that occurs in the periapical area of teeth, whether they have undergone endodontic treatment or not. This condition typically arises from pulp infection and necrosis, resulting from various factors, including untreated cavities, deep restorations, or repeated dental procedures. However, periapical periodontitis can also be related to trauma, which might occur due to bruxism or other mechanical factors [1,2]. In some cases, the inflammatory process can proceed without clinical symptoms [2]. This means that the patient might not experience pain or any other noticeable signs of infection, making it challenging to detect the condition based solely on a clinical examination. Consequently, many patients remain unaware of the infection, which can lead to the progression of the disease and potential complications. Study has demonstrated that periapical radiolucency, visible on radiographic images, is likely indicative of a periapical lesion [3]. Therefore, radiological examinations are crucial for the accurate initial diagnosis of periapical periodontitis.

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Traditional two-dimensional radiographs, such as periapical or panoramic X-rays, are commonly used in dental practice to identify these lesions. However, while the American Association of Endodontists (AAE) and the American Academy of Oral and Maxillofacial Radiology (AAOMR) have stated that the routine use of cone-beam computed tomography (CBCT) imaging is not recommended, there is substantial evidence supporting its efficacy [4]. Many studies have shown that the detection of periapical pathosis is much more accurate when CBCT imaging is utilized [2,5]. CBCT provides a three-dimensional view of the tooth and surrounding structures, offering more detailed information than traditional radiographs. This enhanced imaging capability can reveal lesions that might be missed on two-dimensional images and can provide critical information for treatment planning and management.

Most lesions heal after non-surgical endodontic treatment, with the healing time ranging from 12 to 48 months [6]. Non-surgical endodontic treatment is generally effective for many types of periapical lesions. However, the healing time can vary significantly depending on several factors, including the patient's overall health, the severity of the infection, and the body's response to treatment. There are different types of periapical pathologies, such as granulomas, periradicular cysts (true cysts or pocket cysts), abscesses, and the treatment outcomes can vary. A granuloma is a localized inflammatory lesion composed of granulation tissue, while periradicular cysts include fluid-filled lesions that can form at the root apex [6,7]. These cysts can be classified as true cysts, which are entirely enclosed by epithelial lining, or pocket cysts, which are open to the root canal system. Each of these conditions may respond differently to endodontic treatment. Extraradicular infections, which occur outside the root canal system, or persistent intraradicular infections, which remain within the root canal, can interrupt the healing process [8,9]. These infections can be caused by various microorganisms that are difficult to eradicate or by procedural errors during the initial treatment [1,6,8]. Therefore, careful monitoring of the healing process is essential. Follow-up radiographs should be taken to assess the healing process [1,6]. These radiographs, including periapical and panoramic X-rays or CBCT images, allow clinicians to evaluate the reduction of periapical lesions over time. Regular follow-ups, typically at intervals of 6, 12, and 24 months, help ensure that the lesion is healing and that no new pathology is developing. In cases where the patient remains symptomatic or uncertain, and after 12 months, there are no visible signs of healing on the CBCT image, surgical retreatment must be considered [5,6]. Symptoms may include persistent pain, swelling, or the presence of a sinus tract. Surgical retreatment, such as apicoectomy, involves the removal of the root tip and surrounding infected tissue, followed by a retrograde filling to seal the root canal. This procedure is considered when non-surgical treatment is unsuccessful, and it aims to eliminate the infection and promote healing [4].

In this report, we present the case of a 68-year-old patient diagnosed with symptomatic apical periodontitis attributed to three necrotic teeth. Initial non-surgical endodontic treatment was performed. However, after a 12-month follow-up period, the patient continued to exhibit partial symptoms, and CBCT imaging demonstrated no evidence of healing. Consequently, surgical retreatment (endodontic microsurgery) was undertaken as the subsequent intervention.

Case Report

A 68-year-old female patient with a medical history of hypertension and hypothyroidism, and no other systemic diseases, presented at the dental office complaining of constant pressure and mild pain in the area of the right upper molar and premolars, near the maxillary sinus. The first and second upper premolars and the first upper molar were tender to percussion. All three teeth showed a negative result on the vitality test with a cold cotton pellet. The first upper premolar didn't have carries. The second upper premolar had a carious lesion in the distal wall. First upper molar had large carious lesion in the dentine and presented a crack in a mesial wall. A CBCT image (LAIL 178 Carestream 8200, Carestream, Rochester, NY, USA) with a small Field of View (FOV) was taken to improve the diagnostic protocol. Analysis of the image revealed two periapical radiolucencies with borders showing a narrow opaque margin. Both areas were interpreted as periapical cyst-like lesions. The first lesion measuring 7.1 mm by 6.1 mm by 5.9 mm, was located around the apices of both upper right premolars and was perforating the alveolar bone, while the second bigger lesion measuring 13.7 mm by 16.3 mm by 12.5 mm, was located around all the roots of the first upper right molar.

The treatment plan presented to the patient assumed single-session root canal treatments for all three teeth, followed by a recall phase and most likely microsurgical treatment.

In the first step, the root canal treatment procedures were performed. During the first visit, the first molar was treated, and during the second appointment, both premolars were treated. In both sessions, the teeth were treated under local anesthesia, with the magnification of an operating microscope (OPMI Pico, Carl Zeiss Meditec AG, Oberkochen, Germany), and using a rubber dam. After removing the pulp chamber roof, the chambers were cleaned with 5.25% sodium hypochlorite activated by an erbium-doped yttrium aluminum garnet (Er: YAG) laser (16690345 Light Walker, Fotona, Ljubljana, Slovenia). After locating all the root canal orifices, the canals were shaped with MG3 Blue rotary files (PerfectDental, Shenzhen, China) and cleaned with 5.25% sodium hypochlorite activated with the Er: YAG laser. The canals were then filled using the warm gutta-percha technique, and a composite resin core was placed (Fig. 1).

Because the patient was not fully symptomatic, the first recall CBCT scan was performed one year after the initial treatment. The size of the first lesion around the premolars had increased to 7.6 mm by 8.7 mm by 5.9 mm, while the second lesion remained unchanged. The surgical procedure was postponed due to the patient's health conditions, including hypertension and hypothyroidism, and their medications—Nebivolol (Nebivolol Genoptim 5 mg, Synoptis Pharma, Warsaw, Poland), Acetylsalicylic Acid (Acard 75 mg, Warszawskie Zakłady Farmaceutyczne POLFA S.A., Warsaw, Poland), Levothyroxine (Euthyrox N100, 100 µg, Merck & Co Inc., Rahway, NJ, USA), and Losartan (50 mg, KRKA, Novo Mesto, Slovenia). It was scheduled contingent upon confirmation that there were no contraindications for dental surgical procedures. Additionally, acetylsalicylic acid was discontinued 5 days before the surgical procedure.

For more precise surgery, the static surgical guide was designed and printed. The guide allowed to plan a precise window technique which assumed creating an osteoperiosteal flap. The guide was prepared for the bone window that will provide the access to the cavity of the bigger lesion around the molar tooth and will allow the clinicians to perform the apicectomy, retrograde preparation and the retrograde filling also of the palatal root. This kind of technique provides bigger access to the cavity and in the same time provides faster healing of the alveolar process (Fig. 2).

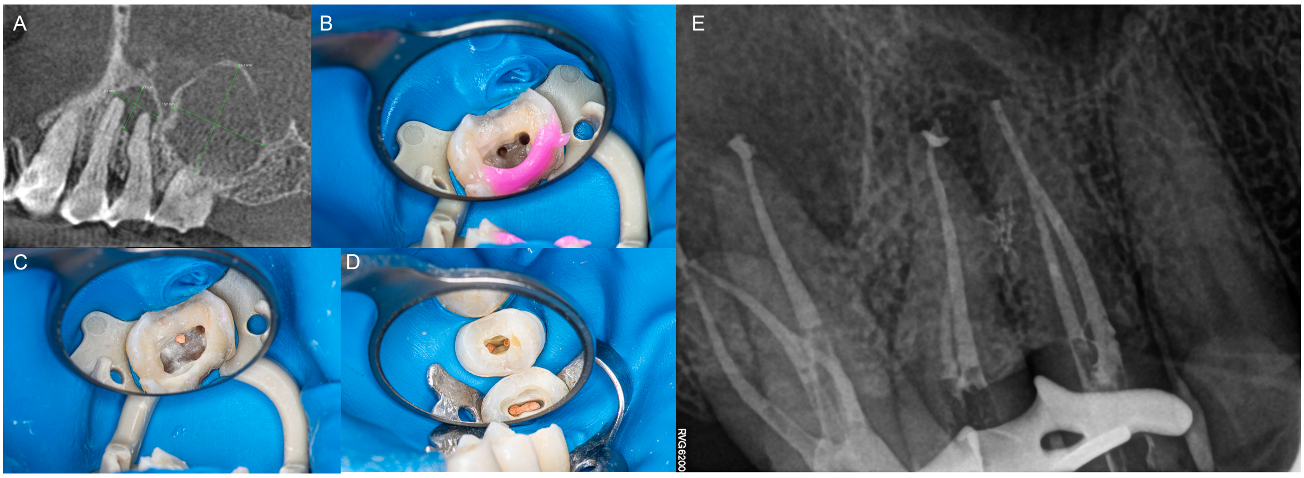

Fig. 1. Endodontic treatment of the teeth. (A) Pre-operative cone-beam computed tomography (CBCT) showing both lesions with measurements. (7.1 mm by 6.1 mm and 13.7 mm by 16.3 mm). (B) First upper molar during endodontic treatment: stage after root canal preparation and irrigation. (C) First upper molar during endodontic treatment: stage after root canal obturation. (D) First and second upper premolars during endodontic treatment: stage after root canal obturation. (E) The post-endodontic treatment.

The procedure was performed by two clinicians: dental surgeon MS and endodontist BK. The procedure was begun by dental surgeon. The surgery was conducted with antibiotic prophylaxis (2 g of amoxicillin with clavulanic acid one hour before the procedure) and under local anesthesia (Total 6.8 mL of articaine with epinephrine 1:100,000). While waiting for the full effect of local anesthesia, six 10-milliliter vials were collected for centrifugation of advanced platelet-rich fibrin (A-PRF) (LD5G006569 PROCESS FOR PRF, 49 Rue Gioffredo, Nice, France) with the centrifugation cycle set at 1300 RPM and a duration of 8 minutes. The surgical part began after achieving the anesthesia effect. A full flap was formed from the upper right canine to the region behind the first molar (the second molar had been extracted many years ago), and the flap was split in the area of the buccal roots of the first molar. Using a piezosurgery unit (409005608 Multipiezo, Mectron, Carasco, Italy) and the printed guide, a window was created.

At this point, the clinicians switched, and the treatment continued with its endodontic part, performed by endodontist. The osteotomy to the first lesion around the premolars was performed with a probe and surgical spoon because the bundle bone was paper-thin, and then it was expanded with endodontic diamond-coated ultrasonic tips (WOODPECKER MEDICAL INSTRUMENT Co., Ltd., Guilin, China). Both roots were cut 3 mm from the apex with a high-speed surgical handpiece (02170138 Ti-Max X 450L, NSK-NAKANISHI INC, Tochigi, Japan) and diamond-coated burs. The root surfaces were polished using the previously used diamond-coated ultrasonic tips. The retropreparation of the root canals was performed with angulated microsurgical diamond-coated tips (Woodpecker Medical Instrument Co., Ltd., Guilin, China). The same apicectomy procedure was repeated for the buccal roots of the first molar. The palatal root was cut only with the ultrasonic tip due to its distance from the access cavity and retropreparation was performed with the same angulated diamond coated tip. To both cavities cotton pellets soaked with 0.1% adrenaline solution were placed to achieve haemostasis. After the bleeding stopped both cavities were flushed with 2% Chlorhexidine solution. All the canals were dried with micro suction with EndoAspirator tip (Cerkamed, Stalowa Wola, Poland). Retrograde filling of the roots was done with bioceramic material (WellRoot PT, Vericom, Chuncheon, South Korea) which was placed with the special carrier - MAP-one (Produits Dentaires SA, Vevey, Switzerland).

At this stage clinicians switched one more time. The PRF was placed to both cavities. The bone window was replaced and the flap was sutured. The histopathological examination of the lesion revealed granulation tissue without malignant characteristics. The control CBCT image was taken (Figs. 3,4). After the procedure, the patient was sent home in good condition.

This case has been reported in line with the case report guidelines: Case Report (CARE) Guidelines to ensure the accuracy and completeness of the report (**supplementary material**).

Results

The patient was scheduled in 7 days for the control visit and suture removal. After the removal of the sutures, the patient stopped reporting any signs of inflammation or discomfort, indicating significant relief.

The control CBCT was taken 8 months after the procedure. A marked reduction in radiolucency was noted, accompanied by areas of increased radioopacity indicative of bone trabeculation. This finding confirms the expected biological response and presence of bone regeneration within the

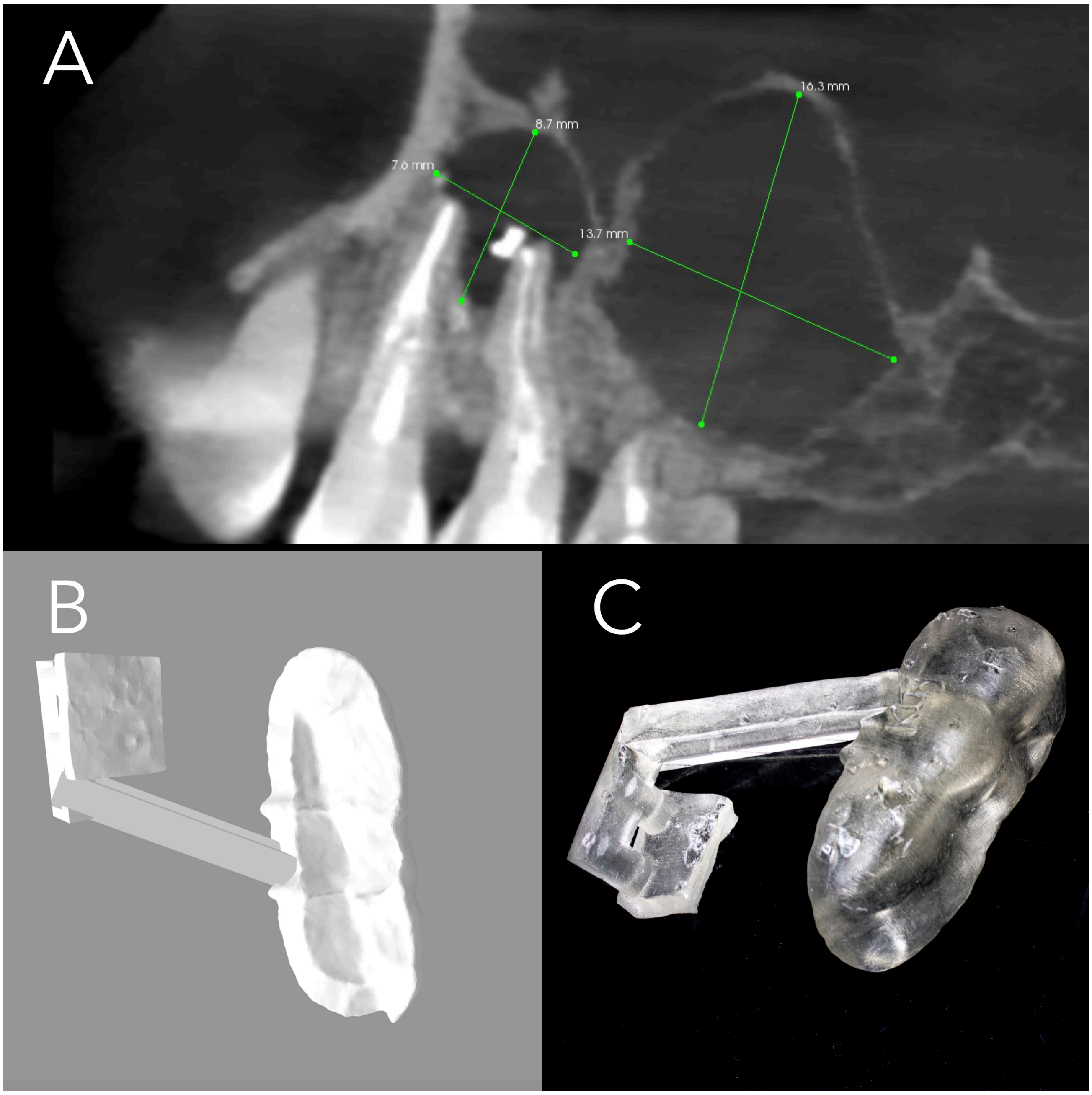

Fig. 2. Fabrication of a surgical template. (A) CBCT image taken 12 months after root canal treatment, showing both lesions with measurements. (B) Design of the surgical guide. (C) Printed surgical guide.

site of the original lesion. Furthermore, the reactive inflammation of the maxillary sinus mucosa has resolved completely.

The clinical effect achieved excellent aesthetic outcome in the treated area (Fig. 5).

Discussion

Even a well-performed root canal treatment may fail after long-term observation. This failure can be attributed to various factors, including both local and systemic influences [10–13]. The most commonly reported causes in the literature are microbial, such as intraradicular infections that persist in the complex apical root canal system, particularly in the apical region (apical delta). Non-microbial causes, such as the accumulation of cholesterol crystals, can irritate periapical tissues and hinder healing. Additionally, true cysts have a lower healing rate compared to other forms of apical periodontitis [10,11]. Systemic factors and diseases can also significantly impact the healing process. These include age, nutrition, stress, smoking habits, genetic factors, cardiovascular diseases, diabetes, osteoporosis, hypertension, and alterations in vascularization and oxygen supply, all of which can lead to delayed or impaired healing [11,12]. Therefore, recall appointments are essential to assess the

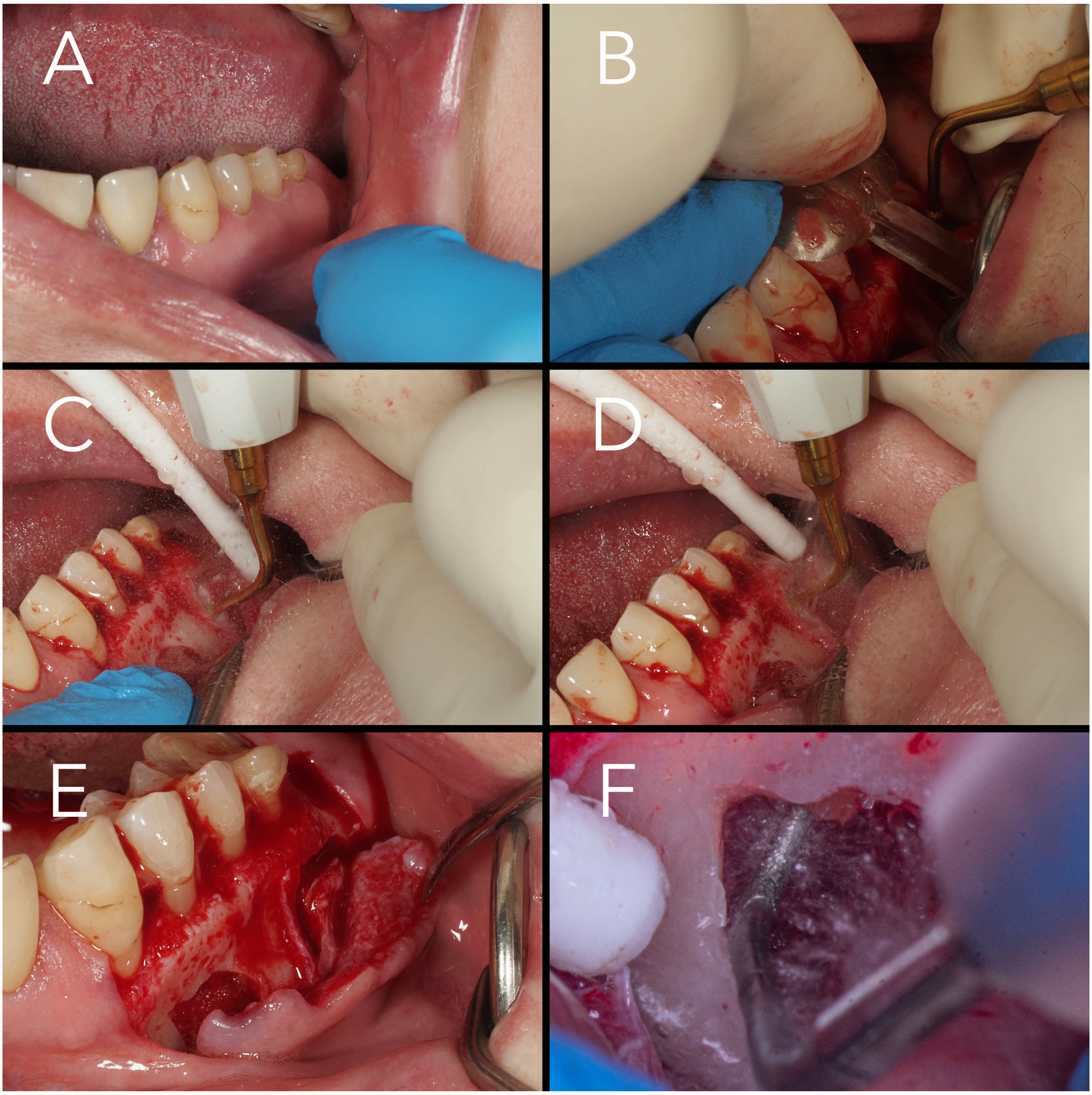

Fig. 3. Apicectomy procedure. (A) Operating field before surgery. (B) Preparation of the bone window using the surgical guide. (C) Continuing the bone window preparation. (D) Further continuation of the bone window preparation. (E) Final creation of the window with both osteotomies visible. (F) Retrograde preparation of the root canal of the first premolar using a diamond-coated ultrasonic tip.

healing process, and in cases where healing is not progressing, additional procedures such as surgical retreatment may be necessary.

Surgical retreatment is a viable option when non-surgical endodontic treatment or retreatment fails. Traditionally, the success rate for conventional endodontic surgery (without magnification, retrograde preparation, or filling) was around 60% [13,14]. However, with modern microsurgical techniques, success rates now exceed 90% [15,16]. The use of magnification during surgery not only allows clinicians to be less invasive but also helps in diagnosing issues like vertical root fractures, which may necessitate tooth extraction [17]. Another critical factor in microsurgical retreatment is the retrograde preparation and filling of the root after apicectomy. In conventional surgery, only the apical delta was removed, which did not address infections in the main canal, often leading to incomplete healing [13,14]. With the use of a microscope, ultrasonic tips, and bioceramic materials, clinicians are now able to address more complex anatomical challenges, such as isthmuses between canals, which are difficult to clean and disinfect thoroughly [18,19].

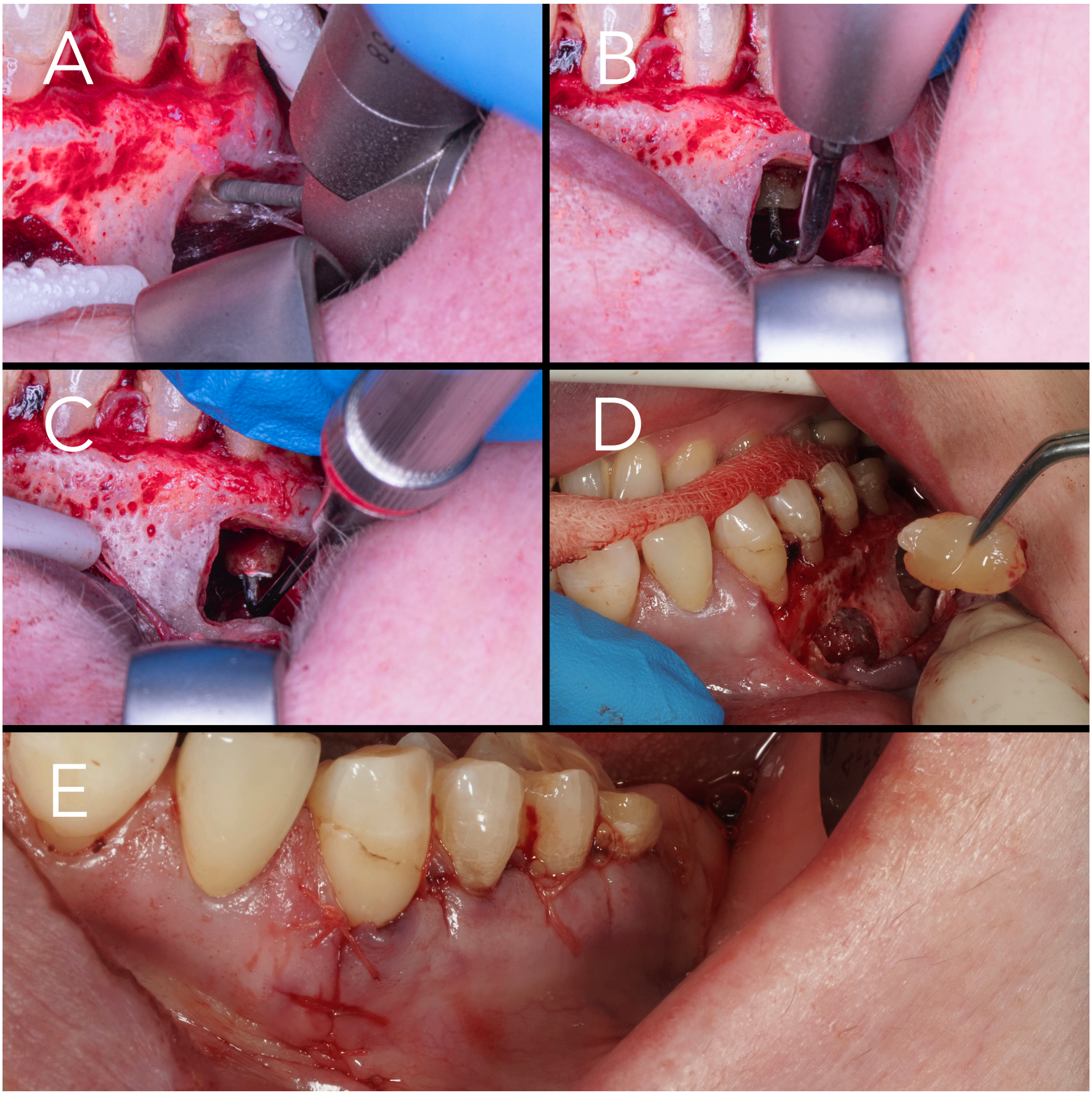

Fig. 4. Retrograde filling and platelet-rich fibrin (PRF) augmentation. (A) Apicoectomy of the buccal roots of the first molar using a high-speed handpiece. (B) Retrograde preparation of the root canal of the palatal root of the first upper molar using a diamond-coated ultrasonic tip. (C) Retrograde filling of the palatal root of the first upper molar with bioceramic material. (D) Placing PRF into the bone defects. (E) Flap closure after suturing.

Ultrasonic preparation facilitates the placement of Mineral Trioxide Aggregate (MTA) or bioceramic materials, which are highly effective for retrograde filling due to their high pH and bioactive properties [18,20]. These advancements have made surgical retreatment a more reliable and successful approach for treating complex endodontic cases.

A full success in endodontic microsurgery is achieved when not only bone tissue regenerates, but also periodontal tissue and root cementum. For this reason, the use of guided tissue regeneration (GTR) in endodontic microsurgery is increasingly employed. In addition to creating a mechanical barrier to prevent surrounding soft tissues from infiltrating the defect, the goal of advanced regenerative techniques is to facilitate the migration and recruitment of bone-forming cells to the regeneration site [21,22]. This approach enhances the biological healing process, ensuring the restoration of both hard and soft tissues essential for long-term success.

The patient's own intact tissues provide the best possible insulation for healing. However, due to the unavoidable invasiveness of surgical treatment, including micro-

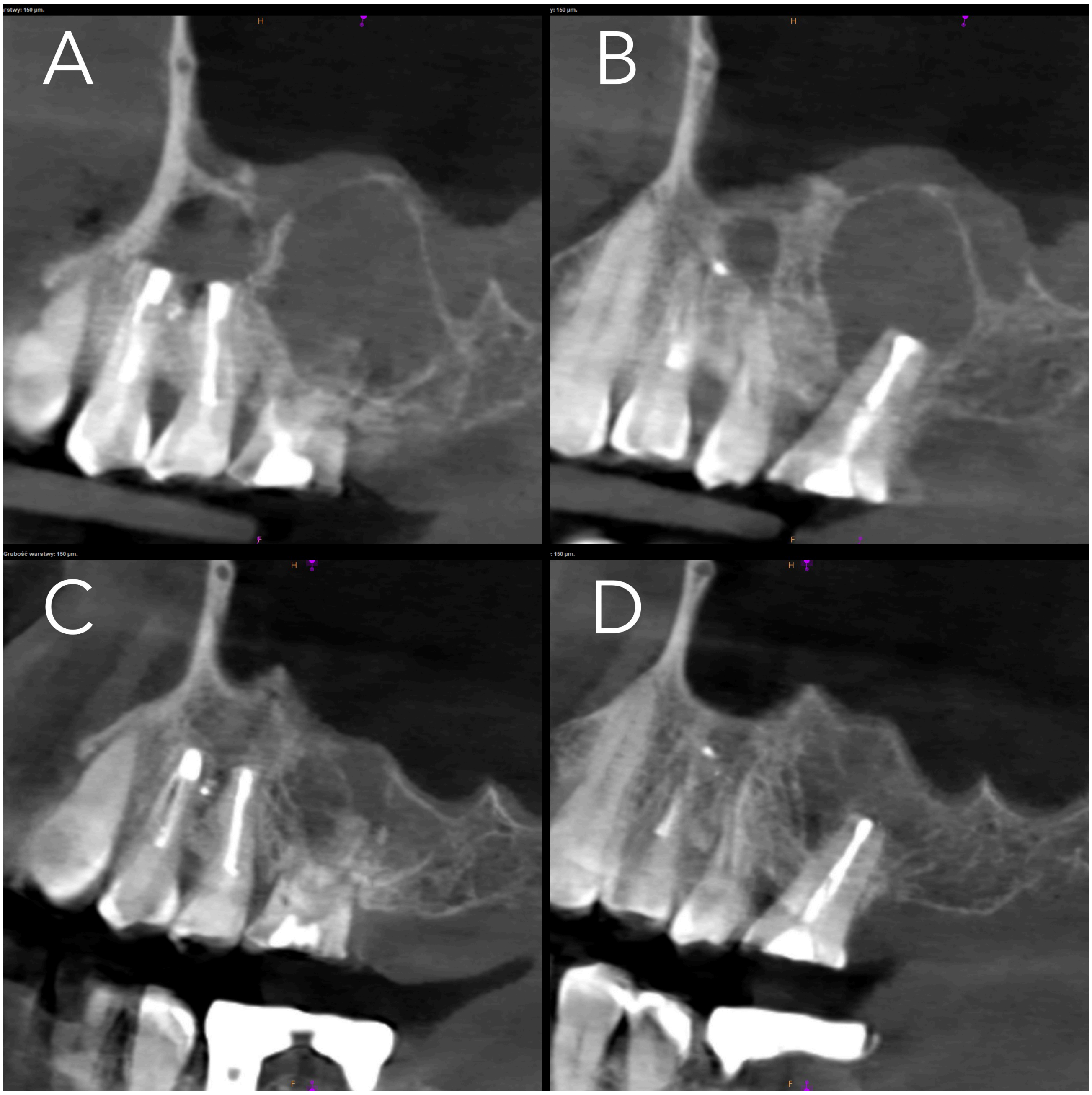

Fig. 5. Healing post-op at 8 months. (A) Post-operative CBCT image showing both premolars. (B) Post-operative CBCT image showing the palatal root of the first molar. (C) 8-month CBCT follow-up: healing around the premolars is visible. (D) 8-month CBCT follow-up: healing around the palatal root is visible.

surgery, many of these tissues are damaged or intentionally removed. In such cases, conventional osteotomy can result in excessive bone removal, leading to delayed or unfavorable healing. To address this, Khoury and Hensher [23] introduced the "bone window" approach in 1987, which allows wide access to the lesion while preserving as much cortical bone as possible. This method has since become a valuable technique for improving surgical outcomes and promoting faster recovery.

With advances in technology, clinicians now have access to more precise and effective tools, such as piezosurgery units and 3D-printed guides, which allow for safer, more accurate procedures [24–26]. The bone-window technique is one of the best alternatives to using various types of barrier membranes. Therefore, when the lesion's configuration allows for the preservation of natural cortical bone, creating a bone window is often recommended [27,28].

Piezosurgery units, widely appreciated by clinicians, offer several advantages in bone window creation. First, osteotomy performed with piezosurgery is less invasive and traumatic, resulting in reduced postoperative discomfort for the patient. Additionally, piezo osteotomy techniques preserve more viable cells at the surgical site, potentially leading to faster and more favorable healing outcomes [29,30]. A similar bone window technique to ours was employed by Sood and Shukla [31], who used a bone window to access an extensive cystic tumor of the mandible. However, the key difference in their approach was that they created a full-thickness flap, removing the periosteum from the future bone window during the procedure. The periosteum, which is rich in cells with immense regenerative potential, plays a critical role in bone healing and regeneration [32]. Its barrier and osteogenic properties have been effectively utilized in numerous regenerative procedures in the maxillofacial area, enhancing outcomes [33]. Therefore, the authors believe that the most biologically favorable surgical approaches should aim to preserve the periosteum on the bone surface whenever possible to maximize regenerative potential and enhance healing outcomes. The authors' unique approach in this study involves preserving the continuously vascularized periosteum on the surface of the bone window in the area of tooth 16, ensuring that the bone window was never removed from the patient's body. This preservation allowed the bone regeneration process to reach its full biological potential by maintaining the vascular supply. Unfortunately, due to the destruction of the buccal cortical plate, this approach could not be applied in the premolar area.

An additional measure to complement the isolation of the surgical field is the supportive use of biomaterials to fill the bone defect. The results of a meta-analysis by Zubizarreta-Macho and colleagues [34] (2022) confirm that the application of guided tissue regeneration (GTR) techniques significantly improves both the quality of periapical tissue healing and the prognosis of endodontic surgery. Ghanaati *et al*. [35] proposed a modification to the preparation scheme of platelet concentrates, naming their original product advanced platelet-rich fibrin (A-PRF). This modification, which involved changes in centrifugation speed and duration, resulted in an increased number of neutrophils in the fibrin clot. The degranulation products of these neutrophils, through their interaction with monocytes, facilitated the differentiation of monocytes into macrophages, which contain growth factors in their granules [35]. The growth factors present in PRF primarily include platelet-derived growth factor (PDGF), transforming growth factor β1 (TGF-β1), insulin-like growth factor (IGF), and vascular endothelial growth factor (VEGF). These factors are known for their ability to stimulate the healing of bone surgical wounds by influencing cell migration, proliferation, and differentiation [36,37].

The effects of administration of autologous blood biomaterial in conjunction with root-end microsurgery assessed by Yahata *et al*. [38] shown accelerated lesion reduction being a promising option to promote healing in patients with impaired healing due to systemic diseases.

Singh *et al*.'s [39] observations from the analysis of 15 cases utilizing PRF in endodontic surgery demonstrate improvements in soft tissue aesthetics and enhanced quality of bone tissue maturation after the cleaning of periapical lesions. Additionally, the author notes that the typical healing time, which usually spans around one year, is nearly halved when PRF is employed [39]. The randomized controlled trial conducted in 2023 by You *et al*. [40] demonstrated significantly higher quality of bone regeneration three months after endodontic microsurgery with PRF, compared to the control group. Studies conducted by Govindaraju *et al*. [41] and Kriplani *et al*. [42] further corroborate that the use of PRF in endodontic surgery enhances the predictability of periapical wound healing due to the gradual and sustained release of important growth factors, all while maintaining relatively low additional costs for the patient. This aligns with our findings.

Importantly, the primary objective of nonsurgical endodontic therapy is to eradicate and prevent infection within the root canal system, which can aid in the resolution of inflammatory radicular cysts. A limitation of this approach, however, lies in the uncertainty of accurately identifying the cyst type (pocket cyst versus true apical cyst) during treatment. A true apical cyst, which has an intact epithelial lining and is detached from the apex, may have developed into an independent structure and might not fully respond to nonsurgical methods. Clinicians should be mindful that such cysts could remain despite nonsurgical efforts, thus often requiring a surgical intervention as a subsequent step, which generally results in a more reliable outcome.

Conclusions

Osteolytic defects associated with failed endodontic treatment can exhibit excellent healing quality when employing a microsurgical approach that preserves the outer bony plate continuously connected to the vascularized periosteum throughout the procedure, especially when the bone cavity is filled with PRF. When this type of access is not feasible, satisfactory clinical and radiological outcomes can still be achieved by utilizing PRF alone.

Availability of Data and Materials

Search for the data that supported this paper was conducted of PUBMED, EMBASE, Web of Science, Cochrane library, and Google Scholar. The key words used for the search were: "radicular cyst", "platelet rich fibrin", "endodontic surgery", "bone window", "guided tissue regeneration" or "apicoectomy". Papers discussed in this study are available from the corresponding author, upon reasonable request.

Author Contributions

BK: study design, data collection, writing the article, literature review. AP: data collection, literature review, writing the article, English editing. MS: study design, data collection. JM: literature review, writing the article, analysis data, critical revision. MD: study design, literature review, critical revision. All authors have been involved in revising it critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The study was carried out in compliance with the Declaration of Helsinki. The patient provided written consent for the procedure in accordance with the applicable legal regulations in Poland.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.62713/aic.3770.

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