Failed Non-Surgical Endodontic Treatment of First and Second Left Incisors and the Next Successful Apical Resection – A Case Report with Three-Year Follow-Up

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Authors' contributions

Katarzyna Lewusz-Butkiewicz: Conceptualization, Surgery, Writing—Original Draft of Introduction and Case Report, Writing—Review & Editing, Kinga Kaczor-Wiankowska: Writing—Original Draft of Discussion, Writing—Review & Editing, Monika Szmidt-Kądys: Supervision of treatment during student classes, Control Vistits of patient, Data Curation, Writing—Review & Editing, Writing – Questions & Answers, Marta Rogocka: Data Curation, Writing—Review & Editing, Writing – Questions & Answers, Ryta Łagocka: Conceptualization, Supervision, Writing—Review & Editing. The author(s) read and approved the final manuscript.

Consent

We routinely obtain written informed consent from the patient for treatment. There is a section in the consent that states that the medical records may be used for future research.

Human and Animal Rights

Not applicable

Ethical Statement

This study was reviewed by the authors' institutional ethics committee and was considered exempted from further review.

Conflict of Interest

Not applicable

ABSTRACT

The main goal of endodontic treatment of teeth is the prevention and treatment of acute and chronic inflammatory changes in periapical tissues. Endodontic treatment consists of chemical and mechanical preparation of the root canal system in order to eliminate organic and inorganic impurities and their filling with biocompatible material. Endodontic microsurgery is recommended when non-surgical endodontic treatments have failed. The main procedure in the field of endodontic microsurgery is apicotomy (resection of the root apex). The absence of apical periodontitis and the absence of clinical symptoms after a period of observation is the definition of therapeutic success. Cone-beam computed tomography is an essential tool to assess the structures involved in the apical periodontitis and the extent of the necessary endodontic surgical procedure. This case report describes the failure of endodontic treatment of chronic apical periodontitis of teeth 21 and 22, supplemented with successful endodontic surgical treatment, with a three-year follow-up.

BACKGROUND

A review of the literature reveals an absence of documented cases of primary endodontic treatment of extensive periapical lesions, in which following the completion of treatment, after two years, radiographic evaluation revealed some tissue healing; however, subsequent follow-up examination, conducted one year later, demonstrated progression of the periapical lesions. The progression of chronic apical periodontitis necessitated endodontic retreatment and microsurgery involving root resection for teeth 11 and 12. The treatment ultimately resulted in the complete regression of the lesions and the restoration of the bone structure.

INTRODUCTION

The goal of endodontic treatment is to save the patient's natural tooth while avoiding early and late complications. From a biomechanical point of view, this means cleaning, shaping, and disinfecting the root canal system, which allows for the three-dimensional filling of these canals at a later stage. Achieving the above goals determine the success of treatment [1-3].

Proper endodontic treatment depends on correct diagnosis, which is based on clinical and radiological examinations. Intraoral radiographs are an essential tool for endodontic treatment planning. They are source of information about tooth anatomy, the presence of chronic apical periodontitis their progression and treatment results. Chronic apical periodontits is visible in the radiological image if loss of bone mineralization ranges from 30 to 50%. For this reason, chronic apical periodontitis is not always visible on X-rays [4-6]. X-rays are a two-dimensional (2D) image of a three-dimensional (3D) structure and unfortunately some features of the examined area are not noticeable in them. Additionally, differences in the density of the bone surrounding the examined tooth and difficulties in obtaining repeatable images may affect the interpretation of this imaging [7,8].

Cone-beam computed tomography (CBCT) is a modification of the concept of computed tomography, which involves a single rotation of the X-ray source around the patient. Creating a CBCT image is quick and uses technology that is becoming relatively affordable. Three-dimensional visualization of the area of interest allows to locate teeth and adjacent structures in a way that is not possible using conventional 2D imaging [9]. The introduction of volumetric tomography into everyday practice use has enabled 3D imaging of the teeth, maxillofacial skeleton and the relationships of anatomical structures [10]. A cone-beam computed tomography order should only be considered when 2D radiography images do not provide the necessary answers regarding the treatment process. This is particularly important for children and adolescents up to 18 years of age, who are more sensitive to the effects of ionizing radiation on the body [11,12]. Both basic intraoral radiographs and more advanced imaging techniques such as CBCT are successfully used in modern dentistry.

Endodontic treatment consists of chemical and mechanical preparation of the root canal system to eliminate organic and inorganic impurities and then filling with biocompatible material. Mechanical preparation enables removing pulp remnants and impurities and shapes the canal to make possible its disinfection and filling. An inherent element of this procedure is using rinsing agents (sodium hypochlorite, chelating agents) to disinfect and eliminate organic and inorganic contaminants without irritating the periapical tissues. For this purpose, the irrigation fluid should be administered into the canal without pushing it, traditionally, by syringe and needle, or with a specialized apical irrigation system utilizing negative pressure, sound, or ultrasound systems [18]. To properly fill root canals, sealers are combined with the main filling material (gutta-percha) to ensure thorough obturation of the canals and promote healing of the surrounding mineralized tissues [1,15,16,19].

The success of endodontic therapy is determined by the absence of clinical symptoms (such as pain, swelling, and other symptoms), no sinus tract, no loss of function, and radiological evidence of a normal periodontal ligament space around the root. Unfortunately, there are situations when conventional endodontic treatment is ineffective. Causes of failure include: intraradicular or extraradicular infection, inadequate coronal seal, procedural errors, such as fractured instrument, ledge, perforation, overfilling of the canal, poor access cavity design, and untreated canals [21,22].

Endodontic microsurgery is recommended when non-surgical endodontic treatments have failed or when a biopsy of a periapical lesion is required. The main procedure in the field of endodontic microsurgery is apicotomy (resection of the root apex), which consists in cutting off the apex of the tooth root, then removing periapical lesions and preparing and retrograde filling of the root canal [23,24].

Indications for endodontic microsurgery according to the guidelines of the European Society of Endodontology are:

1) Radiological findings of apical periodontitis and/or symptoms associated with an obstructed canal (the obstruction proved not to be removable, displacement did not seem feasible or the risk of damage was too great).
2) Extruded material with clinical or radiological findings of apical periodontitis and/or symptoms continuing over a prolonged period.
3) Persisting or emerging disease following root canal treatment when root canal retreatment is inappropriate.
4) Perforation of the root or the floor of the pulp chamber and when conservative approach is impossible [25].

This case report describes the failure of endodontic treatment of chronic apical periodontitis of 21 and 22 teeth supplemented with successful endodontic surgical treatment, with a three-year follow-up.

CASE REPORT

In November 2013, a 49-year-old European female patient was referred to the Department of Conservative Dentistry and Endodontics at the University Dental Clinic in Szczecin, Poland to undergraduate students (fourth-year) because of pain of tooth 21 during biting. The patient was generally healthy, a non-smoker with no known allergies, and denied any history of trauma, orthodontic treatment, or teeth bleaching. During clinical examination stated no gingiva inflammation or pathologic mobility, composite filling on the mesial surface. The pulp sensitivity tests, including the electric pulp test (Vitality Scanner Model 2006; Kerr Corporation, Brea CA, USA) and the cold test, were negative, however the percussion test was positive. Clinical examination of tooth 22 revealed positive pulp response to sensitivity tests. The hygiene was optimal (API index 20%) [28]. A periapical radiograph (RVG) revealed periapical radiolucency of tooth 21 (Figure 1a). The diagnosis was pulp necrosis, symptomatic chronic apical periodontitis of tooth 21. According to the American Association of Endodontists, this case was classified as low difficulty, therefore students were allowed to perform the procedure [26,27].

A rubber dam was placed and endodontic treatment of tooth 21 was performed. Working length was established to 22 mm, cleaning and shaping of the root canal were performed using hand K-files and H-files and step-back technique, master apical file (MAF) was 40.02, and final file (FF) was 55.02. Irrigation of 2% NaOCl and 15% EDTA was performed. The root canal was temporarily filled with non-setting calcium hydroxide and the access cavity was then sealed with zinc sulfate cement Thymodentin (CHEMA, Rzeszów, Poland) for two weeks. At the second visit, the patient reported complete relief from tooth pain. Because the tooth was asymptomatic, the canal was obturated using lateral condensation of gutta-percha and AH Plus sealer (Dentsply Sirona, NC, USA). The access cavity was restored with adhesive OptiBond Solo Plus (OPTB, Kerr Corp., USA) and resin composite Reflectys A3 (ITENA, France). The postoperative RVG image was taken (Figure 1b). By the European Society of Endodontology guidelines, follow-up X-rays were recommended in a year [25].

In October 2014, the patient was referred to fourth-year undergraduate students due to pain of 22 while biting. On clinical examination stated no gingiva inflammation or pathology mobility, the pulp sensitivity tests, including the electric pulp test (Vitality Scanner Model 2006; Kerr Corporation, Brea CA, USA) and the cold test, were negative, but the percussion test was positive. A periapical radiograph revealed the progression of periapical radiolucency of teeth 21 and 22 (Figure 1c). The diagnosis was pulp necrosis, symptomatic chronic apical periodontitis of tooth 22. According to the American Association of Endodontists, this case was classified as low difficulty, therefore students were allowed to perform the procedure [26,27].

Tooth 22 treatment was performed according to the same protocol as tooth 21. Working length 20,5 mm, MAF 30.02, and FF 45.02 were established. The postoperative RVG image showed overfilling of the 22 root canal. (Figure 1d). Following the guidelines of the European Society of Endodontology, follow-up X-rays should be taken after one year [25].

In October 2015 patient was referred to x-ray control of teeth 21 and 22 that showed a regression of the lesion (Figure 1e).

In April 2016 the patient was referred to the dentist because of pain of tooth 22 when biting down. Clinical examination revealed fistula on gingiva, pathologic mobility and performed percussion test was positive. A periapical radiograph with a gutta-percha point in the fistula revealed the progression of periapical radiolucency of teeth 21 and 22 caused by tooth 22 (Figure 1f). According to the American Association of Endodontists, this case was classified as high difficulty, for this reason, the treatment was performed by an endodontist. A rubber dam was placed and endodontic treatment of tooth 22 with a dental operating microscope was performed. The working length was established to 20,5 mm, and cleaning and shaping of the root canal was performed using MTwo (VDW, Munich, Germany) rotary system to 35.04 file size. Ultrasonically activated irrigation of 5,25% NaOCl and 15% EDTA was used. The root canal was temporarily filled with non-setting calcium hydroxide and the access cavity was then sealed with glass-ionomer cement Riva Self Cure (SDI, Victoria, Australia) for two weeks. At the second visit, the fistula regressed and the canal was obturated using gutta-percha and AH Plus sealer (Dentsply Sirona, NC, USA). The access cavity was restored with adhesive Single Bond Universal and resin composite Estelite Sigma Quick A3 (Tokuyama Dental). The postoperative RVG image was taken (Figure 1g).

The patient did not return for the recommended follow-up one year after the end of treatment.

The patient was referred for control of teeth 21 and 22 in May 2018. The examination showed negative percussion test results, no tooth mobility, but a fistula on the labial side of the alveolar ridge. The X-ray revealed an apical periodontitis of the same magnitude as the previous two years and a change in the position of the pushed canal material (as shown in Figure 1h). A cone-beam computed tomography (Cranex 3Dx, Soredex, KaVo Imaging, PA, USA) with a small field of view (FOV) 40 x 40 mm and voxel size 0,125 mm was performed to assess the extent of the apical periodontitis (Figure 2). The cone-beam computed tomography examination showed destruction of the maxillary alveolar bone at the area of teeth 21 and 22 and cortical bone from the palatal side. It was decided to perform the apical resection. Written informed consent was obtained from the patient. Under local anesthesia of 2% lidocaine with epinephrine (Xylodont 1:50000, Molteni Stomat, Kraków, Poland) a full-thickness papilla-based triangular flap was made with a intrasulcular incision of 21, 22, 23 and vertical incision in the frenulum of the upper lip. Osteotomy was made with bone-cutting bur next granuloma was removed with curettes. Perforation of palatal mucosa and connection of operation area with oral environment were avoided. Root-end resection of teeth 21 and 22 was performed by fissure bur - the roots' apexes were cut close to 90°, next root-end inspection with methylene blue was made. Retro-preparation of the canals was done using ultrasonic retro-tips, to the depth of 3 mm. BioMTA (Cerkamed, Stalowa Wola, Poland) was placed in the 3 mm deep retrograde cavity of the root-end. Finally, the flap was reposited and sutured with 5.0 monofilament suture. The procedure was performed with a dental operating microscope. The sutures were removed seven days after the surgery - and normal tissue healing was observed. After 30 days, during the next control visit, no abnormalities were found, RVG image was taken where the beginning of healing was observed (Figure 3a).

In February 2019 patient was referred to x-ray control of teeth 21 and 22 that showed a partial regression of the lesion (Figure 3b). In January 2021 x-ray showed complete regression of the lesion and the patient didn't report any alarming symptoms (Figure 3c). Written informed consent was obtained from the patient for the publication of this case report and any accompanying images.

DISCUSSION

Persistent apical periodontitis, which is refractory or recurrent despite conventional endodontic treatment, indicates that the presence of endodontic bacteria in the canal system, biofilm on the surface of the root or in periapical tissues, or body reaction of root-filling material [29,30]. Combined with symptoms of active inflammation (a fistula in our case) manifested the failure of endodontic treatment, an indication for endodontic surgery or tooth extraction. In this case, the authors decided to apicotomy according to the second indication of guidelines of the European Society of Endodontology [25].

Despite of the use of a surgical microscope and more advanced preparation, irrigation, and filling technique while retreatment, than in primary endodontic treatment, apical surgery was necessary, as a complementary therapy. The other case report described the successful nonsurgical treatment of a large apical lesion in the periapical tissue of the upper lateral incisor [31]. In the study of Olczak, conservative retreatment of tooth 22 (pulp necrosis after dental trauma) caused full healing of inflammatory lesion after one year of finished treatment. In our case, the overfilling canal of tooth 22 which is according to Alrahabi et al. categorized as intraoperative endodontic error could worsen the prognosis of success of conservative treatment, despite gutta-percha being considered biocompatible and well-tolerated by human tissues [32-34]. Moreover, movement of bacterial organisms from the infected, necrotic pulp to the apical part of the root in combination with apical resorption or overpreparing of the canal (probable causes of overfilling the canal in this case) could be a significant factor of persistent apical periodontitis after primary endodontic treatment.

Planning the extent of endodontic surgery should be based on complementary, imaging exams such as CBCT, that precisely show the size and expansion of an apical lesion, its position against adjacent roots and anatomical structures, and the degree of bone destruction [11,35]. In this instance, the CBCT scan revealed that the cortical bone on the palatal side was damaged. Through the use of this information, the risk of perforating the mucosal layer was successfully avoided. This prevented an uncontrolled connection with the oral cavity and minimized the chances of treatment failure. In this case, the flap was performed from the labial side, which ensured good visibility during the procedure, opposite to the case of Shekhar and Shashikala, who removed large lesion regio 13-21 from the palatal side, because of full destruction of cortical bone of this side. The authors emphasize the importance of preoperative CBCT and indicate that periapical lesions may be undetectable in intraoral periapical radiographs when lesions are only in cancellous bone and covered with thick cortical bone [36].

In this case, the authors use an operating microscope, because according to the literature, it significantly improves the probability of success of the procedure from 59% for traditional root-end surgery (without an operating microscope) to 94% for endodontic microsurgery (with operating microscope) [37]. A high microscope magnification should be utilized for the inspection of the resected root surface, cavity after removed inflamed tissues, and the root-end filling. This allows for the observation of fine anatomic details, including accessory canals and isthmus, while excluding microfractures [37,38]. Moreover, methylene blue was used to exclude root cracks, and during the procedure, the root tips were cut at 90°, to minimize the number of exposed dentinal tubules for bacteria leakage [23,39].

Nowadays, root-end filling material should be biocompatible, exhibit bacteriostatic, osteo- and cementogenic properties and therefore have reparative properties for lost structures, shows good adhesion to tooth tissue, resistance to dissolution, has appropriate radiopaque, and be easy to manipulate [40]. In our case report we applied 3 mm thickness of MTA plugs according to Lamb et al., who showed significantly increased amounts of leakage when MTA plugs were 2 mm thick compared with those 3 mm thick [41]. Despite the lack of other studies using BioMTA material as retrograde material, their indications, properties, and our case show that it can be successfully used in endodontic surgery. In the literature, other MTA materials used as a root-end filling, combined with a microsurgical technique, resulted in a high overall clinical success rate varied 88.8% (complete healing: 59,1%; incomplete or progressing healing: 21,7%; uncertain healing: 8%) in research of Saunders or 92% (complete healing: 64%; incomplete healing: 28%) in research of Lindeboom et al. [23,42].

TEACHING POINT

Teaching endodontics is a big challenge that requires student supervision at every stage of treatment, before filling the canal, a radiological inspection of the main gutta-percha point should be conducted to prevent overfilling. Despite the recommendations of scientific societies, in some cases of diffuse periapical periodontitis, radiological monitoring of tissue healing should be considered more often than once a year and the use of CBCT in planning endodontic surgery, along with an operating microscope and modern materials, improves long-term success.

QUESTIONS

Question 1: Which of the following answers concerning success of endodontic therapy is false?

1. no sinus tract
2. persisting pain (applies)
3. no loss of function
4. no swelling
5. no radiological pathology

Explanation:

1. no sinus tract [Sinus tract is the symptom of periapical chronic absccess inflammation]
2. persisting pain [Clinical symptom of different inflammation in oral mouth or body can manifest by appearing pain. This is freuquent clinical sign of pathology].
3. no loss of function [Endodontic tretament should provide healing of inflammatory action and allow to reconstruction and maitain functionality of the tooth.
4. no swelling [Swelling can be symtom of periapical inflammation. Endodontic treatment of tooth affected by such apical pathology should provide healing and lack of swelling].
5. no radiological pathology [Successful endodontic therapy gives radiological evidence of normal perodontal ligament space around the root].

Question 2: Which of the following answer choices is false?

1. Conventional endodontic tretament can be ineffective.
2. Fractured instrument can be one of the reason of endodontic fafilure.
3. Inadequale coronal seal cannot be reason of endodontic failure.(applies)
4. The main procedure in the field of endodontic microsurgery is apicotomy.
5. Retrograde filling of the root canal is part of the apicotomy procedure.

Explanation:

1. Conventional endodontic tretament can be ineffective [Conventional endodontic treatment is not always effective, beacuse of many reasons such as: procedural failure, perforation, ledge formation etc].
2. Fractured instrument can be one of the reason of endodontic fafilure.[Reasons of endodontic failure : intaradicular or extraradicular infection, inadequate coronal seal, procedural errors, such as fractured instrument, ledge, peforation].
3. Inadequale coronal seal cannot be reason of endodontic failure.[Reasons of endodontic failure : intaradicular or extraradicular infection, inadequate coronal seal, procedural errors, such as fractured instrument, ledge, peforation, overfilling of the canal, poor access cavity design].
4. The main procedure in the field of endodontic microsurgery is apicotomy.[Endodontic microsurgery is recommended when non-surgical conventional endodontic tretamnt have failed or when a biopsy of periapical lesion is required. The main procedure in the field of endoodntic microsurgery is apicotomy].
5. Retrograde filling of the root canal is part of the apicotomy procedure. [Apicotomy (resection of the root apex)consists in cutting off the apex of the tooth root, than removing periapical lesions and preparing and retrogade filling of the root canal]

Question 3: Which of the following answers describe valid indications for endodontic microsurgery according to the guidelines of the European Society of Endodontology?

1. Perforation localized only to the floor of the pulp chamber.
2. Always the first choice of treatment when primary endodontic treatment was not performed properly.
3. Extruded material over the root apex with no pain present.
4. Chronic pain combined with the presence of inflammatory symptoms on the radiographs, while reendo treatment is not possible. (applies)
5. Chronic pain combined with the presence of inflammatory symptoms on the radiographs, while reendo treatment is possible.

Explanation:

1. Perforation of both, the root and the floor of the pulp chamber indicate for an endodontic microsurgery. [Perforation of the root or the floor of the pulp chamber and where it is impossible to treat from within the pulp cavity [11].]
2. Endodontic microsurgery is indicated in that case, if a retreatment is not possible. [Persisting or emerging disease following root canal treatment when root canal retreatment is inappropriate.]
3. Pain is an important clinical finding. [Extruded material with clinical or radiological findings of apical periodontitis and/or symptoms continuing over a prolonged period.]
4. The combination of pain and radiological findings of apical inflammation and difficulties with reendo treatment are indications for endodontic microsurgery. [Radiological findings of apical periodontitis and/or symptoms associated with an obstructed canal (the obstruction proved not to be removable, displacement did not seem feasible or the risk of damage was too great).]
5. While the combination of pain and radiological findings of apical inflammation occur, retreatment should be performed, if possible. [Radiological findings of apical periodontitis and/or symptoms associated with an obstructed canal (the obstruction proved not to be removable, displacement did not seem feasible or the risk of damage was too great).]

Question 4: What properties are important for a root-end filling material?

1. Biocompatibility (applies)
2. Resistance to dissolution (applies)
3. No radiographical opacity
4. Bad adhesion to the tooth tissue
5. No osteo- and cementogenic properties

Explanation:

1. Biocompatibility [Nowadays root-end filling material should be biocompatible, have bacteriostatic, osteo- and cementogenic properties, shows good adhesion to tooth tissue,

resistance to dissolution, has appropriate radiopaque, and be easy to manipulate [25].]

2. Resistance to dissolution [Nowadays root-end filling material should be biocompatible, have bacteriostatic, osteo- and cementogenic properties, shows good adhesion to tooth tissue, resistance to dissolution, has appropriate radiopaque, and be easy to manipulate [25].]

3. It should be radioopaque. [Nowadays root-end filling material should be biocompatible, have bacteriostatic, osteo- and cementogenic properties, shows good adhesion to tooth tissue, resistance to dissolution, has appropriate radiopaque, and be easy to manipulate [25].]

4. Good adhesion to the tooth tissue [Nowadays root-end filling material should be biocompatible, have bacteriostatic, osteo- and cementogenic properties, shows good adhesion to tooth tissue, resistance to dissolution, has appropriate radiopaque, and be easy to manipulate [25].]

5. Osteo- and cementogenic properties [Nowadays root-end filling material should be biocompatible, have bacteriostatic, osteo- and cementogenic properties, shows good adhesion to tooth tissue, resistance to dissolution, has appropriate radiopaque, and be easy to manipulate [25].]

Question 5: Indicate true sentences.

1. A possible cause for the failure of endodontic treatment is an extraradicular infection. (applies)

2. Utilization of an operating microscope decreases the probability of success of endodontic microsurgery.

3. Cutting root tips at 45° angle minimizes the exposition of dentinal tubules for bacteria leakage.

4. The chemical and mechanical preparation of root canal treatment eliminates only inorganic parts of smear layer.

5. Endodontic microsurgery is useful for periapical lesions biopsies. (applies)

Explanation:

1. A possible cause for the failure of endodontic treatment is an extraradicular infection. [Causes of failure include: intraradicular or extraradicular infection, inadequate coronal seal, procedural errors, such as fractured instrument, ledge, perforation, overfilling of the canal, poor access cavity design, and untreated canals [7,8].]

2. Utilization of a microscope increases the success rate. [In this case, the authors use an operating microscope, because according to the literature, it significantly improves the probability of success of the procedure from 59% for traditional root-end surgery (without an operating microscope) to 94% for endodontic microsurgery (with operating microscope) [22].]

3. Cutting root tips at 90° angle minimizes the exposition of dentinal tubules for bacteria leakage. [Moreover, methylene blue was used to exclude root cracks, and during the procedure, the root tips were cut at 90°, to minimize the number of exposed dentinal tubules for bacteria leakage [9,24].]

4. The chemical and mechanical preparation of root canal treatment eliminates inorganic and organic parts of smear layer. [Endodontic treatment consists of chemical and mechanical preparation of the root canal system to eliminate organic and inorganic impurities and their filling with biocompatible material.]

5. Endodontic microsurgery is useful for periapical lesions biopsies. [Endodontic microsurgery is recommended when non-surgical endodontic treatments have failed or when a biopsy of a periapical lesion is required.]

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FIGURES

Figure 1a

Figure 1b

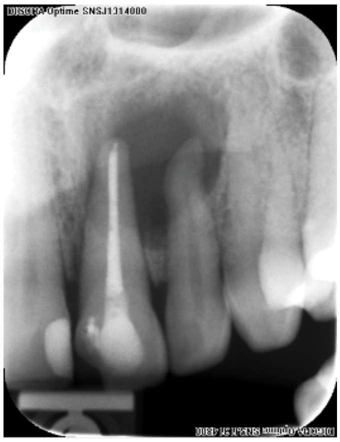

Figure 1c

Figure 1d

Figure 1e

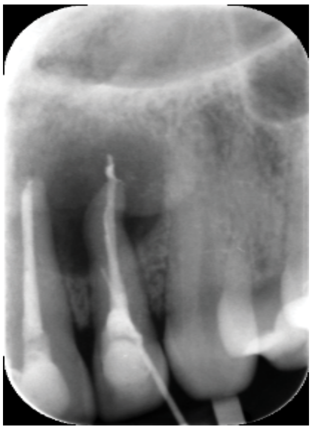

Figure 1f

Figure 1g

Figure 1h

Figure 1a: 49 year old female with pulp necrosis, symptomatic chronic apical periodontitis of tooth 21; a periapical radiograph

Figure 1b: 49 year old female with with pulp necrosis, symptomatic chronic apical periodontitis of tooth 21; a postoperative periapical radiograph showing properly filled canal after endodontic treatment

Figure 1c: 50 year old female with pulp necrosis, symptomatic chronic apical periodontitis of tooth 22; a periapical radiograph

Figure 1d: 50 year old female with pulp necrosis, symptomatic chronic apical periodontitis of tooth 22; a postoperative periapical radiograph showing overfilled canal after endodontic treatment

Figure 1e: 51 year old female; a periapical radiograph showing regression of the chronic apical periodontitis of tooth 21 and 22

Figure 1f: 52 year old female with gutta-percha point in the fistula revealed the progression of periapical radiolucency of teeth 21 and 22 caused by tooth 22; a periapical radiograph

Figure 1g: 52 year old female a postoperative periapical radiograph after endodontic treatment

Figure 1h: 54 year old female with apical periodontitis of teeth 21 and 22 of the same magnitude as the previous two years and a change in the position of the pushed canal material; a periapical radiograph

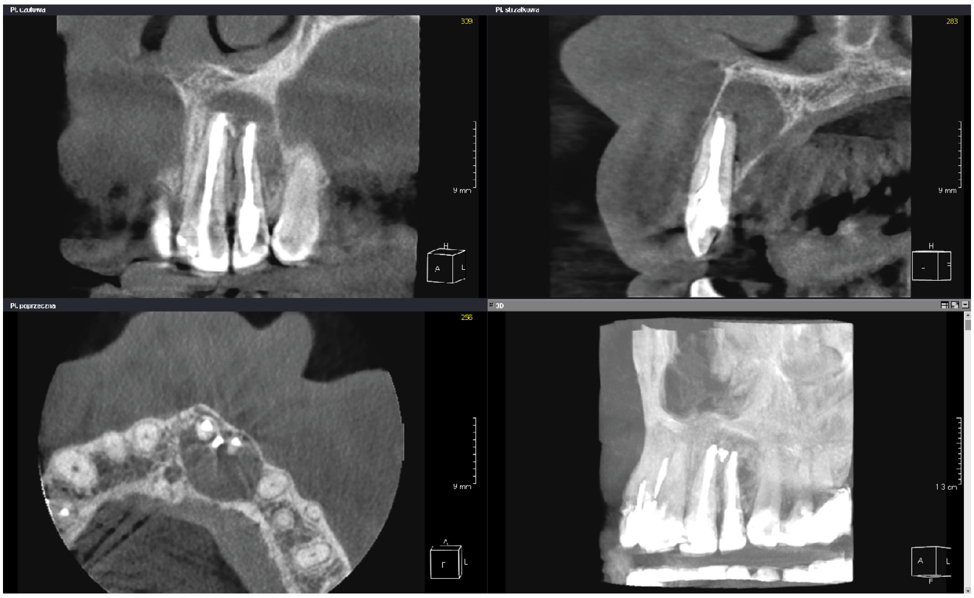

Figure 2: 54 year old female with apical periodontitis of teeth 21 and 22; CBCT: FOV 5x5 cm, voxel size 0,125 mm, 353,2 mGycm^2, 6,3 mA, 90 kV, 6,1 s

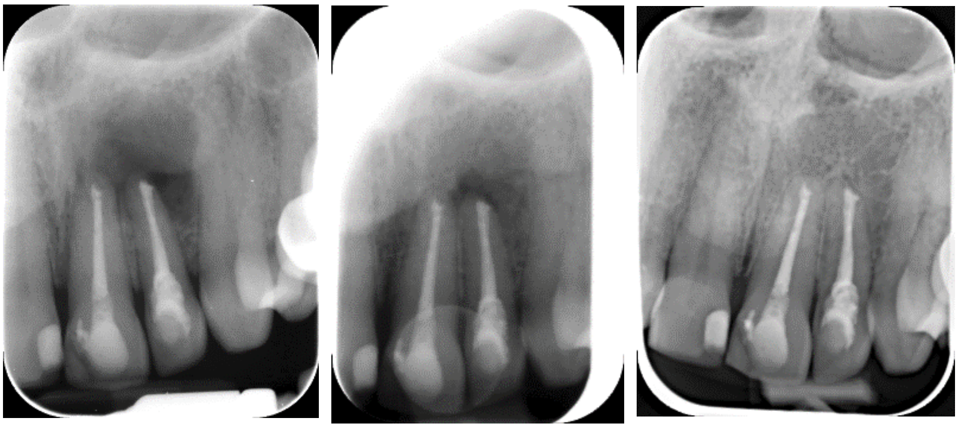

Figure 3a **Figure 3b** **Figure 3c**

Figure 3a: 54 year old female with apical periodontitis of teeth 21 and 22; a periapical radiograph 1 month after apical resection

Figure 3b: 54 year old female with apical periodontitis of teeth 21 and 22; a periapical radiograph 9 month after apical resection, visible partial regression of the lesion

Figure 3c: 56 year old female; control periapical radiograph 32 months after apical resection of teeth 21 and 22 showing complete reversal of apical periodontitis

KEYWORDS

Cone-Beam Computed Tomography; Dental Pulp Diseases; Microsurgery; Root Canal Obturation; Periapical Periodontitis

ABBREVIATIONS

2D: Two-Dimensional; 3D: Three-Dimensional; MAF: Master Apical File; FF: Final File; RVG: A Periapical Radiograph; CBCT: Cone-Beam Computed Tomography; FOV: Field of View

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