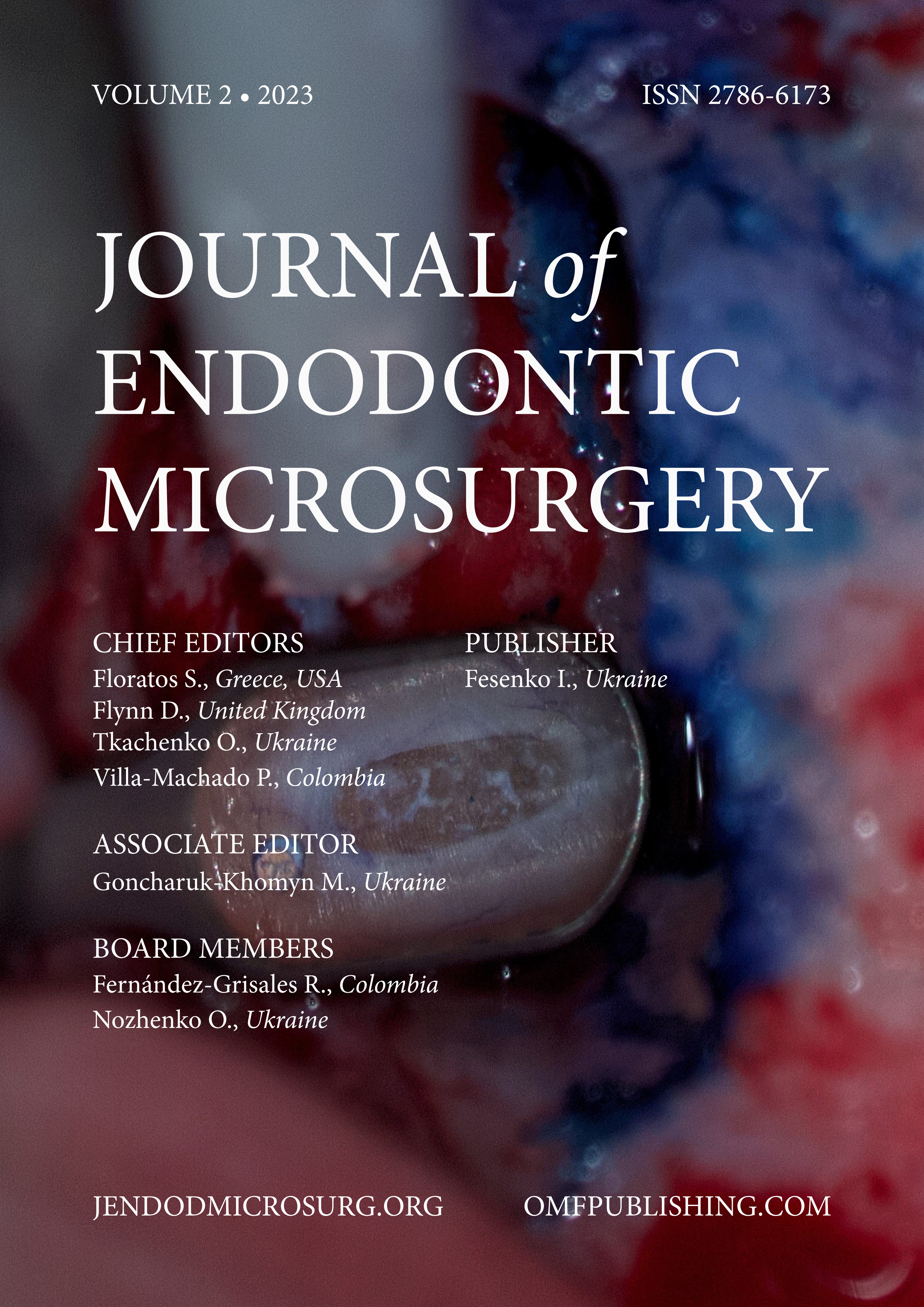

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About the Journal: Aims and Scope

VOLUME 2 • SEPTEMBER 2023
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Official Title

Journal of Endodontic Microsurgery

Acronym

JEM

Standard Abbreviation: ISO 4

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Aims and Scope

This is an annual peer-reviewed journal focused on all directions in endodontic microsurgery.

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The majority of the EB Members have a discernible publication history in Scopus, Web of Science, and journals with a high impact factor.
The publication records of all EB members are consistent with the stated scope and published content of the journal.
The journal has a full-time professional publisher.
Gender distribution of the editorial board: 12.5% women, 87.5% men, 0% non-binary/other, and 0% prefer not to disclose.

Frequency

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Publishing Model

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Type of Peer Review

The journal employs "double blind" and open reviewing.

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The APC for the **short case report** (3-4 pages article) published in the *Journal of Endodontic Microsurgery* is $500 USD, excluding taxes:

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Editorials, Guest Editorials, Case Reports/Case Series, Original Articles, Review Articles, Discussions, Review of Articles, Book Reviews, Letters to the Editors, and Viewpoints.

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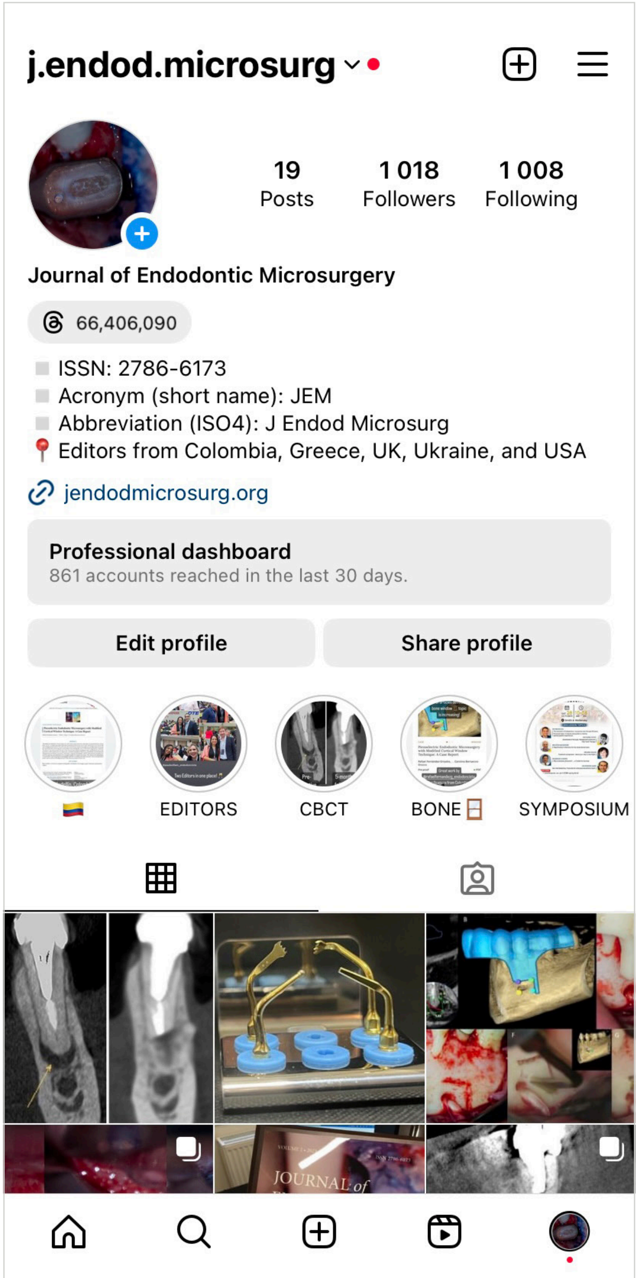

FIGURE. Journal's official Instagram page (@j.endod.microsurg).

Content

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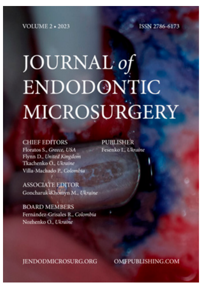

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Journal`s cover image courtesy of Dr. Tkachenko (Bila Tserkva, Ukraine).

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PUBLISHER'S NOTE

Scilit Database and the *Journal of Endodontic Microsurgery*

Ievgen I. Fesenko

Scilit is a multidisciplinary, free scholarly database that indexes scientific material by extracting the latest data from CrossRef, PubMed and other sources on a daily basis [1].
—Bianca Sylvester

Visibility of articles is a key task for any peer-reviewed journal. It makes articles to be cited more likely thus helping journals to grow and to hold higher positions in international ranking systems. Like Elsevier company running the Scopus database, the Scilit database has been launched and is managing by another academic publishing company—MDPI (Basel, Switzerland) [1]. A *Scilit* name (Fig) is a contraction of two words—*scientific* and *literature*. As a publishing house team, we are proud to receive inclusion of the *Journal of Endodontic Microsurgery* to its first database [2]. Like other respected international open access English-language journals, among top priors of our *Journal* are listing in PubMed, Scopus, and Web of Science [3, 4]. For that purposes we will assist the editorial board of the *Journal*, helping to publish high quality articles in the field of endodontic microsurgery.

FIGURE. The Scilit database official symbol.

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CASE REPORT

A Clinical Case of Endodontic Microsurgery with a Histological Diagnosis of an Apical Scar

Oleksandr Tkachenko[a,*] & Alexey Volokitin[b]

SUMMARY

An apical scar is a rare healing reaction that sometimes occurs when periapical pathology destroys the vestibular and oral cortical plates. Radiographically, this appears as periapical radiolucency and can be mistaken for endodontic pathology or other lesions. The presented clinical case in a 31-year-old female patient shows this well. Based on clinical and imaging (radiography and cone-beam computed tomography [CBCT]) assessment with biopsy, the diagnosis was confirmed. X-ray and CBCT before and 1 year and 6 months after the microsurgery are compared. The multiple detailed intraoperative endodontic microsurgery and histopathology photographs are presented and described; the literature data are analyzed.

KEY WORDS

Periapical radiolucency; endodontic microsurgery; root canal transportation; apical/periapical scar

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INTRODUCTION

The main criterion for success in conservative root canal therapy performed on a tooth with a radiolucent area in the periapical region is a complete bone regeneration of the region, with re-establishment of the lamina dura and periodontal membrane [1]. There is evidence (Penick, 1961; Bhaskar, 1966; Seltzer and colleagues, 1967; Nair and colleagues, 1999) [1-4] that unresolved periapical radiolucencies may occasionally be due to healing of the lesion by scar tissue that may be misdiagnosed as a radiographic sign of failed endodontic treatment [5].

According to American Association of Endodontists (AAE) Glossary of Endodontic Terms (2020), apical scar is a dense collagenous connective tissue in the bone at or near the apex of a tooth with a distinctive radiolucent presentation [6]. Another scientific source (Lee and colleagues, 2021) [7] gives such a definition: Periapical scar is a reparative response to a periapical inflammatory lesion with the formation of dense fibrous collagenous tissue instead of normal alveolar bone after an appropriate endodontic treatment/retreatment with or without periapical surgery.

These fibrous (periapical) scars occur most frequently when both the facial and lingual cortical plates have been lost [8].

Scientific articles that included histological studies of periapical lesions were analyzed. Table 1 shows the frequency of detection of scar tissue.

TABLE 1. Frequency of Detection of Scar Tissue according to Publications.

Authors (Years)	Number of Cases (i.e., Biopsies)	Frequency Detection of Scar Tissue Cases: % (Number of Cases)
Bhaskar (1966) [4]	2308	2.5% (58)
Stockdale and Chandler (1988) [9]	1108	4.5% (50)
Spatafore and colleagues (1990) [10]	1659	2% (33)
Nobuhara and Del Rio (1993) [11]	150	12% (18)
Liapatas and colleagues (2003) [12]	45	6.6% (3)
Becconsall-Ryan and colleagues (2010) [13]	4983	0.6% (21)
Peñarrocha and colleagues (2011) [14]	178	18.1% (32)
Çalışkan and colleagues (2016) [15]	93	2.2 % (2)
Lee and colleagues (2021) [7]	445	1.6 % (7)

It is still not clear why some inflammatory periapical lesions heal with the regeneration of new alveolar bone but others repair with the formation of a fibrous scar tissue after an appropriate endodontic therapy. The regeneration of new alveolar bone in a jaw bone defect needs the undifferentiated mesenchymal stem cells and the induction factors (such as bone morphogenetic proteins) or requires the osteoblasts that migrate from the adjacent healthy periosteum or endosteum directly and some bone growth factors that stimulate osteoblasts to proliferate [16, 17]. The lack of the adjacent healthy periosteum or endosteum to provide the bone forming cells (osteoblasts) may result in a defective healing with the formation of fibrous scar tissue [7]. The pattern of healing depends on several factors, 2 of which are decisive: the regenerative potential and the speed with which the tissue cells bordering the defect react. A periapical scar probably develops because precursors of soft connective tissue colonize both the root tip and periapical tissue; this may occur before the appropriate cells, which have the potential to restore various structural components of the apical periodontium, are able to do so [5].

There is a hypothesis that explains why a periapical scar is formed. This hypothesis states that periapical scar formation is caused by bone inhibitory molecular signaling from the epithelial cell rests of Malassez. When these cells are present in teeth with an infected root canal system, a periapical cyst develops, whereas in the case of a treated root canal system infection, periapical inflammation diminishes and periapical lesion heals until the regeneration process reaches the apical part of the tooth where epithelial cell rests of Malassez are present. Cytokines cause rapidly progressive defensive fibroproduction and scar formation, in which osteoblasts cannot differentiate into bone [18].

It was noted that this lesion occurs more often in the maxilla than in mandible, and patients of the fifth decade of life [4].

In general, there is no need to treat this kind of fibrous scar if the clinicians can recognize that the periapical lesion is merely a periapical scar. Therefore, the difficult problem is how to differentiate the rare periapical scar lesion from the more common periapical lesions such as periapical granuloma and radicular cyst. The common clinical and radiographic features of periapical scars would be [7]:

1. The previous endodontic treatment/retreatment shows an adequate root canal filling.
2. The previous periapical surgery is well performed with a proper retrograde filling.
3. The involved tooth is free from any symptom and sign.
4. The involved tooth has no evidence of root fracture and healthy periodontium except the periapical radiolucency.
5. The well-defined periapical radiolucent lesion has persisted without a significant change of its size for a long period of time.

The purpose of this case report is to provide education and awareness regarding apical scar in traumatized anterior upper teeth based on the case in a 31-year-old female. Pre- and post-operative clinical view, x-ray, cone-beam computed tomography (CBCT), intraoperative endodontic microsurgery stages, and histopathology photographs will be analyzed.

CASE REPORT

A 31-year-old female referred for endodontic microsurgery of the teeth 12, 11, and 22 (Fig 1). The patient did not notice general somatic pathology. It was known from the anamnesis that in 2000 she was hospitalized (department of oral and maxillofacial surgery) for 7 days due to an injury to the upper front teeth—the extrusive luxation of teeth 12, 11, 21, and 22 were diagnosed. A splint was put on the teeth for 1 week.

According to the patient, root canals in teeth 12, 11, and 22 were first treated around 2017 for pulpitis. At the stage of root canal treatment, temporary fillings were placed. The patient stayed with temporary fillings for several months, as it was not possible to continue the treatment. The patient notes that during this time some fillings fell out and the teeth were open for several months. Retreatment of root canals in the teeth 12, 21, and 22 was carried out in 2019 by a general dentist.

Clinically, during checkup and examination, teeth 12 (upper right lateral incisor) and 11 (upper right central incisor) were discolored (Fig 2).

Photopolymer fillings are present on the palatal surface of teeth 12, 11, 21 and 22. Percussion of teeth 12, 11, 21 and 22 was negative. Palpation is negative in the area of the transitional fold of the mucous membrane from the vestibular and palatal side. There is a scar in the area of the transitional fold of the mucous membrane on the vestibular surface in the area of the teeth 12, 11, 21, and 22. Periodontal examination is unremarkable, there is no mobility of the teeth, the regional lymph nodes on the right and left sides are not enlarged, not painful, mobile and not fused to the surrounding tissues. Mouth opening unchanged. Movements of mandible without peculiarities.

After the retreatment of a root canal of the tooth 22, the patient periodically (several times) noticed a dull aching pain. Comparing the CBCT scans for 2020 and 2021, we can say that there was no increase in periapical radiolucency in areas of the teeth 12, 11, and 22 (Fig 3).

Endodontic microsurgery was planned to save the teeth 12 (upper right lateral incisor), 11 (upper right central incisor), and 22 (upper left lateral incisor). All manipulations were performed by the experienced doctor (O.T.: 8 years of work with operating microscope) under the control of an OPMI® pico (Carl Zeiss, Gottingen, Germany) operating microscope. Professional oral hygiene and antiseptic treatment of the oral cavity with 0.12% chlorhexidine solution (Chlorhexidine Denta, Hrybyk A.I. Individual Entrepreneur on the production premises of Pharmaceutical Factory LLC, Ivano-Frankivsk, Ukraine) were performed. The incision line was treated with 5% iodine solution. Infiltration anesthesia with 1.7 ml Ubistesin™ forte (4% articaine with 1:100,000 adrenaline [3M™ Deutschland GmbH, Neuss, Germany]) was performed. In the area of the neck of teeth 12 and 22, the gingivectomy was performed to improve aesthetics (wishes of the referring stomatologist). Intrasulcular incision was made. A full-layer muco-periosteal flap was elevated and an osteotomy with a Lindemann burr H162 (Komet Dental, Gebr Brasseler GmbH & Co KG, Lemgo, Germany) was performed. In the area of the defect between the teeth 12 and 11, a pathologically changed tissue that had a dense, fibrous consistency and a white color was noted (Fig 4).

FIGURE 1. Preoperative radiographs of a 31-year-old female who was referred for endodontic microsurgery of the teeth 12, 11, and 22. 12, upper right lateral incisor; 11, upper right central incisor; 22, upper left lateral incisor.

FIGURE 2. Clinically, during checkup and examination, teeth 12 (upper right lateral incisor) and 11 (upper right central incisor) were discolored.

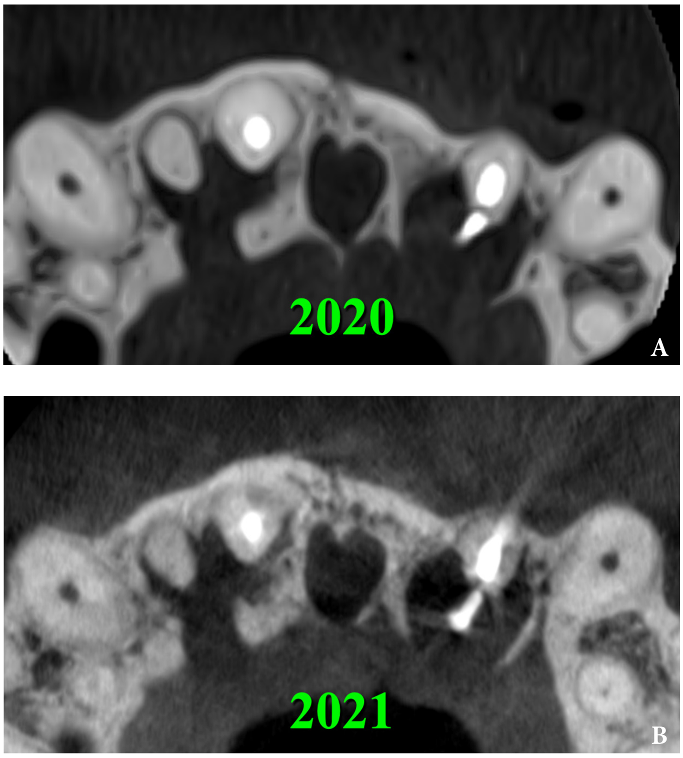

FIGURE 3. Comparing the axial CBCT scans for 2020 (**A**) and 2021 (**B**), we can say that there is no increase in periapical radiolucency in areas of the teeth 12, 11, and 22. 12, upper right lateral incisor; 11, upper right central incisor; 22, upper left lateral incisor.

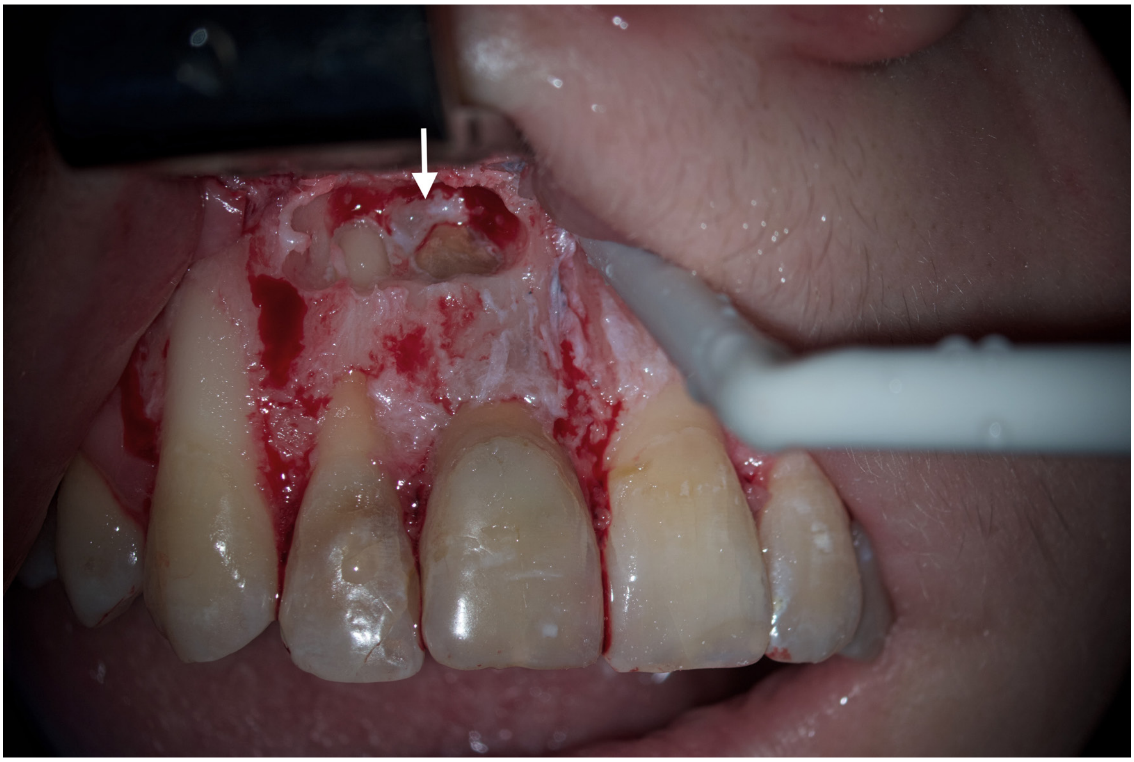

FIGURE 4. During the microsurgery in the area of the defect between the tooth 12 and 11, there was noted a pathologically changed tissue that had a dense, fibrous consistency, and a white color (*arrow*). 12, upper right lateral incisor; 11, upper right central incisor.

Resection of the root apices of the teeth 12, 11, and 22 were performed by 3 mm (Fig 5) with a diamond bur (a green one according to ISO).

The resected root surfaces were polished with diamond bur (yellow according to ISO). Hemostasis was performed with epinephrine pellets (Racellet™ Cotton Pellets size 3 [hemostatic cotton pallets with epinephrine], Pascal International, Inc, Bellevue, WA, USA). Next, a 1% aqueous solution of methylene blue dye (10mL Bottle of Methylene Blue, Vista-BLUE™, Inter-Med, Inc, Racine, WI, USA) was applied to the resected root surfaces using a micro-applicator brushes for 10 seconds [19]. With the help of a MEGAmicro REF B583 (Hahnenkratt E. GmbH, Königsbach-Stein, Germany) retrograde mirror, an examination of the resected root surfaces was carried out (Fig 6).

Looking at the resected surface of tooth 12, one can see signs of sclerosing of the lumen of the root canal, namely calcifying metamorphosis that develops precisely as a result of trauma [5]. The blue dots are microtubules that contain the remains of necrotized pulp. On the resected surface of teeth 11 and 22, it can be seen that methylene blue painted over the perimeter of the filling material in the root canal, which may indicate the presence of gaps with voids and inadequate sealing. Since there is root canal transportation with perforation of the vestibular wall of the root in the area of the tooth which was manifested by slight rarefaction in this place, a decision was made to resect the surface of this root by another 0.5 mm so that there was access to transportation with the possibility of making a retrograde preparation (Fig 7).

Two incisional biopsies were performed. The first one in the area of teeth 12 and 11. The second is in the area of tooth 22. These specimens were placed in separate tubes of 10% buffered formalin solution and sent for histopathological examination. Next, retrograde preparation of these three teeth was performed with a 3-mm Acteon apical surgery diamond-coated tip (AS3D, 3-mm length, Acteon® Group, Mérignac, France). Retrograde irrigation with 2% chlorhexidine solution (Osteohex, Scientific Production Enterprise Osnova LLC, Kharkiv, Ukraine). Drying with sterile paper points. Retrograde filling with mineral trioxide aggregate (MTA) (Bio MTA+, P.P.H. Cerkamed Wojciech Pawlowski, Stalowa Wola, Poland) (Fig 8).

FIGURE 5. Resection of the root apices of the teeth 12, 11, and 22 were performed by 3 mm with a diamond bur (a green one according to ISO). 12, upper right lateral incisor; 11, upper right central incisor; 22, upper left lateral incisor.

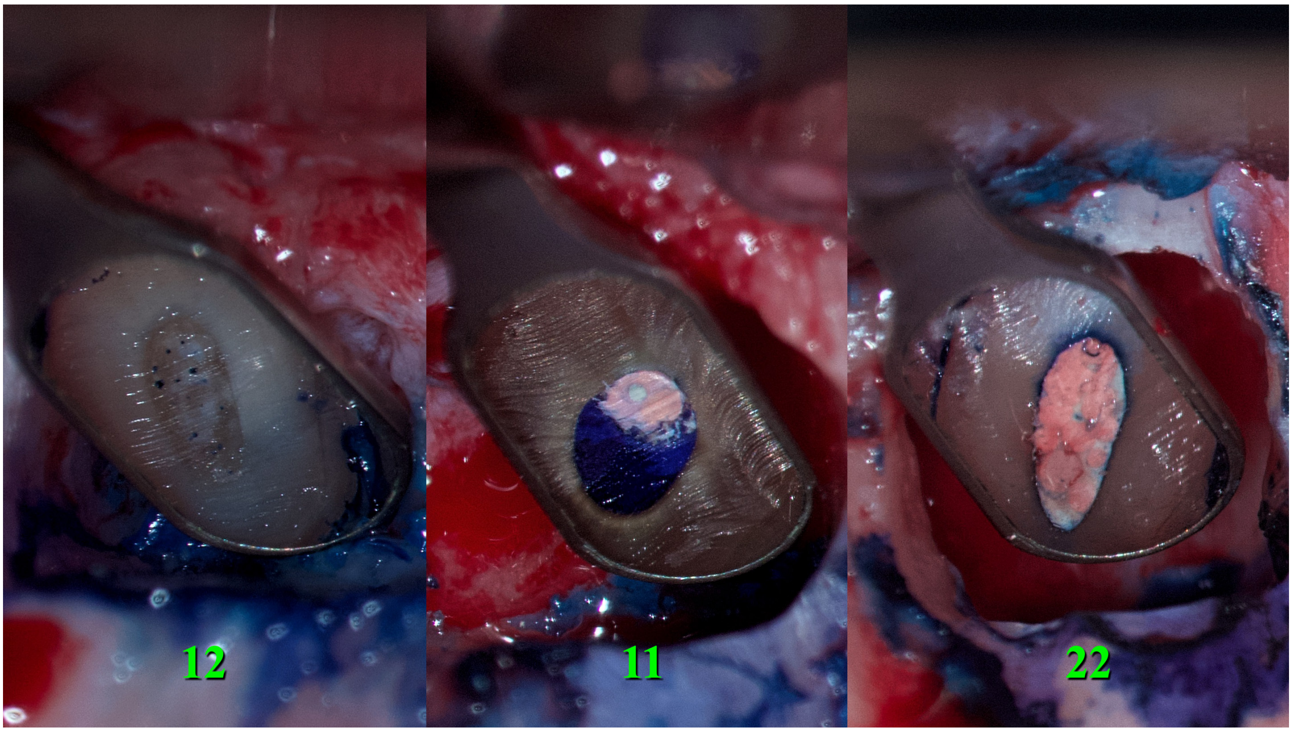

FIGURE 6. With the help of a Ø 5-mm MEGAmicro REF B583 (Hahnenkratt E. GmbH, Königsbach-Stein, Germany) retrograde mirror, the examination of the resected root surfaces was carried out. 12, upper right lateral incisor; 11, upper right central incisor; 22, upper left lateral incisor.

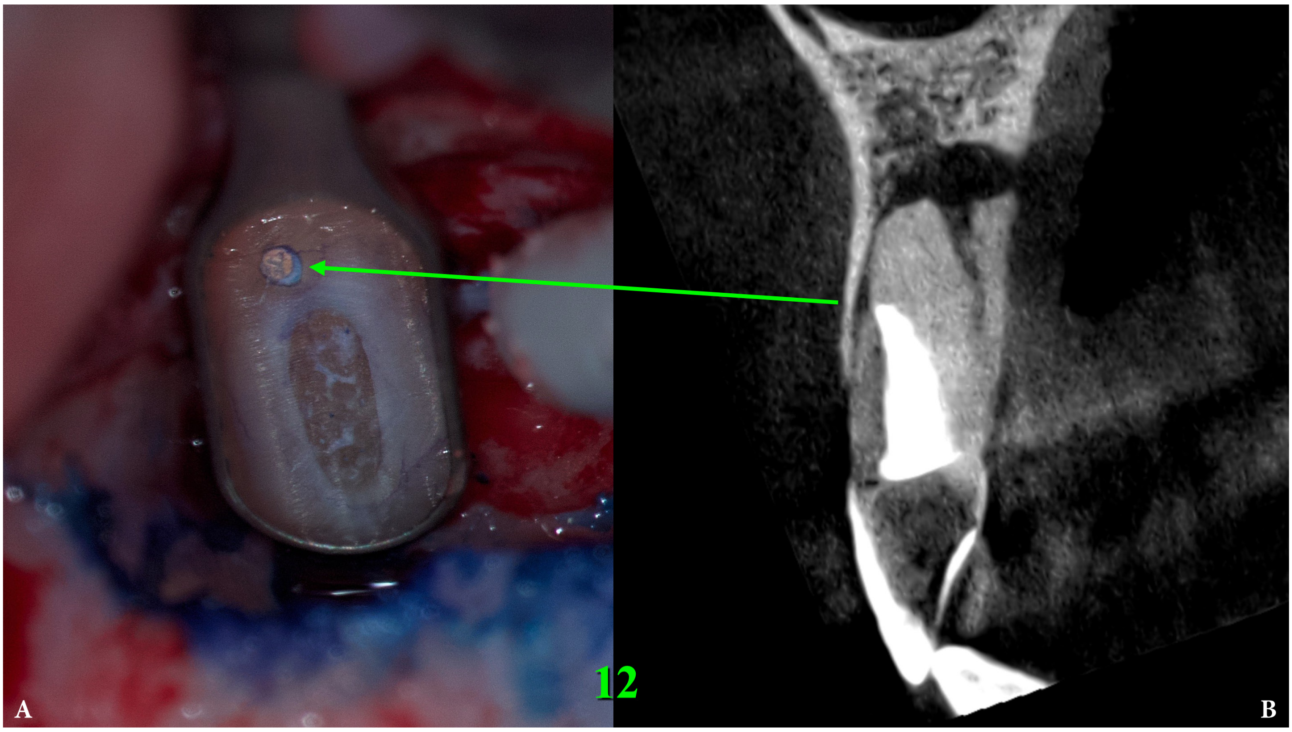

FIGURE 7. Since there was root canal transportation (*arrow*) (**A**) with perforation of the vestibular wall of the root in the area of the tooth 12 which was manifested by slight radiolucency in this place on a sagittal CBCT scan (**B**), a decision was made to perform a resection of the surface of this root by another 0.5 mm so that there was access to transportation with the possibility of making a retrograde preparation. 12, upper right lateral incisor.

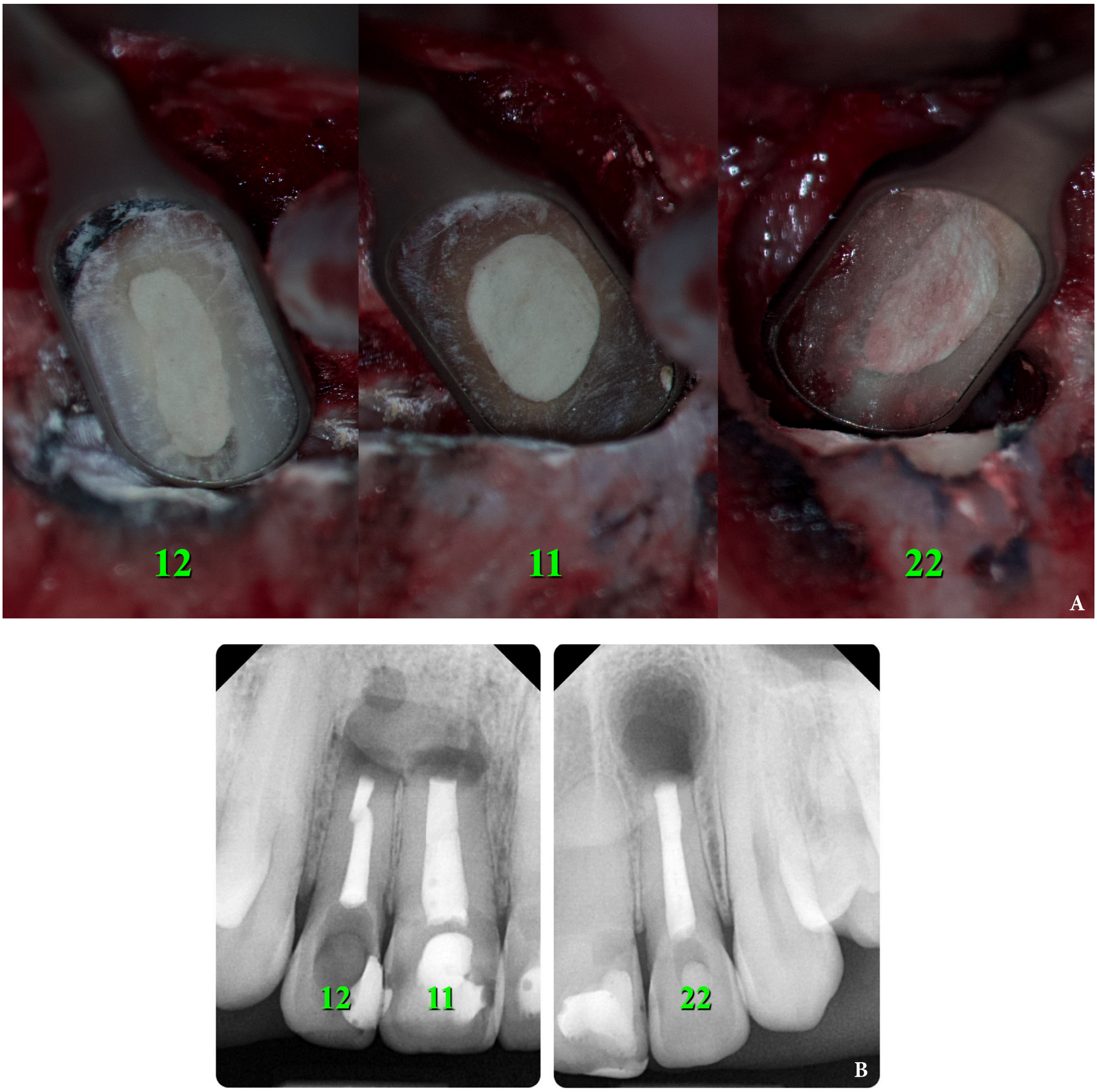

FIGURE 8. Retrograde filling with MTA (Bio MTA+, Cercamed) (**A**) and post-treatment x-ray (**B**). 12, upper right lateral incisor; 11, upper right central incisor; 22, upper left lateral incisor.

Since there was a through and through bone defect in the area of teeth 12, 11, and 22, the Evolution (OsteoBiol® [collagen resorbable membrane], Tecnoss Dental S.R.L., Torino, Italy) collagen membrane was used (Fig 9). The flap was sutured using nylon 6.0 Nylon (Resorba®, RESORBA Medical GmbH, Nürnberg, Germany) (Fig 10).

Pathohistological diagnoses were established by A.V. (his experience in periapical pathohistology is 13 years) using Carl Zeiss Primo Star laboratory microscope (Carl Zeiss Microscopy GmbH, Jena, Germany) and confirmed at the department of pathology. Periapical scar consisting of dense fibrous connective tissue and an area of osteomyelitis have been established as pathohistological diagnosis in the area of the bone defect between the teeth 12 and 11. Dense fibrous connective tissue and bone microsequestration were visualized in the specimen.

Figures 11-19 demonstrate pathohistological findings using different staining (hematoxylin and eosin, Masson's trichrome stain in Goldner's modification with light green, and Brown-Brain staining) and magnification (50x, 100x, and 200x).

Non-epithelialized granuloma with abscessation was established as a pathohistological diagnosis in the bone defect area near apex of the tooth 22. The granulation tissue containing an area of necrosis was noted in the specimen. The Figures 20-27 show histological findings of the specimen with hematoxylin-eosin staining, Brown-Bren staining, and Masson's trichrome stain in Goldner's modification with light green.

FIGURE 9. Since there was a through and through bone defect in the area of teeth 12, 11, and 22, the Evolution collagen membrane (OsteoBiol®) was used.

FIGURE 10. The flap was sutured using nylon 6.0 Nylon (Resorba®).

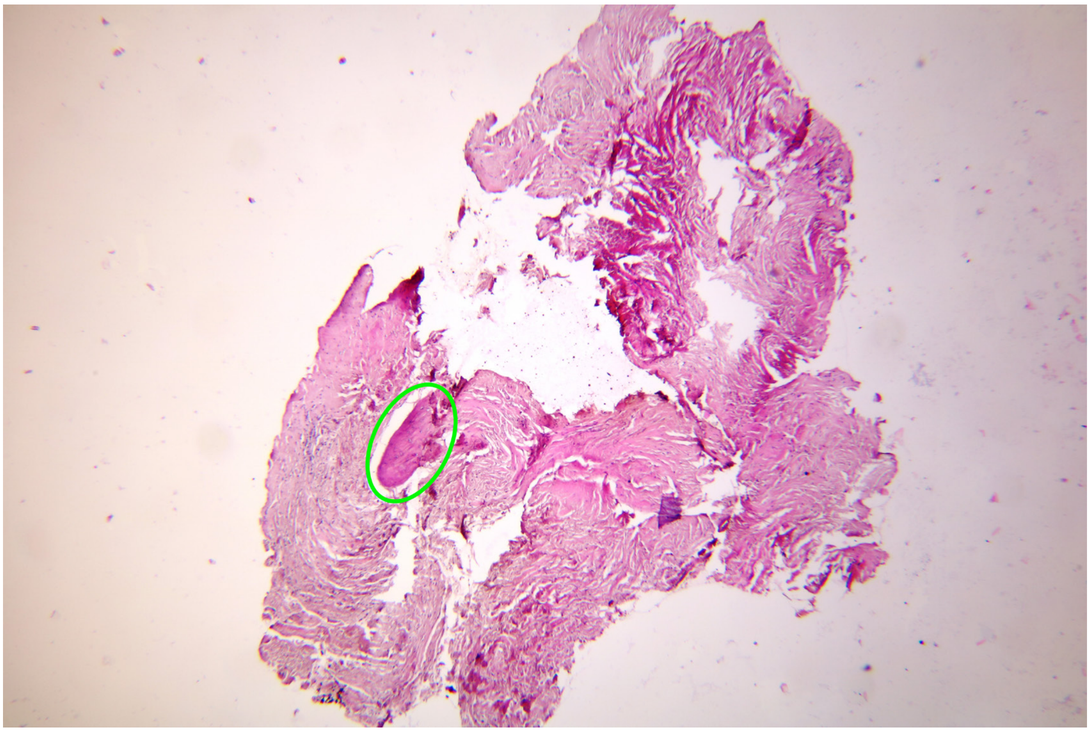

FIGURE 11. Periapical scar consisting of dense fibrous connective tissue and an area of osteomyelitis: Dense fibrous connective tissue, bone microsequestration (circled in *green oval*), staining with hematoxylin-eosin (50x magnification).

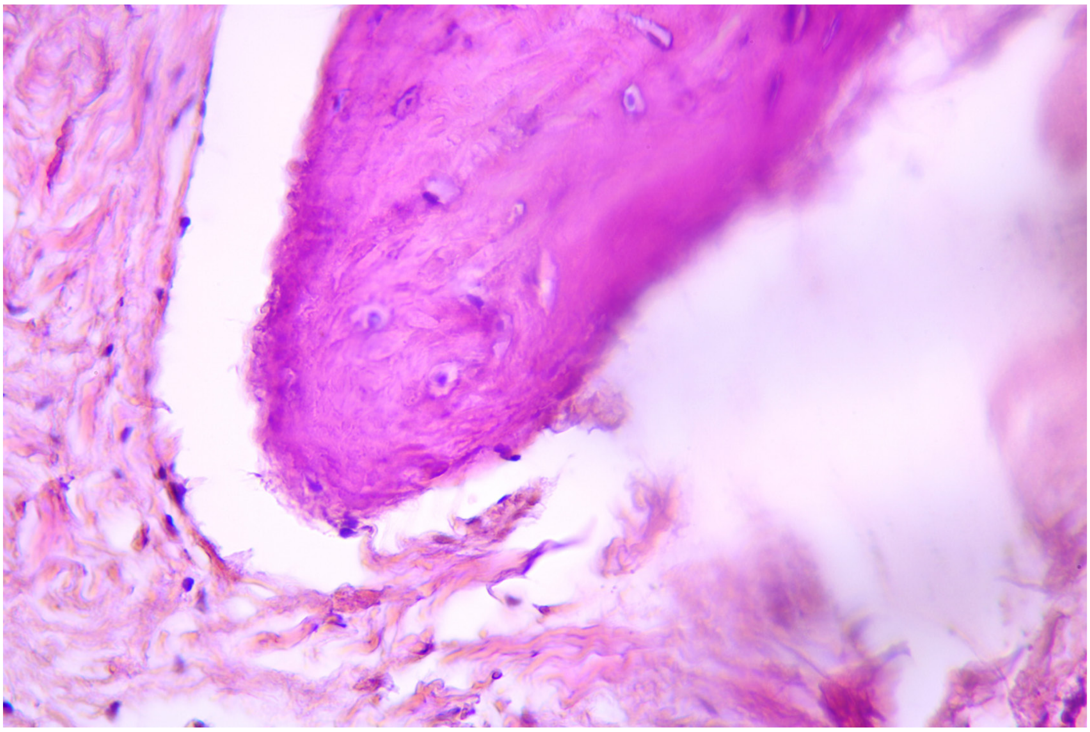

FIGURE 12. Dense fibrous connective tissue, bone microsequestration has more intense staining in pink, hematoxylin-eosin staining (100x magnification).

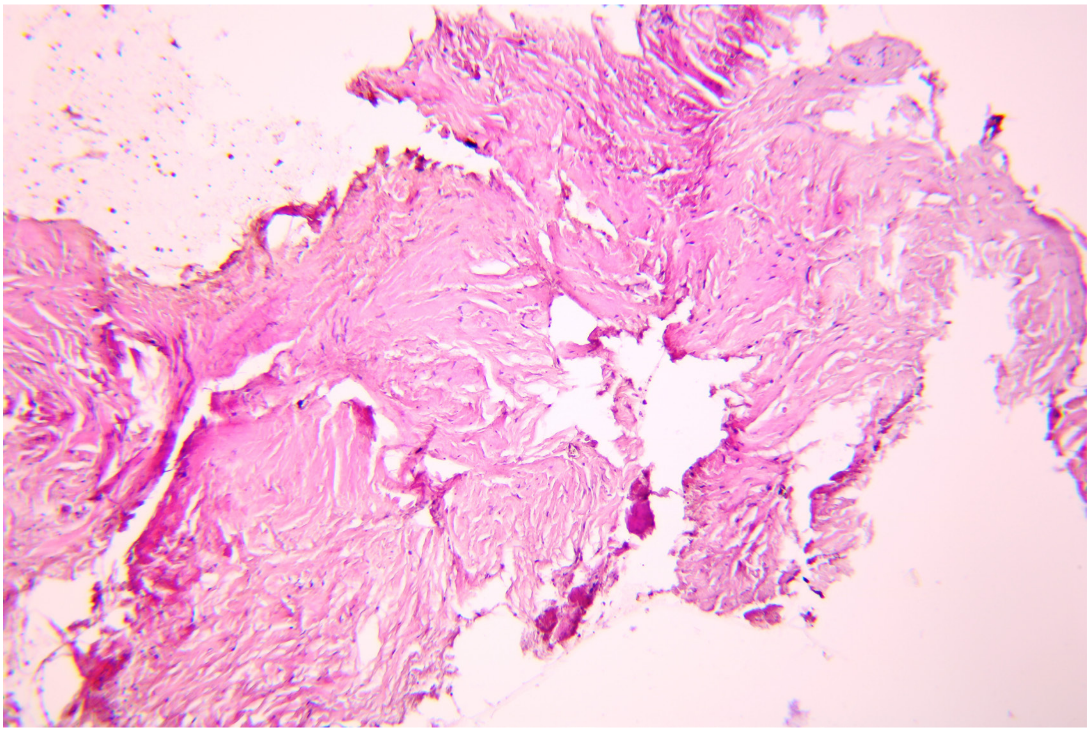

FIGURE 13. Dense fibrous connective tissue, hematoxylin-eosin staining (50x magnification).

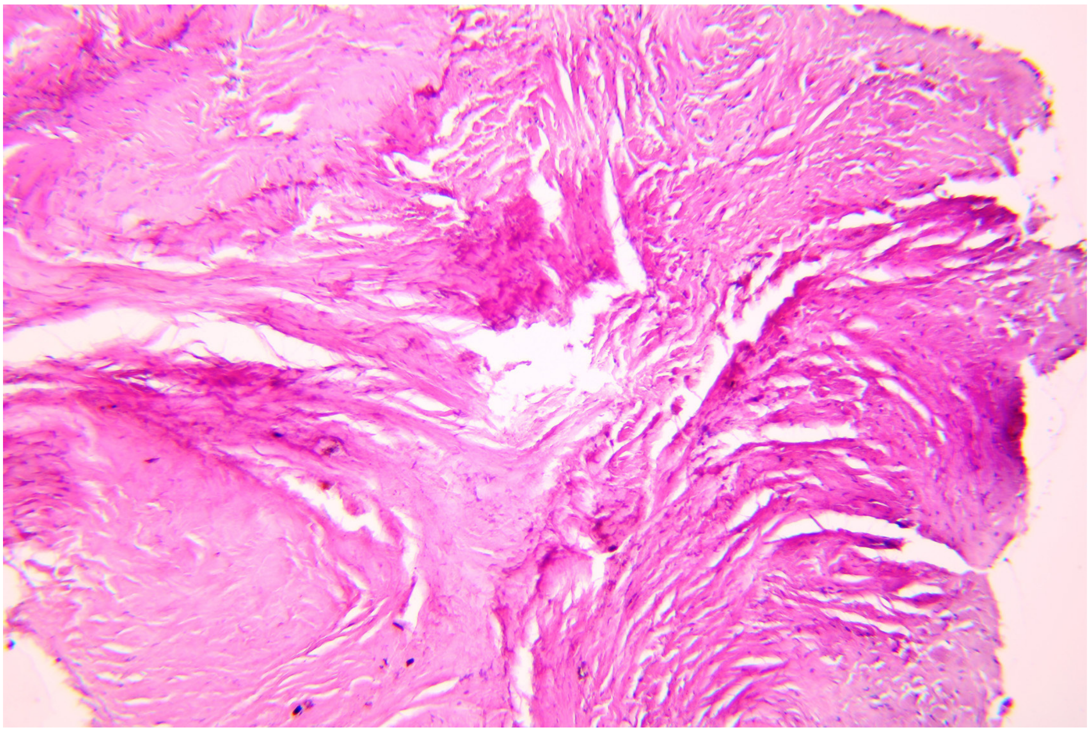

FIGURE 14. Dense fibrous connective tissue, hematoxylin-eosin staining (100x magnification).

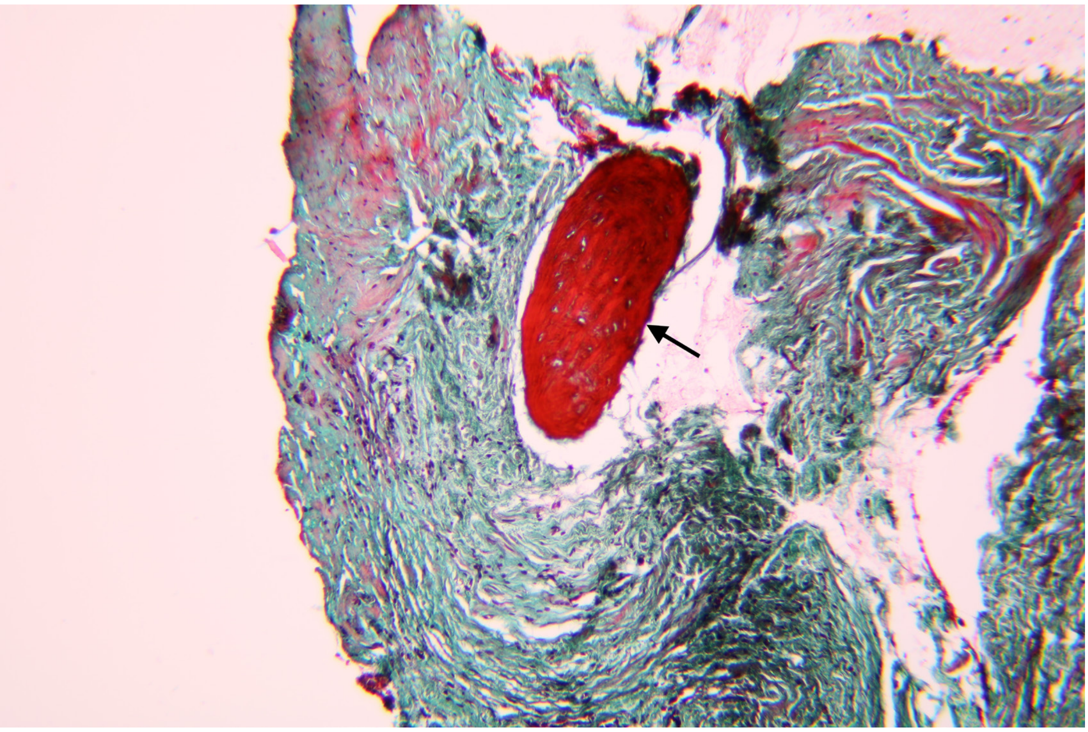

FIGURE 15. Dense fibrous connective tissue, bone microsequester is indicated by *arrow*, Masson's trichrome stain in Goldner's modification with light green (50x magnification).

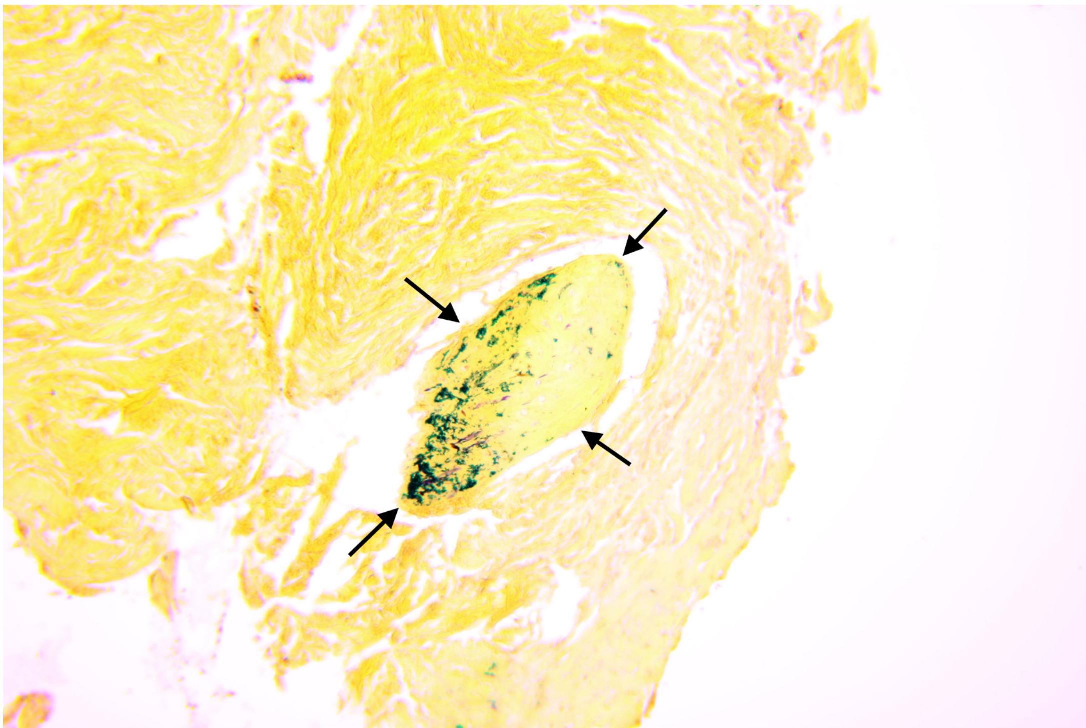

FIGURE 16. Dense fibrous connective tissue, the bone microsequester is indicated by *arrows*, Brown-Brain staining, (50x magnification).

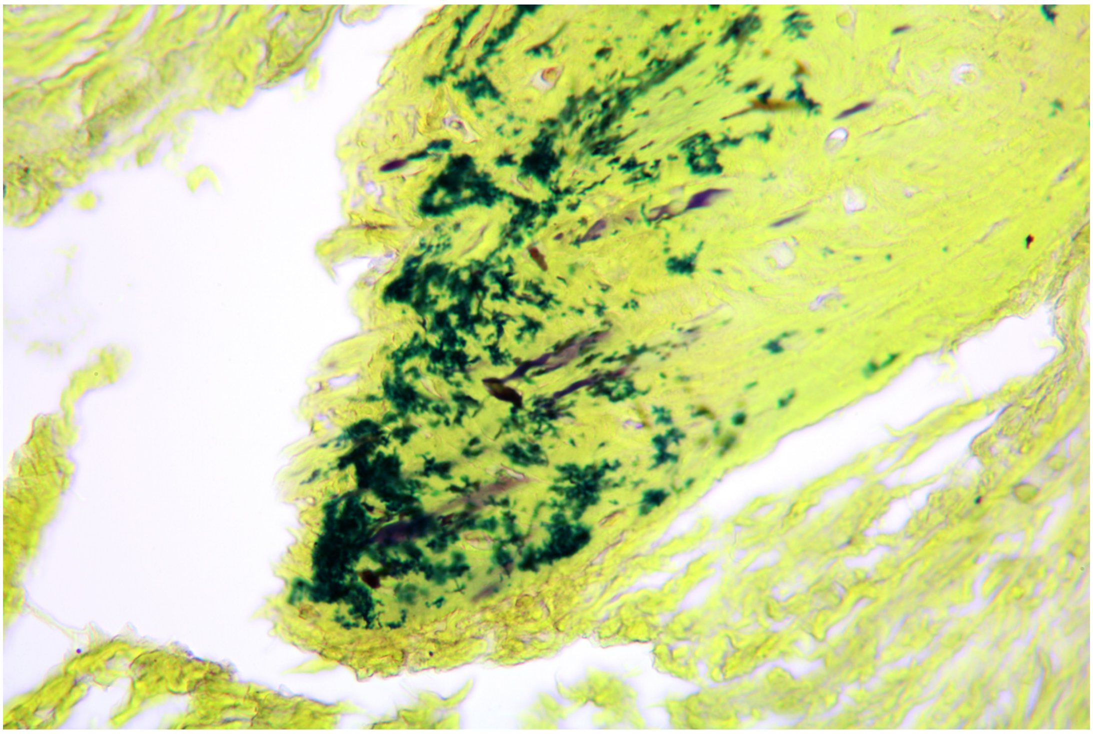

FIGURE 17. Dense fibrous connective tissue, the presence of pathogenic Gr+ microflora (*dark blue color*) is noted in the bone microsequestration, Brown-Bren staining, (100x magnification).

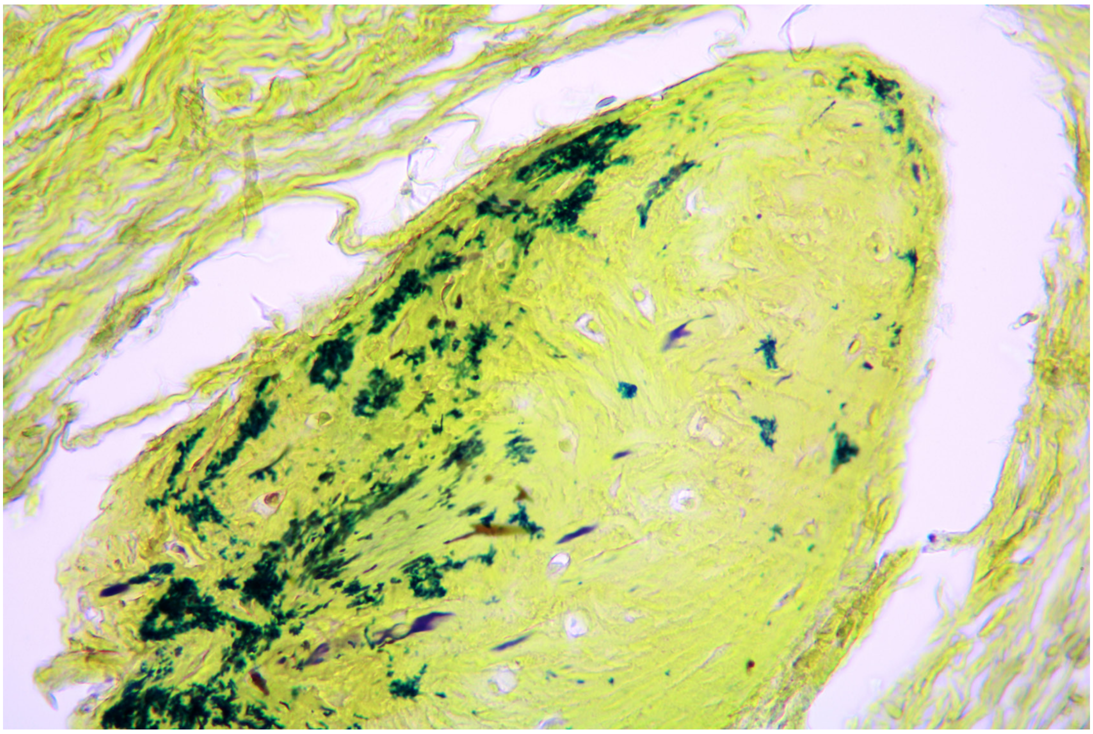

FIGURE 18. Dense fibrous connective tissue, the presence of pathogenic Gr+ microflora (*dark blue color*) is noted in the bone microsequestration, Brown-Bren staining, (100x magnification).

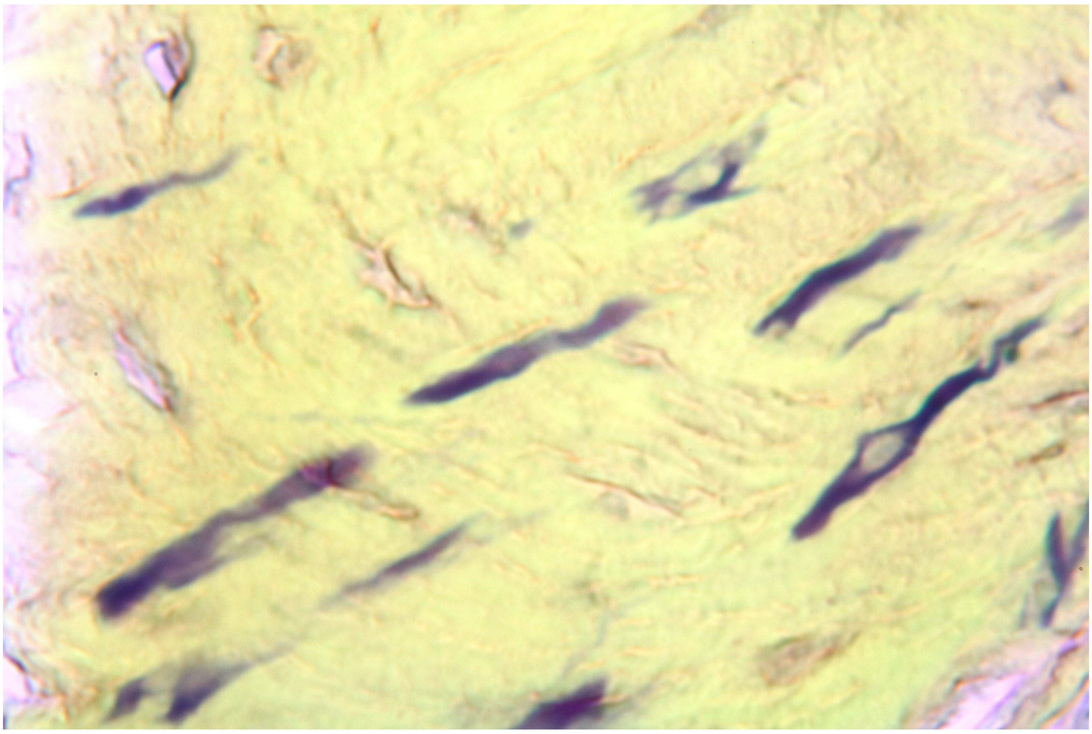

FIGURE 19. Dense fibrous connective tissue, the presence of pathogenic Gr+ microflora (*dark blue color*) is noted in the bone microsequestration, Brown-Bren staining, (200x magnification).

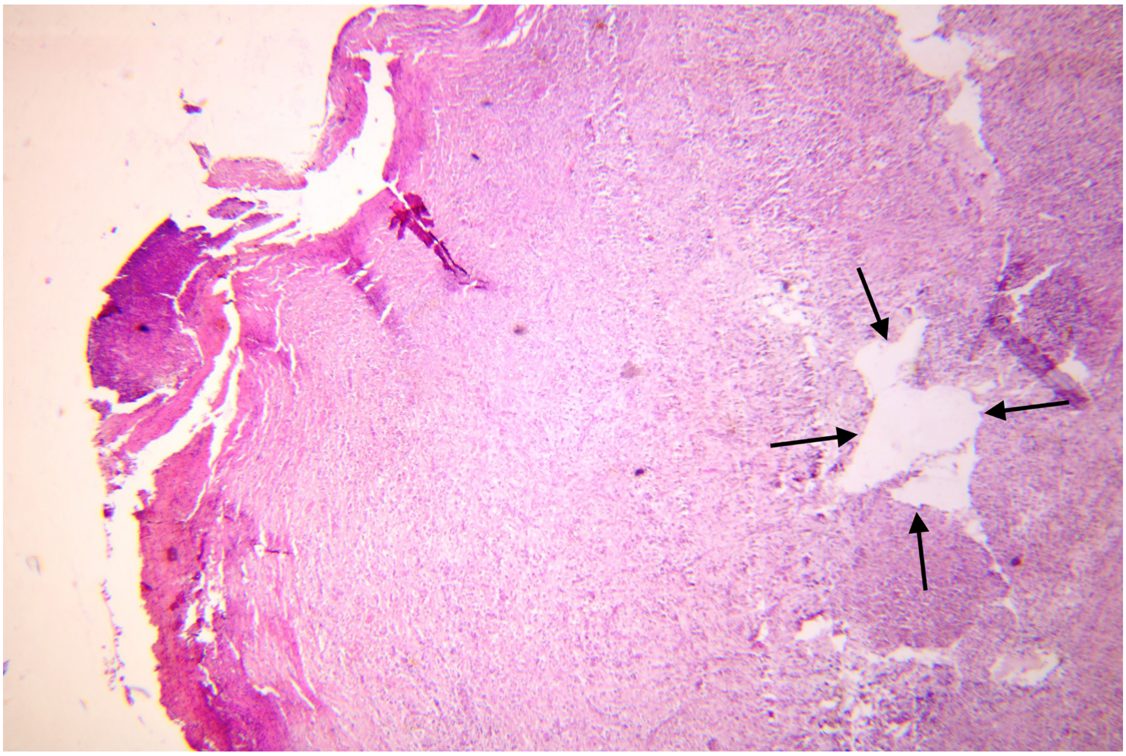

FIGURE 20. Pathohistological diagnosis of the biopsy in the bone defect area near tooth 22: Non-epithelialized granuloma with abscessation: Granulation tissue containing an area of necrosis (*arrows*), staining with hematoxylin-eosin (50x magnification).

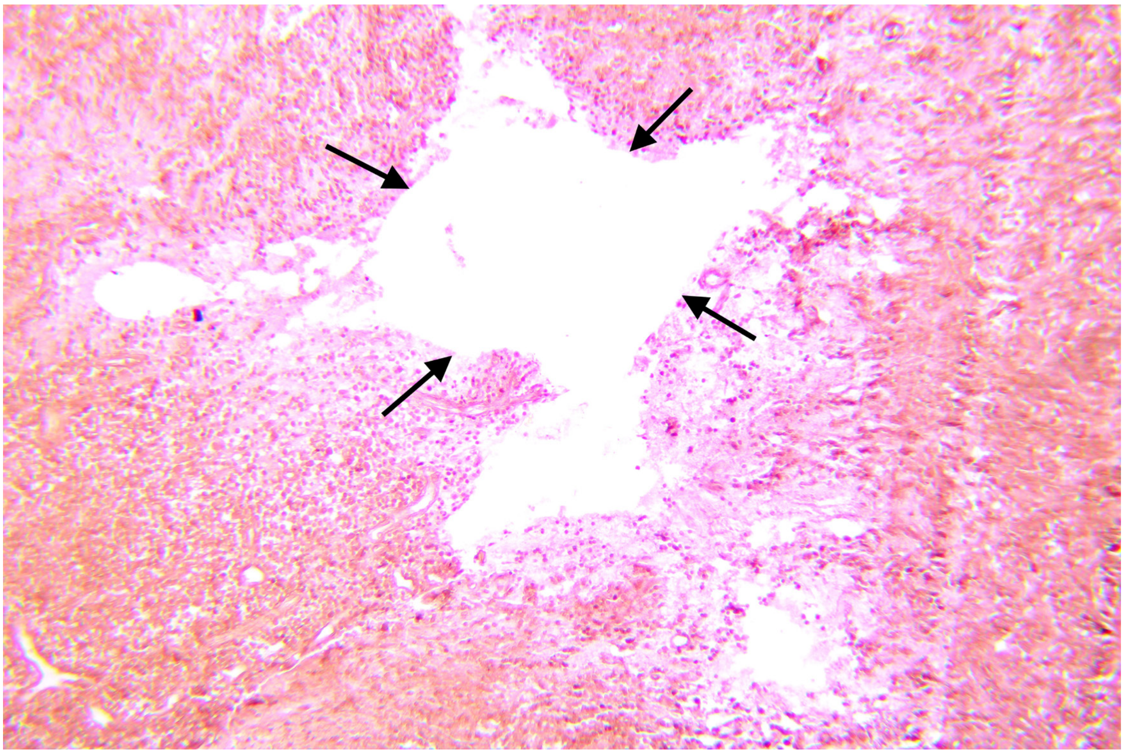

FIGURE 21. Granulation tissue containing an area of necrosis (*arrows*), hematoxylin-eosin (100x magnification).

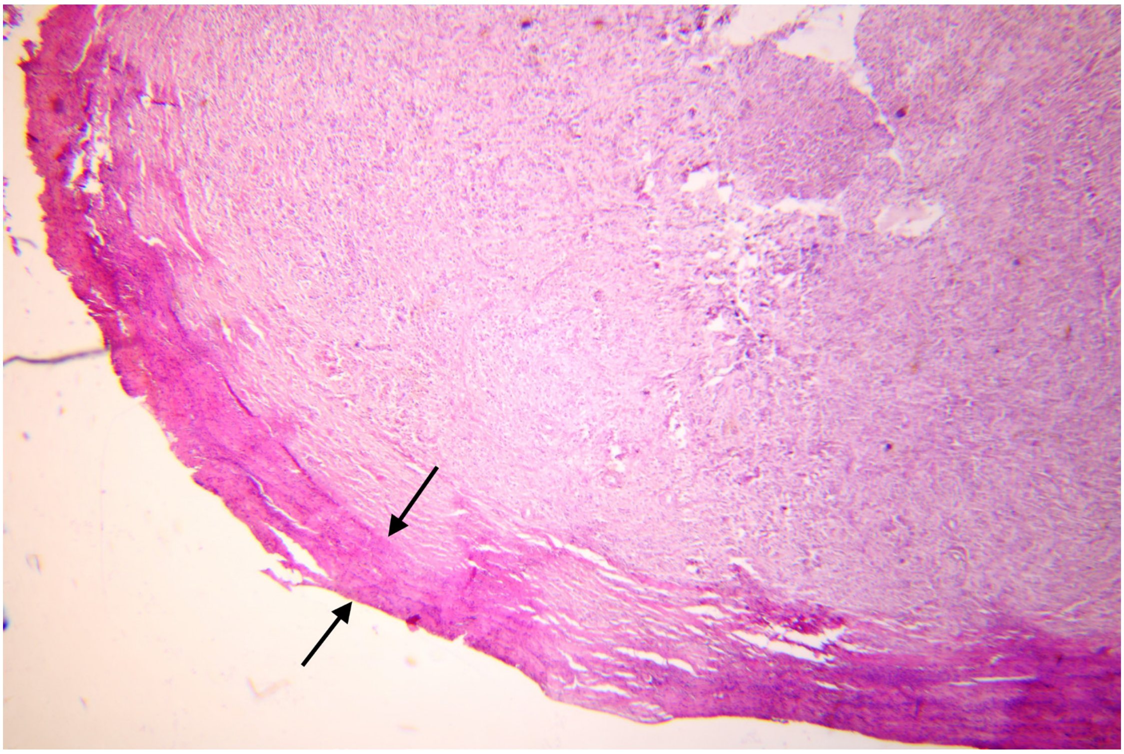

FIGURE 22. Granulation tissue around the perimeter is surrounded by a connective tissue capsule (*arrows*), which consists mainly of collagen fibers, staining with hematoxylin-eosin (100x magnification).

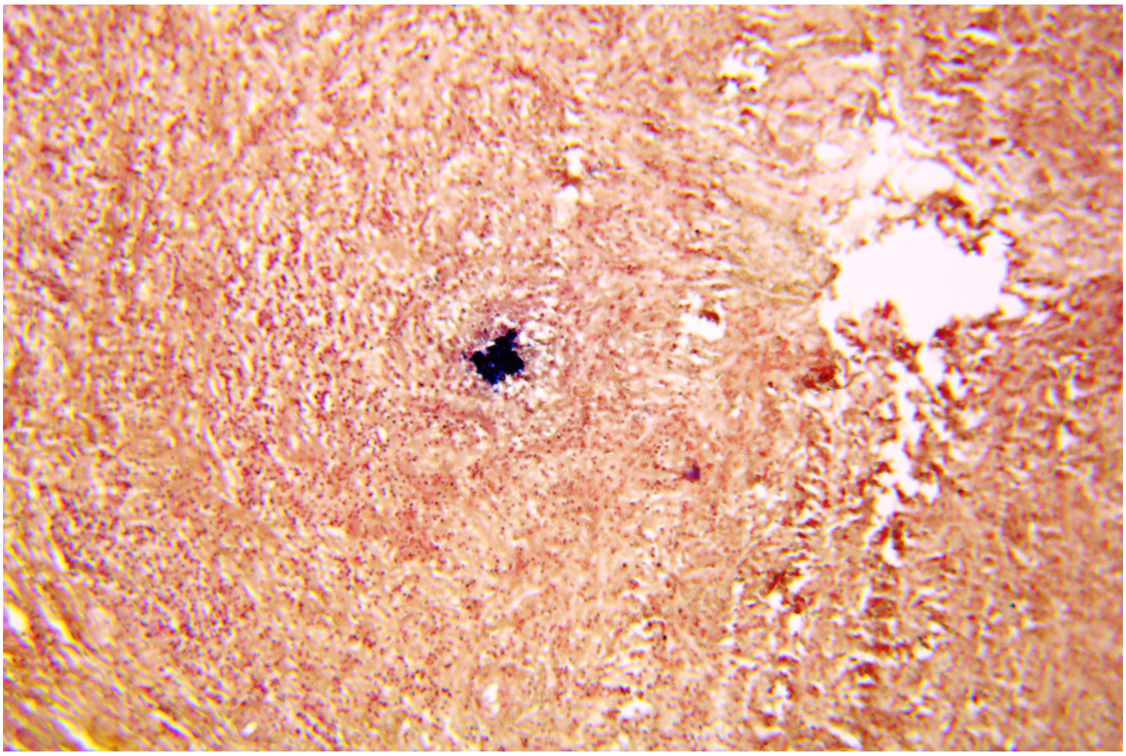

FIGURE 23. Granulation tissue containing pathogenic Gr+ microflora (*dark blue color*), Brown-Bren staining (100x magnification).

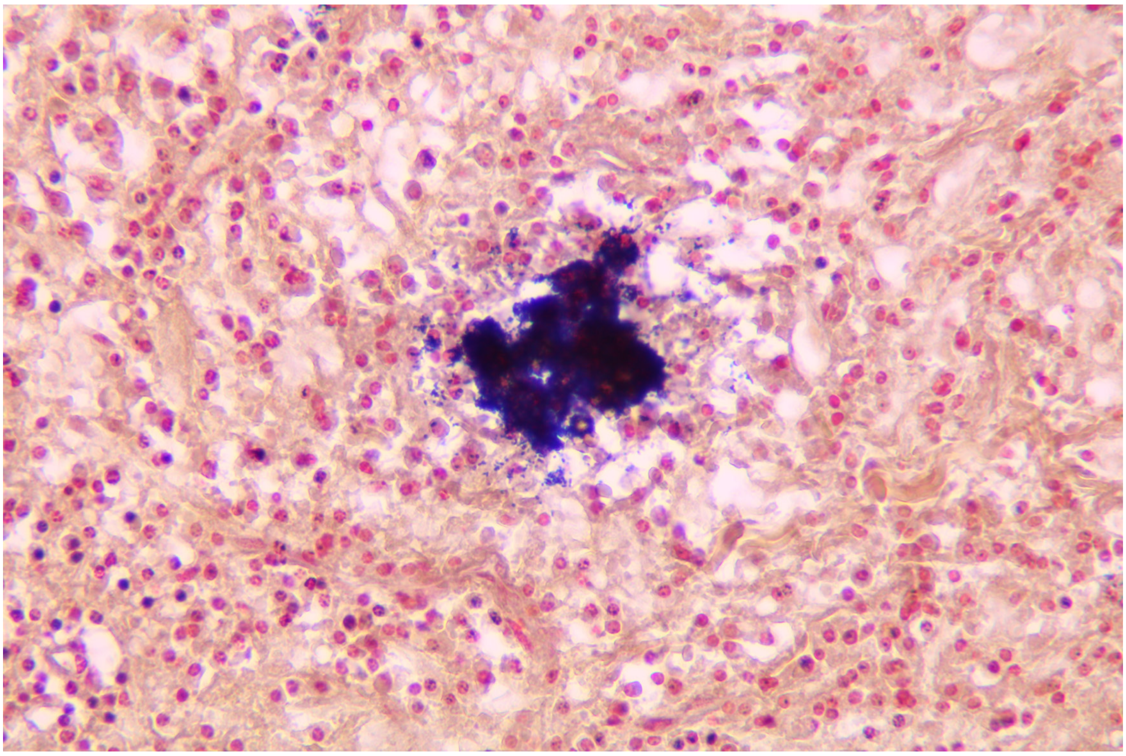

FIGURE 24. Granulation tissue containing pathogenic Gr+ microflora (*dark blue color*), Brown-Bren staining (100x magnification).

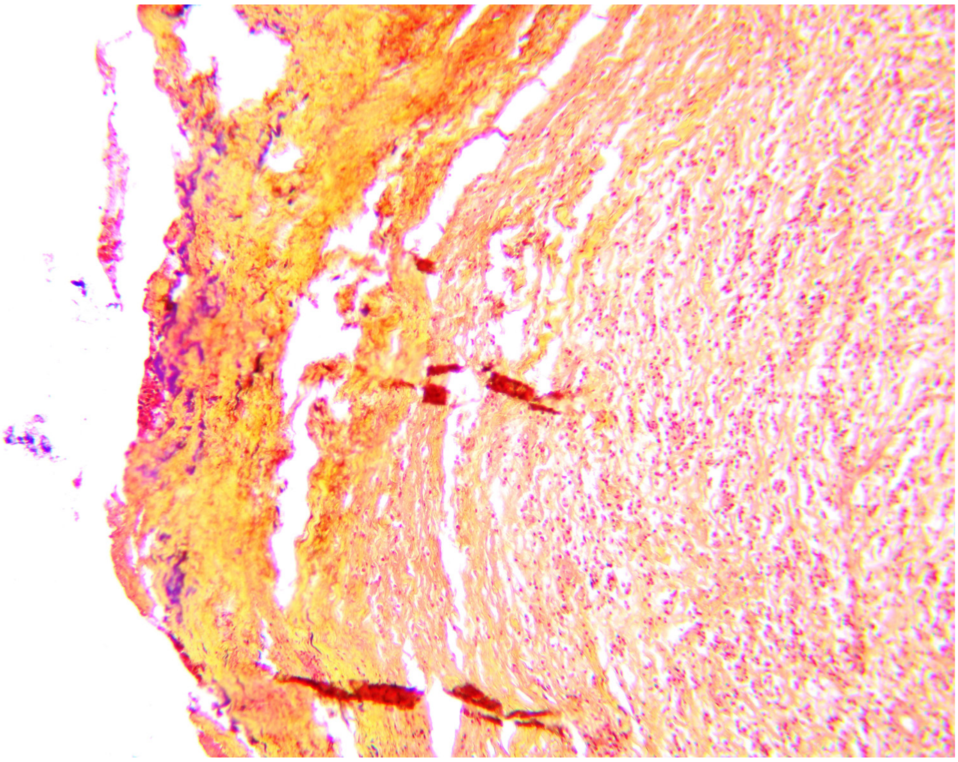

FIGURE 25. Granulation tissue with connective tissue capsule, *dark blue color* in the connective tissue capsule stains filamentous bacteria, Brown-Breen stain (50x magnification).

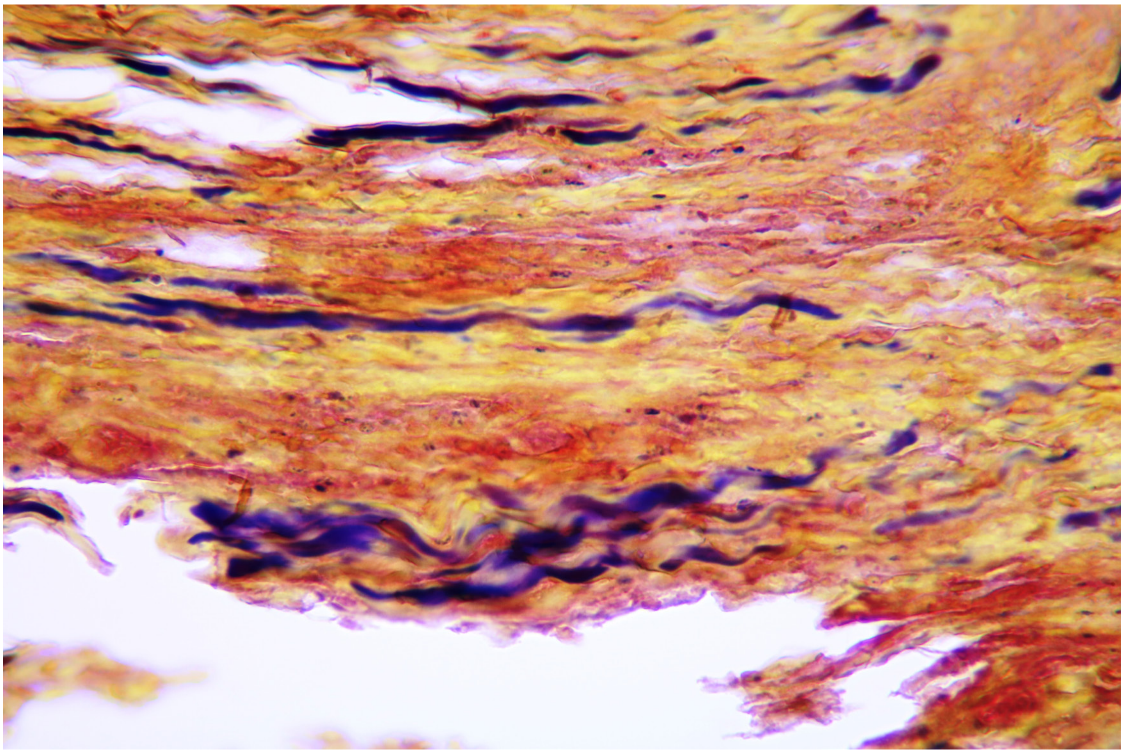

FIGURE 26. Granulation tissue with a connective tissue capsule, *the dark blue color* in the connective tissue capsule stains filamentous bacteria. Brown-Bren staining (200x magnification).

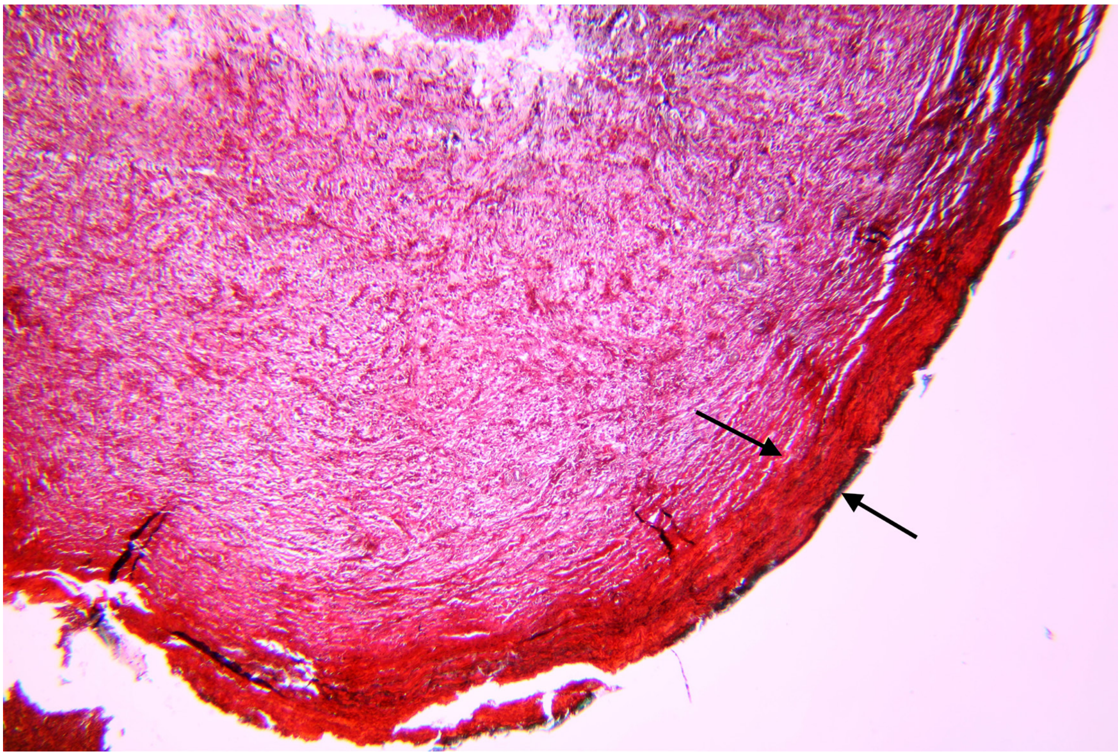

FIGURE 27. Granulation tissue with connective tissue capsule (*arrows*), Masson's trichrome stain in Goldner's modification with light green (100x magnification).

The comparison of histopathological results is highlighted in the Table 2.

A 1.5-year post-microsurgery examination and survey (Fig 28) showed the absence of symptoms, normal appearance of the gingiva from the vestibular and palatal aspects. Temporary crowns, which are visualized on teeth 12, 11, 21, and 22, will be replaced by permanent crowns in the near future.

X-ray (Fig 29) and CBCT (Fig 30) after 1 year and 6 months show signs of incomplete healing (according to Rud and colleagues (1972) [20] and Molven and colleagues (1987) [21] classification) in the area of teeth 11, 12, and 22. It is worth noting that incomplete healing in endodontic microsurgery is evaluated as success [22].

Comparing sagittal CBCT scans before (Fig 30A) and 1.5 year after (Fig 30B) the endodontic microsurgery noted the post-operative repair of the vestibular and palatal cortical plates along with partial repair of cancellous bone substance.

Guided by the modern "3D criteria for the success of healing after endodontic microsurgery of the University of Pennsylvania" based on the CBCT obtained after 1 year and 6 months, it can be stated that the existing type of healing belongs to the category of limited healing [19].

TABLE 2. Comparison of Histopathological Results in the Area of Teeth 11, 12 and Tooth 22.

Histopathological Diagnosis of the Specimen from Bone Defect Area Near the Apices of the Teeth 11 and 12	Histopathological Diagnosis of the Specimen from Bone Defect Area Near the Apex of the Tooth 22
Periapical scar consisting of dense fibrous connective tissue and an area of osteomyelitis	Non-epithelialized granuloma with abscessation

FIGURE 28. A 1.5-year post-microsurgery examination and survey (**A**, **B**) showed the absence of symptoms and normal appearance of the gingiva from the vestibular and palatal aspects. There are temporary crowns on teeth 12, 11, 21, and 22, which will be replaced by permanent crowns in the near future.

FIGURE 29. X-ray (**A**, **B**) and CBCT (Fig 30B) after 1 year and 6 months show signs of incomplete healing (according to Rud and colleagues (1972) [20] and Molven and colleagues (1987) [21] classification) in the area of teeth 11, 12, and 22. It is worth noting that incomplete healing in endodontic microsurgery is evaluated as success [22]. 12, upper right lateral incisor; 11, upper right central incisor; 22, upper left lateral incisor.

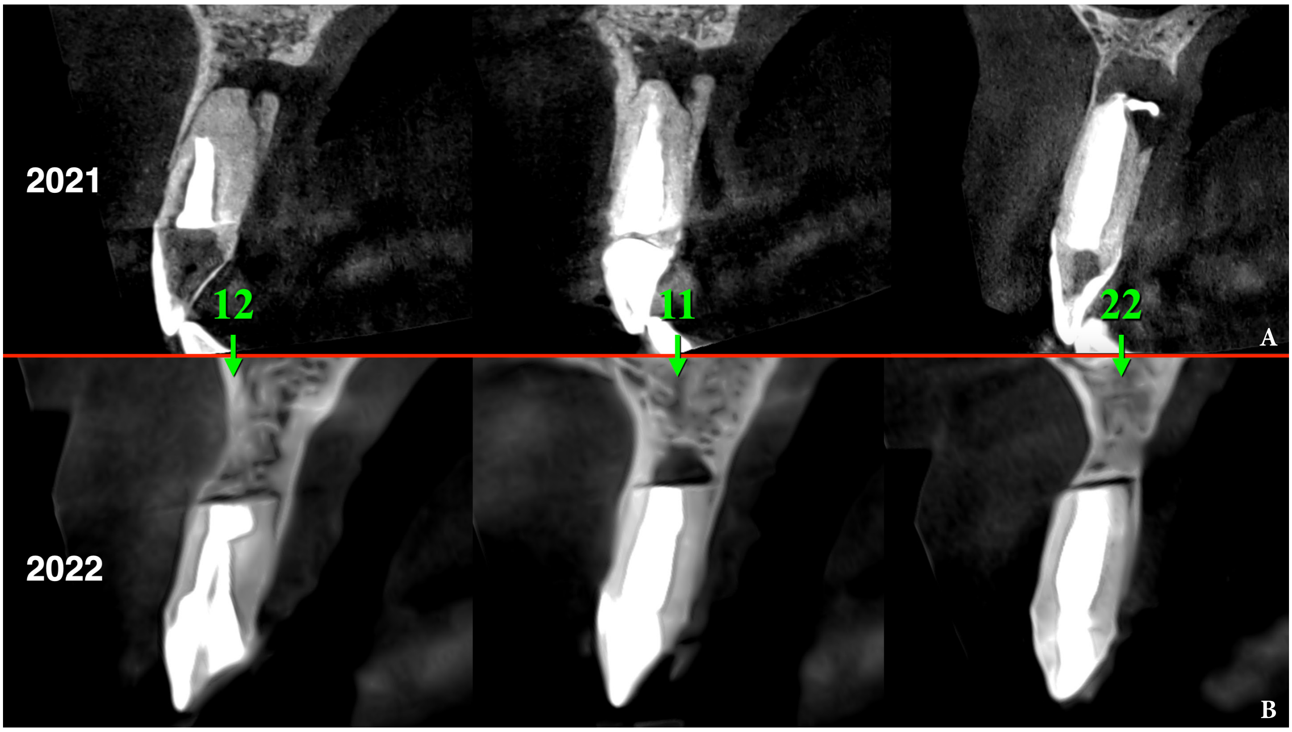

FIGURE 30. Sagittal CBCT scans before (**A**: 2021) and 1.5 year after (**B**: 2022) the endodontic microsurgery. Notes a repair of the vestibular and palatal cortical plates along with partial repair of cancellous bone substance. Repaired bone areas are indicated by *arrows*. 12, upper right lateral incisor; 11, upper right central incisor; 22, upper left lateral incisor.

DISCUSSION

This case illustrates the value and importance of history taking, careful clinical and radiographic evaluation for accurate diagnosis and appropriate management.

An endodontically treated tooth that has a periapical lesion in the form of radiolucency that exists for a long time and does not heal, but at the same time does not bother the patient, for some reason is often interpreted by doctors as a periapical pathology and, accordingly, wrong decisions are made regarding treatment. The small amount of information about the apical/periapical scar in endodontically treated teeth with its characteristic clinical and radiographic features causes the difficulty of differential diagnosis between the apical/periapical scar and various apical/periapical lesions that look like periapical radiolucency. Many scientific sources do not consider an apical/periapical scar to be a pathology that requires treatment [7]. Moreover, it is generally accepted that scar healing is a success in endodontic microsurgery [22]. The listed general clinical and radiological signs of apical/periapical scars according to the data of Lee and colleagues [7] make possible to diagnose apical/periapical scars more accurately and make decisions about the expediency of treatment.

CONCLUSIONS

The purpose of this clinical case report was to provide education and awareness regarding apical scarring occurring in traumatized teeth, subsequent endodontic treatment, and endodontic microsurgery. The importance of careful clinical and radiographic evaluation and biopsy submission for accurate diagnosis and treatment was emphasized.

AUTHOR CONTRIBUTIONS

Conceptualization: Tkachenko O, Volokitin A. Data acquisition: Tkachenko O, Volokitin A. Data analysis or interpretation: Tkachenko O, Volokitin A. Drafting of the manuscript: Volokitin A, Tkachenko O. Critical revision of the manuscript: Tkachenko O, Volokitin A. Approval of the final version of the manuscript: both authors.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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CASE SERIES/TECHNIIQUE

Bone Window Technique in Endodontic Microsurgery – Report of Two Cases

Spyros Floratos[a,*], Vasileios Molonis[b], Apostolos Tsolakis[c], Stylianos Kykalos[d] , & Konstantinos Kontzoglou[e]

ABSTRACT

Endodontic microsurgery was introduced in the ’90s and has significantly increased the success rate of apical surgical intervention in the last few decades. Utilizing the dental operating microscope, ultrasonic tips for root end preparation and biocompatible root end filling materials, predictably manages the apical pathology preserving the buccal cortical plate. The bone window technique for buccal approach to the apical area involves the use of piezoelectric unit to prepare and elevate a buccal cortical bony window and the reposition of the bone after the apical root end filling is completed. Two cases are reported in this article, highlighting the importance of endodontic microsurgery and buccal bone window technique in addressing apical pathology in a minimally invasive way, preserving the hard tissues and the tooth structure. Cases were reevaluated clinically and radiographically after a period of 3 months up to 36 months.

KEY WORDS

Bone window; piezoelectric surgery; autologous graft; endodontic microsurgery; root resection, apicoectomy; ultrasonics

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INTRODUCTION

Endodontic microsurgical approach was introduced in 1990s and today is enormously advanced. The success rates rise to 92% [1], which proves that it is a predictable treatment method. The advantages derive from its main components including the dental operating microscope, the use of ultrasonic tips for root end preparation coaxial to the canal and more biocompatible root end filling materials. Inspection under high magnification is the key stage of microsurgery that is missing from the traditional surgical technique [2, 3]. A careful inspection identifies the possible reasons for failure of the nonsurgical treatment. Due to the improved visualization, magnification and illumination offered by the surgical microscope, the osteotomy became more conservative, and our knowledge of the apical anatomical details has increased [1]. Entities such as isthmi, lateral canals and microfractures can now be clearly visualized. Root-end preparation involves preparing a class I cavity at least 3 mm into root dentin, with walls parallel to and within the anatomic outline of the root canal space [4]. Modern ultrasonic tips can facilitate the preparation of a 4-mm, 5-mm, 6-mm, or even longer root-end cavity [1]. Those tips are very efficient at preparing a class I cavity coaxial to the canal, even in canals with calcification or even obliteration. At the same time, root end sealing is now performed with biocompatible root end filling materials that have antibacterial properties, are dimensional stable, hydrophilic and possess a high sealing ability. Clinically, modern root end filling materials are available in a premixed form and are easy to handle. Mineral trioxide aggregate (MTA; ProRoot MTA; Dentsply, Tulsa, OK, USA) is the material of choice, and more recently bioceramic root repair materials were introduced showing promising results [5–7].

The bone window technique was first described by Khoury and Hensher in 1987 [8]. It involves the buccal approach to the apical area through a bony window. The osteotomy is precise and selectively using piezoelectric saws, without sacrificing healthy bone. Excellent exposure to the operative field and preservation of the cortical bone are obtained. The bony window is carefully preserved and after root resection and reverse filling with biocompatible materials, is repositioned to its initial place.

The technique aims to preserve more bony structure and to maintain the integrity of the buccal cortical plate. Furthermore, it serves as an autologous graft material which can provide optimal healing without the need of additional alternative regenerative materials [9]. As a result, tissue damage and complications are decreased. The bone is cut to a size so that it contains the lesion and the apical thirds of the roots and therefore provides an excellent exposure of the operation field. A necessary condition is that the cortical plate is intact. Care is taken so that the bony window is placed firmly in its initial place after the end of the surgery to avoid its penetration into the osteotomy site [10, 11].

Traditional surgical methods utilize surgical burs to perform osteotomy. However, drilling intact bone while making osteotomy results in greater bone loss and delayed healing [2, 12, 3]. On the contrary, removal of the cortical plate with piezoelectric instruments and reposition after the procedure enables adequate access to the surgical area, excellent visibility, minimal loss of bone structure and protection of special anatomical entities such as the inferior alveolar nerve. Piezoelectric devices enable a safe, selective, and precise surgical bone cut as piezoelectric function stops when the piezoelectric saw contacts soft tissue [11, 13, 14]. It is therefore a safe, predictable, and effective tool for creating and elevating the bone window. In addition, the surgery area is bloodless with great intraoperative visibility.

This study reports two cases where bone window technique was used on mandibular posterior teeth and provides a review of bone window osteotomy along with the modern microsurgical concepts and materials.

CASE REPORTS

CASE 1 (TOOTH #34)

A 60-year-old male patient was referred to the private office for evaluation and treatment of a mandibular first premolar (tooth #34). He reported swelling in the area one month before his appointment. His medical history was noncontributory. In his dental history, tooth #34 was endodontically treated and restored 15 years ago. Clinical examination revealed moderate pain on percussion and palpation and a mild intraoral swelling. The tooth had post and core build up and a porcelain fused to metal crown with good margins. Periodontal probings were within normal limits. Periapical (PA) radiographs and cone-beam computed tomography (CBCT) scans were obtained and revealed a previous incomplete endodontic treatment and a 4- × 4-mm periapical radiolucency. The thickness of the buccal cortical plate was 3–5 mm (Fig 1A–C). Based on the history and clinical and radiographic examination, a diagnosis of previous endodontic treatment with symptomatic apical periodontitis was established. The patient was offered all treatment options. He opted for microsurgical retreatment. A written informed consent was given by the patient prior to surgery. After rinsing with 0.12% chlorhexidine solution (Chlorhexidine 0.12%, Chlorhexil, InterMed, Intermed S.A. Pharmaceutical Laboratories, Kifissia, Greece) for 60 seconds, the patient was administered 1 cartridge of 4% septocaine with 1:100,000 adrenaline for inferior alveolar nerve block (IANB) anesthesia and 2 capsules of 2% lidocaine with 1:50,000 adrenaline for buccal infiltration. After ensuring profound anesthesia, a full-thickness triangular flap was raised, with 4mm distal release incision, and an intact cortical plate was detected. The osteotomy was performed using a piezoelectric device (Woodpecker Surgic Touch unit, Guilin Woodpecker Medical Instrument Co. LTD, Guilin, Guangxi, China). Two vertical and two horizontal grooves were joined to create a bony window of approximately 6x6mm (Fig 1D and 1E). Bone window was removed using an elevator and the bone block was stored in HBSS (Hank's Balanced Salt Solution, Lonza Biotech, Rome, Italy) to keep it hydrated (Fig 1F). Curettage was performed on periapical area followed by 3 mm root tip resections using a Lindeman bur under copious irrigation with sterile water. Healthy bone margins were encountered, and the root tip was clearly visible (Fig 1G). The resected root surfaces were stained with methylene blue, and inspected using a micromirror (Obtura Spartan, Fenton, MO, USA) under ×20 to ×26 magnification. An isthmus was observed joining the canals and was included in the root-end preparation. Root-end preparation was achieved using ultrasonic tips (JeTips, B&L Biotech USA Inc, Bala Cynwyd, PA, USA). The prepared root-end cavity was dried and bioceramic putty mix (TotalFill® BC RRM Putty, FKG Dentaire Sàrl, Le Crêt-du-Locle, Switzerland) was placed as a root end filling (Fig 1H). Adaptation of bioceramic to the canal was confirmed under high magnification (from ×20 to ×26). Bone window was repositioned at the original position. The flap was sutured with 5-0 monofilament sutures (Supramid nylon sutures; S. Jackson Inc, Alexandria, VA, USA) and a postoperative radiograph was taken (Fig 1I). The patient was prescribed oral analgesics (ibuprofen 600 mg 3 times a day) and instructed to rinse twice daily with a 0.2% chlorhexidine mouth rinse for one week. The sutures were removed at 7 days after surgery. The patient presented for follow-up at ten months with radiographic signs of complete healing on periapical radiograph and CBCT (Fig 1J and 1K).

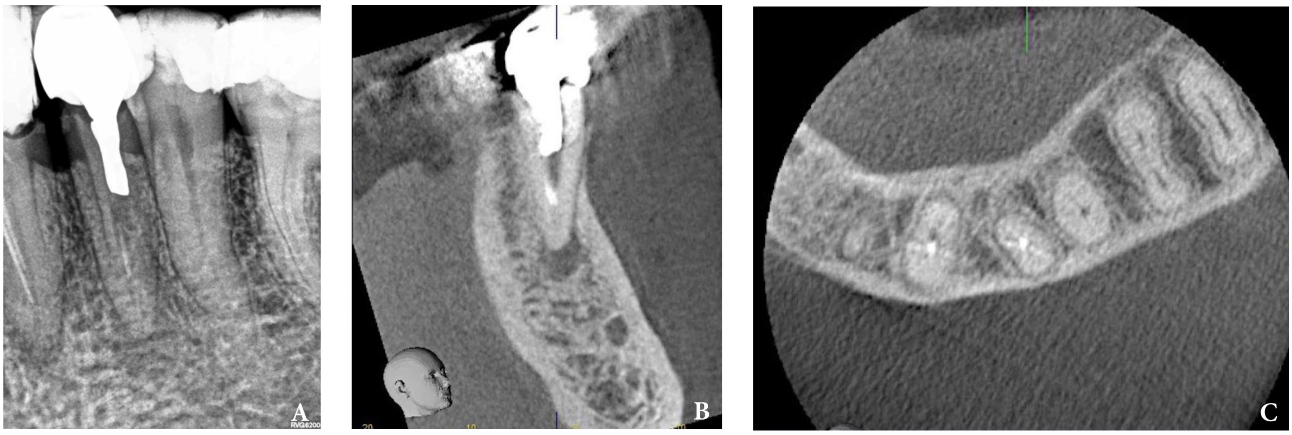

FIGURE 1. Intraoral radiography showing incomplete endodontic treatment and a periapical lesion on tooth #34 (**A**). Limited field-of-view (FOV) preoperative CBCT, demonstrating periapical lesion of tooth #34 and an intact buccal cortical plate (**B**, **C**). **(FIGURE 1 continued on next page.)**

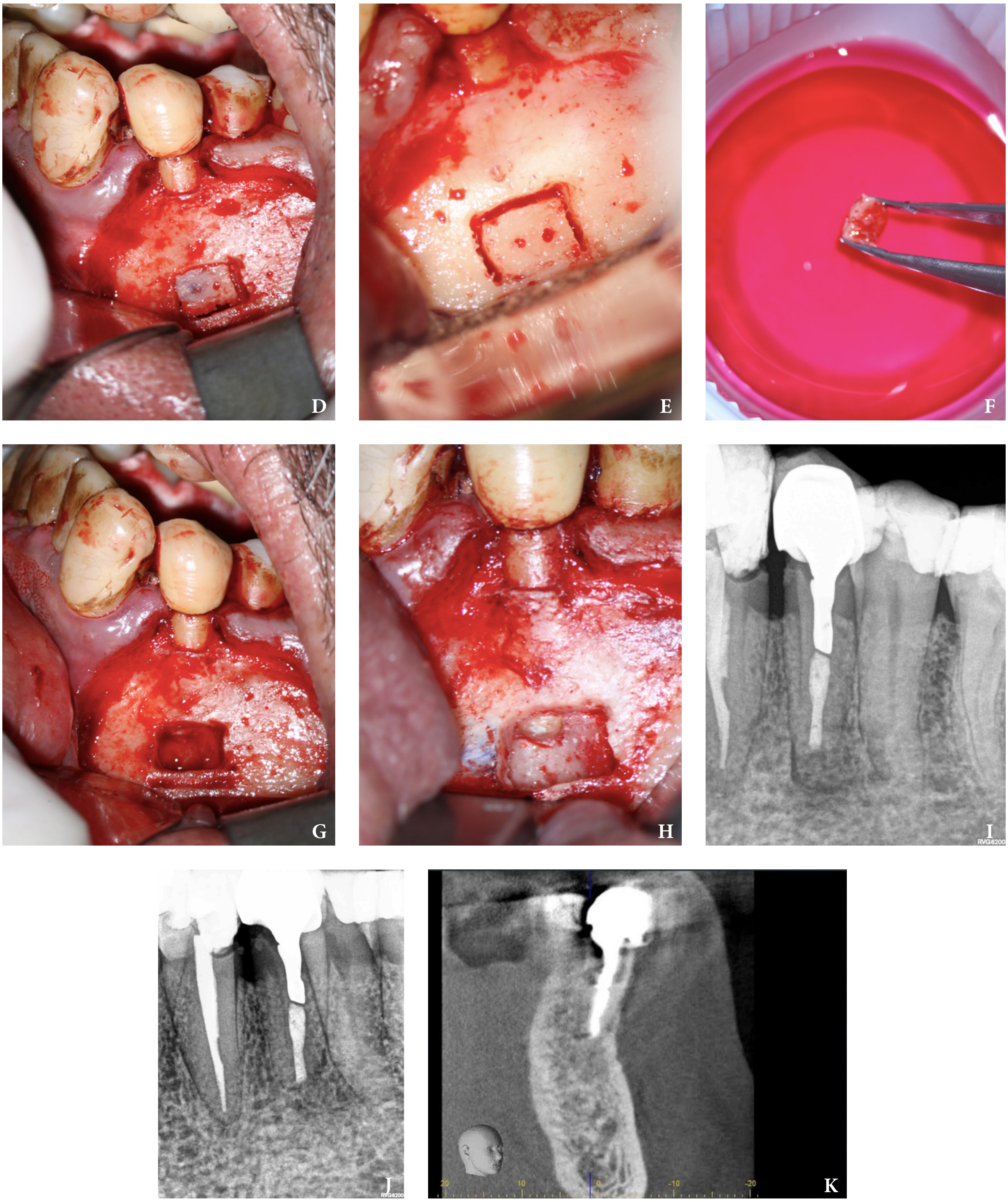

FIGURE 1 (continued). Bone window is prepared. Two openings were created to facilitate blood circulation (**D**, **E**). Buccal bone placed in HBSS hypertonic solution (**F**). Osteotomy site after root tip resection (**G**) and root end filling (**H**). Immediate postoperative PA radiograph of tooth #34 (**I**) demonstrating bone fragment reposition. 10 month follow up demonstrates healing (**J**) and preservation of the buccal cortical plate on the coronal view of CBCT (**K**).

CASE 2 (TOOTH #36)

A 62-year-old male patient was referred to the private office for treatment of the mandibular first molar (tooth #36). Tooth #36 was endodontically treated 15 years ago. Medical history was noncontributory. Tooth was asymptomatic to percussion and palpation upon clinical examination. There was a buccal sinus tract tracing the apical area of #36 as confirmed by the periapical radiograph (Fig 2B). The preoperative periapical radiograph and CBCT revealed a previous endodontic treatment with a 4- × 8-mm apical radiolucency (Fig 2A–C). There was a 3-5mm thick buccal cortical plate present (Fig 2C–E). Based on the history, clinical and radiographic examination, a diagnosis of previous root canal treatment with asymptomatic apical periodontitis was established. In discussion with the patient, apicoectomy was selected as the treatment of choice and the bone window technique was implemented following the surgical protocol described earlier. The buccal bone removed was 9mm × 5mm and was placed into HBSS after removal (Fig 2F and 2G). After the bone defect was verified, root end resection and granulation tissue removal were performed. Root-end preparation was then completed (Fig 2I) with JetTips ultrasonic tips (B&L Biotech USA Inc, Bala Cynwyd, PA, USA) and sealed with EndoSequence BC RRM Putty (Brasseler, Savannah, GA, USA). Bone fragment was repositioned at the original position using a pliers. The flap was sutured with 5-0 monofilament sutures (Supramid nylon sutures; SJackson Inc, Alexandria, VA, USA). The patient presented for follow-up at 3 months (Fig 2J and 2K). At the 36 month follow up radiographic signs of healing and no clinical signs or symptoms were observed (Fig 2L and 2M).

DISCUSSION

By use of a rotary bur for osteotomy, a significant amount of cortical bone loss is inevitable. Increased postoperative pain, delayed healing, and other complications such as nerve damage are frequently associated with conventional surgery [2, 13]. Endodontic microsurgery with bone window osteotomy is a minimally invasive procedure that offers faster healing and a better patient response [1]. The removed cortical bone is carefully replaced in its initial position and serves as an autologous graft. It promotes a complete regeneration in the surgical site as it is both osteoinductive and osteoconductive [11]. At the same time, it prevents the formation of large residual bone defects. The preservation of the cortical bone is confirmed with the use of CBCT. Additional bone grafting is not necessary and postoperative phase is more predictable and with less discomfort for the patient. It is important though, that patients are instructed not to put any digital pressure on the surgerized area, to prevent potential displacement of the bone piece.

FIGURE 2. Preoperative periapical radiographs of the tooth #36 (**A**, **B**). Sinus tract tracing the apical lesion of the tooth (**B**). **(FIGURE 2 continued on next page.)**

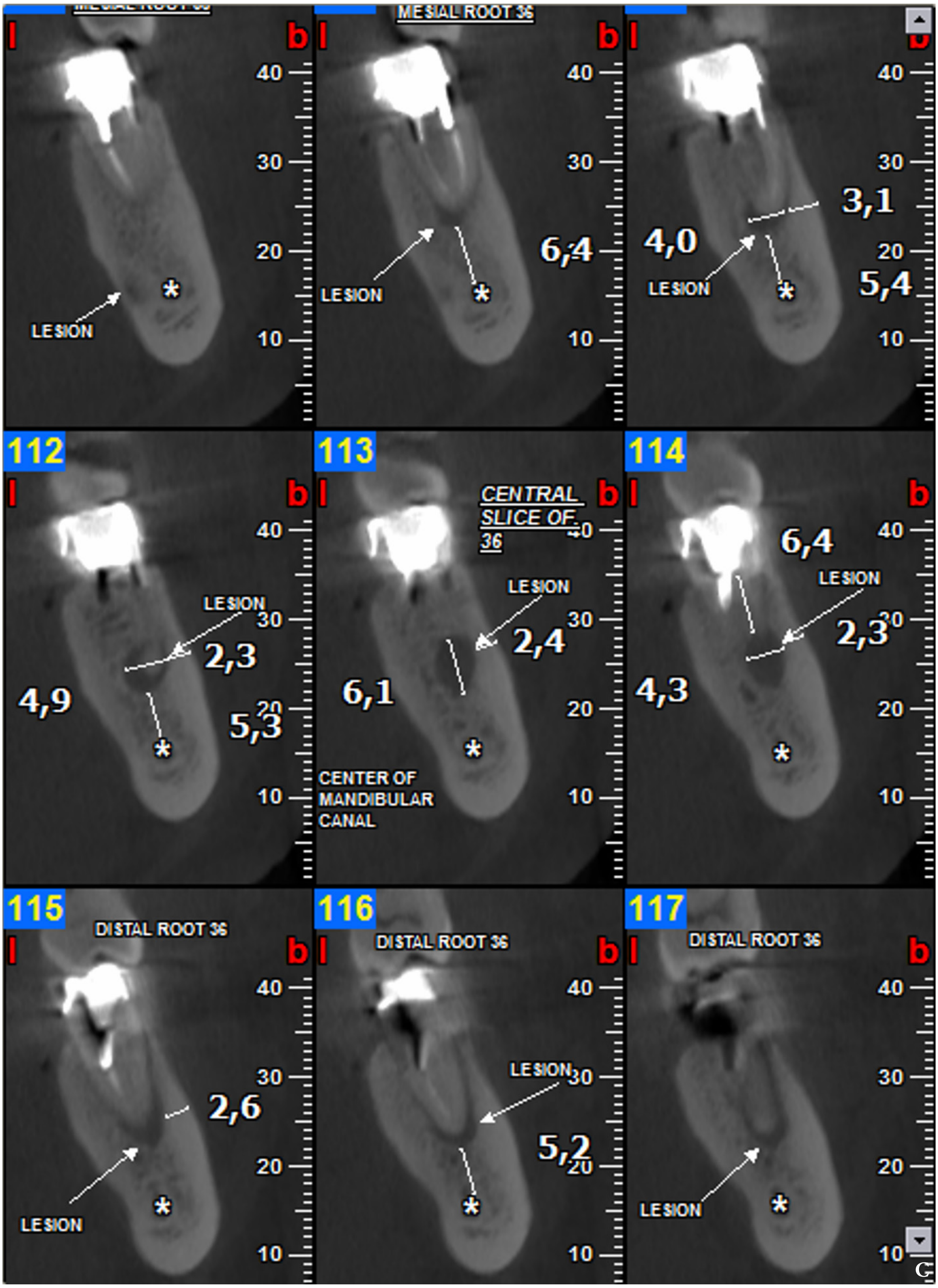

FIGURE 2 (continued). CBCT coronal (**C**) and axial (**D**, **E**) view demonstrating the amount of buccal bone thickness measured as well as the proximity to anatomical structures. **(FIGURE 2 continued on next page.)**

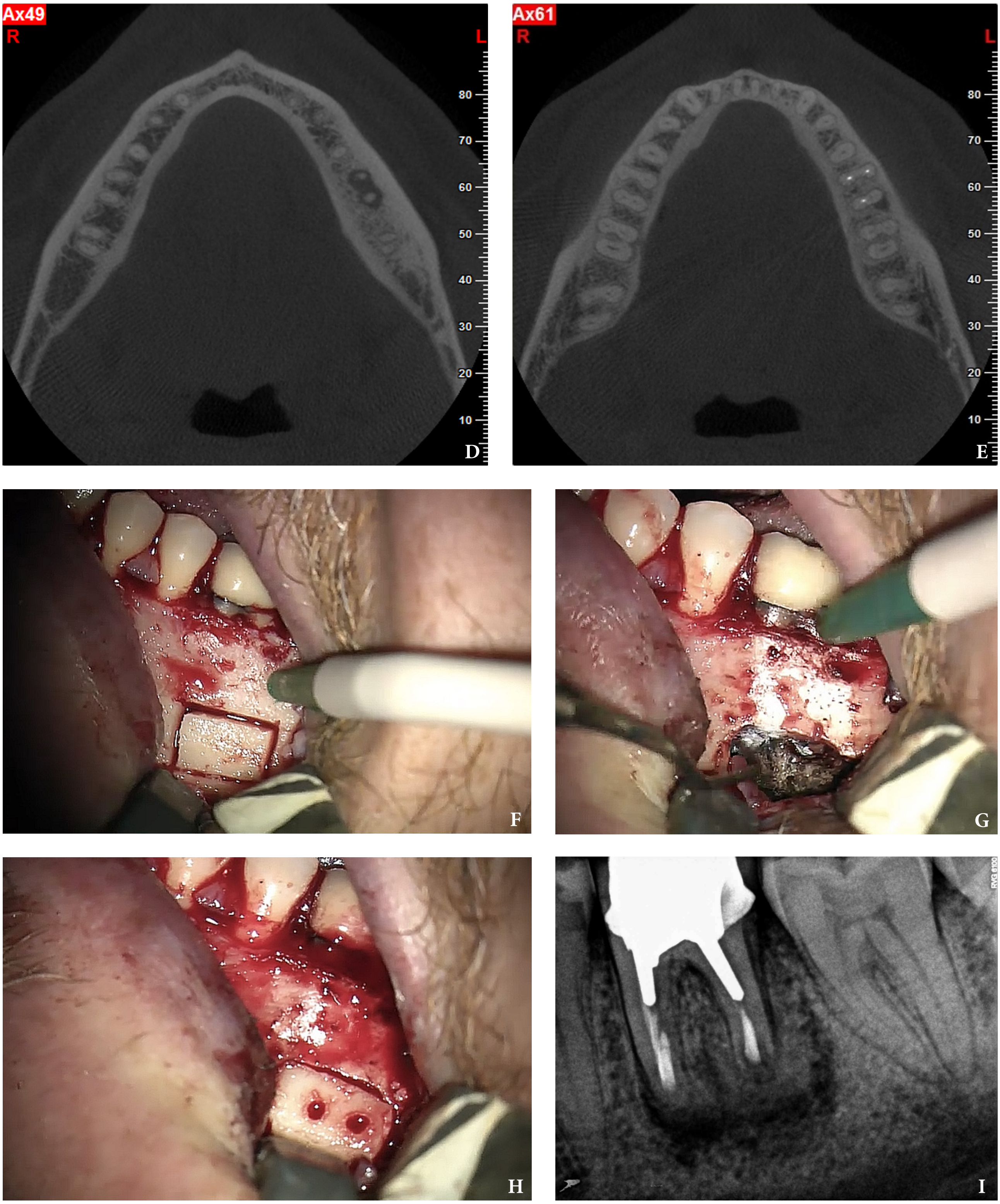

FIGURE 2 (continued). CBCT coronal (**C**) and axial (**D**, **E**) view demonstrating the amount of buccal bone thickness measured as well as the proximity to anatomical structures. Intraoperative clinical pictures of case 2 (tooth #36) show: the piezoelectrically created bone window (**F**), root end filling (**G**), and bone repositioned (**H**). Postoperative periapical radiograph (**I**). **(FIGURE 2 continued on next page.)**

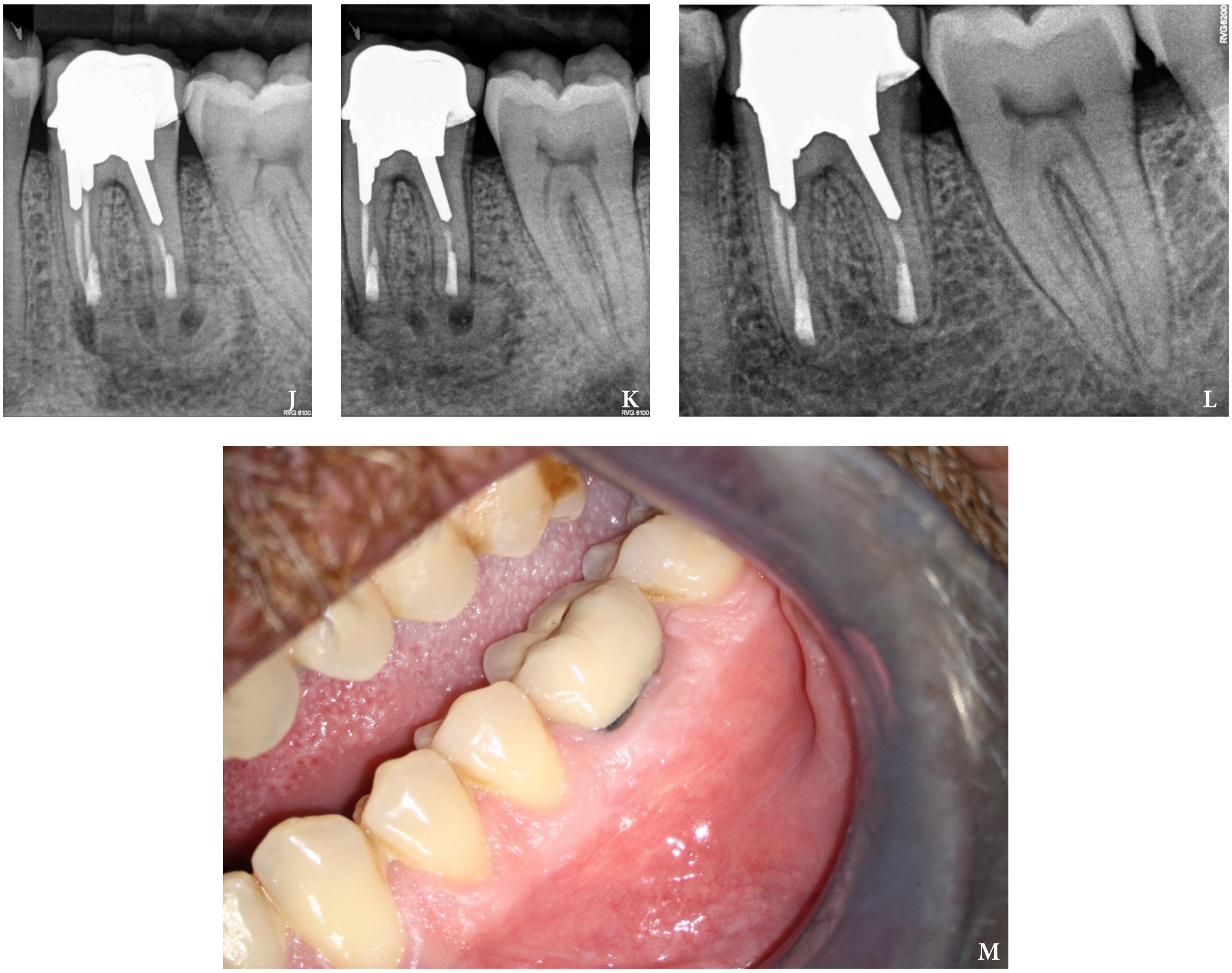

FIGURE 2 (continued). Follow up after 3 months (**J**, **K**). Follow up at three years: Radiographic (**L**) and clinical (**M**) examination showing complete healing.

In the reported cases, no added graft materials were used. Microsurgically treated periapical lesions can heal completely without the use of bone grafts or membranes. However, it is important to mention that guided tissue regeneration (GTR) and guided bone regeneration (GBR), when used, result in favorable healing outcomes. Bone grafts, membranes, and bioceramics have the ability to stimulate tissue regeneration. Indications in endodontic microsurgery include a large sized lesion, the need of additional stimulation of tissue regeneration, or the prevention of bone collapse [9]. The autologous bone is the reference grafting material to achieve bone repair due to its osteogenic, osteoinductive, osteoconductive and non-immunogenic properties. GTR techniques aim at preventing the surrounding connective tissue from growing into the osseous defect and therefore promote bone healing. In the reported case of Hirsch et al [11], CollaCote collagen material (Zimmer Dental, Carlsbad, CA, USA) was used between the margins of the bone window and the surrounding cortical bone. The filler material can be used as GTR material to fill a deficiency and to hold the segment in place, to prevent it from displacement or collapse into the cavity.

Preoperative CBCT provides important information of the surgical area, buccal bone and the exact position and extent of the apical pathosis [15]. The three-dimension radiographic imaging offers the ability of representative linear measurements of the width and height of the periapical lesion, evaluation of the buccal cortical plate and the anatomical structures of the surgical site. Structures such as the adjacent root tips, inferior alveolar nerve, mental foramen, and maxillary sinus should be carefully evaluated before buccal bone is piezo-electrically removed [10, 11]. Computer-assisted design and computer-assisted manufacturing (CAD/CAM) can be applied in dental surgeries including endodontic microsurgery. As shown in recent case reports, with the aid of a 3D-printed surgical template, guided minimal osteotomy is achieved and the buccal cortical plate is successfully preserved and renders the surgical procedure less traumatic [13].

The piezoelectric surgical technique offers a great advantage compared to traditional osteotomy techniques and can be applied to a variety of cases in oral and maxillofacial surgery. The unique function of the piezoelectric saw through its piezoelectric ultrasonic vibrations, offers the ability to cease its action when it comes in contact with nonmineralized tissue [16]. Therefore, it reduces the risk of accidental injuries to special anatomical structures such as the inferior alveolar nerve or the sinus membrane [17]. Due to its precise and selective cut, it differs from drilling with conventional burs that do not distinguish hard from soft tissue. Safe and minimally invasive surgeries can be conducted thanks to the minimized bone loss and preservation of the cortical plates. In addition, these thin piezoelectric saws produce less intraoperative bleeding, because of the cavitation effect of the coolant being used. Therefore, better accessibility and visibility provide the operator with precision and ease [11, 13].

CONCLUSION

Two cases were reported in this study, in which the bone window technique was predictably used. Radiographic follow up evaluation at 10 and 36 months revealed a complete healing with an intact buccal bone and no buccal indentation present.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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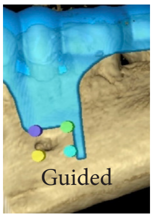

CASE REPORT/TECHNIQUE

Piezoelectric Endodontic Microsurgery with Modified Cortical Window Technique: A Case Report

Rafael Fernández-Grisales[a,*], Wilder J. Rojas[b], & Carolina Berruecos-Orozco[c]

ABSTRACT

Osteotomy in endodontic microsurgery for teeth with periapical lesions which have not perforated the cortical plate can be a complex procedure especially if anatomical structures such as the mental nerve are close to the area of surgical intervention. For such cases, the cortical bone window technique is an excellent option to access the operating field, preserving the cortical bone and avoiding the use of other bone regeneration materials. The present case documented the use of the cortical bone window technique with a modification, due to the proximity of the mental nerve to approach a persistent periapical lesion of a mandibular second premolar with previous endodontic treatment. Cone beam computed tomography (CBCT) and intraoral scanning were used for planning and elaboration of a navigation guide for surgical procedure. The clinical and radiographic 5-month follow-up with periapical radiography and CBCT revealed a favorable outcome, with an asymptomatic patient and an advanced healing process at the previous periapical lesion site.

KEY WORDS

Bone window; cone beam computed tomography; endodontic microsurgery; graft; osteotomy; piezoelectric surgery

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The word 'Guided' at the upper right icon means that article highlights the guided endodontic microsurgery.

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INTRODUCTION

Endodontic microsurgery (EM) is a treatment option for persistent apical periodontitis in endodontically treated teeth where non-surgical retreatment is not deemed not to be feasible [1, 2]. EM has high success rates; 96.8% and 91.5% at 1-year and 5–7 year follow-ups, respectively [3]. Previously, conventional endodontic surgery used periapical radiography for case planning and follow-up and high-speed handpieces for osteotomy and apical resection [4, 5]. Currently, EM is performed with the aid of operating microscopes (OMs), cone beam computed tomography (CBCT), ultrasonics and piezoelectric devices to manage the apical root canal anatomy and surrounding tissues and to improve treatment outcomes [6].

In the presence of bone fenestration, access to the root apex is easier to identify as it is already created by the periapical lesion (PL). However, when the lesion is confined within an intact, thick buccal cortical bone, it may be difficult to locate the root apex, resulting in potentially an extensive osteotomy. This is particularly true if it is performed freehand with a high-speed handpiece [7]. In such cases, piezoelectric-guided EM with the "cortical bone window" technique has been proposed as a more conservative and precise alternative to osteotomy and apicoectomy by use of a bur [8–10]. To carry out this procedure, three elements should be considered: DICOM (Digital Imaging and Communications in Medicine) files derived from CBCT, STL ('Standard Triangle Language' or 'stereolithography') files derived from intraoral scanning, and a software capable of integrating these files to obtain a digital surgical guide, which is later printed for intraoral use [10, 11]. Thus, the osteotomy is performed on the guide's demarcation with the saw-type inserts coupled to the piezoelectric device. Once the bone block is removed, the apicoectomy, retro-preparation, and retro-filling procedures follow. Finally, the bone block is placed in its original position, acting as an autograft with osteogenecity, osteoinductivity, and osteoconductivity features [11, 12].

In cases where the osteotomy/apicoectomy area is close to critical anatomical structures, such as the inferior alveolar and mental nerves the "cortical bone window" technique can be modified to avoid nerve damage [10, 13–15]. The present case report describes a piezoelectric-guided EM with the modified "cortical bone window" (MCBW) technique in a mandibular second premolar with persistent apical periodontitis, whose apex was in proximity to the mental nerve.

CASE REPORT

A 39-year-old woman with non-contributory medical history was referred by a prosthodontist for endodontic management of the left mandibular second premolar (tooth #35). The clinical examination revealed an all-ceramic crown with good marginal adaptation, ≤3 mm periodontal probing, grade I mobility, and pain on vertical percussion. Digital periapical radiography (DPR) (Gendex VISUALIX EHD, Hatfield, Pennsylvania, USA) (Fig 1) and CBCT (Planmeca ProMax 3D Classic, Planmeca®, Helsinki, Finland) operating at 90 kVp, 16 mA, field of view 50 × 40 mm, voxel size 75 µm, 16 bits, and 15 sec exposure (Fig 2A–E), revealed a single root canal with an intraradicular post, an endodontic filling of adequate density but short of the radiographic apex, and a visible root canal lumen in the apical third. In addition, a periapical radiolucent image was observed close to the mental foramen. Based on the above findings, the diagnosis was an endodontically treated tooth with symptomatic chronic apical periodontitis. The treatment plan included guided EM.

In order to plan the guide, DICOM and STL files were obtained from the CBCT and intraoral scan (3Shape Trios3, TR3, 3Shape A/S, Copenhagen, Denmark) respectively, and integrated into the Romexis software (version 3.8.2.R Planmeca, Helsinki, Finland) for the design and construction of a 3D printed (Eden260VS Dental Advantage, Stratasys Ltd.), resin-supported dento-osseous surgical guide (MED610 by Stratasys Ltd., Eden Prairie, MN, USA), which was utilized during the osteotomy ensuring mental nerve integrity (Fig 3A–B). An operating microscope (ZUMAX OMS 2350, Zumax Medical, Suzhou New District, China) and piezoelectric bone surgery system (Woodpecker Ultrasurgic Touch unit, Guilin Woodpecker Medical Instrument Co. LTD, Guilin, Guangxi, China) were also used during the surgical procedure.

Before the procedure, the patient was asked to rinse with 0,12% chlorhexidine (Clorhexol, Farpag, Bogotá, Colombia) for 2 minutes. 2% lidocaine with 1:80.000 epinephrine (New Stetic, Guarne, Colombia) local anesthesia was applied with 3 carpules to anesthetize inferior alveolar nerve and 1 carpule to

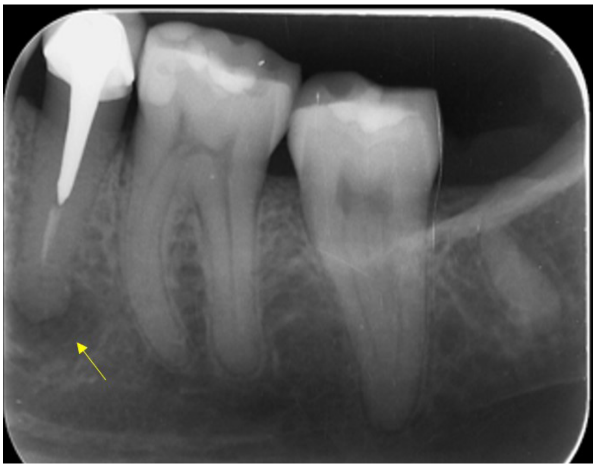

FIGURE 1. Digital periapical radiography of tooth #35. The *yellow arrow* shows the periapical lesion associated with short-length endodontic treatment.

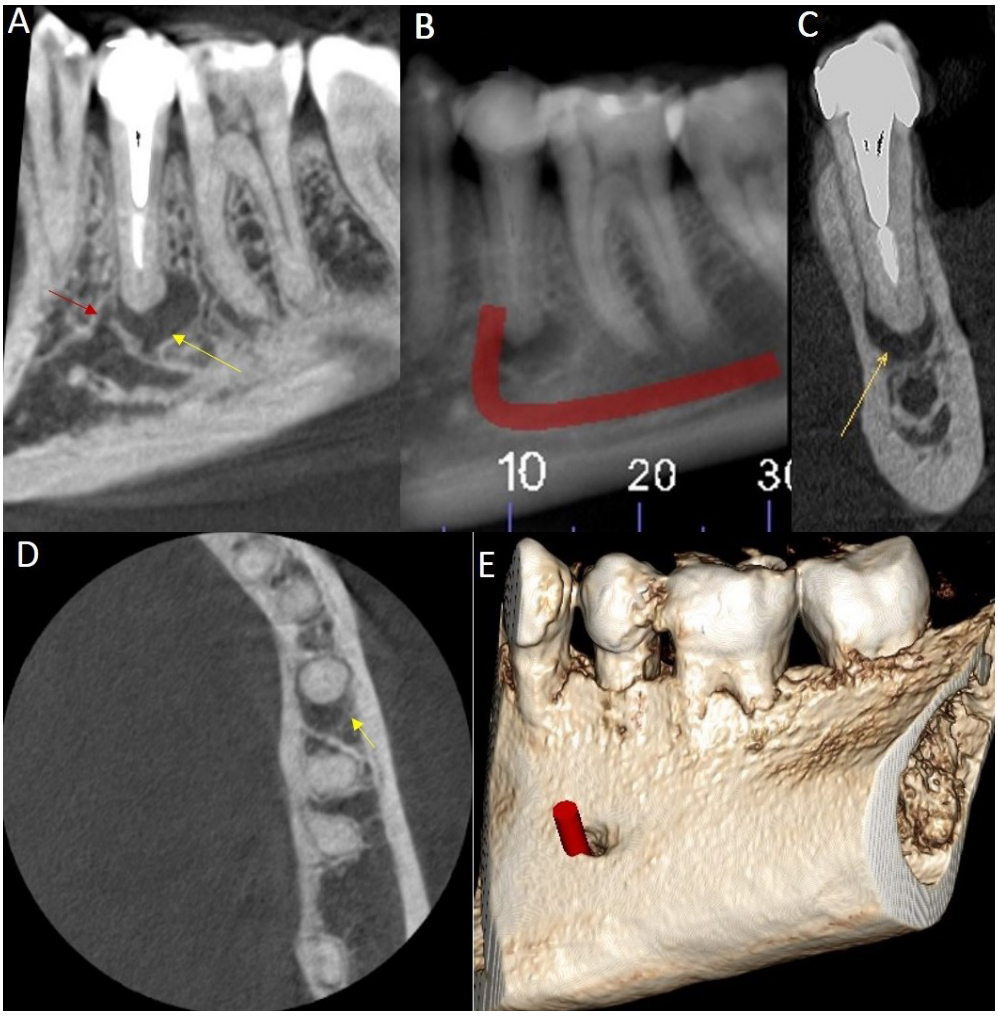

FIGURE 2. Cone beam computed tomography of tooth #35. (**A, B**) (sagittal plane), the *yellow arrow* shows the periapical lesion, and the *red arrow* shows the mental foramen. Also, the trajectory of the mental foramen is indicated by *red curve*. (**C, D**) (coronal and axial sections, respectively), the *yellow arrow* shows the periapical lesion between the buccal and lingual cortical bone. (**E**) volumetric reconstruction showing the mental foramen close to the apex of tooth #20.

anesthetize mental nerve. A full-thickness triangular flap with released on the distal aspect of tooth #33 and an intrasulcular incision extending to the distal aspect of tooth #36 was made. Once the bone surface was exposed, the surgical guide was positioned, and the cutting procedure of the MCBW technique was performed (Fig 3C–G) using the US1L, US1R, US1, and UC1 tip (Fig 4), coupled to the piezoelectric device (Ultrasurgic touch, Woodpecker Medical Instrument Co. LTD, Guilin, Guangxi, China), in bone mode, power level 4 and water level 5 on the screen, with short movements and sustained pressure on the bone surface. Subsequently, a triangular cortical window was dislodged using a mini Buser periosteal elevator (Salvin Inc, Charlotte, NC, USA). Then, the root surface was accessed (Fig 5A–B), and a 3 mm perpendicular cut apicoectomy was completed with the US3 tip, revealing the untreated apical portion of the root canal. This was confirmed with an operating microscope and the aid of methylene blue (Fig 5C–F). After curettage of the periapical inflammatory tissue, hemostasis was obtained with the use of an epinephrine pellet (Racellet™, Ultradent, South Jordan, UT, USA), followed by the retropeparation of the apical cavity apical with a KiS 4-D ultrasonic tip (Young Specialties, Algoquin, IL, USA) (Fig 5G–H). Irrigation of the apical cavity was done with 2% chlorhexidine (Consepsis™, Ultradent, South Jordan, UT, USA), followed by drying with a capillary tip (Ultradent, South Jordan, UT, USA) and apical retro filling with Bio-C© Repair (Angelus, Londrina, Brazil) bioceramic reparative material (Fig 5I). Next, the Racellet™ pellet was removed from the bone crypt, and a collagen dressing (Collatape, Zimplant, Bogotá, Colombia) was applied to help stabilize and hold the cortical window in position (Fig 5J). The flap was repositioned and secured with absorbable Vycril Plus 6-0 (Ethicon, J&J, Cincinnati, OH, USA). Finally, the patient was given post-surgical instructions of 0.12% chlorhexidine (Farpag SAS, Bogotá, Colombia) rinses and 875 mg amoxicillin BID for 7 days, and 7.5 mg meloxicam BID for 3 days. One week later, the sutures were removed, and a post-surgical DPR was taken, showing the cortical window and retro filling material in position. A 5-month follow-up with DPR and CBCT was also documented (Fig 6A–E).

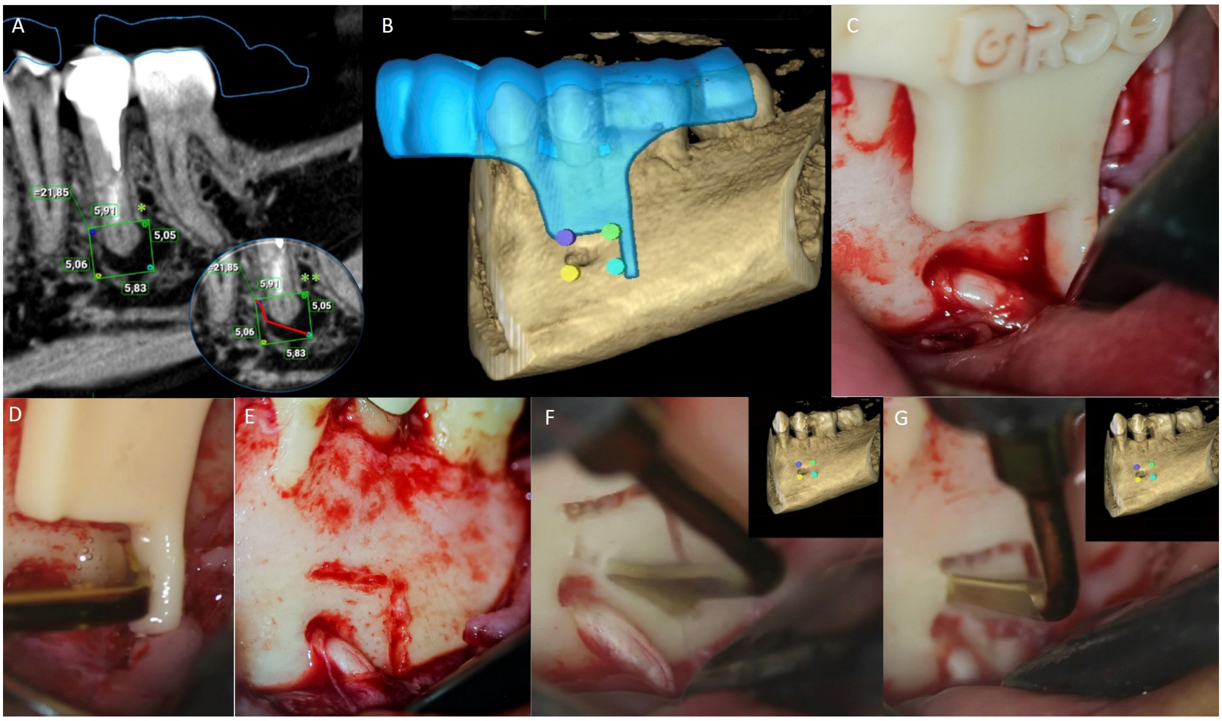

FIGURE 3. Tomographic and clinical sequence of the design and performance of the modified "cortical bone window" technique on tooth #35. (**A**) sagittal plane. *One superscript asterisk* (*) shows the typical rectangular design of the "cortical window" technique. *Two superscript asterisks* (**) show the design of the modified "cortical bone window" technique. (**B**) digital surgical guide design for the modified "cortical window" technique. (**C**) clinical positioning of the surgical guide. (**D**) US1L piezoelectric tip cutting with the surgical guide in position. (**E**) partial design of the modified "cortical bone window" technique. (**F, G**) US1 and UC1 piezoelectric tips, respectively, were used to complete the modified "cortical window" technique.

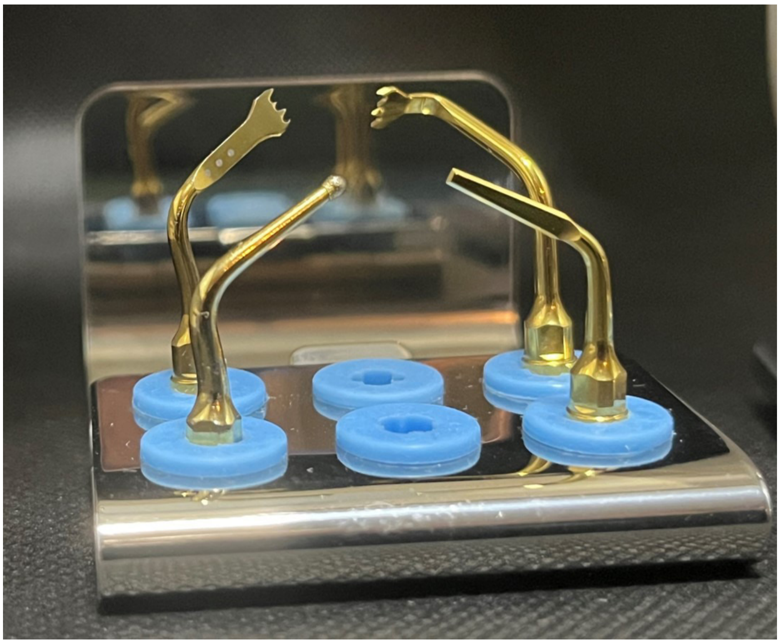

FIGURE 4. Piezoelectric tips kit for bone cutting (Woodpecker Medical Instrument Co. LTD, Guilin, Guangxi, China).

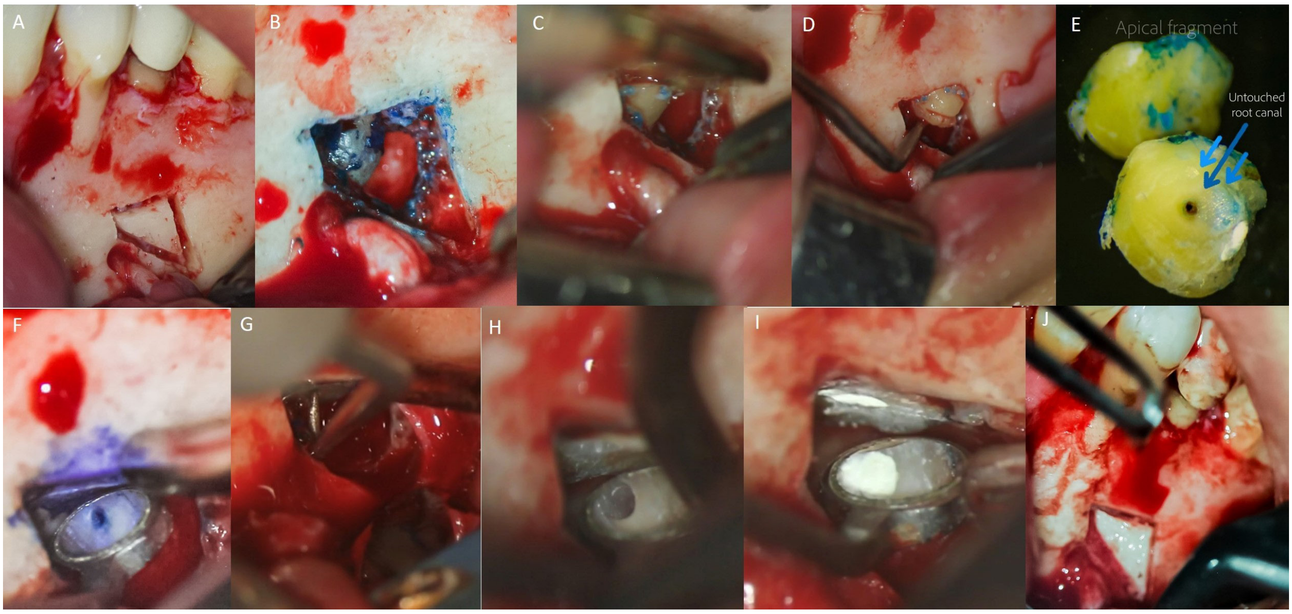

FIGURE 5. Clinical sequence of endodontic microsurgery on tooth #35 with the modified "cortical bone window" technique. (**A**) cortical window ready to be dislodged. (**B**) root surface to be resected, visualized with the operating microscope at 8× and the aid of methylene blue. (**C**) 3 mm per cut apical resection from the root apex, using the US3 piezoelectric tip. (**D**) and (**E**), removal and inspection of the apical portion. (**F**) inspection of the resected tooth surface. Methylene blue shows the untreated portion of the root canal at 12× magnification. (**G**) ultrasound preparation of the apical cavity. (**H**), apical cavity after ultrasonic preparation. (**I**) apical cavity retro-filled with Bio-C© Repair bioceramic reparative material. (**J**) cortical window repositioned and stabilized prior to suturing.

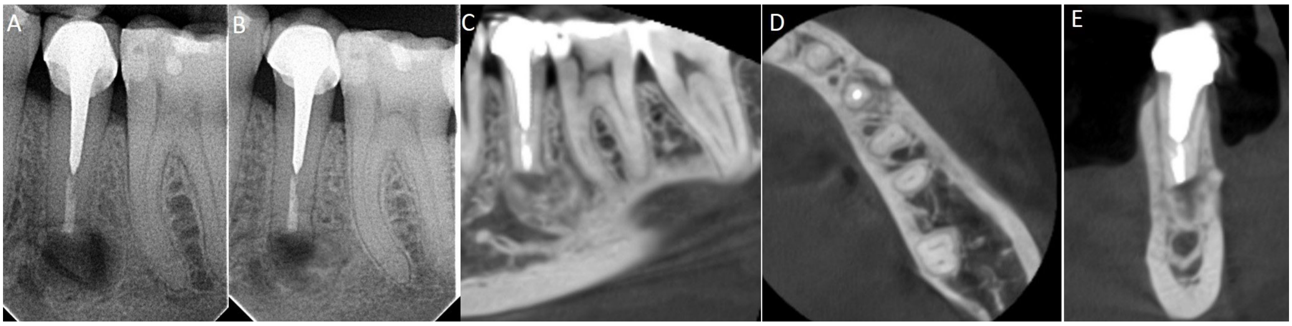

FIGURE 6. Periapical radiograph and CBCT follow-up of tooth #35. (**A**) post-surgical digital periapical radiograph showing apical filling material and cortical window in position. Five-moth follow-up by (**B**) periapical radiograph and CBCT: (**C**) sagittal, (**D**) axial, and (**E**) coronal planes showed healing in progress.

DISCUSSION

The size of the bone defect resulting from osteotomy during endodontic surgery is associated with increased postoperative pain and inflammation and delayed bone healing [10]. Thus, the "cortical bone window" technique is an excellent alternative to preserve the integrity of the buccal cortical plate [6, 7, 12]. In this technique, the cortical window constitutes an autologous bone barrier that has been shown to be better than allografts and xenografts in terms of speed and quality of bone regeneration due to its osteogenic, osteoinductive, and osteoconductive potential [10, 16, 17]. Additionally, this technique allows potentially faster and more accurate access to the root apex, facilitating visibility of the surgical area and higher control of periapical curettage, apicoectomy, retro-preparation, and retro-filling procedures. All these conditions can help complete the technical challenges of EM which in turn may improve the outcome of EM-subjected teeth [5, 7, 18].

According to literature, the "cortical window" technique is indicated for PLs within an intact buccal cortical plate of at least 1 mm thick [10]. In the case presented here, the PL was constrained by a 1.6 mm thick cortical bone based on the CBCT, which was an indication for "cortical bone window" technique in the guided EM. However, the proximity of the PL to the mental nerve required a modification of the technique to avoid its damage. The CBCT with high resolution and small field of view allowed planning the most appropriate shape for the cortical window, which was triangular and not square, rectangular, or trapezoidal, as it is frequently designed [15]. Then, the surgical guide facilitated a precise bone cut and osteotomy utilizing the piezoelectric device. Such a procedure is more challenging to perform when done freehand.

Once the small triangular bone block was removed, the surgical site was easily accessed, and the remaining EM procedures were performed through the cortical window. In this regard, large bone defects derived from osteotomy have been associated with longer healing processes than small bone defects [6, 11, 12]. It is also important to highlight that the piezoelectric device used in this case works with a frequency between 24 and 32 kHz and constant irrigation of 40 ml/min NaCl, which ensures a safe and precise bone cut. When the device power is set to medium, the inserts do not cut into soft tissue, thus protecting nearby nerves and large blood vessels. Moreover, it causes less bleeding and maintains a physiological temperature in the cutting area due to the air-water cavitation effect, resulting in greater surgical visibility, faster bone healing, and improved patient recovery [19, 20]. This correlates with the clinical and radiographic findings of the present case, where the patient only reported a slight inflammation in the surgical area and no use of analgesics after the third postoperative day. No mental nerve paresthesia or dysesthesia were reported by the patient. The digital periapical radiograph and CBCT 5-month follow-up showed satisfactory periapical bone healing, considering the short-term follow-up available.

CONCLUSION

Incorporating CBCT, intraoral scanner, and piezoelectric device into the EM allows the planning and execution of highly complex cases and leads to successful and predictable results. The MCBW technique is an excellent alternative that provides safer and more conservative osteotomy/apicoectomy in EM cases of PLs without bone fenestration located close to critical anatomical structures such as the mental nerve.

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ARTICLE REVIEW

Review of “Outcome of Endodontic Surgery: A Meta-Analysis of the Literature—Part 1: Comparison of Traditional Root-End Surgery and Endodontic Microsurgery” by Setzer and Colleagues in *J Endod* 36(11):1757-1765, 2010

Traditional root-end surgery (TRES) has played an important role in the management of odontogenic periapical pathology in the practice of oral surgeons already from 1871 [1, 2]. Whereas in conditions of growing application of operating microscope in the life of dentists, the importance of carrying out root canals treatment and surgical management of periapical pathology with the use of a microscope (i.e., endodontic microsurgery [EM]) began to grow in parallel from late 1970s [3, 4]. The growing role of EM created not only the conditions for the publication of EM-oriented articles [5-7], for the development of a narrow-profile peer-review publication—the *Journal of Endodontic Microsurgery* [8, 9]—but also for the rethinking of classic surgical techniques, namely a resection of the root-end. Nevertheless, TRES is still applied in numerous oral and maxillofacial surgery departments around the world – without the use of a microscope, appropriate microsurgical tools, and materials. That is why we believe that the meta-analysis by Setzer and colleagues (2010) [10] is such that it has not lost its relevance over the past 13 years. It’s highly important due the fact of unique comparison data of positive outcome for TRES versus EM (Table 1). Their research methods included a 43-year literature review, three electronic databases (Medline, Embase, and PubMed) search, and analysis of human studies in five different languages (English, French, German, Italian, and Spanish) [10]. A minimum follow-up period of 6 months for TRES and EM was analyzed [10].

TABLE 1. Comparison of Positive Outcome for Traditional Root-End Surgery versus Endodontic Microsurgery [10].

Traditional Root-End Surgery, %	Endodontic Microsurgery, %
59	94

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Summarizing the research, it is possible to note that EM is 35% more successful procedure comparing to TRES [10].

Looking at these numbers, all conclusions are obvious. The future lies in the shift of many specialists involved in traditional root-end surgery to self-perform EM or referral to colleagues specializing in this microsurgical direction of dentistry. Having 9 years of experience in dentistry plus 19 years in oral and maxillofacial surgery, I finally want to say to my colleagues that no matter how many years we perform traditional surgical techniques like TRES, we always must rethink what is best for the patient. In sum, it is a pleasure to see how periapical surgery is evolving right in front of our eyes.

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