CASE REPORT

Received / Geliş Tarihi: 06.02.2026
Accepted / Kabul Tarihi: 20.05.2026
Published / Yayın Tarihi: 31.08.2026

Aydın Dental Journal - Volume **12** Issue **2** - August **2026** (173-186)

Aydın Dental Journal

Journal homepage: http://dergipark.ulakbim.gov.tr/adj

DOI: 10.17932/IAU.DENTAL.2015.009/dental_v012i2008

Current Surgical Management of Anterior Periapical Lesions: Case Series

Anterior Periapikal Lezyonların Güncel Cerrahi Yönetimi: Vaka Serisi

Şükran Acıpınar[1]*, Taha Yasin Erdoğan[2]

ABSTRACT

Introduction: Root canal treatment is widely regarded as the primary therapeutic approach for the management of periapical diseases. Nevertheless, owing to the intricate anatomy of the root canal system, as well as the possible development of extraradicular bacterial biofilms and true cystic lesions, nonsurgical treatment may not always result in complete healing. Surgical intervention may be required to achieve effective infection control. Available surgical modalities include apical root resection, retrograde root-end filling, and open flap debridement. These procedures may be further enhanced by the adjunctive use of bone graft materials and platelet-rich fibrin (PRF) to promote bone regeneration in the apical region.

Case reports: Five cases of single-rooted periapical lesions in the maxillary anterior region which showed no radiographic signs of healing following endodontic treatment were treated with open flap debridement under local anesthesia (LA). Three of these cases underwent apical resection. In two cases, open flap debridement of the affected area was performed without apical resection. All bone defects were treated with allograft material and PRF application. The six-month radiographic follow-up of the patients is presented.

Conclusion: Endodontic treatment is generally highly effective in treating apical lesions. However, periapical lesions that do not heal despite treatment are challenging for clinicians to manage, requiring detailed diagnosis and planning. In such cases, a multidisciplinary approach is necessary, and open flap debridement can increase the likelihood of success and bone fill. Performing periapical surgery with an allograft and PRF can successfully treat the lesion while preserving the natural tooth structure.

Keywords: *Allografts, Debridement, Periapical diseases, Platelet-rich fibrin.*

ÖZET

Giriş: Kök kanal tedavisi şu anda periapikal hastalıkları tedavi etmek için en yaygın ve etkili yöntemdir ve %80'den fazla bir başarı oranına sahiptir. Ancak kök kanal sisteminin karmaşıklığı, ekstraradiküler bakteriyel biyofilmlerin oluşumu ve gerçek kistlerin oluşumu nedeniyle bazı periapikal hastalıklar cerrahi tedavi gerektirir. Endodontik tedavinin ardından iyileşme gözlenmeyen periapikal lezyonların tedavisi enfeksiyonun mümkün olan en iyi şekilde ortadan kaldırılmasına yol açacak apikal rezeksiyon, retrograt dolgu ve açık flep debridmanı gibi çeşitli cerrahi tedavi seçeneklerini içerir. Bu cerrahi tedaviler apikal bölgedeki kemik dolumu için greft materyalleri, trombositten zengin fibrin (TZF) gibi materyallerle desteklenebilmektedir.

Olgu Sunumları: Çalışmamızda tüm vakalarda öncelikle endodontik tedavi uygulanmıştır. Endodontik tedaviyi takiben radyografik iyileşme gözlenmeyen maksiller anterior bölgede tek köklü apikal lezyona sahip 5 vaka lokal anestezi altında güncel yaklaşım olan submarjinal insizyon ile açık flep debridmanı ile tedavi edilmiştir. Bunlardan üçüne apikal rezeksiyon uygulanmış, kök ucu retrograt doldurulmuştur. İki vakada ise apikal rezeksiyonsuz ilgili bölge açık flep debridmanı uygulamıştır. Tüm kemik defektleri allogreft materyali ve PRF uygulaması ile tedavi edilmiştir. Hastaların 6 aylık radyografik takibi sunulmaktadır.

Sonuç: Endodontik tedavi, apikal lezyonların tedavisinde önemli ölçüde iyi performans gösterir; ancak endodontik tedaviye rağmen iyileşme gözlenmeyen apikal lezyon durumları detaylı tanı ve planlama gerektiren, klinisyenin üstesinden gelmesi zor olan durumlardır. Multidisipliner tedavi yaklaşımı gerektiren bu durumlarda açık flep debridmanı ile tedavi başarıyı ve radyografik kemik dolumunu artırmaktadır. Greftleme prosedürü, ilgili iyileşmeyi desteklemek ve prognozu iyileştirmek için ek fayda sağlar. Allogreft ve TZF ile uygulanan periapikal cerrahi, doğal diş yapısını koruyarak lezyonun başarılı bir şekilde tedavi edilmesini sağlar.

Anahtar Kelimeler: *Allogreft, Debridman, Periapikal hastalıklar, Trombositten zengin fibrin.*

[1]Assistant Professor, Department of Periodontology, Faculty of Dentistry, Sivas Cumhuriyet University, Sivas, Türkiye
[2] Periodontologist, Şanlıurfa Oral and Dental Health Hospital, Şanlıurfa, Türkiye
***Corresponding Author:** Şükran Acıpınar, **e-mail:** sukranacipinar@cumhuriyet.edu.tr, **ORCID:** 0000-0003-1711-2183, Department of Periodontology, Faculty of Dentistry, Sivas Cumhuriyet University, Sivas, Türkiye

Introduction

The periodontal tissues and pulp are related at embryonic, anatomical and functional levels. Cross-infection can develop horizontally and/or vertically between the root canal and periodontium via various contact routes, including the apical foramen, lateral and accessory canal systems, dentinal tubules, development grooves, treatment-related perforation and radicular fracture.[1] If the pulp tissue becomes affected by factors such as trauma, caries, inflammation can develop in the periodontium via these aforementioned pathways. Infections caused by pulpal-derived bacteria at the root apex are known as periapical diseases (PAD).

Root canal treatment (RCT) is widely accepted as the primary therapeutic approach for the management of PAD. A success rate in excess of 80% has been demonstrated for the treatment of apical lesions.[2] Notwithstanding the advancement of technology and equipment related to RCT, there may be instances of periapical lesions that do not heal. Given the intricacies inherent to the root canal system, the establishment of extraradicular bacterial biofilms, and the genesis of true cysts, certain periapical diseases may necessitate apical surgical intervention. This intervention can employs a combination of resective and regenerative methodologies to ensure the most efficacious eradication of the infection.[3] Apical surgery is indicated for teeth that demonstrate symptoms and/or positive signs following RCT and retreatment, or for teeth exhibiting symptoms and/or positive signs that cannot be accessed coronally for endodontic treatment.[4] A detailed and accurate diagnosis is imperative, as is careful planning, due to the challenges associated with management and the questionable prognoses of these lesions. Consequently, periapical surgery is a promising alternative treatment method that has the potential to preserve natural teeth.

In contemporary practice, apical surgery, periradicular surgery, and intentional replantation are employed in the management of periapical lesions. Apical surgery is a surgical procedure that involves the following: osteotomy, root tip resection, root tip preparation, retrograde obturation, and debridement of the surrounding defect. Despite the technical precision required for this procedure, its complications are minimal and its success rate is high.[5] It is imperative to consider the feasibility of apical surgery in cases where inadequate periodontal support is present, or where the coronal-to-radicular proportion exceeds 1:1 following apical root resection.[4] Periradicular surgery, which includes root resection and hemi-section, is a surgical approach that is performed to remove the root or rootlets of a tooth. In cases where apical surgery is not a viable option, intentional replantation can be performed. This procedure involves extracting the tooth, followed by the implementation of a root-end filling or perforation repair, and subsequent reinsertion into the dental alveolus. According to the protocol recommended by the European Endodontic Society, periapical surgery is indicated in cases of painful and inflammatory PAD affecting a mature tooth undergoing good-quality RCT, periapical pathology with difficult-to-remove prosthetic or conservative restorations, radiotransparent lesions larger than 8–10 mm in diameter, symptomatic gutta-percha extrusion, the presence of a foreign body that cannot be removed orthogradely, perforation of the pulp chamber floor, and other indications such as patients requiring a single-visit endodontic treatment and periapical surgery or fracture of the apical third of teeth.[6]

Von Arx and Cochran[7] proposed a classification system based on the morphology of defects, distinguishing between location, extent, and route of infection. This classification was based on the preservation of the bone crypt walls. Within this framework, class I defects are confined to the apical region and are subdivided into class Ia lesions, characterized by four intact bony walls, and class Ib lesions, defined as through-and-through defects involving loss of the buccal and/or palatal or lingual cortical plate. In addition, apicomarginal, or endoperiodontal, lesions are described as defects in which periapical pathology communicates with a concomitant marginal periodontal lesion.

Apical surgical methods involve the utilization of numerous techniques and materials, which are selected based on the morphology of the defect and the condition of the tooth. These treatments

can be supplemented with materials such as graft materials, membranes, and platelet-rich fibrin (PRF) for bone filling in the apical region to preserve the natural tooth structure. The present study presents the healing processes observed at the 6-month follow-up following periapical surgery with periodontal flaps and apical curettage in five cases of maxillary anterior single-rooted teeth with four-walled periapical lesions.

Case Reports

Informed consent was obtained from all participants included in this study. It is imperative to employ an interdisciplinary approach during treatment planning for cases with periapical lesions to ensure the efficacy and favorable outcomes of treatment. As endodontic infection has been demonstrated to have a detrimental effect on periodontal healing, all cases were initially treated with gutta percha, a primary endodontic material, along with root canal sealer. This case series includes a total of five systemically healthy, non-smoking patients aged 20 to 55 years diagnosed with a single-rooted maxillary anterior tooth exhibiting a four-walled periapical lesion with a greatest diameter ≤10 mm and Periapical Index (PAI) score ≥3. Complete radiographic healing was not observed in these lesions during the 6-month follow-up period after endodontic treatment. Patients with probing pocket depth >5 mm, vertical root fracture, previous periapical surgery, uncontrolled systemic diseases, pregnancy, breastfeeding, and anticoagulant use were excluded from the study. The treatment of these patients involved open flap debridement, performed under LA. The location of the root apex was determined on the basis of preoperative cone-beam computed tomography (CBCT) images, the working length of the RCT, the position of the sinus tract, and the height of the alveolar bone at the root. In all cases, a submarginal incision was preferred to avoid causing gingival recession in the aesthetic zone and osteotomies were performed in the apical region of the involved teeth because the cortical bone in this region was found to be intact. Following submarginal incision and full-thickness flap elevation, an osteotomy was performed using a round steel bur (size 4, diameter 2.1 mm) attached to a high-speed handpiece under copious sterile saline irrigation to prevent thermal bone injury. The osteotomy diameter was approximately 3-4 mm, extending 2-3 mm beyond the root apex to ensure complete exposure of the periapical lesion. Periapical curettage was performed using Gracey curettes (Nos. 5/6, 7/8, 11/12) and Prichard curretes (Nos.1/2 and 3/4) to remove all granulation tissue. In the three cases requiring apical resection, the root apex was resected 3 mm perpendicular to the long axis of the root using a fissure bur. Retrograde cavity preparation was performed to a depth of 3 mm using a fissure bur with continuous water irrigation. The cavity was dried with sterile paper points, and MTA (ProRoot MTA, Dentsply, USA) was mixed according to the manufacturer's instructions (powder-to-liquid ratio of 3:1) and condensed into the retrograde cavity using MTA carrier and pluggers. The MTA was allowed to set for 10 minutes before soft tissue closure. In two cases, open flap debridement was applied to the affected area without apical resection. The treatment of all bone defects was accomplished through the utilization of demineralized freeze-dried bone allograft (DFDBA) material and PRF, which was obtained by centrifuging 10 mL of venous blood at 2700 rpm for a duration of 12 minutes at room temperature in plain glass tubes without anticoagulant.

After centrifugation, the resulting fibrin clot was carefully removed from the tube using sterile tweezers and scissors, and the red blood cell layer was separated from the fibrin clot. The PRF clot was then compressed between two moist sterile gauze pads to obtain a membrane form. The DFDBA allograft used in this study is a demineralized freeze-dried bone allograft with particle sizes ranging from 500 to 1000 µm (Maxxeus, USA). Following periapical curettage, the granulation-like tissue was dispatched to the pathology laboratory for pathological examination. Histopathological examination revealed (periapical granuloma in 3 cases, periradicular cyst in 1 case and dentigerous cyst in 1 case) with no evidence of dysplasia or malignancy. All patients were advised to use chlorhexidine mouthwash to maintain

oral hygiene after surgery, and antibiotics and analgesics were prescribed for 5-7 days to prevent infection. It was recommended that intermittent application of cold compresses to the surgical site should be continued for a period of 24 hours. Postoperatively, mild pain and mild swelling occurred in all cases. Regular clinical and radiographic checks were performed 3 and 6 months after surgery, revealing radiographic bone filling in all periapical lesions. Postoperative radiographic evaluation was performed using periapical radiographs at 6 months postoperatively. All radiographic images were anonymized and evaluated independently by two periodontologist (Ş.A.,T.Y.E.) who were blinded to the clinical data. Periapical bone healing was assessed based on bone filling of the periapical defect and restoration of the lamina dura.[2] Periapical bone healing was assessed as (1) complete healing (complete bone filling with lamina dura restoration), (2) partial healing (>50% reduction in lesion size), (3) indeterminate healing (50% or less reduction or no change), and (4) failure (increase in lesion size or persistence of symptoms). Each examiner independently assigned one of these four categories to each of the 5 cases. Inter-observer agreement was calculated based on these categorical assessments. Two examiners agreed in 4 out of 5 cases (80%). In cases of disagreement, a consensus was reached through discussion. Lesion size at baseline and follow-up was measured in millimeters using digital calipers integrated into the imaging software (Planmeca Romexis).

Table 1. Clinical characteristics, diagnoses, surgical treatments, and 6-month postoperative outcomes of the five cases.

Case	Patient	Tooth	Diagnosis	Surgical Treatment	Outcome
Case 1	23, Female	#11	Periapical granuloma	Debridement + Allograft + PRF (no apical resection)	Complete healing
Case 2	31, Female	#11	Periapical granuloma	Apical resection + Retrograde MTA + Allograft + PRF	Complete healing
Case 3	35, Male	#22	Periradicular cyst	Apical resection + Retrograde MTA + Allograft + PRF	Complete healing
Case 4	55, Male	#12	Periapical granuloma	Debridement + Allograft + PRF (no apical resection)	Complete healing
Case 5	21, Female	#12	Dentigerous cyst	Apical resection + Retrograde MTA + Allograft + PRF	Complete healing

Case 1: A 23-year-old female patient was referred to the periodontology clinic because of a periapical lesion on tooth #11 that failed to heal throughout the course of endodontic follow-up. Subsequent clinical and radiographic examinations following Phase 1 periodontal treatment revealed that the periodontal parameters of the involved tooth were consistent with normal health, and apical surgery was planned. Following the administration of LA, a full-thickness (FT) flap was raised through a submarginal and two vertical incisions, encompassing both adjacent teeth. The defect was meticulously cleared of granulation tissue and thoroughly irrigated with a sterile saline solution. Following a comprehensive evaluation of the crown-to-root ratio, the defect was augmented with an allograft, with no apical resection, and subsequently covered with a PRF membrane. The flap was then repositioned without tension. The pathological result of the lesion revealed a periapical granuloma. Histopathological examination revealed a periapical granuloma characterized by a solid proliferation of inflamed granulation tissue and scattered cholesterol clefts. Consistent with its non-cystic nature, the epithelial lining or lumen formation is completely absent. Periapical radiographs from the patient's 6-month follow-up are presented in Figure 1.

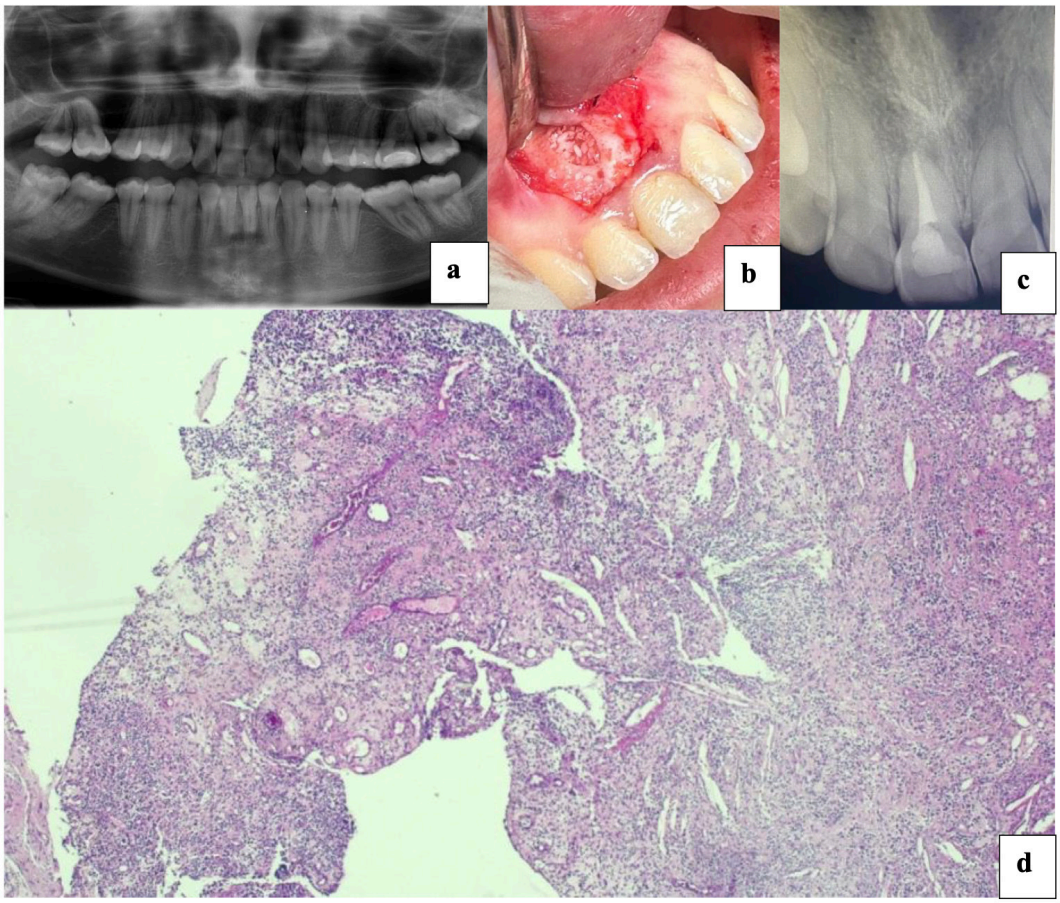

Figure 1. Preoperative panoramic radiograph (a) shows the periapical lesion associated with tooth #11, intraoperative view during apical surgery (b) demonstrates the exposed root apex and the allograft material in the surgical field, postoperative periapical radiograph (c) was taken at the 6-month follow-up, and histopathological hematoxylin-eosin staining image (d) shows the lesion diagnosed as periapical granuloma in Case 1.

Case 2: A 31-year-old female patient was referred to the periodontology clinic due to a periapical lesion in tooth number 11 that did not show improvement during the endodontic follow-up period after re-treatment. Following phase 1 periodontal treatment, the tooth was determined to be periodontally healthy and was scheduled for apical surgery. Following the administration of LA, a FT flap was raised through a submarginal incision and two vertical incisions. The defect was then meticulously cleansed of granulation tissue using periodontal curettes, followed by irrigation with a sterile saline solution. Following a comprehensive evaluation of the crown-to-root ratio, a meticulous apical resection procedure was undertaken. The root surface was resected at a distance of approximately 3 mm perpendicular to the long axis of the tooth, with the use of piezosurgical tips. The resected root surface was flattened, and hemostasis was achieved through mechanical compression. The resected surface was then rinsed with a saline solution, dried, and examined for vertical root fractures, perforations, and other abnormalities. A Class I cavity was prepared on the resected root surface using piezosurgical tips of appropriate diameter and bending direction, reaching a depth of 3 mm. The root canal was then meticulously cleaned and dried. Following this, the cavity was filled with MTA retrograde plug using hand instruments. The excess material located outside the root canal was then removed. The defect was then augmented with an allograft and covered with a PRF membrane. The flap was then replanted, this time without tension. The pathology of the lesion revealed a periapical granuloma. Radiographic images from the patient's 6-month follow-up are presented in Figure 2.

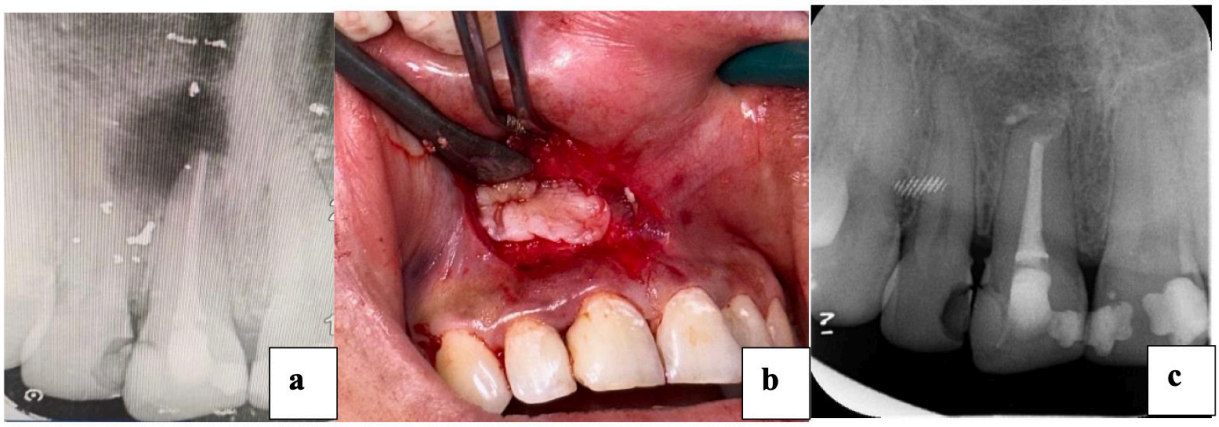

Figure 2. Preoperative periapical radiograph (a) shows the periapical lesion associated with tooth #11, intraoperative view during apical surgery (b) demonstrates the exposed root apex and the PRF membrane in the surgical field, and postoperative periapical radiograph (c) is the 6-month periapical radiograph in Case 2.

Case 3: A 35-year-old male patient presented with a non-healing periapical lesion on tooth 22. He was referred to the periodontology clinic for further evaluation. Subsequent clinical and radiographic examinations following Phase 1 periodontal treatment revealed that the clinical periodontal parameters of the involved tooth were consistent with clinical health and that no pathological conditions were present. Apical surgery was planned. Following the administration of LA, a FT flap was elevated using a submarginal incision and two vertical incisions extending to cover the involved tooth and two adjacent teeth. A minimal osteotomy was performed, with the preservation of adjacent tooth structures being crucial to facilitate access to the defect and improve visualization. The defect was then cleared of granulation tissue using periodontal curettes, after which it was irrigated with a solution of sterile saline. Following a comprehensive evaluation of the crown-to-root ratio, the decision was made to proceed with an apical resection. Under conditions of sterile water cooling, approximately 3 mm of the root apex was resected, with meticulous attention paid to the positioning of the root cross-section to ensure its perpendicularity to the long axis of the root or its inclination at an angle of $\leq 10°$ in the buccal direction. A retrograde Class 1 cavity was created using piezosurgical tips, and a retrograde filling was applied with MTA. The defect was then augmented with an allograft and covered with a PRF membrane. The flap was then repositioned without tension. The pathology result of the lesion revealed a periradicular cyst. Histopathological examination reveals a radicular cyst lined with non-keratinized stratified squamous epithelium exhibiting a characteristic arcading pattern. The underlying fibrous wall exhibits a prominent inflammatory infiltration consistent with its odontogenic origin. Periapical radiographs from the patient's 6-month follow-ups are presented in Figure 3.

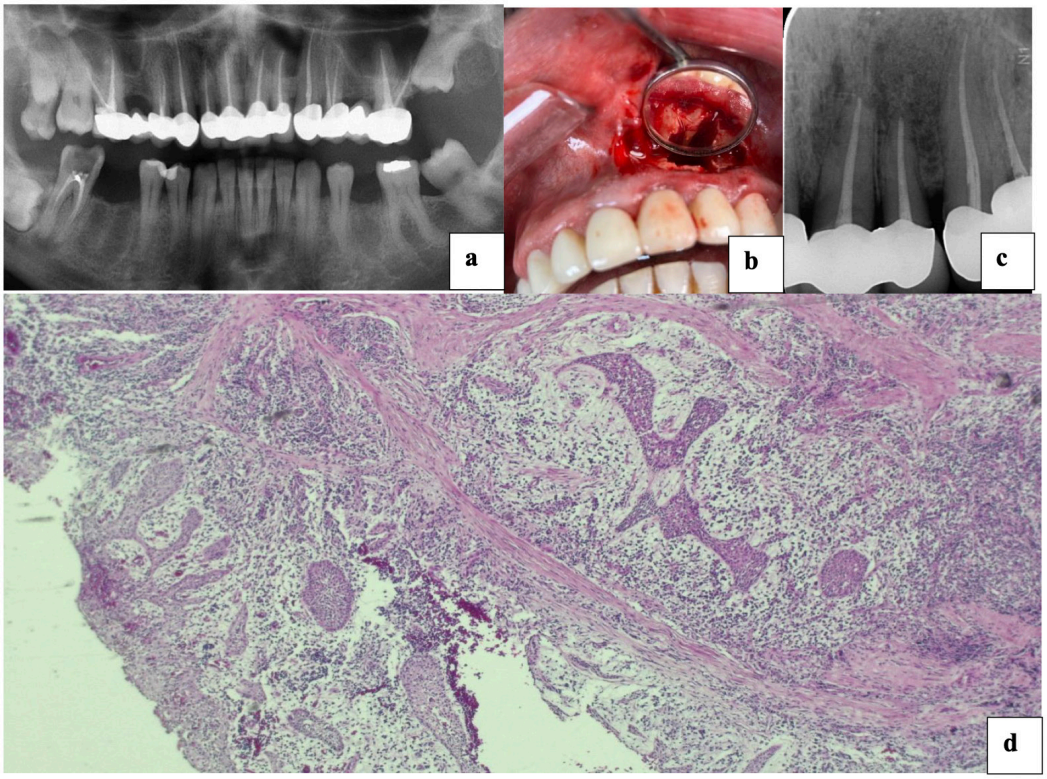

Figure 3. Preoperative panoramic radiograph (a) shows the periapical lesion associated with tooth #22, intraoperative view during apical surgery (b) demonstrates the surgical osteotomy, postoperative periapical radiograph (c) is the 6-month periapical radiograph, and histopathological hematoxylin-eosin staining image (d) shows the lesion diagnosed as periapical cyst in Case 3.

Case 4: A 55-year-old male patient with a non-healing periapical lesion on tooth number 12 was referred to the periodontology clinic for pathological migration in the involved tooth and for evaluation for periapical surgery. Following Phase 1 periodontal treatment, it was noted that the clinical periodontal parameters of the affected tooth corresponded to the clinical health of the diminished periodontium, and apical surgery was planned. Following the administration of LA, a FT flap was raised through a submarginal incision and two vertical incisions. The defect was meticulously cleansed of granulation tissue and foreign material using periodontal curettes, followed by irrigation with a sterile saline solution. In the case of the tooth with diminished periodontium, it was decided to perform apical surgery without apical resection. The defect was augmented with an allograft and covered with a PRF membrane. The flap was then repositioned without tension. The pathological findings for the affected lesion revealed a periapical granuloma. Periapical radiographs from the patient's 6-month follow-up are presented in Figure 4.

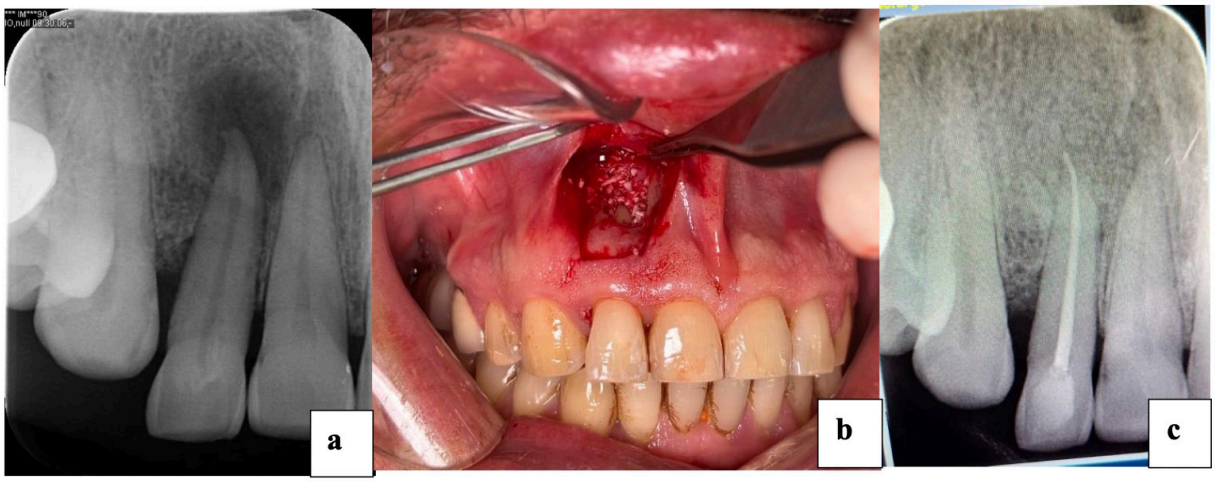

Figure 4. Preoperative panoramic radiograph (a) shows the periapical lesion associated with tooth #12, intraoperative view during apical surgery (b) demonstrates the allograft material in the surgical field, and postoperative periapical radiograph (c) is the 6-month periapical radiograph in Case 4.

Case 5: A 21-year-old female patient was referred to the periodontology clinic following the development of a non-healing periapical lesion on tooth number 12. Phase 1 periodontal treatment was performed after reviewing CBCT images obtained in the endodontic clinic to determine the extent of the lesion and examine its anatomical relationship with the diseased tooth and surrounding tissues. At the subsequent follow-up visit, it was observed that the clinical periodontal parameters of the involved tooth corresponded to the clinical health, and apical surgery was scheduled. Following the administration of LA, a FT flap was elevated using a periosteal elevator through a submarginal incision and two vertical incisions. The defect was meticulously cleared of granulation tissue and thoroughly irrigated with sterile saline. Following a comprehensive evaluation of the crown-to-root ratio, a decision was made to proceed with an apical resection. The root surface was resected at a distance of approximately 3 mm perpendicular to the long axis of the tooth. This was achieved using piezosurgical instruments to expose the root apex. A retrograde Class 1 cavity was created, and a retrograde filling was applied with MTA. The defect was then augmented with an all-graft and closed with a PRF membrane. The flap was then reattached using 4.0 non-absorbable polypropylene sutures, with the application of minimal tension. The pathology result for the lesion revealed a dentigerous cyst. Histopathological examination reveals an inflamed, non-keratinized squamous epithelial lining taken from the fragmented cyst wall. The panoramic and periapical radiographs from the patient's 6-month follow-up are presented in Figure 5.

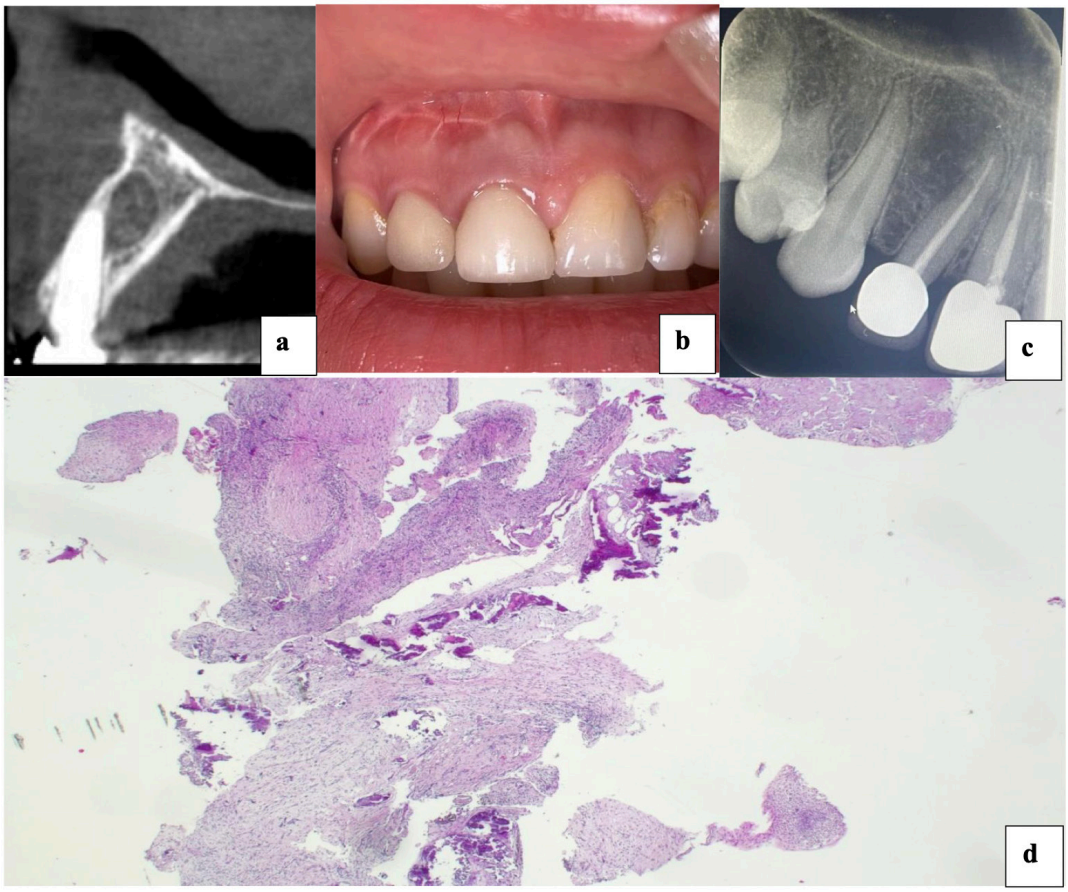

Figure 5. Preoperative CBCT image (a) shows the height and width of the lesion, postoperative clinical image (b) shows no gingival recession, postoperative periapical radiograph (c) is the 6-month periapical radiograph, and histopathological hematoxylin-eosin staining image (d) shows the lesion diagnosed as dentigerous cyst in Case 5.

Discussion

The overall performance of conventional endodontic treatment for periapical lesions is significantly higher; however, in persistent and complex cases or cyst formation, surgical treatment and regeneration are required as the last treatment option before tooth extraction.[6]

The diagnosis, treatment and post-treatment process of periapical lesions present a considerable challenge for the clinician, requiring detailed diagnosis and planning from both endodontic and periodontological perspectives. Despite their relative rarity in clinical practice, they have the capacity to compromise dental prognosis to a significant degree.[8] The prognosis is contingent upon the efficacy of periodontal repair/regeneration initiated by the treatment procedures, and the patient's response to treatment, which can vary from patient to patient.[9] An accurate diagnosis, a well-planned treatment plan incorporating a multidisciplinary approach, and the subsequent implementation of the treatment plan with the selection of appropriate techniques and materials are crucial for successful treatment.

The healing process following periapical surgical treatment is characterized by the local bone repair. This process is defined as wound healing, which involves the formation of new tissue that does not fully restore the architecture or function of the existing bone.[10] The process of complete periapical healing is characterized by the regeneration of periodontium.[6] Regenerative techniques are increasingly incorporated into periapical surgical procedures to enhance healing quality by restoring lost or damaged tissues with biologically compatible cells and to support repair in clinically challenging

situations.[6,10] Although the indication for grafting periapical defects remains controversial, existing evidence suggests that bone grafting may contribute positively to periodontal healing around the affected tooth and improve overall prognosis.[11,12] Within the framework of guided tissue regeneration (GTR), various adjunctive materials—including graft substitutes, barrier membranes, and platelet-derived concentrates—are utilized to promote regenerative outcomes, all of which fall under the principles of tissue engineering.[6,10] GTR has also been advocated in endodontic surgical applications and has demonstrated favorable results in the healing of periapical lesions.[6,7,13] Long-term follow-up data have shown successful regeneration in a high proportion of teeth with advanced apical attachment loss following periodontal regenerative therapy.[14] Conversely, other investigations have reported satisfactory long-term outcomes in four-walled defects treated surgically without the use of membranes, noting that membrane application may increase treatment costs, add technical complexity, and potentially introduce postoperative complications.[7] In the present study, demineralized freeze-dried bone allografts—known to exhibit osteoinductive and osteoconductive characteristics depending on their composition and processing—were selected as grafting materials. Additionally, PRF membranes were employed to assess both clinical effectiveness and cost-efficiency.

Autologous platelet concentrates have been widely recognized as biologically active materials that support healing in intrabony defects. PRF, in particular, functions as a bioactive scaffold that facilitates periodontal regeneration. It remains within the surgical site for a limited duration, during which it promotes tissue repair and regeneration through the sustained release of platelets and a variety of growth factors.[15] The fibrin matrix, owing to its adhesive and mechanical properties, aids in flap stabilization and serves as a reservoir for growth factor release. These bioactive molecules stimulate the migration and proliferation of key regenerative cells—including osteoblasts, fibroblasts, and endothelial cells—thereby supporting angiogenesis, cellular differentiation, wound healing, and periodontal regeneration.[16] Current evidence remains inconclusive as to whether platelet concentrates are more beneficial when applied alone or in conjunction with bone substitute grafts in intrabony defects. Researchers have concluded that the combined use offers superior clinical efficacy,[17] while others have demonstrated no additional benefit.[18] Numerous studies have demonstrated that platelet concentrates combined with bone grafts offer a high success rate, support effective radiographic and clinical bone repair, accelerate lesion healing, and increase the predictability of the regenerative process.[17,19,20] Consistent with our study, a recent research also highlighted that periapical lesions treated with L-PRF showed a higher healing success rate. Additionally, it was concluded that the combination of periapical curettage and L-PRF offers a less invasive alternative, particularly in cases where the crown-root ratio is a concern.[21] Furthermore, due to the poor prognosis in lesions >5 mm, the use of regeneration materials appears necessary.[22] It is well established that regenerative outcomes positively correlate with the number of remaining bone walls, with four-walled defects demonstrating more predictable healing.[23] In our cases, all defects were >5 mm and had a four-walled morphology. For these reasons, allografts were supported with PRF as the regenerative material in the cases in this study. A clinical study compared the effectiveness of PRF and freeze-dried bone allograft in the surgical treatment of periapical lesions. PRF was found to be more effective in healing within the first 6 months, while complete healing was observed in both groups of cases by the 12th month.[24] The combined use of both materials aims to mutually benefit from the slower resorption of graft materials compared to PRF and the potential of PRF to promote regeneration and wound healing through growth factor release, thus supporting periodontal regeneration. At the 6-month follow-up, the presence of bone filling was observed in all radiographic images. Histological analysis of bone tissue is widely regarded as the most reliable technique for assessing healing. However, routine application is limited by ethical considerations.[6,22] In the present study, histopathological evaluation is

necessary to determine whether the healing is complete regeneration, and its absence constitutes a limitation.

Conventional root canal obturation using gutta-percha in combination with a root canal sealer remains the primary filling method because of its favorable handling properties and biocompatibility. However, there is also evidence to suggest that gutta percha is vulnerable to bacterial/coronal microleakage.[25] The utilization of gutta percha and MTA for root canal filling has been demonstrated to facilitate the resolution of complex endo-periosteal lesions.[26] The optimal treatment strategy for such cases involves the combination of MTA filling and bone grafting.[27] Therefore, in the present study, all root canal fillings were performed using gutta-percha, while all retrograde fillings were performed using MTA.

The anatomical characteristics of teeth as well as flap design have been shown to significantly influence the outcomes of regenerative therapy. Multi-rooted teeth are generally regarded as more susceptible to infection because of limited surgical accessibility, complex root canal anatomy, and the presence of furcation areas. In addition, treatment outcomes in these teeth are typically less favorable when compared with single-rooted teeth.[28] Various flap designs—including conventional flaps, papilla-preserving techniques, and minimally invasive surgical approaches with or without papilla elevation—have been reported to minimize exposure of regenerative materials and to lower the risk of early wound-healing complications in regenerative procedures.[29,30] For anterior teeth, a rectangular flap design incorporating mesial and distal vertical releasing incisions together with a horizontal incision placed within the gingival sulcus or adjacent gingiva is commonly preferred.[2] In aesthetically demanding areas, horizontal submarginal or papilla-based incisions are recommended to reduce the likelihood of gingival recession, which may occur following horizontal sulcular incisions.[31] Previous investigations comparing single- and double-flap approaches in periodontal regenerative therapy have demonstrated no significant differences between these techniques with respect to radiographic defect fill at six months. To ensure methodological standardization, the present study included only single-rooted, single-canal teeth.[29] Given the location of all teeth in the maxillary anterior region and the presence of four-walled defects, a single buccal flap approach was employed, with a submarginal design implemented in all incisions, including those adjacent to the attached gingiva. No evidence of regenerative biomaterial exposure was observed in the postoperative period.

The majority of studies on periapical surgery evaluate radiographic criteria and bone fill as the primary criteria for success or failure.[13] The definition of success in this context is considered to be effective if there is no pain or swelling in the involved tooth, good soft tissue healing, no sinus patency, no loss of function, and imaging studies show that the lesions have disappeared or shrunk.[2] In the present study, the healing and bone fill were evaluated using periapical radiographs at follow-up. The results of the study demonstrated that bone filling and trabeculae formation were observed on radiographs in all cases during the follow-up periods. This finding supports the potential of the combined use of allograft and PRF. Furthermore, radiographic criteria for complete healing and failure have been reported to have a high degree of reliability following a 1-year period of follow-up.[13] However, the follow-up period in our study was limited to 6 months, which is shorter than the 12-month period recommended in the literature for reliable radiographic assessment of periapical healing. It is acknowledged that bone healing, particularly in the context of combined periodontal-endodontic lesions, may require a longer observation period to reach complete maturation and stability. Therefore, further studies with extended follow-up durations are recommended to confirm the long-term predictability of the treatment outcomes. It should be noted that radiographic assessment is subject to significant variability and observer bias.

Conclusion

In the surgical treatment of four-walled periapical

lesions requiring a multidisciplinary treatment approach, the use of allograft and PRF provides additional benefits for promoting healing and improving prognosis and may be a potential good treatment strategy. Properly performed periapical surgery can treat endodontically derived diseases with a high success rate, thus preserving the healthy natural dentition. It is imperative that further randomized clinical studies are conducted, incorporating large sample sizes, standardized flap designs, and long-term follow-up, utilizing diverse materials, both individually and in combination, to substantiate the efficacy of bone grafting in such defects and to ascertain the effectiveness of PRF utilization.

Acknowledgements
This case series was presented as an oral presentation at the 28th International Dental Congress of the Turkish Dental Association on 19.09.2025.

The authors would like to thank the patients who agreed to participate in this case study and Prof. Dr. Hatice Reyhan Eğilmez for her support in providing the histopathological images.

Ethical Approval
This study did not use human or animal-derived sources, ethics committee approval was not obtained. An informed consent form is available.

Conflict of Interest
None of the authors of this article has any relationship, connection or financial interest in the subject matter or material discussed in the article.

Sources of Funding
None.

Authorship Contributions
Idea/Concept: Ş.A, T.Y.E Design: Ş.A, T.Y.E Control/Supervision: Ş.A, T.Y.E Resources: Ş.A, T.Y.E Materials: T.Y.E Data Collection and/or Processing: Ş.A Analysis and/or Interpretation: Ş.A Literature Review: Ş.A Writing the Article: Ş.A Critical Review: Ş.A

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