Frontiers in Dentistry

Outcome of Guided Pulpal Regeneration in Immature Molar Teeth with Chronic Apical Abscess: A Case Report and Mini-Review

Mohammad Mahdi Kiafar[1], Farzaneh Afkhami[1,2], Sholeh Ghabraei[1], Ove A Peters[2], Chun Xu[3], Seyyed Ali Abaee[1*]

1. Department of Endodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
2. Department of Endodontics, School of Dentistry, The University of Queensland, Brisbane, Australia
3. Centre for Orofacial Regeneration, Reconstruction and Rehabilitation (COR3), School of Dentistry, The University of Queensland, Brisbane, Australia

Article Info

Article type:
Case Report

Article History:
Received: 18 Mar 2025
Accepted: 3 Jul 2025
Published: 14 Mar 2026

**** Corresponding author:***
Department of Endodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

Email: s.a.abaee73@gmail.com

A B S T R A C T

This case report describes guided pulpal regeneration (GPR) of two immature permanent molar teeth with chronic apical abscess, thin dentinal walls, and open apices. Both teeth were treated with an identical protocol in two sessions, with minimum instrumentation with hand files, irrigation with 1.5% sodium hypochlorite (NaOCl), and application of 1:1 mixture of ciprofloxacin and metronidazole as an intracanal medicament, blood clot as a scaffold, and mineral trioxide aggregate (MTA) as the capping material. At the one-year follow-up, both treated teeth were asymptomatic. However, the root development procedure was different even in different roots of the same tooth, varying from only an increased thickness of dentinal walls to complete closure of the apex along with an increase in root length and dentinal wall thickness. It is concluded that the outcome of GPR is not completely predictable, and may vary among teeth with similar initial conditions and treatment approaches.

Keywords: Apexification; Dental Pulp Necrosis; Guided Tissue Regeneration; Outcome Assessment, Health Care; Periapical Abscess; Regenerative Endodontics

➢ **Cite this article as:** Kiafar MM, Afkhami F, Ghabraei Sh, Peters OA, Xu Ch, Abaee SA. Outcome of Guided Pulpal Regeneration in Immature Molar Teeth with Chronic Apical Abscess: A Case Report and Mini-Review. *Front Dent.* 2026:23:13. http://doi.org/10.18502/fid.v23i13.21567

INTRODUCTION

Treatment of necrotic teeth with immature apices is a clinical challenge. Achieving a sufficient apical seal is difficult in teeth with open apieces. This condition may be addressed by a prolonged calcium hydroxide treatment or by the use of calcium silicate-based plugs. Nevertheless, common treatment procedures such as apexification prevent further root development, and make the teeth more susceptible to fracture as a result of thin root dentinal walls [1]. Today, guided pulpal regeneration (GPR) is suggested as almost the best possible treatment alternative for immature permanent teeth with a necrotic pulp. This biologically based procedure is attempted to restore the anatomy (apical closure and root development) and function of damaged tissues [2]. To induce stem cell proliferation, regenerate dental pulp connective tissue, and continue root maturation, GPR depends on the triad of stem cells, scaffolds, and growth factors [3]. According to recent evidence, induction of bleeding in the periapical tissue of a disinfected root canal,

Copyright © 2026 The Authors. Published by Tehran University of Medical Sciences.
This work is published as an open access article distributed under the terms of the Creative Commons Attribution 4.0 License (http://creativecommons.org/licenses/by-nc/4). Non-commercial uses of the work are permitted, provided the original work is properly cited.

followed by the application of a suitable biomaterial, can stimulate tissue engineering [4]. There are various protocols for this treatment, but most of them follow the same principle as suggested: minimal instrumentation, irrigation with sodium hypochlorite (NaOCl), application of intracanal medicament, blood clot formation, or introduction of a scaffold into the canal space, biomaterial placement, and coronal sealing [5]. The available reports of successful GPR procedures appear to be attributed to proper infection control. Different techniques/methods of disinfection (mainly using calcium hydroxide or different antibiotic pastes) have been introduced for this purpose [6]. Although GPR is mainly used for anterior teeth, this technique was recently used for treatment of immature necrotic molars as well [7].

This study aimed to monitor the outcome of GPR with blood clot scaffold and double antibiotic paste (DAP) as an intracanal medicament for treatment of immature necrotic molars. In addition, a mini-review of the factors affecting the outcome of GPR is provided.

CASE REPORT

Case 1:

An 8-year-old female patient with a chief complaint of pain and abscess in the posterior mandible and no history of systemic problems was referred to our dental clinic. After clinical and radiographic dental examinations, tooth #36 was diagnosed with chronic apical abscess (Fig. 1). A pedunculated gingival growth with a sinus tract opening was found in the vestibule. Following administration of local anesthesia using one cartridge of 2% lidocaine with 1:80,000 epinephrine (2% Xylopen; Exir Pharmaceutical Co., Tehran, Iran), the tooth was isolated with a rubber dam. Access cavity was prepared, and the working length was determined radiographically; due to the presence of open apices, an electronic apex locator could not be reliably used for working length determination. Root canal disinfection was done with minimum mechanical instrumentation with a #30 stainless-steel K-file (Mani Co., Utsunomiya, Japan). Irrigation was performed with 1.5% NaOCl (20mL/canal, 5min) with a side-vented 30-gauge needle (Tribest Co., Tehran, Iran). A 1:1 mixture of ciprofloxacin (Exir Pharmaceutical Co., Tehran, Iran) and metronidazole (Exir Pharmaceutical Co., Tehran, Iran) was dissolved in sterile saline (DAP) and a 1mg/mL solution of DAP was prepared for use as an intracanal medicament. After inserting the medicament into the canals with a sterile #25 K-file (Mani Co., Utsunomiya, Japan), the orifices were covered with polytetrafluoroethylene (Asia gold Co., Tehran, Iran), and the access cavity was temporarily restored with glass ionomer cement (GC Co., Tokyo, Japan). After 2 weeks, the patient was recalled for the second visit; the sinus tract had been completely healed. Local anesthesia was induced using one cartridge of plain 3% mepivacaine (3% Exicaine; Exir Pharmaceutical Co., Tehran, Iran), the tooth was isolated with a rubber dam, and the temporary restoration was removed.

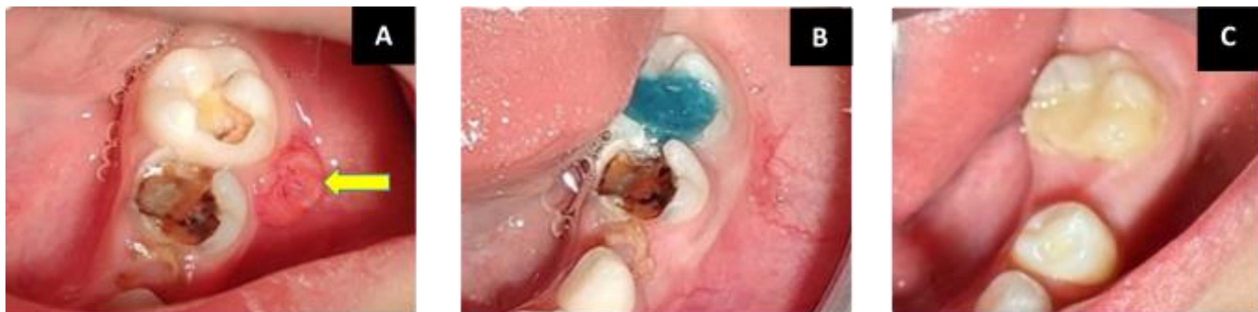

Fig 1. Intra-oral view of the tooth. A: First visit; arrow indicates a pedunculated sinus tract in the vestibule B: Second visit; the sinus tract healed after 2 weeks. C: 1-year follow-up.

Intracanal medicament was removed with saline using a side-vented 30-gauge needle (Tribest Co., Tehran, Iran) activated with an ultrasonic tip (Ultra Mint Pro; Eighteeth Co., China). Final irrigation was performed with 5mL of 17% EDTA (Morvabon Co., Tehran, Iran). A #25 hand file was used to provoke bleeding. The blood clot was used as a scaffold, mineral trioxide aggregate (MTA; Ex Root, Tehran, Iran) was placed in contact with the blood clot 2mm below the orifice, a wet cotton pellet was placed over it, and the tooth was temporarily restored with glass ionomer cement. A third visit was scheduled the following week for the patient to check the MTA setting before referral for permanent restoration with a composite built-up. After one year, the patient returned for the follow-up (Fig. 2). The patient reported no symptoms, the periapical lesion was completely healed, the mesial root apex was closed, and the dentinal wall thickness of the mesial and distal roots increased but no increase in root length was observed. The tooth did not respond to the sensibility tests, although we did not expect any response.

Case 2:

An 11-year-old female patient with a chief complaint of pain and abscess in the posterior mandible with a bad odor and no history of systemic health problems was referred to our dental clinic for treatment. Tooth #36 was diagnosed with a necrotic pulp with chronic apical abscess after clinical and radiographic dental examinations (Fig. 3). A sinus tract was visible in the vestibule, and a narrow 11-mm-deep pocket was also found on the distal surface of the distal root. The same treatment procedure was followed as in the first case.

Rubber dam was placed after local anesthesia was achieved by using one cartridge of 2% lidocaine with 1:80,000 epinephrine (2% Xylopen; Exir Pharmaceutical Co., Tehran, Iran). An access cavity was prepared, and the working length was determined using a periapical radiograph. Root canal disinfection was done with minimum instrumentation with a #30 stainless-steel K-file, and irrigation with 1.5% NaOCl (20mL/canal) using a side-vented 30-gauge needle (Tribest Co.,). The same procedure as described for Case 1 was used to prepare 1mg/mL concentration of DAP (1:1) for use as an intracanal medicament.

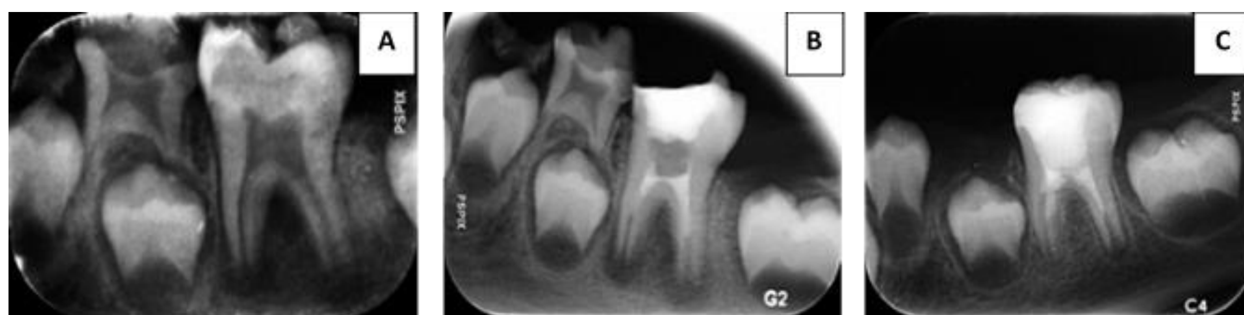

Fig 2. A: Preoperative radiograph; B: Radiograph immediately after GPR. C: 1-year follow-up radiograph.

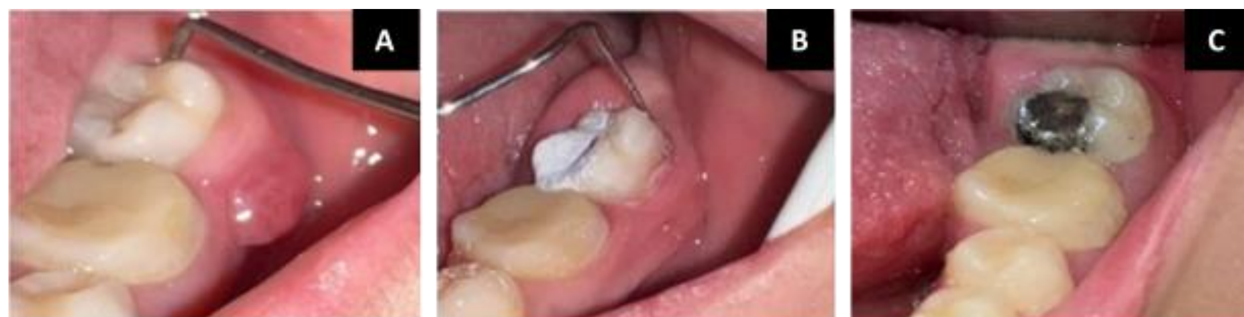

Fig 3. Intra-oral view of the tooth. A: First visit; a pedunculated sinus tract is visible in the vestibule and a 10mm narrow deep pocket can be seen in the distal surface. B: Second visit; the sinus tract and narrow deep pocket healed after 3 weeks. C: Clinical view of the tooth at the 1-year follow-up was normal.

After delivery of the medicament into the canal with a sterile #25 K-file (Mani Co., Japan), the orifices were covered with polytetrafluoroethylene (Asia gold Co.,), and the access cavity was temporarily restored with glass ionomer cement (GC Co.,). After 3 weeks, the patient was recalled for the second visit. The sinus tract had been completely healed; local anesthesia was administered using one cartridge of plain 3% mepivacaine (3% Exicaine; Exir pharmaceutical Co.,), the tooth was isolated with a rubber dam, and the temporary restoration was removed. The intracanal medicament was removed with saline using a side-vented 30-gauge needle with an ultrasonic tip (Ultra Mint Pro; Eighteeth Co.,). A final irrigation with 5mL of 17% EDTA (Morvabon Co.,) was performed. Bleeding was induced with the use of a #25 hand file. MTA (Ex Root, Tehran, Iran) was placed in contact with the blood clot 2mm below the orifice, a wet cotton pellet was placed over it, and the tooth was temporarily restored with glass ionomer cement. One week later, the patient returned for the third appointment to verify the MTA settings, after which she was referred for permanent amalgam restoration. At the one-year follow-up, the patient had no symptoms, and the periapical lesion had been completely healed (Fig. 4). The mesial root canals exhibited calcification, while the distal root apex displayed near-complete closure, and the dentinal wall thickness and root length had increased. The tooth did not respond to the sensibility tests.

DISCUSSION

Despite all the efforts and research done in the field of GPR, the outcome of GPR is still unpredictable. Table 1 provides a summary of systematic reviews that compared variables influencing the GPR outcome. Based on the American Association of Endodontists' statement about the clinical considerations of GPR procedures, the outcome of GPR treatment is measured by 3 main criteria: the first goal is elimination of symptoms and evidence of bone healing, the second goal is an increase in root wall thickness and/or increment in root length (desirable, but perhaps not essential), and the third goal is a positive response to pulp tests (which if achieved, could indicate a more organized vital pulp tissue) [8]. A case series conducted by Chrepa et al., [9] which was claimed to have the largest number of samples among all similar studies discussed different factors associated with the outcome of GPR treatment. They used age instead of the stage of root development and apical foramen diameter because these factors are strongly correlated with each other [9]. A recent meta-analysis comparing the outcome of GPR and non-surgical root canal treatment reported that there was no significant difference between these methods. The criterion of success in their study was the resolution of clinical signs and symptoms and healing of periapical lesions (indicating the first goal of GPR), but there was a significant difference between GPR and non-surgical root canal treatment in responding to electric pulp test (indicating the third goal of GPR) [10]. A meta-analysis assessing the effect of the etiology of pulp necrosis on the outcome of GPR concluded that the outcome of the treatment was the same whether the pulp necrosis etiology was caries, trauma, or dens invaginatus [11].

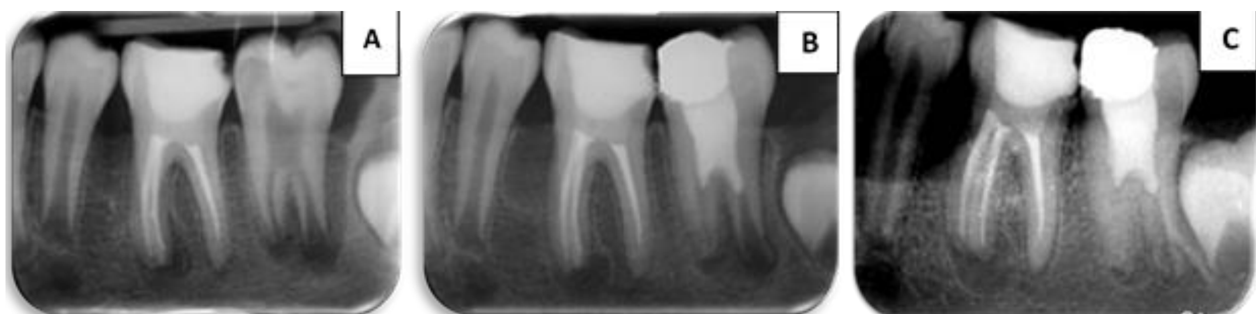

Fig 4. A: Preoperative radiograph; B: radiograph immediately after GPR; C: 1-year follow-up radiograph.

Table 1. Studies comparing factors affecting GPR

<table>
<tr><th>Author</th><th>Aim of the study</th><th>Compared factors</th><th colspan="2">Conclusion</th></tr>
<tr><td>Fang et al. (2018) [15]</td><td>To compare the effect of apical diameter on regenerative endodontic outcome</td><td>Clinical success: Complete or incomplete healing</td><td colspan="2">Clinical success rates were the highest for teeth with apical diameters between 0.5 and 1.0mm</td></tr>
<tr><td rowspan="3">Koç & Del Fabbro (2020) [11]</td><td rowspan="3">To compare the effect of pulp necrosis etiology on regenerative endodontic outcomes</td><td>Pulp necrosis due to caries</td><td rowspan="3" colspan="2">Pulp necrosis etiology did not have a significant effect on regenerative endodontic outcomes.</td></tr>
<tr><td>Pulp necrosis due to trauma</td></tr>
<tr><td>Pulp necrosis due to dens invaginatus</td></tr>
<tr><td rowspan="8">Chrepa et al. (2020) [9]</td><td rowspan="8">To assess the predictors of regenerative endodontic outcome</td><td>Success rate</td><td colspan="2">Pulp necrosis due to caries, using $Ca(OH)_2$ as an intra-canal medicament and 1.5% NaOCl was associated with a higher risk of failure</td></tr>
<tr><td rowspan="5">Root development</td><td>Age</td><td>Younger patients had more root development.</td></tr>
<tr><td>sex</td><td>Female patients had more root development.</td></tr>
<tr><td>Etiology of pulp necrosis</td><td>Pulp necrosis due to caries was a risk factor for root development.</td></tr>
<tr><td>Disinfection protocol</td><td>6% NaOCl and full-strength DAP were associated with more root development.</td></tr>
<tr><td>Perioperative apical diagnosis</td><td>An acute apical abscess was associated with more root development and asymptomatic apical periodontitis was associated with less root development.</td></tr>
<tr><td>Sensibility test response</td><td colspan="2">Teeth with more root development were associated with more sensibility response.</td></tr>
<tr><td>Discoloration</td><td colspan="2">Use of MTA as biomaterial was associated with tooth discoloration.</td></tr>
<tr><td rowspan="3">Glynis et al. (2021) [10]</td><td rowspan="3">To compare regenerative endodontic outcomes with non-surgical root canal treatment</td><td>Resolution of signs and symptoms</td><td colspan="2">There was no significant difference between the two methods.</td></tr>
<tr><td>Healing of preapical lesion</td><td colspan="2">There was no significant difference between the two methods.</td></tr>
<tr><td>Response to electric pulp test</td><td colspan="2">Response to electric pulp tests was significantly higher in regenerative endodontic treatment.</td></tr>
</table>

Table 1 cont'd

Tang et al. (2022) [3]	To compare the effect of a blood clot and platelet concentrate as the intracanal scaffold on regenerative endodontic treatment	Clinical success	There was no significant difference between scaffolds.
		Response to cold and electric pulp tests	There was no significant difference between scaffolds.
		Periapical healing	GPR with blood clot scaffold resulted in more periapical healing.
		Apex closure	There was no significant difference between scaffolds.
		Root lengthening	There was no significant difference between scaffolds.
		Root canal thickening	There was no significant difference between scaffolds.
Panda et al. (2022) [14]	To compare the effect of a blood clot and platelet concentrate as the intracanal scaffold on regenerative endodontic treatment	Dentin wall thickness	There was no significant difference between scaffolds.
		Increased root length	There was no significant difference between scaffolds.
		Apical foramen width	There was no significant difference between scaffolds.
		Vitality response	GPR with platelet concentrate scaffold resulted in more significant vitality responses.
		Success rate	There was no significant difference between scaffolds.
Almutairi et al. (2022) [16]	To compare the effect of intracanal medicament on intracanal calcification after regenerative endodontic treatment	Calcium hydroxide paste compared with antibiotics	Calcium hydroxide paste as intra-canal medicament resulted in more intra-canal calcification after Regenerative endodontic treatment.
Hu et al. (2023) [2]	To evaluate treatment outcomes of regenerative endodontic treatment in nonvital immature permanent teeth due to developmental malformation and trauma	Root development	The etiology influenced the outcome, and malformation cases were more likely to present with a positive outcome than trauma cases.

According to a systematic review and meta-analysis by Koç and Del Fabbro [11], the etiology of pulp necrosis before regeneration treatment such as trauma, dens evaginatus, and caries did not make a significant difference in treatment outcome. They highlighted that GPR can be successfully applied to immature necrotic teeth, irrespective of the specific cause of pulp necrosis [11]. However, another study showed that the etiology seems to influence the outcome of regeneration treatments, as the prognosis of malformation cases was better than that of trauma cases following treatments [12].

Two meta-analyses compared the effects of different scaffolds on GPR outcome. Tang et al. [13] compared blood clots and platelet concentrate as intra-canal scaffolds. Based on their meta-analysis, there was no difference

between these two methods in treatment outcome success, root length, thickness increment, apical closure, and electric pulp test response. Panda et al. [14] conducted another meta-analysis comparing outcomes of different GPR procedures using apical platelet concentrate and blood clots as an intracanal scaffold. They showed that these two scaffolds led to the same outcome.

Apical foramen size may affect the outcome of GPR. A review conducted by Fang et al. [15] led to the conclusion that the highest level of success was achieved when the apical foramen size was 0.5-1 mm. They also mentioned that this might be related to other potential factors including patient's age, the etiology of pulp necrosis, presence of preoperative apical radiolucency, procedural details, follow-up period, or sample size [15].

The intracanal medicament may also affect the outcome of GPR. Almutairi et al. [16] conducted a meta-analysis to assess the effect of antibiotic paste and calcium hydroxide on GPR outcome. Data analysis showed that calcium hydroxide placement as intracanal medicament resulted in more canal calcification compared to antibiotics.

CONCLUSION

Recent meta-analyses have identified several factors associated with favorable outcomes in GPR. These include better periapical healing with blood clot scaffolds (rather than platelet concentrate scaffolds), better pulpal response to electric pulp testing with platelet concentrate scaffolds (rather than blood clot scaffolds), and less intra-canal calcification after medication with antibiotic pastes (rather than calcium hydroxide paste). Nevertheless, the outcome of GPR remains unpredictable even in teeth with similar initial conditions and similar treatment protocols, or even in different roots of the same tooth, and an ideal protocol for GPR is still lacking.

CONFLICT OF INTEREST STATEMENT

None declared.

GENERATIVE AI IN SCIENTIFIC WRITING

None declared.

REFERENCES

1. Zhujiang A, Kim SG. Regenerative Endodontic Treatment of an Immature Necrotic Molar with Arrested Root Development by Using Recombinant Human Platelet-derived Growth Factor: A Case Report. J Endod. 2016 Jan;42(1):72-5.
2. Chaniotis A. Treatment Options for Failing Regenerative Endodontic Procedures: Report of 3 Cases. J Endod. 2017 Sep;43(9):1472-1478.
3. Justin MR, Patil PN, Sarda AS, Darade LD, Zanjad SR, Bowlekar R. Review on regenerative endodontics: Past concepts, current protocols and future strategies. IP Indian J Conserv Endod. 2021 Dec 15;6(4):205-11.
4. Asgary S, Parhizkar A, Samiei M. Management of an infected immature tooth with a talon cusp using regenerative endodontic treatment: A case report. J Clin Pediatr Dent. 2022 Nov;46(6):45-49.
5. Sachdeva GS, Sachdeva LT, Goel M, Bala S. Regenerative endodontic treatment of an immature tooth with a necrotic pulp and apical periodontitis using platelet-rich plasma (PRP) and mineral trioxide aggregate (MTA): a case report. Int Endod J. 2015 Sep;48(9):902-10.
6. Asgary S, Fazlyab M, Nosrat A. Regenerative Endodontic Treatment versus Apical Plug in Immature Teeth: Three-Year Follow-Up. J Clin Pediatr Dent. 2016;40(5):356-60.
7. Yoshpe M, Kaufman AY, Lin S, Ashkenazi M. Regenerative endodontics: a promising tool to promote periapical healing and root maturation of necrotic immature permanent molars with apical periodontitis using platelet-rich fibrin (PRF). Eur Arch Paediatr Dent. 2021;22(3):527-34.
8. Galler KM, Krastl G, Simon S, Van Gorp G, Meschi N, Vahedi B, Lambrechts P. European Society of Endodontology position statement: Revitalization procedures. Int Endod J. 2016 Aug;49(8):717-23.
9. Chrepa V, Joon R, Austah O, Diogenes A, Hargreaves KM, Ezeldeen M, et al. Clinical Outcomes of Immature Teeth Treated with Regenerative Endodontic Procedures-A San Antonio Study. J Endod. 2020 Aug;46(8):1074-1084.
10. Glynis A, Foschi F, Kefalou I, Koletsi D, Tzanetakis GN. Regenerative Endodontic Procedures for the Treatment of Necrotic Mature Teeth with Apical Periodontitis: A Systematic Review and Meta-analysis of Randomized Controlled Trials. J Endod. 2021 Jun;47(6):873-882.
11. Koç S, Del Fabbro M. Does the Etiology of Pulp Necrosis Affect Regenerative Endodontic Treatment Outcomes? A Systematic Review and Meta-analyses. J Evid Based Dent Pract. 2020 Mar;20(1):101400.
12. Hu X, Wang Q, Ma C, Li Q, Zhao C, Xiang K.

Is Etiology a Key Factor for Regenerative Endodontic Treatment Outcomes? J Endod. 2023 Aug;49(8):953-962.
13. Tang Q, Jin H, Lin S, Ma L, Tian T, Qin X. Are platelet concentrate scaffolds superior to traditional blood clot scaffolds in regeneration therapy of necrotic immature permanent teeth? A systematic review and meta-analysis. BMC Oral Health. 2022 Dec 9;22(1):589.
14. Panda P, Mishra L, Govind S, Panda S, Lapinska B. Clinical Outcome and Comparison of Regenerative and Apexification Intervention in Young Immature Necrotic Teeth-A Systematic Review and Meta-Analysis. J Clin Med. 2022 Jul 5;11(13):3909.
15. Fang Y, Wang X, Zhu J, Su C, Yang Y, Meng L. Influence of Apical Diameter on the Outcome of Regenerative Endodontic Treatment in Teeth with Pulp Necrosis: A Review. J Endod. 2018 Mar;44(3):414-431.
16. Almutairi W, Al-Dahman Y, Alnassar F, Albalawi O. Intracanal calcification following regenerative endodontic treatment: a systematic review and meta-analysis. Clin Oral Investig. 2022 Apr;26(4):3333-3342.