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Treatment of Immature Permanent Teeth With Platelet-Rich Fibrin: A Series of Three Cases

İmmatür Daimi Dişlerin Trombositten Zengin Fibrin İle Tedavisi: Üç Olgu Serisi

Handan ÇELİK[1] https://orcid.org/0000-0002-5642-4641
Neda MOJARRAB[2] https://orcid.org/0000-0001-5884-4693
Nazan ERSİN[2] https://orcid.org/0000-0002-5425-9582

[1]İzmir Demokrasi Üniversitesi, Diş Hekimliği Fakültesi Pedodonti Anabilim Dalı, İzmir
[2]Ege Üniversitesi Diş Hekimliği Fakültesi Pedodonti Anabilim Dalı, İzmir

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ABSTRACT

Introduction: The loss of vitality and cessation of root development in immature permanent teeth are frequently encountered in children due to traumatic injuries and deep caries. In this three series case study, we aimed to present the clinical and radiological follow-ups after 3 and 4 years following regenerative endodontic therapy of an open apex premolar and two central incisors using platelet-rich fibrin.

Methods: In all the three cases, the intracanal disinfection was performed with limited mechanical instrumentation, abundant irrigation, and calcium hydroxide. At the final appointment, intracanal bleeding was induced. PRF which was obtained by centrifuging the blood withdrawn from the patients, was placed with plugger into the blood clot that reached up to the coronal 1/3rd level of the canal.

Results: In the 24-month controls, the lesions around the roots were completely healed, the dentin walls were thickened, and the root lengths were elongated. In the 48-month controls of the other two cases, the roots development were continued and their apexes were closed.

Discussion and Conclusion: The results postulated that regenerative endodontic treatment of necrotic immature teeth using PRF is a viable alternative to the apexification treatment and other endodontic treatment methods of immature permanent teeth in achieving thickened dentin walls and elongated root lengths.

Keywords: *Regenerative endodontics, scaffold, platelet-rich fibrin, apex closure, apexification*

ÖZET

Giriş ve Amaç: Çocuklarda immatür daimi dişlerde travmatik yaralanmalar ve derin çürükler nedeniyle vitalite kayıplarına ve kök gelişiminin durmasına sıkılıkla rastlanmaktadır. Bu üç olgu sunumunun amacı, trombositten zengin fibrin (PRF) kullanılarak açık apeksli premolar ve iki adet santral kesici dişe uygulanan rejeneratif endodontik tedavinin 4 ve 3 yıllık klinik ve radyolojik takiplerinin sunulmasıdır.

Yöntem ve Gereçler: Her 3 olguda sınırlı mekanik enstrümantasyon, bol irrigasyon ve kalsiyum hidroksit ile kanal içi dezenfeksiyon yapıldı. Final randevuda, kanal içine doğru kanama indüklendi. Kanalın koronal 1/3 seviyesine kadar ulaşan kan pıhtısının üzerine hastaların kendilerinden alınan kan satrifüj yapılarak PRF elde edildi ve pluggerla kanala yerleştirildi.

Bulgular: 24 aylık kontrollerde kök çevrelerinde bulunan lezyonların tamamen iyileştiği, dentin duvarında kalınlaşma sağlandığı ve kök boyunda uzama olduğu belirlendi.48. aylık kontrollerinde her üç olgunun da kök boylarının uzadığı ve apekslerinin kapandığı gözlendi.

Tartışma ve Sonuç: Elde edilen sonuçlara göre; nekrotik immatür dişlerin PRF kullanılarak yapılan rejeneratif endodontik tedavilerinin, dentin duvarında kalınlaşma ve kök boyunda uzama sağlaması nedeniyle immatür daimi dişlerde apeksifikasyon tedavisi ve diğer endodontik tedavi yöntemlerine alternatif olarak kullanılabileceği düşünülmektedir.

Anahtar Kelimeler: *Rejeneratif endodonti, iskele, trombositten zengin fibrin, apeksin kapanması, apeksifikasyon*

Sorumlu yazar/Corresponding author*: dthandancelik@gmail.com
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INTRODUCTION

Dental and supporting tissue traumas are common in children.[1] In addition, factors such as caries and pulp pathologies can lead to the loss of pulp vitality, cessation of root development, and lack of apical narrowing.[2] The endodontic treatment required due to the loss of pulp vitality of an immature tooth is complex. Since the root tip is not yet closed in these teeth, it is difficult to obtain a suitable apical seal using the traditional obturation methods. In addition, the thin root canal walls make the teeth susceptible to future fractures.[3] Traditionally, the long-term apexification treatment with calcium hydroxide ($Ca(OH)_2$) is applied to permanent teeth with necrotic pulp and incomplete root development to close the root tip.[4] However, studies have shown long-term use of $Ca(OH)_2$ to weaken the dentin walls and increase the risk of teeth fractures.[5] Alternatively, an artificial apical plug can be created with mineral trioxide aggregate (MTA). However, since physiological apical closure and root dentin thickening cannot be achieved, the tendency of the tooth to fracture remains.[6] Hence, regenerative endodontic procedures, which allow for the physiological formation of the apex, have gained popularity in recent years.[7] Regenerative endodontic treatments utilize various autogenous tissue transfers to create tissue scaffolds. Examples of these include platelet-rich fibrin (PRF) and platelet-rich plasma.[8] In this case report series, we evaluated the 3- and 4-year functional and radiological follow-ups after regenerative endodontic treatments with PRF of traumatized immature, maxillary right central, maxillary left central, and right lower second premolar teeth with loss of vitality due to caries.

CASE REPORTS

The informed consent form was obtained from the parents of the patients before the treatment.

Case 1

An 8-year-old male patient was admitted to our clinic due to discoloration in his upper left central tooth, which had a history of trauma. Clinical and radiological examinations diagnosed the tooth as devital and observed lesions in the periapical region and an open apex end (Figure 2a). Regenerative endodontic treatment using autogenous PRF tissue scaffold was proposed considering immature tooth development.

In the first session, the access cavity of the left central tooth was prepared after providing isolation with a rubber dam under local anesthesia with 3% safecaine. An apex locator determined the working length. No instrumentation was utilized in the root canals. After root canal irrigation with 20 ml 1.5% sodium hypochlorite (NaOCl) and SALİN, they were dried with paper points. After drying, $Ca(OH)_2$ paste (Kalsin; Spot Dis Deposu A.Ş., İzmir, Turkey) was prepared and placed in the root canals, and the access cavity was sealed using glass ionomer cement. An appointment after 3 weeks was scheduled with the patient (Figure 2b). In the second session, after providing local anesthesia with 3% safecaine, isolation was achieved with a rubber dam and the temporary restoration was removed. Irrigation was performed with 20 ml of 1.5% NaOCl and distilled water, finally with 20 ml of 17% ethylenediaminetetraacetic acid (EDTA). After drying the root canals with paper points, the apical area was irritated with no. 15 K-files to induce bleeding (Figure 1a). The patient's blood was drawn from a vein in the forearm and collected in glass tubes (10 mL each). Then, the patient's blood was centrifuged at 1200 rpm for 8 minutes in a centrifuge device to obtain PRF. Using sterile tweezers, the fibrin clot was squeezed between two gauze pieces to create an autologous fibrin membrane which was placed in the canal with the help of pluggers (Figures 1b and 1c). A minimum of 4 mm of white MTA (MTA Angelus, Netherlands), prepared by the manufacturer's recommendations, was carefully placed on the PRF without applying pressure. The canal mouth was sealed with 2 mm glass ionomer cement (Ketac Cem, 3M ESPE, Germany). Two weeks later, its permanent restoration was completed (Figure 2c).

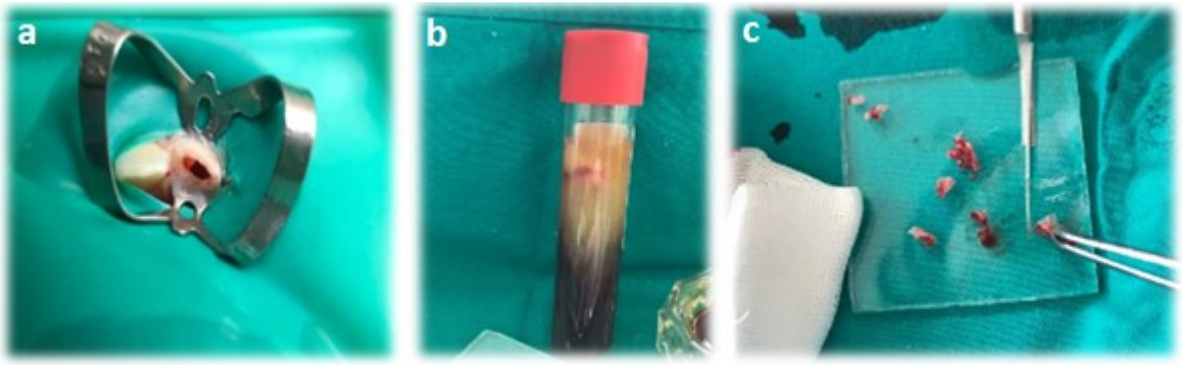

Figure 1: a: Inducing blood supply to the pulp chamber with a K file; b and c: Platelet-rich fibrin tissue

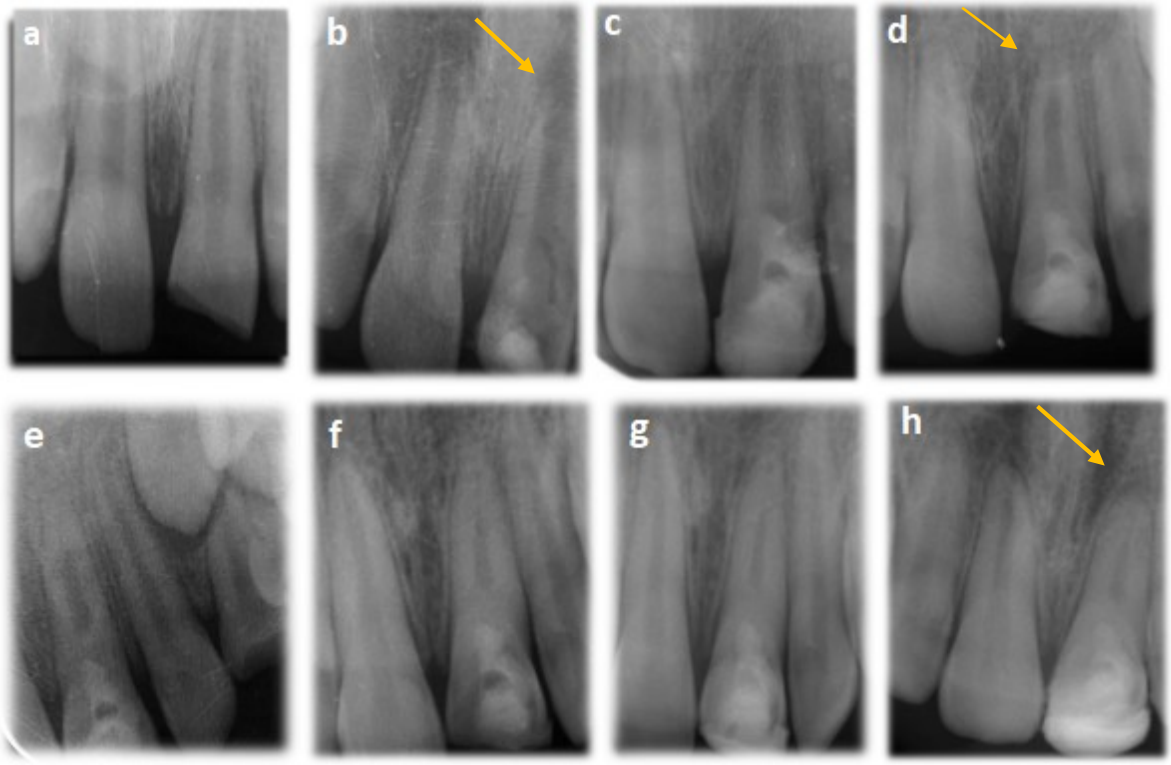

Figure 2: a: Preoperative radiograph; b: Disinfection and intracanal medicament placement in the first session; c: Postoperative radiograph; d: 6-month radiograph; e: 12-month radiograph; f: 24-month radiograph; g: 36-month radiograph; h: 48-month radiograph

In the clinical controls at the 6th, 12th, 24th, 36th, and 48th months, it was observed that tooth no. 21 was asymptomatic and negatively responded to the pulp sensitivity tests. Radiographic examinations observed considerable shrinkage of the periapical lesion in the 6th month (Figure 2d) and its complete disappearance in the 12th month. (Figure 2e) The canal walls appeared thickened at the 24th month, (Figure 2f), and in the 36- and 48-months controls, complete closure of the apex and formation of lamina dura around it was observed (Figures 2h and 2g, respectively).

Case 2

A healthy 7-year-old girl was admitted to our clinic with discoloration in her maxillary right central tooth. In the anamnesis reported, it was learned that her tooth had experienced trauma a month ago. Radiographic and clinical examinations demonstrated extrusion of the maxillary right central tooth with an open apex with symptoms of necrosis (Figure 3). Regenerative endodontic treatment was applied considering the width of the apex. In the first session, local anesthesia was

provided with 3% mepivacaine, and after the preparation of the endodontic access cavity, the necrotic pulp was removed. Following the mechanical preparation of the tooth, the canal was irrigated with 20 ml of 1.5% NaOCl and 20 ml of distilled water. After irrigation, intracanal disinfection with $Ca(OH)_2$ was conducted. In the last session, 20 ml of 17% EDTA was used for irrigation and the area was dried with paper points. Then, PRF was obtained in the same way as in case 1. Bleeding was induced in the canal using a no. 15 K file, and the fibrin tissue extracted from the centrifuged blood of the patient was placed in the canal cavity with the help of a plugger (Figures 3a, 3b, and 3c). MTA (Biofactor MTA IMICRYL, Konya, Turkey) was placed over the PRF, 2 mm below the enamel–cement boundary, and the access cavity was restored with glass ionomer cement (Ketac Cem, 3M ESPE, Germany) and resin composite (GC Gradia Plus, Tokyo, Japan) (Figure 3d).

The patient was called to the clinic after 6, 12, 24, and 36 months, and clinical and radiographic checks were performed. The examinations demonstrated that the tooth was asymptomatic and vital, the apex was completely closed, and the dentin walls were thickened (Figures 4 and 5).

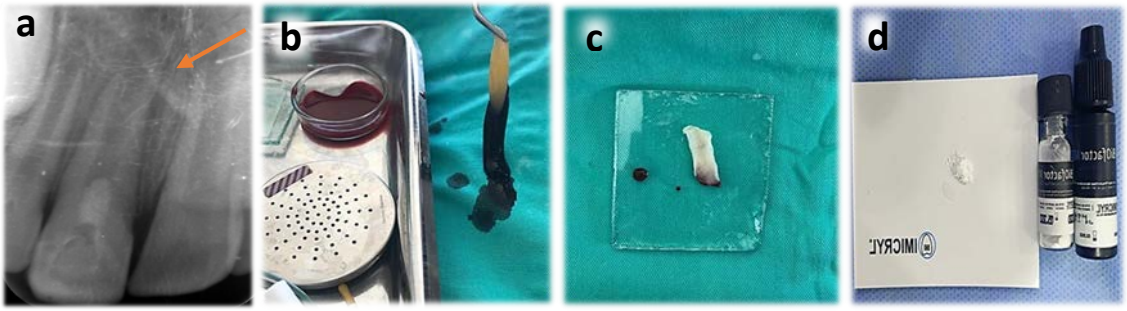

Figure 3. a: Last session endodontic regenerative treatment radiograph; b: Fibrin tissue obtained from the patient's blood; c: Platelet-rich fibrin; d: Mineral trioxide aggregate

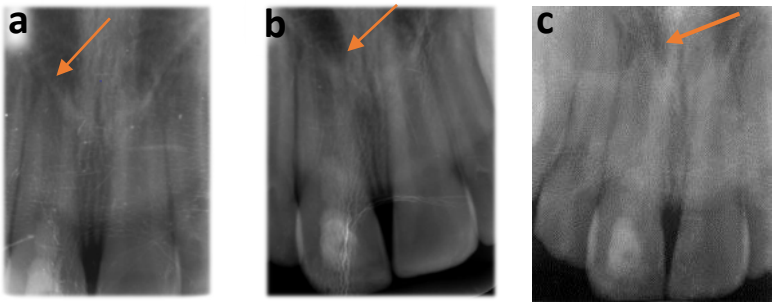

Figure 4. a: 6-month radiograph; b: 1-year radiograph; c: 3-year periapical radiograph

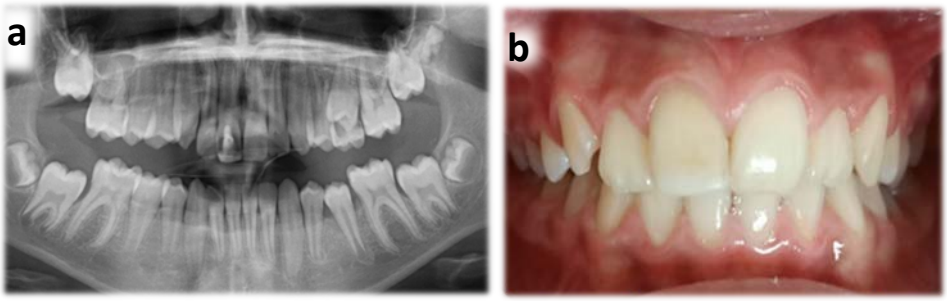

Figure 5. a: 3-year panoramic radiograph; b: 3-year intraoral photograph

Case 3

An 11-year-old male patient was admitted to our clinic due to extensive dental caries. Clinical and radiographic examinations diagnosed the right mandibular second premolar tooth with excessive crown damage and pulp necrosis. Regenerative endodontic treatment with PRF was considered appropriate due to the large open apex and immature tooth development. In the first session, following the preparation of the access cavity, the necrotic pulp tissue was removed. Distilled water and 20 ml of 1.5% NaOCl were used for root canal irrigation, following which metronidazole antibiotic (Flagyl, Eczacıbaşı, Istanbul, Turkey) was placed in the root canal for two days for gangrene treatment. After two days, root the canals were again irrigated with 20 ml of 1.5% NaOCl and 20 ml of distilled water, dried with paper points, and covered with pure $Ca(OH)_2$ paste (Kalsin, Spotdent, Karabağlar, İzmir). The orifice was closed with cotton pellets, and glass ionomer cement (Ketac Cem, 3M ESPE, Germany) was placed on it temporarily. During the second session two weeks later, under local anesthesia with 3% safecaine, the temporary filling was removed in isolation. The root canals were irrigated with 20 ml of 1.5% NaOCl and distilled water and finally with 20 ml of 17% EDTA. After drying the root canals with paper points, the apical area was irritated with no. 15 K file files and bleeding was induced up to the coronal 1/3rd level of the root. PRF was obtained in the same way as in case 1. PRF was inserted into the canal with a plugger. Following this procedure, a minimum of 4 mm of white MTA (MTA Angelus, Netherlands), prepared by the manufacturer's recommendations, was carefully placed directly over the PRF without applying pressure to ensure hermetically sealed closure. The canal mouth was closed with 2 mm glass ionomer cement (Ketac Cem, 3M ESPE, Germany). After two days, the permanent restoration was completed with the direct composite application (Filtek Ultimate Universal Restorative Composite, 3M ESPE, Germany). The patient was called for controls after 1, 3, 6, 12, 24, and 36months. In the clinical and radiological follow-ups performed at the end of the 36th month, thickened dentin walls, completely closed apex, and continuous lamina dura was observed.

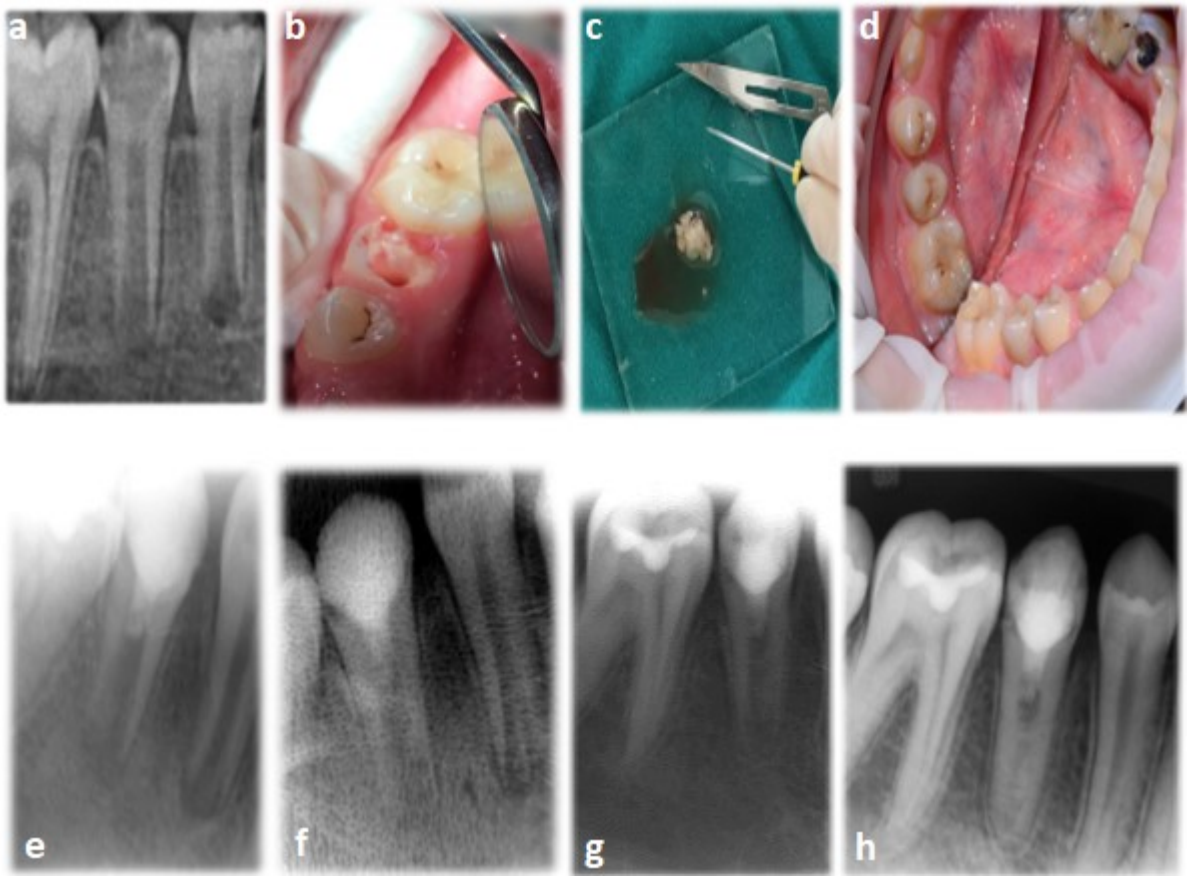

Figure 6. a: Preoperative radiograph; b: Endodontic access cavity; c: Platelet-rich fibrin; d: Composite restoration; e: Postoperative radiograph; f: 6-month radiograph; g: 12-month radiograph; h: 36-month radiograph

DISCUSSION

The endodontic treatment of nonvital immature teeth is one of the most challenging procedures for pediatric dentists. When permanent teeth erupt, they can only complete 60%–80% of their dentin and root development. This developmental period, however, coincides with the stage in which children are most frequently exposed to injuries, especially because of trauma. In addition, caries observed in children with poor oral hygiene may progress rapidly due to incomplete maturation following the eruption and the width of the pulp chambers, leading to the cessation of root development because of infection and loss of vitality of the pulp.[9] Root development in necrotic teeth ceases, resulting in thin root dentin walls and a divergent, open apex. For this reason, it becomes difficult to provide appropriate mechanical preparation and hermetic fillings during endodontic treatments.[10]

"Apexification" is the treatment method by which apical closure in immature necrotic permanent teeth is achieved by creating mineralized tissue at the apex.[11] Several techniques have been attempted in apexification, including blunt-ended gutta-percha cone technique, short canal filling technique, periapical surgery, apical closure by controlling infection, $Ca(OH)_2$ apexification, single session (MTA) apexification, and regenerative endodontic treatment. Among these methods, $Ca(OH)_2$ apexification, apexification with MTA, and regenerative endodontic treatment techniques have been the most emphasized applications by researchers.[12]

Regenerative endodontic treatment of immature teeth with necrotic pulp, regardless of periapical lesions, has gained popularity in recent years. One of the major etiological factors in immature teeth with necrotic pulp undergoing regenerative endodontic treatment is trauma.[13] In all the three cases presented, successful results were obtained after six months of follow-ups, which is consistent with the relevant literature. Over time, conventional root canal treatments and abrasions applied to eliminate the infected pulp tissue may cause fractures in the crown–root complex. In the first and second cases, regenerative endodontic treatment with PRF was applied due to the loss of vitality of the pulp in the permanent central incisor with an open apex, and in the third case due to trauma and necrosis in the permanent premolar tooth with an open apex because of caries. The dentin walls of young permanent teeth with open apexes are thinner, weaker, and prone to fractures.[14] Different complications, such as root fractures, may be encountered during the traditional apexification procedure.[15] In addition, the prolonged duration of the treatment affects the patient's ability to cooperate and the treatment can remain unfinished.[16] Apexification treatment performed in a single session usually causes the roots to be shorter and weaker and increases the chances of tooth fractures.[17,18] Because of these disadvantages, creating a cell scaffold with regenerative endodontic treatment has been presented as an alternative method.[19] In all three cases, the fibrin tissue obtained from the patients' blood by centrifugation was placed in the root canal cavity to form a skeleton. PRF contains numerous growth factors, such as polypeptides and cytokines, which enable the cells to differentiate, migrate, proliferate, and survive.[20,21] Studies have shown that PRF placement in the canal cavity is a suitable and successful method of regenerative endodontic treatment, which provides vitality to the tooth. In the second and third cases, before the application of the regenerative method, metronidazole group antibiotics were placed topically in the root canal cavity for gangrene treatment. The triple antibiotic containing minocycline was not preferred due to side effects, such as discoloration and toxicity.[23] Antibiotics placed in the root canal cavity eliminate the endodontic pathogens.[24,25] $Ca(OH)_2$ is preferred as root canal medicament as it induces hard tissue formation and has antibacterial properties.[26] Studies have reported that the use of EDTA after $Ca(OH)_2$ increases the release of beta-1 growth factor.[27] regenerative endodontic treatment with PRF aims to create tissue scaffolding within the root canals, provide blood supply, and summon growth factors to the periapical region.[28] For this purpose, local anesthesia without a vasoconstrictor is preferred during the procedure.[29] Finally, biocompatible materials, such as MTA and Biodentine, should be preferably used for sealing.[30] In some studies, it has been reported that Biodentine is better than MTA because it does not cause coloration and hardens quickly.[31] In all three cases, the thickening of the dentin and canal walls on regeneration with PRF during the follow-up period is consistent with the observations in the relevant literature.[32] In the radiological follow-ups, no lesions were observed around the roots. In the cases where we applied regenerative endodontic treatment with PRF, the infections in the periapical region had healed, the root walls had thickened, and the root tips had closed because of continued root development. These results are consistent with the relevant literature.[33]

CONCLUSION

On the treatment of immature permanent teeth with PRF, the existing infections in the periapical region healed, the root walls thickened, and the root tips closed because of continued root development. However, before the application of the treatment, certain factors, such as patient cooperation, the width of the apex opening, and restoration of the crown, should be considered as they are important criteria affecting the success rate of the procedure, and long-term follow-up studies are required to evaluate the success rate of this treatment option.

CONFLICT OF INTEREST STATEMENT

The authors confirm that they have no conflict of interest.

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