Effect Of Platelet-Rich Plasma and Platelet-Rich Fibrin on Apical Response Type in Regenerative Endodontics: A Retrospective Study

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ABSTRACT

Effect Of Platelet-Rich Plasma and Platelet-Rich Fibrin on Apical Response Type in Regenerative Endodontics: A Retrospective Study

Background: Recent studies in regenerative endodontics have revealed that treatment shows different types of root growth. In the Chen and Chen index, 5 different types of root growth were reported after regenerative endodontic treatment (RET). The aim of this study is to evaluate the effect of platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) scaffolds used in RET on apical response type.

Methods: In this study, 38 cases who received RET were evaluated retrospectively. PRP scaffold was used in 16 of the cases and PRF scaffold was used in 22 of the cases. Root development results of the treatment in both treatment groups were evaluated radiographically. The root response type of all cases was classified according to the Chen and Chen index.

Results: Type 3 was found to be the most common apical response type for the treatment groups. There was no statistically significant difference between PRP and PRF treatment groups (p=0,363>0,05). Obliterations were observed in the root canals of some teeth.

Conclusion: It is difficult to predict the apical healing type in RET. Obliterations are a common consequence of RET and the risk of obliteration may increase over time. Although the types of healing differ, all types of healing show successful results in terms of the survival of the teeth. Although healing types vary, all healing types shows successful results in terms of dental survival.

KEYWORDS

Apical Response Type, Platelet-Rich Fibrin, Platelet-Rich Plasma, Regenerative Endodontic Treatment

ÖZ

Trombositten Zengin Plazma ve Trombositten Zengin Fibrinin Rejeneratif Endodontide Apikal Yanıt Tipine Etkisi: Retrospektif Bir Çalışma

Amaç: Rejeneratif endodontide son çalışmalar tedavinin farklı kök gelişim tipleri gösterdiğini ortaya çıkarmıştır. Chen ve Chen indeksinde rejeneratif endodontik tedavi sonrasında 5 farklı kök gelişim tipi rapor edilmiştir. Bu çalışmanın amacı rejeneratif endodontik tedavide kullanılan trombositten zengin plazma (PRP) ve trombositten zengin fibrin (PRF) iskelelerinin kök yanıt tipi üzerine etkisini değerlendirmektir.

Gereç ve Yöntemler: Bu çalışmada rejeneratif endodontik tedavi görmüş 38 tane vaka retrospektif olarak değerlendirildi. Tedavi gören dişlerin 16 tanesine PRP iskelesi, 22 tanesinde PRF iskelesi kullanılmıştır. Her iki tedavi grubunda tedavinin kök gelişim sonuçları radyografik açıdan değerlendirildi. Tüm vakaların kök yanıt tipi Chen ve Chen indeksine göre sınıflandırıldı.

Bulgular: Tedavi grupları için en sık görülen apikal yanıt tipi tip 3 bulundu. İstatistiksel açıdan PRP ve PRF tedavi grupları arasında anlamlı farklılık bulunmadı (p=0,363>0,05). Bazı dişlerde kök kanallarında obliterasyonlar görüldü.

Sonuç: Rejeneratif endodontik tedavide apikal iyileşme tipini tahmin etmek zordur. Obliterasyonlar, rejeneratif endodontik tedavinin yaygın sonucudur ve zamanla obliterasyon riski artabilir. İyileşme türleri farklılık gösterse de tüm iyileşme türleri dişlerin hayatta kalması açısından başarılı sonuçlar göstermektedir.

ANAHTAR KELİMELER

Apikal Yanıt Tipi, Trombositten Zengin Fibrin, Trombositten Zengin Plazma, Rejeneratif Endodontik Tedavi

INTRODUCTION

Treatment results in regenerative endodontics are different compared to traditional endodontic treatments, and this difference has increased the interest in this treatment in recent years.[1] Regenerative endodontics in immature teeth has shown successful results since 2001, especially in terms of ongoing root development and vitality of teeth.[2] As a result of traditional apexification treatments in necrotic immature teeth, root development cannot continue and the roots remain fragile.[3] However, regenerative endodontics strengthens thin and fragile tooth roots by supporting root development.[4]

Creating a healthy pulp tissue that can maintain root maturation by giving vitality to the teeth is one of the goals of regenerative endodontics.[4] However, studies to date have not proven that the tissue formed in the root canals is real dental pulp.[5] Instead, it was observed that bone-like, cement-like, periodontal tissue-like tissues were formed.[6] It has been shown in many studies that regenerative endodontics with these hard tissue formations promotes root length increase and dentin thickness increase.[7] As a result of all these studies, regenerative endodontic treatment (RET) is considered as the first treatment option for immature teeth.[8]

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In studies, root development was generally examined with two-dimensional radiographs.[3] However, when root development is examined in three dimensions, irregular and defective areas are seen.[9] Healthy tissues and cells in the tooth roots can be damaged due to infection and trauma. In addition, damage to the Hertwig's epithelial root sheath (HERS) may adversely affect root maturation.[10] This unpredictability of root development may be caused by abnormal interactions of HERS and mesenchymal stem cells in the dental follicle.[11] As a result of these uncertain and unpredictable processes, although RET supports root development, root growth types may differ.[12] Chen et al.[12] reported 5 types of apical response types seen in teeth after RET.

Scaffolds that can guide new tissues to be formed are used in RET.[13] Among them, the most commonly used scaffold is the blood clot obtained through apical bleeding.[14] However, when bleeding cannot be obtained, it can be waited until the periapical tissues heal.[1] Tissue scaffolds such as platelet-rich plasma (PRP), platelet-rich fibrin (PRF) obtained by centrifugation of blood taken from the patient are also frequently used in regenerative endodontics.[15] PRP is preferred as a potential scaffold in regenerative endodontics due to its abundant growth factor.[16] Compared to PRP obtained using anticoagulant tubes, PRF can be easily obtained from endogenous components only.[17] The aim of this study is to compare and evaluate the apical response types of RET using PRP and PRF radiographically. The null hypothesis of this study is that there is no difference between PRP and PRF scaffolds on the apical response type of RET.

MATERIAL AND METHODS

This research was conducted with the approval of Selçuk University Faculty of Dentistry Non-Interventional Clinical Research Ethics Committee No. 2020/51. In this study, patients who had undergone RET using PRP or PRF scaffold between 2014-2019 were screened through their treatment records. Written informed consent form was obtained from the parents for the use of radiographic images recorded on Picture Archiving and Communication Systems (PACS). According to the archive records, a total of 38 (4 patients with 2 teeth each) immature permanent teeth, consisting of 34 (14 boys, 20 girls) healthy cooperative patients who had undergone RET, were included in this study. Those who had missing archive records or did not want to participate in the study were excluded from the study. 32 of the cases were infected by trauma and 6 of them were infected with caries. Out of 38 teeth, 32 are incisors and 6 are premolars. The ages at which the patients came to the last control ranged from 9 to 19. As a result of the negative response of the teeth to both the cold test (Endo-Frost; Coltene-Roeko, Langenau, Germany) and the electric pulp (Digitest, Parkell Inc, Brentwood, NY) test, the diagnosis of necrosis was made and RET was planned. The treatments were performed by three different dentists. The clinical and radiographic records of the treatment results were made by the same dentists.

The current treatment protocol of the American Endodontists Association was taken as reference.[4] A diagnosis of necrosis of the teeth was made and treatment was started after local anesthesia (4% articaine with vasoconstrictor: Ultracaine DS Forte; Aventis, Istanbul, Turkey). The access cavity was opened under rubber dam isolation. Radiographs were used to determine the working length. Working length in root canals was determined to be 1 mm behind the root apex. The channels were gently irrigated with 20 mL of 1.5% sodium hypochlorite for 5 minutes. Finally, the canal irrigation was completed using 20 mL of saline. After the canals were dried, triple antibiotic paste (TAP) (a mixture of 250 mg ciprofloxacin, 400 mg metronidazole, and 50 mg minocycline in a 1:1:1 ratio) was placed in the canal for disinfection. The cavity was closed temporarily with glass ionomer cement (Fuji™ II, GC Corporation, Tokyo, Japan) and a second appointment was called 3 weeks later.

If the symptoms (swelling, fistula, purulent drainage, ongoing pain, and sensitivity to percussion and palpation) persisted, the first session was repeated. After the symptoms disappeared, local anesthesia without adrenaline (3% mepivacaine: Citanest; AstraZeneca, London, UK) was applied in the second session. After isolation, the access cavity was opened. Root canals were irrigated with 20 mL of 17% Ethylenediaminetetraacetic acid (EDTA) for 5 minutes and then dried. Bleeding was achieved by overinstrumentation of 2 mm with a sterile K-file from the root apex. Afterwards, PRP was prepared according to Okuda et al.[18] Immediately after the blood was taken from the patient, it was filled into sterile tubes coated with an anticoagulant and centrifuged at 2400 revolutions per minute (rpm) for 10 minutes. After the first centrifugation, PRP and platelet-poor plasmas were separated from red blood cells. A second centrifugation was then performed at 3600 rpm for 15 minutes. The PRP remaining under the tube was taken into a sterile syringe. In 16 cases, the PRP scaffold was injected 3 mm below the cemento-enamel junction with the help of a 27-G sterile injector. On the scaffold 3 mm Mineral trioxide aggregate (MTA) (ProRoot MTA; Dentsply Tulsa Dental, Tulsa, OK) was sealed. In the same session, the final restoration was completed with glass ionomer cement (Fuji™ II, GC Corporation, Tokyo, Japan) and composite resin (ceram.x SphereTEC one universal, Dentsply Sirona, USA).

PRF prepared according to Dohan et al.[17] was used in 22 cases. Immediately after the blood was taken from the patient, it was filled into without anticoagulant sterile tubes and centrifuged at 3000 rpm for 10 minutes. The scaffold was removed from the tube with sterile tweezers. The PRF scaffold was placed 3 mm below the cemento-enamel junction using sterile pluggers in small pieces. Subsequently, MTA, glass ionomer cement and composite resin restoration were performed as described above. Patients were called for control appointments. Clinical and radiographic treatment results were evaluated. The PRP or PRF scaffold to be used in the treatments was selected according to the clinical conditions (presence of coagulant/non-coagulant tube).

The clinical evaluation results of all patients who received regenerative endoodontic treatment were recorded in the treatment follow-up forms of our faculty. In the records, it was noted whether there was any symptom (swelling, fistula, purulent drainage, ongoing pain, and sensitivity to percussion and palpation) in the teeth. Radiographs were taken to assess the health of the periapical tissues in the control appointments.

Diagnostic and control films of all cases included in this study were recorded on the computer. Root development of all recorded cases was evaluated by a single dentist according to the apical response type classification of chen et al.[12] There are 5 different types of apical response in this classification.

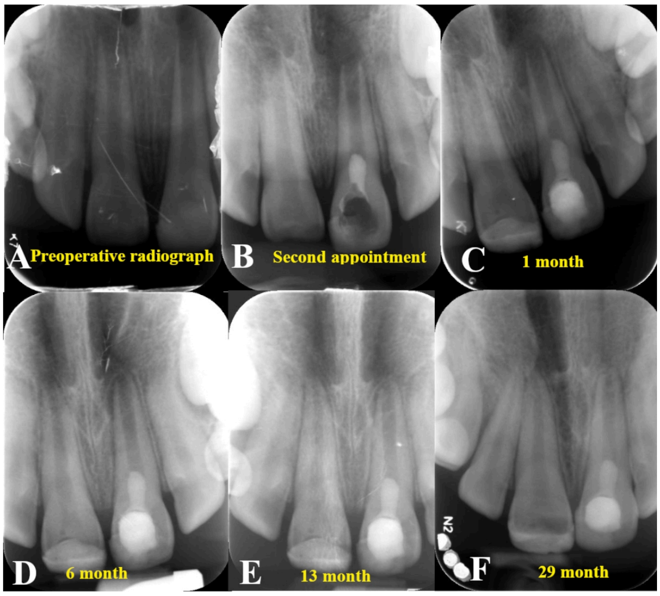

Figure 1

Thickening of the canal walls and continued root maturation (Type 1: PRF case 17)

Figure 2

Blunt closure of the root tip and no obvious continuation of root development (Type 2: PRF case 22)

Figure 3

Although the root tip remained open, root development continued (Type 3: PRP case 3)

Figure 4

Severe obliteration of the canal space (Type 4: PRP case 10)

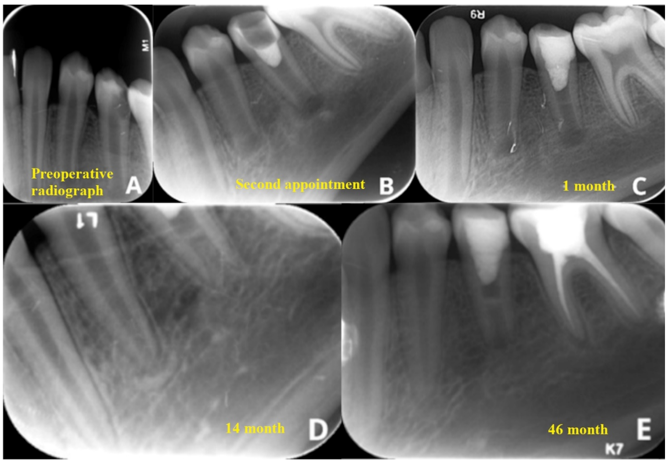

Figure 5

Hard tissue barrier between the coronal MTA plug and the root apex in the canal (Type 5: PRP case 4)

Evaluation results were recorded in SPSS software. Both treatment groups were analyzed statistically using the Chi-Square test.

RESULTS

The follow-up period of the cases varies between 12-77 months. All cases showed periapical healing clinically and radiographically. However, a case with Type 5 root response started to show symptoms of pain and percussion sensitivity in the 77-month follow-up. Demographic information, follow-up times, etiologies, and apical response type of the cases are shown in Table 1. The apical response types were shown radiographically on the cases (Fig. 1-5).

Table 1

Demographic data and apical response types

	Platelet-Rich Plasma					Platelet-Rich Fibrin				
Case	A/S	E	TN	T	ART	A/S	E	TN	T	ART
1	14/M	T	22	59	4	19/M	T	11	24	3
2	13/F	T	21	48	1	9/M	T	11	22	5
3	18/M	T	11	48	3	9/M	T	21	13	3
4	13/F	D	35	46	5	14/M	T	21	21	3
5	15/F	T	11	30	3	10/F	T	22	19	1
6	14/F	D	35	30	3	12/M	T	11	39	3
7	13/M	T	11	51	3	12/M	T	21	39	3
8	14/M	T	21	31	5	9/F	T	11	20	3
9	11/M	T	21	36	5	9/F	T	21	15	3
10	11/F	T	21	55	4	16/F	D	34	31	4
11	14/M	T	21	55	2	11/F	T	21	46	4
12	14/F	T	21	77	5	10/M	T	21	21	1
13	12/F	D	45	49	2	13/F	D	45	33	2
14	13/F	T	11	57	3	11/F	T	11	32	3
15	14/M	T	21	58	4	11/F	T	21	32	3
16	12/F	T	21	55	5	14/M	T	21	32	5
17						10/M	T	21	29	1
18						14/F	T	21	12	3
19						14/F	T	21	33	3
20						17/F	D	34	30	3
21						11/F	T	11	24	4
22						10/F	T	21	25	2

A/S, age/sex (M, male; F, female); ART, apical response type; E, etiology (T, trauma; D; decay); T, time (month); TN, tooth no

In this study, apical response types of all cases were found to be type 1 10.5% (n=4), type 2 10.5% (n=4), type 3 44.7% (n=17), type 4 15.8% (n=6), and type 5 18.4% (n=7), respectively, without separating the treatment group. The most common apical response type in the PRP (n=5) group was type 3 an table 2d 5, in the PRF (n=12) group was type 3. Apical response type between the PRP and PRF groups were statistically insignificant (p=0,363>0,05).

Table 2

Apikal yanıt tiplerinin tedavi gruplarına göre dağılımı ve ki kare değeri

	Platelet-rich plasma n (%)	Platelet-rich fibrin n (%)	Total n (%)
Type 1	1 (6.3)	3 (13.6)	4 (10.5)
Type 2	2 (12.5)	2 (9.1)	4 (10.5)
Type 3	5 (31.3)	12 (54.5)	17 (44.7)
Type 4	3 (18.8)	3 (13.6)	6 (15.8)
Type 5	5 (31.3)	2 (9.1)	7 (18.4)
Total	16 (100.0)	22 (100.0)	38 (100.0)
Chi-Square/p		4,329/0,363	

Severe canal obliteration was seen in 3 cases in each of the PRP and PRF groups. A hard tissue barrier was seen between MTA and root apex in 5 cases in the PRP group and in 2 cases in the PRF group. One of the most common apical response types in the PRP group was type 5.

DISCUSSION

In recent years, RET has gained popularity and has even become the first choice for the treatment of immature teeth.[8] However, there are rare cases where RET is not indicated, such as cases where an intracanal post is required for restoration, those who are allergic to the intracanal paste, noncompliant parents and patients.[4]

The continuation of root development with the formation of hard tissue after RET has been shown radiographically in many studies.[3,12,15] Root development is much more successful in RET, especially when compared to apexification treatment.[19] Etiological factors such as pulp necrosis level, patient's age, tooth type, trauma may affect periapical healing.[20] Lin et al.[21] reported in their study that etiological factors such as trauma have an adverse effect on root development. Odontoblasts that differentiate from ectomesenchymal cells in the apical papilla after receiving a signal from HERS, forms root dentin.[22] HERS and the apical papilla may lose vitality depending on the extent of infections such as apical periodontitis. For this reason, root development stops and it cannot be predicted how root development, which can be affected by many factors, will occur in regenerative endodontics.[23]

Selvakumar et al.[24] reported a type 5 response in only one case and a type 3 response in all the remaining cases. In the study of Jiang et al.[25], type 1 and 3 root response types are the most common after RET. Shetty et al.[26] observed all apical response types except type 2 after RET in three-dimensional radiographic examinations. Again, the most common apical response type was type 3. The absence of type 2 apical response type is thought to be a clearer observation of root elongation in three-dimensional images.[26] In the study of Shivashankar et al.[27] using blood clot, PRP, and PRF scaffolds, type 3 was the most common apical response type for each treatment group. Types 4 and 5 responses were the least common apical response types.[27] In our study, all apical response types were seen, and in addition, the most common response was type 3 for both treatment groups. This result agrees with the previous studies. In our study, TAP was used in all cases and this paste may have a cytotoxic effect on apical papilla stem cells.[28] Even if used in low concentration, TAP may have a cytotoxic effect on stem cells, causing the apical foramen not to be closed. When our study is evaluated together with other studies, the most common result of RET can be considered as the continuation of root development while the apical foramen remains open. However, although this is the result, the short follow-up periods in some cases limit the continuity of apical development.

One of the consequences of RET is canal obliteration. Obliterations are common especially after acute dental trauma and are more common in immature teeth than in mature teeth.[29] The cause or mechanism of hard tissue formation in root canals after RET is unknown.[12] However, there are studies stating that the use of calcium hydroxide may increase the risk of obliteration.[30] In addition, high obliteration rates have been reported in some studies using TAP.[31] As another option, when the blood clot is used as a scaffold, the hard tissue thickenings that progress extensively in the root walls are also responsible for the formation of obliteration.[3, 32] The reason for this may be that bleeding from the root apex contains periodontal ligament and alveolar bone stem cells and these cells have a high potential to produce hard tissue.[31] The osteoinductive activity of the MTA material placed on the clot may also be associated with the risk of obliteration.[33] Chueh et al.[32] reported 2 total and 21 partial canal obliterations in a study of 23 cases. In addition, there are many studies showing different degrees of obliteration after RET.[27,31,34] Obliterations in the canals may complicate the chances of endodontic treatment that may be required in the future.[15] However, endodontic treatment is not recommended unless the teeth are symptomatic.[35] Wang et al.[33], in a histological study in dogs, showed that in the apical third of the canals, cementum tissue in the canal formed a hard tissue bridges with growth. Case reports have been published that started as a hard tissue barrier (type 5) and then turned into total canal obliteration (type 4). This clearly demonstrates the progressive nature of root canal obliteration over time.[31] When all these studies are evaluated, hard tissue barrier and canal obliteration are possible consequences of RET. In our study, severe obliteration (type 4) was observed in 6 cases (3 PRP, 3 PRF), and hard tissue barrier (type 5) was observed in 7 cases (5 PRP, 2 PRF). Obliteration was observed in over 34% of cases in total. In fact, one of the most common apical response types in the PRP group was type 5. Although statistically insignificant, more hard tissue barrier formation was observed in the PRP group compared to PRF. The probable reason for this may be that the follow-up period of the PRP group was much longer. Over time, obliteration and an increase in the number of hard tissue barriers may occur.

CONCLUSION

PRP and PRF scaffolds were statistically insignificant on the apical response type. In this case, the null hypothesis was accepted. It is difficult to predict the apical healing type in RET and more studies are needed to better understand this issue. Obliterations are another common consequence of RET and the risk of obliteration may increase over time. Although healing types vary, all healing types shows successful results in terms of dental survival.

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Conflict of Interest

The authors declared no conflict of interest.

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