Case Report

Cone-beam Computed Tomography Evaluation Timings of Closure of Open Apex by Using Deciduous Tooth Pulp Autotransplantation for the Regenerative Endodontic Treatment of Permanent Teeth with Pulp Necrosis

Abhinandan Patra[1], Sonal Gupta[1], Rohan Shrivastava[1], Sheenam Ayub[1], Meghali Langthasa[2]

[1]Department of Pediatric and Preventive Dentistry, Kanti Devi Dental College and Hospital, Mathura, Uttar Pradesh, India, [2]Department of Pediatric and Preventive Dentistry, GDC, Dibrugarh, Assam, India

Abstract

Regenerative endodontic therapy (RET) of young permanent teeth with necrotic pulps and apical periodontitis in young people, deciduous tooth pulp may be utilized as a natural, biologic scaffold. Recent developments in stem cell biology and material sciences are beneficial for new treatment methods. Previously traumatized and necrotic young permanent tooth was treated with RET protocol. In the first visit, irrigation, and placement of triple antibiotic paste dressing were done. After that in the second visit, intracanal medication was removed and whole pulp tissue harvested from the deciduous tooth was transplanted in the young permanent tooth. Following placement of Biodentine® coronal barrier, access cavity was restored with acid-etch resin composite. This case report would highlight favorable outcome of RET using deciduous pulp autotransplantation in young permanent tooth using cone-beam computed tomography for 6 months' follow-up.

Keywords: *Autologous transplantation, deciduous tooth pulp, regeneration, regenerative endodontics*

Introduction

Dental pulp is an important component of tooth structure which primarily helps in the formation of reparative dentin. In contrast to the deposition of primary and secondary dentin, tertiary dentinogenesis represents a defensive function of the pulp because it is stimulus dependent.[1] Because odontoblasts and other cells are supplied with oxygen and metabolites through arterioles and sub odontoblastic capillaries, the pulp tissue also serves as a source of nutrition. When pulp necrosis occurs, the entire pulp tissue is degraded and loses all functions. As a result, bacteria colonize the empty root canal and form a biofilm that must be removed by thorough disinfection.[1]

Dental pulp necrosis, which results from caries, trauma, and improper endodontic care, has become one of the most prevalent health issues. In addition to affecting the long-term life and maintenance of teeth, dental pulp necrosis can function as a breeding ground for bacteria that can infect periapical tissue and even the craniofacial region. The most effective treatment for pulp necrosis to date is root canal therapy, which involves replacing inflammatory or necrotic pulp tissue with synthetic filling materials. However, neither the injured pulp's vitality nor the neurovascular system is reconstituted by this conventional treatment.[2] Therefore, restorative dentistry and endodontics are trending toward a regenerative approach for the pulp/dentin complex.

Regenerative endodontic Procedure (REPs), also known as "revascularization" and "revitalization," are designed to encourage the ingrowth of new, vascularized tissue inside the cleaned-out root canal area after the administration of stem cells from the apical papilla.[3] The transplantation of the entire pulp might yield the optimal "scaffold" for the differentiation of dental pulp stem cells (DPSCs) in their natural environment[4] without the risk of host rejection. The same potential applies to deciduous tooth pulp, which is a rich source of highly proliferated stem cells and growth factors in a natural scaffold containing

How to cite this article: Patra A, Gupta S, Shrivastava R, Ayub S, Langthasa M. Cone-beam computed tomography evaluation timings of closure of open apex by using deciduous tooth pulp autotransplantation for the regenerative endodontic treatment of permanent teeth with pulp necrosis. Contemp Clin Dent 2024;15:279-84.

Submitted : 05-Jul-2023
Revised : 23-May-2024
Accepted : 21-Aug-2024
Published : 24-Dec-2024

Address for correspondence:
Dr. Abhinandan Patra, Department of Pediatric and Preventive Dentistry, Kanti Devi Dental College and Hospital, Mathura - 281 001, Uttar Pradesh, India.
E-mail: abhi007patra@gmail.com

Access this article online

Website: https://journals.lww.com/cocd

DOI: 10.4103/ccd.ccd_307_23

Quick Response Code:

vasculature.[3] Furthermore, nerves and blood vessels are formed, thereby facilitating the revascularization and connective process of transplanted pulp.[3,4] For more than 20 years, platelet products have been employed in tissue regeneration and dentistry. They have shown significant promise in creating the best scaffold for pulp regeneration. Platelet-rich fibrin (PRF) the second-generation platelet concentrate, is a kind of purely natural autologous fibrin matrix with trapped platelets and leucocytes, guaranteeing the prolonged release of growth factors and cytokines.[2-4] Blood clot revascularization (BCR) is the most common revascularization method and is formed by an endodontic file introduced into the root canal beyond the apical foramen to provoke bleeding from the periapical tissue. The clot that develops in the canal space after the root canal has been passively filled with blood acts as a biologic scaffold for cell proliferation and differentiation. In addition, the blood clot contains several blood-derived growth factors that can draw additional stem cells from the periapical tissues. These stem cells can then start the ectopic deposition of mineralized tissues (such as bone and cementum) inside the root canal and cause a progressive narrowing of the canal space, which could make future endodontic treatment more difficult.[3,4]

Cone-beam computed tomography (CBCT) provides a clear three-dimensional view of the teeth and the associated structures. CBCT is valuable in treatment planning, as the proper dentinal thickness or root formation can be seen.[2]

Thus, this case study presents the autotransplantation of deciduous tooth pulp as a scaffold for the biologically based endodontic treatment of traumatized, necrotic young permanent teeth, and the 12 months' clinical and radiographic CBCT outcomes comparing the DPSCs, PRF, and BCR of blunderbuss canals.

Case Report

A 9-year-old boy referred department to pediatric dentistry for the endodontic and restorative treatment of traumatized maxillary incisors. On detailed enquiring about a history of the present illness, the patient parent revealed that he had experienced a fall accident 1 year earlier, but detained to visit a dentist. During intraoral examination, it revealed complicated crown fractures of 11 (upper right central incisor), 12 (upper right lateral incisor), and 21 (upper left central incisor) with the absence of pain on percussion, swelling, sinus tracts, and mobility [Figure 1]. The fractured incisors did not respond to heat test and electric pulp tests, whereas the contralateral and neighboring teeth responded positively to both tests. Radiographic examination showed open apex and slight radiolucency in the 12, 11, 21 [Figure 2]. When diagnosis was done, it revealed that Ellis Class 4 fracture with respect to 11, 21 which were in Nolla's Stage 8 and Ellis Class 3 fracture with respect to 12 which were in Nolla's Stage 7. Blunder buss was present with respect to 11, 21 and 21. Donor deciduous canine 53

Figure 1: Preoperative

showed no caries or any periapical pathology. Preoperative CBCT of 12, 11, 21 shows open apex in cross sectional view [Figure 2].

A regenerative endodontic treatment protocol using deciduous pulp autotransplantation with respect to 21, platelet-rich fibrinogen with respect to 11, and induced bleeding with respect to 12 was planned. This was done because the affected teeth had varying degrees of incomplete apical closure and there were nearby intact donor primary teeth available. Informed consent was obtained parent after explaining and discussing the possible outcomes of treatment.

Autotransplantation protocol

All teeth underwent a common, 2 visit regenerative endodontic treatment protocol.

At the first appointment, the incisors requiring treatment were isolated with an Optradam, local anesthesia, and endodontic access was obtained with water-cooled high-speed diamond burs. By using a traditional radiography technique, the root canal length was calculated. Without utilizing any equipment, the root canals were gently irrigated with 20 ml of 3% sodium hypochlorite (NaOCl) and 17% ethylenediaminetetraacetic acid using close-ended, side-vented needles that were positioned 2–3 mm below the apex. Following copious irrigation with sterile saline, the root canals were dried with sterile paper points, and triple antibiotic paste with carrier propylene glycol placed into root canals and sealed with temporary cement and the patient was recalled after 4 weeks.

At the second appointment for tooth 21, a disinfection and isolation protocol, based on a previously described report to acquire sterile pulp samples, was performed before operative procedures. Accordingly, the patient first rinsed with 0.12% chlorhexidine mouthwash for 30 s Then the injection site for the local anesthetic involving the primary canine #53 was scrubbed with 10% povidone iodine for 2 min. Optradam, previously disinfected by thorough scrubbing with 10% povidone iodine for 2 min was placed exposing only the primary canine #53. Then, the interface of tooth and rubber dam were sealed with light cured resin barrier [Figure 3]. Mechanical pulp exposure with respect to 53 (donor) done and pulp tissue removed using

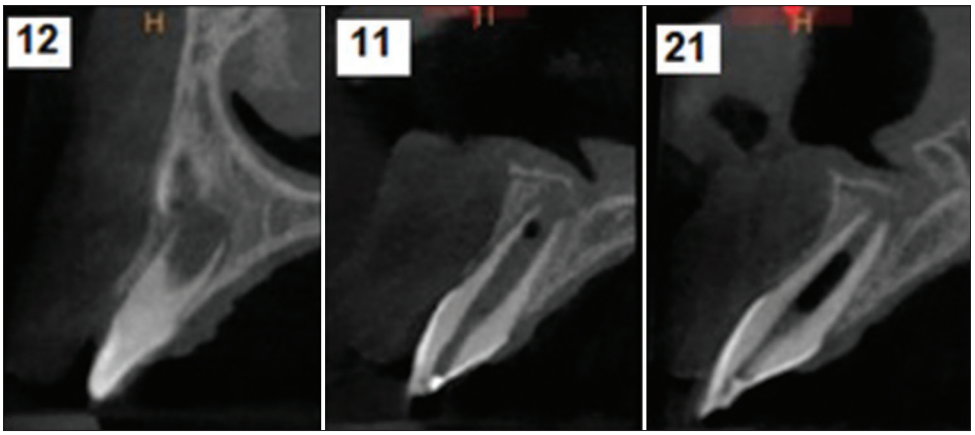

Figure 2: Preoperative CBCT of teeth irt #12-Right upper lateral incisor, #11-Right upper central incisor, #21- Left upper central incisor

Figure 3: Optradam isolation

presterilized barbed broach [Figure 4] and gently inserted into recipient root canal of tooth 21 using disinfected gutta percha (GP) cones followed by Biodentine® placement over the deciduous pulp scaffold and later deciduous tooth is obturated with Metapex® [Figure 5]. Five milliliters of whole blood was collected from patient's median cubital vein. The blood sample was subjected to centrifugation at 2400 rpm for 12 min to prepare PRF (Choukroun's method). At the second appointment for tooth 11, placement of PRF in to canal space up to middle third were done and followed by the placement of Biodentine up to 3–4 mm [Figure 4]. The surgical procedure for tooth 12 was performed during the second session by inducing bleeding using a k-file size #25 at 2 mm post the apical foramen with the aim of filling the whole canal with blood up to the level of the cementoenamel junction. Cotton pellet was placed till the clotting of blood seen in canal and Biodentine placed over clotted blood scaffold and later orifice sealed with glass ionomer cement (GIC) [Figure 6]. Then, wet cotton roll placed over the surface of Biodentine sealed canal and followed by GIC placement. The patient was recalled on 1, 3, and 6 months for CBCT to evaluate the evident calcification, revascularization and constriction is seen in apical third of root treated. Resulted #21 (treated with pulp stem cells) shows evident calcification and constriction is seen in apical third of root treated in 1 month and conical closure pattern seen in 3 months [Figure 7]. #11 (treated with PRF) shows calcification at the level of middle third of the root in 3 months and apical constriction seen at 6 months (blunt closure pattern) [Figure 8]. #12 (Treated with induced bleeding) shows calcification at the level of middle third of the root in 3 months and apical constriction seen at 6 months still under follow-up [Figure 9].

Discussion

Open apex refers to incomplete closure of the root canal apex due to insufficient root formation, which resulted in a difference in canal morphology. A blunderbuss canal is another name for it since the canal's conical form has been altered.[5] Open apex can be treated surgically or nonsurgically, depending on the approach used. The nonsurgical approach included a basic endodontic root canal procedure, which included apexogenesis by roll cone technique or apexification with mineral trioxide aggregate (MTA), Biodentine, or calcium hydroxide ($Ca[OH]_2$), which was later finished with obturation by GP.[5] The surgical method involved the excision of the apex surgically, followed by retrograde sealing and GP obturation.[6] Due to the fragile dentinal and root canal walls, the tooth with an open apex frequently presents a number of technical challenges, including partial pulp removal, incomplete apical seal development, and inappropriate filing.[7] By properly establishing the apical barrier and promoting hard tissue growth at the apex (also referred to as apexification), this can be prevented. Apexification can be carried out using a variety of biocompatible materials, including $Ca(OH)_2$, MTA, Biodentine, and bone morphogenetic protein.[8]

A mixture of antibiotics (ciprofloxacin, minocycline, and metronidazole) has been used to disinfect the affected necrotic root canals. Removal of bacteria from the canal, especially in the deeper layers of infected root, plays a key role in revascularization success.

Due to their relative simplicity when compared to apexification procedures and their favorable patient- and clinician-based outcomes, which include periapical healing, tooth survival and function, and radiographic root length, current REPs using the so-called revascularization or revitalization technique with induced apical bleeding have been used extensively for the endodontic treatment of immature permanent teeth with pulp necrosis. It should be noted that unpredictability in treatment results can result from the level of damage to Hertwig's epithelial root sheath and apical papilla brought on by trauma or apical periodontitis. This limits the capability of the new, vascularized repair tissue to support continuing root growth.[9,10] When used without prior apical bleeding, autologous platelet concentrates can induce root growth and innervation with a significantly lower risk of progressive root canal obliteration, making them the most suitable alternative scaffold to the blood clot, according to published literature.[8] However, platelet concentrates are more expensive and unfriendly to patients, particularly in kids and teenagers.[10] In an animal model, it has previously been demonstrated that employing autologous deciduous tooth pulp as a biologic scaffold for regenerative endodontic therapy is feasible.[11]

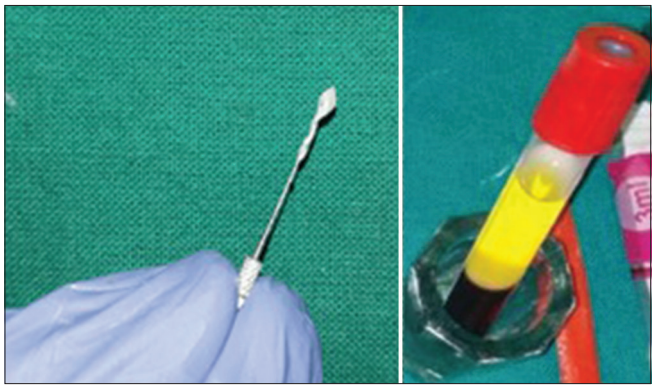

Figure 4: Pulp stem cell and platelet rich fibrinogen and insertion in respect to 21 and 11

Figure 5: IOPAR in respect to #11 with platelet rich fibrin and #21 with pulp stem cell and Doner #53 with Metapex

This case report presents the clinical use of deciduous pulp autotransplantation and its 12-month outcomes. Clinically, deciduous pulp autotransplantation may have several advantages in children and young patients due to its accessibility and lack of need for apical hemorrhage or onerous peripheral blood collection to obtain platelet-derived scaffolds. Furthermore, the complete course of therapy may be carried out in a clinical environment without the requirement for extra tools or laboratory techniques.[12] A large population of stem cells with a faster rate of proliferation than those from adult human teeth may be found in deciduous pulp, which serves as a biologic scaffold.[13] Several growth factors, including transforming growth factor-beta, fibroblast growth factor-2, platelet-derived growth factor, and vascular endothelial growth factor, are also present in deciduous pulp in a natural micro environment. Dental pulp is not the main source of growth factors, but should ideally contain them if used as a scaffold and source of cells in a regenerative therapy.[12,13]

Considering risk of extrusion of NaOCl solution during intracanal irrigation, particularly with conventional or positive pressure-based irrigation methods, the "Paper point" technique can be further supplemented with the "Reservoir" technique by using a dental syringe or irrigants delivery device to carry and deposit a few drops of NaOCl

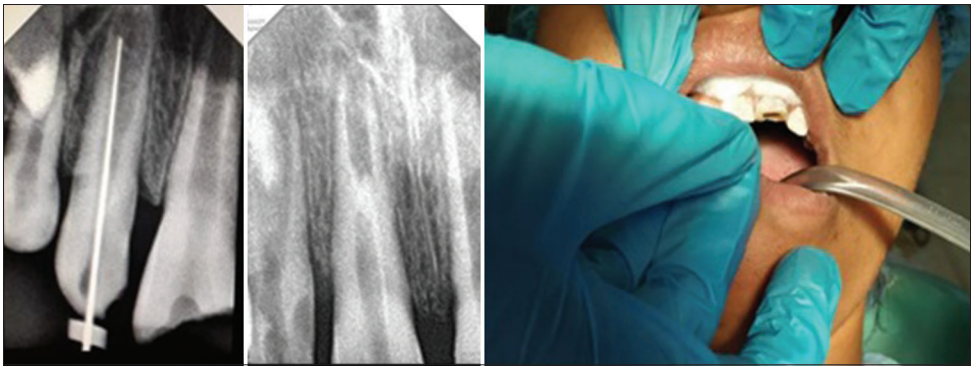

Figure 6: IOPAR in respect to #12 with bleeding induced

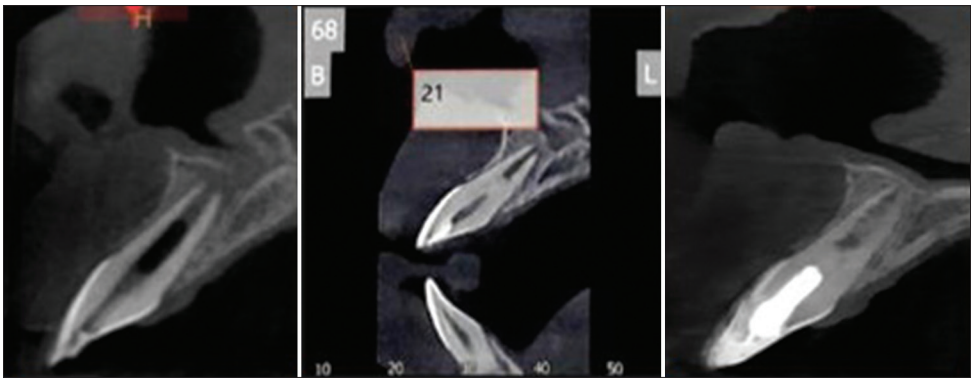

Figure 7: CBCT of pulp stem cell treated tooth irt #21 (From left to right)- Postoperative, 1 month and 3 months

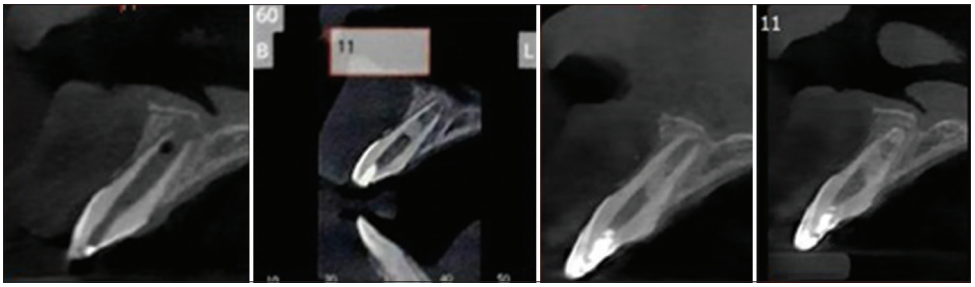

Figure 8: CBCT of PRF treated tooth irt #11 (From left to right)- Postoperative, 1 month and 3 months

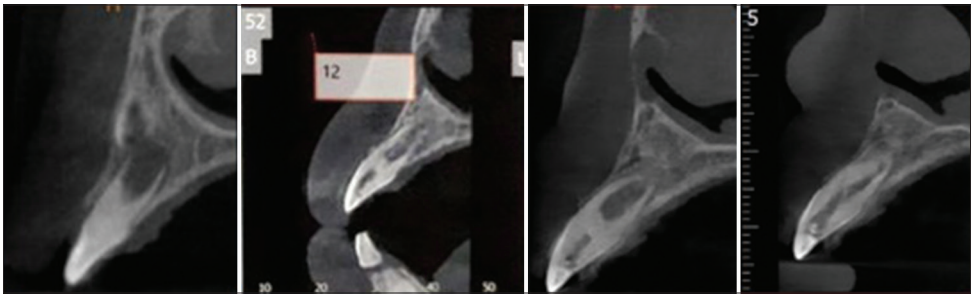

Figure 9: CBCT of bleeding induced tooth irt #12 (From left to right)- Postoperative, 1 month and 3 months

solution passively into the pulp chamber and/or access cavity, and the paper point does the rest by wicking or capillary action. The supplemented technique may still carry the risk of NaOCl extrusion in cases with an open apex, a blunderbuss canal, or an apex that has widened due to resorption or over instrumentation because the apical access allows for easy seepage of NaOCl solution and it is challenging to control a paper point, file, or GP point to the desired length.[14]

Regarding to radiographic (CBCT) changes, there was complete healing of the radiolucent lesions in the patients showing evident calcification and constriction is seen in apical third of root treated in 1 month and conical closure pattern seen in 3 months in the tooth treated with pulp stem cells. Followed by PRF which shows calcification at the level of middle third of the root in 3 months and apical constriction seen at 6 months and blunt closure pattern of root end was formed. Moreover, last tooth treated with induced bleeding shows calcification at the level of middle third of the root in 6 months and apical constriction seen at 6 months, but no apical closure was seen at the root end so still under follow-up. With regard to changes in root length, there was an increase in root length. In terms of changes in root dentine thickness, there was significant increase in root dentin thickness at pulp stem cell transplant compared with the PRF and Bleeding induced, and this result may be due to the difference in the growth factor presence in the scaffold.

These DPSC retain the ability to tissue regeneration and can proliferate into newly formed blood clot matrix, differentiating into odontoblasts, and depositing third-degree or tubular dentin.[15,16]

The more plausible explanation for the mechanism of revascularization in the apical papilla of undeveloped teeth is the papilla has collateral circulation that enables it to survive during the process of pulp necrosis. The step of inducing a hematopoietic column leads to a large accumulation of growth factors into the canal space.

Furthermore, it contributes to the regeneration of pulpal tissues, and under the influence of epithelial cells surviving from epithelial sheath of Hertwig's roots; it can differentiate into primary odontoblasts to continue root formation.[17]

The present case report suggests that deciduous pulp may have a potential for use as a biologic scaffold in the regenerative endodontic treatment of necrotic and open-apex of young permanent teeth, using a patient friendly, uncomplicated autotransplantation, same donor protocol without the need to extract the donor deciduous tooth.

Conclusion

Pulp autotransplantation is a newer treatment for regenerative endodontic procedures, it seems effective for immature teeth because it allows faster root formation as compared to PRF and bleeding induced.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the legal guardian has given his consent for images and other clinical information to be reported in the journal. The guardian understands that his names and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

Acknowledgments

Words can never express my gratitude towards you. Thanks for all your sacrifices, daddy and mummy dearest Dr Kanai Lal Patra and Mrs. Tanusri Patra. Also, thanks for giving me best HOD mam, Dr. Sonal Gupta who actually made us feel so much like a family, to have such guide you actually need to be blessed. I can no other answer make but thanks, and thanks, and ever thanks to Dr Sourav Majhi (DADA), Department of Oral and Maxillofacial Surgery, KDDC, Mathura

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Schmalz G, Widbiller M, Galler KM. Clinical perspectives of pulp regeneration. J Endod 2020;46:S161-74.
2. Liang Y, Ma R, Chen L, Dai X, Zuo S, Jiang W, *et al.* Efficacy of I-PRF in regenerative endodontics therapy for mature permanent teeth with pulp necrosis: Study protocol for a multicentre randomised controlled trial. Trials 2021;22:436.
3. Cehreli ZC, Unverdi GE, Ballikaya E. Deciduous tooth pulp autotransplantation for the regenerative endodontic treatment of permanent teeth with pulp necrosis: A case series. J Endod 2022;48:669-74.
4. Feitosa VP, Mota MN, Vieira LV, de Paula DM, Gomes LL, Solheiro LK, *et al.* Dental pulp autotransplantation: A new modality of endodontic regenerative therapy-follow-up of 3 clinical cases. J Endod 2021;47:1402-8.
5. Thiyagarajan G, Manoharan M, Veerabadhran MM, Murugesan G, Vinodh S, Kamatchi M. Biodentine as bioroot inlay: A case report. Int J Clin Pediatr Dent 2023;16:400-4.
6. Cvek M. Prognosis of luxated non-vital maxillary incisors treated with calcium hydroxide and filled with gutta-percha. A retrospective clinical study. Endod Dent Traumatol 1992;8:45-55.
7. Kvinnsland SR, Bårdsen A, Fristad I. Apexogenesis after initial root canal treatment of an immature maxillary incisor – A case report. Int Endod J 2010;43:76-83.
8. Grech L, Mallia B, Camilleri J. Characterization of set intermediate restorative material, biodentine, bioaggregate and a prototype calcium silicate cement for use as root-end filling materials. Int Endod J 2013;46:632-41.
9. Cvek M. Treatment of non-vital permanent incisors with calcium hydroxide. I. Follow-up of periapical repair and apical closure of immature roots. Odontol Revy 1972;23:27-44.
10. Shamszadeh S, Asgary S, Nosrat A. Regenerative endodontics: A scientometric and bibliometric analysis. J Endod 2019;45:272-80.
11. Huang Y, Tang X, Cehreli ZC, Dai X, Xu J, Zhu H. Autologous transplantation of deciduous tooth pulp into necrotic young permanent teeth for pulp regeneration in a dog model. J Int Med Res 2019;47:5094-105.
12. Ulusoy AT, Turedi I, Cimen M, Cehreli ZC. Evaluation of blood clot, platelet-rich plasma, platelet-rich fibrin, and platelet pellet as scaffolds in regenerative endodontic treatment: A prospective randomized trial. J Endod 2019;45:560-6.
13. American Association of Endodontists. AAE Clinical Considerations for a Regenerative Procedure. Available from: https://www.aae.org/specialty/clinical-resources/regenerativeendodontics/. [Last accessed on 2021 Dec 06, Last revised on 2021 May 05].
14. Pai AR. Sodium hypochlorite irrigation and safety. Br Dent J 2023;234:488.
15. 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;46:1074-84.
16. Lin LM, Huang GT, Sigurdsson A, Kahler B. Clinical cell-based versus cell-free regenerative endodontics: Clarification of concept and term. Int Endod J 2021;54:887-901.
17. Mishra N, Narang I, Mittal N. Platelet-rich fibrin-mediated revitalization of immature necrotic tooth. Contemp Clin Dent 2013;4:412-5.