

原文題目(出處)：	Long-term follow up of revascularization using platelet-rich fibrin. Dental Traumatology 2016;32: 80-4
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報告日期：	105.9.8

內文：

● Abstract :

1. Introduction:

- Prior to regenerative endodontics, treatment of necrotic, immature teeth with open apices was limited to long-term calcium hydroxide (Ca(OH)<sub>2</sub>) apexification and subsequent root canal therapy or extraction.
- Through revascularization, retention of these teeth and the elimination of patient symptoms and the radiographic appearance of continued root development were obtained.

2. Case review:

- This report illustrates a revascularization protocol through a case where platelet-rich fibrin (PRF) was utilized as an autologous scaffold for traumatized, necrotic, immature teeth with incomplete root development.

3. Discussion:

- This case demonstrates the feasibility of utilizing PRF as an effective treatment protocol for traumatized teeth in lieu of traditional treatment protocols.

● Introduction :

1. Dental caries and dental trauma are the two leading causes of injury to the dental pulp
2. Oral cavity comprises less than 1% of the total body area, it accounts for 5% of injuries in all ages and 17% of injuries in children
3. Dental trauma in children is of particular concern in the underdeveloped tooth, as immature and open apices limit possible treatment options.
4. The purpose of this study was to discuss a revascularization protocol utilized for the treatment of a traumatized permanent tooth with an immature apex.
5. Historical approaches v.s. Revascularization:

	Historical approaches	Revascularization
Method	Long-term calcium hydroxide therapy for apexification	Combination of antibiotic paste and a biologic scaffold
Prognosis	Increased fracture rates as dentinal organic matrix is weakened with extended exposure to calcium hydroxide	Enhanced survivability, alleviation of symptoms, and a radiographic confirmation of root thickening and lengthening
Role of blood clot	A blood clot within the root canal system served as a biological scaffold	Paved the way for the next phase of revascularization—platelet concentrates providing an autologous scaffold

\*Antibiotic paste

- The antibiotic paste historically consisted of a combination of metronidazole, ciprofloxacin, and minocycline.
  - Purpose was to decrease and potentially eliminate bacterial strains and the pro-inflammatory response within the root canal system in preparation for the biologic scaffold.
  - Concerns over tooth discoloration have been attributed to minocycline use.
  - The survivability of stem cell progenitors within the root canal system in the face of the antibiotic treatment may also be jeopardized
6. Recently, Pandey (2013) reported a case of an anterior traumatized permanent tooth with platelet- rich fibrin (PRF):
    - A second-generation platelet concentrate consisting of autologous platelets and leukocytes present in a complex fibrin matrix
    - Utilized as a scaffold for revitalization
    - Composed of fibrin membranes enriched with platelets, growth factors, and cytokines
    - Enhance the healing potential of soft and hard tissues and slowly release growth factors, such as PDGF and TGF-B1 over the span of 7–14 days
  7. The case demonstrates the viability of utilizing platelet-rich fibrin as a potential modality to treat necrotic, immature teeth with open apices.

● Case review :

1. SOAP:

S	An 11-year-old male was evaluated 4 months after sports-related trauma to the permanent maxillary left central incisor
O	<p>Tooth 21:</p> <ul style="list-style-type: none"> <li>➤ Cold testing: (-)</li> <li>➤ Percussion: (-)</li> <li>➤ Palpation: (+)</li> <li>➤ Mobility: Grade II</li> <li>➤ Deep pockets on all sides</li> <li>➤ Restored with a Class IV composite resin restoration</li> <li>➤ Intruded 3 mm and luxated buccally</li> <li>➤ Periapical radiolucency</li> <li>➤ Thin dentinal walls</li> <li>➤ Incomplete root development with an open apex</li> <li>➤ Irregular root surface (indicative of external root resorption)</li> </ul>
A	<p>Pulp: necrosis                      Periapical: asymptomatic apical periodontitis</p>

P	<p>Treatment options :</p> <ul style="list-style-type: none"> <li>➤ Conventional root canal therapy with a mineral trioxide aggregate (MTA) plug</li> <li>➤ Extraction</li> <li>➤ Procedures to revascularization</li> </ul>
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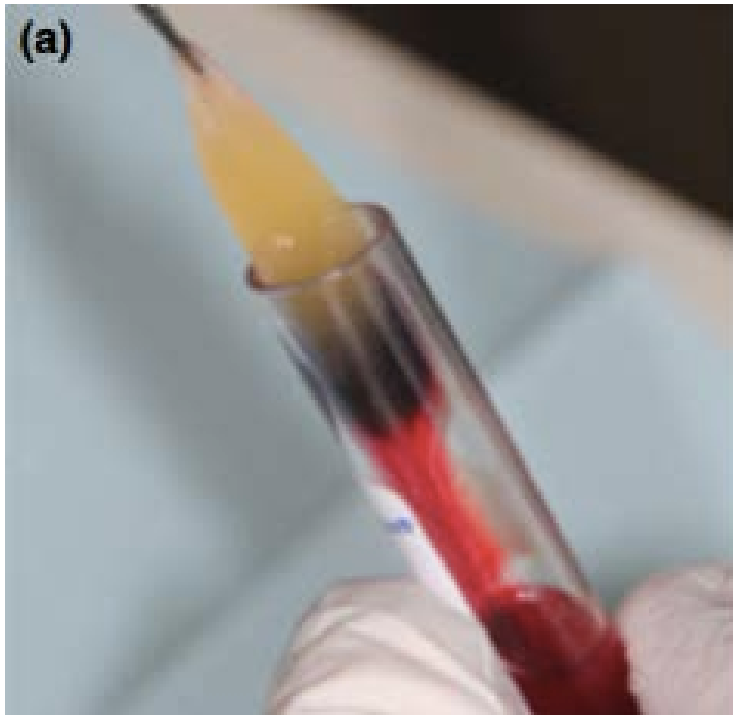
2. Treatment course:

➤ First treatment appointment:

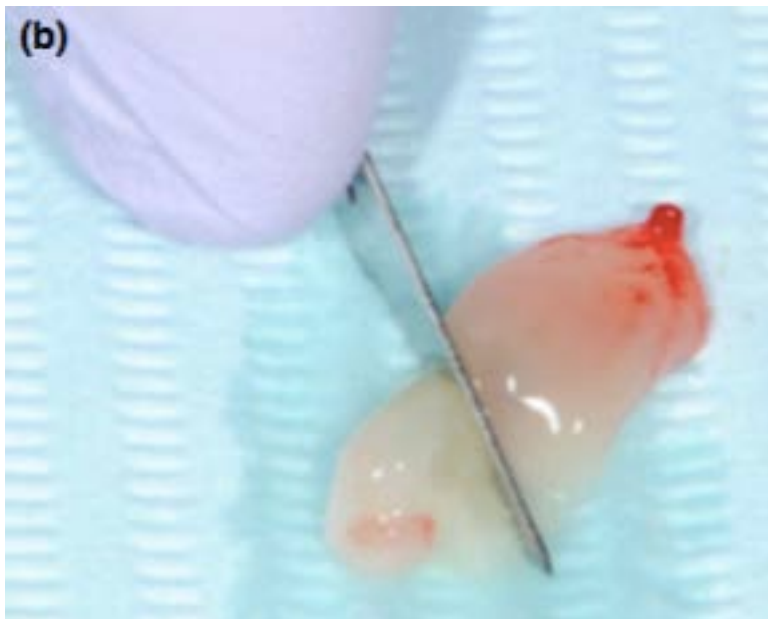
- Rubber dam isolation without anesthesia.
- The root canal space was accessed lingually and irrigated with copious amounts of an alternating rinse of 0.5% NaOCl and 17% EDTA.
- The canal space was dried, and a double antibiotic paste (DAP), consisting of 200 mg ciprofloxacin and 500 mg metronidazole mixed into propylene glycol, was placed within the canal system.
- The tooth was temporized with a cotton pellet and Ketac Glass Ionomer temporary restoration.

➤ Second treatment appointment (4 weeks after the first treatment appointment):

- 3% mepivacaine without vasoconstrictor was used to obtain local anesthesia.
- The canal space was accessed under rubber dam isolation and irrigated with 0.5% sodium hypochlorite, followed by 17% EDTA
- 7 ml of blood from the patient was obtained in nonheparinized test tubes (Becton, Dickinson, and Company Franklin Lakes, NJ).
- The tubes were placed in a centrifuge (Salvin Sealed Technology, Charlotte, NC) and spun for 20 min at 402 g, separating the blood sample into the plasma-poor, plasma-rich, and red blood cell components.
- The straw-colored plasma-poor layer was decanted. The platelet-rich fibrin, which appears as a gelatinous yellow–white substance, was removed from the vial with sterile college pliers and dragged across a sterile 4X4 gauze pad to remove excess red blood cells.



- The prepared PRF sample was then cut into segments approximately 2 by 5 mm



- Segments were placed into the canal space to a level 3 mm below the DEJ
- Induction of bleeding into the canal space delivers mesenchymal stem cells into the canal space from the apical papilla.
- An MTA cap was placed over the PRF scaffold, followed by a glass ionomer base. A composite resin restoration provided a definitive seal to the access of the cavity

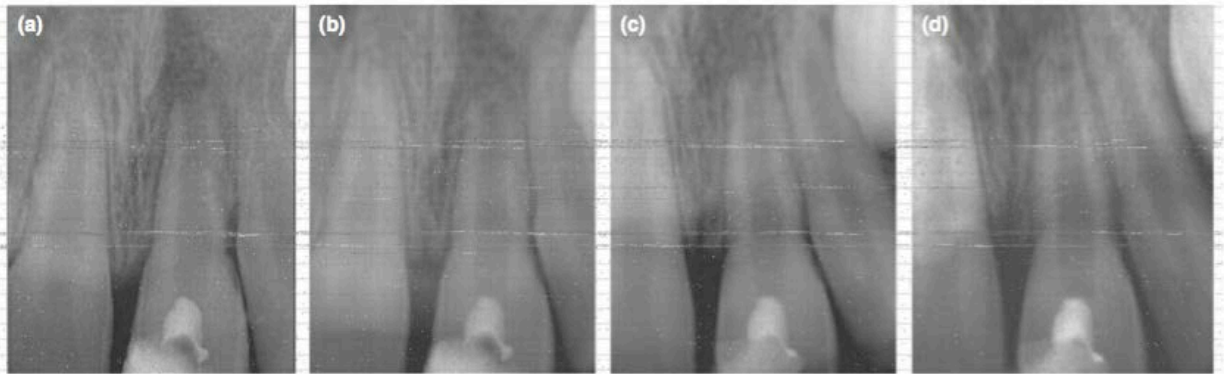


Fig. 2. (from left to right): (a) Postoperative radiograph immediately after placement of PRF and definitive restoration; (b) 12-month recall; (c) 24-month recall; (d) 36-month recall.



Fig. 3. Clinical photograph on 36-month follow up.

#### ● Discussion:

1. Controlling infection is an important first step for revascularization procedures. The use of triple and double antibiotic paste combinations has proven efficacy against a wide variety of odontogenic bacteria.
2. DAP (double antibiotic paste) consisting of ciprofloxacin and mynocyline has shown to minimize crown discoloration compared to TAP (triple antibiotic paste) while providing similar intracanal disinfection benefits.
3. PRF addresses two parts of the triad for tissue regeneration, growth factors and a scaffold; the third part of the triad is addressed with stem cells of the apical papilla (SCAP)
4. SCAP:
  - SCAP cells are capable of odontoblast-like differentiation and formation of dentin in vivo. Their high proliferative potential makes them a likely source of odontoblasts for root dentin formation even during conditions of pulp necrosis.

- In a mouse model, after dentin conditioning with EDTA, SCAP cells exhibited an intimate association with dentin and differentiated into odontoblast-like cells with the expression of DSPP.
- Higher NaOCl concentrations have also shown a negative effect on SCAP cell survival and dentin sialophosphoprotein (DSPP) expression. The use of 0.5% or 1.5% NaOCl, followed by 17% EDTA, counters these deleterious effects on stem cell viability.
- SCAP experience over 80% cell death with double and triple antibiotic paste concentrations as low as 10 mg ml.
- In retrospect, the cytotoxic concentration of antibiotics that SCAP cells were exposed to in this case may explain the lack of increase in root thickness in the presence of osseous healing, root length increase, and periodontal healing.

5. Platelet-rich fibrin (PRF):

- A fibrin biomaterial that encourages the migration of stem cells and angiogenesis, while acting as an autologous source for the controlled release of growth factors over an extended period of time.
- An immune and platelet concentrate that contains all the constituents of a blood sample considered to be favorable for healing and immunity.
- He et al. compared the efficacy of PRF and PRP on proliferation and differentiation of rat osteoblasts:

	PRF	PRP
levels of released growth factors (TGF-B1,PDGF)	markedly increased and reached the highest amount on day 14, and then decreased mildly	uncontrolled release, which reached the highest amount on day 1 and then decreased rapidly

- PRF has been used is the radiographic appearance of the canal space not being obliterated by calcification, which may be attributed to the controlled release of growth factors.

6. Recent studies have addressed the possibility of utilizing revascularization therapy in teeth with more developed apices.

- Laureys et al. suggest that the size of the apical foramen is not the decisive factor for determining whether revascularization is possible.
- Cases with a diameter much smaller than 1 mm did not prevent the ingrowth of new vital tissue.

## Conclusion:

This case demonstrates a clinically feasible protocol utilizing platelet-rich fibrin as an autologous scaffold for pulp revascularization. Further studies and continued improvements in the revascularization protocol can determine how fibrin matrix predictably increases the success of revascularization and consistently produces long-term successful clinical outcomes.

## ● Thought:

1. 相較傳統的pulpotomy，pulpotomy甚至是regeneration已經漸漸受到重視，使得根管治療上有更多的選擇。同時也提醒我們，畢竟pulpotomy後牙齒有很大的斷裂風險，在下治療計畫前應該多方考量，選擇對病人最有利的方方式。
2. PRF應用在牙周治療方面已受到廣泛討論，讀完這篇journal才發現在根管治療上也有可以發揮之處。期待日後可以看到更多相關的case report來佐證。

題號	題目
1	刺激牙本質生成的眾多因子中，何者為最多且最重要？ (A) 轉型生長因子(TGF-β) (B) 骨成型蛋白質(BMP-2) (C) 血管表皮生長因子(VEGF) (D) 胰島素樣生長因子(IGF)
答案 (A)	出處：103年第二次專門職業及技術人員高等考試牙醫師考試牙醫學(三)(包括齒內治療學、牙體復形學、牙周病學等科目及其相關臨床實例與醫學倫理) Cohen's. Pathways of the Pulp. 10 <sup>th</sup> Ed Chapter 16 : Regenerative Endodontics P. 605
題號	題目
2	下列何者不是成功的活髓治療(Vital pulp therapy)之必要條件？ (A) 沒有發炎的牙髓組織 (B) 細菌無法感染的緊密填補 (C) 合適的牙髓組織用藥 (D) 立即處置
答案 (D)	出處：102年第二次專門職業及技術人員高等考試牙醫師考試牙醫學(三)(包括齒內治療學、牙體復形學、牙周病學等科目及其相關臨床實例與醫學倫理) Cohen's. Pathways of the Pulp. 10 <sup>th</sup> Ed Chapter 23: Pediatric Endodontics P.823