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Revascularization of an Immature Permanent Tooth with Periapical Periodontitis: A Case Report

Huimin Li[1,#], Yingxuan Teng[2,#], Siqi Xia[2], Wenxinyu Huang[2], Peiran Yang[2], Jie Wu[2], Shuhua Wang[2,*]

[1]School of Stomatology, Zhejiang Chinese Medical University, Xiaoshan Campus of Hangzhou Dental Hospital, Hangzhou, Zhejiang, 311202, China
[2]School/Hospiital of Stomatology, Zhejiang Chinese Medical University, Hangzhou, Zhejiang, 310053, China
**Corresponding author: 385164787@qq.com*
[#]These authors contributed equally to this work.

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Abstract: To prove pulp revascularization is a valuable dental treatment technique for immature but necrotic teeth and allows continuous root development. This report describes a successful case of revascularization in the treatment of first maxillary premolars with severe apical periodontitis. Installed rubber barrier under local anesthesia. After entering the pulp cavity, the root canal was rinsed with 1% sodium hypochlorite, 17% EDTA and physical saline. A scaffold was created by inducing the formation of a blood clot within the canal. Then we inserted MTA into the root canal and sealed it with glass ionomer material temporarily. Finally, temporary sealing material was removed and resin filling repair was carried out. During the follow-up period of 10 months after the operation, the teeth were asymptomatic, the clinical examination showed good recovery, and the imaging examination showed that the root was well-developed and had normal function. This case adds evidence for the effectiveness and clinical potential of revascularization in the treatment of young permanent teeth with pulp necrosis. MTA is a reliable and effective material in dental pulp treatment in children.

1. Introduction

The treatment of young permanent teeth with pulp necrosis and apical lesions has always been a common problem and challenge in the field of endodontics. Conventional treatment methods with multiple operations using calcium hydroxide are the preferred treatment for young permanent teeth with pulp necrosis[1]. Its purpose is to form an apical hard tissue barrier. However, apexification has some limitations, such as frequent dressing changes will increase the risk of infection, as the effect of calcium hydroxide only lasts for about 2 weeks[2]. At the same time, root fracture may occur, as long-term sealing of calcium hydroxide in the root canal will increase root brittleness[3]. Unlike apexification techniques, dental pulp revascularization is the most ideal healing response, because it allows the natural development of the root to continue, and finally achieves the goal of

restoring pulp vitality[4].

Pulp revascularization is a biological regeneration therapy and alternative method for the treatment of necrotic immature teeth. The indications include young permanent teeth with retention value whose pulp lesions have spread to the root pulp, suffering from pulp necrosis or periapical disease, resulting in partial preservation or failure to retain the root pulp[5]. As a treatment with a relatively simple clinical operation, good long-term curative effect, and a high degree of acceptance, it is highly respected in the treatment of young permanent teeth that meet the indications. Even if the first pulp revascularization fails, the second pulp revascularization can still be carried out on the original basis, or we still have the chance to choose MTA apical barrier surgery or CH apexification instead[6].

This report describes a case of successful revascularization of necrotic immature first premolars. The follow-up period was 10 months.

2. Case Report

The patient was a 12-year-old boy. He was afraid to chew because the pain in his upper right posterior tooth lasted one day. And the pain affected his sleep at night. So, he came to the Xiaoshan branch of Hangzhou dental hospital for treatment. The patient had an unremarkable medical history, and there was no relevant family history of medical or dental abnormalities. Clinical examination revealed that all teeth were brown and yellow in the entire mouth with a large amount of soft dirt on their surface, and melanin deposited (Figure 1).

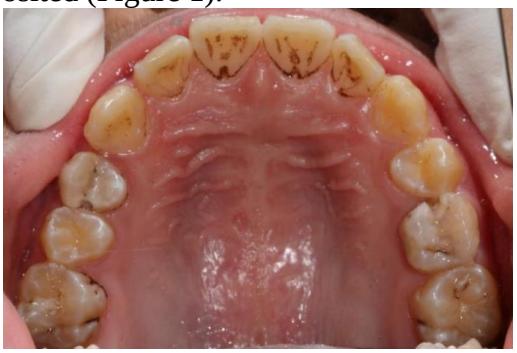

Figure 1: Preoperative intraoral photograph showing there is deep caries in the distal adjacent surface of the maxillary right second premolar, which has penetrated the pulp.

Figure 2: Postoperative Preoperative radiograph showing an immature open apex and enlargement of the periodontal ligament space and extensive radiolucency in the periarticular region in the maxillary right first premolar.

It was worth noting that tooth 14 was gray. A deep cavity was found in the distal adjacent aspect with a penetrating floor of the tooth, which contained a lot of hummus. There was no loosening and gingival fistula, but the gingiva in the buccal apical area was sensitive to palpation. The affected teeth were discomfort when making a probe examination and painful when making percussion. Radiographic examination revealed that there was a low-density shadow in the crown of tooth 14 connected with the myeloid cavity, and the root developed at Nolla 9 stage. Apical foramen were flared open, the low-density projection was around the root tip and the bony plate disappeared at the apex (Figure 2). According to the above inspection, the concluding diagnosis was apical periodontitis of tooth 14, and considering the immaturity of the tooth, our first and optimal treatment option was revascularization[7].

Under local anesthesia with articaine, the rubber dam was installed. During caries removal, we found that the caries of the distal adjacent aspect had reached 1mm subgingivally. We uncovered the pulp chamber roof and discovered a lot of food residue in the root canal without bleeding. We cleaned the root canal. The pulp showed bean-slag-like changes and was out of shape. 1% sodium hypochlorite, 17% EDTA and physiological saline were used to irrigate the root canal alternately and then dried. We disinfected the root canal with calcium hydroxide paste and temporarily sealed it with glass ionomer (Figure 3).

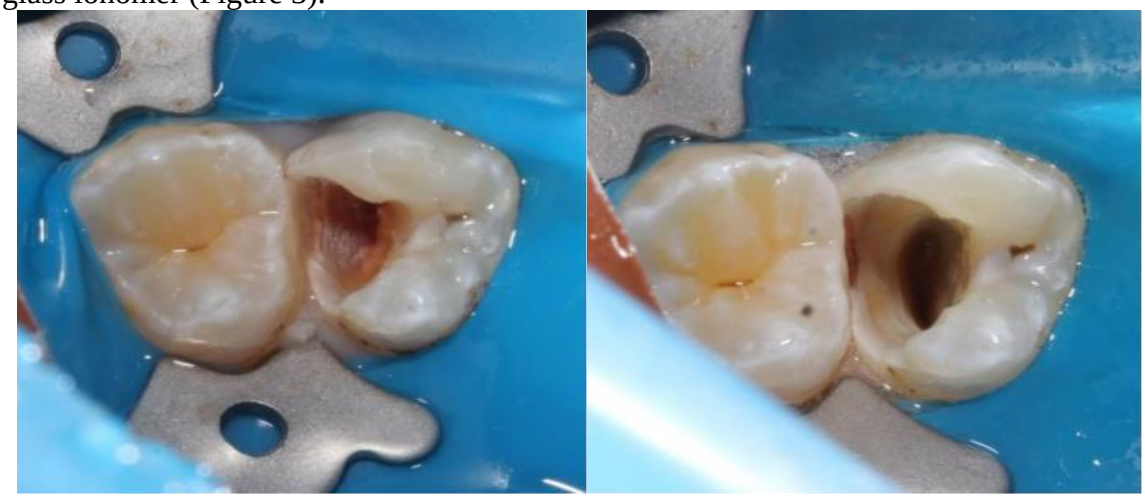

Figure 3: The decayed tissue was removed and cleaned and disinfected.

After a 1-week follow-up appointment, the patient came for a second visit. The temporary seal of tooth 14 was intact without loose. The tooth was slightly sensitive to percussion and palpation. We palpated the gingiva in the buccal root tip area and found that the patient was without discomfort. We disinfected the root canal again, as the operation at the initial diagnosis.

Two weeks later, the patient revisited. The temporary restoration was intact without loose. The patient felt slightly uncomfortable when percussed. After Lidocaine cream anesthesia and rubber dam isolation, temporary material was removed again. The canal was cleaned with 20ml 17% EDTA and then dried. Bleeding was induced into the canal by stimulation of tissue beyond the apex using a 10K sterile endodontic file(the buccal lingual root tube was about 19mm long). Then we covered the cavity access with MTA paste and sealed it with glass ionomer cement (Figure 4).

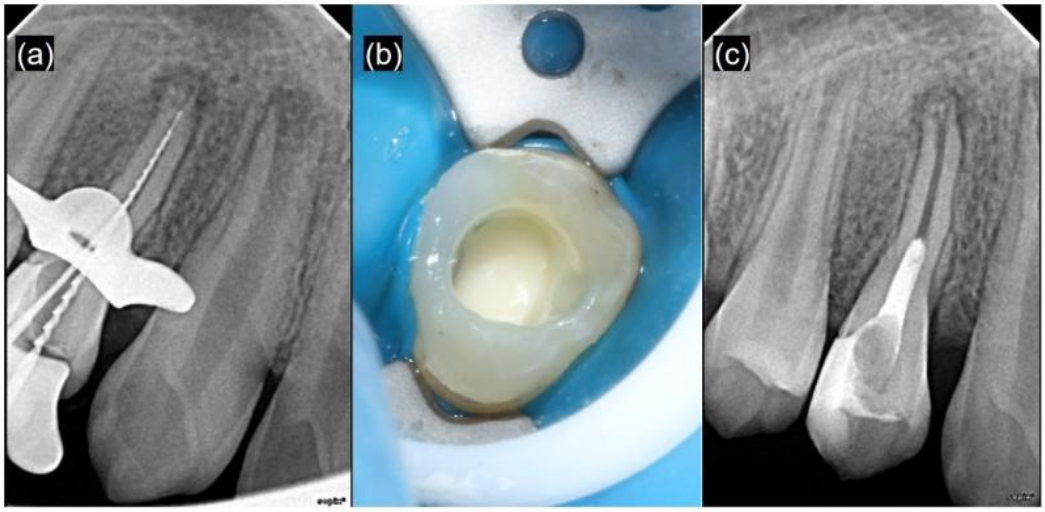

Figure 4: (a)Working length was determined and bleeding was induced into the canal, and (b) placement of MTA, and (c) X-ray after pulp revascularization

After 2 days, the patient came for the 4th visit. We found temporary restoration was intact and the gingiva was normal. The tooth was functional, and insensitive to percussion and palpation. After Lidocaine cream anesthesia and rubber dam isolation, we removed the glass ionomer temporary seal and found the MTA has hardened. We cleared the cavity, disinfected it, and then dried it. The pulp cavity was bottomed with zinc oxide and glass ions and then filled with SDR+ resin. We performed shape modification and occlusal adjustment, then polished (Figure 5). Finally, we give the patient common advice and exhorted him to revisit after 3 months.

Figure 5: Two days later, the cavity of the tooth was cleaned, disinfected, and dried. The pulp cavity was bottomed with zinc oxide and glass ions and then filled with SDR+ resin, and the teeth were shaped, occluded, and polished.

Three, seven, and ten months after treatment, the patient was recalled to evaluate the curative effect (Figure 6). We found that the temporary restoration was intact and the gingiva was normal. The tooth was functional and was not sensitive to percussion and palpation. 3 months after the permanent closure of the access cavity, the radiograph revealed the first signs of apical closure. The X line showed the root of tooth 14 had obvious proliferation compared with before, with a clear contiguous apical perimembranous and no pathological shadow. During the long-term follow-up, the apical foramen was gradually closed, and the tooth was asymptomatic and functional.

Figure 6: Follow-up radiographs after revascularization. (a) 3-mo, (b) 7-mo, and (c) 10-mo which show complete resolution of the periapical radiolucency and thickening of the root canal walls.

3. Discussion

Since there was a possibility to gain the benefits of root development, we chose to use revascularization treatment rather than an artificial barrier technique or apexification with calcium hydroxide in this case. The main benefits of the revascularization technique over the conventional apexification or artificial barrier technique in the endodontic treatment of immature necrotic teeth are the continuation of root development and the strengthening of the root structure[8].

In general, the operation difficulty of revascularization is relatively lower. And for young single-rooted teeth with pulp necrosis, many cases do not need to use an oral operating microscope, and good treatment results can still be achieved. At present, other treatment methods that can induce pulp regeneration such as adult stem cell therapy and pulp implantation are mostly in the experimental stage, and it will take time to fully enter the clinic and is subject to certain restrictions. Therefore, for a long time in the future, revascularization is still a more feasible technique than other treatments. At least it provides a new treatment for young permanent teeth with pulp necrosis.

The histological origin of new biomass after root canal revascularization is generally considered to be related to stem cells. Immature young permanent teeth have large apical foramen. The stem cells in the apical papilla are abundant and vigorous and can obtain a rich blood supply from the surrounding tissues. In the process of guiding apical bleeding, the stem cells in the apical papilla can be brought into the root canal with the blood. Apical papilla stem cells have the potential to promote the regeneration of dental pulp tissue and the continuous development of tooth roots. It is considered that they may be the main seed cells for the continuous development of young permanent teeth after pulp necrosis or pulp treatment[9]. Some scholars also believe that there are residual dental pulp cells in young permanent teeth with periapical diseases, which can further differentiate into odontoblasts, osteoblasts, chondroblasts, and adipoblasts. Therefore, the new tissue in the root canal may be produced by the differentiation of residual dental pulp cells. Undifferentiated dental pulp stem cells also exist in these residual dental pulp tissues. It is speculated that the abundance of dental pulp stem cells with multidirectional differentiation potential in young permanent teeth is the key to the continuous development of tooth roots[10].

In this case, we did not give the patient crown repair, only made composite resin filling, the patient’s tooth used in good condition, there are no lesions later, and dental function exercise is good, proving that our repair treatment is relatively successful. According to research by Brian M Gillen et al[11]. successful root canal treatment and crown repair are both parts of the success of

repair, and although inadequate coronal restoration repair and inadequate crown repair may lead to poor clinical outcomes, there is no significant difference in the chances of cure between the two combinations. Therefore, after we fully coronal restoration, consider the patient's age, temporarily do not carry out crown restoration, the patient's teeth can also function normally. However, we may also have some improvements, such as the patient can do Cervical Margin Relocation before the resin filling, to achieve a better filling repair effect[12].

In the treatment of this case, we used the bioceramic pulp capping agent MTA and achieved the ideal therapeutic effect. MTA stands for Mineral Trioxide Aggregate. The trioxide aggregate in MTA consists of calcium, aluminum, and selenium. Clinical studies showed that MTA has excellent biocompatibility, high sealing capability, and outstanding material stability[13]. What's more, MTA has many desirable properties in terms of its Bioactivity, hydrophilic, and ray-opaque. Bonson S et al., observed differentiation of fibroblasts and bone formation when MTA was applied to gingival and periodontal ligament fibroblast cell cultures. MTA is therefore regarded as a bioactive material with osteoinductive properties. Currently, MTA is used for apexogenesis, perforation repairs, apexification, regenerative procedures, pulpotomies & pulp capping. Despite the high and stable success rate of MTA in surgery, the long solidification time brings a lot of inconvenience to clinicians' operations.In addition, the use of MTA may also cause the risk of discoloration of the teeth. The tooth in this case is not located in the aesthetic area of the anterior teeth, so the discoloration factor caused by MTA is not the primary determinant of the selection of treatment materials[14].

To address these limitations, more new materials are introduced, such as Biodentine, BP, etc. The main benefits of this material over MTA are its lower cost and quicker setting. Additionally, studies have demonstrated that Biodentine's compressive and flexural strength is superior to MTA's, and its mobility and cost-effectiveness are also in its favor[15]. iRoot BP Plus (Innovative BioCeramix Inc., Vancouver, BC, Canada) is a pre-mixed, ready-to-use, laboratory-synthesized, injectable bioceramic-based endodontic material[16]. MTA has been compared to iRoot BP Plus as a substitute.

Besides, when compared to MTA in vitro, iRoot BP Plus has a greater capacity for the formation of apatite crystals[17]. However, from the long-term follow-up[18], MTA offers a superior safety profile and, by physiologically bolstering the root walls, can assist in saving infected, developing teeth. Based on this, we selected MTA material in this case.

In summary, by taking advantage of the existing conditions of young permanent teeth, the advantages of pulp revascularization, and the properties of MTA materials, we treated a case of apical periodontitis of tooth 14 without crown restoration and achieved a good effect. Nevertheless, there are still some limitations and areas that need to be optimized in this case report.

First of all, our follow-up visit for this case was not long enough. We only conducted follow-up visits and radiography at 3, 7, and 10 months after the operation, and later follow-up visits could not be carried out due to the patient's uncooperativeness. If we can carry out a longer postoperative follow-up, we can ensure that the long-term treatment effect on patients is good.

In addition, although the patient was able to heal well without crown repair, which also partially confirmed the success of this treatment, there may still be a small gap between the resin and the tooth tissue during crown closure using SDR+ resin, with the risk of microleakage. If the tooth can be crowned, we can better avoid bacterial pathways, prevent secondary infections after treatment, and ensure long-term outcomes.

4. Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Patients' right to privacy: We have obtained informed consent from the patient (or parent or guardian)

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References

[1] Rafter M. Apexification: a review[J]. Dental traumatology : official publication of International Association for Dental Traumatology. 2005, 21(1):1-8.

[2] Arruda MEF, Neves MAS, Diogenes A, et al. Infection Control in Teeth with Apical Periodontitis Using a Triple Antibiotic Solution or Calcium Hydroxide with Chlorhexidine: A Randomized Clinical Trial[J]. Journal of Endodontics. 2018, 44(10):1474-1479.

[3] Guerrero F, Mendoza A, Ribas D, et al. Apexification: A systematic review[J]. Journal of conservative dentistry : JCD. 2018, 21(5):462-465.

[4] Kottoor J, Velmurugan N. Revascularization for a necrotic immature permanent lateral incisor: a case report and literature review[J]. International Journal of Paediatric Dentistry. 2013, 23(4):310-316.

[5] Huang GTJ. Apexification: the beginning of its end[J]. International Endodontic Journal. 2009, 42(10):855-866.

[6] Iwaya SI, Ikawa M, Kubota M. Revascularization of an immature permanent tooth with apical periodontitis and sinus tract[J]. Dental traumatology : official publication of International Association for Dental Traumatology. 2001, 17(4):185-187.

[7] Yang Y, Peng C-f, Qin M. Pulp revascularization of immature teeth with apical periodontitis: a clinical study[J]. Chinese journal of stomatology. 2013, 48(2):81-85.

[8] Saeki K, Fujita Y, Shiono Y, et al. Pulp revascularization in immature permanent tooth with apical periodontitis using mineral trioxide aggregate[J]. Case reports in medicine. 2014,564908-564908.

[9] Chandran V, Chacko V, Sivadas G. Management of a nonvital young permanent tooth by pulp revascularization[J]. International journal of clinical pediatric dentistry. 2014, 7(3):213-6.

[10] Bose R, Nummikoski P, Hargreaves K. A Retrospective Evaluation of Radiographic Outcomes in Immature Teeth With Necrotic Root Canal Systems Treated With Regenerative Endodontic Procedures[J]. Journal of Endodontics. 2009, 35(10):1343-1349.

[11] Gillen BM, Looney SW, Gu L-S, et al. Impact of the Quality of Coronal Restoration versus the Quality of Root Canal Fillings on Success of Root Canal Treatment: A Systematic Review and Meta-analysis[J]. Journal of Endodontics. 2011, 37(7):895-902.

[12] Devillard R, Rémy M, Kalisky J, et al. In vitro assessment of a collagen/alginate composite scaffold for regenerative endodontics. International endodontic journal. Jan 2017, 50(1):48-57.

[13] Tawil PZ, Duggan DJ, Galicia JC. Mineral trioxide aggregate (MTA): its history, composition, and clinical applications[J]. Compend Contin Educ Dent. 2015, 36(4):247-52.

[14] Bonson S, Jeansonne BG, Lallier TE. Root-end filling materials alter fibroblast differentiation[J]. Journal of Dental Research. 2004, 83(5):408-413.

[15] Kaur M, Singh H, Dhillon JS, et al. MTA versus Biodentine: Review of Literature with a Comparative Analysis[J]. Journal of clinical and diagnostic research : JCDR. 2017, 11(8):Zg01-zg05.

[16] Liu S, Wang S, Dong Y. Evaluation of a bioceramic as a pulp capping agent in vitro and in vivo[J]. Journal of Endodontics. 2015, 41(5):652-7.

[17] Zhu L, Yang J, Zhang J, et al. In vitro and in vivo evaluation of a nanoparticulate bioceramic paste for dental pulp repair[J]. Acta Biomaterialia. 2014, 10(12):5156-5168.

[18] Sultana N, Singh M, Nawal RR, et al. Evaluation of Biocompatibility and Osteogenic Potential of Tricalcium Silicate-based Cements Using Human Bone Marrow-derived Mesenchymal Stem Cells[J]. Journal of Endodontics. 2018, 44(3):446-451.