

Case Report

Three-year follow-up results for non-surgical root canal therapy of idiopathic external root resorption on a maxillary canine with MTA: a case report

Zheng Huang¹, Li-Li Chen¹, Cong-Yi Wang², Lin Dai³, Bo Cheng¹, Jun Sun³, Jun Sun⁴

¹Department of Stomatology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, 1277 Jiefang Ave, Wuhan, Hubei, 430022, China; ²The Center for Biomedical Research, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, 1095 Jiefang Ave, Wuhan, Hubei, 430030, China; ³Department of Stomatology, The First Hospital of Wuhan, Wuhan, Hubei, 430022, China; ⁴Department of Restorative Dentistry, Indiana University School of Dentistry, Indianapolis, IN 46202, USA

Received March 26, 2014; Accepted May 20, 2014; Epub May 15, 2014; Published June 1, 2014

Abstract: External root resorption (ERR) is an uncommon and intractable disease. Treatment alternatives are case-dependant and aim for the repair of the resorptive lesion and long-term retention of the tooth. A forty-year-old Asian female was diagnosed with idiopathic ERR on tooth #11 (the left maxillary canine) by CBCT. Non-surgical root canal therapy was completed with the aid of an operating microscope. The apical third of the root canal was filled with warm gutta-percha and the resorption defect was filled with mineral trioxide aggregate (MTA). The periapical radiographs were taken immediately after operation, one-month follow-up, six-month follow-up and three-year follow-up, respectively. Clinically, the canine was asymptomatic, and no evidence of any further resorption was found. The six-month follow-up radiograph showed initial healing of the bony lesion, while the three-year follow-up radiograph manifested almost complete healing. MTA can be a superior material to be successfully used in the non-surgical treatment of ERR. CBCT is very useful for evaluating the true nature and severity of absorption lesions in root resorption. It is the first complete case report from China about non-surgical treatment of severe ERR along with a relatively long term follow-up.

Keywords: External root resorption, non-surgical root canal therapy, MTA, CBCT, canine

Introduction

The root resorption associated with primary teeth is physiological and desirable because it results in exfoliation of the teeth, thereby allowing eruption of the permanent teeth. However, root resorption (either internal or external) of permanent dentition is usually pathological and undesirable because it might result in irreversible damage and/or eventual tooth loss.

The hard tissues (dentin, cementum, and enamel) of permanent teeth do not normally undergo resorption. External root resorption (ERR) occurs when the periodontal ligament or cementum on the root surface are either damaged or removed [1]. Although the exact cause of ERR is poorly understood, it is generally accepted that the etiology of different types of ERR requires two phases: mechanical or chem-

ical injury to the protective tissues and stimulation by inflammation or pressure [2].

The clinical signs of ERR depend mainly on the extent of the resorption. The usual asymptomatic nature of the early stage of ERR can be explained by the minimal pulp involvement due to protection from the predentin layer. However, some advanced cases develop symptoms of pulp disease when this protective layer is destroyed and the pulp is exposed to oral microorganisms through the resorptive defect. Therefore, many ERR patients delay treatment because of absence of symptoms and eventually lose the affected tooth.

This paper presents a rare case of an idiopathic ERR of tooth #11 (the left maxillary canine) treated by non-surgical root canal therapy and a mineral trioxide aggregate (MTA) perforation

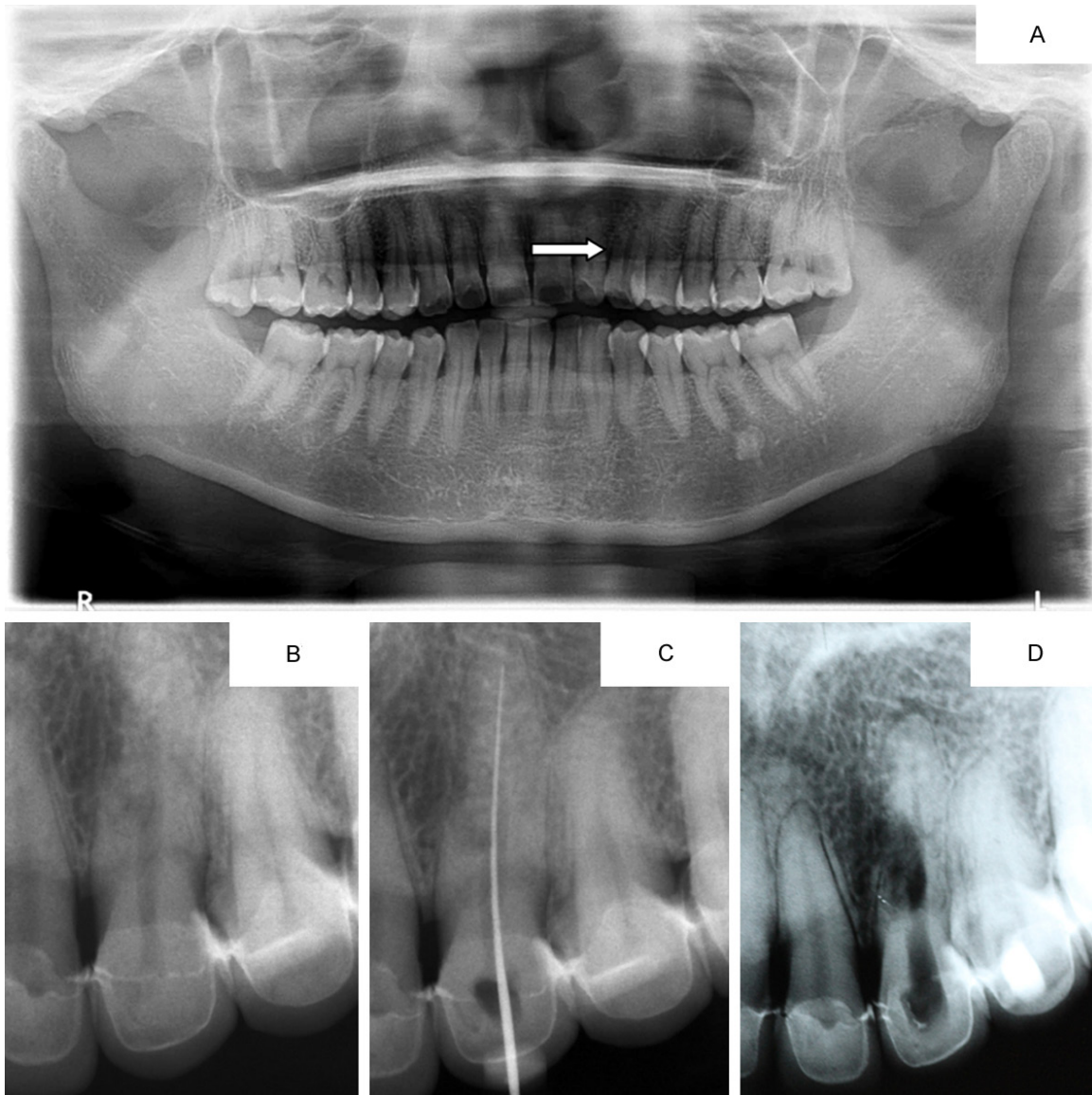


Figure 1. A: Panoramic radiographic survey was performed before therapy. An irregular radiolucency localized in the mesial mid-third root of tooth #11 (pointed by the white arrow) was not observed until referring and reviewing this radiograph. B: A periapical radiograph of tooth #11 was performed before opening the pulp cavity. Unfortunately the radiolucent area was still not recognized by the private dentist. C: Measuring the working length during the process of root canal therapy on tooth #11. D: While taking the periapical radiograph of tooth #12, an extensive and predominant resorption area in the mesial mid-third root of tooth #11 was found by the private dentist.

repair, showing healing at a three-year follow-up. It is the first complete case report from China about non-surgical treatment of severe ERR with a relatively long term follow-up.

Case report

Medical history

A forty-year-old Asian female was referred by a private prosthodontist to the Endodontics De-

partment of Wuhan Union Hospital. The patient presented to the private dentist two months earlier and was diagnosed with severe tetracycline-stained teeth. She had no other discomfort or chief complaint except for unfavorable tooth color. Panoramic radiographic survey was performed before therapy and no obvious pathological change was observed (**Figure 1A**). At the private dentist, she had twenty zirconium dioxide veneers/crowns placed from tooth #4

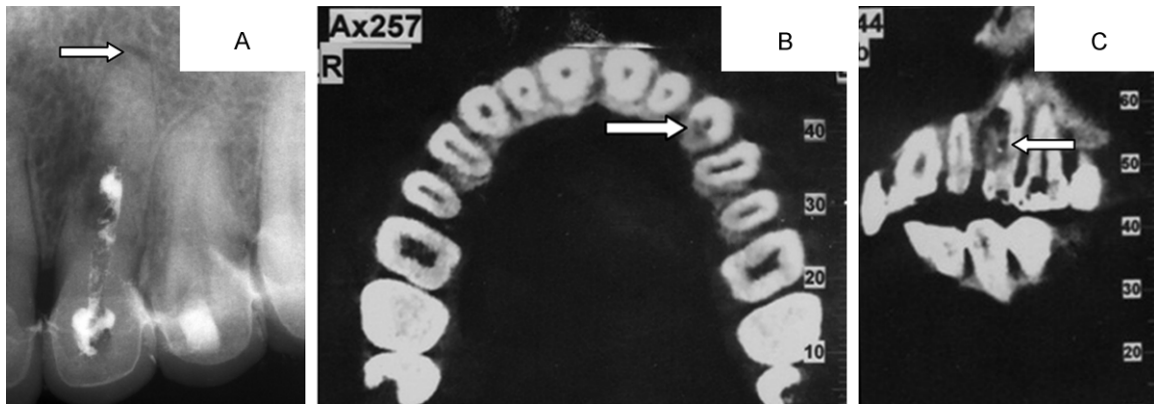


Figure 2. A: The new periapical radiograph of tooth #11 revealed that there was a clear radiolucent area situated in the mesial mid-third root of tooth #11 and was communicating with the pulp. A widened periodontal ligament space at the periapical area was also observed (pointed by white arrow). B: Horizontal section view of CBCT image: extensive external resorption area in the lingual mid-third root of tooth #11 which was communicating with the pulp. C: Coronal section view of CBCT image: extensive external resorption area in the mesial mid-third root of tooth #11 which was communicating with the pulp.

to tooth #13 in the maxilla and from tooth #20 to tooth #29 in the mandible. One month after the permanent cementation of the veneers/crowns, the patient complained of paroxysmal, sharp, spontaneous pain in her left arch, but she couldn't pinpoint the exact tooth. The pain was not relieved by antibiotics and analgesics. Intraoral examination revealed that tooth #11 responded positively to thermal testing (hot stimulus) and was sensitive to percussion. The private dentist took a periapical radiograph of tooth #11 and did not find any abnormal signs (**Figure 1B**). He then anesthetized tooth #11 and the pain disappeared immediately. Symptomatic irreversible pulpitis with symptomatic apical periodontitis of tooth #11 was diagnosed. An access cavity was prepared and root canal preparation was completed (**Figure 1C**). The chief complaint disappeared for two days and the patient presented almost the same chief complaint again in both right and left arches during the following days. So the private dentist diagnosed tooth #20, tooth #28 and tooth #12 with symptomatic irreversible pulpitis sequentially using the same diagnosis tests and rendered the same therapy without filling the root canal of tooth #11. While taking the periapical radiograph of tooth #12, the private dentist was surprised to find an extensive and predominant resorption area in tooth #11 (**Figure 1D**). After removing the temporary sealing, severe bleeding was found in the root canal of tooth #11. The private dentist couldn't understand and manage this disorder and

transferred this patient to our department with an iodoform-zinc oxide paste filling in the root canal of tooth #11.

The patient presented to our department with non-contributory systemic medical history. Her oral medical history excluded tooth trauma, orthodontic treatment, bleaching or periodontal operation on tooth #11. The patient had no obvious discomfort while being referred to our clinic. She had a strong desire to preserve this tooth and was reluctant to remove the crown. Due to the limited space, this paper will not describe and discuss the treatment of the other teeth except tooth #11.

Clinical features

The extraoral examination revealed negative findings. The intraoral examination revealed a zirconium dioxide veneer and a palatal access cavity restored with a temporary restoration on tooth #11. The tooth was slightly sensitive both to percussion and palpation but without mobility, obvious swelling, sinus tract or periodontal pockets. No special exception was found considering the whole oral cavity (tooth #20, tooth #28 and tooth #12 were treated by the private dentist).

Reviewing the former panoramic radiograph (**Figure 1A**) and the periapical radiograph of tooth #11 (**Figure 1B**), there was an irregular, radiolucency localized in the mesial mid-third

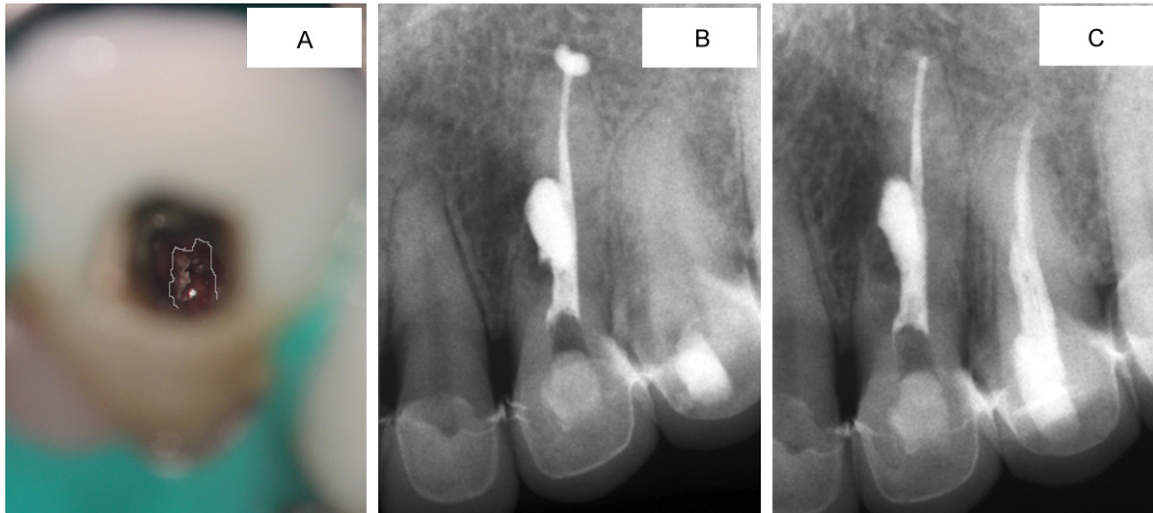


Figure 3. A: The resorption section in the mid-third root canal could be observed under microscope (outline tracing of features). B: Vitapex was used as an intracanal medication when there was no excessive bleeding and then the access cavity was sealed temporarily. C: The periapical radiograph displayed the resorption of excess Vitapex. Vitapex was injected again after thorough ultrasonic irrigation (2.5% sodium hypochlorite and 0.9% sodium chloride solution) to remove the remaining old medicament.

root. A new periapical radiograph was obtained and revealed a clear radiolucent area situated in the mesial mid-third root of tooth #11, communicating with the pulp. A widened periodontal ligament space at the periapical area was also observed (**Figure 2A**). In order to know the nature of this lesion, such as internal or external resorption and the extent of the lesion, a cone beam computed tomography (CBCT; NewTom™ VGi, QR S.r.l., Verona, Italy) image of tooth #11 was obtained, which showed an extensive external resorption lesion in the mesial and lingual mid-third root of tooth #11, communicating with the pulp (**Figure 2B, 2C**).

Two diagnoses of tooth #11 were made: (1) idiopathic ERR (communicating with the pulp) and (2) symptomatic apical periodontitis.

Treatment plan

Three alternative treatment options were given to the patient. The first was non-surgical root canal treatment and perforation repair with MTA from the inside of the root canal. The second was endodontic surgery and repair from the outside of the root canal. The third was extraction and replacement with an implant. Benefits and risks of each treatment plan were fully discussed with the patient, and the first option was chosen along with informed consent.

Management

During her first visit, after local anesthesia (Primacaine® Adrenaline, Acteon China, Beijing, China) and rubber dam (Hygenic® Dental Dam, Coltène/Whaledent Inc., Cuyahoga Falls, OH, USA) isolation, a large amount of granulation tissue was removed and the resorption defect in the mid-third root canal was observed under dental microscope (OPMI® pico, Zeiss, Oberkochen, Germany) (**Figure 3A**). The working length was verified by apex locator (SybronEndo, Glendora, CA, USA). A ProTaper universal® hand file (Dentsply Maillefer, Ballaigues, Switzerland) was used to a size F3 file to finish the preparation. Sodium hypochlorite (5.25%) was used as the irrigant with passive ultrasonic activation (Varios 750™ Lux, NSK NaKanishi Inc., Tochigi, Japan). Vitapex (Neo Dental Chemical Products, Tokyo, Japan) was employed as an intracanal medication when there was no excessive bleeding and then the access cavity was sealed temporarily (Cavition, GC corporation, Tokyo, Japan) (**Figure 3B**).

On her second visit 12 days later, the symptoms of slight sensitivity to percussion and palpation had been resolved. Tooth #11 manifested no evidence of mobility, swelling, sinus tract or periodontal pockets. The periapical radio-

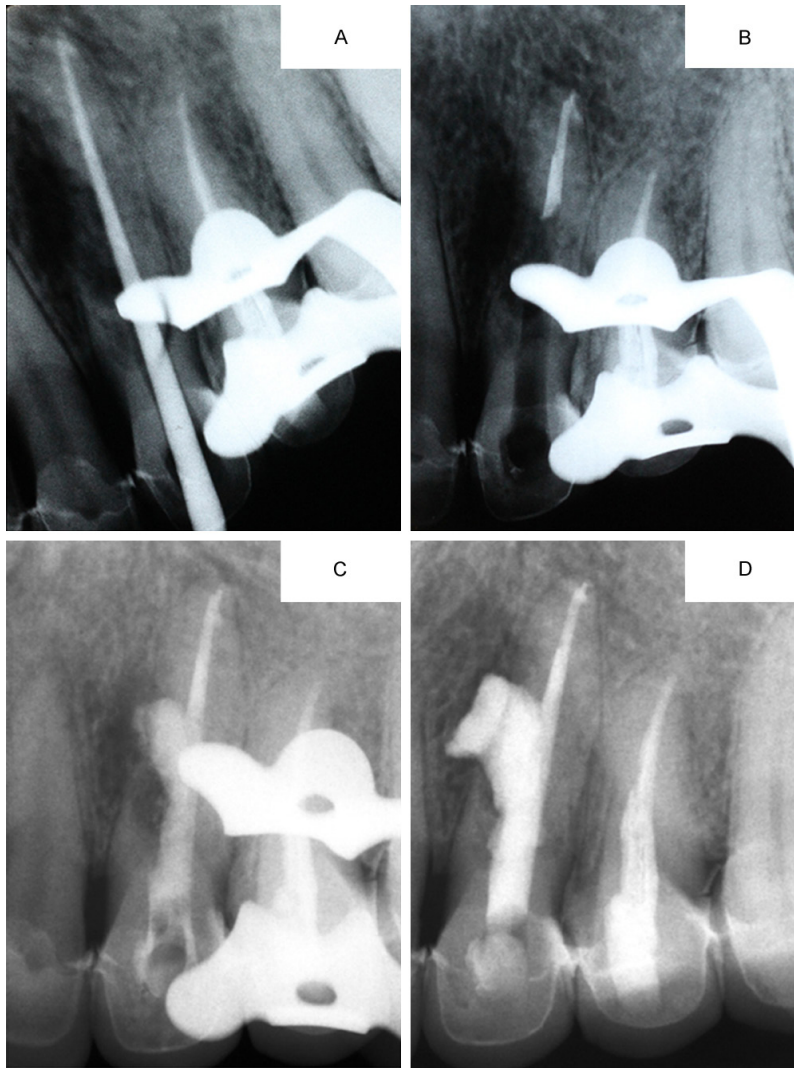


Figure 4. A: Master cone fit of tooth #11. B: The apical third of the root canal below the resorption defect was sealed with warm gutta-percha and AH Plus cement by continuous wave condensation technique. C: The perforation and the upper part of the root canal were filled with White MTA. Periapical radiographs were taken to judge if the filling was acceptable. D: The last periapical radiograph showed the filling was acceptable.

graph displayed the resorption of excess Vitapex in periapical and defect regions (**Figure 3C**). Vitapex was injected again after thorough ultrasonic irrigation (2.5% sodium hypochlorite and 0.9% sodium chloride solution) to remove the remaining old medicament.

On the third visit after 21 days, tooth #11 was asymptomatic. After local anesthesia and rubber dam isolation, the Vitapex was completely removed by K files (Dentsply, Konstanz, Germany) and ultrasonic irrigation. When there was no obvious bleeding, the root canal was

dried by sterilized paper points (Dentsply, Tianjin, China) and the apical third of the root canal below the resorption defect was sealed with warm gutta-percha-points (.06) (Dentsply, Tianjin, China) and AH Plus cement (Dentsply, Konstanz, Germany) by continuous wave condensation technique (Elements Obturation Unit, SybronEndo, Glendora, CA, USA) under microscope. The master cone fit and the apical sealing were both checked by the periapical radiographs (**Figure 4A, 4B**). Subsequently, the perforation and the upper part of the root canal were filled with White MTA (Pro-Root, Dentsply Tulsa, Tulsa, OK, USA) using root canal vertical condensation pluggers (Hu-Friedy Mfg. Co., Chicago, IL, USA) under a microscope. During the course of this procedure, several periapical radiographs were taken to judge if the filling was acceptable (**Figure 4C, 4D**). A small, wet sterilized cotton ball was placed to hydrate the MTA. The access cavity was temporarily sealed, and then permanently filled with glass ionomer (Fuji IX GP, GC China, Suzhou, China) at the one-month follow-up.

Follow-up

The patient reported no discomfort during telephone follow-ups on the first day and the first week after operation. The patient presented to our department with no discomfort at one-month and six-month recalls. Intraoral examination revealed that the periapical area of tooth #11 was normal without erythema and swelling. It was not sensitive to percussion and palpation as well as no mobility, sinus tract or periodontal pockets. The periapical radiograph proved the radiolucent area began to decrease

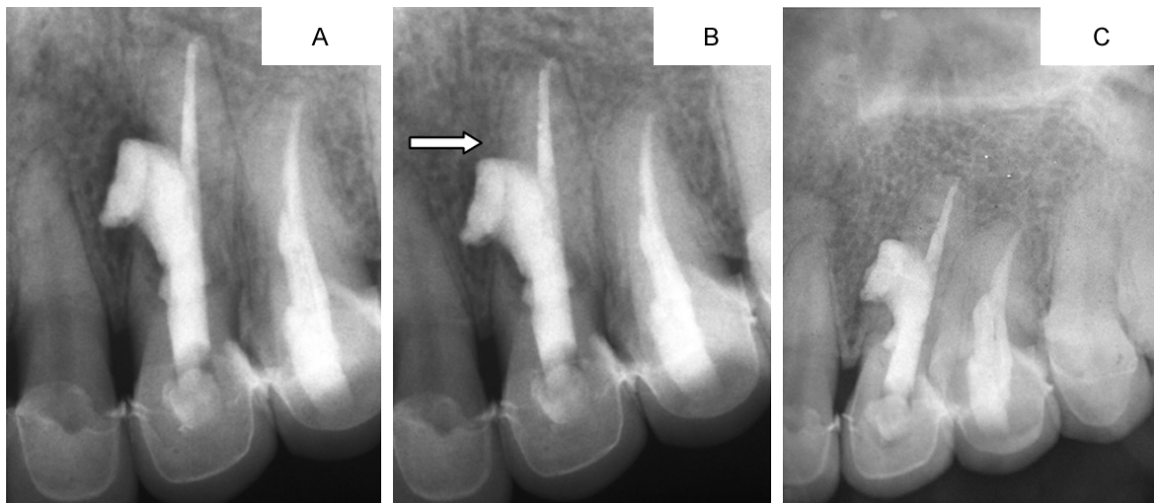


Figure 5. A: One-month X-ray: the resorption region stopped enlarging. B: Six-month X-ray: the radiolucent area began to decrease (pointed by the white arrow). The filling material was intact. C: Three-year X-ray: it showed almost complete healing of the resorption region and the filling material was intact. The periapical radiolucency was resolved. The cortical bone forming the socket of tooth #11 and the interdental alveolar crest bone were clear.

even early at the six-month recall. The filling material was intact (**Figure 5A, 5B**). There was no new external root resorption.

The patient could be reached only by e-mail after three-year follow-up since she was abroad. The patient said tooth #11 had good function and no discomfort. The scanning copy of her three-year review periapical radiograph was asked to be sent by e-mail. It showed encouraging results, with almost complete healing of the resorption region, and the filling material was intact. The periapical radiolucency was also resolved. The cortical bone forming the socket of tooth #11 and the interdental alveolar crest bone were clear (**Figure 5C**).

Discussion

External root resorption is a particularly frustrating type of dental abnormality for both patients and practitioners because there is no plausible explanation for the condition and no predictable treatment [3]. This manuscript, along with other publications [4-7], can further our understanding of this disease process and its treatment.

Etiology

ERR may occur on one tooth or on several teeth and it may be caused by trauma, tooth re-implantation, orthodontic treatment, internal bleaching, periodontitis or previous periodontal

surgery, pressure from adjacent unerupted teeth, cysts, tumors, or by stimuli from a necrotic dental pulp [8]. ERR may also occur as a result of systemic disease and endocrine disorders, such as hyperparathyroidism, Paget's disease, calcinosis, Gaucher's disease and Turner's syndrome as well as after radiation therapy [9]. There are also some rare ERRs of unknown cause, usually called "idiopathic" [4].

In this case report, the ERR of tooth #11 was already present, but not immediately recognized by the private dentist. The possible reason why the resorption occurred on the mesial part of the root of tooth #11 is that this part is the site of fusion of the globular and the maxillary process during development and the remnants of vestigial structures (enclaved epithelium) might cause some oral diseases [10]. In addition, the apical periodontitis from the restoration process may exacerbate the existed lesion. Therefore the diagnosis could be "idiopathic ERR" according to the patient's dental history and clinical manifestations.

Imaging diagnosis

The private dentist didn't recognize the lesion on tooth #11 on the pre-operative panoramic radiograph and the first periapical radiograph, which indicates the difficulties in the detection of root resorption through routine images [11, 12]. In addition, the differential diagnosis for internal and external root resorption with the

common imaging technology is also a formidable challenge. Gartner AH et al [13] suggested that it often requires two periapical radiographs to make the differential diagnosis, one taken perpendicular to the tooth, and the other one taken from a mesial angle. This technique may be helpful to a certain degree; however, the periapical radiographs could not provide the three-dimensional location and determine the true size of the resorption lesions, which is an important information [14].

Cone beam computed tomography (CBCT) technology has been specifically designed to produce three-dimensional scans of the maxillo-facial skeleton. One of CBCT's major advantages over common computed tomography (CT) scanners is the reduction in radiation exposure. CBCT has been successfully used for evaluating the true nature and severity of resorption lesions in case reports [15]. In this case, CBCT provided more details to facilitate the diagnosis, and to educate the patient and manage the defect.

An in-vitro study revealed that the features essential for the differential diagnosis of root resorption were not apparent in conventional radiographs, however, clearly visible in the micro-CT reconstructions [16]. Thus, the more digital simulation studies will provide better understanding about the nature of ERR diseases[17].

Treatment

Some articles suggested various treatment options depending on the etiology and type of ERR such as root canal therapy alone, periodontal surgery alone, root canal therapy plus periodontal surgery or extracting the tooth and implantation [5]. However, a recent systematic review illustrates that there is no reliable source of evidence regarding the most appropriate means of treating ERR. Moreover, it reveals that in most of the cases, the treatment alternative is case-dependent and related to the clinician's experience or an expert's opinion [6].

Therefore, the choice of treatment by root canal therapy alone in this case also depends on a complete communication with the patient combining the patient's condition and trust with the author's experience and confidence. There are several successful case reports about root resorption by root canal therapy alone from

other countries to support this choice [18-20]. The main reasons to suggest preserving the tooth by root canal therapy alone are due to that the canine, because of its arch position, serves as a major support of facial muscles and keeps the overall vertical dimension of the face intact [21]. The patient had a healthy oral hygiene and a long root canine with good periodontal condition. The resorption area was in the mid-third root without communication with the oral cavity. All of these demonstrated the necessity and probability to preserve this tooth. Another important factor is that the patient was satisfied with the zirconium dioxide veneers. She may encounter gingival recession potential after the periodontal flap elevation to repair the perforation surgically. Also, the root canal access had been established when the patient was referred to us, and the patient was young, healthy and had a strong desire to preserve this tooth.

As aforementioned, ERR can be stimulated by inflammation [2] and, as a result, infection control is the key to success. In this case, rubber dam isolation, completely removing granulation tissue, and ultrasonic cleaning with 5.25% sodium hypochlorite were all very helpful in infection control. The use of Vitapex as intracanal medication to control the infection for ERR is also supported by Bhat SS [22], who presented a case report of infection external root resorption on maxillary central incisor with a thirteen-month clinical and radiographic follow-up.

MTA, a commonly used repair material in endodontics, has many excellent properties such as biocompatibility, good sealing ability, and the ability to inhibit bacteria. The most important reason to choose MTA as the permanent repair material in this case is because it has a capacity to promote hard tissue formation and to inhibit osteoclastic bone resorption [7]. The excellent three-year follow-up radiograph result is the best testimony for MTA (**Figure 5C**). In short, with careful clinical procedures, proper disinfectant and superior repair material, successful non-surgical treatment for severe ERR is possible.

Prognosis

By the three-year follow-up, the resorption region had almost completely healed and the filling material in the root canal was intact,

which demonstrates a favorable clinical outcome. From the limited available knowledge, the longest observation time about ERR is a ten-year observation [23]. The authors plan to follow this case in the future as long as possible.

Conclusions

In summary, endodontists should have confidence in treating such extensive ERR disease with careful clinical procedures, complete control of infection and superior filling material such as MTA. With proper treatment, the tooth may be preserved for a long time. CBCT is an effective technique in diagnosing and choosing treatment plans of ERR for both dentists and patients.

Acknowledgements

This work was supported by grant from the National Natural Science Foundation of China (No. 81370405, to Bo Cheng).

Disclosure of conflict of interest

None to declare.

Address correspondence to: Dr. Jun Sun, Department of Restorative Dentistry, Indiana University School of Dentistry, Indianapolis, IN 46202, USA. Tel: 317-274-2126; Fax: 317-278-2818; E-mail: jun-sun@iu.edu; Dr. Bo Cheng, Department of Stomatology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei 430022, China. Tel: 86-13507-190986; E-mail: chengbo_01@hotmail.com

References

- [1] Lambrechts P and Vanhoorebeeck B. Root resorption. *Rev Belge Med Dent* 1992; 47: 54-75.
- [2] Fuss Z, Tsesis I and Lin S. Root resorption: diagnosis, classification and treatment choices based on stimulation factors. *Dent Traumatol* 2003; 19: 175-182.
- [3] Regezi JA, Sciubba JJ and Jordan RCK. Oral Pathology (Clinical Pathologic Correlations). In: Dolan J and Nebel J, eds. *Abnormalities of Teeth*. St. Louis: Saunders; 2003. pp. 374-375.
- [4] Heithersay GS. Management of tooth resorption. *Aust Dent J* 2007; 52: S105-S121.
- [5] Segal GR, Schiffman PH and Tuncay OC. Meta-analysis of the treatment-related factors of external apical root resorption. *Orthod Craniofac Res* 2004; 7: 71-78.
- [6] Ahangari Z, Nasser M, Mahdian M, Fedorowicz Z and Marchesan MA. Interventions for the management of external root resorption. *Cochrane Database Syst Rev* 2010; 16: CD008003.
- [7] Hashiguchi D, Fukushima H, Yasuda H, Masuda W, Tomikawa M, Morikawa K, Maki K and Jimi E. Mineral trioxide aggregate inhibits osteoclastic bone resorption. *J Dent Res* 2011; 90: 912-917.
- [8] Rathe F, Nölken R, Deimling D and Ratka-Krüger P. External root resorption. *Schweiz Monatsschr Zahnmed* 2006; 116: 245-253.
- [9] Carrotte P. Endodontics: Part 9. Calcium hydroxide, root resorption, endo-perio lesions. *Br Dent J* 2004; 197: 735-743.
- [10] Rushton MA, Cooke BED and Duckworth R. *Oral Histopathology*. London: E. & S. Livingstone; 1970. pp. 189.
- [11] Patel S and Ford TP. Is the resorption external or internal? *Dent Update* 2007; 34: 218-220, 222, 224-226, 229.
- [12] Chapnick L. External root resorption: an experimental radiographic evaluation. *Oral Surg Oral Med Oral Pathol* 1989; 67: 578-582.
- [13] Gartner AH, Mack T, Somerlott RG and Walsh LC. Differential diagnosis of internal and external root resorption. *J Endod* 1976; 2: 329-334.
- [14] Kim E, Kim KD, Roh BD, Cho YS and Lee SJ. Computed tomography as a diagnostic aid for extracanal invasive resorption. *J Endod* 2003; 29: 463-465.
- [15] Patel S and Dawood A. The use of cone beam computed tomography in the management of external cervical resorption lesions. *Int Endod J* 2007; 40: 730-737.
- [16] Luso S and Luder HU. Resorption pattern and radiographic diagnosis of invasive cervical resorption. A correlative micro CT, scanning electron and light microscopic evaluation of a case series. *Schweiz Monatsschr Zahnmed* 2012; 122: 914-930.
- [17] Huang Z and Chen Z. Three-dimensional finite element modeling of a maxillary premolar tooth based on the micro-CT scanning: a detailed description. *J Huazhong Univ Sci Technol Med Sci* 2013; 33: 775-779.
- [18] Oktem ZB, Cetinbaş T, Ozer L and Sönmez H. Treatment of aggressive external root resorption with calcium hydroxide medicaments: a case report. *Dent Traumatol* 2009; 25: 527-531.
- [19] Araújo RA, Silveira CF, Cunha RS, De Martin AS, Fontana CE and Bueno CE. Single-session use of mineral trioxide aggregate as an apical barrier in a case of external root resorption. *J Oral Sci* 2010; 52: 325-328.
- [20] Danesh F, Karamifar K and Abbott PV. Management of an extensive invasive root resorptive

Non-surgical therapy of external root resorption with MTA

- lesion with mineral trioxide aggregate: a case report. *J Oral Sci* 2011; 53: 397-401.
- [21] Balogh MB and Fehrenbach MJ. Illustrated Dental Embryology, Histology, and Anatomy. Dental Anatomy. Illustrated by Thomas P. Philadelphia: W.B. Saunders; 1997. pp. 246-247.
- [22] Bhat SS, Sharan SS and Madan I. Healing of root resorption: a case report. *J Clin Pediatr Dent* 2003; 27: 235-238.
- [23] Kqiku L, Ebeleseder K and Glockner K. Treatment of invasive cervical resorption with sandwich technique using Mineral Trioxide Aggregate: a case report. *Operative Dentistry* 2012; 31: 98-106.