



Original Article

Management of Oblique Root Fracture Using Mineral Trioxide Aggregate: A Case Report

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Abstract: Root fractures are relatively uncommon compared to other types of dental traumas. It is sometimes extremely difficult for practitioners to decide what should be done and which approach was the optimal choice for patients. This study describes the treatment of an oblique root fracture in the right maxillary central incisor (tooth 11) using mineral trioxide aggregate (MTA) and lingual splint with composite and 0.3 mm 3-strand twisted stainless steel wire. The study performs a detailed management from the first visit to the next appointments. After four months, the tooth was asymptomatic with neither discoloration nor draining sinus. Radiographs show the increasing of periapical radiolucency in the fracture area. Thus, the tooth needs further interventions.

Keywords: Dental trauma, root fracture, mineral trioxide aggregate, dental trauma splint.

1. Introduction

Root fractures referred to fractures involving dentin, cementum and pulp are relatively uncommon compared to other types of dental traumas with only 0.5-7% for the permanent dentition. Frequent causes of root fractures in the permanent dentition are fights and foreign bodies striking the teeth. Root fractures usually affect the maxillary central incisor region with complete development, and the fracture line is

often oblique [1]. They occur most commonly in the middle-third (57%) and less in the apical (34%) and coronal-third of the root [2]. Diagnosis is mainly determined by radiograph examinations, normally used periapical radiographs by changing the beam angulations. However, sometimes, Cone-beam Computer Tomography (CBCT) might take more benefits than intraoral radiography about the location, extent, and direction of a root fracture which can be visualized in all three dimensions [3-5].

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The first step in the management of root fractures is repositioning and stabilizing the coronal fragment with flexible splint for 4 weeks [6]. In the case of getting pulp necrosis, the next steps should be based on the location of fractures [6]. Endodontic treatment is indicated for only coronal segment when fracture line is on middle and apical third [7] and resembles the apexification technique [8].

Mineral trioxide aggregate (MTA) was first mentioned in the scientific article in 1993 [9] and until now, a good many evidences have shown the bioactivity of MTA in the contemporary endodontics [10]. MTA has been used as an *công sữ* alternative to conventional calcium hydroxide in the apexification procedure [11].

The following case report performs the management and follow-ups of the right maxillary central incisor (tooth 11) with oblique root fracture treated by MTA for coronal fragment.

2. Case Report

An 18-year-old patient came to 182 Luong The Vinh General Clinic, Hanoi, Vietnam within an hour immediately after a dental trauma while playing basketball. Clinical examination revealed palatal and incisal displacement of the right maxillary central incisor (tooth 11), slight bleeding from gingival sulcus and gazes on the upper lip. Periapical radiographs showed a horizontal root fracture in the middle third and an impacted supernumerary at the level of the root apex of tooth 11. CBCT was indicated. CBCT images revealed an oblique root fracture at the middle third (Figure 1) and an obliquely orientated tuberculate located from the right side at the apical third level to the inferior and palatal of the root apex of tooth 11. The supernumerary had a close contact with tooth 11 without touching (Figure 2).

After repositioning the coronal segment, the tooth was immobilized without antibiotics by composite and 0.017 x 0.025-inch orthodontic wire from tooth 12 to tooth 23 (Figure 3); however, the tooth still had mobility I (Miller's classification). The next appointment was made for four weeks to check-up and remove splint.

However, after two months, the patient returned with a little discomfort while eating. While a draining sinus appeared on the buccal gingiva at the middle root level, the affected tooth was tender to percussion and palpation, had mobility II and had no color change. Radiograph showed the widening of space between two fragments of tooth 11 (Figure 4A). Based on that, after removing the splint, the endodontic treatment was performed on the coronal fragment. The necrotic pulp was extirpated, and the working length was obtained by apex locator ProPex II (Dentsply Maillefer, Ballaigues, Switzerland) and X-rays. The root canals were prepared with K-files and manual Protaper. Irrigation was applied with 5.25% sodium hypochlorite. Calcium hydroxide was applied in the pulp space and the cavity was temporarily filled with Ceivitron (Recodent, Taiwan) for a week. At the next visit, MTA premixed injectable syringe was inserted directly according to the manufacturer's instructions with the stopper 1 mm short of the working length (Figure 4B). After a week, adhesive coronal resin restorations were performed. At the same time, lingual splint made from 0.3 mm 3-strand twisted stainless steel wire was adhesively applied from tooth 13 to tooth 23 (Figure 5A).

With the 2-month follow-up, the tooth was asymptomatic with neither discoloration nor draining sinus (Figure 5B) and had mobility II. Periapical radiolucency increased in the fracture area (Figure 4C). In that case, the tooth needed more observation and splint would be retained for the next visit. The patient was followed-up each 3 months during the first year.

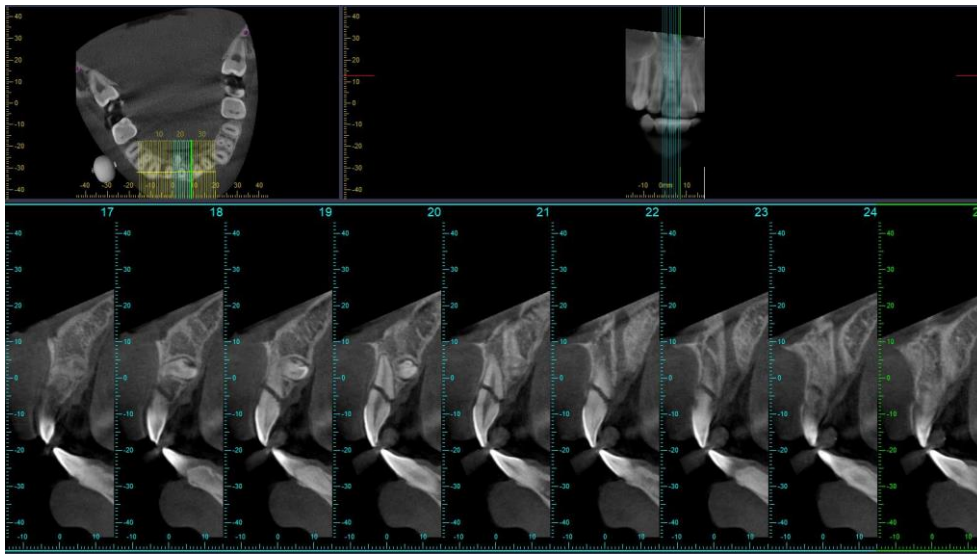


Figure 1. The sagittal section on CBCT showed the oblique fracture at the middle third root.

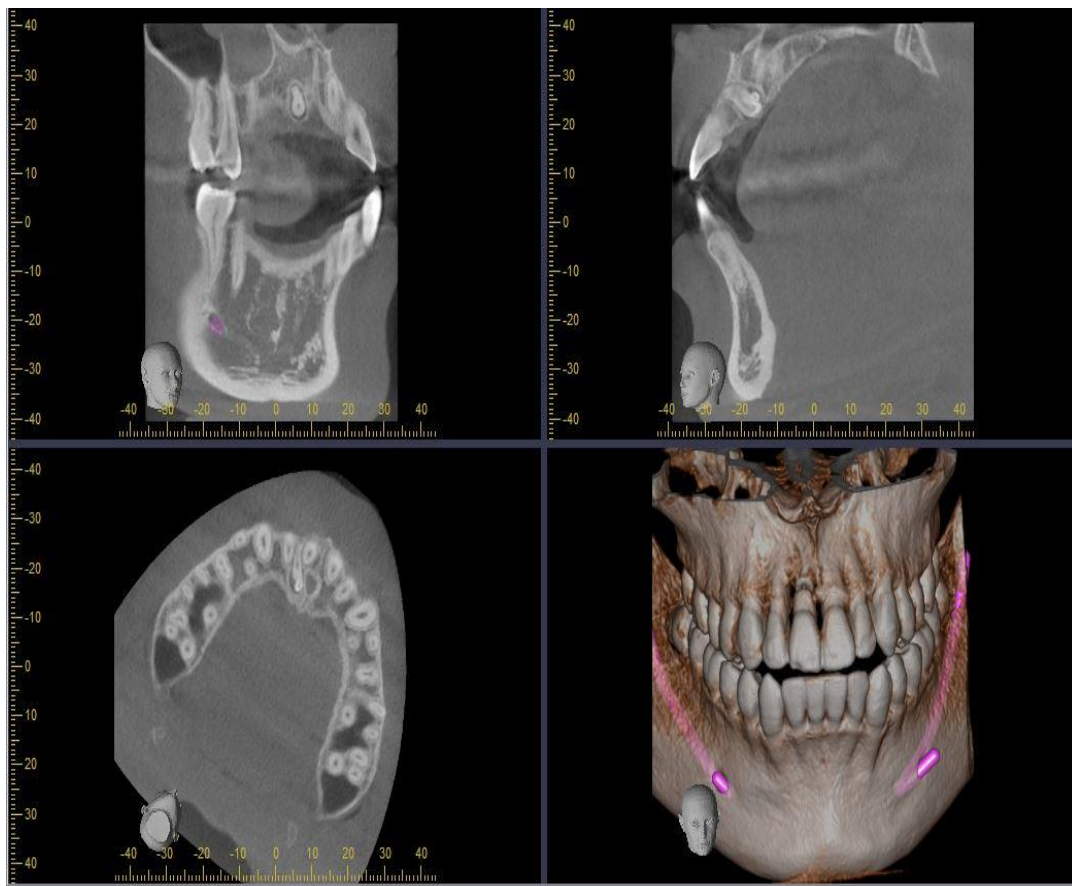


Figure 2. Oblique tuberculate supernumerary located from the right side at the apical third level to the inferior and palatal of the root apex of tooth 11.

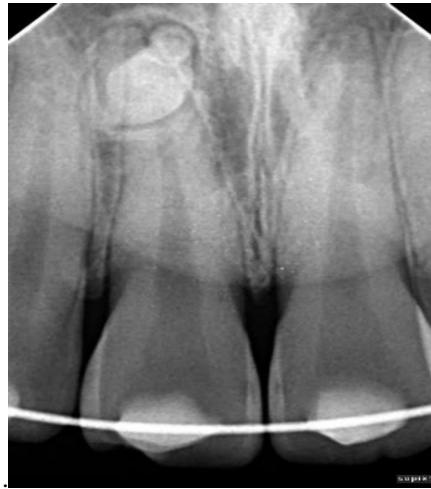


Figure 3. Tooth 11 after applying splint, the appropriate placement with no diastasis.

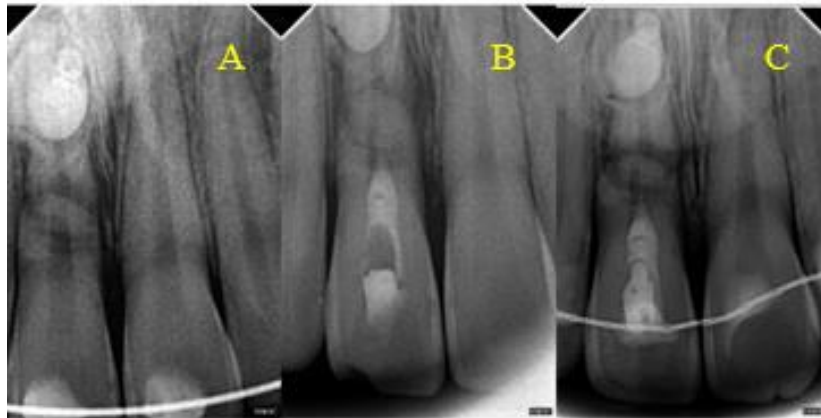


Figure 4. A. Periapical radiograph performed the widening of space between two fragments. B. MTA was placed as an apical plug. C. After 2-month follow-up, periapical radiograph showed resorption in the fracture region. Periapical radiolucency had increased in the fracture area.



Figure 5. A. Splint was adhesively applied to the lingual surfaces. B. After 2-month follow-up, no color change, no draining sinus.

3. Discussion

3.1. Diagnosis

Diagnosis in root fracture is based on both clinical and radiographic findings. It is usually not possible to distinguish clinically between displacement due to a root fracture and a luxation injury when the coronal segment displaces in the palatal direction, thus, diagnosis mainly depends upon radiographs [1]. In this case, the sagittal CBCT slice of tooth 11 reveals an oblique root fracture from the middle third on the facial aspect through the cervical third on the palatal aspect, rather than the horizontal fracture that was diagnosed on periapical radiographs. While the final diagnosis just needs periapical radiographs for root fractures in the apical or cervical third, CBCT is recommended for fracture lines in the middle third of root [3, 4, 12]. Besides, this patient revealed the impacted tuberculate tooth in the maxillary region which needed CBCT to determine either its location or relationship with the affected tooth. Through three sections of CBCT, the supernumerary is in close contact with tooth 11 without touching; however, it has the radiolucency around its crown. Thus, at that moment, tooth 11 took priority over the supernumerary and needed more follow-ups for a time before being transferred to oral and maxillofacial surgeon.

3.2. Dental Trauma Splints

According to the guidelines of International Association of Dental Traumatology (IADT) and American Association of Endodontics (AAE), the first step is repositioning the coronal fragment as soon as possible and stabilizing it with flexible splint [6, 7]. Splints are classified as rigid, semi-rigid and flexible splint [1, 13]. Among many different types of splints, composite and wire splints are the most commonly used for traumatized teeth. According to a study by S. Gautam et al., [14] all patients found composite wire splints as an easy, maintainable, economical option in stabilizing traumatized teeth and had no problem in

maintenance of oral hygiene. K. Oikarinen et al., [15, 16] and S. C. Kwan et al., [17] showed that while both stainless steel and Niti wires with diameter 0.3-0.4 mm could be flexible enough for a functional fixation, composite splints were rigid and therefore, should not be used for long-term splinting of traumatized teeth. K. S. Mirza et al., [18] stated that although splinting with 0.7 mm and 0.4 mm stainless steel orthodontic wires were equally effective in the management of traumatic dental injuries, 0.7 mm stainless steel wire, which was slightly more rigid in comparison to 0.4mm stainless steel wire, had added effectiveness in managing post splinting pain. In the article of Y. Zhu et al., [19] the 0.8 mm stainless steel wire-composite splint is flexible regardless of the abutment tooth position and the adhesive point dimension. Ebeleseder et al., [20] found that splints made of composite resin and 0.017 x 0.025 inch orthodontic steel wire, where mobility was tested with Periotest mobility measurements, reported immobilization did not exceed normal tooth firmness. C. Berthold et al., [20, 21] 0.41 x 0.41 mm rectangular orthodontic wire, 0.45 mm multi-stranded flexible orthodontic wire, titanium trauma splint (TTS) with 0.2 mm thickness, have suitable flexibility for splints, whereas splint made of three-stranded strengtheners 0.8 x 1.8 mm and titanium ring splint (TRS) with 0.6 mm thickness are rigid and can be used for treating alveolar process fractures and intra-alveolar root fractures in the cervical part. In our research presented at the Australian and New Zealand Academy of Endodontists meeting, Brisbane, 2011 and the American Association of Endodontists meeting, San Antonio, 2011 by J. Y. Hu et al., [23] GC Fuji Ortho LC was considered as an ideal splinting adhesive material that might alter composite because of its ease of application without the need for enamel etching, ability to resist physical forces during the splinting period, and most importantly, ease of removal with minimal or no damage to the enamel surface. While GC Fuji Ortho LC has been shown to fulfill the requirements of an ideal

splinting adhesive material, a practical alternative is GC Fuji 2 which has similar physical characteristics and handling properties, and is more commonly used in dental practices [24]. H. S. Zagalska et al., [25] and M. W. Ben Hassan et al., [26] reported that PC (power chain) might be an interesting novel alternative with suitable flexibility and the fastest to apply and remove as well as the most aesthetic splint. Some authors agreed that there was no advantage from extending the splint to more than one adjacent uninjured tooth on each side [20, 22]. In some current studies, influence of defined splint width, thickness or adhesive dimension onto rigidity was paid more attention. The article of Y. Zhu et al., in 2016 [19] showed that while mobility was still higher than in unaffected teeth, increase in size of the adhesive splinting point decreased horizontal but not vertical mobility. According to the research of T. Shirako et al., [27], effects of composite splints differed depending on the width of the splint and mobility of injured teeth, thus, it might not suggest composite splints as rigid splints which were mentioned in some previous studies [15-17]. Composite splints can be useful in immobilizing injured teeth having a high degree of mobility [27]. Although there was no significant relation between the time of treatment after trauma and healing, an acute (within a few hours) or subacute (within the first 24 h) treatment [28, 29] was still recommended. There is no difference in healing in non-displaced tooth between splint and no splint, so teeth with minimal mobility and little periodontal injury or subluxation of the coronal element may be treated without splint [29, 30]. The period of time for splint is for 4 weeks and up to 4 months (2-3 months [29]) for fracture at the cervical third [6, 7]. In a case report in 2002, splint was maintained for 3 years after the initial treatment [31].

In the case presented above, although the tooth was repositioned and stabilized within an hour after trauma with composite and 0.017 x 0.025-inch orthodontic wire extending two the

teeth on the right side and three teeth on the left side. After splinting, the tooth had mobility I. X-rays photographs showed the appropriate placement with no diastasis (Figure 3). However, pulp still necroses after two months. The wire selected is flexible enough [20]. The fracture line runs obliquely from the middle third on the labial surface to the cervical third on the palatal, thus, it is resembled treatment and prognosis for fracture at the gingival third more than the middle. Prognosis of pulp healing in root-fractured teeth, that has dependence upon type of injuries more than factors associated with splinting, is good [33] with about 26.7 - 40% teeth developing pulp necrosis [8, 32] and survival of pulp is poorest for fractures located at the gingival third of the root [30]. Antibiotic therapy is considered to be unnecessary in management of root fracture [8, 29, 33].

3.3. Endodontic Treatment for Pulp Necrosis

In the case of pulp necrosis, endodontic treatment would be indicated for the coronal segment [1, 6, 7] because only 1% of cases had pathosis associated with the apical fragment [30]. Treating the coronal fragment resembles the apexification procedure for tooth with open apex.

Working length takes an important role in endodontic treatment including control of extruding debris or obturated materials out of canal. There have been a good many evidences proving the more accuracy of electronic apex locators (EALs) in determining the working length (WL) compared to 2-dimension radiographs. However, for teeth with open apices, controlling the WL is always a challenge for practitioners. Therefore, the use of EALs and radiographs should be supplemented with other methods, especially when treating very wide apical terminations [34]. In this case, for oblique fracture, using periapical radiograph has limited efficiency to determine WL. Based on a research in 2008, EALs are capable of measuring the WL of coronal root canal in teeth with oblique root fractures [35].

Traditionally, an apexification procedure of this segment technique involves the repeated placement of calcium hydroxide over a period of time until a calcific barrier is formed at the fracture line before obturation of the root canal. The main disadvantages of this procedure include a need for multiple visits and reducing root resistance after a long-term contact between calcium hydroxide and root dentin [11, 12, 36]. For these reasons, the use of MTA in teeth with necrotic pulps and open apices has been considered [37]. In a systematic review by M. Singh et al., in 2021, while both calcium hydroxide and MTA provide similar success rates, MTA takes shorter time (3 +/- 2.9 months) to form the apical than calcium hydroxide (7 +/- 2.5 months) in immature necrotic permanent teeth [38].

The success of MTA in treatment root-fractured teeth is quite high; however, the number of cases recorded has been small. We found six articles about using MTA for the management of root-fractured teeth. One of them is a case report about the use of MTA and intracanal post reinforcement for both fragments and its success after 18-month follow-up [39]. According to G. Erdem et al., in 2009 [40], in three cases, the clinical and radiographic examinations of the horizontally root-fractured teeth treated with MTA used as an apical barrier revealed asymptomatic and excellent healing patterns after 36-month follow-up. A case from the report of R. Rothom and P. Chuveera [12], one from K. Er [41] and three cases from A. Kusgoz [42], showed favorable outcomes. A research of D. Kim et al., in 2015 [43] showed that of the 22 root-fractured teeth received endodontic treatment with MTA, 19 cases participated in the follow-up for a period of at least 3 months. Seventeen of the 19 cases (89.5%) found healing of tooth fractures, whereas, 2 failed cases revealed interposition of granulation tissue without healing. In most cases, working length was determined by radiographs, irrigation was applied with sodium hypochlorite 1-2.25%, intracanal medication was dressed with calcium hydroxide or triple antibiotic paste (for

only two cases) and MTA was mixed according to the manufacturer's instructions and inserted into canals by Messing gun.

In our case, the working length was mainly obtained by apex locator ProPex II (Dentsply Maillefer, Ballaigues, Switzerland) because it was hard to get accurate WL in 2-dimension periapical images for the oblique fracture. Unlike the cases mentioned above, we used MTA premixed injectable syringe that was inserted directly according to the manufacturer's instructions with the stopper 1 mm short of the working length. Although the canal was not sealed as tightly as we expected (Figure 4), the tooth was asymptomatic with neither discoloration nor draining sinus (Figure 5B). Because of mobility II, we decided to re-splint with 0.3 mm 3-strand twisted stainless steel wire on the lingual surfaces for esthetic problem. After 2 months, periapical radiolucency seemed to increase in the fracture area (Figure 4C), while tooth still had no pain, no sinus, no discoloration. This case has required further follow-ups.

Lately, there has been a new approach for apexification: using an apical barrier of platelet-rich fibrin (PRF) for stabilization of MTA in canal in order to prevent material from extruding beyond the apex [44]. It deserves to receive more concern in the management of root-fractured tooth.

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