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Case report

Successful traction of a mesially 90° dilacerated root of impacted maxillary canine: A case report

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ABSTRACT

Background: *Impacted maxillary anterior teeth are a problem that has a significant impact on the aesthetics of the smile, dental arches, and occlusion.Teeth that have higher tendencies to get impacted are third molars, maxillary central incisors, maxillary canines, and mandibular premolars. Impacted teeth with severe root dilacerations are usually extracted surgically, then the space will be closed by orthodontic treatment or using a prosthesis.* ***Purpose:*** *This study aims to report the successful orthodontic traction of mesially 90° dilacerated root of impacted maxillary canine.* ***Case:*** *A 15-year-old female patient with the chief complaint of an unerupted left maxillary canine. Intraoral examination showed a class I molar relationship on both sides, a unilateral crossbite on the right side, 8 mm spacing between the maxillary left lateral incisor and the premolar. Also, mild crowding was found on both upper and lower anterior segments. CBCT results showed a left maxillary canine was palatally semi-vertical impacted and had a mesially 90° dilacerated root. A significant stress concentration occurred at the middle and apical of the dilacerated root apex when exposed to orthodontic force; this tends to be a higher potential for resorption.* ***Case Management:*** *The impacted dilacerated canine was successfully moved to the proper position by combining crown exposure surgery, orthodontic traction using continuous light force, and gingivectomy. Furthermore, traction was held using a gold chain combined with an elastic thread tied initially to a modified stainless-steel main archwire; this was followed by piggyback tandem wire and a vertical 3/16" light elastic traction.* ***Conclusion:*** *The patient showed successful traction of the canine in less than six months. In addition, the unilateral posterior crossbite was corrected and functional occlusion was achieved. That canine showed good orthodontic and periodontal stability at one-year follow-up, without any evidence of root resorption.*

Keywords: *impacted dilacerated canine; orthodontic treatment; light force; orthodontic traction*

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INTRODUCTION

Impaction has been well-defined as total or partial lack of eruption of a tooth well after the normal age of eruption.[1] The tooth impaction is caused by multiple factors which are divided into local and systemic factors.[1,2] The impacted tooth can be caused by lack of space, lack of eruptive force, and sometimes a physical barrier such as mucosa, supernumerary tooth, bone or even retained deciduous tooth can prevent a tooth from erupting.[1,3] Teeth that have higher tendencies to get impacted are third molars, maxillary central incisors, maxillary canines, and mandibular premolars.[1] In treatment plans, surgical and orthodontic management, those teeth are usually harder to treat and more challenging. Achieving the ideal result in the treatment of teeth impaction usually depends on several factors such as biomechanical and clinical considerations, parent's and patient's commitment to their decision regarding the therapeutic limitation and possible complications of tooth traction like tooth ankylosis, periodontal support's loss of attachment and the resorption of root apical external area.[1,4]

Impacted maxillary anterior teeth are a problem that has a significant impact on the aesthetics of the smile, dental arches, and occlusion.[5] They can disturb the tooth function in patients and have to be repaired as soon as possible so the greater deviation like alveolar height loss, the inclination of adjacent teeth to an incorrect space and the deviation

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of midline will not occur. Canines are the most impacted anterior teeth and this can be caused by narrowing of the eruption space, wrong tooth placement, root dilaceration, and ankylosis.[5,6] Additionally, this can be alternated with surgical extraction of the tooth, or traction of the impacted tooth with orthodontic treatment.[6] The success rate of eruption and the procedure's risk are essential factors to consider in treating of impacted teeth.[5,6]

Dilaceration refers to abnormal angulation or curvature formed in the root or crown of a tooth.[7] Root dilaceration is a shape abnormally in the root of a tooth and the deviation of the longitudinal axis is usually seen. The curve is usually seen in labiolingual or mesiodistal.[7,8] Moreover, the roots' deviation from the axis of the tooth crown makes it difficult for the teeth to erupt according to the normal eruptive pathway.[9,10] Root dilaceration is usually caused by idiopathic developmental disorders or trauma and has also been associated with advanced root canal infection. Other etiologies that can cause root dilacerations are cysts, developmental of dental germ that cause a change in anatomic structures, lack of space that cause ectopic tooth development, and facial clefts.[8]

An impacted tooth with dilacerated tooth can be treated with several treatments like tooth's extraction or orthodontic traction. It all depends on the prognosis of periodontal and biomechanical considerations. Impacted teeth with severe root dilacerations are usually extracted surgically and the space can be closed by orthodontic treatment or using a prosthesis, but usually a tooth with the such condition can be challenging to be treated by a surgical-orthodontic approach.[5,6] This case report describes the interdisciplinary treatments of impacted maxillary left canine with root dilaceration in the apical third portion at 90° mesially. The treatment included orthodontic, oral surgery and periodontal approach. This study aims to report the successful orthodontic traction of mesially 90° dilacerated root of impacted maxillary canine.

CASE

A 15-year-old girl came in for treatment for an unerupted permanent left maxillary canine. There was no history of serious health problems, allergies, or trauma in her medical history. The patient had a convex profile and a class I skeletal base-jaw relationship. Except for the left maxillary canine, intraoral examination revealed that all permanent teeth completely erupted. She demonstrated a Class I molar relationship with 4.5 mm overjet and 1 mm overbite. There was mild crowding in the maxillary arch (ALD +6 mm; 2.5 mm anterior crowding; 0.5 mm central diastema and 8 mm spacing between the left maxillary lateral incisor and the first premolar); mild crowding in the mandibular arch (ALD -2 mm) with a unilateral crossbite on the right side (Figure 1).

The panoramic radiograph demonstrated an impacted left maxillary canine in a semi-vertical position with root laceration (Figure 2A). Additionally, the three-dimensional cone-beam computerized tomographic (CBCT) reconstructed images showed that the tooth was semi-vertical with the crown of the tooth palatally and the root of the tooth buccally. Meanwhile, 1/3 of the root tip was lacerated 90° mesially (Figure 2B).

As shown in Figure 2, the root formation was completed. CBCT confirmed that the left impacted maxillary canine was located close to the alveolar ridge with only a thin layer of bone covering the crown. The crown was in the palatal with the buccal side facing the dental arch which is favorable to orthodontic traction using one-step approach, in which the attachment is placed on the tooth at the time of surgical exposure. It is considered as a factor leading to a good prognosis.

This case can be treated using several options such as surgical exposure and followed by prosthesis or surgical exposure with orthodontic traction. It was all discussed with the patient and parents. The difficulty during extraction was expected because the root of the impacted canine was already severely dilacerated. The patient and her family had a strong desire to retain the tooth. As a result, the decision to expose the tooth surgically followed by orthodontic traction was taken. We would also maintain the integrity of periodontal tissue supporting the tooth at the same time. Since this treatment plan was approved, informed consent was signed.

CASE MANAGEMENT

Fixed orthodontic appliances (Roth .022 3M Unitek, Monrovia, CA USA) were bonded from the second molar forward on both sides in the maxillary and mandibular arches, except the left maxillary canine. Initial alignment and leveling were achieved with super-elastic nickel-titanium (NiTi) wire followed by 0.016x0.022-in stainless steel (SS) wire. After that, the surgical exposure of the impacted left maxillary canine with dilacerated root was done using the open window method. Under local anesthesia, the surgeon created a window to expose the crown of the impacted tooth (Figure 3A). The gold chain was attached to the buccal part of the crown in the palatal. The use of gold chain was considered because it can support good adhesive strength and almost no one has an allergic reaction to it. Subsequently, the chain was tied with an elastic thread using light orthodontic force (≈ 20g measured by tension gauge) on a modified 0.016x0.022-in SS wire; this was performed with an omega-shaped hook facing occlusal in the distal third wire length area spacing (Figure 3B). Every three weeks, the elastic thread was replaced. After nine weeks, the crown of the tooth was getting labially closer to the arch. As a result, the force was applied differently using the piggyback tandem wire technique with full arch anchorage; this was performed with a 0.012-in NiTi wire over a 0.016x0.022-in SS wire as the main archwire while still using light orthodontic force (≈ 30-40g measured by

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Figure 1. Pretreatment intraoral photographs.

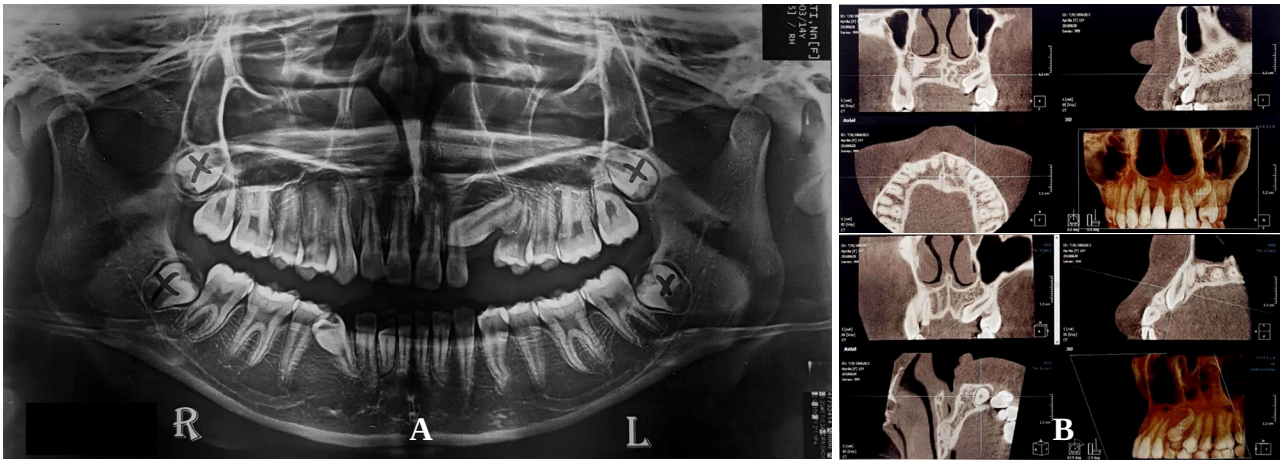

Figure 2. A. Pretreatment panoramic; B. CBCT.

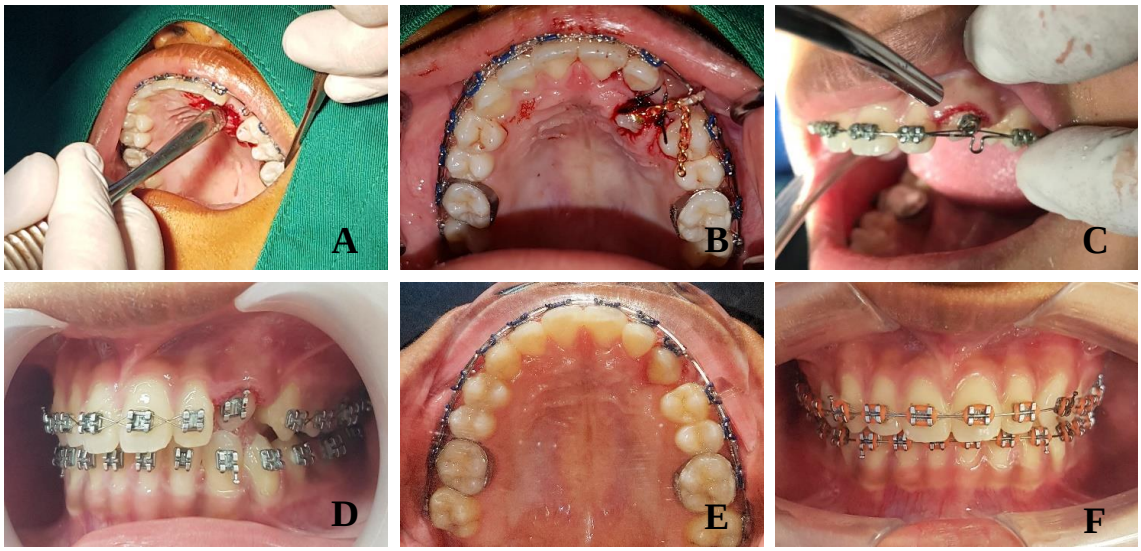

Figure 3. Treatment Progress. A. surgical exposure, B. traction with gold chain and elastic thread, C.gingivectomy, D. bracket placement, E. re-alignment and re-leveling, F. traction result.

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tension gauge). After six weeks, the tooth appeared more extruded (the height of the visible crown was about 6 mm) and more labial in position; gingivectomy and bracket placement of the tooth were performed (Figure 3C). The force was then applied using the piggyback tandem wire technique as before.

In addition, the patient was instructed to use a light force 3/16 inch vertical-triangular elastic band, replaced twice a day for three weeks by anchoring all the mandibular teeth that had been aligned and leveled. After the next control period, the canine position did not crossbite with a distance of about 2 mm from the buccal surface of the tooth to the main archwire. This stage of using piggyback tandem wire was completed. Therefore, bracket repositioning, re-alignment, and re-leveling were performed using an initial super-elastic 0.014 NiTi wire with the other tooth positions having figure-eight ligation to add anchors (Figure 3D). In less than six months, the left maxillary canine was in a good arch of occlusion (Figure 3E); this happened in May to November 2019. Occlusion setting and detailing was started in January 2020, but unfortunately, since March 2020 the patient had difficulty coming to visit for routine control because of the COVID-19 pandemic, so the fixed appliances were debonded in October 2020 according to the patient's request related to the uncertain situation at that time. Hawley retainers were placed in maxillary and mandibular arches after debonding.

In less than six months, surgical exposure and orthodontic traction of mesially 90° dilacerated root of impacted maxillary canine was successfully performed. The roots of the teeth showed no resorption. Additionally, no abnormalities were found in the alveolar bone or the surrounding tissues since the traction or after the recall one year following the completion of orthodontic treatment (Figure 4). Treatment limitations occurred due to the pandemic situation in 2020. Root parallelism did not achieve because the setting and detailing phases were disrupted during the pandemic. Post-treatment photographs could not be taken because the procedure for handling patients during the pandemic at that time did not allow cameras. Panoramic after one-year follow-up (Figure 4B) has shown a slight decrease in alveolar bone height in the anterior region which could be related to various factors, including the lack of monitoring of the patient's oral hygiene since 2020 and during the use of the Hawley retainer.

DISCUSSION

Impacted and dilacerated are two different types of conditions that can complicate dental care, especially orthodontic treatment. This case is quite rare, and because the success rate is still rarely reported, the treatment is a

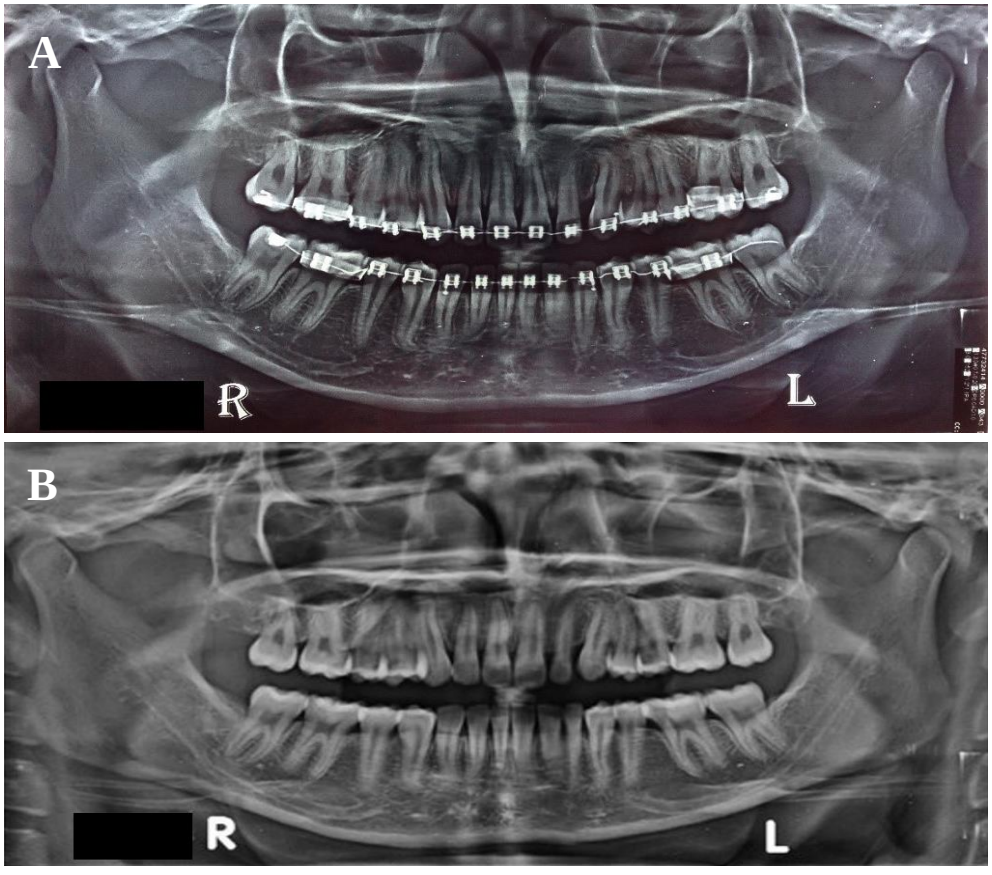

Figure 4. Panoramic A. after orthodontic traction B. after one-year follow-up.

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big challenge. The impact of tooth's position and direction, the extent of root formation, direction and angulation of dilacerations, and the amount of space available for aligning the impacted tooth are all factors affecting the successful alignment of impacted dilacerated teeth. Meanwhile, the prognosis of the orthodontic traction treatment can be seen from the low position of the alveolar ridge, incomplete formation of the root and fan obtuse inclination angle.[9–11] This case had a semi-vertical impacted tooth crown palatally and root buccally positioned, mesially 90° root laceration. Furthermore, this position causes stress concentrated at the middle and apical regions of the root during intrusive, extrusive, tipping, and rotational force application. Therefore, the potential for root resorption is increased.[9,12]

Root resorption causes many dental problems and complications. In orthodontics, root resorption is referred to as resorption caused by inflammation. It is a pathological condition because the orthodontic force will be focused on the tooth and the area will be hyalinized. This will cause the loss of periodontal tissue.[13] The root resorption can be caused by a complex multifactorial etiology like the combination of genetic, mechanical and biological factors and also some factors that are related to the orthodontic treatment.[13–15]

The application of force in orthodontic treatment is essential for successful treatment and is an iatrogenic factor that harms the teeth and surrounding tissues.[16] The mean optimal force on teeth with normal roots should not be applied to teeth with dilacerated roots. Applying the same magnitude of force to the two different root states resulted in higher stress apical to the dilacerated root state. This difference could be up to 20 times higher.[12] Also, the first force applied in this case was tipping; this was accomplished by applying a light force from a continuous elastic thread of about 20 grams, resulting in a tooth shift of 4 mm for nine weeks. A twisting effect delivered by the direction of the elastic thread knot was made oblique to the distal 10°. Since the initial position of the labial teeth was facing anterior, the elastic thread's pull direction would transmit tensile forces and rotate the labial teeth laterally.

Abnormal root morphology such as dilacerated root is a high enough risk factor for root resorption. Similarly, orthodontic treatment is also a mechanical risk factor for root resorption.[16] The application of orthodontic force to the dilacerated root can be a bad scheme for the tooth condition. Therefore, consideration of the magnitude and direction of the force is needed to minimize adverse effects.[17] However, no references specifically describe applying the optimum orthodontic force to perform tooth traction with dilacerated roots.

Orthodontic traction on impacted teeth is performed in many ways, including cantilever springs such as Kilroy springs, Ballista springs by Jacoby, buccal auxiliary springs by Kornhauser, and other spring innovations.[18–21] The design and dimensions of the wire are used to influence the force generated by the spring. Making a spring to produce a continuous light force is not simple, mainly if applied to a tooth with a root dilaceration.[12,20] Due to the relatively easy application, tooth traction using an elastomeric chain is also a preferred option.[22,23]

The principle of treatment performed refers to two principles: Oppenheim's principle (1911) regarding light forces and Martin Schwarz's (1932) principle that the limit of orthodontic forces should not exceed capillary blood pressure, 20 g/cm^2 for tipping and 40-50 g/cm^2 for bodily movement.[24,25] In addition, the first application of force was performed using an elastic thread, with the pulling distance adjusted based on the force measured with an orthodontic force gauge or tension gauge; this makes it easy to control the magnitude of the force and determine the direction of the pull. The increase in styling is performed gradually. Using only the piggyback technique with super-elastic 0.012 NiTi wire, the force application was performed. After that, a combination of the piggyback technique was performed using the super-elastic 0.012 NiTi wire with elastic vertical light force. This combination divides the force into two directions, buccal and occlusal, without increasing the magnitude of the previous force. Since the distance of the tooth's crown is getting closer to the labial arch, the buccal force of the piggyback technique is smaller than the previous one. This significant difference in force is applied to pull the tooth occlusally with a vertical elastic. The anchorage was obtained from ligation of all other teeth, both from the maxillary and mandibular dental arches aligned and leveled. The success of orthodontic treatment with the traction of impacted teeth lies in pulling the teeth into the normal arch, maintaining the surrounding tissue, and functional occlusion.

Orthodontic traction of mesially 90° dilacerated root of impacted maxillary canine has been successfully performed by applying light force from an elastic thread, tandem wire and vertical elastic. After the traction was successful, the alignment and leveling process was repeated, with the total duration of orthodontic treatment lasting two years. The smile aesthetics and tooth occlusion of the patient were improved and the patient was delighted by the result. In a one-year follow-up, the treated canine showed good stability both orthodontically and periodontally without resorption of the root. However, this treatment showed some limitations. The pandemic COVID-19 occurred when approaching the end of treatment. This became a significant obstacle to achieving the ideal finishing, such as root parallelism, occlusal adjustment and periodontal monitoring. The clinical implications of this condition can lead to periodontal problems, so the patient was informed for having a routine dental checkup when the pandemic situation improved. Some suggestions for clinical management are to plan and carry out the orthodontic treatment, especially in cases of traction always using light force, and also to establish professional communication with patients, which is very important so that, when unexpected things happen, they remain under supervision and patients are willing to cooperate well.

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