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Orthodontic Treatment in an Endodontically Treated Maxillary Central Incisor: A Case Report

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ABSTRACT

Childhood dental trauma leads to long-term complications that affect pulp health and subsequent orthodontic treatment outcomes. Therefore, this case report concerns a 19-year-old male with protruding maxillary anterior teeth and midline diastema subjected to orthodontic treatment following root canal analysis of the traumatized maxillary central incisor. Orthodontic treatment was initiated after six months of observation. Root length changes were evaluated using the relative root–crown ratio (rRCR) on pre- and post-treatment panoramic radiographs. After 18 months of treatment, significant improvements in tooth consistency, overjet, and overbite were observed. Mild inflammatory root resorption was reported in both teeth due to orthodontic movement, with a greater degree in the important tooth compared to the root canal-treated part. The results showed that orthodontic movement in root canal-treated teeth could be safely performed with controlled force application and appropriate treatment timing. There were no signs of clinical or radiographical ankylosis during treatment, allowing orthodontic tooth movement to proceed without significant complications.

Keywords: Ankylosis, Orthodontics, Root Canal Therapy, Tooth Injuries, Tooth Resorption

ABSTRAK

Trauma gigi pada masa anak dapat menimbulkan komplikasi jangka panjang yang memengaruhi kesehatan pulpa dan hasil perawatan ortodonti di kemudian hari. Laporan kasus pada seorang laki-laki berusia 19 tahun dengan protrusi gigi anterior maksila dan diastema garis tengah menjalani perawatan ortodonti setelah perawatan saluran akar pada insisivus sentral maksila yang mengalami trauma. Perawatan ortodonti dimulai setelah observasi selama enam bulan. Perubahan panjang akar dievaluasi menggunakan relative root–crown ratio (rRCR) pada radiograf panoramik sebelum dan sesudah perawatan. Setelah 18 bulan perawatan, perbaikan yang bermakna terjadi pada susunan gigi, overjet, dan overbite. Resorpsi akar inflamasi akibat pergerakan ortodonti dengan derajat ringan ditemukan pada kedua gigi, dengan derajat resorpsi yang lebih besar pada gigi vital dibandingkan gigi yang telah perawatan saluran akar. Temuan ini menunjukkan bahwa pergerakan ortodonti pada gigi yang telah menjalani perawatan saluran akar dapat dilakukan secara aman dengan penerapan gaya ortodonti yang terkontrol dan waktu perawatan yang tepat. Selama perawatan tidak ditemukan tanda ankilosis, baik secara klinis maupun radiografis, sehingga pergerakan gigi ortodonti dapat berlangsung tanpa komplikasi yang bermakna.

Kata kunci: Ankilosis, Ortodonti, Perawatan Saluran Akar, Trauma Gigi, Resorpsi Akar Gigi

1. Introduction

Dental trauma during childhood frequently affects the anterior teeth and leads to long-term complications that extend beyond the immediate loss of pulp vitality. In this context, traumatic dental injuries include damage to the hard dental tissues, pulp, and supporting periodontal structures caused by external forces. Among all permanent teeth, the maxillary central incisors are the most commonly affected because of the prominent position within the dental arch and greater susceptibility to direct impact [1,2].

The long-term consequences of traumatic dental injuries become particularly important when orthodontic treatment is shown. Teeth subjected to endodontic treatment may exhibit altered biological responses during orthodontic tooth movement due to changes in pulpal status and periodontal tissue behavior. Therefore, clinicians often express concern regarding the risk of orthodontically induced inflammatory root resorption (OIIRR) and other treatment-related complications in the teeth [3].

OIIRR is characterized by progressive loss of cementum and dentin at the root surface resulting from inflammatory processes associated with orthodontic force application [4]. Even though OIIRR has been reported in more than 90% of orthodontic patients, the majority of cases are mild and have limited clinical significance [5]. However, the extent of root resorption may increase considerably in patients with predisposing risk factors, including previous dental trauma, endodontic treatment, prolonged treatment duration, excessive orthodontic force, unfavorable tooth movement, root morphology, and genetic susceptibility [6,7]. Understanding the risk factors is essential for minimizing treatment-related complications.

Radiographic monitoring plays an important role in identifying early changes in root morphology during an orthodontic treatment plan [8]. In addition, modification of the applied orthodontic force may be considered, such as reducing the force magnitude, shortening the duration of force application, or combining both approaches to minimize further resorption [9].

Radiographic evaluation remains the primary method for assessing root resorption during orthodontic treatment. Even though periapical radiographs provide higher accuracy, panoramic radiographs are commonly used in routine orthodontic practice due to the ability to capture the entire dentition with minimal additional radiation exposure [10–12]. The use of relative root–crown ratio (rRCR) is a reliable method used to minimize distortion errors inherent in panoramic imaging.

Careful assessment of previous dental trauma, combined with detailed clinical and radiographic examinations, is necessary before orthodontic treatment. This evaluation helps clinicians recognize teeth susceptible to root resorption and supports proper treatment planning as well as patient counseling [13].

Traumatized teeth may develop several complications, including pulp necrosis, ankylosis, and root resorption. Ankylosis is characterized by fusion of the root surface to the surrounding alveolar bone, leading to obliteration of the periodontal ligament space and prevention of orthodontic tooth movement [3,14]. Therefore, assessment of ankylosis is an essential step before initiating orthodontic treatment in traumatized teeth. This report describes the orthodontic treatment of a patient with a traumatized maxillary central incisor subjected to root canal therapy. Particular attention is given to radiographic evaluation of root resorption and the clinical considerations required to minimize complications during orthodontic treatment.

2. Case Report

A 19-year-old male presented to the Dental Hospital of Universitas Sumatera Utara with the chief complaint of protrusive maxillary anterior teeth associated with a midline diastema. The patient reported a history of dental trauma at the age of 9 years following a bicycle accident, which led to a crown fracture of the right maxillary central incisor. Root canal treatment was performed ten years after the injury following the diagnosis of pulp necrosis, as reported in Figure 1.

Comprehensive clinical and radiographic examinations were performed before orthodontic treatment. There was no detection of clinical or radiographic signs of ankylosis. Percussion testing did not produce a metallic sound, physiological tooth mobility was present, and radiographic examination showed preservation of the periodontal ligament space surrounding the traumatized tooth.

Intraoral examination reported a maxillary overjet of 6.5 mm, an overbite of 3.5 mm, and a 3-mm maxillary midline diastema. The blanch test was negative, showing the absence of abnormal labial frenum inclusion. Cephalometric analysis reported a skeletal Class I relationship (ANB = 3°) with a mildly convex facial profile.

The primary treatment objectives were to reduce maxillary anterior protrusion, close the midline diastema, establish functional overjet and overbite, and improve facial esthetics while minimizing the risk of OIIRR.

3. Case Management

Figure 1. Pre-treatment facial and intraoral photographs

Orthodontic treatment was initiated after a six-month healing period following completion of root canal therapy to allow adequate periapical tissue repair. Fixed orthodontic appliances were placed, and light continuous orthodontic forces were applied throughout treatment to reduce the risk of root resorption.

Root changes were evaluated using panoramic radiographs obtained before (T0) and after completion of treatment (T1). Measurements were performed using ImageJ software. Root (R) and crown length (C) were recorded to calculate the root–crown ratio (RCR). The rRCR was used to quantify changes in root length over time, as reported in Figures 2 and 3.

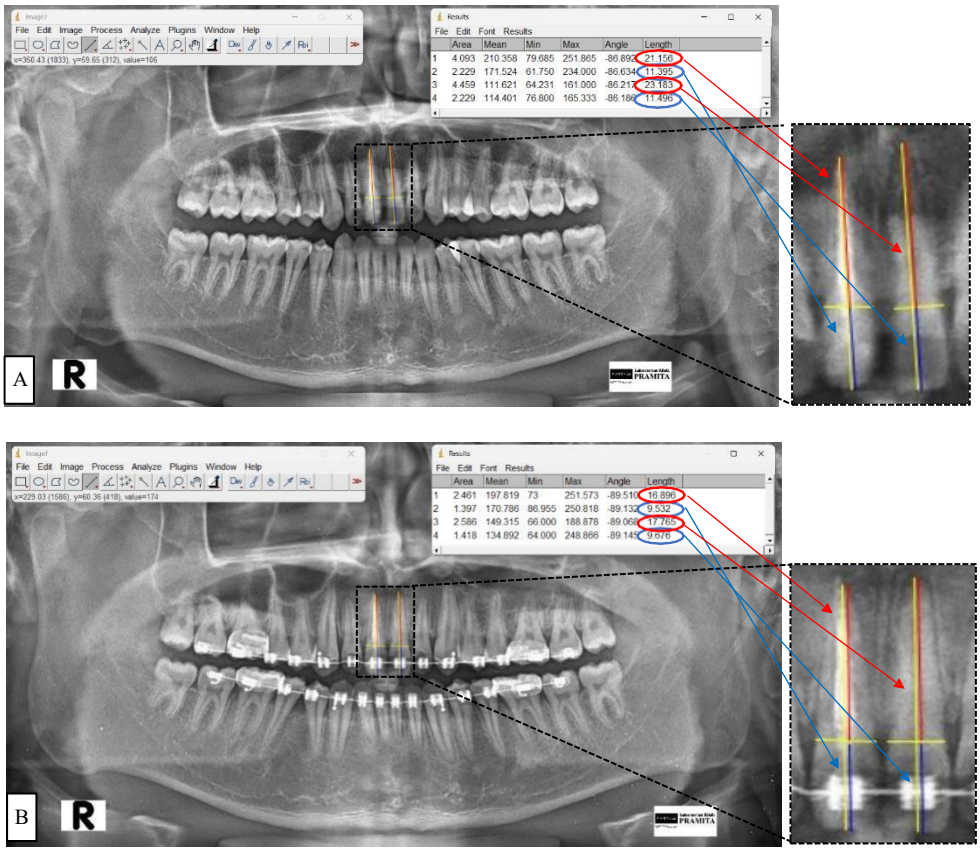
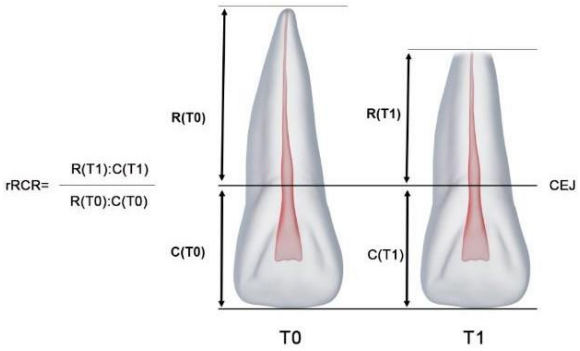


Figure 2. Measurement analysis on panoramic radiographs obtained before orthodontic treatment (A) and after treatment (B). Yellow lines show the cementoenamel junction and tooth long axis, while the blue and red lines represent crown length and root length, respectively.



$$\text{rRCR tooth \#11(Non Vital)} = \frac{16{,}896 : 9{,}532}{21{,}156 : 11{,}395} = \frac{1{,}772}{1{,}856} = 95{,}4\%$$

$$\text{rRCR tooth \#21(Vital)} = \frac{17{,}765 : 9{,}676}{23{,}183 : 11{,}496} = \frac{1{,}835}{2{,}012} = 87{,}2\%$$

Figure 3. Evaluation of root and crown lengths on panoramic radiographs obtained before and after orthodontic treatment [15].

Satisfactory correction of the malocclusion was achieved after18 months of active orthodontic treatment. Overjet was reduced from 6.5 mm to 2 mm, overbite was lowered to 2 mm,

the maxillary midline diastema was completely closed, and dental consistency as well as facial esthetics showed marked improvement.

Radiographic evaluation reported mild OIIRR in maxillary central incisors. Based on the rRCR classification, both teeth were categorized as having mild OIIRR. However, the important left maxillary central incisor exhibited greater root reduction than the endodontically treated right part. There was no clinical or radiographic evidence of ankylosis or other treatment-related complications throughout the treatment. According to the scale, rRCR ≥ 100%, rRCR = 90–99%, rRCR = 80–90%, and rRCR < 80% were scored as zero, mild, moderate, and severe OIIRR, respectively [13].

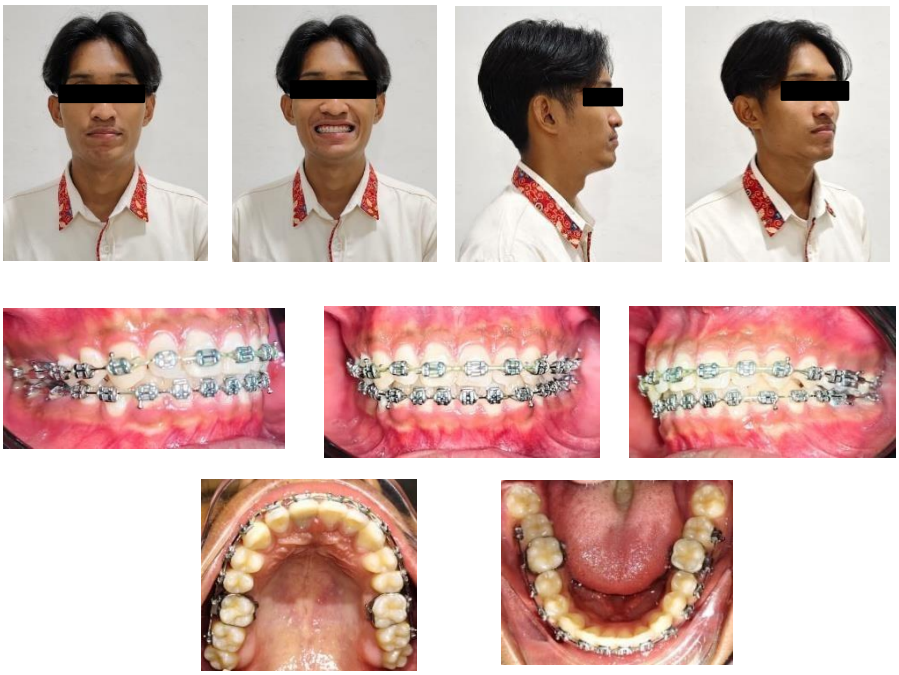


Figure 4. Post-treatment facial and intraoral photograph 18 months after treatment

Table 1. Pre-treatment and post-treatment cephalometric measurement

Measurements	Mean	SD	Pre Treatment	Post Treatment
SNA^{o}	82°	± 2	81.5^{o}	81^{o}
SNB^{o}	80°	± 2	78.5^{o}	78.5^{o}
ANB^{o}	2°	± 2	3^{o}	2.5^{o}
NAPog^{o}	0°	-8.5^{o}-10^{o}	2.5^{o}	2^{o}
MP : SN^{o}	32^{o}	±5^{o}	25 ^{o}	33 ^{o}
1: ī ^{o}	135.4°	130°-150.5°	113^{o}	120^{o}
1: SN^{o}	102°	±2°	119^{o}	106^{o}
I:MP^{o}	90°	±3°	108^{o}	110^{o}
1: APog mm	2,7 mm	-1 - 5 mm	+9 mm	*+5 mm*
1 : NA^{o}	22^{o}	± 4^{o}	37^{o}	*26*^{o}

1 : NA mm	**4 mm**	**±2 mm**	**+8 mm**	***4mm***
ī: NBº	**22º**	**± 4º**	**29º**	**32º**
ī: NB mm	**4 mm**	**±2 mm**	**+6.5 mm**	***5mm***
E: LS mm	**-2 mm**	**±2 mm**	**+3 mm**	**+1mm**
E:LI mm	**0 mm**	**±3 mm**	**+1mm**	**-0.5mm**
Nasolabial Angle	**102°**	**±8**	**87°**	**85°**

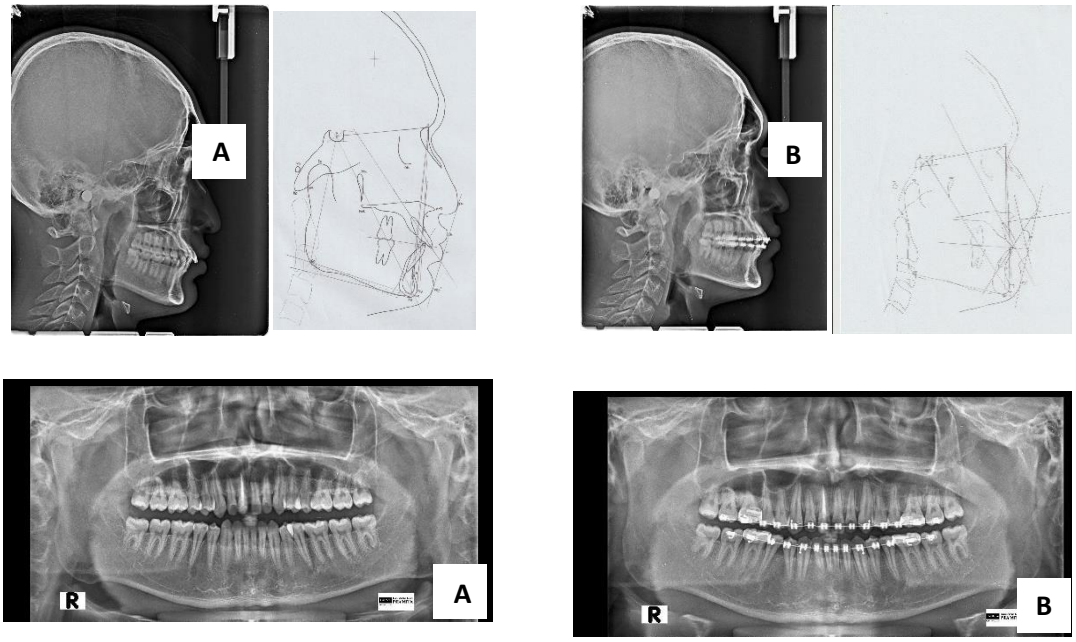


Figure 5. A. Pre-treatment lateral cephalometric tracing and panoramic radiograph; B. Post-treatment lateral cephalometric tracing and panoramic radiograph.

3. Discussion

OIIRR is among the most common biological sequelae of orthodontic treatment. Even though OIIRR is generally mild and clinically insignificant, the occurrence becomes a greater concern in patients with predisposing risk factors, particularly a history of dental trauma or previous endodontic treatment [16]. Therefore, careful treatment planning and continuous radiographic monitoring are essential when orthodontic tooth movement is performed in traumatized teeth.

The primary consideration before initiating orthodontic treatment in previously traumatized teeth is the exclusion of ankylosis. In this context, ankylosis is characterized by direct fusion between the root surface and alveolar bone, leading to obliteration of the periodontal ligament space and the inability of the tooth to respond to conventional orthodontic forces [3,14].

In the present case, ankylosis was excluded based on the absence of a metallic percussion sound, the presence of physiological tooth mobility, and radiographic preservation of the periodontal ligament space. Successful consistency and complete closure of the midline diastema confirmed that the traumatized tooth responded normally to orthodontic force throughout treatment.

The timing of orthodontic intervention following endodontic therapy represents another critical determinant of treatment success. Current evidence recommends postponing orthodontic treatment until adequate healing of the periapical tissues has occurred. A healing period of approximately six months has been suggested to allow regeneration of the periodontal ligament and stabilization of the periapical tissues before orthodontic force application [17,18]. In accordance with the recommendations, orthodontic treatment in the present case was initiated after a six-month healing period. There was no adverse clinical or radiographic result during treatment.

Delivanis and Sauer showed that immediate orthodontic movement after root canal treatment increased the risk of root resorption compared with treatment initiated after an adequate healing interval [14]. The results emphasize the importance of allowing sufficient periapical healing before orthodontic force application. In addition to treatment timing, the magnitude and duration of orthodontic force are well-recognized determinants of OIIRR. Excessive orthodontic forces may compress the periodontal ligament, compromise vascular perfusion, induce local hypoxia, as well as stimulate osteoclastic and cementoclastic activity, increasing the risk of root resorption [19]. Therefore, light continuous forces were applied throughout treatment to minimize undesirable biological responses.

Several studies have suggested that important teeth are more susceptible to orthodontically induced root resorption [20]. This difference may be explained by the absence of pulpal tissue in endodontically treated teeth, leading to a reduced inflammatory response and decreased stimulation of cementoclastic activity during orthodontic tooth movement [21]. The results of the present case support this biological mechanism since greater root resorption was observed in the important maxillary central incisor (#21) than in the endodontically treated contralateral tooth (#11). ElAbbasy et al. [22] reported significantly greater apical root resorption in important teeth than in endodontically treated teeth following orthodontic treatment.

The report has several limitations despite the favorable clinical outcome. As a single case report, the results cannot be generalized to all patients with traumatized teeth. In addition, root resorption was evaluated using panoramic radiographs, which were affected by image distortion despite the use of the rRCR to improve measurement reliability. Future studies, including larger patient cohorts and cone beam computed tomography, are required to provide a more accurate assessment of root resorption and strengthen the evidence regarding orthodontic treatment in endodontically treated teeth. From a clinical perspective, this case shows that orthodontic treatment can be successfully performed on previously traumatized, endodontically treated teeth following confirmation of the absence of ankylosis, completion of adequate healing before force application, application of light continuous orthodontic forces, and continuous radiographic monitoring throughout the treatment period.

4. Conclusions

In conclusion, orthodontic treatment could be performed successfully in a previously traumatized, endodontically treated maxillary central incisor when appropriate case selection and careful clinical management were implemented. Exclusion of ankylosis, adequate healing following endodontic therapy, application of light continuous orthodontic forces, and regular radiographic monitoring contributed to favorable treatment outcomes while minimizing the risk of OIIRR. Mild root resorption was observed and remained clinically acceptable, with greater resorption occurring in the important tooth than in the endodontically treated tooth. These results supported the feasibility and safety of orthodontic tooth movement in endodontically treated teeth when evidence-based treatment protocols were followed.

5. Acknowledgments
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6. Conflict of Interest
The authors declare no conflicts of interest in this case report.

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