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Endodontic Management of Maxillary Central Incisor with Two Roots, and Lateral Incisor with a C-shaped Canal; A Case Report

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The knowledge of anatomical variations in the morphology of root canal systems can affect the successful diagnosis to deliver proper endodontic treatment. The current case report enlightens the endodontic management of an anomalous maxillary left central incisor with two roots/root canals, a C-shaped root canal configuration in a maxillary left lateral incisor identified by three-dimensional cone-beam computed tomography imaging as well as the successful aesthetic rehabilitation of maxillary fractured incisors. The chief complaint of patient was a history of trauma during his outdoor play and consequent broken upper front teeth. Tooth #9 was diagnosed with pulpal necrosis accompanied by asymptomatic apical periodontitis with two relatively dilacerated roots while the maxillary left lateral incisor (tooth #10) was diagnosed with necrotic pulp and asymptomatic apical periodontitis having a C-shaped canal. Endodontic treatment for teeth #9 and #10 were performed, followed by post and core fabrication. Tooth reinforcement was achieved with prefabricated un-polymerized glass fiber post for lateral incisor and Interlig Fiber for central incisor. Intentional root canal treatment of tooth #8 was considered to reduce labial inclination. The anomalous maxillary central incisor with two roots is an unexpected variant during endodontic treatment, and the presence of C-shaped canal in lateral incisors is extremely rare requiring careful diagnosis with radiographs, clinical examination along with additional aids; *e.g.* Three-dimensional (3-D) cone-beam computed tomography. 3-D imaging has added the advantages of appropriate identification of anomalous anterior teeth and careful location of additional root canal(s) during endodontic treatment.

Keywords: C-shaped Canal; Cone-beam Computed Tomography; Two-rooted Maxillary Central Incisor

Introduction

Recognition of anatomical variations in the morphology of root canal systems affects the successful outcome(s) of endodontic treatment. Existing literature shows that the anatomy of maxillary central incisors comprises a single-rooted structure with a single canal in ~100% of cases [1, 2]. However, presence of multiple root canals has been reported, and the prevalence of a second root canal could be as high as 2% [3-5]. Moreover, the prevalence of maxillary central incisors with two roots is extremely rare; with only few clinical case reports published [6-8]. Due to their low prevalence, additional root canals in maxillary central incisors may be overlooked by clinicians; specifically when the diagnostic steps are neglected or non-specific complementary examinations are not performed; e.g. conventional two-dimensional radiographic imaging techniques. To overcome the aforementioned limitations, cone-beam computed tomography (CBCT) can be used as effective equipment for identifying dental anatomical variations, as it ensures three-dimensional precision for the detection of roots and root canals [10]. The reported case highlights the endodontic management of maxillary incisors with aberrant morphology identified by CBCT imaging, and the successful aesthetic rehabilitation of fractured maxillary incisors.

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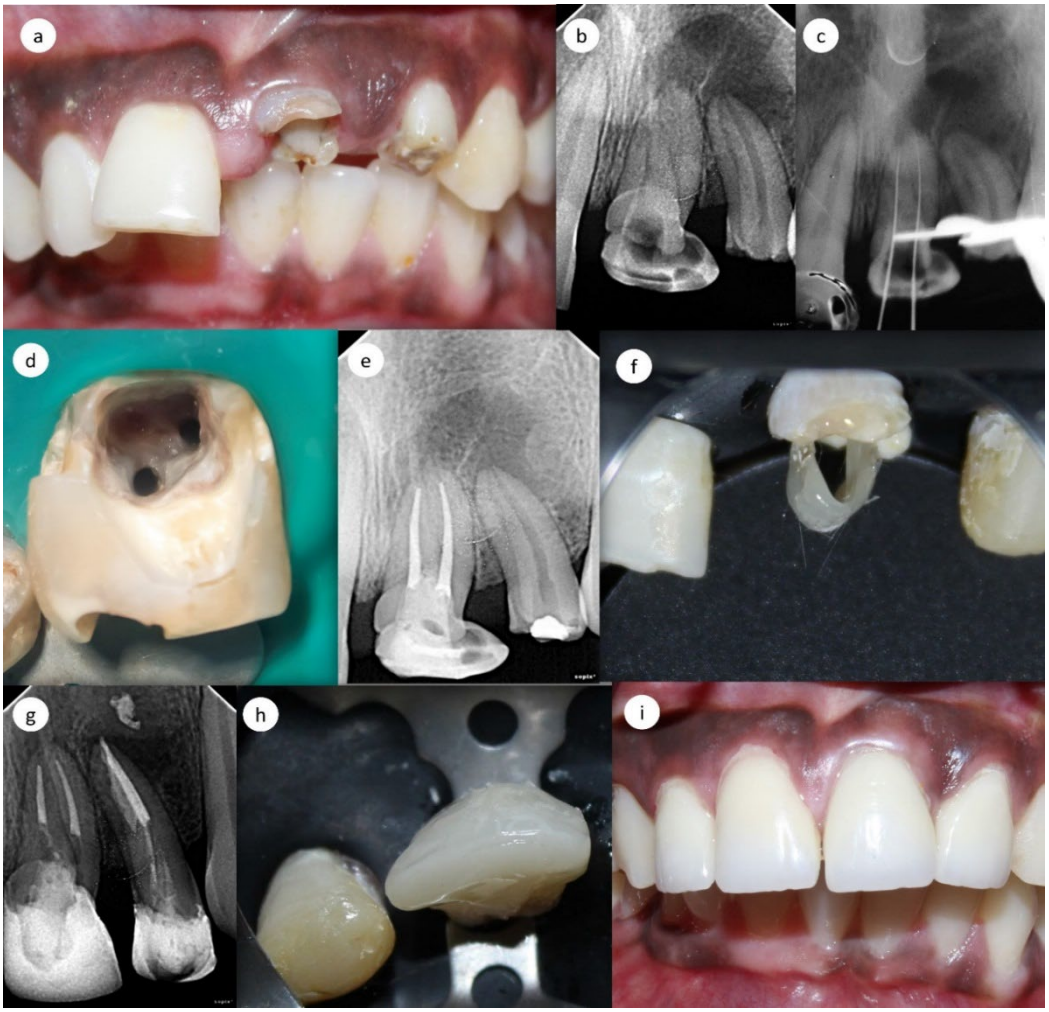

Figure 1. *A*) Pre-operative view of tooth #9 and tooth #10; *B*) Pre-operative periapical radiograph of tooth #9 and tooth #10; *C*) Working length radiograph of tooth #9; *D*) Mesio-labial and disto-palatal canal orifices in tooth #9; *E*) Post-obturation radiograph of tooth #9; *F*) Labial view of tooth #9 with Interlig™ fibre placed in an inverted U-shape to form core reinforcement; *G*) Post-operative radiograph; showing post and core build-up of tooth #9, and tooth #10; *H*) Post and core build-up of tooth #9 and tooth #10; *I*) Post-operative view; showing rehabilitated maxillary incisors with full coverage zirconia crowns

Case Presentation

A 17-year-old male patient was referred to the department of "Conservative Dentistry and Endodontics" with the chief complaint of broken upper front teeth and inability to confidently smile for the past 6 years. Medical history was non-contributory, and no history of congenital abnormalities was reported. Intraoral examination showed the presence of palatally curved coronal tooth structure in the maxillary left central incisor (tooth #9) (Figure 1A) and fractured maxillary left lateral incisor (tooth #10) with a groove running along the mesial surface (Figure 2E). Sensibility testing with thermal and electrical pulp testing gave negative results for both teeth.

The radiographic examination showed the presence of an additional root with an individual outline and two separate root canal spaces in tooth #9 as well as a wide radiolucent root canal space in tooth #10. Furthermore, a discrete radiolucent periapical lesion with a dimension of 6 mm * 6 mm was discovered; involving the root apices of tooth #9 and tooth #10 (Figure 1B). In addition, an occlusal radiograph was taken to confirm the findings (Figure 2A).

Computed tomography was performed using "NewTom Cone-Beam 3D Dental Imaging System (Imaging Sciences International, Hatfield, PA, USA)" to study the morphology of maxillary incisors and plan the required endodontic treatment. The CBCT examination confirmed the presence of two roots in tooth #9 (Figures 3G and 3H) and acute curvature at the junction of cervical and middle thirds of tooth crown; forming an L-shaped curvature in the clinical crown (Figure 3J).

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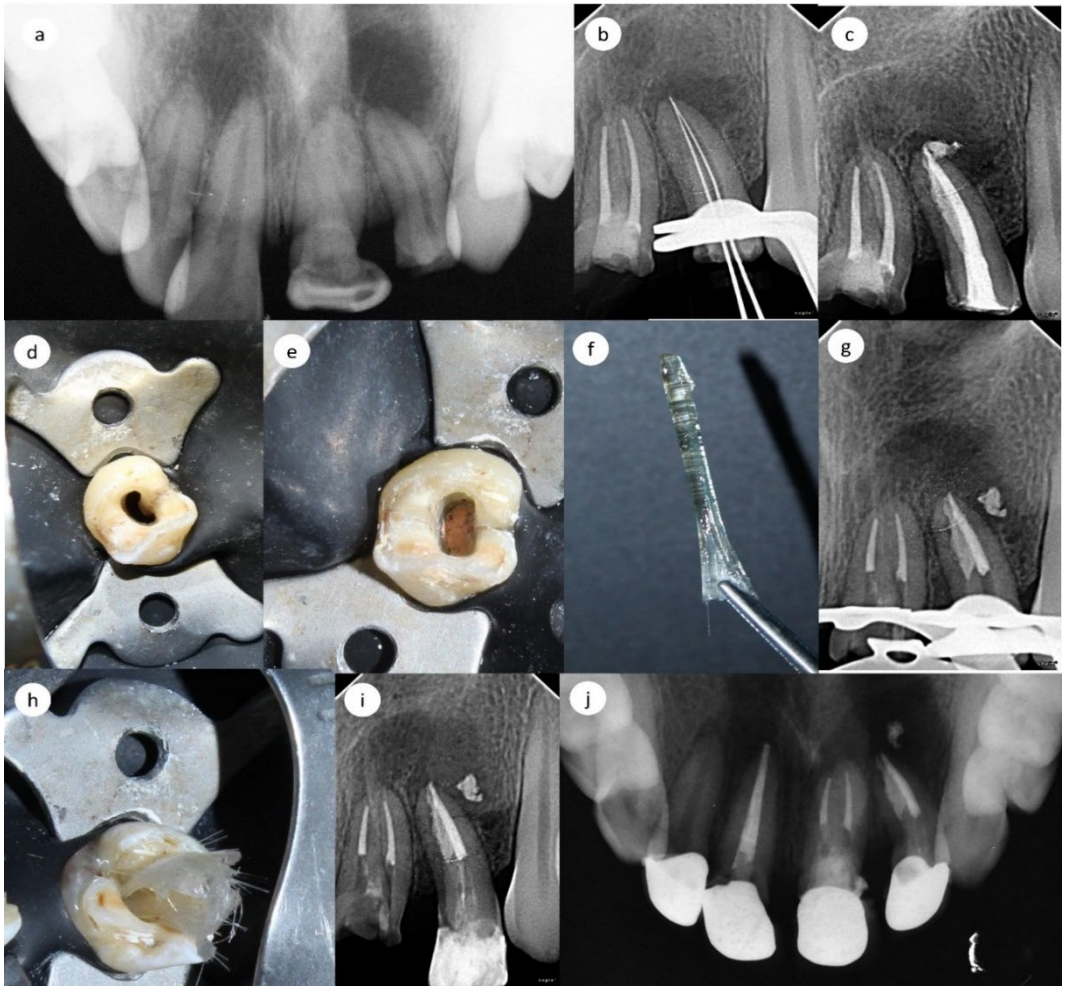

Figure 2. *A*) Pre-operative occlusal radiograph of tooth #9 and tooth #10; *B*) Working length radiograph of tooth #10; *C*) Post-obturation radiograph of tooth #9 and tooth #10; *D*) C-shaped canal orifice in tooth #10; *E*) Post-obturation clinical view of tooth #10; *F*) Pre-fabricated resin impregnated EverStick post (0.9 mm); *G*) Post space creation of tooth # 10; *H*) EverStick post in inverted U-shape to form core reinforcement; I) Radiograph after post and core build-up of tooth #10; *J*) Occlusal post-operative radiograph of teeth #7, #8, #9 and #10

Tooth #10 showed a single root with a C-shaped canal, and a mesial marginal developmental groove which gave the tooth a double-tooth appearance. The groove ran from the mesial surface of the cervical third of crown and continued to the root portion. The presence of the above-mentioned groove caused a C-shape canal formed in the lateral incisor (Figure 3K).

The periapical lesion was well-confined with two root apices of tooth #9 and tooth #10; fenestrating the buccal cortical plate and thinning the palatal cortical plate in tooth #9. The lesion measured 6.7 mm long and 3 mm wide in relation to the sagittal section of tooth #9. The lesion in tooth #10 measured 7.5 mm long and 3.8 mm wide in relation to the sagittal section of tooth#10 (Figures 3A-3C). Tooth #9 was diagnosed with asymptomatic apical periodontitis and necrotic pulp; having two roots and showing dilaceration. The maxillary left lateral incisor tooth #10 was diagnosed with asymptomatic apical periodontitis with necrotic pulp and a C-Shaped canal.

Endodontic treatments for tooth #9 and tooth #10 were planned; followed by post and core, and tooth reinforcement with prefabricated un-polymerized glass fibre post, *i.e.* EverStick Post™ (GC Europe, Leuven, Belgium), for the lateral incisor and Interlig™ Fibre (Angelus, Londrina, PR, Brazil) for the central incisor. Vital preparation of tooth #7 and intentional root canal treatment of tooth #8 were to be performed in order to reduce labial inclination, followed by the full coverage restoration of teeth #7, #8, #9 and #10.

The treatment plan was thoroughly explained to the patient and his informed consent was obtained. The prognosis of tooth #9 and tooth #10 were considered fair, due to a developmental groove in the radicular aspect of both teeth, probably serving as a nidus.

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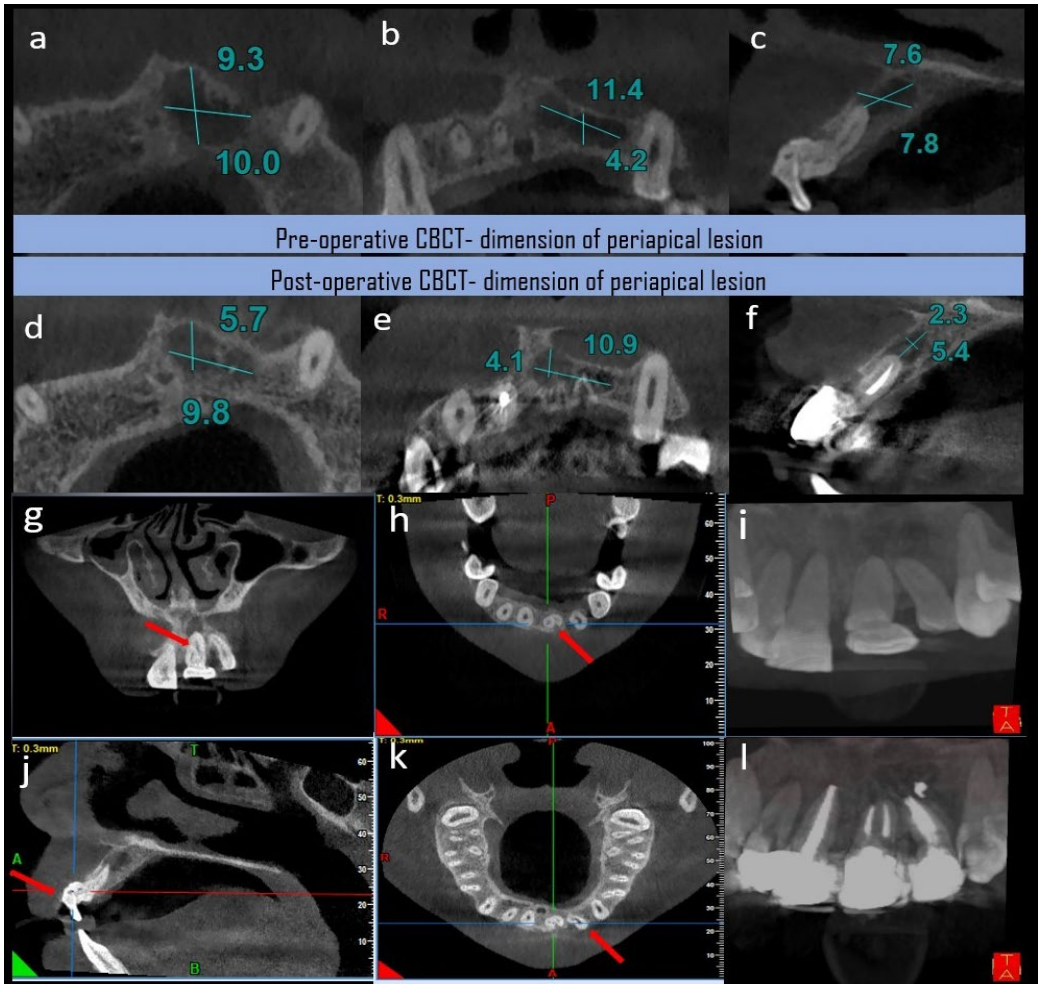

Figure 3. A) Pre-operative periapical lesion dimensions; CBCT axial section of tooth #9 and tooth #10; B) CBCT coronal section of tooth #9 and tooth #10; C) CBCT sagittal section of tooth #9; D) Post-operative healing of periapical lesion; CBCT axial section of tooth #9 and tooth #10; E) CBCT coronal section of tooth #9 and tooth #10; F) CBCT sagittal section of tooth #9; G) CBCT coronal section of tooth #9; showing two roots; H) CBCT axial section of tooth #9; I) Pre-operative 3-D image of tooth #9 showing tooth structure palatally curved when compared to tooth #8; J) CBCT sagittal section of tooth #9 with palatally curved crown; K) CBCT axial section of tooth #10; showing a C-shaped canal; L) Post-operative 3-D image of teeth #7, #8, #9 and #10

Treatment of two-rooted maxillary left central incisor

Local anaesthesia was administered with infiltration technique using 0.9 mL of 2% lignocaine with 1:80,000 epinephrine (Lignox 2%A, Kilitch Drugs India Ltd., Navi Mumbai, India). Under rubber dam isolation, access cavity preparation was performed using a high-speed handpiece with a round diamond bur BR45 ISO-001/016 (Mani Medical India Pvt Ltd, New Delhi, India) under sufficient cooling. The labial access cavity was prepared; facilitating the exploration of the second root canal in tooth #9. After proper access preparation, glide path was established with a #15 K-type file (Dentsply/Maillefer, Switzerland), and the radicular cervical third was prepared using #2 and #3 Gates-Glidden burs (Dentsply Maillefer, Switzerland). The working length was determined using an electronic apex locator (Woodpex III, woodpecker, China) and confirmed radiographically with 19 mm and 20 mm for the mesio-labial and disto-palatal canals, respectively (Figure 1C).

Cleaning and shaping was performed using Protaper Gold system up to F1. Afterwards, the canals were irrigated with 3% sodium hypochlorite (NaOCl) (Prime Dental Products, India), 0.9% normal saline, and finally 17% EDTA (DeSmear, India), and then dried with F1 paper points (Dentsply Maillefer, Switzerland). F1 Protaper Conform Fit (Dentsply Maillefer, Switzerland) was selected as the master cone of choice for both canals; being confirmed radiographically. The canals were obturated with AH-plus root canal sealer and Gutta-percha (Dentsply Maillefer, Switzerland). The procedure was followed by the coronal seal, which was achieved with Glass Ionomer Cement (Fuji Gold Label IX; GC, Tokyo, Japan).

Following obturation, post space was created in both canals

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with #3 peeso reamers (Mani, India). Next, the formed space was acid-etched with 37% phosphoric acid (Eco Etch; Ivoclar Vivadent, Schaan, Liechtenstein), and Te Econom bonding agent (Ivoclar Vivadent, Schaan, Liechtenstein) was then applied and light-cured (Bluephase, Ivoclar Vivadent). The Interlig™ Resin Impregnated fibre (Interlig™, Angelus, Brazil) was used for radicular reinforcement via inserting into the mesio-labial and disto-palatal canals; moulded into inverted U-shape for coronal reinforcement. (Figure 1F). An A2 shade flowable resin-based dental composite restorative material (Te Econom flow, Ivoclar Vivadent, Schaan, Liechtenstein) was used for the core build-up of tooth #9 (Figure 1H).

Treatment of maxillary left lateral incisor with a C-shaped root canal

Local anaesthesia was administered with infiltration technique using 0.9 mL of 2% lignocaine with 1:80,000 epinephrine. Under rubber dam isolation, an appropriate access cavity was prepared and glide path was established with a #15 K-type file. The working length was determined at 18 mm radiographically (Figure 2B). The cleaning and shaping of the C-shaped canal was performed using step-back technique, with its consecutive circumferential filing afterwards. Then, the canals were irrigated with 3% NaOCl, 0.9% normal saline, and finally with 17% EDTA. Next, the root canals were dried with paper points and ≠40 gutta-percha cone (2% taper) was selected as the master cone. The C-shaped canal was obturated using cold lateral condensation technique, with AH-plus as the root canal sealer (Figure 2C-2E). Post Endodontic coronal restoration was achieved with type IX glass ionomer cement (GC Gold Label IX, Tokyo).

The post space was created with peeso reamer #3 and etched with 37% phosphoric acid (Eco Etch), followed by the application and light-curing of an appropriate bonding agent (Te Econom). The EverStick prefabricated post (0.9 mm) was selected and Stick Resin was used for moulding EverStick post into an inverted U shape (Figures 2F-2H). Then, it was inserted into the C-shaped canal for radicular reinforcement, and followed by using/light-curing of an A2 shade flowable resin-based dental composite material (Te Econom flow) for core build-up (Figure 2I).

The crown angulation was changed by employing Interlig™ and EverStick post pre-impregnated resin fibres to rectify teeth #9 and #10, respectively. To reduce the labial proclination, tooth #8 was intentionally treated endodontically and all the four upper incisors were prepared for full coverage zirconia crowns. Next, crowns were cemented with dual cure resin cement (Ultrafusion D/C; Prevest DenPro, India) (Figure 1I). A follow-up of 6 months was recorded; showing considerable healing of periapical lesion examined by occlusal radiography (Figure 2J), and confirmed by CBCT (Figures 3D-3I).

Discussion

The anomalous maxillary anterior teeth with unusual morphology and periapical lesion has been successfully managed by endodontic treatment and rehabilitation with fibre post and core system and full coverage restoration and the periapical lesion regression healing was confirmed by CBCT. The etiologic cause is directly related to traumatic injury [11]. Traumatic injuries are usually reported amongst children between 6 and 18 years of age. The teeth most vulnerable to trauma are maxillary incisors due to their position in the arch as well as their eruptive pattern. Coronal fractures of permanent incisors represent 18% to 22% of all trauma to dental hard tissues [11]. Moreover, a defect in the dental lamina in the early stages of root formation could be considered an etiological factor for bi-rooted incisors. Besides, bi-furcated roots may be related to the in-growth of Hertwig's epithelial root sheath [12].

Root dilacerations are more common than crown dilacerations, and usually occur in the posterior region of permanent dentition. However, crown dilacerations are frequently observed with a palatal inclination in the permanent maxillary incisors, and with a labial inclination in the permanent mandibular incisors[13, 14]. Pulp necrosis and periapical inflammation may be a common subsequent finding, even in the absence of decay; since the curved portion may act as a nidus for bacterial entry due to defective enamel and dentine [12]. The C-shaped root canal constitutes an unusual root morphology usually found in maxillary lateral incisors [15, 16].

In the current case report, the possible aetiology for pulp necrosis and apical periodontitis in the affected teeth may have been a traumatic event reported by the patient. The presence of a radicular groove running on the mesial surface of tooth #10 would have served as a nidus for infection [17, 18]. Following a recent classification on the internal root canal anatomy, the maxillary left central incisor with two roots in the mesio-labial and disto-palatal aspects was shown as $^{2}21^{ML1\text{-}1DP\ 1\text{-}1}$, and the maxillary left lateral incisor with a C-shaped canal was coded as $^{1}22^{1}$ [19].

Radiographic examinations are used for the enhanced diagnosis, appropriate planning and proper evaluation of treatment success rates [20]. The amount of information obtained using two-dimensional periapical radiography is limited, and may be affected by the geometric distortions and/or overlap of anatomical structures. The use of computerised tomography scans has been encouraged to diagnose cases with multiple root canals. In the present report, computerised tomography ensured treatment safety as it indicated the location of root canals. However, when computed tomography is not available, (periapical) radiographic images at different

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angulations can be considered an alternative.

The pre-operative dimension of periapical lesion was "9.3 * 11.4 * 7.8" measured with CBCT (Figures 3A-3C). In addition, the pre-operative periapical index assessment using three-dimensional CBCT for the periapical lesion was score 5+E+D, i.e. in accordance with Estrela et al. [21], accompanied by the expansion and destruction of cortical bone. In six-month follow-up, the post-operative lesion size was measured "5.7 * 10.9 * 5.4" after periapical healing. In the mentioned six-month follow-up, the CBCT of lesion was assessed by Estrela Periapical Index; showing marked regression of periapical lesion with the score of 4+E (Figures 3D-3F).

The radicular tooth structure was reinforced with polyethylene fibres Interlig™; consisting of glass fibres pre-impregnated with light curable resin-based dental composite arranged in a braided design (Figure 1F). The used glass fibres have the ability to be moulded and formed into a U-shape design without fraying so as to reinforce the core as well as the radicular portion of tooth (Figures 1F and 1H). A study by Beli *et al.* demonstrated that endodontic and restorative treatments could have a detrimental effect on the fracture resistance of teeth [22].

Conclusions

It is of crucial importance that clinicians should be aware of possible anatomical variations even in teeth with seemingly less complex anatomy; e.g. the one presented in the current report. Therefore, it is essential to consider radiographic or other imaging methods; CBCT and alike, for the accurate diagnosis and a more predictable treatment of similar cases.

Conflict of Interest: 'None declared'.

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