World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(CASE REPORT)

ENDODONTIC MANAGEMENT OF A C-SHAPED CANAL IN A MANDIBULAR SECOND MOLAR WITH FUSED ROOTS USING CONE-BEAM COMPUTED TOMOGRAPHY: A CASE REPORT

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World Journal of Advanced Research and Reviews, 2026, 31(03), 505–510

Publication history: Received on 27 July 2026; revised on 02 September 2026; accepted on 04 September 2026

Article DOI: https://doi.org/10.30574/wjarr.2026.31.3.2293

ABSTRACT

Aberrant root canal morphology complicates endodontic treatment planning and execution. This report details the management of a mandibular second molar presenting with two buccally fused roots and a continuous C-shaped canal system. Cone-beam computed tomography (CBCT) was utilized to assess the three-dimensional anatomy. Treatment involved a modified access cavity design, rotary chemomechanical preparation, and thermoplasticized gutta-percha obturation. Advanced diagnostic imaging was critical in identifying the anatomical variations and guiding the clinical intervention, thereby preventing potential iatrogenic errors and optimizing the treatment outcome.

Keywords: C-Shaped Canal, Cone-Beam Computed Tomography (CBCT), Mandibular Second Molar, Root Canal Morphology, Thermoplasticized Obturation.

1 INTRODUCTION

A thorough understanding of root canal configurations is fundamental to endodontic success [1]. Unidentified and untreated canals remain a primary cause of post-treatment disease [2, 3]. While clinicians often anticipate supplementary roots or canals, developmental anomalies can also result in fewer roots or canals than typically expected [4].

The C-shaped root canal is a distinct morphological variation first documented in the endodontic literature by Cooke and Cox in 1979 [5]. It exhibits a strong racial predilection and is predominantly observed in mandibular second molars.

This article reports the endodontic management of a mandibular second molar with an uncommon presentation: two fused roots containing a single C-shaped canal. It highlights the diagnostic role of cone-beam computed tomography (CBCT) and the clinical protocols employed for negotiation, shaping, and thermoplasticized obturation.

2 CASE REPORT

A 29-year-old female reported to the Department of Conservative Dentistry and Endodontics complaining of pain in the left mandibular posterior region for the past month. The medical history was non-contributory. The patient described a dull, intermittent pain that had a gradual onset and worsened during mastication.

Intraoral examination revealed a fractured restoration on tooth 37, which exhibited tenderness to vertical percussion. Cold testing (RC Ice; Prime Dental Products, Mumbai, India) elicited a severe, lingering pain response, corroborated by an exaggerated response to electric pulp testing (Parkell, Farmingdale, NY, USA). Periodontal probing depths were within physiological limits, and mobility was normal. The preoperative periapical radiograph indicated fused roots with atypical canal morphology [Figure 1]. A diagnosis of symptomatic irreversible pulpitis with symptomatic apical periodontitis was formulated.

Figure 1: Pre Operative Radiograph

Following the administration of 2% lidocaine with 1:200,000 epinephrine and rubber dam isolation, an endodontic access cavity was prepared using an Endo Access bur (Dentsply Sirona, Tulsa, OK, USA). A single, large C-shaped orifice was identified centrally on the pulpal floor [Figure 2].

Figure 2: Access Opening Done Under Rubber Dam Isolation

Access cavity modifications are often necessary in C-shaped anatomies to allow straight-line access to the entire canal system. Depending on the orifice shape—continuous, oval, or round—the underlying canal structure can vary significantly [Figure 3].

Figure 3: C shaped root canal anatomy

To better map the root canal geometry, a CBCT scan (Carestream CS9300; 85kV, 8mA, 19.96s) was acquired. Axial and coronal sections confirmed the fusion of the mesial and distal roots, enclosing a single, continuous C-shaped canal extending from the orifice to the radiographic apex [Figures 4-8].

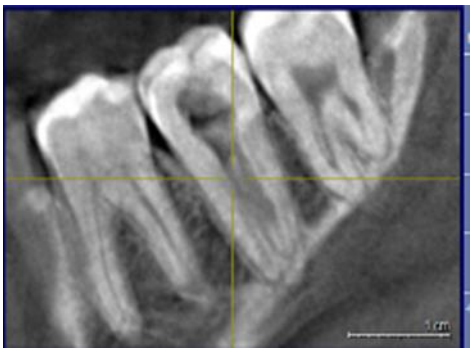

Figure 4: CBCT evaluation – mesio oblique view

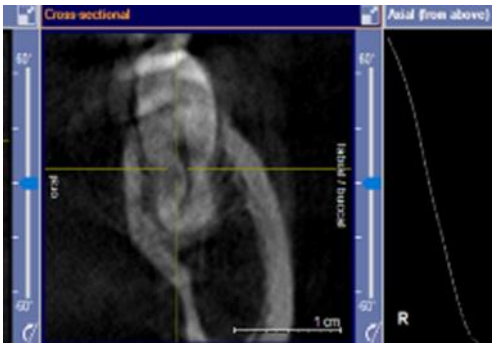

Figure 5: CBCT evaluation – disto oblique view

Figure 6: CBCT evaluation – cross section view (coronal third)

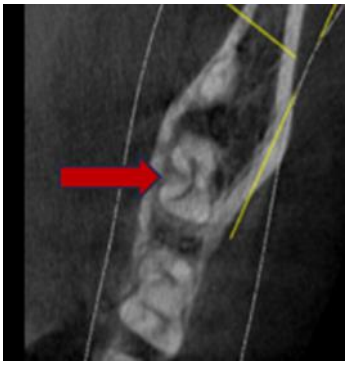

Figure 7: CBCT evaluation – cross section view (middle third)

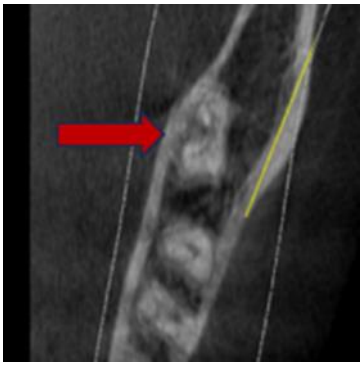

Figure 8: CBCT evaluation – cross section view (apical third)

Working length was established using an electronic apex locator (Raypex 6; VDW, Munich, Germany) and verified radiographically [Figures 9, 10].

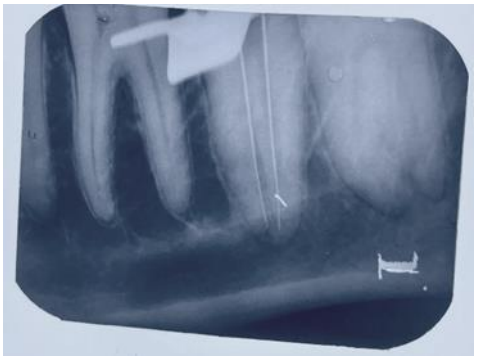

Figure 9: Working Length Determination Radiograph

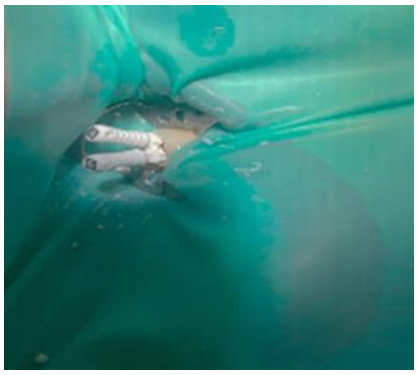

Figure 10: Working Length Determination Photograph

The canal was negotiated and initially shaped using a circumferential filing technique with size 15 and 20 hand files (Mani Inc., Tochigi, Japan), followed by rotary instrumentation using HyFlex CM files (Coltène/Whaledent) up to size 20/.04. Irrigation was performed with 5.25% sodium hypochlorite (Vishal Dental Products, Mumbai, India) and normal saline, followed by a final rinse with 17% EDTA (Prime Dental Products, Mumbai, India) to remove the smear layer.

After drying the canal with paper points, a thermoplasticized obturation technique was utilized due to the irregular cross-section of the canal. The apical third was obturated using a sectional technique [Figure 11,12],

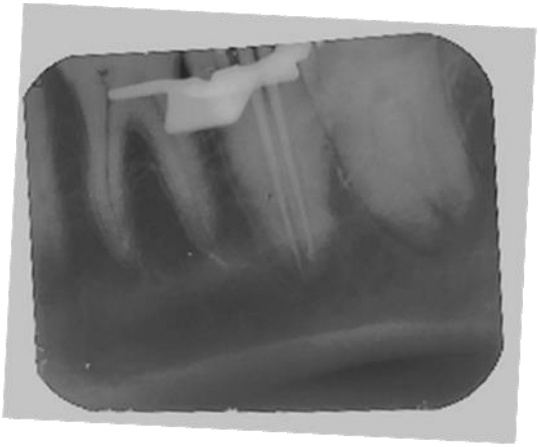

Figure 11: Master Cone Radiograph

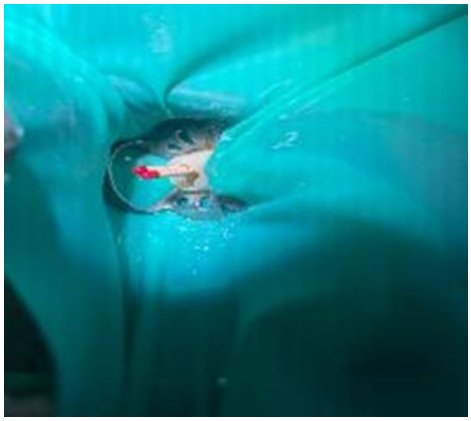

Figure 12: Master Cone Photograph

and the remainder of the canal was backfilled with thermoplasticized gutta-percha (Obtura II; Obtura Spartan, Algonquin, IL, USA) and a bioceramic sealer (Bio-C Sealer; Angelus, Londrina, Brazil) [Figure 13].

Figure 13: Obturation Photograph

Figure 14: Post Operative Radiograph

The access cavity was subsequently restored with composite resin (3M ESPE, St. Paul, MN, USA) [Figure 14].Informed consent was obtained from the patient prior to the initiation of thearpy and thoroughly briefed on the procedure and formally consented to the publication of this case report, including the use of their de-identified clinical data, intraoral findings, and radiographic images for academic and scientific purposes.

3 DISCUSSION

Mandibular second molars typically erupt between 11 and 13 years of age, with apical closure occurring by age 14 or 15 years. Disturbances during Hertwig's epithelial root sheath development can lead to significant variations in canal anatomy. While Sabala et al. [6] suggested that rare anatomical aberrations have a high probability of occurring bilaterally, the contralateral mandibular second molar had previously been extracted in this patient, precluding bilateral comparison.

Fava et al. [7] documented various anatomical anomalies in mandibular second molars. While most present with two distinct roots and three to four canals, the incidence of C-shaped canals varies widely by ethnicity: 2%–8% in Indian populations, 2.7%–7.6% in American populations, and up to 32.7%–44.5% in Korean and 31.5% in Chinese populations.

Systematic reviews by de Pablo et al. [8] and Ballullaya et al. [9] highlight the rarity of a single root and single canal in mandibular molars. However, Reuben et al. [10] and Demirbuga et al. [11] reported incidences of 0.12% for single root/single canal and 0.85% for C-shaped canals in specific demographics.

Melton et al. [12] classified C-shaped canals based on cross-sectional morphology, a system later modified by Fan et al. [13] into five categories (C1 to C5). The present case exhibited a Category C1 configuration, characterized by a continuous "C" shape without separation. The primary challenge in C1 canals is the presence of a narrow fin or web connecting the main canals, which often harbours tissue debris and bacteria, complicating chemomechanical debridement.

Conventional two-dimensional radiography is often inadequate for mapping the intricate anatomy of C-shaped canals due to superimposition. Here, CBCT provided cross-sectional imaging that confirmed the C1 classification and allowed for the assessment of radicular dentin thickness. This was particularly crucial for identifying "danger zones" along the mesiolingual aspect, guiding conservative instrumentation to prevent strip perforations.

A thermoplasticized obturation technique was selected to manage the wide, irregular C-shaped space. Vertical compaction of warm gutta-percha allows for better adaptation to the fins and webs compared to cold lateral compaction.

Furthermore, lateral compaction in a C-shaped canal can generate excessive stress against thin dentinal walls, increasing the risk of vertical root fracture.

4 CONCLUSION

The C-shaped canal is a complex anatomical variant requiring careful diagnostic and clinical management. Fused or conical roots observed on preoperative radiographs should raise the index of suspicion for this morphology. Integrating three-dimensional imaging (CBCT) with adapted preparation protocols and thermoplasticized obturation techniques allows for the predictable management of these challenging endodontic cases.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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