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Management of Maxillary Central Incisor with Two Canals - A Case Report

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Abstract: ***Aim**: To report the successful endodontic management of a maxillary central incisor with two root canals thereby emphasizing the importance of accurate diagnosis and treatment planning. **Background**: Maxillary central incisors typically have a single canal. However, anatomical variations though rare can occur. The presence of two canals poses a diagnostic challenge and if left unrecognized might lead to treatment failure. Advanced imaging techniques like cone-beam computed tomography (CBCT) aids in detecting such variations thereby ensuring effective root canal therapy. **Case Description**: A 28-year-old male presented with persistent pain in the maxillary right central incisor. Clinical and radiographic examinations revealed deep caries and an additional canal. CBCT confirmed a single root with two canals (Vertucci Type III). The access cavity was modified to locate both canals which were instrumented using rotary NiTi files and irrigated with 2.5% sodium hypochlorite. Obturation was performed using the warm vertical compaction technique followed by post-endodontic restoration. The patient remained asymptomatic at follow-up. **Conclusion**: Recognizing root canal variations is crucial for treatment success. Multiple angulated radiographic images enhance anatomical assessment thereby ensuring thorough debridement and obturation. **Clinical Significance**: Failure to identify additional canals may lead to endodontic failure. Multiple angulated radiographic images guided diagnosis improves treatment outcomes.*

Keywords: Maxillary central incisor, Root canal variation, radiovisiography, Endodontic management

1.Background

Maxillary central incisors generally have a single root and a single root canal. However, variations in root canal morphology have been documented in the literature. The occurrence of two canals in a maxillary central incisor is a rare anatomical finding that presents challenges in endodontic diagnosis and treatment. Failure to identify and treat additional canals may result in persistent infection and compromised treatment outcomes. Studies using advanced imaging techniques have reported an increased detection of anatomical variations which emphasizes the importance of preoperative assessment. Conventional radiographic techniques such as periapical radiographs and radiovisiography (RVG) still remain as valuable diagnostic tools in routine clinical endodontics.

Anatomical Variations in Maxillary Central Incisors

Root canal morphology is classified based on variations in canal number and configuration. Vertucci's classification (1984) remains the most widely used system for categorizing root canal configurations [1, 2]. The eight types of Vertucci's classification are as follows:

- **Type I** (1-1): A single canal extending from the pulp chamber to the apex.
- **Type II** (2-1): Two separate canals that merge into one before exiting at the apex.
- **Type III** (1-2-1): A single canal that bifurcates and then rejoins before the apex.
- **Type IV** (2-2): Two separate canals that remain distinct throughout their course.
- **Type V** (1-2): A single canal that bifurcates near the apex, forming two separate canals.
- **Type VI** (2-1-2): Two canals that merge and then re-divide before the apex.
- **Type VII** (1-2-1-2): A complex variation in which a single canal bifurcates, rejoins, and bifurcates again before the apex.
- **Type VIII** (3-3): Three distinct canals extending from the pulp chamber to the apex.

Most maxillary central incisors exhibit a **Type I** configuration, with a single root and single canal. However, variations such as **Type II, III and IV** have been observed in rare cases. Studies by Martins et al. (2020) and Lizzi et al. (2021) have documented such variations in approximately **2-3%** of maxillary central incisors, emphasizing the need for careful radiographic evaluation [3, 4]. A recent study by Patel et al. (2023) suggests that these variations may be underreported due to the limitations of conventional radiographs.

2.Case Description

A 28-year-old male patient reported to the endodontic clinic with a chief complaint of pain in his maxillary right central incisor (tooth #11). The patient provided a history of previous caries in the same tooth, which was temporarily restored three months earlier. He described the pain as continuous and dull, exacerbated by mastication. There was no history of trauma to the tooth. The patient's medical history was non-contributory.

Clinical Examination

Extraoral examination revealed no facial asymmetry, swelling or sinus tracts. Intraorally, the maxillary right central incisor exhibited a deep carious lesion with mild discoloration. The tooth was tender to percussion and

palpation. There was no significant mobility and periodontal probing depths were within normal limits.

Thermal and electric pulp testing revealed a delayed response, indicative of irreversible pulpitis.

Radiographic Examination

A digital periapical radiograph (RVG) (Dentsply Sirona, 13320 Ballantyne Corporate Place, Charlotte, NC, USA) was taken to evaluate the root canal morphology. The image displayed an unusual radiolucency in the root canal system, suggesting the presence of two separate canals. Multiple radiographic angulations were taken to confirm the unusual canal anatomy. The radiographic findings confirmed the diagnosis of symptomatic irreversible pulpitis with apical periodontitis.

Treatment Plan and Procedure

Based on the findings, **single-visit root canal therapy** was planned.

Preoperative Preparation

The patient was informed about the rare canal anatomy and the need for careful treatment planning. The treatment was explained in detail and informed consent was obtained. Preoperative photographs were taken for documentation purposes **(Figure 1).**

Access Cavity Preparation

Under rubber dam isolation (Sanctuary Dental Dam, Sanctuary Health Sdn Bhd, Selangor, Malaysia), an access cavity was prepared using a high-speed diamond bur (Mani FG Diamond Burs, Mani Inc., Utsunomiya, Japan) under magnification (Zeiss OPMI Pico, Carl Zeiss Meditec AG, Jena, Germany). The access was modified to locate both canals. The additional canal was identified using an endodontic explorer (DG16, Hu-Friedy, Chicago, IL, USA) and confirmed using multiple radiographic angulations.

Working Length Determination

An electronic apex locator (Root ZX II, J. Morita, Kyoto, Japan) was used to determine the working length. The readings were confirmed with radiographs **(Figure 2).** Multiple radiographs were taken from different angulations to ensure precise canal length measurement.

Cleaning and Shaping

Biomechanical preparation was performed using rotary nickel-titanium (NiTi) files (ProTaper Gold, Dentsply Maillefer, Ballaigues, Switzerland). The canals were irrigated using 2.5% sodium hypochlorite (NaOCl) (Chloraxid, Cerkamed, Stalowa Wola, Poland) with a side-vented irrigation needle (NaviTip, Ultradent, South Jordan, UT, USA). A final rinse with 17% ethylenediaminetetraacetic acid (EDTA) (RC-Prep, Premier Dental, Plymouth Meeting, PA, USA) was performed to remove the smear layer.

Obturation

The canals were dried using sterile paper points (Dentsply Sirona) and obturated using the warm vertical compaction technique with gutta-percha (Thermafil, Dentsply Sirona) and an epoxy resin-based sealer (AH Plus, Dentsply Maillefer) **(Figure 3 & 4).** Post-obturation radiographs confirmed the complete sealing of both canals.

Figure 1: Pre-Operative

Figure 2: Working Length Determination

Figure 3: Master CONE

Figure 4: Obturation

Post-Endodontic Restoration

Post-obturation restoration was performed using composite resin (Tetric-N-Ceram, Ivoclar Vivadent, Schaan, Liechtenstein). The patient was then recalled after one week for full-coverage restoration.

3.Discussion

The internal anatomy of maxillary central incisors is typically straightforward, with a single root and a single canal. However, variations such as the presence of two canals have been documented. Vertucci's classification remains the gold standard for categorizing root canal configurations [1]. A systematic review by Martins et al. (2020) analyzed multiple studies and found that approximately 2.4% of maxillary central incisors exhibit two canals, making it a rare but significant anatomical variation [3]. Additionally, Cleghorn et al. (2008) reviewed extracted teeth and found similar results, further reinforcing the need for vigilance during treatment [2].

Recent studies using radiographic assessments, such as Lizzi et al. (2021), highlighted the importance of multiple angulated periapical radiographs in detecting such variations [4]. While CBCT provides an enhanced three-dimensional view, traditional radiography when used judiciously can still provide valuable diagnostic information.

The success of root canal therapy is heavily dependent on the complete debridement and obturation of the canal system. Several techniques exist which includes lateral condensation, warm vertical compaction and thermoplasticized gutta-percha techniques. Warm vertical compaction was chosen in this case due to its ability to achieve dense three-dimensional obturation thereby ensuring superior sealing at the apex.

A comparative study by Schilder (1967) was among the first to highlight the advantages of warm vertical compaction [6]. More recent studies, including a randomized controlled trial by Castagnola et al. (2018) confirmed that warm vertical compaction provides better adaptation to canal walls compared to lateral compaction [7]. Similarly, a meta-analysis by Peng et al. (2007) suggested that warm vertical techniques reduce void formation and improve long-term success rates [8].

Single-visit root canal therapy (SRCT) is an evolving concept in endodontics, with research indicating that it can be as effective as multi-visit therapy. Traditionally, multiple visits were preferred due to concerns about microbial elimination, post-operative pain and long-term success. However, recent studies have challenged this notion.

A Cochrane systematic review by Figini et al. (2008) compared single-visit versus multiple-visit RCTs and found no significant difference in long-term treatment success [9]. Similarly, another systematic review by Sathorn et al. (2013) concluded that single-visit therapy offers comparable healing rates while reducing chair side time and patient discomfort [10]. Furthermore, a prospective study by Su et al. (2011) analyzed healing outcomes over five years and demonstrated a 91% success rate for single-visit root canal therapy [10].

Clinical Management Strategies for Complex Anatomy

When encountering unusual root canal anatomy, the following clinical strategies are recommended:

1. **Enhanced Preoperative Diagnosis:** Multiple angulated RVG images should be taken to identify anatomical complexities. This is critical when CBCT is unavailable.
2. **Modified Access Cavity Design:** A careful and conservative access opening ensures that all canals are located without excessive tooth structure removal.
3. **Magnification and Illumination:** The use of an operating microscope or dental loupes improves the detection of additional canals.
4. **Sequential Instrumentation:** Utilizing a combination of hand files and rotary NiTi instruments ensures efficient shaping while preventing procedural errors.
5. **Optimal Irrigation Protocol:** Sodium hypochlorite (NaOCl) with passive ultrasonic activation enhances canal disinfection which is crucial for long-term success.
6. **Effective Obturation Technique:** Warm vertical compaction ensures superior apical sealing thereby reducing the risk of microleakage.

4.Summary of Findings

This case demonstrated the importance of recognizing anatomical variations, employing modern obturation techniques and also by performing single-visit root canal therapy for efficient treatment. Comparative literature supports the efficacy of these approaches in ensuring superior long-term success rates and patient comfort.

Clinical Significance

A comprehensive clinical examination, careful interpretation of radiographs and modified access cavity preparation are critical in managing such cases. Proper shaping, disinfection and obturation techniques helps to improve the prognosis of the affected tooth. The use of single-visit root canal therapy reduces chair time and maintains treatment efficiency while ensuring long-term success.

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