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Importance of cone beam computed tomography in endodontics for assessment of MB2 canal in Maxillary First Molar - A review

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Abstract
Successful endodontic therapy depends on thorough debridement and obturation of the entire root canal system. One of the most common causes of endodontic failure in maxillary first molars is the inability to detect and treat the second mesiobuccal canal (MB2). Anatomical variations in the mesiobuccal root make conventional two-dimensional radiography insufficient for accurate detection. Cone Beam Computed Tomography (CBCT) has emerged as a valuable diagnostic tool that provides three-dimensional visualization of root canal morphology without superimposition of structures. CBCT allows precise localization of the MB2 canal, assessment of canal configuration, curvature, and associated periapical pathology. This review article discusses the anatomical complexity of the mesiobuccal root of maxillary first molars, limitations of conventional imaging, and the role of CBCT in improving detection and treatment outcomes of the MB2 canal. Current literature supporting the diagnostic accuracy and clinical significance of CBCT in endodontics is also reviewed.

Keywords: CBCT, endodontics, MB2 canal, maxillary first molar, root canal morphology, three-dimensional imaging

Introduction

Successful root canal treatment requires complete knowledge of root canal anatomy and its variations. Missed canals remain one of the leading causes of persistent periapical pathology and post-treatment disease. Among all teeth, the maxillary first molar demonstrates highly complex internal anatomy, particularly in the mesiobuccal root, where the presence of a second mesiobuccal canal (MB2) is common but often difficult to locate.

Studies have reported that the incidence of MB2 canals in maxillary first molars ranges from 50% to over 90%, depending on the diagnostic method used [2]. Conventional intraoral periapical radiographs provide only two-dimensional information and often fail to reveal additional canals due to anatomical superimposition. Even with magnification aids such as dental operating microscopes, detection of MB2 canals may remain challenging because of calcification, narrow canal morphology, or complex canal curvature [3].

Cone Beam Computed Tomography (CBCT) has significantly enhanced diagnostic capabilities in endodontics by providing high-resolution three-dimensional imaging of dental structures. CBCT enables clinicians to visualize root canal morphology in axial, coronal, and sagittal planes, thereby improving the detection rate of accessory canals such as MB2. It also assists in evaluating canal curvature, root thickness, resorption, and periapical lesions.

With increasing availability and reduced radiation dose compared to conventional medical CT, CBCT has become an important adjunct in complex endodontic cases. The present review focuses on the importance of CBCT in identifying MB2 canals in maxillary first molars and its impact on treatment planning and prognosis.

Anatomy of the Mesiobuccal Root of Maxillary First Molar

The mesiobuccal root of the maxillary first molar presents significant anatomical variability. The canal configurations have been extensively studied using different methods including tooth clearing techniques, micro-CT, and CBCT.

The most commonly reported canal configurations include:

- Single canal (MB1 only)
- Two separate canals (MB1 and MB2)
- Two canals merging into one
- Complex intercanal communications

Vertucci's classification describes several variations, with Type II and Type IV configurations frequently observed in the mesiobuccal root [1].

Factors influencing MB2 detection include:

- Age-related calcification
- Canal curvature
- Pulp chamber floor anatomy
- Operator experience
- Quality of diagnostic imaging

Causes of Missed MB2 Canal

Failure to locate the MB2 canal may occur due to:

- Inadequate access cavity design
- Calcified canal orifices
- Lack of magnification
- Reliance on two-dimensional radiography
- Complex canal morphology

Missed MB2 canals are strongly associated with persistent periapical lesions and endodontic retreatment cases.

Limitations of Conventional Radiography

Intraoral periapical radiographs are routinely used in endodontics but have several limitations:

- Two-dimensional representation of three-dimensional structures
- Superimposition of anatomical structures
- Difficulty in detecting additional canals
- Limited visualization of root canal curvature
- Inability to accurately assess complex root morphology

Because the MB2 canal is usually located palatal to MB1, it is often masked in standard radiographic views.

Role of CBCT in Endodontics

CBCT has revolutionized diagnostic imaging in endodontics due to its ability to provide three-dimensional visualization with relatively low radiation dose compared to conventional CT [4].

Advantages of CBCT in Endodontics

- Three-dimensional assessment of root canal morphology
- Accurate detection of additional canals
- Visualization without anatomical superimposition [5, 6]
- Evaluation of periapical pathology
- Assessment of root fractures and resorption
- Treatment planning for complex cases

CBCT imaging allows clinicians to evaluate the mesiobuccal root in axial sections, which significantly increases the detection rate of MB2 canals [7].

CBCT in Detection of MB2 Canal

Several studies have shown that CBCT significantly improves the detection rate of MB2 canals compared to conventional radiography [8].

CBCT helps in:

- Locating the exact position of MB2 canal orifice
- Determining canal configuration
- Assessing canal curvature
- Evaluating calcified canals
- Identifying canal merging patterns

Axial sections at different root levels provide clear visualization of canal bifurcation and interconnections.

Clinical Significance

Detection and treatment of MB2 canals directly influence endodontic success rates. Untreated canals may harbor bacteria leading to persistent infection.

CBCT is particularly recommended in:

- Retreatment cases
- Calcified canals
- Persistent periapical lesions
- Complex root morphology
- Non-healing endodontic cases

However, CBCT should be used judiciously following ALARA (As Low as Reasonably Achievable) radiation principles.

Limitations of CBCT

Despite its advantages, CBCT has certain limitations:

- Radiation exposure higher than intraoral radiography
- Image artifacts due to metallic restorations
- Cost considerations
- Limited soft tissue contrast

Therefore, CBCT should be considered an adjunct rather than a replacement for conventional imaging.

Conclusion

The mesiobuccal root of the maxillary first molar exhibits complex and variable canal anatomy, with the MB2 canal being frequently present but often missed during conventional endodontic treatment. Cone Beam Computed Tomography provides accurate three-dimensional visualization of root canal morphology and significantly enhances the detection of MB2 canals. Incorporating CBCT in complex and retreatment cases improves diagnostic accuracy, treatment planning, and overall prognosis. Judicious use of CBCT in endodontics represents an important advancement toward achieving predictable treatment outcomes.

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