Prevalence of Second Mesiobuccal Canals in Maxillary First Molars Detected Using Cone-beam Computed Tomography, Direct Occlusal Access, and Coronal Plane Grinding

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Abstract

Introduction: The purpose of this study was to determine the prevalence of the second mesiobuccal canal (MB2) in 100 maxillary first molars using 3 independent methods and a combination method. **Methods:** One hundred extracted human maxillary first molars were collected. The teeth were mounted in the maxillary first molar extraction sockets of a human cadaver head. A cone-beam computed tomographic (CBCT) scan was taken of each tooth. Two radiology faculty independently evaluated the CBCT volume for the presence of an MB2 canal. Additionally, teeth were accessed. If a canal was not found, a preoperative CBCT scan was viewed followed by a second attempt to locate an MB2 canal. Lastly, the mesiobuccal root was dissected by grinding in a coronal plane. **Results:** A review of CBCT volumes found the presence of an MB2 canal 69% of the time. Accessing the tooth led to an MB2 detection of 78%. When a CBCT scan was viewed, this brought the access detection rate up to 87%. Coronal plane root grinding had an MB2 canal detection rate of 92%. Differences between each method were statistically significant. **Conclusions:** The results of this study show that an MB2 canal is present up to 92% of the time. Direct access of teeth found statistically significant more MB2 canals than viewing CBCT volumes alone ($P = .032$). Therefore, exposing every patient to a preoperative CBCT scan may not be appropriate. However, taking a CBCT scan when an MB2 canal is not found clinically can significantly increase the chances of finding an MB2 canal ($P < .001$). *(J Endod 2017;■:1–5)*

Key Words

Cone-beam computed tomography, coronal plane grinding, direct occlusal access, maxillary first molar, mesiolingual canal, prevalence, second mesiobuccal canal

Significance

This study combined 3 independent techniques as well a combination technique as a unique way to evaluate the mesiobuccal root for the prevalence of MB2 canals. This information can be used to help guide clinicians on appropriate CBCT scan indications.

Although physically small in size when compared with other bodily tissues, an inflamed dental pulp can inflict agonizing and unrelenting pain to an individual. Because of its unique location, the dental pulp can be both challenging to locate and difficult to remove. Therefore, a thorough understanding of tooth morphology and root canal anatomy is required when performing root canal therapy (1).

Of particular interest in the field of endodontics is the maxillary first molar, which has been studied extensively (1–27). Variations and complex morphology, particularly in the mesiobuccal root, have been demonstrated dating back to 1925 (2). In fact, the maxillary first molar is the largest tooth in total volume and is generally considered the most anatomically complex tooth (3).

Throughout the literature, much of the focus of the maxillary first molar has revolved around the mesiobuccal root and the second mesiobuccal canal, which is referred to as either the MB2 or the mesiolingual canal. Although not always located, the MB2 canal is present on average 56.8% of the time when all studies are taken into account (4). Depending on the study referenced and the method used, the presence of the MB2 canal ranges from 18.6% (5) to 96.1% (6). When the MB2 canal cannot be located or properly treated, it may contribute to continued patient pain or root canal failure (8).

Over the years, cone-beam computed tomographic (CBCT) studies (15–18, 24, 27), laboratory studies (2, 6, 8–15, 22, 23), and clinical studies (5, 7, 19–21, 25, 26) have examined the prevalence of the MB2 canal in maxillary first molars. These studies have evaluated the prevalence of the MB2 canal using only 1 or 2 methods. A search of the literature shows the absence of any study that has used the combination of CBCT imaging, direct access, grinding, and a combination of CBCT imaging and access to determine the prevalence of the MB2 canal in maxillary first molars.

The purpose of this study was to determine the prevalence of the MB2 canal in 100 maxillary first molars using 3 independent methods and a combination of these methods: group 1, CBCT evaluation; group 2, direct occlusal access with a dental

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operating microscope (DOM); group 3, direct occlusal access followed by CBCT evaluation and reaccess; and group 4, coronal plane root grinding of the mesiobuccal root.

Materials and Methods

Teeth Selection

One hundred extracted human maxillary first molars were collected and analyzed. No information regarding age, sex, or clinical history of the studied teeth was available. Selection specification for teeth included normal crown anatomy, 3 separate roots, fully formed apices, an intact pulpal floor, and no developmental anomalies. After extraction, the teeth were placed in 5% sodium hypochlorite, debrided of periodontal tissue, and rinsed under running tap water. The teeth were then stored in physiologic saline until the beginning of the experiment. Over the course of the study, 1 of the teeth with typical normal crown anatomy was removed because of unusual root anatomy. The total number of teeth included in the study was 99 (50 #14 and 49 #3 teeth).

Group 1: CBCT Imaging

To simulate a clinical preoperative CBCT scan environment, an embalmed human head (Science Care, Phoenix, AZ) with an intact dentition was used. Before CBCT scanning, the mandible was resected at the level of the maxillary occlusal plane, and the left and right maxillary first molars were extracted. The experimental teeth were then mounted in those extraction sockets. A CBCT scan (J Morita Veraviewepocs 3de, Irvine, CA) was taken of each tooth when mounted using the following presets: a small-volume 40 mm × 40 mm field of view, high resolution (0.125-mm^3 voxel size), 80 kV, and 10 mA. One Volume Viewer software (J Morita, Irvine, CA) was used to view each CBCT scan. Two faculty from Loma Linda University's Department of Radiology and Imaging Sciences independently viewed and evaluated in user-selected multiplanar views the mesiobuccal root for the presence of an MB2 canal and the number of apical exit points. Each diagnosed MB2 canal included image-supported screenshots. If an MB2 canal was suspected but not definitively seen on the CBCT volume, it was not considered present.

Both evaluators viewed and manipulated the CBCT volumes independently and were completely blinded from the results of the other tests. Initial calibration involved independent viewing and manipulation of 35 CBCT volumes to standardize readings and agreement. Intraexaminer reliability was 94% (33/35).

Group 2: Direct Occlusal Access under a DOM

All aspects of this method were performed by the principle investigator under a DOM using at least 10× magnification. The preoperative CBCT volumes were not available to the operator at this time. For documentation purposes, preoperative periapical (PA) radiographs were taken from the buccal and mesial views of each unmounted tooth using a stationary Nomad portable x-ray machine and digital sensor (Aribex, Inc, Charlotte, NC). Images were viewable in the MiPACs Dental Enterprise Viewer (Medicor Imaging, Charlotte, NC). Each tooth was randomly selected, and a standard access was made, in hand, directly through the occlusal surface creating an ideal straight-line access. Access preparations were refined, as needed, to a more rhomboidal configuration to support the identification of the MB2 canal. All remaining tissue was removed from the pulp chamber and canals using hand files and sodium hypochlorite. If not immediately identified, the operator spent up to 15 minutes per tooth attempting to locate the MB2 canal using a combination of hand files, rotary files, and ultrasonic instruments. No more than 2 mm of tooth structure, apical from the pulpal floor, was removed when necessary.

Group 3: Direct Access Followed by CBCT Volume Evaluation and Reaccess

After initial access and exploration, if an MB2 canal was not located, the CBCT volume of that specific tooth was reviewed. If the operator noted an MB2 canal on the CBCT volume, the operator returned to the tooth and spent an additional 5 to 10 minutes attempting further canal negotiation.

Group 4: Coronal Plane Root Grinding

After access of all samples, the teeth were selected at random by the principal investigator. Using a high-speed handpiece equipped with a long shank diamond bur, the mesiobuccal root of each tooth was carefully ground under a DOM in the coronal plane until the canal system was visualized. The number of canals was documented, and the root canal system was classified according to Vertucci's classification system (8). Throughout the process of accessing and grinding, photographic and radiographic documentation was taken as shown in Figure 1.

Statistical/Data Analysis

Statistical analysis was accomplished using SPSS software (IBM, Armonk, NY). Chi-square analysis was performed to test and compare the prevalence among the 4 methods of evaluation. All hypotheses testing were conducted at an alpha level of 0.05.

Results

Results are outlined in Tables 1 and 2. The prevalence of an MB2 canal with blinded CBCT volume evaluation (group 1) was 69% (68/99). Group 2, initial access of the tooth under a DOM, showed an MB2 canal 78% (77/99) of the time. Group 3, initial access followed by a review of the CBCT volume and return to the tooth, led to an MB2 detection rate of 87% (86/99). Group 4, root grinding, demonstrated the presence of an MB2 canal 92% (91/99) of the time.

When the prevalence of MB2 canals found in group 1 (69%) was compared with groups 2 (77%), 3 (87%), and 4 (92%), these differences were all found to be statistically significant ($P = .032$, $P = .002$, and $P < .001$, respectively). Additionally, when group 2 (77%) was compared with group 3 (87%), this difference was also found to be statistically significant ($P < .001$). Lastly, when group 3 (87%) was compared with group 4 (92%), this difference was again found to be statistically significant ($P < .001$).

In terms of Vertucci's canal classification (8), the following canal types were noted from root grinding: type I (8/99), type II (43/99), type III (1/99), type IV (37/99), type V (1/99), and type VI (9/99). Additional information from grinding showed that 23% of type II canals had 2 to 3 apical exit points, and 22% of type IV canals had an isthmus present. In a similar fashion, the CBCT evaluation yielded 68 teeth with an MB2 canal. Of these teeth, 44% (30/68) had 1 apical exit, and 56% (38/68) had 2 apical exit points visible on the CBCT volume.

Discussion

Canal identification is critical to successful root canal treatment. In a recent retrospective cohort study, Karabucak et al (27) evaluated the prevalence of missed canals in endodontically treated teeth using CBCT volumes. They found that when a canal was missed the tooth was 4.38 times more likely to have an associated lesion. Additionally, the MB2 canal was the most frequently missed canal.

Previous studies used CBCT scanning (15–18, 24, 27), laboratory techniques (2, 6, 8–15, 22, 23), and clinical examinations (5, 7, 19–21, 25,26) to determine the prevalence of the MB2 canal in maxillary