A Cone-beam Computed Tomographic Study of Root and Canal Morphology of Maxillary First and Second Permanent Molars in a Thai Population

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Abstract

Introduction: Understanding tooth anatomy is crucial for effective endodontic treatment. This study investigated the roots and root canal morphology of maxillary first and second permanent molars in a Thai population using cone-beam computed tomographic (CBCT) imaging. **Methods:** This study evaluated 476 maxillary first molars and 457 maxillary second molars receiving CBCT examination and determined the number of roots and canal morphology according to Vertucci's classification, and the prevalence of a second mesiobuccal (MB2) canal in the mesiobuccal (MB) root was correlated with sex, age, and tooth side. **Results:** Three roots were most commonly found in maxillary first and second molars. MB2 canals in the MB root were found in 63.6% and 29.4% of first and second molars, respectively. The most common canal morphology in the first molar MB roots was type I (36.4%) followed by type II (28.8%), and type IV (25.3%). The most common canal morphology in the second molar MB roots was type I (70.6%) followed by type II (14.6%) and type IV (7.5%). Bilateral MB2 canals in the MB roots were present in 80.93% and 82.59% of the first and second molars, respectively. There was a significant correlation between males and the prevalence of MB2 canals in first molars ($P < .05$). **Conclusions:** CBCT imaging is useful to determine root canal morphology. The prevalence of MB2 canals is approximately 60% and 30% in first and second molars, respectively. Furthermore, bilateral MB2 canals were commonly found. Our results can help endodontists to improve endodontic treatment outcomes. *(J Endod 2017;■:1–6)*

Key Words

Cone-beam computed tomography, first maxillary molar, mesiobuccal canal, root canal morphology, second maxillary molar, Thai population

Significance

Studying the morphology of maxillary molars and their canals in a Thai population using CBCT imaging may help dentists to understand and improve the outcomes of endodontic treatments.

The main objective of endodontic treatment is to perform a thorough mechanical and chemical cleansing of the entire root canal system of a tooth and its obturation with an inert filling material (1). The most frequent cause of endodontic failure is untreated or poorly debrided/obturated root canals. Hence, there is persistence of microbial infection in the root canal system (2). Thus, a better understanding of root canal morphology and its variations is crucial for successful endodontic treatment.

Many studies reported that the prevalence of a second mesiobuccal (MB2) canal in maxillary molars is over 50% (3–10). The wide variations reported in the prevalence of the MB2 canal may be caused by differences in race, age, and sex of the population and methods among the studies. The laboratory methods for evaluating root canal morphology are clearing and staining (1, 3, 4, 11–13), sectioning (14), conventional radiographs (6, 15), magnification (16), micro–computed tomographic imaging (17), and mixed methods (5). The clinical identification of the MB2 canal includes patient record reviews, radiography, and inspection during endodontic treatment with or without magnification (18–20). Cone-beam computed tomographic (CBCT) scanning has been used to study tooth anatomy (7–10, 21–25) since 1990. The advantages of CBCT imaging are a lower effective radiation dose, shorter exposure time, less expense than conventional computed tomographic imaging, high resolution, high accuracy, minimal distortion, 3-dimensional (3D) visualization, and it is a nondestructive technique.

There has been 1 study of root canal morphology in a Thai population using the clearing and staining technique (4). However, there was no study of root canal morphology in a Thai population using CBCT imaging. The aim of this study was to investigate the root canal morphology of maxillary first and second permanent molars in a Thai population using CBCT imaging and to determine any correlation between the prevalence of a second canal in the mesiobuccal (MB) root of maxillary permanent molars with sex, age, and tooth side.

Material and Methods

The research was approved by the Human Research Ethics Committee, Chulalongkorn University (HREC-DCU 2016-020), Bangkok, Thailand. Two-hundred sixty-six patients requiring CBCT examination as part of their dental diagnosis and

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treatment had CBCT scanning performed at the Department of Radiology, Faculty of Dentistry, Chulalongkorn University between January 2014 and January 2016. The patients consisted of 107 men and 159 women between 12 and 76 years old, and 476 maxillary first molars and 457 maxillary second molars were evaluated. The teeth were selected based on being fully developed maxillary first and second permanent molars. Exclusion criteria were teeth with open apices, root resorption, or calcification and teeth with prior root canal treatment. The CBCT system used in this study was a 3D Accuitomo CBCT machine (J Morita Manufacturing Corp, Kyoto, Japan). The scan settings were 80 kVp and 5 mA with a 17.5-second exposure time. A field of view of 100.025 × 100.025 mm and a 0.25 × 0.25 mm voxel size were used. Axial, coronal, and sagittal 2-dimensional sectional images were displayed on a monitor using One Volume Viewer software (J Morita Manufacturing Corp). The number of root canals from the coronal third to the apical third of each root was observed, and the number of roots and canal morphology of the root canal system were evaluated according to Vertucci's classification with modification (4). A single canal was classified as type I. Two canals in the MB root that gradually joined into 1 canal were classified as type II. One canal that divided into 2 and then joined into 1 canal again was classified as type III. Two separate root canals that extended from the pulp chamber to the apex were classified as type IV. If 1 of 2 canals disappeared in the apical third, it was also classified as type IV because the root apex was curved or they may not have disappeared simultaneously. A single canal that split into 2 was classified as type V. Two coronal canals that joined at the middle of the root to form one and then divided into 2 canals again near the apex were classified as type VI. A single canal that separated into 2 canals, rejoined after some distance, and then divided into 2 canals again near the apex was classified as type VII. Three separate root canals from the pulp chamber to the apex were classified as type VIII. We also determined the correlation of the MB2 canal in the MB root with sex, age, and tooth side. Age group was separated into 6 groups (11–20, 21–30, 31–40, 41–50, 51–60, and >60 years old) for analysis.

TABLE 1. The Number of Roots in Maxillary First and Second Molars

No. of root	Maxillary first molars, *n* (%)	Maxillary second molars, *n* (%)
1 root	0	16 (3.5)
2 roots	0	42 (9.2)
3 roots	475 (99.8)	398 (87.1)
4 roots	1 (0.2)	1 (0.2)
Total	476 (100)	457 (100)

The correlation between the prevalence of MB2 canals and sex and tooth side was assessed using the Fisher exact test ($P < .05$). The chi-square test was used for correlation between the prevalence of the MB2 canal and age ($P < .05$). Two calibrated examiners (residents in endodontics) evaluated the images twice, with a 3-week interval between the assessments. The reliability data were analyzed using the kappa test. After intraexaminer calibration, the 2 examiners separately evaluated the images in the study samples. If a disagreement in the interpretation of an image was found, it was first discussed between the 2 examiners. If a consensus could not be reached, a radiologist assisted in reaching a decision.

Results

The intraexaminer reliability was 0.84, and the interexaminer reliability was 0.81.

Number of Roots and Morphology

The number of roots in each of the 476 maxillary first molars and 457 second molars was determined (Table 1). The prevalence of 3-rooted first molars was 475 (99.8%), and in second molars, it was

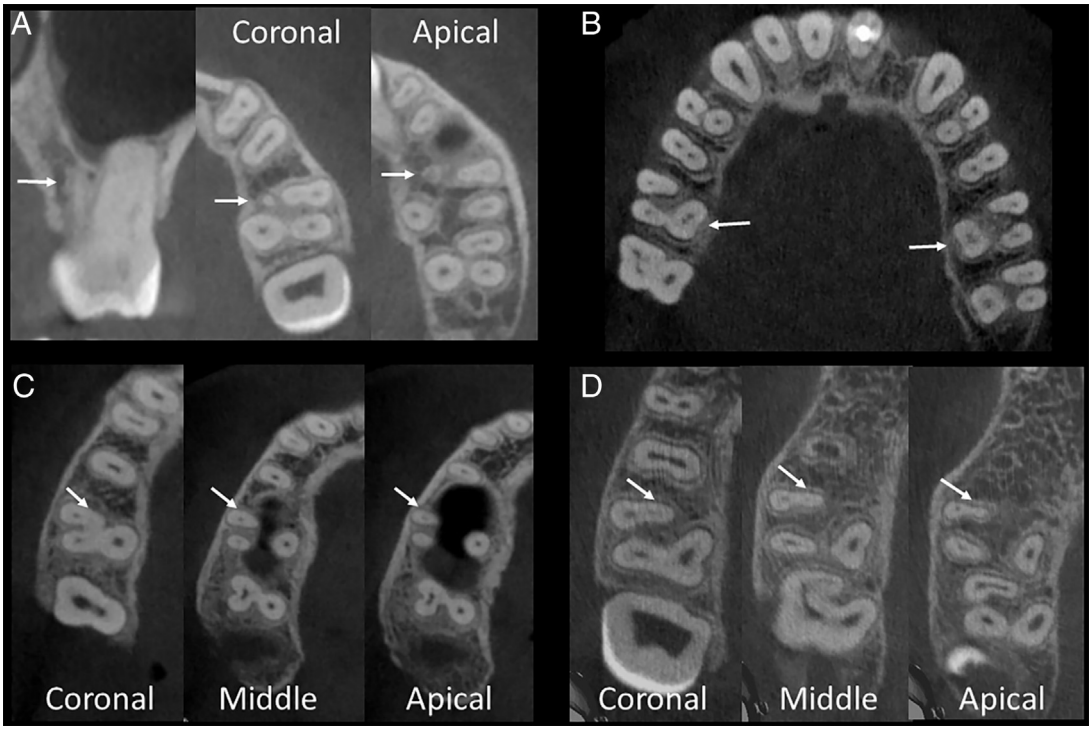

Figure 1. Maxillary first molars. (*A*) A 4-rooted molar whose MPa root (*arrows*) was small, conical, and had no detectible canal. (*B*) A 3-rooted molar in which the Pa root canal separated into 2 canals at the coronal third (*arrows*). (*C*) An MB root showing type II canal configuration (2 canals into 1). (*D*) A MB root with a type IV canal configuration (2 separate canals).