Evaluation of Root and Canal Morphology of Maxillary Permanent Molars in an Egyptian Population by Cone-beam Computed Tomography

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Abstract

Introduction: The purpose of this study was to evaluate the number of roots and canal morphology of maxillary permanent molars in an Egyptian population. **Methods:** Six hundred fifty-seven cases were included in this study. Digitized images from cone-beam computed tomographic scanning were assessed by 2 endodontists. The number of roots and canal configuration according to Vertucci were tabulated. Age, sex, and bilateral distribution differences were calculated. **Results:** All maxillary first molars showed 3-root configuration, whereas maxillary second molars showed 3-, 2-, and single-root configurations. For maxillary first molars, the most common Vertucci classifications for the mesiobuccal root were type II (2-1, 45.6%), type IV (2-2, 27.27%), and type I (1, 25.45%). For maxillary second molars, the most common Vertucci classifications for the mesiobuccal root were type II (2-1, 47.1%), type I (1, 42.06%), and type IV (2-2, 8.03%). The prevalence of a second mesiobuccal canal is statistically not affected by either sex, tooth position (right or left side), or age. **Conclusions:** Under the conditions of this study, the root canal configurations of an Egyptian population showed that the most common Vertucci classifications for the mesiobuccal root for maxillary first molars were type II (2-1), type IV (2-2), and type I (1). For maxillary second molars, the most common types were type II (2-1), type I (1), and type IV (2-2). Pre-evaluation of the endodontic case using cone-beam computed tomographic digital imaging provides better information of root canal morphology, which might improve the management and prognosis of the case. *(J Endod 2017;■:1–4)*

Key Words

Egyptian population, maxillary molars, morphology

Significance

Morphologic evaluation of root canal morphology using CBCT imaging is considered essential for better management and improved prognosis of the endodontic case.

Recognition of the internal complex 3-dime-nsional morphology is considered essential for complete debridement and obturation of the root canal system and hence successful root canal therapy (1). Numerous methods have been used for *in vitro* examination of root canal morphology including canal staining and tooth clearing techniques (2), contrast medium–enhanced radiography (3), and micro–computed tomographic imaging (4). However, these techniques are *ex vivo* methods that can be used only with extracted teeth, limiting the applicability of these techniques in clinical practice.

Other *in vivo* methods include conventional intraoral periapical radiographs (5) and cone-beam computed tomographic (CBCT) imaging (6–9). Conventional radiography produces only 2-dimensional images of 3-dimensional objects, resulting in the distortion and superimposition of structures. Recently, CBCT scans have significantly improved the understanding of 3-dimensional root canal morphology. In addition, CBCT scans have lower radiation doses than conventional computed tomographic imaging, which make them more feasible for clinical application.

Many studies have reported ethnically related differences in root canals of different populations (10–12). The diversity of the internal anatomy of root canals is genetically determined and carries definite importance to consider ethnic variations during clinical treatment. The aim of this study was to identify the root and canal morphology of the maxillary first and second molars in an Egyptian population using CBCT imaging *in vivo*.

Materials and Methods

Digital CBCT images of the maxillary first and second molars were collected from patients who had undergone CBCT scanning for diagnosis purposes at Misr International University, Cairo, Egypt, from January 2015 to September 2016. The CBCT images of 657 patients were selected according to the following inclusion criteria:

1. Age between 16 and 75 years
2. Presence of the maxillary first and/or second molar
3. Maxillary molars with fully matured apices and without apical periodontitis
4. No root canal fillings, posts, or full-crown restorations

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TABLE 1. Root Canal Configuration in the Maxillary First Molars

Molar configuration	Root	Type I (1), *n* (%)	Type II (2-1), *n* (%)	Type III (1-2-1), *n* (%)	Type IV (2-2), *n* (%)	Type V (1-2), *n* (%)	Type VI (2-1-2), *n* (%)
3-root configuration	MB	154 (25.45)	276 (45.62)	6 (0.99)	165 (27.27)	4 (0.46)	0 (0)
	DB	605 (100.00)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	P	605 (100.00)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
2-root configuration	B	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	P	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Single-root configuration		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

B, buccal; DB, distobuccal; MB, mesiobuccal; P, palatal.

The CBCT images were obtained using a Cranex 3D (Soredex, Tuusula, Finland) with the following parameters: 80 kVp, 9.0 mA, and 133-μm voxel size. Serial axial, coronal, and sagittal CBCT images were acquired by an experienced radiologist according to the operation instructions. Reformatted images were examined by carefully rolling the toolbar from the pulp chamber to the apex. All the images were assessed independently by 2 endodontists, and any disagreement between them was discussed until a consensus was reached.

The number and configuration of the roots, the number of root canals, the canal configurations according to Vertucci's classification (2), the incidence of additional canals in the mesio- and distobuccal roots and the palatal roots, and symmetry in the number of canals between adjacent and contralateral molars were determined.

Statistical analysis was performed using SPSS software (Version 20.0; SPSS Inc, Chicago, IL). The relationships among sex, tooth position (right or left side), and age with the incidence of additional canals were determined using the chi-square test. In addition, the concurrency pattern of additional canals in the 2 adjacent or bilateral molars was analyzed using the chi-square test. Differences were considered significant if the *P* value was less than .05.

Results

A total of 605 maxillary first molars and 610 maxillary second molars in 657 patients comprising 53.7% women and 46.3% men were assessed.

Number and Morphology of Roots

Regarding the maxillary first molars, a 3-root configuration was recorded in 100% of the patients. For the maxillary second molars, the most common configuration was 3 roots (87.7% of the cases) followed by a 2-root configuration (10.66%) and a single-rooted configuration (1.64%).

Root fusion was not observed in all assessed maxillary first molars. For the maxillary second molars, mesiobuccal-palatal root fusion was observed in 51 cases (8.3%).

Number and Configuration of Root Canals

The number and configuration of root canals are shown in Tables 1–3. The canal morphology was analyzed using Vertucci's classification for each root (Fig. 1). The prevalence of a second mesiobuccal (MB2) canal is not statistically affected by sex, tooth position (right or left side), or age (*P* = .21) as shown in Table 3.

Discussion

The aim of the present study was to provide a detailed description of the morphology of the maxillary first and second molars by means of CBCT imaging in a large sample of an Egyptian population. Because of the high rates of variation in maxillary molars (1, 2, 4, 8, 13, 14), thorough understanding of root canal morphology is essential for successful root canal therapy. Many methods have been advocated for *in vitro* examination of root canal morphology. These methods include a tooth clearing technique with or without the use of a microscope (13, 15–17) and micro–computed tomographic imaging. Micro–computed tomographic imaging is considered a nondestructive radiographic technique for accurate and reliable evaluation of root canal morphology and root anatomy (18–22). However, all these *in vitro* techniques are only applicable to extracted teeth, hence creating a limited sample size without the ability to detect bilateral tooth morphology. CBCT imaging is considered a reliable yet nondestructive method for morphologic evaluation. CBCT imaging provides high-resolution images with a lower radiation dose and lower cost compared with micro–computed tomography.

Many authors compared the use of CBCT imaging with other methods for the evaluation of root canal morphology. Matherne et al (23) compared the efficacy of CBCT imaging with a charge-coupled device and photostimulable phosphor plate radiography. They found that CBCT imaging was better in morphologic identification than the other methods. Domark et al (4) found that there was no significant difference between CBCT imaging and micro–computed tomographic imaging in canal identification for maxillary molars. Blattner et al (24) compared CBCT results with tooth sectioning results and concluded that there was no difference regarding the accuracy of CBCT imaging.

TABLE 2. Root Canal Configuration in the Maxillary Second Molars

Molar configuration	Root	Type I (1), *n* (%)	Type II (2-1), *n* (%)	Type III (1-2-1), *n* (%)	Type IV (2-2), *n* (%)	Type V (1-2), *n* (%)	Type VI (2-1-2), *n* (%)
3-root configuration	MB	225 (42.06)	252 (47.1)	0 (0)	43 (8.03)	10 (1.87)	5 (0.93)
	DB	535 (100.00)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	P	535 (100.00)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
2-root configuration	B	65 (100.00)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	P	65 (100.00)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Single-root configuration		10 (100.00)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

B, buccal; DB, distobuccal; MB, mesiobuccal; P, palatal.