

A Study of the Root Canal Morphology of Mandibular Anterior Teeth Using Cone-beam Computed Tomography in a Chinese Subpopulation

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Abstract

Introduction: The purpose of this study was to investigate the root canal configuration of the mandibular anterior teeth using cone-beam computed tomographic (CBCT) imaging in a Chinese subpopulation. **Methods:** A total of 3,871 CBCT images of mandibular anterior teeth were collected from 648 patients who accepted CBCT projection as a preoperative assessment for implants or orthodontic treatment. The following items were recorded and evaluated: tooth position, root number, canal number, root canal type, the distance between the anatomic apex and the point at which the canal divided into 2 for mandibular anterior teeth with 2 root canals (excluding canines with 2 roots), and the distance between the 2 root canal orifices. The Fisher exact test was used to analyze the correlation between the number of root canals and tooth position. **Results:** All of the incisors in this study had 1 root, and 1.32% of the canines had 2 roots. The prevalence of 2 root canals in the lateral incisors (354, 27.36%) was higher than that in the central incisors (202, 15.71%) ($P < .05$) and the canines (81, 6.27%) ($P < .05$). **Conclusions:** There is a high prevalence of 2 root canals in the mandibular anterior teeth of the studied Chinese subpopulation. This study provides detailed information about the root canal morphology of mandibular anterior teeth in a Chinese subpopulation. (*J Endod* 2014;40:1309–1314)

Key Words

Cone-beam computed tomography, mandibular anterior teeth, root canal morphology

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Successful root canal treatment depends on the thorough debridement, proper shaping, and complete obturation of the root canal system. A comprehensive knowledge of the root and canal morphology and the anticipation of their possible variations are essential to avoid the failure of root canal treatment. The omission of root canals may be catastrophic during endodontic treatment because it may leave infectious areas untouched.

It was first believed that mandibular incisors generally had a single root canal (1). Little attention was paid to these so-called single-canal teeth. Because a study performed by Rankine and Henry (2) in 1965 showed a high prevalence of 2 canals in mandibular incisors, further studies were stimulated on the root canal configuration and high variation was confirmed in different populations by various studies (3–13). However, these studies were conducted mainly in Europe, North America, and Japan, whereas the information from Chinese populations was scarce. There were even fewer data on mandibular canines (4, 9, 10).

In the existing literature on root canal morphology, most studies were performed on extracted teeth using staining and clearing techniques (3, 4, 7–13), transverse cross-sectioning (14), radiographic examination (5), and micro-computed tomographic imaging (15). In clinical situations, conventional periapical radiography is commonly used at various stages of root canal treatment. However, periapical radiography only provides 2-dimensional images in which the roots may overlap with the surrounding tissue. Recently, cone-beam computed tomographic (CBCT) scanning has been used in the field of endodontics (16, 17). CBCT scanning is an extraoral imaging system that produces 3-dimensional scans of the maxillofacial skeleton. The images obtained from the CBCT scanner are displayed in axial, sagittal, and coronal planes and reduce the superimposition of surrounding structures. CBCT imaging, as a noninvasive tool, has been widely used to detect periapical lesions and root canal morphology (18). The purpose of this study was to use CBCT scanning to investigate the root and canal morphology of mandibular anterior teeth in a Chinese subpopulation.

Materials and Methods

Sample Selection

A total of 3,871 CBCT images of mandibular anterior teeth were collected from 648 patients who accepted CBCT projection as a preoperative assessment for implants or

TABLE 1. Prevalence of the Number of Root Canals of Mandibular Anterior Teeth according to Tooth Position

Tooth position		1 root canal (%)	2 root canals (%)	Total
Mandibular central incisors	Right	549 (85.51)	93 (14.49)	642
	Left	535 (83.07)	109 (16.93)	644
	Total	1,084 (84.29)	202 (15.71)	1286
Mandibular lateral incisors	Right	476 (73.57)	171 (26.43)	647
	Left	464 (71.72)	183 (28.28)	647
	Total	940 (72.64)	354 (27.36)	1294
Mandibular canines	Right	603 (93.49)	42 (6.51)	645
	Left	607 (93.96)	39 (6.04)	646
	Total	1,210 (93.73)	81 (6.27)	1291

TABLE 2. Distribution of Root Canal Types of Mandibular Anterior Teeth

Tooth	Type I	Type II	Type III	Type IV	Type V	Type VI	Type VII	2-1-2-1	2 roots	Total
Mandibular central incisors, <i>n</i> (%)	1,084 (84.29)	44 (3.42)	84 (6.53)	15 (1.17)	50 (3.89)	0 (0)	4 (0.31)	5 (0.39)	0 (0)	1,286 (100)
Mandibular lateral incisors, <i>n</i> (%)	940 (72.64)	52 (4.02)	201 (15.53)	30 (2.32)	66 (5.10)	2 (0.15)	2 (0.15)	1 (0.08)	0 (0)	1,294 (100)
Mandibular canines, <i>n</i> (%)	1,210 (93.73)	8 (0.62)	49 (3.25)	0 (0)	7 (0.54)	0 (0)	0 (0)	0 (0)	17 (1.32)	1,291 (100)

orthodontic treatment at the Hospital of Stomatology, Shandong University, Jinan, China, between January 2012 and August 2013. Informed consent was obtained from the patients, and this study was approved by the Medical Ethics Committee of Shandong University. The samples were selected based on the following criteria:

1. Available CBCT images of mandibular anterior teeth with complete root formation
2. Absence of root canal treatment
3. Absence of coronal or post coronal restorations
4. Absence of root resorption or periapical lesions
5. High-quality CBCT images

Image Acquisition

The CBCT images were acquired using a CBCT scanner (Galileos; Sirona Germany, Bensheim, Germany) at 85 kV and 35.0 mA with an

exposure time of 2–6 seconds. The voxel size of the images was 0.125 mm, and the slice thickness was 1.0 mm. The acquisition process was performed by an experienced radiologist according to the manufacturer’s recommended protocol with the minimum exposure necessary for adequate image quality.

Image Evaluation

The CBCT images were analyzed with the built-in software package SIDEXIS XG 2.53. The contrast and brightness of the images were adjusted to ensure optimal visualization. Two endodontists evaluated the images together twice with an interval of 2 weeks between evaluations. When disagreements occurred, a professional oral radiologist was consulted to perform a third evaluation and reach a final consensus. All of the images from the 3,871 mandibular anterior teeth were evaluated. The following information was recorded and analyzed:

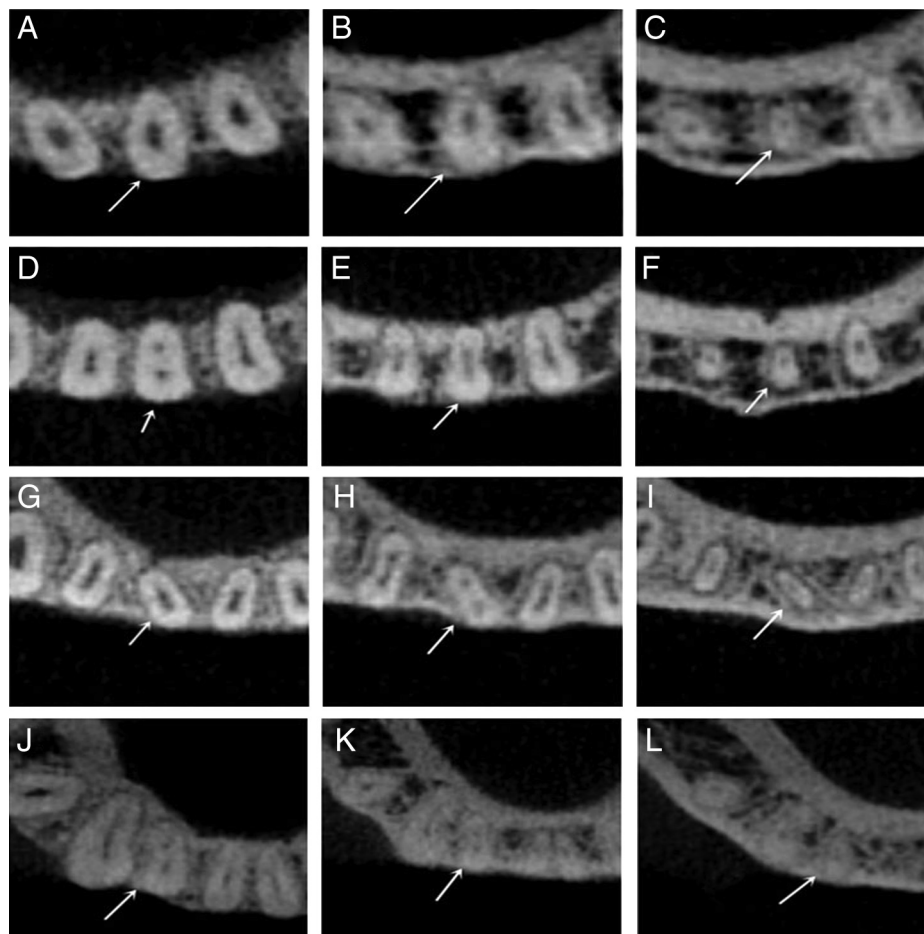


Figure 1. The axial planes of CBCT scanning in the coronal, middle, and apical thirds of the root displayed variations in canal morphology. (Arrows denote the canal morphology.) (A–C) Type I, (D–F) type II, (G–I) type III, and (J–L) type IV.

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