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ORIGINAL ARTICLE

Evaluating root canal configuration of mandibular incisors with cone-beam computed tomography in a Turkish population

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Abstract *Background/purpose:* The aim of this retrospective study was to analyze the morphology of root canal systems of mandibular incisors using cone-beam computed tomographic (CBCT) images.

Materials and methods: A total of 374 mandibular incisors' images obtained from CBCT of 101 patients were included in the study. The following information was recorded: (1) the age and sex of the patient, (2) the tooth type, (3) the number of roots, (4) the root canal configuration, and (5) the bilateral/unilateral diversity in root number and the configuration of the root canals. The configuration of the root canals was categorized using Vertucci's classification as the main reference. Statistical analysis was carried out using Chi-square and Spearman's rank correlation tests ($P = 0.05$).

Results: Overall, 52.4% ($n = 196$) of the teeth had one root canal (Type I), and 47.6% ($n = 178$) had two root canals with different root canal configurations. The rate of complex root canal configurations was higher in males than in females ($P < 0.001$).

Conclusion: Almost one of two mandibular incisors had complex root canal systems. The CBCT may be recommended as an effective diagnostic device for identifying complex root canal configurations. The prevalence of complex root canal configuration was higher in males than in females.

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Introduction

Successful management of endodontic cases stems from a detailed understanding of the morphology of the root canal system. Adequate chemomechanical preparation and effective filling of the root canal system are based on knowledge of normal root canal morphology and variations from the norm obtained from studies of root and canal morphology.¹ It is well established that the failure to treat all the canals effectively leads to poor endodontic outcomes.^{2–4} The morphology of the root canal systems of mandibular incisor teeth may be different depending on the population.^{5–9} Previous studies have shown that a high percentage of mandibular incisor teeth have more than one root canal. The incidence of mandibular incisor teeth with more than one canal has been reported to range from 11.5% to 50%.^{6,10} A case report also recorded more than one root in these teeth.⁷ The variations in mandibular incisor teeth may result in missing root canals, nonsurgical endodontic treatment failure, and a need for surgical procedures.

Clearing techniques, cross sections, and radiographic evaluations have been used in studies that evaluated the root canal morphology of mandibular incisor teeth.^{5,6,8} In recent times, cone-beam computed tomography (CBCT) has been used to evaluate the morphology of root canals.^{11–15} The CBCT provides a practical tool for noninvasive and three-dimensional reconstruction imaging by clinicians in endodontic applications and morphological analyzes.

Kartal and Yanikoğlu,⁶ and Sert and Bayirli¹⁶ used clearing technique and evaluated the mandibular incisors using a microscope. Bellizzi and Hartwell⁸ conducted a clinical *in vivo* study and evaluated the root canal systems on mandibular incisors using radiographs. In the study by Karagoz-Kucukay,¹⁷ the frequency of root canal ramifications in mandibular incisors was evaluated at 30× magnification after a low-temperature injection of thermoplasticized gutta-percha (Table 1). The CBCT can depict a more detailed feature of root canal configuration of mandibular incisors. However, this imaging method has not been used to detect the root canal configuration of mandibular incisors. Thus, the purposes of this study were to investigate the morphology of the root canal systems of mandibular incisor teeth in a Turkish population using CBCT and to correlate the findings with the patient's age and gender.

Materials and methods

We selected 217 previously obtained CBCT images from the archive of the Department of Oral and Maxillofacial Radiology of Izmir Kâtip Çelebi University, Izmir, Turkey. All the images were obtained with a NewTom 5G CBCT machine (QR Srl, Verona, Italy) from patients with different dentomaxillofacial problems between October 2012 and April 2013. The voxel size was 0.15 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 time necessary for adequate image quality.

Inclusion criteria were the presence of (1) high-quality CBCT images and (2) CBCT images of mandibular incisors with fully formed apices. Exclusion criteria were the presence of (1) coronal restoration, (2) root canal fillings and posts, and (3) internal/external resorption or periapical lesions in mandibular incisors. The CBCT images of 374 mandibular incisors from 101 patients who met the inclusion/exclusion criteria were analyzed with NNT software using a Dell Precision T5400 workstation (Dell, Round Rock, TX, USA). Eighty-eight patients had bilateral mandibular central incisors, and 89 patients had bilateral mandibular lateral incisors. These data were used to analyze the distribution and the occurrence of the unilateral and bilateral root canal configurations.

Two independent endodontists assessed the axial, sagittal, and coronal sections to reach a consensus on the interpretation of the radiographic findings. In cases where a consensus was not reached, a third professional oral radiologist was asked to perform a decisive evaluation. Forty of the images were selected and assessed by the same examiners 6 weeks after the first evaluation.

The following information was recorded: (1) the age and gender of the patient, (2) the tooth type (central or lateral), (3) the numbers of roots, (4) the root canal configuration, and (5) the bilateral/unilateral diversity in root number and root canal configuration. The root canal configuration was categorized using Vertucci's classification¹⁸ as the main reference (Fig. 1).

- *Type I*: In this type, single root canal leaves the pulp chamber and ends as single foramen.

Table 1 Prevalence of complex root canals in mandibular incisors based on a survey of available studies in the past 30 years.

Investigators	Year	Model	Total number of mandibular incisors ^a	Number of teeth with more than one single canal	Percentage of total (%)
Kartal and Yanikoğlu ⁶	1992	Clearing technique; microscope	100	45	45
Sert and Bayirli ^{16, a}	2004	Clearing technique; microscope	400	271	67.75
Bellizzi and Hartwell ⁸	1983	<i>In vivo</i> ; radiographs	417	76	18.2
Karagoz-Kucukay ^{17, b}	1994	Thermoplasticized gutta-percha; microscope	40	15	37.5

^a Other tooth groups except mandibular incisor were evaluated. The numbers are only for mandibular incisors.

^b Root canal ramifications were evaluated.

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