

Evaluation of Anatomy and Root Canal Morphology of the Maxillary First Molar Using the Cone-Beam Computed Tomography among Residents of the Moscow Region

Abstract

Background: The success of endodontic treatment depends on the knowledge of root canal system. The root canals have complex morphology and wide individual variations. The aim of this study was to evaluate the root canal morphology of the maxillary first molars among residents of the Moscow region using cone-beam computed tomography (CBCT) scanning. **Materials and Methods:** Three hundred CBCT images of patients aged 20–70 years old were analyzed to study the root canal system (the number of canals and the configuration according to Vertucci's classification) of the maxillary first molars. The prevalence of a second mesiobuccal (MB2) in the mesiobuccal root (MB) was recorded in each age group. **Results:** three separated roots of the maxillary first molar were observed in 100% of cases. MB2 canals were found in 59.8% of cases. A second distobuccal canal was observed in 0.5% of cases. The canal morphology in the MB root was 40.2% in Type I, 22.4% in Type II, and 37.3% in Type IV. **Conclusion:** The prevalence of MB2 canals was 59.8%, and the most common canal morphology was Vertucci's Type I. Using CBCT scanning is a useful technique to evaluate and analyze the root canal system.

Keywords: Cone-beam computed tomography, maxillary first molar, morphology, root canal system

Introduction

The main goal of endodontic treatment is to diagnose, prevent, or treat apical periodontitis, and successful endodontic treatment depends on the precise knowledge of root and root canal anatomy, which is an important challenge due to the complexity of the root canal system and the anatomical variation.^[1] Root canal morphology has been classified using different ways by several investigators in the literature.^[2,3] Weine *et al.*^[2] classified it into four types depending on the pattern of division of the main root canal of a tooth along its course from the floor of the pulp chamber to the root apex. Vertucci^[3] also classified the root canal morphology in a more descriptive manner into eight types. This classification has been widely used by many researchers to classify the canal system of different teeth. The study of the anatomy of root canals was carried out by many researchers using various techniques such as sectioning, radiography, dye penetration, and clearing, posttreatment

clinical examination to modern-day cone-beam computed tomography (CBCT) techniques.^[1-6] The CBCT scanning has been used to study tooth anatomy since 1990; it is a diagnostic modality that provides high-quality, high-resolution, and accurate three-dimensional visualization.^[7] According to various authors, who conducted studies in various populations, the anatomy of root canal system has population features.^[8-10] The maxillary first molar is the earliest permanent tooth that appear in the oral cavity and that makes it vulnerable to caries and endodontic treatment. It has three roots and four canals in the most common form;^[11] many researches had studied the morphology of the maxillary first molar root canal system all over the world using many different techniques.^[1,2,9-20] The study of the anatomy and root canal morphology of the maxillary first molar in Russia was carried out in some regions. Till now, we have scattered data on the anatomy of root canals, which makes it relevant to study this issue in different regions of the Russian Federation and in different age groups.^[21,22]

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The aim of this study was to evaluate the root canal system of the maxillary first molars among residents of the Moscow region using CBCT.

Materials and methods

Three hundred individuals (170 females and 130 males) were enrolled in this study, from those who attending the radiologic diagnostic center for three-dimensional radiological scanning in the period between May and November 2017. Written consent was signed by all individuals.

CBCT images were taken using a 3D eXam (KaVo, Biberach, Germany) with standard exposure settings (23 cm × 17 cm field of view, 0.3 mm voxel size, 110 kv, 1.6–20 s) and were viewed by three examiners in a semi-dark room using I-CAT viewer software (version 10, Hatfield, England). Patients were divided into three age groups: young (20–44 years), middle age (45–59 years), and elderly (60 years and older), 410 maxillary first molars were evaluated. Inclusion criteria were (1) patients aged 20–70 years old and (2) permanent maxillary first molars with no periapical lesions. Exclusion criteria were teeth with root resorption and open apices and maxillary molars with caries involving pulp up to the furcation. The teeth were analyzed in axial, coronal, and sagittal planes, and the number of roots and the number of canals in each root were recorded. The canal morphology of the root canal system was evaluated according to Vertucci’s classification.^[3] A single canal was classified as Type I and two canals that joined into one canal at the apex was classified as Type II. One canal that divided into two and then joined into one canal again was classified as Type III and two separate canals from the pulp chamber to the apex were classified as Type IV. A single canal that split into two was classified as Type V. Two coronal canals that joined at the middle of the root to form one and then divided into two canals again near the apex were classified as Type VI. A single canal that separated into two canals, rejoined after some distance, and then divided into two 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 evaluated the presence of second mesiobuccal (MB2) canal in each group. Three examiners separately evaluated the images. IBM SPSS Statistics v 22.0 licensed package (IBM, Chicago, IL, USA) was used for statistical processing of the study data. The method of descriptive statistics was used for statistical processing of the received data. The correlation between the prevalence of the MB2 canal and age group was determined using Chi-square test with $P < 0.05$.

Results

Four hundred and ten maxillary first molar were identified with three separated roots (distobuccal [DB],

mesiobuccal [MP], and palatal [P]) in 100% of cases. The P root was observed to contain one root canal in 100% of cases. The DB root contained one canal in 99.5% of cases and two canals in 0.5% of cases [Table 1]. In the MB root, it was recorded one canal in 40.2% of cases and two canals in 59.8% of cases [Figures 1 and 2].

The classification and canal configurations of the maxillary first molar according to Vertucci’s criteria are shown in Table 2. The morphology of the MB root canal has shown different types of Vertucci’s; Type I was recorded in 40.2% of cases, followed by 37.3% of cases in Type IV and 22.4% of cases in Type II. Other types of Vertucci’s classification were not observed at all in any root of maxillary first molar. The prevalence of MB2 was higher in young group than other groups [Table 3].

The canal configurations of the distobuccal root are also shown in Table 2, and it was observed that Type I of Vertucci’s classification was the highest with 99.5% followed by Type II with 0.5%.

Table 1: The root canal number in each root of maxillary first molars

Maxillary first molar	Roots	Canals (%)
410	3 separated (100%)	
	DB	1 (99.5)
		2 (0.5)
	MB	1 (40.2)
		2 (59.8)
	P	1 (100)
	2 (0)	

DB: Distobuccal; MB: Mesiobuccal; P: Palatal

Table 2: Configuration of root canal system in maxillary first molar

Maxillary first molar	Root	Type I,	Type II,	Type III,	Type IV,
		n (%)	n (%)	n (%)	n (%)
		1	2-1	1-2	2-2
410	DB	408 (99.5)	2 (0.5)	-	-
	MB	165 (40.2)	92 (22.4)	-	153 (37.3)
	P	410 (100)	-	-	-

DB: Distobuccal; MB: Mesiobuccal; P: Palatal

Table 3: Distribution of second mesiobuccal according to age group

Maxillary first molar	Young age (20-44) (%)	Middle age (45-60) (%)	Elderly age (>60) (%)	Total
Presence of MB2	119 (74.4)	81 (62.8)	44 (36.4)	244
Absence of MB2	41 (25.6)	48 (37.2)	77 (63.6)	166
Total	160 (100)	129 (100)	121 (100)	410
χ^2, P		42.15, <0.0001		

MB2: Second mesiobuccal

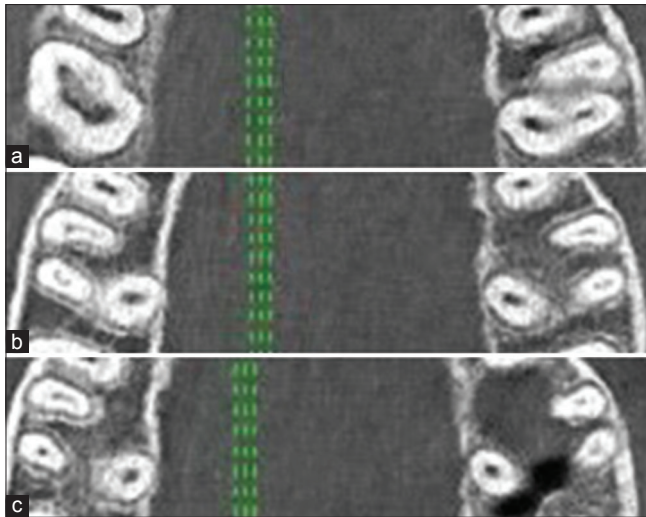


Figure 1: Case of bilateral maxillary first molars with five canal system, (a) coronal third showing second mesiobuccal, second distobuccal, and first palatal, (b) middle third showing second mesiobuccal, second distobuccal, and first palatal, (c) apical third showing second mesiobuccal, first distobuccal, and first palatal

Discussion

Successful endodontic therapy requires a significant knowledge of the anatomic features of root and root canal system. The lack of knowledge and missing a root canal are the most common reasons for failure in endodontic treatment.^[1] The current study provides information about the root canal morphology of maxillary first molars among residents of the Moscow region using CBCT technique. The study has reported 100% of three separated roots of the maxillary first molars, and this result is very close to other studies. Ratanajirasut *et al.* reported three separated roots of maxillary first molar in 99.8% of cases in Thai population.^[10] Alrahabi and Sohail Zafar^[13] and Ghoncheh *et al.*^[14] used the CBCT technique to study the morphology of maxillary molars and reported 94% and 92.1% of three roots, respectively. We also agreed with Al Shalabi *et al.*'s study,^[12] which reported 79.6% of three separated roots. It is obvious that the number of roots varies among populations, such as in a Brazilian population;^[15] the prevalence of maxillary first molar with three separated roots was 53% and it could be related to racial differences.

The morphology of root canal system remains the main concern. This study showed that P root had one root canal in 100% of cases, and the distobuccal root contained single canal in most of cases and two canals in 0.5%. Similar results were obtained by Ratanajirasut *et al.* (Thai population),^[10] Zheng *et al.* (Chinese),^[11] Neelkantan (India),^[16] and Kim (Korea),^[1] in which second distobuccal was found in 1%, 1.2%, 2.2%, and 1.25% of cases, respectively. According to Vertucci's classification, the DB root canal showed Type II in 0.5% and Type I in 99.5% of cases.

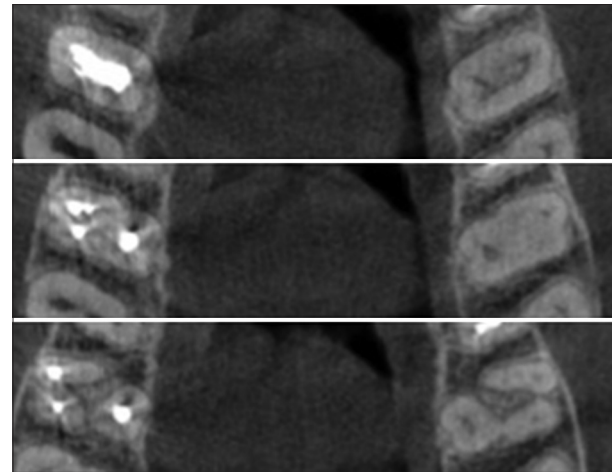


Figure 2: Case of bilateral first molars with three roots and four canal systems in axial section

For the MB root in our study, it was contained one canal in 40.2% of cases and two canals in 59.8% of cases. These findings are consistent with other studies on other populations about the prevalence of MB2: 63.59% (Korea),^[1] 48% (Pakistan),^[17] 63.3% (Thailand),^[10] 42.63% (Brazil),^[15] 59.5% (Poland),^[18] and 70.6% (Saudi Arabia).^[13] In other populations, the incidence of two canals in MB root was higher: 88.2% (Japan),^[19] 86.6% (Iran),^[9] and 71% (Caucasian population).^[20] According to Vertucci's classification, several studies indicated that Type IV was the most common canal configuration, and so it was in our study.

Regarding the correlation between the prevalence of MB2 in age groups, it was observed that the presence of MB2 was higher in young group with 48.8% than that in middle with 33.2% and elderly group with 18%. Many studies concluded that the prevalence of MB2 decreases by aging, due to dentine apposition which results in narrowing the MB2 canal. Similar results were obtained in a study by Zheng *et al.*,^[11] which observed a higher prevalence of MB2 among patients between 20 and 30 years of age. Our findings are in contrast with Ratanajirasut *et al.*^[10] and Olczak and Pawlicka,^[18] which did not find correlation between age and the prevalence of MB2. These differences could be related to the sample size and the anatomical variations among populations. However, MB2 could exist in any age group, and the clinician should be aware of finding and treating it.

Conclusion

Within the limitations of this study, it was concluded that most of the maxillary first molars among residents of the Moscow region had three separated roots and four root canal systems in all age groups. The highest frequency of the fourth canal was found in the MB root. Using CBCT technique is a noninvasive method for endodontic diagnose and enhance the detection of fourth or fifth canals.

Clinical significance

The knowledge of the anatomy and morphology of root canal system is essential for endodontic treatment and it helps the clinician to avoid the treatment failure.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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