Original Article

Prevalence of Mid-Mesial Canal and Isthmuses in Mandibular First and Second Molars in an Iranian Population

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ABSTRACT

Background and Aim: It is essential to know the internal root canal anatomy to reach a successful root canal debridement and a subsequent successful root canal obturation. Due to the importance of knowing the complexity of mid-mesial (MM) canals and isthmuses and how to deal with these anatomic variations, in this study, we examined the incidence and prevalence of the MM canal and isthmuses in mandibular first and second molars.

Materials and Methods: In this cross-sectional study, cone-beam computed tomography (CBCT) records of patients presenting for diagnostic purposes to a radiology center in the city of Sari were used. A total of 207 mandibular first molars (81 males and 126 females) and 235 mandibular second molars (94 males and 140 females) were examined. Data were entered into SPSS 16 software. Descriptive data were presented using frequency percentage with the significance level of less than 0.05.

Results: Among the mandibular first molars that were examined in the study population, the prevalence of the MM canal was reported to be 2.5% in males and 4% in females. Similarly, the prevalence of the MM canal in the mandibular second molars was reported to be 2.1% in males and 3.6% in females. Also, the prevalence of isthmuses was 81.2% (males) and 78.9% (females) in the first molars and 78.7% (males) and 70.7% (females) in the second molars.

Conclusion: Based on the results of this study, it is important for dentists to be familiar with the root canal anatomy and to consider the referral of complex cases to endodontists.

Keywords: Cone-Beam Computed Tomography, Anatomic Variation, Root Canal, Mandible, Molar

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Introduction:

In order to reach a successful root canal debridement and a subsequent successful root canal obturation, it is essential to know the internal root canal anatomy.(1) It is necessary to know unusual root canal anatomies and their differences. It has been proven that the presence of a conical root canal with a single apical foramen is an exception and not a rule.(2)

Root formation initiates with the apical proliferation of the epithelial cells of the Hertwig epithelial root sheath (HERS).[3] Epithelial cell distribution and proliferation are determined genetically, and the distribution pattern determines whether the root canal is wide or narrow, direct or curved, and long or short.[4]

Various forms of root canal anatomy can occur in the first and second mandibular molars. The third canal in the mesial root of mandibular molars is the mid-mesial (MM) canal.[5]

Since the time that Vertucci and Williams reported the presence of the MM canal in mandibular molars for the first time, several case reports have been presented on additional canals in the mesial root.[6] Although several authors agree on the presence of three orifices in the mesial root of mandibular molars, only a small number of them have reported the presence of three distinct independent root canals.[7]

There is a probability for the presence of an isthmus in every dental root that contains two root canals. Isthmuses may contain necrotic debris, tissue remnants or organic layers that can support the growth of microorganisms and can lead to root canal treatment failure, especially in maxillary and mandibular molars.[8]

Cone-beam computed tomography (CBCT) is a new technology that was first introduced in 1982 for angiography and later for maxillofacial imaging.[9] CBCT systems have recently been introduced for imaging the hard tissues of the maxillofacial region. CBCT is capable of providing accurate images below the limit of millimeters with lower scan times and a lower dose, and its three-dimensional (3D) information of root morphology, pulp chamber, and root canals is more accurate than that rendered by intraoral radiography. CBCT can be used to evaluate the number and the morphology of root canals and their path along the root in all three dimensions prior to endodontic treatments.[10]

Due to the importance of knowing the complexity of MM canals and isthmuses and how to deal with these anatomic variations, in this study, we examined the prevalence of MM canals and isthmuses in mandibular first and second molars.

Materials and Methods

In this cross-sectional descriptive study, we used the CBCT images of patients who referred to a maxillofacial radiology center in the city of Sari for diagnostic and therapeutic purposes. A total of 207 CBCT images (81 males and 126 females) of first mandibular molars and 235 CBCT images (94 males and 140 females) of second mandibular molars were evaluated in terms of the prevalence of the MM canal and isthmuses.

The inclusion criteria for CBCT images of mandibular second molars were as follows:

- No apical lesion,
- No previous root canal treatment,
- Fully developed root apices,
- No deep carious lesion,
- No root canal calcification or resorption,
- High-quality CBCT images of second molars.

High-resolution CBCT images were taken by an oral and maxillofacial radiologist using Cranex 3D (Soredex, Helsinki, Finland) with the following exposure settings: voxel size=130 µm, milliampere (mA)=6, kilovoltage peak (kVp)=89, and field of view (FOV)=6×8 cm. The CBCT images were processed using OnDemand3D™ Dental software (Cybermed, Seoul, South Korea).

Data were evaluated by a general dentist and an endodontist; in case of no consensus, an oral and maxillofacial radiologist evaluated the images. Data were entered into SPSS 16 software (SPSS Inc., Chicago, IL, USA). Descriptive data were presented using frequency percentage with the significance level of less than 0.05.

Result:

The prevalence of the MM canal in the mandibular first molars according to gender is shown in Table 1. The prevalence of the MM canal in the mandibular first molars was 2.5% in males and 4% in females.

The prevalence of the MM canal in the mandibular second molars according to gender is shown in Table 1. The prevalence of the MM canal in the mandibular second molars was 2.1% in males and 3.6% in females.

The prevalence of isthmuses in the mandibular first molars according to gender is shown

in Table 2 (81.2% in males and 78.2% in females). According to Table 2, the prevalence of isthmuses in the mandibular second molars was 78.7% in males and 70.7% in females.

Table 1: Prevalence of the mid-mesial (MM) canal in the first and second molars

	First mandibular molar		Second mandibular molar	
	Total number of teeth	Number of teeth with the MM canal	Total number of teeth	Number of teeth with the MM canal
Male	81 100%	2 2.5%	95 100%	2 2.1%
Female	126 100%	5 4%	140 100%	5 3.6%
Total	207 100%	7 4%	235 100%	7 3%

Table 2: Prevalence of isthmuses in the first and second molars

	First mandibular molar		Second mandibular molar	
	Total number of teeth	Teeth with isthmuses	Total number of teeth	Teeth with isthmuses
Male	81 100%	66 81.2%	95 100%	75 78.7%
Female	128 100%	101 78.9%	140 100%	99 70.7%
Total	209 100%	167 79.9%	235 100%	174 74%

Discussion:

Several researchers have examined the morphological features of mandibular molars. In previous articles, the presence of a third canal in the mesial roots of mandibular molars has been evaluated as the presence of an MM canal or an isthmus. However, there is still debate on the prevalence of MM canals and isthmuses in the mesial roots of mandibular molars.

Related studies have been performed using various techniques.[6-8,11,12] Transparency procedures and radiography were the most common methods; the limitations of these methods in the field of diagnosis have been mentioned in these articles.[12-17] Other methods include decalcification, histologic evaluation, stereomicroscopic analysis, scanning electron microscopy (SEM), micro CT, and CBCT [11-13,18,19] with different results.

The prevalence of the MM canal has been reported to be 0.82% to 37.5%. [20-23] The differences in the results can be due to the study design, sample size, and ethnicity.

In several studies, genetics has been considered as a predisposing factor, while other studies have found no such correlation.[21]

In this study, we evaluated the prevalence of the MM canal in the mesial roots of mandibular molars in an Iranian population.

The limitations of study tools in the evaluation of the anatomic features of teeth lead to various interpretations. The advancements of imaging methods have made it possible to produce non-destructive 3D images in vivo with the aid of CBCT.[22] For this reason, in this study, we evaluated the prevalence of the MM canal in the mesial roots of mandibular molars using CBCT.

In our study, the prevalence of the MM canal was 2.5% (males) and 4% (females) in the mandibular first molars and 2.1% (males) and 3.6% (females) in the mandibular second molars.

Versiani and colleagues examined the prevalence of the MM canal in Turkish and Brazilian populations.[12] They reported that the prevalence of the MM canal was higher among the Brazilian population (22.1%) compared to the Turkish population (14.8%), which is higher compared to our results (3.5%).

In a CBCT study by Nosrat et al, the MM canal was observed in 0.26% of the lower molars.[15] It was claimed that the inadequate cut-off thickness and the low spatial resolution of CBCT were the causes of the low reported prevalence.[15]

The MM canal orifice is located in the developmental groove between the mesiobuccal orifice and the mesiolingual orifice, and it is often covered by dentin shelves that should be

removed using an ultrasonic tip under light and magnification.[23-26]

In our study, the prevalence of isthmuses was 81.2% (males) and 78.9% (females) in the first molars and 78.7% (males) and 70.7% (females) in the second molars.

In their study on the prevalence of isthmuses in the mesial roots of mandibular first molars, Teixeira et al reported the incidence of isthmuses to be high.[26] Isthmuses were observed with a higher incidence at the apical third of the root; some of the isthmuses were complete and some were incomplete.[26]

Von Arx reported a prevalence of 83% for isthmuses, which was close to our results.[21]

In 2017, Tahmasbi et al studied the prevalence of isthmuses in the mesial roots of mandibular molars in a CBCT study; they reported a prevalence of 64.7% for isthmuses.[11] Since the methodology of the mentioned study was similar to ours, the difference in the results may be due to the different study populations.

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