

## Original Article

# Prevalence of middle mesial canal in mandibular first molars using cone-beam computed tomography technique

Mohsen Hasheminia<sup>1</sup>, Hamid Razavian<sup>2</sup>, Ladan Khorrami<sup>3</sup>, Hamid Mosleh<sup>4</sup>, Sanaz Mohamadi<sup>5</sup>

<sup>1</sup>Department of Endodontics, Dental Research Center, Dental Research Institute, Isfahan University of Medical Sciences, <sup>2</sup>Department of Endodontics, Dental Materials Research Center, Dental Research Institute, Isfahan University of Medical Sciences, <sup>3</sup>Department of Oral and Maxillofacial Radiology, Dental Research Center, Dental Research Institute, Isfahan University of Medical Sciences, <sup>4</sup>Department of Pediatric Dentistry, Dental Materials Research Center, Dental Research Institute, Isfahan University of Medical Sciences, <sup>5</sup>Dentist, Private Practice, Isfahan, Iran

## ABSTRACT

**Background:** The purpose of this study was to evaluate the prevalence of middle mesial canal in mandibular first molars using cone-beam computed tomography (CBCT).

**Materials and Methods:** In this descriptive study, a total of 768 radiographs of mandibular first molars, 384 for males and 384 for females, taken at a private radiology center in Isfahan, were assessed for the presence of middle mesial canal based on the gender of the patients. All samples had been prepared by one CBCT machine. The images were evaluated by endodontists and radiologists. Then, the morphology of first molar mesial root canals was assessed by Vertucci classification, and the obtained results were analyzed by SPSS software using a Chi-square test. The comparison was considered statistically significant at  $P < 0.05$ .

**Results:** Twenty-four samples (3.13%) had a middle mesial canal. The prevalence rates of the middle mesial canal in the females and males were found to be 9 and 15 (2.35% vs. 3.92%), respectively, indicating no statistically significant difference ( $P = 0.21$ ). Of 24 teeth with middle mesial canal, 17 samples (70.8%) were of Type XII and 7 samples (29.2%) were of Type VIII. There was no statistically significant difference between genders with regard to the prevalence of different types of middle mesial canals ( $P = 0.19$ ).

**Conclusion:** The prevalence of the middle mesial canal was rather low in this study, and it is necessary to detect additional canals in the patients under root canal treatment.

**Key Words:** Cone-beam computed tomography, root canal preparation, root canal therapy

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Address for correspondence:  
Dr. Hamid Razavian,  
Department of Endodontics,  
Dental Materials Research  
Center, Dental Research  
Institute, Isfahan  
University of Medical  
Sciences, Isfahan, Iran.  
E-mail: hamidrazavian@  
yahoo.com

## INTRODUCTION

The main purpose of the root canal treatment is cleaning the whole root canal system chemically and mechanically and preparing this space for intra canal filling materials.<sup>[1]</sup> The anatomy of the pulp space has many variations and complexities, and lack of knowledge about the anatomy of the root canal can

bring about errors in diagnosis and treatment plan and consequently results in treatment failure.<sup>[1,2]</sup> The presence of additional canals in the root is one of the factors leading to root canal treatment failure, whose lack of detection during treatment can cause treatment failure.<sup>[2]</sup> Middle mesial is one of the

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additional canals in molars that is often disregarded due to lack of knowledge about its presence and its low prevalence in many cases during root canal treatment.<sup>[3]</sup>

The mandibular first molar is the first permanent erupting tooth. Since children do not care for their oral hygiene, these teeth are the most susceptible teeth to carries and often require root canal treatment.<sup>[3]</sup> Mandibular molars usually have two roots, in distal and mesial areas, and three canals. Diversity in the number of roots and canal morphology in these teeth is quite common.<sup>[4]</sup> These teeth usually have complicated canal morphology.<sup>[4]</sup> Periapical radiography is used as a diagnostic tool for the detection of canal anatomy and root canal treatment,<sup>[5]</sup> which has limitations because of being two-dimensional (2D). Furthermore, this technique is not so useful in diagnosing additional canals like middle mesial canal.<sup>[6]</sup> Therefore, it seems necessary to employ other methods with higher diagnostic accuracy such as clearing,<sup>[7]</sup> cross-section preparation,<sup>[2]</sup> cone-beam computed tomography (CBCT),<sup>[6]</sup> and guided troughing under high magnification.

Since laboratory methods cannot be used in clinics, periapical radiography is the most common diagnostic method for root canal treatment<sup>[5]</sup> and is known as a significant tool for the evaluation of root canal morphology.<sup>[5]</sup> Nevertheless, these radiographs are not fully reliable because errors such as distortion and superimposition can occur in the images prepared.<sup>[6,8]</sup>

CBCT is a highly accurate diagnostic tool for observation of middle mesial canals<sup>[6]</sup> and makes it possible to restore and present three-dimensional (3D) orofacial structures in a scale perfectly adapted to the individual's anatomy.<sup>[6]</sup> Many studies have shown that various races have different canal morphologies.<sup>[7-12]</sup> Further, there are studies on the canal morphology of mandibular first molars assessed by CBCT.<sup>[6]</sup> Since detection of subcanals and additional canals can affect the quality of treatment,<sup>[2,13]</sup> and no study has been done on the prevalence of middle mesial canals in Isfahan, Iran, the present study was carried out to evaluate the prevalence of middle mesial canal in mandibular first molars by CBCT technique.

## MATERIALS AND METHODS

This study was approved by Isfahan University of Medical Sciences research Committee (code:393835). This descriptive study was conducted in a private

radiology center in Isfahan, Iran, during 2015–2016. The study population consisted of CBCT images of mandibular first molars of the patients referring to the above radiology center. The inclusion criteria comprised of the images of mandibular first molars, lack of root canal treatment on the given tooth, absence of restorative treatments, images with a small field of view (FOV)(60 × 60), and voxel size (V1) as well as images with high quality and resolution. Moreover, images with poor quality and resolution and large FOV were excluded from the study. The sample size was calculated to be 384 samples in each gender by simple random sampling at 95% confidence level and 0.05 error rates. The comparison was considered statistically significant at  $P < 0.05$ .

The CBCT machine used in this study was a Sannora 3D with low dose, fast imaging, and high accuracy (UMDNS code: 99915; Cert. no: TMM-933 16–1901; Corporation: SOREDEX; Finland). The device for small FOV (60 × 60) involves two voxel sizes,  $V_1 = 0.133$  mm and  $V_2 = 0.2$  mm.

A total of 768 CBCT images were evaluated by On Demand 3D application. The restored images were displayed on the screen in sagittal, coronal, axial and panoramic views. Then, the axial views of the images were selected and analyzed. Next, 0.3 mm sections with 0.3 mm distance from each other were prepared. Finally, the sections were assessed by a radiologist and an endodontist for the presence of the middle mesial canal. In the case of disagreement, the opinion of a third radiologist was applied. The form of mesiobuccal and mesiolingual canals was initially determined by Vertucci classification, and the form of middle mesial canal was evaluated according to Vertucci classification and study of Gulabivala *et al.*<sup>[7,10]</sup> Data were analyzed by SPSS22 software (SPSS Inc., Chicago, IL, USA) using Chi-square statistical test.

## RESULTS

In this study, a total of 768 CBCT images, 384 male and 384 female samples, were investigated, from which 24 (3.13%) samples had middle mesial canal. The prevalence rates of the middle mesial canal in the males and females were 9 and 15 (2.34% vs. 3.91%), respectively, indicating no significant difference between the two genders (Chi-square,  $P = 0.21$ ).

The prevalence of Types II, III, IV, V and VI canals were 41.9%, 0.3%, 51.8%, 0.8% and 1.3% in men

**Table 1: Prevalence of mesiobuccal and mesiolingual canals in mandibular first molar**

| Type of canal | Men (%) | Women (%) | Total mean (%) |
|---------------|---------|-----------|----------------|
| II (2-1)      | 41.9    | 36.4      | 39.2           |
| III (1-2-1)   | 0.3     | 1         | 0.6            |
| IV (2-2)      | 51.8    | 56.3      | 54             |
| V (1-2)       | 0.8     | 2.3       | 1.6            |
| VI (2-1-2)    | 1.3     | 1.6       | 1.5            |
| VII (1-2-1-2) | 2.9     | 1.6       | 2.2            |
| VIII (3-3)    | 1       | 0.8       | 0.9            |
| Total         | 100     | 100       | 100            |

and 36.4%, 1%, 56.3%, 2.3% and 1.6% in women, respectively, showing no significant difference between genders, as revealed by Chi-square test (Chi-square,  $P = 0.19$ ). In general, Type IV followed by Type II had the highest prevalence among all different types of canals [Table 1].

In the teeth with additional middle mesial canal, the prevalence rates of Types VIII and VII canals were 1% and 2.9% in men and 0.8% and 1.6% in women, respectively, indicating no significant difference between the two genders ( $P = 0.19$ ). In the teeth with additional middle mesial canal, Type VII canal was more prevalent than Type VIII.

## DISCUSSION

Numerous studies have been conducted on the anatomy and form of the mandibular first molar root canal.<sup>[14,15]</sup> Several studies have also been performed to introduce and detect the middle mesial canal and morphology of mandibular first molar root canals by CBCT.<sup>[6]</sup> However, no study, to the best of the researchers' knowledge, has evaluated the prevalence of middle mesial canal by CBCT in Isfahan city, Iran.

There is a canal or passage for vessels and nerves in each tooth. In most cases, each root has also a nerve canal, but there is more than one canal in a single root in some teeth. The percentage of these additional canals is higher in some teeth. Why additional canals are created is unknown to the medical sciences. In fact, the pathway of a vessel or nerve mains as an additional passage.<sup>[1,2]</sup>

There are different methods to evaluate the anatomical variations of various root canals, including cross-section preparation,<sup>[2]</sup> clearing,<sup>[7]</sup> clinical evaluation<sup>[5]</sup> and imaging.<sup>[5,6]</sup> *In vivo* techniques such as sectioning and clearing make it possible to more accurately assess the root canal anatomy.<sup>[2,7]</sup>

However, the clearing technique is preferred over other methods.<sup>[7]</sup> Nevertheless, these techniques are not performed in clinics, so radiography is the only technique to be used in clinics.<sup>[5,6]</sup>

Periapical radiography has the maximum application in endodontic treatments<sup>[5]</sup> but it is difficult to detect the middle mesial canal through this technique due to its being 2D and superimposed canals.<sup>[6]</sup>

Most of the studies have used 3D imaging system.<sup>[6,8,12]</sup> CBCT is a 3D imaging system that can help us to detect additional canals through preparing different sections from the canal.<sup>[6]</sup> Moreover, most of the studies have reported the prevalence of two canals in the mesial root.<sup>[4,11,14]</sup> The first case of three independent mesial canals with separate orifice and foramen was reported by Vertucci and Williams.<sup>[10]</sup>

Azim *et al.*<sup>[9]</sup> conducted a cross-sectional study in 2015 and assessed the prevalence of the middle mesial canal in mandibular molars by guided troughing under high magnification. They reported the prevalence rate of 37.5% for this canal in the first molar, which is indicative of a higher prevalence rate than the results obtained in the current study.<sup>[9]</sup> Further, in their study Versiani *et al.*<sup>[13]</sup> reported the prevalence of middle mesial canal to be 18.6%, indicating a higher rate than the findings of the present study. This difference seems to be due to the racial differences among various populations as well as the method used to evaluate the additional canals.<sup>[13]</sup>

In addition, Baugh *et al.*<sup>[5]</sup> performed a retrospective review analysis of the middle mesial canal in 2004 and reported a prevalence rate of 1%–15% for this canal, which is in line with the results of the current study.

Furthermore, Gulabivala *et al.*<sup>[7]</sup> performed a study in 2001 and evaluated 139 first molars by root canal staining and clearing technique. They showed types II and IV canals to be the most prevalent,<sup>[7]</sup> which is in agreement with the results of the current study. In another study by Chourasia *et al.*<sup>[15]</sup> in 2012 carried out on an Indian population, 115 mandibular first molars were analyzed by a stereomicroscope at  $\times 7.5$  magnification and categorized according to Vertucci classification. The most prevalent canals were reported to be Type IV (54%) and Type I (3.65%).<sup>[15]</sup>

Therefore, the prevalence of the middle mesial canal is different among various populations, and it can

be concluded that the middle mesial canal with a prevalence of 3.13%, if not detected, can reduce the quality of root canal treatment. On the other hand, the results of our study showed no significant difference between genders in terms of the prevalence of the middle mesial canal, so accuracy in the detection of additional canals is necessary in both genders.

Unfortunately, due to the absence of CBCT machine in all dental centers as well as in accuracy of periapical radiography in the diagnosis of additional canals, it is not possible to fully detect middle mesial canal in the patients under root canal treatment of mandibular first molars. Thus, an attempt is suggested to be made to supply CBCT machines in dental centers. Further, cases with unsuccessful treatment are recommended to be referred to the specialized centers with more diagnostic facilities. In addition, future studies are advised to compare the ability of different brands of CBCT machines in detecting the middle mesial canal.

## CONCLUSION

Although the prevalence of middle mesial canal in this study was low, it is necessary to be more accurate in detecting additional canals in the patients under root canal treatment. Thus, additional analyses are required to assure the presence or absence of additional middle mesial canals in suspicious cases.

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### Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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