

Incidence of Missed Middle Mesial Canal in Endodontically treated Mandibular Molar Teeth: A Cone-Beam Computed Tomography Study

GA Tartuk, S Kaya¹

Department of Endodontics, Diyarbakir Oral and Dental Health Hospital, Diyarbakir
¹Department of Endodontics, Dicle University, Diyarbakir, Turkey

ABSTRACT

Background: In endodontic treatment, the aim is to completely determine, shape, and fill all root canals in a three-dimensional way. Missed canals lead to treatment failure. In mandibular molars, there may be an extra canal called the middle mesial canal between the mesiobuccal and mesiolingual canals. **Aim:** The aim of this study was to evaluate the prevalence of missed middle mesial canals in root canal-treated mandibular molar teeth. **Materials and Methods:** In this study, cone-beam computed tomography (CBCT) images of 1054 patients were analyzed. We identified 121 endodontically treated mandibular molars and evaluated the prevalence of missed canals. **Results:** Although 33.05% of the root canal-treated teeth did not have a middle mesial canal, this canal was detected in the other 66.94%; 97.53% of teeth with a middle mesial canal could not be detected by clinicians. **Conclusion:** Clinicians performing endodontic treatment of mandibular molar teeth should not ignore the presence of the middle mesial canal. Thus, it is very important for clinicians to have sufficient information about the localization, morphology, and variations of the middle mesial canal.

KEYWORDS: CBCT, endodontic treatment, middle mesial canal

Received: 27-Oct-2022;
Revision: 06-Feb-2023;
Accepted: 15-Feb-2023;
Published: 14-Jul-2023

INTRODUCTION

Success in endodontic treatment depends on the complete removal of bacteria and bacterial by-products from the root canal system. Microorganisms in root canals that cannot be cleaned adequately are highly likely to cause apical periodontitis in the periapical tissues.^[1]

In teeth with complex root anatomy including deltas, fins, accessory canals, loops, and multiple orifices, improper cleaning of any part of the canal system carries the risk of microorganisms surviving in the root canal system.^[2] It is very important to have sufficient information about the configurations of the root canals for successful endodontic treatment in these teeth. In multi-rooted teeth especially, one or more canals that are overlooked or undetected can lead to failure of the endodontic treatment if left untreated.^[3]

Mandibular molars are among the teeth that most frequently need endodontic treatment. It is important to protect these teeth in order not to lose their effective

chewing function. Mandibular molars are usually described as having two roots, one mesial and one distal. The mesial root usually has a mesiobuccal canal and a mesiolingual canal, whereas the distal root usually has a centrally located canal. Sometimes, a second canal can be found in the distal root. Between the mesiobuccal and mesiolingual canals, there is a narrow connection known as the isthmus, which contains pulp tissue. The extra canal in the isthmus is called the middle mesial canal.^[4]

The presence of the middle mesial canal was first reported in 1974 by Vertucci and Williams^[5] and Barker *et al.*^[6] Since then, numerous case reports of aberrant canal morphology of mandibular molars have been published^[6-9] Pomeranz *et al.*^[10] classified the middle mesial canal into three categories: confluent,

Address for correspondence: Dr. GA Tartuk, Diyarbakir Oral and Dental Health Hospital, Diyarbakir, Turkey. E-mail: gzmakin@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Tartuk GA, Kaya S. Incidence of missed middle mesial canal in endodontically treated mandibular molar teeth: A cone-beam computed tomography study. Niger J Clin Pract 2023;26:756-9.

| Access this article online | |
|---|---|
| Quick Response Code: | Website: www.njcponline.com |
|  | DOI: 10.4103/njcp.njcp_743_22 |

independent, and fin. In the confluent type, the middle mesial canal emerges as an independent orifice and merges with the mesiobuccal or mesiolingual canal before the apex. In the independent type, the middle mesial canal starts as an independent orifice and ends at the apex with a different foramen, without interacting with the mesiobuccal or mesiolingual canals along the course of the canal. In the fin type, there is an isthmus at any point between the middle mesial canal and the mesiobuccal or mesiolingual canal, and an instrument can freely pass through this region.^[10] Bansal *et al.*^[11] reported that the most common middle mesial canal type was confluent, followed by fin, and the least common type was independent.

The diameter of the middle mesial canal is usually smaller than the diameter of the mesiobuccal and mesiolingual canals. In addition, the middle mesial canal has a much smaller volume than the two main canals in the mesial root.^[12] Therefore, over-preparation of the middle mesial canal may cause perforations.^[13]

The prevalence of the middle mesial duct in the literature varies widely (from 0.2% to more than 50%). This wide range of variation is thought to be caused by multiple factors.^[11] One of the most important of these is the imaging method used in the evaluation of root canal anatomy [microscopic tooth sections, clinical studies, transparent tooth samples, conventional radiography, cone beam computed tomography (CBCT), micro-CT, etc.].^[14]

CBCT has gained popularity in recent years because it offers the opportunity to clearly visualize anatomical structures. Because it provides a three-dimensional evaluation of the teeth, it makes it possible to examine all the details of root canal morphology. Thus, the safety of the diagnosis and treatment stages of teeth with complicated root canal anatomy that require endodontic treatment is improved.^[15]

In this retrospective study, we aimed to evaluate the prevalence of missed middle mesial canals by examining CBCT images of root canal-treated mandibular molar teeth.

MATERIALS AND METHODS

In this study, the data of 1054 patients who underwent a CBCT scan for any reason between 2018 and 2021 were retrospectively analyzed after ethics committee approval. An iCAT CBCT device (Model 17–19, Imaging Sciences International, Hatfield, Pa) with a voxel thickness of 0.3 mm was used in the previously obtained CBCT images. The CBCT images were viewed with a 22-inch monitor with a resolution of 1680 X 1050

pixels. The inclusion criteria for mandibular molar teeth were as follows: having a root canal-treated first or second molar tooth, images taken in the last 5 years, and high image quality. Single roots or fused roots were excluded in this study. Axial, sagittal, and coronal images were exported in DICOM file format and on all planes evaluated with iCATVision (Imaging Sciences International, Hatfield, PA) software. CBCT images were evaluated according to pre-defined criteria by two expert endodontists with more than 5 years of experience. A pilot study was conducted using the Cohen kappa test to assess inter-observer consistency, and the inter-observer reliability was high ($\kappa = 0.96$). The mid mesial canal was recorded when it could be clearly seen in both the axial and coronal sections. The data of 121 teeth that met the inclusion criteria of mandibular first molars and second molars with root canal treatment were analyzed. The presence of the middle mesial canal and whether root canal filling was performed in endodontically treated teeth were evaluated. The obtained data were analyzed by observing the frequency and percentile values.

RESULTS

In total, 121 root canal-treated mandibular molar teeth were detected in the 1054 CBCT images analyzed. Although 33.05% of the root canal-treated teeth did not have a middle mesial canal, 66.94% of them did (57.02% in mandibular first molars, 9.91% in mandibular second molars). Overall, 97.53% of teeth with a middle mesial canal could not be detected by clinicians and root canal fillings were not performed [Figure 1].

DISCUSSION

Mandibular first molars are the first permanent teeth to erupt. Because they are the teeth with the highest risk of developing caries, they are the most exposed to root canal treatment.^[2] Therefore, having sufficient knowledge about the root canal anatomy of these teeth and possible variations significantly affects the success of endodontic treatment.

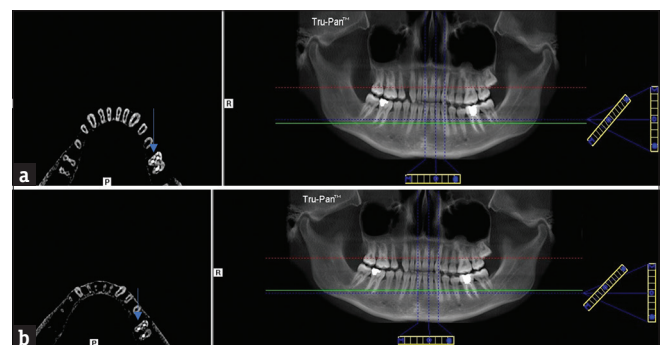


Figure 1: Cross-sectional images of the coronal (a) and apical (b) regions of a missed middle mesial canal

A middle mesial canal that is overlooked during root canal treatment can lead to periapical inflammation. In the same way, combined endodontic-periodontal lesions may occur and a permanent infection site may endanger the longevity of the related tooth.^[16] Therefore, knowing how often the middle mesial canal will be encountered guides the clinician applying endodontic treatment to the mandibular molar teeth.

The middle mesial canal in mandibular molars and variations in this canal are anatomical formations that complicate treatment for clinicians. Detecting this canal, identifying it, and treating it appropriately require additional effort. In the literature, there are many studies in which the prevalence of the middle mesial canal has been evaluated by different methods (such as intra-oral radiography,^[17] clinical studies,^[3] CBCT,^[18] and micro-CT^[12]).

CBCT provides clear three-dimensional images by eliminating the superposition of anatomical structures seen in periapical and panoramic radiographs.^[19] For this reason, it has become popular in recent years, especially among endodontists. Locating overlooked canals provides accurate results in many subjects, such as cases of retreatment, root resorption, apical periodontitis, and root fractures.^[20]

CBCT imaging has proven to be as effective as a dental operating microscope in locating the middle mesial canal. Investigations using an operating microscope show that the incidence of the middle mesial canal ranges from 1% to 37.5%.^[10,21,22] Therefore, CBCT is a good alternative for understanding root canal morphology when a dental operating microscope is not available.^[23]

In our study, the prevalence of missed middle mesial canal in mandibular molar teeth treated with root canal was evaluated using CBCT. A middle mesial canal was detected in 66.94% of the examined teeth. Only 2.46% of these canals were identified by the clinician performing the endodontic treatment, whereas 97.53% were missed and no root canal filling was performed. In a study by Weinberg *et al.*,^[23] in which they evaluated the prevalence of the middle mesial canal, they reported that 66.66% of the teeth studied had a middle mesial canal. The rate of identification of the middle mesial canal in this study was almost equal to our study results.

In the literature, great differences can be seen in the prevalence of the middle mesial canal. For example, Azim *et al.*^[24] detected the middle mesial canal in 46.2% of the 91 mandibular molar teeth they evaluated. However, Srivastava *et al.*^[25] evaluated the CBCT images of 130 Saudi patients and found a significantly

lower (18.2%) middle mesial canal prevalence compared to our results. Wang *et al.*^[18] evaluated the CBCT images of 558 Chinese patients and reported that the prevalence of the middle mesial canal in mandibular molars was 2.7%. The lower prevalence than the data we obtained in our study may be because of differences in both sample size and methodology. In addition, the differences in the ethnic groups in which the study took place may also lead to inconsistent results.

Tahmasbi *et al.*^[26] evaluated CBCT images of 90 patients and reported that the prevalence of the middle mesial canal was 26.4% in first molars and 8% in second molars. In the study of Aldosimani *et al.*,^[14] in which they evaluated the prevalence of the middle mesial canal in the Saudi population, they reported that they detected the middle mesial canal more often in mandibular first molars than in mandibular second molars. In our study, middle mesial canals were detected more frequently in first molars compared to second molars. These results are supported by the results of studies showing that middle mesial canals are more frequent in mandibular first molars than in second molars.

It is also very important to have sufficient information about the localization of the middle mesial canal entrance during endodontic treatment. The middle mesial canal entrance may be at the enamel–cementum junction or 1–2 mm deeper.^[27] If the canal entrance is located in the apical part of the enamel–cementum junction, this may also cause the clinician performing the endodontic treatment to miss the middle mesial canal. This may be because of the high prevalence of the middle mesial canal, which could not be detected by the clinicians in our study.

In conclusion, the presence of an untreated middle mesial canal is an important cause of failure of endodontic treatment. It is very important for clinicians performing endodontic treatment to have sufficient knowledge about the morphology of the middle mesial canal and to follow current studies. Clinicians should thoroughly examine the pulp chamber to identify the middle mesial canal, which is most likely to be present in mandibular molars during endodontic treatment. In particular, a 1–2 mm deep canal mouth should be sought between the two mesial canals. In addition, effective use of CBCT or a dental operating microscope for the detection of the middle mesial canal would be an appropriate approach for its detection.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Karabucak B, Bunes A, Chehoud C, Kohli MR, Setzer F. Prevalence of apical periodontitis in endodontically treated premolars and molars with untreated canal: A cone-beam computed tomography study. *J Endod* 2016;42:538-41.
- Bhatti UA, Muhammad M, Javed MQ, Sajid M. Frequency of middle mesial canal in mandibular first molars and its association with various anatomic variables. *Aust Endod J* 2022;48:494-500
- Ahmed H, Versiani M, De-Deus G, Dummer P. A new system for classifying root and root canal morphology. *Int Endod J* 2017;50:761-70.
- Kuzekanani M, Walsh LJ, Amiri M. Prevalence and distribution of the middle mesial canal in mandibular first molar teeth of the Kerman population: A CBCT study. *Int J Dentistry* 2020;2020. doi: 10.1155/2020/8851984.
- Vertucci FJ, Williams RG. Root canal anatomy of the mandibular first molar *J N J Dent Assoc.* 1974;45:27-8.
- Barker BC, Lockett BC, Parsons KC. The demonstration of root canal anatomy *Aust Dent J.* 1969;14:37-41.
- Mittal R, Singh R, Thareja P, Singh R. A rare case of three mesial and two distal independent canals in mandibular first molar. *Ann Prosthodont Restor Dent* 2016;2:42-5.
- Çiçek E, Özsezer E, Özsevik S. The root canal treatment in maxillary and mandibular molars with five root canals. Two case reports with two years follow up. *Int J Case Rep Images* 2012;3:11-5.
- Versiani MA, Pereira MR, Pecora JD, Sousa-Neto MD. Root Canal Anatomy of Maxillary and Mandibular Teeth. In: Versiani M, Basrani B, Sousa-Neto M, editors. *The Root Canal Anatomy in Permanent Dentition.* Cham, Switzerland: Springer Press; 2019 pp. 181–97.
- Pomeranz HH, Eidelman DL, Goldberg MG. Treatment considerations of the middle mesial canal of mandibular first and second molars. *J Endod* 1981;7:565-8.
- Bansal R, Hegde S, Astekar M. Morphology and prevalence of middle canals in the mandibular molars: A systematic review. *J Oral Maxillofac Pathol* 2018;22:216. doi: 10.4103/jomfp.JOMFP_194_17.
- Versiani MA, Ordinola-Zapata R, Keleş A, Alcin H, Bramante CM, Pécora JD, *et al.* Middle mesial canals in mandibular first molars: A micro-CT study in different populations. *Arch Oral Biol* 2016;61:130-7.
- Sherwani OAK, Kumar A, Tewari RK, Mishra SK, Andrabi SMUN, Alam S. Frequency of middle mesial canals in mandibular first molars in North Indian population-An *in vivo* study. *Saudi Endodontic Journal* 2016;6:66. doi: 10.4103/1658-5984.180618.
- Aldosimani MA, Althumairy RI, Alzahrani A, Aljarbou FA, Alkathheeri MS, AlGhizzi MA, *et al.* The mid-mesial canal prevalence in mandibular molars of a Saudi population: A cone-beam computed tomography study. *Saudi Dent J* 2021;33:581-6.
- Scarfe WC, Levin MD, Gane D, Farman AG. Use of cone beam computed tomography in endodontics. *Int J Dent* 2009;2009. doi: 10.1155/2009/634567.
- Isola G, Polizzi A, Iorio-Siciliano V, Alibrandi A, Ramaglia L, Leonardi R. Effectiveness of a nutraceutical agent in the non-surgical periodontal therapy: A randomized, controlled clinical trial. *Clin Oral Investig* 2021;25:1035-45.
- Van Pham K, Le AHL. Evaluation of roots and canal systems of mandibular first molars in a vietnamese subpopulation using cone-beam computed tomography. *J Int Soc Prev Community Dent* 2019;9:356.
- Wang Y, Zheng Q-H, Zhou X-D, Tang L, Wang Q, Zheng G-N, *et al.* Evaluation of the root and canal morphology of mandibular first permanent molars in a western Chinese population by cone-beam computed tomography. *J Endod* 2010;36:1786-9.
- Zheng Q-H, Wang Y, Zhou X-D, Wang Q, Zheng G-N, Huang D-M. A cone-beam computed tomography study of maxillary first permanent molar root and canal morphology in a Chinese population. *J Endod* 2010;36:1480-4.
- Kaya S, Tartuk GA, Eskibağlar M, Özata MY, Falakaloglu S. Determining the mental foramen location in a Turkish population: A cone beam computed tomography study. *Turk Endod J (TEJ)* 2021;6:87-91.
- Fezai H, Al-Salehi S. The relationship between endodontic case complexity and treatment outcomes. *J Dent* 2019;85:88-92.
- Nosrat A, Deschenes RJ, Tordik PA, Hicks ML, Fouad AF. Middle mesial canals in mandibular molars: Incidence and related factors. *J Endod* 2015;41:28-32.
- Weinberg EM, Pereda AE, Khurana S, Lotlikar PP, Falcon C, Hirschberg C. Incidence of middle mesial canals based on distance between Mesial Canal orifices in mandibular molars: A clinical and cone-beam computed tomographic analysis. *J Endod* 2020;46:40-3.
- Azim AA, Deutsch AS, Solomon CS. Prevalence of middle mesial canals in mandibular molars after guided troughing under high magnification: An *in vivo* investigation. *J Endod* 2015;41:164-8.
- Srivastava S, Alrogaibah NA, Aljarbou G. Cone-beam computed tomographic analysis of middle mesial canals and isthmus in mesial roots of mandibular first molars-prevalence and related factors. *J Conserv Dent* 2018;21:526.
- Tahmasbi M, Jalali P, Nair MK, Barghan S, Nair UP. Prevalence of middle mesial canals and isthmi in the mesial root of mandibular molars: An *in vivo* cone-beam computed tomographic study. *J Endod* 2017;43:1080-3.
- Keleş A, Keskin C. Detectability of middle mesial root canal orifices by troughing technique in mandibular molars: A micro-computed tomographic study. *J Endod* 2017;43:1329-31.