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The Prevalence of Middle Mesial Canals and Isthmi in Mandibular First and Second Molars in a Tabriz Subpopulation Using Cone-Beam Computed Tomography

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Objectives Having knowledge of root canal morphology is a crucial requirement for effective treatment. Taking into account the impact of factors such as age, gender, and race on the diversity of root canals in teeth, this study aimed to investigate the prevalence of middle mesial (mid-mesial) canals and isthmus in mandibular first and second molars in a specific subpopulation of Tabriz patients. Cone-beam computed tomography (CBCT) was used for this investigation.
Methods CBCT radiographs of 215 patients were examined to determine the presence of the mid-mesial canal and isthmus in mandibular first and second molars without endodontic treatment based on gender. All samples were obtained from the Faculty of Dentistry, Tabriz University of Medical Sciences, in 2019. The obtained results were analyzed using SPSS version 16, employing a chi-square test ($P < 0.05$).
Results On the left mandibular side, twenty-eight samples (13%) exhibited a mid-mesial canal in both the first and second molars. On the right side, these values were 29 (13.5%) and 47 (21.9%) for the first and second molars, respectively. Regarding the frequencies of isthmus in mandibular first and second molars, the values were 2 (0.9%) and 18 (8.4%) on the right side and 5 (2.3%) and 21 (9.8%) on the left side, respectively (P-values = 0.147, P = 0.938, P = 0.193, and P = 0.713 in left first, left second, right first, and right second mandibular molars, respectively, which were insignificant).
Conclusion This study revealed a low prevalence of mandibular first and second molars with mid-mesial canal and isthmus. The left and right sides and gender did not influence this prevalence.
Keywords Root canal; Dental pulp; Molar; Cone-Beam computed tomography; Mandible

Introduction

The success of root canal treatment depends on the thorough cleaning and shaping of all root canals, which necessitates a comprehensive understanding of dental pulp anatomy. Failure to locate and clean all root canals within the pulp system is a significant cause of endodontic treatment failure. [1-3] An uncleaned canal can allow the passage of irritants between the pulp and periodontal tissues, leading to apical periodontitis. [4] Variations in canal shape and number can pose challenges and contribute to endodontic treatment failures. Therefore, the identification of additional canals, including the mid-mesial canal, is crucial for successful endodontic treatment.

Mandibular molars are teeth with complex pulp anatomy. [5] Usually, the mesial root of mandibular molars consists of 2 canals (mesio-lingual and mesio-buccal) connected by an isthmus. [6, 7] Numerous studies have shown the presence of a third canal positioned between the mesio-lingual and mesio-buccal canals, referred to as the middle mesial or accessory mesial. [8-10] The reported prevalence of the mid-mesial canal in previous studies ranges from 0% to 46.2%. This discrepancy could be attributed to variations in examination methods or the age of the patients under study. [11-14]

In most studies investigating the anatomy of lower molars in the Iranian population, the presence of the mid-mesial canal was not reported. [15-17] In studies conducted on the Iranian people with section-dye methods and clearing method with a stereomicroscope, the frequency of isthmus in the mesial root has been reported as 83% and 44.6%, respectively. [18, 19, 20, 21] Furthermore, it has been noted that the mesial canal of the first and second molar of the mandible is consistently connected to the mesiolingual and mesiobuccal canals in all cases. [22]

Among the commonly used methods for identifying root canals, digital radiography and clinical examination are worth mentioning. [23] The validity of clinical examination depends on the skill and knowledge of the examiner. [23, 24] Radiography plays a crucial role in diagnosis, treatment, and post-treatment evaluation. However, this method has its limitations and requires alternative approaches. Radiographs provide a 2-dimensional (2D) image of a 3-dimensional (3D) object, which may result in the omission of certain details. [25] Limitations of conventional parallel periapical radiography include film quality issues and superimposition of structures. [26] These limitations can lead to the failure to identify canals, particularly in teeth with unusual pulp anatomy. [23] The use of magnifying lenses or microscopes enhances the ability to detect sub-canals. [27]

Another imaging method is computed tomography (CT), which has disadvantages such as high radiation dose, low resolution, time consumption, and high cost. [28] Cone-beam computed tomography (CBCT) is a non-invasive alternative that overcomes the limitations of previous methods, generating a 3D image without sample destruction. [28, 29] Compared to CT, CBCT has a lower radiation dose, higher spatial resolution, and reduced cost

for the patient. [30] CBCT employs a single conical X-ray beam irradiated onto the object, limiting the field of view to the desired area and minimizing the received radiation dose compared to other forms of CT. CBCT has higher spatial resolution, enabling the visualization of fine details such as canals, and is very useful in situations such as internal anatomy and sub-canal analysis. The CBCT radiation dose is considered to be equivalent to that of a digital panoramic film, which is approximately one-third of the dose of a complete intraoral series with F film. [20] Today, CBCT is used in dentistry for diagnosis, treatment planning, and pre- and post-surgical evaluations, offering a more realistic visualization of the root canal system through the creation of a 3D image. [31]

Since no study has been conducted on the prevalence of the mid-mesial canal and isthmus in the Iranian population using the CBCT method, the objective of this study was to determine the frequency of the mid-mesial canal and isthmus in mandibular first and second molars using CBCT in patients referred to the Department of Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences.

Methods and Materials

This descriptive-analytical cross-sectional study aimed to investigate the prevalence of the isthmus and mid-mesial canal in mandibular first and second molars in 2019 at the Faculty of Dentistry, Tabriz University of Medical Sciences.

Convenience sampling was used to recruit the samples, which included all eligible patients. Inclusion criteria consisted of CBCT images of mandibular first and second molars without endodontic treatment. Exclusion criteria included CBCT images with poor resolution, and first and second molars with metal restorations, root resorption, or developmental anomalies such as C-shaped canals.

Following approval from the Ethics Committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1398.1160) and considering the inclusion and exclusion criteria, 215 CBCT images were included in the study. These images were captured using the CBCT scanner Newtom VGi version 8.0.0 (Verona/Italy) in the Department of Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran. A conical X-ray beam device with a flat plane detector of 1920 × 1536 pixels, a pixel size of 127 × 127 mm^2, a pixel depth of 14 bits, a 360-degree rotation, a scan time of 4.6 seconds, and a maximum voltage of 110 kilovolts. The NNT Viewer software, version 2.17, was used for initial and final reconstruction, with automatic settings for the irradiation conditions. First, the distances between axial sections were chosen as minimum as possible in the software, which was 0.3. mm, and axial sections were checked by the scrolling method.

The stereotyped images were evaluated by a dental radiologist in a semi-dark room on a Philips (190B) LCD 19 monitor with a resolution of 1208 × 1024 pixels and 32 bits. The observer checked the items on the checklist (g if 3 canals were evident in mesial roots, it was considered mid-mesial canals and if two canals were not separated, it was considered isthmus) , and measurements from a radiology expert were used for analysis. Additionally, information regarding gender, molar tooth number, and molar tooth position in the lower jaw were analyzed.

The data were analyzed using SPSS version 16. The chi-square test was used to compare the frequency of the mid-mesial canal and isthmus between men and women in the left and right mandibular first and second molars. The results were presented as frequencies and percentages, and P values less than 0.05 were considered statistically significant.

Results

This study analyzed a total of 215 CBCT images. Of the participants, 100 (46.5%) were males, and 115 (53.5%) were females. In the mandibular CBCTs, the left first molars exhibited 28 (13%) mid-mesial canals and 5 (2.3%) isthmuses, while the right first molars had 29 (13.5%) mid-mesial canals and 2 (0.9%) isthmuses. Regarding the mandibular second molars, the left side showed 28 (13%) mid-mesial canals and 21 (9.8%) isthmuses, while the right side had 47 (69.8%) mid-mesial canals and 18 (8.4%) isthmuses.

The chi-square test indicated that there was no statistically significant difference between the gender of the participants and the frequency of the mid-mesial canal and isthmus in the left and right mandibular first and second molars (P = 0.147, P = 0.938, P = 0.193, and P = 0.713 in left first, left second, right first, and right second mandibular molars, respectively). The results are presented in Table 1.

Table 1. Frequency and percentage of first and second mandibular molars according to left and right sides and gender

	Male N (%)	Female N (%)	Total N (%)	p-value*
Left first Mandibular molars				0.147
Mid-mesial canal	17(60.7)	11(39.3)	28(13.02)	
Isthmus	1(20)	4(80)	5(2.32)	
None (tooth with no mid-mesial canal and no isthmus)	82(45.1)	100(54.9)	182(84.65)	

Continue the table 1				
Left second Mandibular molars				0.938
Mid-mesial canal	13(46.4)	15(53.6)	28(13.02)	
Isthmus	9(42.9)	12(57.1)	21(9.77)	
None	78(47)	88(53)	166(77.2)	
Right first Mandibular molars				0.193
Mid-mesial canal	18(62.1)	11(37.9)	29(13.5)	
Isthmus	1(50)	1(50)	2(0.93)	
None	81(44)	103(56)	184(85.6)	
Right second Mandibular molars				0.713
Mid-mesial canal	22(46.8)	25(53.2)	47(21.86)	
Isthmus	10(55.6)	8(44.4)	18(8.37)	
None	68(45.3)	82(54.7)	150(69.77)	

*According to the chi-square test

Discussion

Considering the significance of thoroughly cleaning the entire root canal system for successful root canal treatment and the variability in the number and shape of canals in mesial roots [32, 33], this cross-sectional study aimed to determine the prevalence of isthmus (Figure 1) and mid-mesial canals (Figure 2) in mandibular first and second molars and explore the influence of gender on this prevalence. The study was conducted at the Department of Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences, and included patients referred to this department.

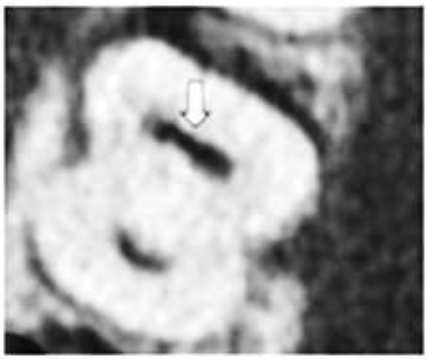

Figure 1: cropped axial CBCT image of the mandibular molar depicting the isthmus (arrow)

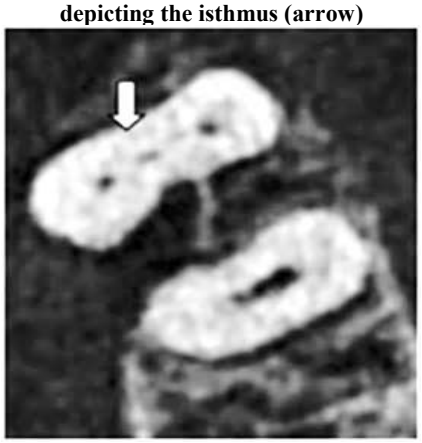

Figure 2: Cropped axial CBCT image of the mandibular molar depicting the mid-mesial canal (arrow)

Different studies have reported various hypotheses and findings regarding root canal anatomy, which may be partly due to differences in the internal anatomy of root canals and partly due to the difficulties of studying a root canal system and other issues, such as the type of techniques and classification systems used by different researchers. [18-23]

The findings of this study showed a low prevalence of mid-mesial canals and isthmuses in mandibular first and second molars among the population under investigation. Additionally, no significant differences were observed between genders or between the left and right sides. Our results highlight the importance of accurately identifying additional canals in both genders and sides. Similar to our findings, Baugh et al (2004) reported a prevalence rate of 1-15% for mid-mesial canals in mandibular molars. [34] Versiani et al (2016) reported a prevalence of 18.6% for mid-mesial canals. [8] Xu et al found a prevalence of 3.1% for mid-mesial canals and 55.5% for isthmuses in a Chinese population, which differs from our results. However, in the same study, there was no significant association between genders or between mandibular sides with the isthmus, consistent with our results. [35]

Previously, de Toubes et al (2012) [36] and Karapinar-Kazandag et al (2010) [10] reported a meager success rate in locating and accessing the mid-mesial canal, ranging from 1% to 25%. A study conducted on the American population revealed that the frequency of the mid-mesial canal and isthmus was 16.4% and 64.7%, respectively. Furthermore, the study indicated that the frequency of the isthmus was higher in second molars compared to first molars. [13] In addition, Azim et al (2015) demonstrated that 46.2% of mandibular molars had the middle mesial canal [12], indicating a higher prevalence rate than our findings. This difference could be due to various methods used to assess the additional canals, racial differences, and different definitions for mid-mesial canals in various studies. For example, in a study consistent with ours, the mid-mesial canal was defined based on the existence of a distinct round

cross-sectional area in a radiographic image located in or between the mesio-lingual and mesio-buccal canals regardless of the presence or absence of isthmus. [27] In other studies, if 3 canals were evident in mesial roots, it was considered mid-mesial canals. The incidence rate of mid-mesial canals was determined to be 20% by Nosrat et al, who did not report any significant differences in the distribution of mid-mesial canals based on gender, ethnicity, and molar type. [37] In a study at the University of Maryland, the frequency of mid-mesial canal in molars was 20%, which was inversely related to the increasing age of the patient. [14] In the present study, a higher detection rate of mid-mesial canals was observed in second molars compared to first molars. Similarly, Azim et al showed a greater tendency to locate the middle mesial canal in second molars (60%) vs first molars (37.5%). [12] On the contrary, in the study by Aminsobhani et al in Tehran (Iran), the frequency of the third mesial canal in first molar teeth was more than in second molar teeth. [20] Madani et al found 3 roots in 1.9% of first molars and 0.6% of second molars. [17] Also, in a study conducted by Gulabivala et al on the root and canal morphology of mandibular molar teeth in the Burmese population, it was shown that 90% of mandibular first molar teeth and 58% of mandibular second molar teeth had 2 roots and were separate, and 10% of mandibular first molar teeth had 3 roots. [6]

This study is the first assessment of the prevalence of both the mesial canal and isthmus in the first and second molars by the CBCT modality in the Iranian population. The main limitation of our study was the small sample size due to limited sample collection, which is suggested to be addressed in future multicenter studies. Finally, considering the clinical importance of root canal treatment, and locating canals, especially in molars, it is recommended that additional studies be conducted in this field.

Conclusion

This study revealed that the frequency of the mid-mesial canal and isthmus in the mandibular first and second molars is low and there is no statistically significant difference between mandibular right and left sites and between males and females in the prevalence of midmesial canal and isthmus.

Conflict of Interest

No Conflict of Interest Declared ■

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