International Journal of Dentistry and Oral Science (IJDOS)
ISSN: 2377-8075

Prevalence of Middle Mesial Canal in the Mesial Roots of Mandibular Molar using Cone Beam Computed Tomography - An *In Vivo* Radiographic Study

Research Article

Karthiga Senthil[1], Pradeep S[2*]

[1] Graduate Student, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.
[2] Associate Professor, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.

Abstract

Introduction: The pulp cavity is the most complex structure in nature. Mandibular molar demonstrates considerable variations with respect to additional canals or roots.
Aim: The main aim of this radiographic study is to detect the presence of Middle Mesial [MM] canal in mandibular first and second molars. In this study the primary outcome was to check the prevalence in mandibular first and second molars and the secondary outcome is to analyse the configuration/types of middle mesial canal.
Materials and Methods: A 50 CBCT were collected, 100 mandibular first molar and 100 mandibular second molars were analysed in all the three spatial planes. The inclusion criteria as follows: presence of bilateral mandibular molars with no resorption or any cracks or lesion.
Results: 89 teeth had MM canal out of 200 teeth observed. In mandibular first molar 59 teeth were present, in mandibular molar 30 teeth present with MM canal. Bilateral predilections were found to be 66 teeth. The Significance difference was observed stating the first molar had more occurrence than the second molar.
Conclusion: The clinician should have adequate knowledge to identify the presence of additional orifice present between Mesio-Bucaal [MB] and Mesio-lingual [ML] canal orifices.
Clinical Significance: The understanding of the complex anatomy of the tooth is the key to the success of endodontic treatment. The careful interpretation of the radiograph, use of magnification, latest instruments, proper irrigation protocol and sealing of all portals of exit leads to the successful treatment.

Keywords: CBCT; Mandibular Molar; Mandibular Teeth; Middle Mesial Canal; Radiographic Study; Root Canal Morphology.

Introduction

The main objective of root canal treatment is the thorough shaping and cleaning of the entire pulp space followed by complete obturation with inert filling material. It is a well-known fact that all the pulp space should be cleaned and obturated with inert material for outcome of the root canal treatment to be successful [1]. Complexity of the root canal morphology is one of the greatest challenges that the clinicians face and a thorough knowledge of the pulp space anatomy is thus necessary [2]. The identification of aberrant anatomy determines the success of root canal treatment.

Mandibular molars usually have two roots and three or four root canals. However, several variations such as an additional distolingual or mesiobuccal [MB] root, C-shaped root canal system, and isthmuses connecting the canals may also be present [3]. Moreover, sometimes a third canal may also be present in the isthmus between the MB and mesiolingual [ML] canal known as the middle mesial [MM] canal [4].

Although the internal anatomy of mandibular molars has been studied extensively, there is limited information about MM canals. Its prevalence in different studies is shown in the range of 10-37.5% in the first molars and 18-60% in the second molars. MM canal is a small orifice deep in the isthmus/developmental groove joining the MB and ML canal and this is difficult to see and more

***Corresponding Author**:
Pradeep S,
Assocaite Professor, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India.
Tel: 9710404482
E-mail: pradeeps@saveetha.com

Received: November 05, 2020
Accepted: November 18, 2020
Published: November 25, 2020

Citation: Karthiga Senthil, Pradeep S. Prevalence of Middle Mesial Canal in the Mesial Roots of Mandibular Molar using Cone Beam Computed Tomography - An In Vivo Radiographic Study. *Int J Dentistry Oral Sci.* 2020;S10:02:0011:59-62. **doi:** http://dx.doi.org/10.19070/2377-8075-SI02-010011

likely to be missed [5].

Pomeranz et al. have classified the MM canal into three types: Fin, confluent, and independent. Fin type does not have a separate orifice and it is usually a small linear extension of MB or ML canal of very small length allowing free movement of the file between the main canal and fin [6]. The confluent type has separate orifice but it merges either with the MB or the ML canal. Independent type has a separate orifice and separate exit at the foramen [7].

The primary aim of this study was to locate MM canals by various aids like cone beam computed tomography [CBCT] images analysis.

Materials and Methods

Image selection

CBCT images of 50 patients within the age group of 18-45 years were selected irrespective of gender. All the images were taken as part of the dental examination for diagnosis and treatment planning purposes. Inclusion criteria for CBCT images were fully erupted bilateral presence of first and second mandibular permanent molars with mature apex and high-resolution images. Exclusion criteria were open apices, root resorption, calcifications, root canal treatments, posts, crowns, developmental disorders, pathologies, and history of orthodontic treatment.

Imaging method

The CBCT unit used in this study was GALILEOS Comfort [Dentsply-Sirona Dental Systems, Galileos, Bensheim, Germany]. It had a tube voltage of 85 kVp; tube current of 5–7 mA; field of view 15×15×15 cm 3; isotropic voxel size 0.3–0.15 mm and exposure time of 14 s to 2–6 s. The level of the images was adjusted using the image processing tool in the software to ensure optimal visualization.

Imaging analysis

All 200 mandibular first and second molars were examined in the three i.e planes axial, sagittal, and cross-sectional at 1.0 mm intervals by continuously moving the toolbar from the floor of the pulp chamber to the apex. In the axial view when a narrow ribbon-shaped communication was visualized between the MB and ML canals an isthmus was recorded. The MM canal was recorded when there is a radiolucency with a distinct round cross section seen between the MB and ML canals regardless of the presence or absence of an isthmus. The findings were divided into two categories as follows: relation to Mesio-Buccal, relation to Mesio-Lingual for mandibular first and second molars.

Data analysis was performed with the help of the Statistical Package for Social Sciences Version 22 [SPSS Inc., Chicago, IL, USA]. Differences in the prevalence of the MM canal and isthmus based on sex and age were compared using the Chi-square test with a level of significance as $P < 0.05$.

Results and Discussion

50 CBCT were collected with a mean age of 27.9 years. A total of 100 of mandibular first molar and 100 of mandibular second molar images were analysed.

Out of the 200 mandibular molars, 44.5% [89 teeth] had MM canals. The prevalence of the MM canal of mandibular first molar was 59% and mandibular second molar was 30%. Among the 89 MM canals identified, 58 had a separate orifice from the MB and ML canals and 31 had merged with either MB or ML canals [Table 1]. The 51 MM canals with separate orifice were found to be located closer to the ML canal than as compared to MB canal [Table 2].

Most of the time, the number of canals present in any patient varies based on ethnicity, gender and the race. In this study, advanced techniques like CBCT were used for the detection of MM canal in the mandibular molars. MM canals have very small orifices and may lay deeper into the isthmus [8]; hence, troughing to widen and deepen the isthmus and then exploring the developmental groove improves the chances of canal detection. The advantage of using long shank bur rather than the ultrasonic tip is that it allows the formation of large debris, which can be easily removed by irrigation. Magnification with loupes or microscope improves the visibility and thus helps in the detection of small hidden canals [9].

In this study the prevalence of MM canal of mandibular first molar was 59% and mandibular second molar was 30%. The first study that reported the presence of a middle mesial [MM] was Vertucci and Williams, in a mandibular molar [10]. Since then, there had been multiple case reports of aberrant canal morphology in the mesial root [11]. Pomeranz et al found that 12 molars

Table 1. Prevalence of MM canal in Mandibular First and Second Molars, based on the distribution mandibular first molar had more occurrence of middle mesial canal than madnibular second molar.

Teeth	Prevalence	Percentage
Mandibular first Molar	59[100]	59%
Mandibular Second Molar	30 [100]	39%
Bilateral Existence in Mandibular first molar	48 teeth [100]	48%
	24 patients [50]	
Bilateral Existence in Mandibular second molar	18 teeth [100]	18%
	9 Patients [50]	

Table 2. Type Middle Mesial canal in all teeth.

Separate MM canal	MM – MB canal joining	MM- ML canal Joining
23[25.8%]	15[16.8%]	51[57.3%]

had MM canals in their mesial roots out of 100 mandibular molars [12]. Goel et al reported mandibular first molars had 15.0% of MM canals [13]. Among the MM canals, only 6.7% of MM canals was of independent type [14]. The presence of two MM canals has been reported in two in-vitro studies and four case reports [15].

The presence of a third canal namely the middle mesial canal in the mesial root of the mandibular molars has been reported to have an incidence of about 0.95–15% [16]. Although it is agreed and accepted by many researchers about the presence of three orifice in the mesial root, only a few cases has reported the presence of three independent canals, which presents as a rare anatomic variant [17]. This additional canal may occur independently with a separate foramen or the additional canal may present with a separate foramen or join apically with either the mesiobuccal or the mesiolingual canal [18]. The clinician should accurately assess the pulp chamber floor to locate possible canal orifices. Pulp chamber floor and wall anatomy provide an indispensable guide to determine the root canal morphology [19].

The observations done by Krasner and Rankow, which are presented in the form of laws are yet another valuable aid to the clinician searching for elusive canals [20]. Failure to identify extra canals and to recognize any unusual canal configuration is one of the most common reasons for the failure of endodontic therapy. An ultrasonic tip or round bur can be used for removal of any protuberance from the mesio-axial wall in-order to see the developmental groove. This developmental groove should be carefully assessed with the sharp tip of an endodontic explorer [Vertucci, 2005] [21].

Radiographic examination using conventional intraoral periapical views is an important tool for the evaluation of the canal configuration. However, it has its limitation in the assessment of the root canal system completely. Digital radiography at different angles with subsequent image analysis can be used effectively [22]. Digital radiography has many added advantages compared to conventional radiography like less radiation exposure, faster image acquisition without the requirement of chemicals, and a number of processing tools such as magnification, colour contrasting. Computed tomography [CT] is an imaging technique that uses a fan shaped beam and multiple exposures around an object to reveal internal structure of an object [23].

CBCT has been invaluable to provide comparable images at reduced dose and costs to be considered as an alternative to multi detector CT imaging in endodontics [24, 25]. Cotton et al., reported the various useful applications of CBCT imaging in endodontics [26]. La et al. in 2010 suggested clinical judgement and management of an independent middle mesial canal in the mandibular first molar by using 3D imaging [27]. CBCT imaging can be done to get correct diagnosis and management of the aberrant canal morphology prior to initiation of therapy.

Other diagnostic aids that are used by the clinicians as an effective means to locate additional canal orifices include dyes, champagne bubble test, ultrasonics, micro openers and trans-illumination aids, irrigators to improve pulp chamber visibility and observing the chamber for bleeding spots [28]. Recent advancement, including the dental operating microscope and dental loupes, offer maximum magnification and illumination of the operating field and significantly improves the visualisation of root canal orifices by the clinicians [29]. The present study confirms that the third canal in the mesial root of mandibular second molar does occur and must be found most commonly along the line between the two mesial canals. We had done many invitro studies, case reports and clinical trial. Now we are focussing on prevalence of canal variations amongst Indian population [30-44].

In our study, 89 MM canals identified, 58 had a separate orifice from the MB and ML canals and 31 had merged with either MB or ML canals. The 51 MM canals with separate orifice were found to be located closer to the ML canal which was joined at middle third of the ML canal. 23 MM had separate orifice and separate canal till apex, 15 MM joined with MB canal at middle third region respectively [Table 2].

The fin types are likely to be cleaned and prepared during the biomechanical preparation of the main canals, thus not affecting the outcome of the treatment. The confluent type has separate orifices and they merge with the main canal. They usually lead to communication thereby connecting the MB and ML canals, commonly found at the level of 3-6 mm coronal to the apical foramina in mesial roots [45]. This was noted by Srivastava et al. in 17–83% of the first molars facilitating irrigation of otherwise such inaccessible areas [46]. Age also plays an important role in detecting the presence of MM canals.In one of the in-vitro study of isthmus anatomy of mandibular molars higher prevalence [50%] of isthmuses was found in patients aged 20–39 years as compared to 24% in patients older than 60 years [47].

The incidence of MM canals was more in the first molars than the first molars. It is in accordance with findings of de Carvalho and Zuolo, [38] who found that prevalence is more in the first molars [17.2%] as compared to the second molars [4.5%].However, a recent study of Azim et al found the incidence to be 60% in second molars and 37.5% in the first molars [48].

Conclusion

The occurrence of MM canal was found to be more in the mandibular first molar than the mandibular second molar. The clinician should have adequate knowledge to identify the presence of additional orifice present between Mesio-Buccal [MB] and Mesiolingual [ML] canal orifices. Nowadays with the help of magnification aids, ultrasonic tips, advanced irrigation systems and three dimensional obturation led to higher success in endodontic therapy.

Clinical Significance

The understanding of the complex anatomy of the tooth is the key to the success of endodontic treatment. The varied location and configuration of middle mesial canal makes the canal preparation and obturation more challenging. The careful interpretation of the radiograph, use of magnification, latest instruments, proper irrigation protocol and sealing of all portals of exit leads to the successful treatment.

Acknowledgment

I thank all the faculty members of department of conservative dentistry and endodontics.

References

[1]. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol1984;58(5): 589-99. Pubmed PMID: 6595621.

[2]. Vertucci FJ, Williams RG.Root canal anatomy of the mandibular first molar. JNJ Dent Assoc. 1974; 45(3):27-8.Pubmed PMID: 4523925.

[3]. Weine FS.Case report: three canals in the mesial root of a mandibular first molar.J endod. 1982; 8(11):517-20.Pubmed PMID: 6960128.

[4]. Bond JL, Hartwell GR, Donnelly JC, Portell FR. Clinical management of middle mesial root canals in mandibular molars. J endod. 1988; 14(6):312-4.Pubmed PMID: 3251990.

[5]. Fabra-Campos H.Unusual root anatomy of mandibular first molars. JEndod. 1985;11(12):568-72.Pubmed PMID: 3867722.

[6]. Pomeranz HH, Eidelman DL, Goldberg MG.Treatment considerations of the middle mesial canal of mandibular first and second molars. J endod. 1981;7(12):565-8.Pubmed PMID: 6985549.

[7]. Min KS.Clinical management of a mandibular first molar with multiple mesial canals: a case report. J Contemp Dent Pract. 2004; 5(3):142-9.Pubmed PMID: 15318265.

[8]. Ricucci D. Three independent canals in the mesial root of a mandibular first molar. Dent Traumatol. 1997; 13(1):47-9.Pubmed PMID: 9206390.

[9]. Goel NK, Gill KS, Taneja JR. Study of root canals configuration in mandibular first permanent molar. J Indian SocPedodPrev Dent. 1991; 8(1):12-4.Pubmed PMID: 2056340.

[10]. Tachibana H, Matsumoto K.Applicability of X-ray computerized tomography in endodontics. Dent Traumatol. 1990; 6(1):16-20.Pubmed PMID: 2390962.

[11]. Hassan B, Metska ME, Ozok AR, van der Stelt P, Wesselink PR. Detection of vertical root fractures in endodontically treated teeth by a cone beam computed tomography scan. J endod. 2009;35(5):719-22.Pubmed PMID: 19410091.

[12]. Cotton TP, Geisler TM, Holden DT, Schwartz SA, Schindler WG.Endodontic applications of cone-beam volumetric tomography. J endod. 2007;33(9):1121-32.Pubmed PMID: 17931947.

[13]. Matherne RP, Angelopoulos C, Kulild JC, Tira D. Use of cone-beam computed tomography to identify root canal systems in vitro. J endod. 2008;34(1):87-9.Pubmed PMID: 18155501.

[14]. Holtzmann L.Root canal treatment of a mandibular first molar with three mesial root canals. Int. Endod. J.1997; 30(6):422-3.Pubmed PMID: 9588984.

[15]. Estrela C, Bueno MR, Leles CR, Azevedo B, Azevedo JR.Accuracy of cone beam computed tomography and panoramic and periapical radiography for detection of apical periodontitis. J endod. 2008;34(3):273-9.Pubmed PMID: 18291274.

[16]. Lofthag-Hansen S, Huumonen S, Gröndahl K, Gröndahl HG.Limited cone-beam CT and intraoral radiography for the diagnosis of periapical pathology. Oral Surg Oral Med Oral Pathol Oral RadiolEndod. 2007;103(1):114-9. Pubmed PMID: 17178504.

[17]. Reuben J, Velmurugan N, Kandaswamy D.The evaluation of root canal morphology of the mandibular first molar in an Indian population using spiral computed tomography scan: an in vitro study. J endod. 2008;34(2):212-5. Pubmed PMID: 18215685.

[18]. Baugh D, Wallace J.Middle mesial canal of the mandibular first molar: a case report and literature review. J endod. 2004;30(3):185-6.Pubmed PMID: 15055441.

[19]. Nosrat A, Deschenes RJ, Tordik PA, Hicks ML, Fouad AF.Middle mesial canals in mandibular molars: incidence and related factors. J endod. 2015;41(1):28-32.Pubmed PMID: 25266468.

[20]. Cleghorn BM, Goodacre CJ, Christie WH. Morphology of teeth and their root canal systems. Endodontics. 2008; 6:151-210.

[21]. Gulabivala K, Opasanon A, Ng YL, Alavi A.Root and canal morphology of Thai mandibular molars. Int. Endod. J.2002; 35(1):56-62.Pubmed PMID: 11853239.

[22]. Grossman IL, Oliet S, Del Rio E. Endodontic Practice(11thedtn). Philadelphia, PA: LeaandFabringer; 1988; 145-51.

[23]. Pomeranz HH, Eidelman DL, Goldberg MG. Treatment considerations of the middle mesial canal of mandibular first and second molars. J endod. 1981;7(12):565-8.Pubmed PMID: 6985549.

[24]. Durack C, Patel S. Cone beam computed tomography in endodontics. Braz. Dent. J. 2012; 23(3):179-91.Pubmed PMID: 22814684.

[25]. Rahimi S, Shahi S, Lotfi M, Zand V, Abdolrahimi M, Eshaghi R.Root canal configuration and the prevalence of C-shaped canals in mandibular second molars in an Iranian population. J Oral Sci.2008; 50(1):9-13.Pubmed PMID: 18403877.

[26]. Sert S, Bayirli GS.Evaluation of the root canal configurations of the mandibular and maxillary permanent teeth by gender in the Turkish population. J endod. 2004;30(6):391-8. Pubmed PMID: 15167464.

[27]. Ahmed HA, Abu-Bakr NH, Yahia NA, Ibrahim YE.Root and canal morphology of permanent mandibular molars in a Sudanese population. Int. Endod. J.2007; 40(10):766-71.Pubmed PMID: 17714468.

[28]. Aminsobhani M, Bolhari B, Shokouhinejad N, Ghorbanzadeh A, Ghabraei S, Rahmani MB.Mandibular first and second molars with three mesial canals: a case series. Iran Endod J. 2010; 5(1):36-39.Pubmed PMID: 24778681.

[29]. Beatty RG, Krell K. Mandibular molars with five canals: report of two cases. The J Am Dent Assoc.1987;114(6):802-4.Pubmed PMID: 3475358.

[30]. Rajendran R, Kunjusankaran RN, Sandhya R, Anilkumar A, Santhosh R, Patil SR. Comparative Evaluation of Remineralizing Potential of a Paste Containing Bioactive Glass and a Topical Cream Containing Casein Phosphopeptide-Amorphous Calcium Phosphate: An in Vitro Study. Pesquisa-BrasileiraemOdontopediatria e ClínicaIntegrada. 2019; 19.

[31]. Nandakumar M, Nasim I. Comparative evaluation of grape seed and cranberryextracts in preventing enamel erosion: An optical emission spectrometric analysis. JConserv Dent.2018; 21: 516–520.Pubmed PMID: 30294113.

[32]. Rajakeerthi R, Ms N. Natural Product as the Storage medium for an avulsed tooth–A Systematic Review. Cumhuriyet Dental Journal. 2019;22(2):249-56.

[33]. Manohar MP, Sharma S. A survey of the knowledge, attitude, and awareness about the principal choice of intracanal medicaments among the general dental practitioners and nonendodontic specialists. Indian J Dent Res. 2018; 29: 716-720.Pubmed PMID: 30588997.

[34]. Siddique R, Sureshbabu NM, Somasundaram J, Benoy Jacob, Deepak Selvam.Qualitative and quantitativeanalysis of precipitate formation following interaction of chlorhexidine with sodiumhypochlorite, neem, and tulsi. J Conserv Dent. 2019; 22: 40–47.Pubmed PMID: 30820081.

[35]. Teja KV, Ramesh S, Priya V. Regulation of matrix metalloproteinase-3 geneexpression in inflammation: A molecular study. J Conserv Dent. 2018; 21: 592–596.Pubmed PMID: 30546201.

[36]. Azeem RA, Sureshbabu NM. Clinical performance of direct versus indirectcomposite restorations in posterior teeth: A systematic review. J Conserv Dent. 2018;21:2-9.Pubmed PMID: 29628639.

[37]. Poorni S, Srinivasan MR, Nivedhitha MS. Probiotic Streptococcus strains in cariesprevention: A systematic review. J Conserv Dent. 2019;22:123-8. Pubmed PMID: 31142979.

[38]. Jenarthanan S, Subbarao C.Comparative evaluation of the efficacy of diclofenacsodium administered using different delivery routes in the management of endodonticpain: A randomized controlled clinical trial. J Conserv Dent. 2018;21:297-301.Pubmed PMID: 29899633.

[39]. NivedhithaMalliSureshbabu, KathiravanSelvarasu, Jayanth Kumar V, MahalakshmiNandakumar, Deepak Selvam.Concentrated Growth Factors as an IngeniousBiomaterial in Regeneration of Bony Defects after Periapical Surgery: A Report of TwoCases. Case Reports in Dentistry. 2019;2019:7046203. Pubmed PMID: 30805222.

[40]. Govindaraju L, Neelakantan P, Gutmann JL.Effect of root canal irrigating solutions onthe compressive strength of tricalcium silicate cements. Clin Oral Investig. 2017; 21(2):567-571.Pubmed PMID:27469101.

[41]. AkshayKhandelwal, AjithaPalanivelu.Correlation Between Dental Caries And Salivary Albumin In Adult Population In Chennai: An In Vivo Study. Braz. Dent. Sci.2019; 22(2): 228-233.

[42]. Ramarao S, Sathyanarayanan U.CRA Grid - A preliminary development andcalibration of a paper-based objectivization of caries risk assessment in undergraduatedental education. J Conserv Dent. 2019; 22:185-90.Pubmed PMID: 31142991.

[43]. Siddique R, Nivedhitha MS.Effectiveness of rotary and reciprocating systems onmicrobial reduction: A systematic review. J Conserv Dent.2019; 22:114-22.Pubmed PMID: 31142978.

[44]. Janani K, Sandhya R.A survey on skills for cone beam computed tomography interpretationamong endodontists for endodontic treatment procedure. Indian J Dent Res. 2019; 30:834–838.Pubmed PMID: 31939356.

[45]. Manning SA.Root canal anatomy of mandibular second molars. Part I. Int. Endod. J. 1990; 23(1):34-9.Pubmed PMID: 2391179.

[46]. Holtzmann L. Root canal treatment of a mandibular first molar with three mesial root canals. Int. Endod. J.1997; 30(6):422-3.Pubmed PMID: 9588984.

[47]. Cimilli H, Cimilli T, Mumcu G, Kartal N, Wesselink P.Spiral computed tomographic demonstration of C-shaped canals in mandibular second molars. DentomaxillofacRadiol. 2005; 34(3):164-7.Pubmed PMID: 15897287.

[48]. Shahi S, Yavari HR, Rahimi S, Torkamani R.Root canal morphology of human mandibular first permanent molars in an Iranian population. J. Dent. Res. Dent. Clin. Dent. Prospects.2008; 2(1):20-23.Pubmed PMID: 23285325.