Occurrence of Second Mesio-buccal Canal in Maxillary First Permanent Molar: A CBCT Study

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ABSTRACT

Introduction: Complexity in root canal morphology leads to chances of failure in endodontic treatment due to missed canal. Availability of Cone-beam Computed Tomography (CBCT) has contributed to assess second mesiobuccal canals in maxillary first molars.

Objective: To study the presence of second mesiobuccal (MB2) canals, classify morphology of canals according to Vertucci's classification and to measure the distance between MB1 and MB2 canals.

Materials & Method: 72 CBCT scans including 115 permanent maxillary first molars were evaluated by endodontist and oral radiologist separately using Dicom software to study the mesiobuccal root canal morphology. Oral radiologist and endodontist individually evaluated the scans through coronal, axial and oblique views to study canal configurations. Vertucci's Classification was used to classify the canal configurations. Statistical tests were done to assess the gender variation and arch side difference.

Result: Among 115 images evaluated; 30.4% samples had second mesiobuccal canal. The most common canal configuration was Type I (60.9 %) in mesiobuccal root. The mean distance between MB1 and MB2 canals was 2.39 mm in female and 2.56 mm in male.

Conclusion: The occurrence of second canal in mesiobuccal root of maxillary permanent molar is considerable in Nepali patients. CBCT can be an effective tool to detect MB2 canal and other complexities of root canal system to achieve clinical success.

Keywords: CBCT, endodontic, mesio-buccal canal, Vertucci's classification

INTRODUCTION

Maxillary first molar is one of the longest standing teeth in the dental arch which serves as a key of occlusion[1] and anchorage in most of the orthodontic treatments. However, they are susceptible to various insults such as dental caries, attrition etc. The tooth is very important in masticatory process and overall balance of the occlusion; hence it is strategically important to maintain the tooth in dental arch as far as possible, which often requires endodontic treatment.

Success of endodontic treatment is attributed to adequate cleaning, disinfecting, shaping, and three dimensionally sealing the root canal system.[2] The process is routinely challenged by the complexity of root canal morphology. Knowledge of root canal morphology is a key factor which aids in successful treatment outcome. Maxillary molars possess complex morphology which has highest rate of clinical failures due to missed second mesio-buccal canal with substantial variations in mesio-buccal root morphology.[3]

Numerous studies have been conducted to investigate root canal configurations of maxillary first molars adopting both in vitro and in vivo methods such as canal staining and clearing techniques, contrast medium–enhanced radiography, micro–computed tomographic imaging, intraoral periapical radiographs, dentin troughing under magnification, clinical operating microscope, ultrasonics and cone-beam computed tomographic (CBCT) imaging methods.[4] Among all, later five have been utilized in clinical practice and CBCT is considered as gold standard. CBCT is helpful for clinicians in identifying all canals and their configurations in clinical scenario.[5]

This study aims to assess the presence of second mesiobuccal canal in mesiobuccal root, classify the canals according to Vertucci and measure distance between first and second mesiobuccal canals utilizing CBCT images.
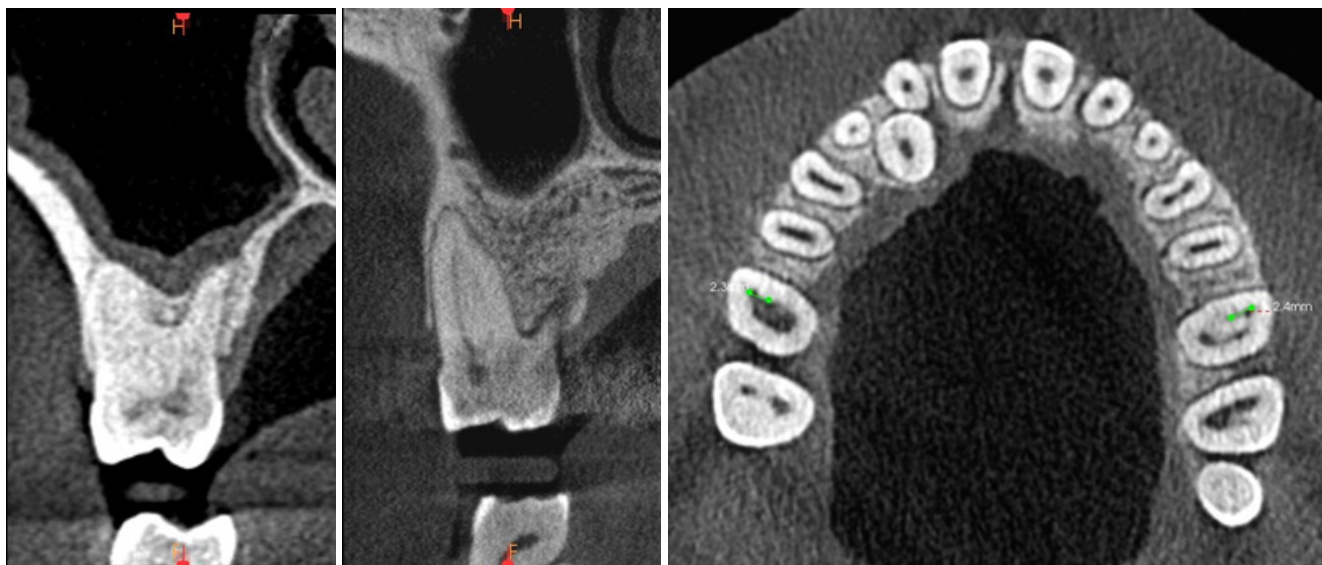
Figure 1: CBCT scans

MATERIALS AND METHOD

The retrospective study was conducted by evaluating the CBCT scan records of the Department of Oral Medicine & Radiology, Kantipur Dental College during June 2016 to March 2017. The CBCT were taken for diagnostic or treatment planning purposes. The CBCT scans were taken on patients by using principles of ALARA on Carestream machine CS9300 (USA). The Field of View (FOV) of the machine was 17x13.5 cm. The scans were taken in either 5x5 cm,10x5 cm or 10x10 cm endo, perio or implant mode. The patients were exposed to a Dose Area Product of 315 mGY.cm^2 to 956mGY.cm^2 dose depending on built of the patient.

A total of 72 scans with the presence of 115 permanent first molars on either one side or two sides of the maxillary arch were selected based on the inclusion criteria. The subjects selected were within the age range of 16-60 years. The scans were excluded if the tooth had incomplete root development, fused root, developmental anomaly, endodontically involved or obturated root canal, crown restoration, root resorption or gross loss of coronal tooth structure. Blurred or unclear images were also excluded.

The data were anonymized before evaluation. The images were evaluated by using Dicom CS 3D imaging software version 3.5.18. To standardize the data a voxel size of 180μ was chosen across all scans. An oral radiologist and endodontist individually evaluated the scans through coronal, axial and oblique views to check the morphology of canals (Figure 1), assess the presence of MB2 canal, classify canals based on Vertucci's Classification (Figure 2), and measure the distance between MB1 and MB2 canals if present at the level of pulpal floor.

The data was recorded in excel sheet and was statistically analyzed using SPSS 20 software. Statistical tests were done by using chi square test to check the association between M2 canal and gender and arch side. Independent t-test was used to compare the statistical difference between distance between the canals and gender. Level of significance was set at $p<0.05$.

Kappa test was done to check the inter-observer reliability between the oral radiologist and endodontist. Cronbach alpha test was done to check the inter-observer reliability in measuring the distance between MB1 and MB2 canals.

Vertucci's Classification of root canal morphology

Type	Description	Configuration
Type I	A single canal from pulp chamber to the canal terminus	1-1
Type II	Two separate canals leaving the chamber but merging short of the canal terminus to form a single canal	2-1
Type III	A single canal that divides into two and subsequently merges to exit as one	1-2-1
Type IV	Two distinct canals from pulp chamber to the canal terminus	2-2
Type V	A single canal leaving the chamber and dividing into two separate canals at the canal terminus	1-2
Type VI	Two separate canals leaving the pulp chamber, merging in the body of the root, and dividing again into two distinct canals short of the canal terminus	2-1-2
Type VII	A single canal that divides, merges and exits into two distinct canals short of the canal terminus	1-2-1-2
Type VIII	Three distinct canals from pulp chamber to the canal terminus	3-3

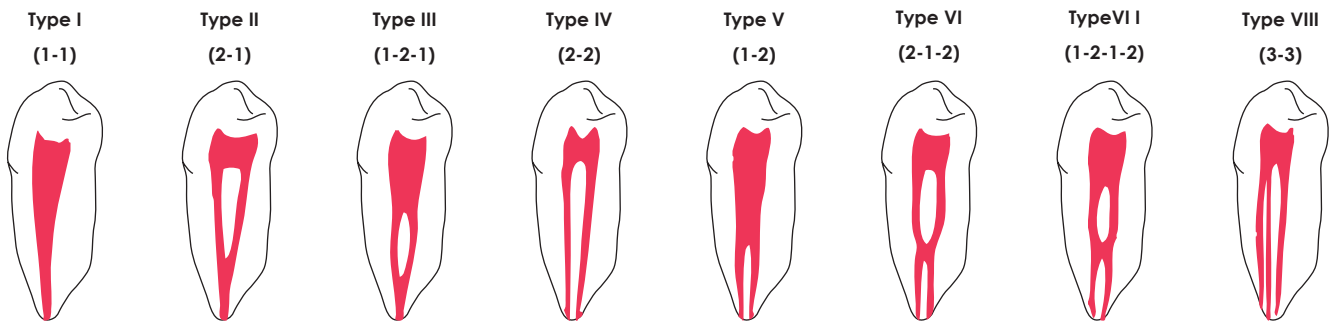| Type I (1-1) | Type II (2-1) | Type III (1-2-1) | Type IV (2-2) | Type V (1-2) | Type VI (2-1-2) | TypeVI I (1-2-1-2) | Type VIII (3-3) |

**Figure 2: Diagrammatic representation of Vertucci's classification**

RESULT

A total of 115 maxillary first molar samples on 72 CBCT scans were observed. Among all, 53.9% were right and 46.1% were left sided first molar. The samples comprised of 55.56% male and 44.44% female subjects. Mean age of the sample was 33.53 years (SD 14.60) with the age range 16-60 years.

The study revealed that 30.4% of maxillary first molars showed the presence of MB2 canal in mesiobuccal root. The most common canal configuration was Vertucci's Type I (60.9%), followed by Type II (19.1%), Type IV (7.8%) (Graph 1). There was no finding of Type V and Type VI in any sample.

The mean distance between mesiobuccal-1 (MB1) and mesiobuccal-2 (MB2) canals were 2.56 mm in male and 2.39 mm in female. There was no significant difference between distance between the canals and gender (p=0.506) (Table 1).

There was no statistically significant association between the presence or absence of MB2 canal and the gender (p= 0.138; Chi Square = 2.199) as well as sides (p= 0.724; Chi Square = 0.125) (Table 2,3).
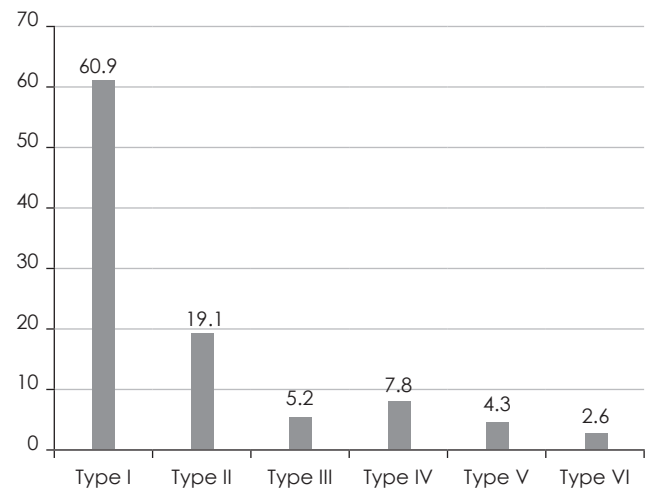
Graph 1: Frequency of types of canal configuration (%)

Table 1: t-Test of significance for comparison of distance between canals Vs gender

	Mean Distance (mm)	SD	t-Value	p-Value
Female	2.39	0.75	-0.673	0.506 (NS)
Male	2.56	0.65		

Table 2: Association between M2 canal and gender

MB2 Canal	Gender		Total	X²	p-Value
	Female	Male			
Present	11	24	35	2.199	0.138 (NS)
	22.9%	35.8%	30.4%		
Absent	37	43	80		
	77.1%	64.2%	69.6%		
Total	48	67	115		

Table 3: Association between M2 canal and side

MB2 Canal	Maxillary First Molar		Total	X²	p-Value
	Right	Left			
Present	18	17	35	0.125	0.724 (NS)
	29.6%	32.1%	30.4%		
Absent	44	36	80		
	67.9%	69.6%	71.0%		
Total	62	53	115		

NS: Not significant

Inter-observer agreement was high for the presence or absence of MB2 canal (Kappa = 0.918, p<0.001), canal configuration (Kappa = 0.876, p< 0.001) and distance between MB1 and MB2 (Chronbach's alpha = 0.976).

DISCUSSION

Morphological complexity in maxillary first molar often results in failure to identify and locate second mesiobuccal canal leading to endodontic treatment failure.[6-8]

Various studies have reported various occurrences of MB2 canal in maxillary permanent first molar. Hartwell *et al* reported 40-95%,[2] Weine *et al* reported 51% prevalence,[9] Buhrley *et al* reported 93%,[10] Pardo *et al* 23.81%.[11] The present study revealed 30.4% occurrence of MB2 canal which is consistent with the study of Hartmann *et al* with 29.2%.[12] The abridgement of literature on prevalence of MB2 in maxillary molar is enlisted in Table 4.[11]

The variation in results in different studies is attributed to difference in age, gender, ethnicity/race, procedures and conditions of conducting research.[13] Alacam *et al* compared direct observation, microscope, combination of microscope and ultrasonic method and dissecting techniques for evaluating MB2. The results were 62%, 67%, 74% and 82% respectively revealing difference in results.[14] Pardo *et al* compared the efficacy of three methods of canal identification;

viz CBCT, clinical analysis and operating microscope and revealed CBCT as the best in finding the canals.[11]

In the present study, canal configurations were identified according to Vertucci's classification system[15] revealing the most prevalent type as Type I in 60.9%. However, Faramarzi *et al* found Type II canal configuration as the most common in 71.3%.[16] According to Rwenyonyi *et al*; Type I was the most frequent accounting up to 75.1-100%.[17] Synopses of various literatures regarding canal configuration is listed in Table 5.[18]

MB2 canal orifice in pulpal floor of the mesiobuccal root is commonly situated within the developmental groove on an approximate line between MB1 and the palatal orifice, parallel to mesial marginal ridge.[7] The present study found maximum and minimum distance between MB1 and MB2 orifices as 3.80 mm and 1.40 mm respectively, with mean value being 2.39 mm and 2.56 mm in female and male respectively. These values are in accordance with Faramarzi *et al* with maximum and minimum distance as 4 mm and 1.5 mm respectively.[16] Zhang *et al* ascertained that MB2 canal lies less than 1 mm mesially to MB-P line and 2 mm palatally to MB orifice.[19] Furthermore, no statistically significant association was found among gender groups and bilateral sides in occurrence of MB2 canal. These findings are is consistent with the study of Das *et al*.[20]

Table 4: Occurrence of MB2 canal in maxillary first molar in various studies

Investigator	Year	N	Model	%
Weine *et al*	1969	208	in vitro	62
Pineda	1973	245	in vitro	54.3
Hartwell & Belizzi	1982	1976	in vitro	18.6
Weller & Hartwell	1989	1134	in vitro	39.1
Kulild & Peters	1990	83	in vitro	95.2
Fogel *et al*	1994	208	in vivo	71.2
Stropko	1999	1732	in vivo	73.2
Sempira & Hartwell	2000	200	in vivo	33.1
Buhrley *et al*	2002	660	in vivo	93
Baldassari-Cruz *et al*	2002	39	in vitro	90
Coutinho Filho *et al*	2006	108	in vitro	90.7
Smadi & Khraisat	2007	100	in vitro	77.32
Alaçam *et al*	2008	100	in vitro	82
Hartmann *et al*	2009	65	in vitro	29.2
Baratto Filho *et al*	2009	100	in vitro & in vivo	67.14
Blattner *et al*	2010	20	in vitro	68.4
Pardo *et al*	2012	42	in vitro	23.81
Shrestha *et al*	2017	115	in vitro	30.4

Table 5: Canal configuration in mesiobuccal root of maxillary first molar in various studies

Investigator	Year	N	Country	Study Technique	Type I	Type II	Type III	Type IV
Weine	*1969*	208	USA	Vertical Sectioning	48.5	37.5	14.0	0
Pineda	1973	262	Mexico	Radiographic	39.3	12.2	35.7	12.8
Seldberg	1973	100	USA	Horizontal Sectioning	38.0	37.0	25.0	0
Evenot	1980	378	France	Radiographic and microscopic	28.8	23.5	38.8	8.8
Vertucci	1984	100	USA	Decalcified & decayed	45.0	37.0	18.0	0
Weine *et al*	1996	300	Japan	Files in extracted teeth	42.0	24.2	30.4	3.4
Shrestha *et al*	2017	115	Nepal	CBCT	60.9	19.1	5.2	7.8

CONCLUSION

The occurrence of second canal in mesiobuccal root of maxillary permanent molar is considerable i.e. 30.4% in Nepali patients' sample. Clinicians should therefore assume the presence of MB2 canal during the endodontic procedure to optimize the treatment result. The clinicians should explore 1.4-3.8 mm distance palatally in an imaginary line joining MB1 and palatal orifice to access MB2 canal orifice. Conventional radiographs usually do not yield the presence of MB2 canal; thus CBCT is the gold standard diagnostic tool in complex, doubtful and in retreatment of missed canal cases.

OJN

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