An assessment of morphological patterns and number of canals in mesiobuccal root of maxillary second molars in our patients: Analyzed by Cone Beam Computed Tomography

Muhammad Arslan Muzaffar[1], Alia Ahmed[2], Hamza Ulfat[1], Usman Bhatti[3], Muhammad[1], Kiran Khan[1]

ABSTRACT

Objective: To assess the number of canals and morphological patterns of mesiobuccal root of maxillary second molars based on Vertucci's classification analyzed by Cone Beam Computed Tomography (CBCT) scans in our patients.
Study Design: Retrospective Cross sectional analytical study.
Place and Duration: At Operative Dentistry Department, Islamic International Dental Hospital, Islamabad from 1st September 2020 to 1st January 2021.
Methodology: Cone-beam computed tomography (CBCT) scans (PLANMECA, Finland) were used with image size 13 x 9cm (651 x 651 x 451 cm^3), voxel size 200µm to include maxillary anatomy with 96 KV radiation dose, exposure time of 12.527 seconds and current of 9 MA. Slice thickness of 0.200mm was recorded. Axial, coronal and sagittal planes were used to evaluate root canal anatomy of maxillary second molars. Number of canals and morphological patterns as per Vertucci's classification were recorded in mesiobuccal root of maxillary second molars.
Results: Out of 200 cone-beam computed tomography (CBCT) scans, 316 maxillary second molars met the inclusion criteria. Mesiobuccal root of maxillary second molars having one canal were found in 78.48% and 2 canals in 21.52%. Maximum frequencies of canals in mesiobuccal root of maxillary second molars as per Vertucci's Classification were found to have type I i.e. 78.5% followed by type IV in 16.5% and type II in 5%.
Conclusion: Number of canals is variable for the mesiobuccal root of maxillary second molar. Single canal and Vertucci's type I is the most common canal configuration type in mesiobuccal root of maxillary second molars. Significant difference was found between gender and Vertucci's classification in mesiobuccal root.
Keywords: Cone Beam Computed Tomography, Maxillary Second Molar, Root Canal Morphology

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1. Resident MDS
2. Professor
3. Assistant Professor

Department of Operative Dentistry
Islamic International Dental Hospital, Islamabad

Correspondence:
Muhammad Arslan Muzaffar
Resident MDS, Department of Operative Dentistry
Islamic International Dental Hospital, Islamabad
Email**:** dmak_001@yahoo.com

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INTRODUCTION

A thorough anatomical knowledge of the roots and root canals is an essential prerequisite for the success of root canal treatment[1]. Innovations in endodontic procedures has revolutionized the way dentists practice the root canal procedure. With the advanced diagnostic tools and automated instrumentation available today, the conventional root canal treatment is very different from what it used to be 50 years ago. However, certain aspects of this treatment have not been changed[2,3].

Many studies have revealed that the root canal system has complex anatomical characteristics such as main and accessory canals, multiple foramina, isthmuses between canals, and irregularly shaped canals[4]. More importantly, many studies have described different trends in the number and morphology of roots and root canals among different ethnicities, between the two sexes and among different ages[1].

Before any dentist begins the root canal procedure, diagnostic decision should be made regarding the treatment of choice for the patient in question. In order to reach this decision, a good history,

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thorough examination and judicious use of diagnostic aids is imperative[5]. After the final decision to begin the treatment has been reached, the dentist would normally proceed with the access cavity opening, followed by other steps that have been thoroughly described in textbooks of endodontics[6].

A three-dimensional filling has to be done within the root canal. Awareness of the root canal morphology is the most essential step in achieving this goal[4].Clinical skills of the dentist and technical knowledge are of utmost importance. However, besides the clinical finesse, having a sound, well-educated knowledge of the root canal morphology of the tooth being treated is of equal, if not more value. Inability to identify any canal in a multi-rooted tooth will result in the failure of endodontic treatment[7,8].

Detecting and locating the second mesiobuccal canal MB2 in maxillary molars has always been an endodontic challenge for clinicians[9].Tooth morphology differs in different ethnic populations and the prevalence of MB2 canal in maxillary second molars has been reported in Brazilian[10],Chinese[9] and Korean[11] population, respectively.

A number of methods have been used to assess the root canal morphological patterns. The most commonly used methods include canal staining and tooth clearing, periapical radiographs and cone beam computed tomography and micro-computed tomography[12,13]

CBCT is a technique that uses a specific beam to produce three dimensional images to reveal anatomic details precisely[14]. The key advantages of using CBCT are that it is non-invasive and permits 3-D reconstruction of the root canals[15,16]. It has been widely used in endodontic regions because it provid es improved accuracy, higher resolution, and lower effective radiation doses than does conventional CT scans. CBCT images can display the axial, coronal and sagittal planes of root canals thus reducing the superimposition of surrounding tissues[17]. Cone-beam computed tomography (CBCT) has been introduced as one of the most reliable method for detection of the root canal morphology[18–20].

The maxillary molars are important teeth with a central role in masticatory function. Maxillary second molars documented as most difficult tooth for endodontic treatment due to its number of roots, canal configuration and different pulp cavity configuration.[9] The present is conducted with an objective to assess the number of canals and morphological patterns as per Vertucci's classification in mesiobuccal root of the maxillary second molars analyzed by Cone Beam Computed Tomography (CBCT) in our patients.

METHODOLOGY

This cross sectional analytical study was conducted from 1st September 2020 to 1st January 2021 at department of Operative Dentistry in Islamic International Dental Hospital, Islamabad. The sample of this study consisted of 200 CBCT scans of patients seeking routine dental checkup at the hospital. Patients with closed apical foramina of maxillary second molars, age group (20 to 40 years) were included in this study. Scans with periapical pathology, indirect restorations, open apex and blurred images were excluded.

CBCT scans (PLANMECA, Finland) were used with image size 13 x 9cm (651 x 651 x 451 cm3) Voxel size 200µm to include maxillary anatomy and with 96 KV radiation dose, exposure time of 12.078 seconds and current of 9 MA. Slice thickness of 0.200mm was used. Axial, coronal and sagittal planes were used to evaluate root canal anatomy. CBCT images were analyzed with the in-built software named PLANMECA ROMEXIS Version 4.6.0.R viewer in a Dell Desktop core i7 with 21 inches View sonic screen, with the resolution of 1366x768 pixels in a dark room. The contrast and brightness of the image is adjusted using the image-processing tool in the software to ensure optimal visualization.

All CBCT images were independently evaluated by running intra class correlation (ICC). Three-Dimensional images were obtained from the software and recorded the following in mesiobuccal root: number of canal/canals and configuration of canal morphology as per Vertucci's classification.[9]

Data Analysis: All data was entered and analyzed using SPSS v 24.0. Frequencies and percentages were described for the number of canals and Vertucci's classification configuration types in mesiobuccal root of maxillary second molars. Gender wise analysis was done for number of canals and Vertucci's classification in mesiobuccal root of maxillary second molars. Chi-squared test was applied for checking the significant association. An arbitrary value of ≤ 0.05 was considered to be significant.

RESULTS

Out of the total 200 CBCT scans, 316 teeth were included and analyzed. In mesiobuccal root of maxillary second molars, one canal was found in 248 (78.48%) whereas two canals in 68 (21.52%).(Table I)

Table I: Frequency of canals in mesiobuccal root of maxillary second molars (N=316)

Number of canals in mesiobuccal root	Frequency (n)	Percent
One	248	78.48 %
Two	68	21.52 %
Total	316	100 %

Table II. Total Number of canals in mesiobuccal root of maxillary second molar according to Vertucci's Classification (N=316)

Frequency of canals in maxillary second molar according to Vertucci's Classification	Frequency (n)	Percent
Type 1	248	78.48
Type 2	16	5
Type 4	52	16.52
Total	316	100

Frequency of Type 1 canals in mesiobuccal root of maxillary second molar according to Vertucci's Classification was found in

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248 teeth (78.48%), Type II was found in 16 teeth (5%) and Type IV was found in 52 teeth (16.52%). (Table II)

Table III: Gender wise cross tabulation regarding number of canals in maxillary second molar (N= 316)

Number of canals in mesiobuccal root	Gender		Total	P-Value
	Male n(%)	Female n(%)		
One	118 (37.3%)	130 (41.1%)	248 (78.4%)	0.1704
Two	26 (8.31%)	42 (13.29%)	68 (21.6%)	
Total	144	172	316	

In males, one canal was found in 118 (37.3%) and two canals in 130 (41.1%). Whereas, in females one canal was found in 26 (8.31%) and two canals in 42 (13.29%) After applying Chi-square test, significant association was not found between number of canals in mesiobuccal root of maxillary second molar and gender i.e., males and females (P=0.1704). (Table III)

Table IV: Gender wise cross-tabulation regarding Vertucci's Classification in mesiobuccal root of maxillary second molar (N = 316)

Vertucci's Classification	Gender		Total	P-Value
	Male n (%)	Female n (%)		
Type I	118 (37.3%)	130 (41.1%)	248 (78.48%)	0.001
Type II	16 (5.06%)	0 (0.0%)	16 (5%)	
Type IV	10 (3.2%)	42 (13.3%)	52 (16.52%)	
Total	144	172	316	

Vertucci's classification of canal configuration found in male were 118 (37.3%) in type I, 16 (5.06%) in type II and 10 (3.2%) in type IV. Vertucci's classification found in female were 130 (41.1%) type I, 0 in type II and 42 (13.3%) in type IV. (Table IV)
Significant association was found between Vertucci's Classification in mesiobuccal root of maxillary second molar and gender (P=0.001).

DISCUSSION

Having a thorough knowledge of the anatomy of maxillary molars is of great significance for the success of root canal treatment. The pulp canal is a very complex system having canal ramifications where the canal divides, branches off and rejoins back[12]. Weine et al.[13] categorized the root canal system into four basic types. Vertucci[11] classified eight-canal space configuration system.
Different methodologies have been used to study root canal system such as staining and clearing technique[14,15], contrast medium enhanced radiography.[17] However, canal staining ,clearing and cross sectioning technique is invasive and causes irreversible damage to the tooth. Intraoral radiograph produces two dimensional radiograph[21].
The introduction of CBCT in dentistry has led to revolutionary changes regarding the diagnosis of oral conditions. In contrast to in-vitro methods, the use of CBCT in in-vivo studies of tooth anatomy offer a much more efficient, swifter, non-invasive and accurate method[2,13]The CBCT is a three-dimensional advanced diagnostic tool that allows the imaging in axial, coronal and sagittal planes. With respect to the tooth morphology, the number of roots, and their morphological features can be observed in three dimensions[20,22].
Using CBCT, a number of studies have been done to assess the root canal morphology of different teeth in the human dentition. Wide variations in root morphological features, based on race and ethnicity have been reported in literature[23–25]. The present study adds to the literature by reporting the number of canals in mesiobuccal root of the maxillary second molars as per Vertucci's classification in our patients.
In this section of our research, variations in the number of canals were found for the mesiobuccal root of maxillary second molars. Single canal was most common occurring in different ethnic studies[11, 26-31] that varied from 66% to 100%. Our study reported that majority (78.48%) of teeth having single canal and 21.52% have two canals in mesiobuccal root. Comparable results were found in the Brazilian study by George et al[29] i.e. (81%) having one canal and 19% having two canals in MB root.
In our study, the majority (78.48%) of teeth having type I configuration in MB root. Almost similar results were found in the Brazilian study by George et al[29] (78.15%). Vertucci's type I is the most commonly occurring canal configuration in mesiobuccal root and varies from (32.5% to 78.15%) in different ethnic studies[26,28,31]. For type IV configuration, similar results were reported in Korean population (15.2%) by Kim et al[11] that are comparable to our study (16.52%). Type II canal configuration occurred in 5% cases only in our study.
To our knowledge, the current study is the first on assessing the number of canals in mesiobuccal root of maxillary second molars in our patients under CBCT. It identified the number of canals in MB root of maxillary second molars and its different morphological patterns as per Vertucci's classification, which can be helpful in obtaining better success rate in endodontic treatment.

CONCLUSION

In our study, number of canals is variable for MB root of the maxillary second molars. One canal and Vertucci's type I is the most common morphological pattern in mesiobuccal root of maxillary second molars. Significant difference was found between gender and Vertucci's classification.
Limitations: This study has few limitations that images were assessed from a single diagnostic morphological pattern. Further studies with larger sample size and inclusion of different ethnicities are recommended for better judgment of maxillary second molars morphology.

AUTHOR'S CONTRIBUTION

Muzaffar MA: Conceived idea, Designed methodology, Data analysis, Manuscript writing
Ahmed A: Final critical review of manuscript

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Ulfat H: Data collection, Literature Review
Bhatti U: Manuscript writing, Data collection, Data analysis
Muhammad: Manuscript writing, Data collection, Data analysis
Khan K: Data collection, Data analysis

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