Morphology of Maxillary Second Molars Analyzed by Cone Beam Computed Tomography in Western Indian Population

Akash Azad[1], Rupal Vaidya[2], Shraddha Chokshi[3], Zarna Sanghvi[3], Pruthvi Patel[4]

ABSTRACT

Introduction: One of the key factors of a successful endodontic treatment depends on the detection of all root canals. To accomplish this, a thorough knowledge of root canals configuration is crucial. And invaluable information regarding the root canal systems is provided by Cone-beam computed tomography (CBCT). This research was aimed to analyse the number of roots and root canal variations in maxillary second molars in Western Indian population using CBCT.

Material and methods: We screened through 133 CBCT images of patients, who had previously got their CBCT done at the SLR Diagnostic imaging center, Ahmedabad, Gujarat. 217 CBCT image samples of maxillary second molars were observed. The number roots and root canals, with their canal configuration according to Vertucci's classification were determined.

Result: 93.7% of maxillary second molars had three completely separate roots, rest 6.3% had two roots and 0.9% had one root with Vertucci's type I. In case of the mesiobuccal root had one canal in 43.7% samples with Vertucci's type I and two canals in 56.2 % samples with Vertucci's type II (72.5%) and type IV (27.5%) whereas in case of palatal root and distobuccal root, they contained one root canal in all the samples with Vertucci's type I configuration.

Conclusions: Maximum amount of variation is observed in mesiobuccal roots compared to that of the distobuccal and palatal roots of maxillary second molar teeth. CBCT is a highly potent and valuable tool in the detection of variations in root canal morphology for radiographic evaluation during root canal treatment.

Keywords: Morphology of Maxillary Second Molars, Cone Beam Computed Tomography, CBCT, Canal Configuration, Canal Variations

INTRODUCTION

The goal of an endodontic treatment is to achieve complete debridement, disinfection, and obturation of the root canal system[1], in order to achieve these goals, an understanding of fundamental root canal anatomy is imperative for dentists to perform endodontic therapy. Clinicians should be aware of common root canal configurations and possible anatomic variations.[2]

Conventional intraoral periapical radiographs have been used to examine root canal morphology in vivo.[3] However, these radiographs produce only 2-dimensional (2D) images of 3-dimensional (3D) objects, resulting in the distortion and superposition of structures.

Recently, cone-beam computed tomographic (CBCT) images have been found to be useful in providing accurate anatomic details in 3D for diagnosis and treatment planning before endodontic therapy.[4-6] CBCT uses a cone-shaped X-ray beam that has been designed specifically for use in dentistry, instead of the fan shaped beam. The key advantages of using CBCT are that it is non-invasive and permits 3D reconstruction of the root.[3] In addition, CBCT scans have lower radiation doses, short exposure time (10–15 seconds),is less expensive than conventional CT, and has higher accuracy and higher resolution than conventional spiral computed tomography scans, which give them an edge for clinical application.[7] CT has been suggested as the preferential imaging modality in difficult situations demanding localization and description of root canal systems because of its ability to render 3D information.[8-10]

Maxillary molars have been investigated frequently because of their complex root anatomy and canal morphology.[2,11–15] Based on the published results, it is generally accepted that most maxillary molars have 3 roots and 4 canals.[2,11–15] Most studies reported incidences of a second canal (MB2) in the mesiobuccal (MB) root in over 50% of the cases.[13-17]

Root canal morphologies are different in various racial populations.[18] A literature search reveals that very few studies have been done for mandibular molars in Indian population and no studies have been done for maxillary second molars using CBCT

The aim of the current research was to analyse prevalence of number of roots and root canal variations in maxillary second molars in Western Indian population using CBCT scanning.

MATERIAL AND METHODS

A Thorough screening of 133 CBCT image samples of maxillary second molars was conducted at the SRL Diagnostics imaging center, X-ray House, Ellis Bridge, Ahmedabad, Gujarat, in a span of four months. The images were of those patients, who had undergone their CBCT scanning for different diagnostic purposes, prior to our research, at the SRL Diagnostics imaging center. CBCT images of 217 maxillary second were identified in the database

CBCT scanning had being conducted with Kodak 9000 3-D CBCT machine, Kodak, United States. The image scanning was performed under the following parameters; with an exposure time of 15 seconds at 2-15 mA current 60 to 90 kV. A voxel size was 90-500 µm and a slice thickness was 300 µm.

The analysis of the CBCT data was done using CS 3D software (Care stream Health, Inc.) on a 32 inch screen Dell LCD screen

[1]Consultant Endodontist, Ahmedabad, [2]Professor and Head, [3]Professor, [4]Reader, Department of Conservative Dentistry and Endodontics, Ahmedabad Dental College and Hospital, Gandhinagar, Gujarat, India.

Corresponding author: Dr. Akash Azad, 10, Aden Park Society, Opp. Lalbhai Center, Maninagar (East), Ahmedabad -380008, Gujarat, India.

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having a resolution of 1280x1080.

None of the patients were exposed solely for the purpose of the study. All the records were collected from pre-existing database of SRL Diagnostics imaging center, X-ray House, Ellis Bridge, Ahmedabad and Gujarat. Our study got its approval by the Ethics Committee of the Ahmedabad Dental College and Hospital.

Examination was done in axial, sagittal and coronal sections. The contrast, brightness and magnifying functions of the software were used and adjusted whenever they were required. In case where confirmation was not reached, a second opinion of an oral radiologist was taken to come to a conclusion.

The analysis of all the maxillary molar images for their number of root, canals and apical foramina per root was carefully performed. To classify the root canal configuration, the reference of Vertucci's[1] classification was taken.

RESULT

Out of the total 217 maxillary second molar images examined, three completely separate roots were observed in 201 (93.7%) samples (Figure 1). Whereas maxillary second molars having one root and one canal was found in 2 (0.9%) samples (Figure 2), and having two roots with two canals was found in 14(6.4%) samples (Figure 3). The percentage wise distribution of roots of maxillary second molar is listed in Table-1.

In cases where three completely separate roots were present, the mesiobuccal roots of 43.7% (88) molars had one canal and the rest of them had a mesiobuccal second canal (MB2) (Figure 4) all of the distal and palatal roots had a single canal. Number of canals in maxillary second molar having three roots are listed in Table-2. The canal configurations in mesiobuccal second canals of maxillary second molar are listed in Table-3.

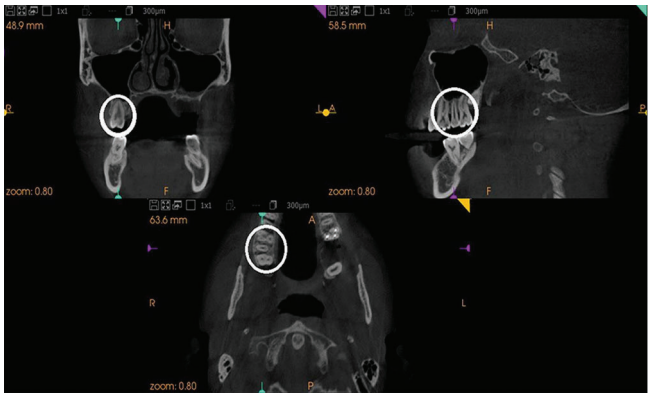

Figure-1: Single root in maxillary second

Figure-3: MB2 canal in mesial root of maxillary second molar

DISCUSSION

Having a thorough knowledge of the anatomical morphology and variations of the maxillary molars is of great significance for the success of their endodontic treatment. The pulp canal is complex system having canals which may many ramifications where the canal divides, branches off and rejoins back. Weine et al.[2] categorized the root canal system into four basic types. Others found a much more complex canal system; Vertucci identified eight canal space configurations.[1]

Different methodologies have being used to examine the root and root canal morphology using various methods such as canal

Number of roots		
One	Two	Three
0.9%	6.4%	93.7%

Table-1: Percentage of the number of roots of maxillary 2nd molar

Root Canals	Number of canals	
	One	Two
Palatal root	100% (201)	0%
Distobuccal root	100% (201)	0%
Mesiobuccal root	43.7% (88)	56.2%(113)

Table-2: Number of canals in maxillary second molar having three roots

Type	Frequency
Type 2	72.5% (82)
Type 4	27.5% (31)
Total	100% (113)

Table-3: The Canal Configuration in Mesiobuccal Second Canals of Maxillary Second Molar

Figure-2: Two roots in maxillary second molar

Figure-4: Three roots in maxillary second molar

staining and clearing technique[11,19,20] cross-sectioning technique, contrast medium-enhanced radiography[23], radiographic examination[21,22] and computed tomography scanning.

However, canal staining and clearing technique and cross-sectioning technique are invasive and result in irreversible damage. Even with the intraoral periapical radiographs, the drawback is that they are able to produce only two-dimensional images. Therefore, all these are not beneficial in the evaluation of complex root canal anatomies due to their natural limitations. Compared to the cross-sectional and clearing methods CBCT is a non-invasive technique which can help in the evaluation of the patients directly. CBCT has been widely used for endodontic application in the past few years, as it imparts the operator with vital information in three dimensions, about the external and internal morphology of the root and root canal systems.

The slice thickness in CBCT ranges from 90–300 µm. The slice thickness used in our study was 300 µm. Furthermore, CBCT measurements are geometrically accurate, owing to the fact that the CBCT voxels (3D pixels containing data) are isotropic.[24-26]

In recent years, CBCT scans have become available for the private dental offices as a diagnostic and treatment planning technique. It is mainly used for the evaluation of intraoral pathoses, assessment of root canal morphology, root canal shape, assessing the dimensions of root resorptions, assessing the obturation quality and helping in the removal of root canal fillings, preoperative planning and analysis of internal and external root resorption. It was recently concluded in studies, that scanning through CBCT was an impeccable method for the detection of the second mesiobuccal canal in human maxillary molars[27,28]

In our study, we found that 56.2% of samples had four canals including MB2 and 43.7% of teeth had three canals. Which is in similar to E Silva et al's study where the presence of 3 separate roots, namely mesiobuccal, palatal and distobuccal, all having1 canal in each root was recorded in 45.09% of cases. But their incidence of MB2 is comparatively lesser, i.e. in 34.32% of the samples.

Zhang[12] and Zheng[13] obtained different results of MB2 in Chinese population using CBCT. Different results could be due to different CBCT systems used to evaluate the samples or different races and populations. They reported 52% and 50%, respectively, which were lower than the result of our study.

Neelakantan et al[3] reported the most common canal morphology in the mesiobuccal roots of three-rooted second molars was type I 62% and MB2 canal configuration in 44.1%; which had type II canal configuration 13% and type IV 50%. The palatal roots of three-rooted maxillary second molars showed type I canal 87.8% which is lower than our results which showed 100% type I canal configuration in three rooted palatal canals. However the findings our study are in agreement with Kim et al[18], Farhad et al[27], E Silva et al.[29]

In cases in which an unexpected complex anatomy is visualized after access or when canals are not found, intraoperative CBCT imaging is always an excellent choice (Ball *et al*. 2013) One of the prime questions for an endodontists, that how many canals are present in each root, can be answered with the help of CBCT. The present results provides useful information for the endodontic treatment because prior knowledge of anatomic variations can help dentists locate the root canals and thus prepare and obturate them with greater efficiency.

CONCLUSION

Within the limitations of our research, we can come to a conclusion that the Western Indian population exhibits high variability in root canal morphology for the maxillary second molar.

Mesiobuccal roots and root canal system of maxillary second molar teeth had a greater amount of variations than the palatal or distobuccal roots. Vertucci's Type II canal configuration was commonly detected in the mesiobuccal canal and Type I canal configuration in palatal roots and distobuccal and. CBCT is a highly potent and valuable tool in the detection of variations in root canal morphology for radiographic evaluation during root canal treatment.

REFERENCE

1. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol. 1984;58:589-599.
2. Weine FS, Healey HJ, Gerstein H, Evanson L. Canal configuration in the mesiobuccal root of the maxillary molar and its endodontic significance. Oral Surg Oral Med Oral Pathol. 1969;28:419–25.
3. Neelakantan P, Subbarao C, Subbarao CV, Ravindranath M. Root and canal morphology of mandibular second molars in an Indian population. J Endod. 2010;36:1319-22.
4. Pineda F, Kuttler Y. Mesiodistal and buccolingual roentgenographic investigation of root canals. Oral Surg Oral Med Oral Pathol. 1972;33:101–10.
5. Durack C, Patel S. Cone beam computed tomography in endodontics. Braz Dent J. 2012;23:179-191.
6. Cotton TP, Geisler TM, Holden DT, et al. Endodontic applications of cone-beamvolumetric tomography. J Endod. 2007;33:1121–32.
7. Mozzo P, Procacci C, Tacconi A, Martini PT, Andreis IA. A new volumetric CT machine for dental imaging based on the cone-beam technique: preliminary results. Eur Radiol. 1998;8:1558–64.
8. Patel S, Horner K. The use of cone beam computed tomography in endodontics. Int Endod J. 2009;42:755–6.
9. La SH, Jung DH, Kim EC, Min KS. Identification of independent middle mesial canal in mandibular first molar using cone-beam computed tomography imaging. J Endod. 2010;36:542–5.
10. Bornstein MM, Wo¨ lner-Hanssen AB, Sendi P, von Arx T. Comparison of intraoral radiography and limited cone beam computed tomography for the assessment of root-fractured permanent teeth. Dent Traumatol. 2009;25:571–7.
11. Alavi AM, Opasanon A, Ng YL, et al. Root and canal morphology of Thai maxillary molars. Int Endod J. 2002;35:478–85.
12. Zhang R, Yang H, Yu X, et al. Use of CBCT to identify the morphology of maxillary permanent molar teeth in a Chinese subpopulation. Int Endod J. 2011;44:162–9.
13. Zheng QH, Wang Y, Zhou XD, et al. A cone-beam computed tomography study of maxillary first and second permanent molar root and canal morphology in a Chinese population. J Endod. 2010;36:1480–4.
14. Lee JH, Kim KD, Lee JK, et al. Mesiobuccal root canal anatomy of Korean maxillary first and second molars by cone-beam computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;111:785–91.
15. Baratto Filho F, Zaitter S, Haragushiku GA, et al. Analysis

of the internal anatomy of maxillary molars by using different methods. J Endod. 2009;35:337–42.
16. 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;30:391–8.
17. Kottoor J, Velmurugan N, Sudha R, et al. Maxillary molars with seven root canals diagnosed with cone-beam computed tomography scanning: a case report. J Endod. 2010;36:915–21.
18. Kim S, Kim BS, Woo J, Kim Y. Morphology of mandibular molars analyzed by cone-beam computed tomography in a korean population: Variations in the number of roots and canals. J Endod. 2013;39:1516-1521.
19. Vertucci FJ. Root canal morphology of mandibular premolars. J Am Dent Assoc. 1978;97:47–50.
20. Awawdeh L, Abdullah H, Al-Qudah A. Root form and canal morphology of Jordanian maxillary first premolars. J Endod. 2008;34:956–61.
21. Weine FS, Hayami S, Hata G, et al. Canal configuration of the mesiobuccal root of the maxillary first and second molars of a Japanese sub-population. Int Endod J. 1999;32:79–87.
22. Patel S, Dawood A, Whaites E, et al. New dimensions in endodontic imaging: part 1. Conventional and alternative radiographic systems. Int Endod J. 2009;42:47–62.
23. Naoum HJ, Love RM, Chandler NP, et al. Effect of X-ray beam angulation and intraradicular contrast medium on radiographic interpretation of lower first molar root canal anatomy. Int Endod J. 2003;36:12–9.
24. La SH, Jung DH, Kim EC, Min KS. Identification of independent middle mesial canal in mandibular first molar using cone-beam computed tomography imaging. J Endod. 2010;36:542–5.
25. Bornstein MM, Wo¨ lner-Hanssen AB, Sendi P, von Arx T. Comparison of intraoral radiography and limited cone beam computed tomography for the assessment of root-fractured permanent teeth. Dent Traumatol. 2009;25:571–7.
26. Peters OA, Laib A, Ruegsegger P, Barbakow F. Three-dimensional analysis of root canal geometry using high-resolution computed tomography. J Dent Res. 2000; 79:1405–9.
27. Farhad Faramarzi, Mitra Vossoghi, Cone Beam Computed Tomography Study of Root and Canal Morphology of Maxillary Molars in an Iranian Population. Avicenna J Dent Res. 2015; 7:e24038.
28. Alrahabi M, Zafar MS. Evaluation of root canal morphology of maxillary molars using cone beam computed tomography. PJ Med Sci. 2015;31:426-430.
29. E Silva, Evaluation of Root Canal Configuration of Maxillary Molars in a Brazilian Population Using Cone-beam Computed Tomographic Imaging: An In Vivo Study. J Endod. 2014;40:173–176.
30. Ball RL, Barbizam JV, Cohenca N. Intraoperative endodontic applications of cone beam computed tomography. J Endod. 2013;39:548–57.

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