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Efficacy of cone beam computed tomography as a modality to accurately identify the presence of second mesio buccal canal in maxillary first and second molar: An in-vitro study

[1]Dr. Vinayam, M.D.S, Junior Resident, Department of Conservative Dentistry and Endodontics, ESIC Hospital, Lucknow, Uttar Pradesh, India

[2]Dr. Rashmi, M.D.S, Assistant professor, Department of Conservative Dentistry and Endodontics, RDJM Medical college & hospital, Turki, Muzaffarpur, Bihar, India

[3]Dr. Neha Kumari, M.D.S, Dental Practitioner (Consultant Pedodontist), Department of Pedodontics and Preventive Dentistry, Dental Life Care, Param Parwati market, 1st Floor, Vijay Nagar, Bailey Road, Patna - 800014, Bihar

[4]Dr. Kritika Roy, M.D.S, Senior resident, Department of Dentistry, AIIMS, Bhubaneswar

[5]Dr. Pragya Singh, M.D.S, Senior resident, Department of Dentistry, Government Medical College & Hospital, Chandigarh

Corresponding Author: Dr. Neha Kumari, M.D.S, Dental Practitioner (Consultant Pedodontist), Department of Pedodontics and Preventive Dentistry, Dental Life Care, Param Parwati market, 1st Floor, Vijay Nagar, Bailey Road, Patna - 800014, Bihar

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Abstract

Aim: The purpose of this study is to determine whether the Pre-operative CBCT image increases the effectiveness of the clinical identification of the second mesiobuccal canal in maxillary molars

Methods: 40 previously extracted maxillary first and second molars were collected from the department of Dentistry AIIMS, Bhubaneswar .All the records from the periapical x-ray evaluation, CBCT evaluation and sectioning and clinical analysis of the mesiobuccal root of maxillary molars was recorded and sent to a statistician for the statistical analysis.

Results: Clinical and cbct analysis shows some percentage of MB 2 canal while rvg shows zero percentage.

Conclusion: Our study incontestable that pre-operative CBCT image can increase the effectiveness of clinical identification of MB2. Further high-quality clinical studies are needed to substantiate our findings.

Keywords: MB 2 canal, RVG, CBCT

Introduction

The primary objective of root canal therapy is the treatment and/or prevention of apical periodontitis. To accomplish this goal, inflamed or necrotic pulp tissue is removed by complete chemomechanical debridement of the root canal system and this space is then sealed with an appropriate obturating material.[1] A successful result requires that the operator understands and appreciates the internal anatomy and morphology of the root canal system.[2,3] The permanent maxillary first and second molars commonly present with three roots and four canals.[1] The distobuccal root has a conical shape and usually contains one canal. The palatal root, while ribbon-like and broad mesio-distally, also usually only contains a single canal. The mesiobuccal root, on the other hand, is broad in a buccal-lingual direction and usually contains two root canals, the first and second mesiobuccal canals.[1,4] Authors have used various terminologies when referring to the second canal in the mesiobuccal root. It has been referred to as mesiolingual, mesiopalatal, second mesiobuccal, and MB2.[5,6,7] MB2 and second mesiobuccal are the most widely accepted terms in the literature and will therefore be used in this study. While previous studies have found the prevalence of a second mesiobuccal canal to be high (up to 95.2%, depending on the method of evaluation), identifying it during endodontic treatment can be a clinical challenge.[8,9,10] Traditional means of determining its presence and location include clinical examination and conventional two-dimensional radiography. Clinical examination and identification of MB2 can be a challenge for practitioners for several reasons. Due to its smaller size and location often beneath overlying calcification, searching for its presence may lead to an increased likelihood of iatrogenic errors including perforation.[9] Conventional radiography, while an essential aspect of endodontic treatment, has several limitations that make it less than an ideal tool for locating MB2. Because periapical (PA) radiography shows only a two-dimensional image, the buccolingual dimension of the root cannot be appreciated.[11,12] The internal anatomy of the root canal system is also under-represented in two-dimensional images. Moreover, overlying structures and adjacent roots make periapical films of maxillary molars particularly difficult to interpret.[11]Cone-Beam Computed Tomography (CBCT) is a relatively recent innovation that overcomes many of the limitations of conventional radiography. It has many applications in endodontics because its three dimensional images allow inspection of the tooth in the axial, coronal, and sagittal planes. The axial plane is particularly useful in helping the clinician determine the number of root canals and their location relative to one another.[11,12] Studies have also shown that CBCT images accurately depict anatomical structures in their true state without significant magnification or distortion.[13] Because success in endodontics requires treatment of the entire root canal system, failure may occur if a canal is unidentified and untreated. The identification and treatment of the second mesiobuccal canal in maxillary first and second molars using traditional methods has proven to be a challenge for practitioners. The limitations of conventional radiography in particular make the pre-operative detection of MB2 difficult. This may lead the practitioner to rely solely on clinical examination for the identification of MB2. Iatrogenic errors may occur while the practitioner searches for a canal that may or may not be present. These problems together may adversely influence the success rate of root canal treatment of maxillary molars.

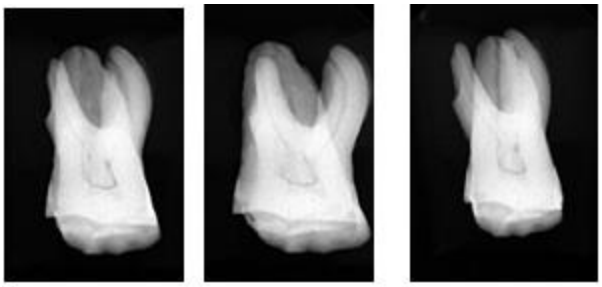
Considering the many limitations of conventional radiographs in detecting root canals (particularly MB2), it is in the practitioner's best interest to find a modality that can pre- operatively determine the existence and location of MB2 and aid in its clinical detection. CBCT uses focused three dimensional imaging and has gained recent popularity in the dental field. Several in vitro studies have shown that CBCT imaging significantly enhances root canal identification compared to conventional radiography.[14,15] However, few studies have determined its effectiveness in enhancing root canal identification in vivo.

Therefore, in order to provide a higher level of evidence and clinically relevant data, it was the objective of this study to determine whether pre-operative CBCT imaging can increase the effectiveness of clinical identification of MB2.

Material & Methods

40 previously extracted maxillary first and second molars were collected from the department of Oral and Maxillofacial Surgery clinic at BIDSH. After extraction the teeth was stored in 0.1% thymol at room temperature.Each tooth was selected solely based on the complete intactness of all roots and crowns.All the teeth selected were extracted for treatment purpose and not for the purpose of this study. All teeth used was extracted strictly as a necessary disease control protocol. The previously extracted maxillary first and second molars were first examined under the radiograph. Next the CBCT was done for the same number of teeth and data was recorded. Finally the teeth were sectioned and the data was recorded. The information for MB2 canal was noted. First intraoral periapical radiograph of all the sample teeth were taken in three different horizontal angles : orthogonal (0^{o}), mesial (15^{o}) and distal (15^{o}) angulation. The film images were evaluated under transmitted light from a radiograph view box under magnification. The presence or absence of MB2 canal was recorded.After the radiographic study, the samples were scanned by CBCT. For tomographic acquisition, the samples were placed together on the desk of the tomographic device. Axial, frontal and sagittal section were obtained by following specific protocols based on the voxel resolution. Images were analysed using software. All pre-operative CBCT images were taken with a Kodak 9000 scanner with the FOV (field of view) centered on the tooth to be treated. Images were analyzed using Kodak Imaging Software by the principal investigator. MB2 was recorded as present if two separate and distinct radiolucent canals were noted anywhere in the mesiobuccal root. After radiographic and CBCT diagnosis, the teeth were placed in 0.1% thymol solution at room temperature until clinical root segmentation. During the sectioning the portion the MB root of each tooth scanned was resected with #169 carbide bur at the CEJ and cut into two section with a diamond disk on the slow speed handpiece. One cut was made 3mm coronal to the root apex, and the other was made 6mm coronal to the apex. Each of the root section was stained with methylene blue dye and analysed under Sanma dental operating microscope. The number of canal present in each section was confirmed by the use of an endodontic explorer. This process was repeated for each of the 40 teeth .All the records from the periapical x-ray evaluation, CBCT evaluation and sectioning and clinical analysis of the mesiobuccal root of maxillary molars was recorded and sent to a statistician for the statistical analysis.

Fig-1 Extracted teeth



Orthogonal (0°) Mesial (15°) Distal (15°)

Fig. 2: Periapical x ray evaluation in three different horizontal angles

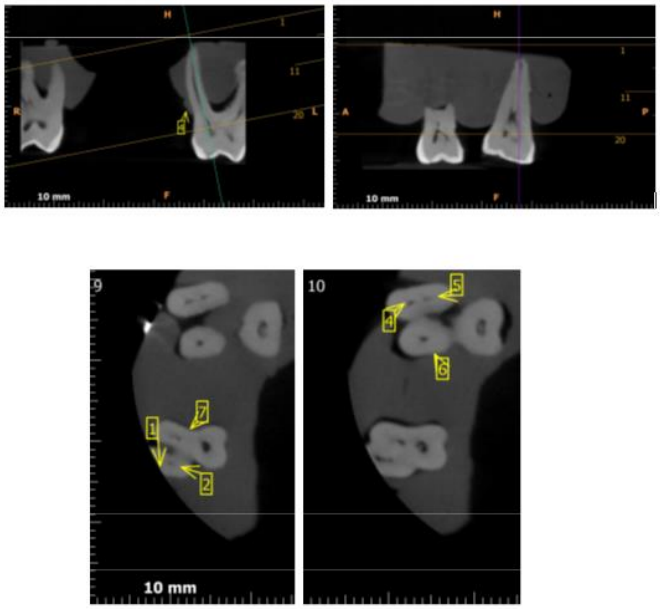


Fig. 3: CBCT evaluation

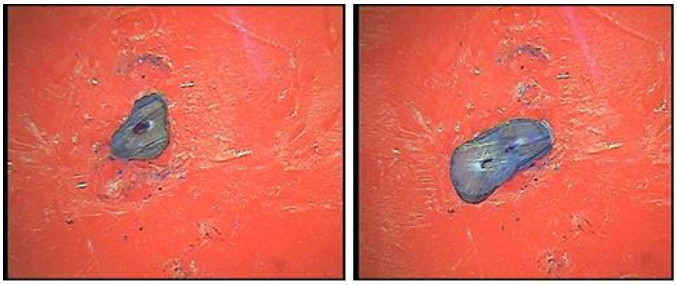


Fig. 4: section of tooth showing MB2 canal

Results

A total of 40 teeth were examined. Clinical sectioning analysis identified an MB2 canal in 31 out of 40 (77.5%) teeth in which we observed an MB2 canal in 2 out of 31 (6.45%) in 3mm, 14 out of 31 (45.16%) in 6mm whereas by both (3 mm and 6 mm) sectioning 15 out of 31 (51.61%). CBCT analysis identified an MB2 canal in 20 out of 40 (50%) teeth which was also identified 1 out of 20 (5%) in 3mm, 8 out of 20 (40%) in 6mm and by both (3 mm and 6 mm) sectioning 11 out of 20 (55%). "The interrater reliability for the CBCT was found to be kappa = 0.45 ($p < 0.001$)." This measure of agreement, while statistically significant, CBCT is moderately reliable for identification of MB2 canal in teeth. Out of 31 MB2 canal identified by clinical sectioning, none of them were identified by RVG (0%).

		Sectioning		Total
		Positive	Negative	
CBCT	Positive	20 (64.5%)	0 (0%)	20 (50%)
	Negative	11 (35.5%)	9 (100%)	20 (50%)
Total		31 (100%)	9 (100%)	40 (100%)

Table 1: Kappa analysis for agreement between CBCT and Sectioning

Kappa = 0.45 Standard Error = 0.118, P value = 0.001

Discussion

In the present study CBCT analysis identified an MB2 canal in 20 out of 40 (50%) teeth while clinical sectioning analysis identified an MB2 canal in 31 out of 40 (77.5%) teeth. Out of 31 MB2 canal identified by clinical sectioning, none of them were identified by RVG (0%). The results of this study denote that CBCT is moderately reliable for identification of MB2 canal in teeth. The result of this study was at par with several other studies done in different parts of the world and there were no aberration found in the present study when compared to other similar research works. A study conducted by Blattner et al[15] in the year 2010 to identify the presence of MB2 canals in maxillary 1st and 2nd molars revealed that in approximately 58% of the cases, MB2 canals were identified by CBCT analysis and in 68.4% of cases, MB2 canals were identified by clinical sectioning analysis, which is in accordance with the present study where we found 50% of the teeth having MB2 canals identified by CBCT analysis. In 2013, Vizzotto et al[16] in their study of assessment of the MB2 canals by CBCT in maxillary molar teeth depicted and compared various techniques along with CBCT to detect MB2 canals among which were (a) clearing technique and (b) radiographic examination. They found that in 67% of the samples, MB2 canals were detected by clearing technique and they also compared radiographic examination versus CBCT which clearly suggested that to detect MB2 canals, CBCT technique was much better than radiographic examination. In this present study we also found similar results which showed none of the MB2 canals could be identified by radiographic examination, whereas 20 out of 40 (50%), MB2 canals were detected by CBCT, clearly suggesting the efficacy of CBCT over radiographic examination. On the basis of various studies, AAE[17] in the year 2011 also validated the use of CBCT analysis in accurately identifying the presence or absence of MB2 canals in maxillary molars, which sums up to 78.95%. It also stated that there was no significant difference in the ability of CBCT scanning in detecting the MB2 canals when compared to gold standard of clinical sectioning. Though in the present study we found significant difference between the above two methods that could be due to difference in the sample size, quality of the machine used and operators skill. Our study result were also similar to a recent study conducted by Shetty et al[18] in 2017 on endodontically treated permanent maxillary 1st and 2nd molars with CBCT evaluation of MB2 canals. It was found that the general incidence of MB2 canals was 86.36% in maxillary 1st molars and 29.4% in maxillary 2nd molars. They also found that 77.19% and 90% of maxillary 1st and 2nd molars respectively had an unfilled MB2 canals. They also revealed that 72.7% and 88.8% of maxillary 1st and 2nd molars respectively showed significant periapical radiolucencies in unfilled MB2 canals, clearly throwing light on the importance of using CBCT for the detection of MB2 canals. A research conducted in the year 2015 on 1374 teeth by J. Abarca et al[19] found that MB2 canal frequency in the maxillary 1st molar was 73.44% and in the 2nd maxillary molar was 42.48%. This result was not similar to result of our study and it also highlighted the effectiveness in detecting MB2 canals in maxillary molars. An in vitro study conducted by Monika et al[20] showed presence of MB2 canals by CBCT in 32 out of 42 (76.19%) samples which can be compared to our group. In our study we found 20 out of 40 (50%). The discrepancy in results could be due to quality of the machine used, time of exposure and operating skills.

Conclusion

Based on the results of this study and comparing them to previous studies, it can be concluded that a pre-operative CBCT image can increase the effectiveness of clinical identification of MB2. Further high-quality clinical studies are needed to substantiate our findings.

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