Efficacy of cone beam computed tomography in the detection of MB2 canals in the mesiobuccal roots of maxillary first molars: An *in vitro* study

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**Abstract**

**Background:** Numerous researches have been done on the permanent maxillary first molars for the presence of an extra canal, especially the mesiobuccal roots for the presence of MB2 canals. Cone beam computed tomography (CBCT) has been used recently in the detection of these canals. However, literature discussing the efficacy and reliability of CBCT in the detection of these canals is scanty.

**Aims:** This study aims to evaluate the efficacy of CBCT as a preoperative diagnostic aid in locating the second mesiobuccal canal in maxillary first molars.

**Methods:** Selected sixty extracted maxillary first molars were placed in the skull base, and CBCT scans were done for evaluating the presence of MB2 canals in the mesiobuccal root. Sectioning of the roots at 3, 5, and 7 mm from the tip was performed and further examined under the microscope for the presence of the MB2 canals. Evaluations were done by two evaluators independently. Results of evaluations were statistically analyzed. Statistical analysis used were standard normal deviation \( (Z \text{ value}) \), interrater reliability (Chronbach's alpha-), \( P \) value and receiver operating curve(ROC).

**Results and Conclusions:** Detection rates of MB2 using both the methods did not show any significant difference \( (P > 0.05) \). CBCT was found to be a reliable tool for the detection of MB2 canal in maxillary first molar teeth when compared to gold standard sectioning technique.

**Keywords:** Cone beam computed tomography; MB2 canals; receiver operating characteristic; sectioning technique

**INTRODUCTION**

The primary objective of root canal therapy is complete cleaning, disinfection followed by three dimensional obturation.\(^{[1]}\) Permanent maxillary first molars have been reported to present important variations in terms of root canal anatomy and have undergone numerous researches for the presence of an extra canal. One of the earliest literatures available discussing the presence of MB2 canals in the mesiobuccal roots of the maxillary first molars is by Hess and Zurcher, in 1925.\(^{[2]}\) The prevalence of MB2 canals has been reported in several studies in different population groups since then.\(^{[1,2,3]}\) According to available literature, two separate mesiobuccal canals occur in percentages varying from 18%–88% of the maxillary first molar teeth.\(^{[1,4]}\)

Wide variation has been observed in clinical studies where lesser number of MB2 canals were found, as compared to the laboratory studies.\(^{[7]}\) In a study by Seidberg *et al*., 33.3% of the first molars were reported to have an MB2 canal *in vivo* while 62% in their *in vitro* study.\(^{[8]}\) Similar results were reported in a study by Pomeranz and Fishelberg.\(^{[9]}\) About 31% of the maxillary first molars were found to have an MB2 canal *in vivo* as compared to 69% in their *in vitro* study.\(^{[9]}\)

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**How to cite this article:** Gupta R, Adhikari HD. Efficacy of cone beam computed tomography in the detection of MB2 canals in the mesiobuccal roots of maxillary first molars: An *in vitro* study. J Conserv Dent 2017;20:332-6.
It is known that preoperative intraoral periapical radiographs are not able to detect the second mesiobuccal canals predictably in most cases. Numerous aids have therefore been used for the detection of an extra canal, including the cone beam computed tomography (CBCT).

However, very few literature exists which discuss the reliability of CBCT in the detection of MB2 canals. Therefore, the present study was designed to evaluate the efficacy of CBCT in the detection of MB2 canals in the mesiobuccal roots of maxillary first molars when compared with gold standard sectioning.

METHODS

Sixty permanent maxillary first molars were selected from the patients coming from different parts of West Bengal in the Department of Oral and Maxillofacial Surgery, Dr. R. Ahmed Dental College and Hospital, Kolkata, for extraction. The tooth was extracted due to periodontal causes, having grossly decayed or due to trauma, etc., rendering them nonrestorable.

Root canal treated tooth, tooth with fracture passing through the mesiobuccal root, tooth with calcifications, and resorptions associated with the mesiobuccal root were excluded from the study. The teeth were stored in 0.1% thymol following extraction.

Cone beam computed tomography analysis

The extracted permanent maxillary first molar teeth were placed in a human skull base in the Maxillary first and the second molar socket bilaterally and stabilized using a modeling wax. Modification of the socket was done where necessary using a No. 8 surgical round bur. The two sockets on each side were used to hold two maxillary first molars of the respective sides. The soft tissue replication was done using wax sheets, which was placed in the region of the periodontal ligament and around the buccal and the palatal cortices. Before scanning, the skull base was placed in the anatomical position using a plasticine in a preformed box on the specific location of CBCT machine. CBCT scan of the 60 samples was done using MYRAY CBCT scanner. Fixed Field of view volume was 6” and the scanner was operated at 90 kV and 10 mA. Details of the CBCT Scan in the form of digital imaging and communication in medicine format images were read through the iRYS viewer software. Coronal, sagittal, and axial sections of the 60 samples were examined. Axial sections at the level of 3, 5, and 7 mm coronal from the apex were recorded for the presence of MB2 canals as it may not extend to the entire length of the root. The entire procedure of examining the CBCT scans was repeated by another observer independently.

Sectioning

The Mesiobuccal roots of the sample teeth were sectioned using a diamond disk at the level of 3, 5 and 7 mm from the tip and the coronal aspect of each sections were viewed for the presence of MB2 canal under the Dental Operating Microscope at ×24 magnification. This procedure was repeated by another observer independently.

The total findings of CBCT at 3, 5, and 7 mm coronal to the apex and sectioning at the same level, suggesting the presence or absence of MB2 were tabulated.

Data thus obtained was statistically analyzed including a receiver operating characteristic curve (ROC). ROC curve provides degree of accuracy of a diagnostic test.

RESULTS

A total of 60 teeth were examined.

CBCT analysis identified MB2 canal in 38 (63.33%) teeth by observer 1 while 39 (65.0%) by observer 2.[Table 1]

There was no significant difference between the two observers as Z = 0.25 and P = 0.80, i.e., P > 0.05. The cronbach’s alpha (α) for these two observations was seen to be 0.954786, i.e., α > 0.9, so internal consistency of these two observers was excellent.

Sectioning analysis identified MB2 canal in 40 (66.67%) teeth out of 60 teeth by both the observers.[Table 1]

Test of proportion showed that there was no significant difference in the proportion of identified MB2 canal by CBCT analysis and clinical sectioning analysis either by the first observer (Z = 0.49; P = 0.62) or by the second observer (Z = 0.24; P = 0.81)[Table 1]

Observation for the presence of MB2 at a different level of the root (3, 5, and 7 mm from the apex) through CBCT and sectioning of each sample were tabulated and compared for categorizing the test samples accordingly:[Table 2].

i. Present both in CBCT and sectioning—true positive

ii. Neither in CBCT nor sectioning—true negative

iii. Observed in CBCT but not found in sectioning—false positive

iv. Present in sectioning but not observed in the CBCT—false negative.[Table 2]

The presence of true positives and true negatives suggested that CBCT scan can detect the presence of MB2 in most cases; however, false positive and false negative suggested it is unable to detect its presence exactly in few sample cases.
Therefore, a ROC curve was required to be constructed through true positive rate (TP/[TP + FN] × 100) and false positive rate (FP/[TN + FP] × 100) to ascertain the accuracy and reliability of CBCT. This procedure was performed by the data obtained from observation of the axial sections at 3, 5, and 7 mm from the apex [Table 2 and Graph 1].

The area under the curve (AUC) was calculated for the analysis of the ROC curve (accuracy was noted as good if AUC >0.80, moderate, 0.60–0.80, and poor <0.60) and that at 3, 5, and 7 mm level was obtained to be 0.6875, 0.7555, and 0.9625, respectively. When the total findings were considered together, the AUC was calculated as 0.8254 [Graph 2]. Hence, accuracy and
reliability of CBCT diagnosis for MB2 detection was proved to be good.

**DISCUSSION**

The frequency and risk of missed canal anatomy are strictly linked with the complexity of the root canal system. 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 to determine the number of root canals and their location relative to one another. Studies have also shown that CBCT images accurately depict anatomical structures without significant magnification or distortion. However, the role of CBCT in the detection of MB2 canal is a dubious issue.

The present study was undertaken to evaluate the efficacy of CBCT in the detection of MB2 canals in the mesiobuccal root of maxillary first molars. MB2 canals were detected using the CBCT analysis by the two observers independently. There was no significant difference between the two observers ($P = 0.80$) and both were reliable in the detection of the MB2 canal using the CBCT analysis. The internal consistency/reliability of these two observers was excellent ($\alpha > 0.9$).

Almost similar percentage was obtained in a study done in Saudi subpopulation by Alrahabi and Sohail Zafar using CBCT who obtained two canals in 70.6% of cases while a lesser percentage (52%) was observed in a study by Zhang et al. 2011 on Chinese population.

The difference in the detection rate might be attributed to the fact that the population group studied was of different ethnicity.

A contrasting result of 48.2% MB2 canals in an Indian population was shown in a CBCT study by Neelakantan et al. However, confirmation of the prevalence rate in the above study was not done using sectioning analysis.

In the present study, sectioning identified MB2 canal in 66.67% of cases by both the Observers. Sample No. 60 showed MB3 canal in the mesiobuccal root which merged with the MB2 in the apical 3mm [Figure 2B (a-c)] of the root. Since
the extracted teeth were taken from the patients from the state of West Bengal, India, prevalence rate of MB2 canals in maxillary first molars here could be considered to be 66.67%.

In the sectioning studies of Blattner et al. 2010[12] and Acousta Vigouroux and Trugeda Bosaans,[19] nearly similar percentages of cases (68.4% and 69.3% respectively) were found to contain MB2 canals while Alaçam et al. 2008[20] in their similar study suggested the presence of MB2 canal in as much as 82% of the cases.

In the present study, detection rates of MB2 using CBCT analysis and clinical sectioning did not show any significant difference ($P > 0.05$), suggesting that the CBCT is similar to sectioning studies in the detection of MB2 canals.

The reliability of CBCT was judged by ROC and subsequently with AUC. Since the overall AUC (meaning detection rate at 3, 5, and 7 mm when considered altogether) was 0.8254, it can be concluded that the accuracy of CBCT in detection of MB2 canal is good. (Accuracy is considered to be good if AUC > 0.8).

Since CBCT is found to be a reliable aid in the present in vitro study, further studies can be conducted to assess the clinical detection rate with a preoperative CBCT evaluation of the mesiobuccal root of the maxillary first molars in vivo.

**CONCLUSION**

Detection rates of MB2 using both the methods did not show any significant difference ($P > 0.05$). CBCT was found to be a reliable tool for the detection of MB2 canal in maxillary first molar teeth when compared to gold standard sectioning technique. It can be concluded that the CBCT can be used in-vivo for the preoperative assessment of the second mesiobuccal canals in the maxillary molars.

**Limitations**

The limitation of this study is that the sectioning of the samples at 3, 5, and 7 mm coronal from the apex may not have been possible exactly corresponding the viewed axial sections.

Intrarater reliability for the assessment of the CBCT scans was not assessed.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

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