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Comparison of Four Diagnostic Methods for Locating MB_2 Canals in Permanent Maxillary First Molars

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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Original Research Article

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ABSTRACT

Context: Failure to locate and treat all root canals is a major cause of endodontic treatment failure. Various diagnostic methods are used to locate second mesiobuccal canal (MB2) canals, including direct visual inspection, loupe magnification, operative microscope, and cone-beam computed tomography (CBCT).
Aims: This study compared the efficacy of four diagnostic methods for locating MB2 canals in extracted human permanent maxillary first molars: direct visual inspection, loupe magnification, operative microscope and CBCT.
Settings and Design: Cross-sectional study.
Methods and Materials: CBCT images of forty extracted human permanent maxillary first molars were obtained. Access cavities were prepared on the teeth and the floor of the pulp chamber was refined. The other 3 analyses (direct visual inspection, loupe with 2.5× magnification and 16× magnification microscope) were carried out.
Statistical Analysis Used: Cohen's kappa and Cochran's Q test were employed. A pair-wise comparison using McNemar test was done.

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Results: CBCT was the most accurate method for detecting MB2 canals, with a sensitivity of 67.5%. The operative microscope and loupe magnification were also effective, with sensitivities of 62.5% and 52.5%, respectively. Direct visual inspection was the least accurate method, with a sensitivity of only 25%.
Conclusions: These findings suggest that CBCT is the most accurate diagnostic method for locating MB2 canals. However, the operative microscope and loupe magnification are also effective options, especially in cases where CBCT is not available.
Clinical Relevance: Choosing the most accurate diagnostic tool and knowing where to look for the extra mesiobuccal canal is the key to endodontic treatment success.

Keywords: Cone-beam computed tomography; diagnosis; endodontics; root canal treatment.

1. INTRODUCTION

Root canal configuration of permanent first maxillary molar is usually complicated, variable and diverse [1,2].

Majority of the mesiobuccal roots have two canals(MB1, MB2) [3] 25%-96% of these exhibit a second canal [2]. Some studies have reported a third canal" [4]. "Incidence of second MB canal was 62%, 68.5%, 80.8%, and 90% [5]. According to a study by Pomeranz and Fishelberg, clinicians are aware that the mesiobuccal root often contains two canals; however, MB2 is the most commonly missed canal during endodontic treatment" [6-8]. "The MB2 canal is usually difficult to locate just by clinical inspection and is not apparent in the radiograph" [9].

Root canals are traditionally located by direct visual inspection [10]. The frequency of locating the MB2 canal may drop to as low as 17% [11]. Auxiliary tools used to facilitate the location of canals include Magnifying loupe, Operative Microscope and Computed Tomography (CT) images. A study found that using dental loupes, the MB2 canal was located in 41% of cases [12]. "It was found that using a dental microscope, the MB2 canal was located in 94% of cases" [12]. CBCT-assessed MB2 prevalence of 21 geographic regions was 73.8%, ranging from 48.0% in Venezuela to 97.6% in Belgium" [13]. CBCT scans are a feasible option for the private dental practice [3]. Obtaining acquisitions with small FOV and voxel aiming decreases the dose of radiation" [14].

Numerous studies have located extra mesiobuccal canals using different diagnostic methods [8]. ; however very few have evaluated the incidence and compared the diagnostic efficacy of the following four methods: direct visual inspection, use of loupe, use of microscope and use of CBCT to detect MB2 canals in human permanent maxillary first molars. The purpose of this study would extend to assist the clinician in identification, negotiation, and treatment of missed MB2 canals in the permanent maxillary first molar for improved prognosis.

Aim: To compare the efficacy of four diagnostic methods (direct visual inspection, use of loupe, use of microscope, and CBCT) to detect prevalence of extra mesiobuccal canals in human permanent maxillary first molars.

Subjects and Methods: The samples for this study consisted of 40 extracted human permanent maxillary first molars taken from private dental clinics in Ghaziabad and Hoshiarpur.

1.1 Inclusion Criteria

•Extracted human permanent maxillary first molars with intact roots without any prior signs of root canal treatment were included.

1.2 Exclusion Criteria

- Fractured teeth.
- Root canal treated teeth.
- Teeth with missing roots.

1.3 Armamentarium Used

40 extracted permanent maxillary first molar teeth were selected.

•#6, #8 K files (Mani)

•#10 K file (Dentsply Maillefer Switzerland)

•Endo Access bur #2 (Dentsply, Switzerland)

•Modelling wax (Mdm)

•Purified filtered water

•NSK Pana Air Handpiece Fx TU B2

•Carl Zeiss Opt. System 2.5x/450

•Gem Opticals Microscope 1.6X

•CS9300 CBCT

Study Design: Cross-sectional study.

2. METHODOLOGY

•Forty extracted human permanent maxillary first molars were used for this study and assessed in vitro.

• The teeth were stored in normal saline.

•4 teeth were positioned and organised in a wax slab in a row. Teeth were mounted in wax blocks up to the cemento enamel junction [Fig. 4].

• Four diagnostic methods i.e. cone-beam computed tomography (CBCT), without magnification through naked eye (direct visual method), dental loupe (with 2.5 x magnification) and microscope (with 16 x magnification) were used to detect MB2 canals.

•Variable: Number of root canals in mesiobuccal root of first maxillary molars.

•Prepared specimens were explored for MB2 in the following sequence [Fig. 3].

•Stage 1 CBCT: Each wax slab was scanned with CS9300 CBCT.

•CBCT images will be analysed in sagittal, coronal and axial planes for detecting the MB2 canal. [Fig. 8]

•1MM (right and left) and 2MM (right and left) CBCT images were included where the presence of all maxillary molars could be observed. All images were independently analysed in a dark room. Images were analysed using CS 3D Imaging software. To ensure adequate/consistent image quality, image contrast and brightness levels were adjusted using a tool available on the program. The second mesiobuccal canal in each maxillary first molar was detected based on CBCT axial scans. Number of teeth in which MB2 canals were detected was recorded.

• Stage 2 Visual method: Endo Access bur #2 (Dentsply) mounted on a high-speed handpiece, with cooling, was used to prepare all access cavities. Beneath the cusp tip, exploration of MB canal was done.

• Teeth were checked with naked eye (unaided vision) for MB2 canal using explorer followed by k-files #6 or #8.

•Samples were subjected to stage 3.

•Stage 3, using a loupe with 2.5× magnification [Fig. 5]: Teeth were examined with dental loupes with 2.5 magnification for locating MB2 canals. [Fig. 6] 6, 8, or 10 k-files were inserted in MB and MB2 canals that penetrated the cervical third canal.

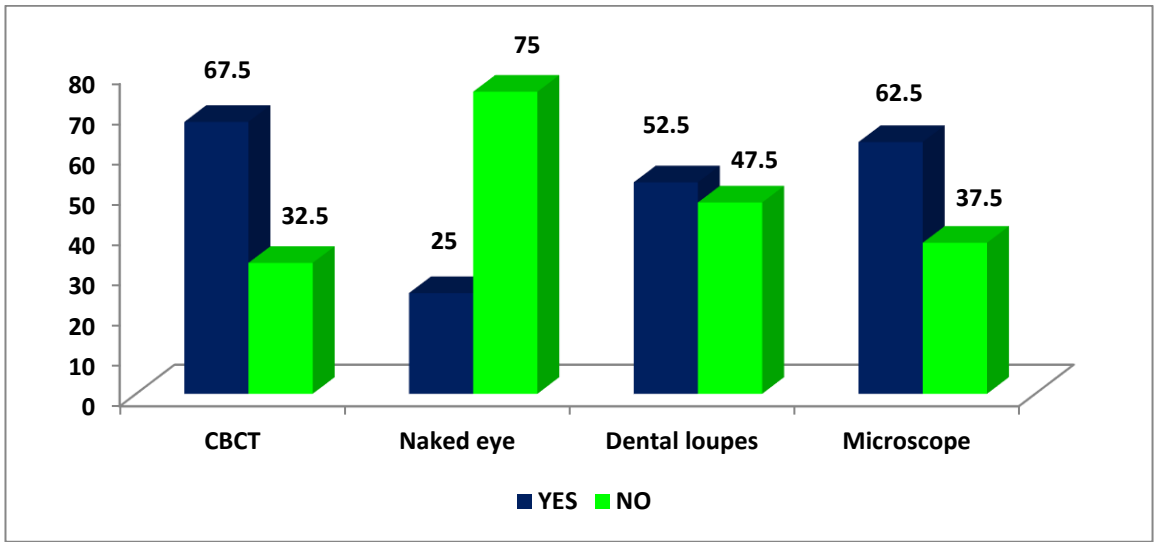
•Stage 4 using a microscope under 16x magnification [Fig. 7], the teeth were examined and MB2 canals were located that penetrated the cervical third canal.

3. RESULTS AND DISCUSSION

In the present study, 40 extracted teeth were subjected to CBCT, operative microscope, dental magnifying loupe, and naked eye to find extra mesiobuccal canal incidence and to evaluate the diagnostic efficacy of these four methods in finding MB2 canal. MB2 canal was seen with CBCT in 27/40 (67.5%) teeth. With naked eye, it was found in 10/40 (25%), whereas in dental loupe, MB2 canal was located in 21/40 (52.5%) and while using microscope, MB2 canal was located in 25/40 (62.5%) cases.

Table 1. Percentage of detection of MB2 canal with the four diagnostic methods

	Value (%)	
	Yes	**No**
CBCT	27 (67.5)	13(32.5)
Naked eye	10 (25)	30 (75)
Dental loupes	21(52.5)	19 (47.5)
Microscope	25 (62.5)	15 (37.5)



Graph 1. Percentage frequency locating MB2 canal with the four diagnostic methods

Cohen's kappa was employed to estimate the intra-observer agreement among the four methods. Kappa value was 0.28 for naked eye detection and CBCT, 0.59 for dental loupes and CBCT, and 0.89 CBCT for microscope and CBCT, all of which were significant (<0.01). The result indicates that the maximum agreement was found between CBCT and Microscope detection.

Further Cochran's Q test was employed to detect the difference in ability to detect MB2 with CBCT, naked eye, dental loupes and microscope.

Table 2 indicates that there exists a significant difference in the ability of four methods of CBCT, Naked Eye, Dental Loupes and Microscope to detect the MB2 canal (χ^2 (3) = 35.14, P < 0.001).

A pair-wise comparison of CBCT, Naked Eye, Dental Loupes and Microscope using McNemar test was employed.

Table 3 indicates pair-wise comparison of CBCT, Naked Eye, Dental Loupes and Microscope using McNemar test and the result revealed that significantly more number of MB2 canals were detected using CBCT, microscope and dental loupes as compared to naked eye (P < 0.001).

Not locating a root canal reduces the chances of treatment success and causes failure of endodontic treatment [5].

"Clinically, the mesiobuccal root contains MB2 canal, which can be identified and treated more than 70% of the time" [15]. In 1969 Weine conducted a study showed a higher frequency of MB2 canal in the MB root region ;20].

CBCT allows clear visualisation of the morphology of the mesial root of the maxillary molars, from the cervical to the apical third [11].

Using a magnification device in any endodontic procedure is related to a better clinical outcome as compared to the same procedure performed without magnification [16].

Iqbal conducted a study on 300 extracted maxillary molars. MB2 canal observed visually was 77 (25.7%), whereas using dental loupe, the number of second mesiobuccal canals located was increased up to 223 (88.3%) [17].

Table 2. Percentage of detection of MB2 canal with the diagnostic methods of CBCT, Naked Eye, Dental Loupes and Microscope

	Value (%)		Cochran Q Test	
	Yes	No	χ^2 (d_f)	*p*
CBCT	10 (25)	17 (42.5)	35.14 (3)	<.001
Dental loupes	10 (25)	11(27.5)		
Microscope	10 (25)	15 (37.5)		

Table 3. Comparison of CBCT, Naked Eye, Dental Loupes and Microscope

	Naked Eye (%)		Total (%)	McNemar test (p)
	Yes	No		
CBCT				
Yes	10 (25)	17 (42.5)	27 (67.5)	P<.001
No	0 (0)	13 (32.5)	13 (32.5)	
Total	10 (25)	30 (75)	40(100)	
Dental loupes				
Yes	10 (25)	11(27.5)	21(52.5)	P<.001
No	0 (0)	19 (47.5)	19 (47.5)	
Total	10 (25)	30 (75)	40(100)	
Microscope				
Yes	10 (25)	15 (37.5)	25 (62.5)	P<.001
No	0 (0)	15 (37.5)	15 (37.5)	
Total	10 (25)	30 (75)	40 (100)	

Fig. 1. #2 endo access bur, #6, #8, #10 K files

Fig. 2. Modelling wax

With the naked eye the detection rate of extra mesiobuccal canals was 17.2% which increased to 62.5% with dental loupes. This further increased to 71.1% using the surgical microscope. Baratto Filho et al in their studies found out frequency of extra mesiobuccal canal as 93.45% (CBCT findings), 95.63% (clinical outcomes) and 92.85% (ex vivo).

This study has evaluated the diagnostic efficacy of direct visual inspection, inspection using loupe, inspection using microscope, and analysis of CBCT images. The result of this study supplements the general knowledge by presenting sensitivity, specificity, positive and negative predictive values for these four methods.

When a diagnostic method is used, measuring its diagnostic accuracy is useful to judge the options and choose the best one [18].

In vitro studies have some limitations and applying their results to the clinical scenario is not scientific. However CBCT is a reliable tool for detecting missing canals *In vivo* [19,20,21].

Limitation lies in high cost of higher magnification diagnostic tools. Dentists must apply effort, knowledge and time in locating and preparing second mesiobuccal canals. Failure in detecting this leads to pathologies and retreatment [22]. Significance of this study lies in judgment of the accuracy of different diagnostic methods [23-25].

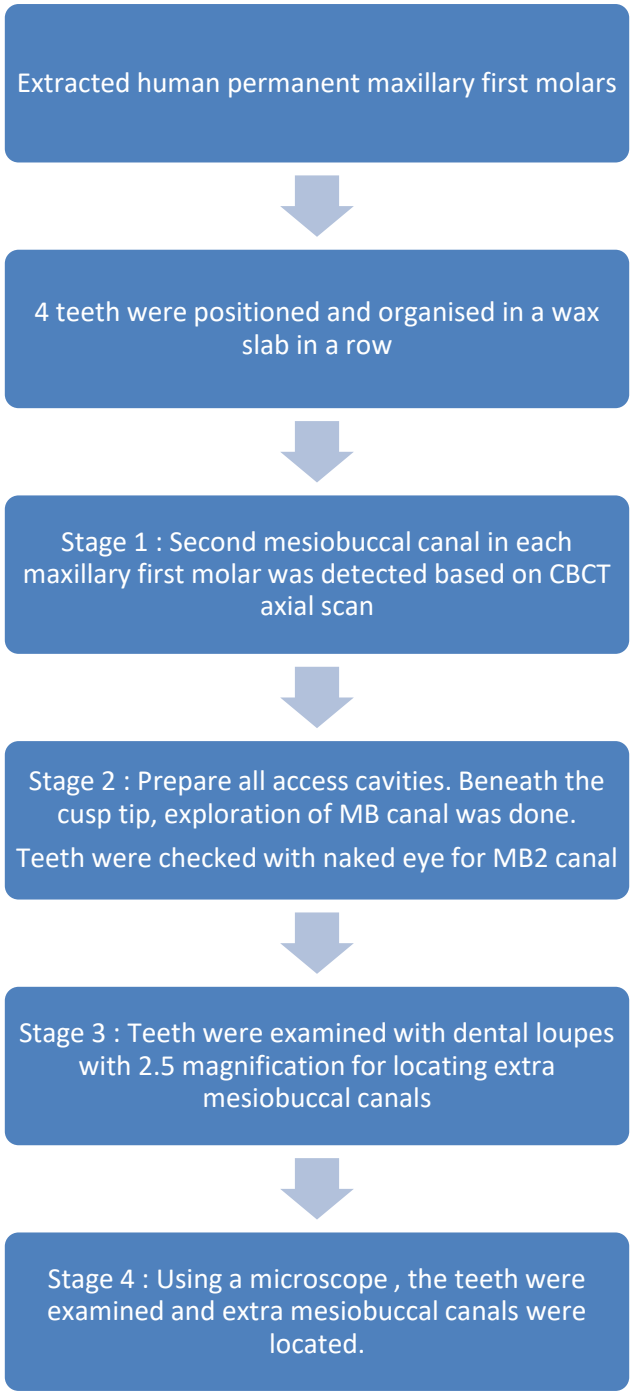


Fig. 3. Flowchart of sequential procedure

Fig. 4. 4 teeth positioned and organised in a wax slab in a row. Teeth mounted in wax blocks up to the cementoenamel junction

Fig. 5. Magnifying loupe 2.5 x magnification

Fig. 6. Teeth were examined with dental loupes with 2.5x magnification for locating extra mesiobuccal canals

Fig. 7. Detection of extra mesiobuccal canals using microscope

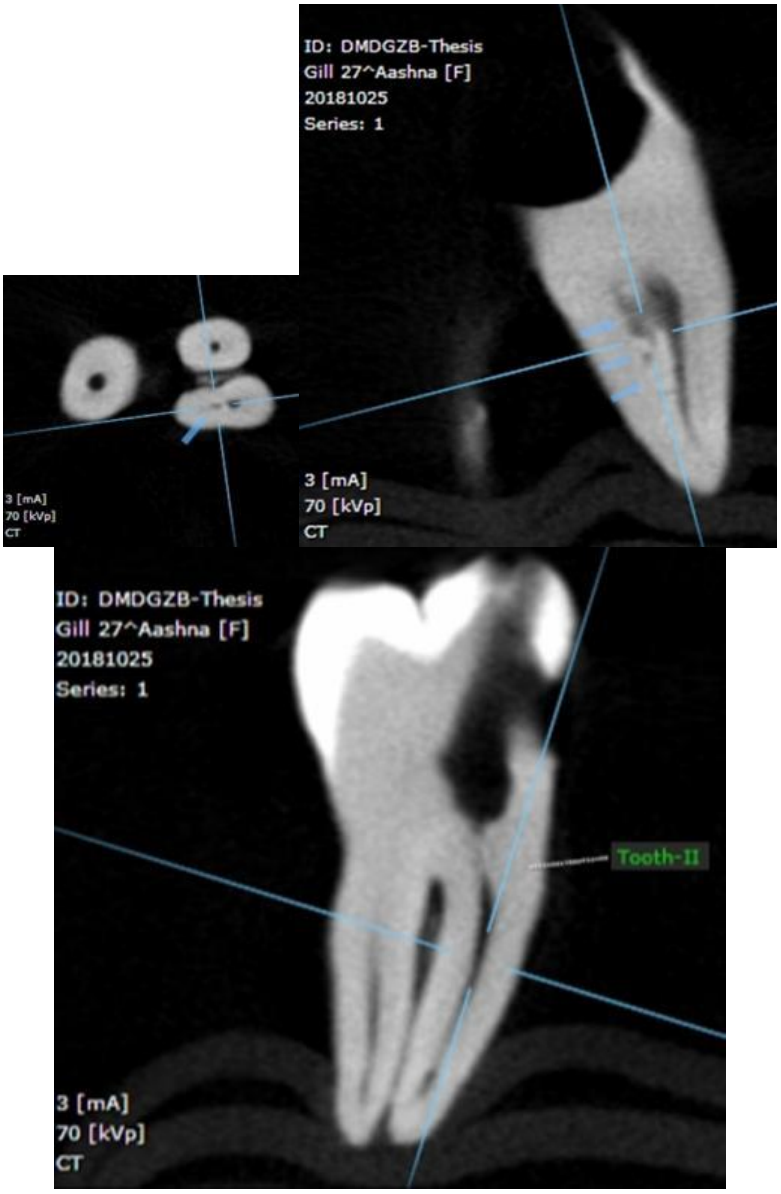


Fig. 8. CBCT images analysed in sagittal, coronal and axial planes for detecting the MB2 canal

4. CONCLUSION

A fundamental aspect of endodontic treatment is treating all the canals in the involved tooth. The inability to recognise the presence of all root canals is the major cause for failure of root canal treatment. MB2 canal should be expected to be found in all maxillary first molars. However, the canal is generally difficult to locate since it is often hidden under a dentin shelf and tends to be calcified. Choosing the most accurate diagnostic tool and knowing where to look for the second mesiobuccal canal is the key to endodontic treatment success. My study shows that magnification increases the clinical ability to locate canals. This study concluded that the incidence of MB2 canal detection was increased by using CBCT scans.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The study was approved by Scientific and Ethic Screening Committee of Santosh Dental College and Hospital.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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