Original Article

Microscope magnification and ultrasonic precision guidance for location and negotiation of second mesiobuccal canal: An *in vivo* study

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Abstract

Objective: The aim of this study was to evaluate the influence of using the dental operating microscope (DOM) and ultrasonics for the detection of second mesiobuccal (MB2) canal orifice in maxillary first molars. **Materials and Methods:** Sixty subjects seeking root canal therapy for maxillary first molar were assessed for the presence of MB2 canal using endodontic explorer without magnification. Teeth in which the MB2 canal orifice could not be located were examined under magnification using DOM. If the MB2 canal orifice could not be found even after using DOM, ultrasonic tips were used to prepare 3-mm-long trough from the mesiobuccal canal orifice toward the palatal canal and examined under DOM for location of the canal. **Results:** With naked eye, the MB2 canal was located in 12 teeth; with the use of the DOM, the MB2 canal was located in 21 additional teeth; and with the combined use of ultrasonic tip and DOM, the MB2 canal was located in 9 more teeth. Statistical comparisons between the tested techniques were done by analyzing the Receiver Operating Characteristic (ROC) curves; a statistically significant difference was found ($P < 0.001$). **Conclusion:** The results of this study indicate that the DOM and ultrasonics provide increased opportunity for the dentist to detect canal orifices.

Key words: *Dental operating microscope, maxillary first molar, second mesiobuccal canal, ultrasonics*

INTRODUCTION

Endodontic treatment outcome is directly related to thorough mechanical and chemical cleansing of the entire root canal system followed by its complete obturation with an inert filling material. The ability to locate all the canals present in the root canal system is an important factor in determining the eventual success of treatment. Undetected root canals are of concern as they are the major reason for endodontic failure.[1] Additional hidden second mesiobuccal (MB2) canal may be encountered in up to 93.5%[2] maxillary molars and their presence has been demonstrated in *in vitro*[3,4] as well as *in vivo* studies.[5-7] Optical magnification and use of precision guiding equipment have been found to increase endodontic success. The purpose of this *in vivo* study was to determine whether use of optical magnification with dental operating microscope (DOM) and precision guiding by troughing with ultrasonic tips either individually or in combination significantly

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enhance clinician's ability to locate the MB2 canal in permanent maxillary first molars.

MATERIALS AND METHODS

Thirty-four male and 26 female healthy subjects of age between 14 and 40 years, requiring root canal therapy for maxillary first molar were randomly included for the study. The study was approved by the institutional ethical committee and informed consent was obtained from all participants. All subjects were treated by a single operator. The procedure was carried out under local anesthesia [xylocaine 2% with adrenaline (1:200,000) (Astra Zeneca Pharma, Astrazenca - Bangalore)] and rubber dam isolation. Standard access cavities were prepared using Endo access bur and cavity access set (Dentsply Maillefer, Astrazenca - Bangalore). Complete de-roofing of the pulp chamber was achieved by Endo Z bur (Dentsply Maillefer). DG-16 endodontic explorer, DOM (Carl Zeiss, Astrazenca - Bangalore), and ultrasonic tips (ProUltra Endo Tips; Dentsply Tulsa Dental Astrazenca - Bangalore) were used in sequence to locate MB2 [Figure 1]. While using ultrasonic tips, a 3-mm-long trough was prepared from the mesiobuccal (MB) canal toward the palatal canal and re-examined under DOM for location of the canal. Once the canal was located, it was negotiated incrementally with K files- Mani company Japan Carl Zeiss - Bangalore of size No. 06, 08, 10, and 15, respectively. Mesial shift intraoral periapical radiograph was taken with a file in each of the canals of the MB root to confirm the presence of two canals. Images of MB2 canal [Figure 2] were captured using laptop TV tuner card (Honestech, Bangalore) connected to the DOM. 3% Sodium hypochlorite was used as endodontic irrigating solution. After the identification procedure, closed dressing was given and was scheduled for continuation of endodontic therapy. Endodontic therapy was completed within 2 weeks of identification. Statistical comparisons for visualisation of MB2 between the naked eye, DOM, and DOM with ultrasonic techniques were done by analyzing the Receiver Operating Characteristic (ROC) curves using SPSS 16.0 version software. The level of significance was set at 0.01.

RESULTS

The present study was conducted to determine the presence of MB2 canal in maxillary first molars. With naked eye, the MB2 canal was located in 12 teeth; with the use of the DOM, the MB2 canal was located in 21 additional teeth; and with the combined use of the ultrasonic tip and DOM, the MB2 canal was located in 9 more teeth [Figure 3]. MB2 canals were easily identified in younger patients [Table 1]. Among the 42 canals located, 13 were negotiated up to 16 mm and 29 were partially negotiated, i.e. up to 4–5 mm from the pulpal floor, and 18 canals were not negotiable. MB2 canal was located within 5 mm distance from the MB canal in majority of cases [Table 2]. Statistical comparisons between the tested techniques were done by analyzing the ROC curves. In this study, a curve for each MB2 canal detection technique was drawn according to its sensitivity (true-positive performance) and specificity (false-positive performance) [Figure 4]. The area under each curve was calculated and compared pair-wise with the others. Among the comparisons between naked eye, DOM, and ultrasonics–DOM combination, a statistically significant difference was

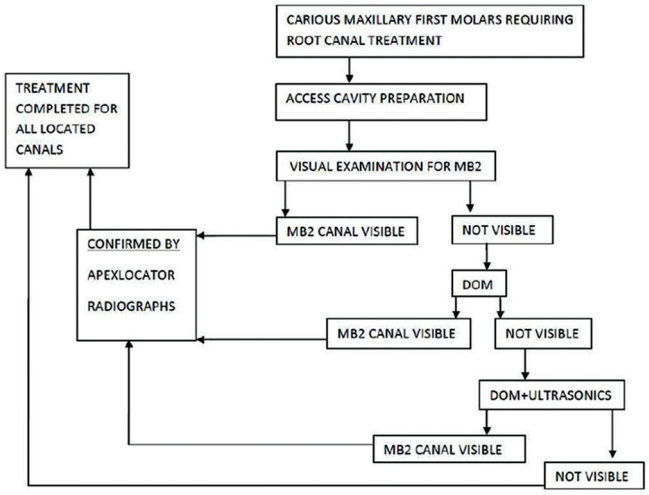

Figure 1: Protocol for identification of MB2 canal

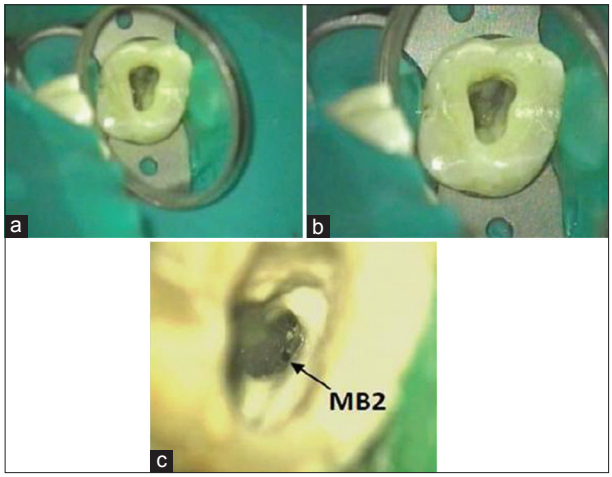

Figure 2: (a) MB2 canal not visible under naked eye. (b) MB2 canal not visible under DOM. (c) MB2 canal visible after troughing with ultrasonic tips

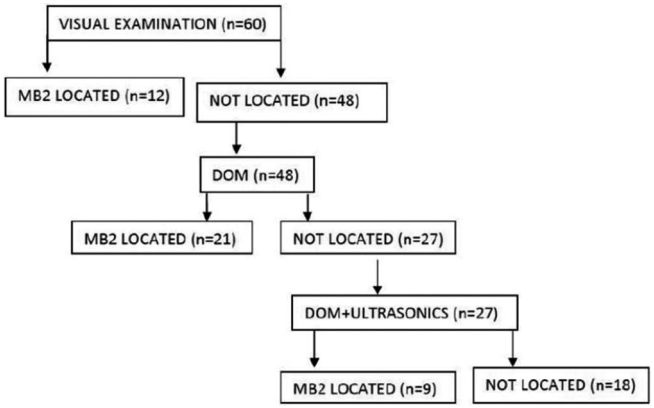

Figure 3: Results showing MB2 canal location using various techniques

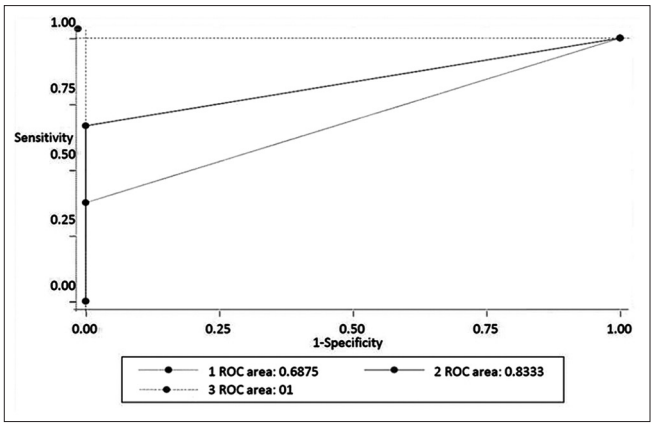

Figure 4: Receiver operating characteristic curves pertaining to MB2 canal detection using various methods

Table 1: Age distribution in study and incidence of MB2 canal

Agegroup (years)	*N*	MB2 found	MB2 not found
14-20	14	12	2
21-30	23	20	3
31-40	23	10	13

Table 2: Distance Between MB and MB2 canal

<5MM	>5MM
30	12

Table 3: ROC area of various methods

NO.	Method	ROC AREA+- SE (95%CI)
1	Naked eye	0.68+-0.03 (0.57-0.71)
2	DOM	0.83+-0.03 (0.83-0.95)
3	DOM and ultrasonic	1.000+-0.00 (1.00-1.00)

found only between the naked eye group and the DOM group ($P < 0.001$) [Table 3].

DISCUSSION

Identifying MB2 canals has always been taxing without the use of technological advances like DOM and ultrasonic devices. Hence, this study was conducted to determine if the efficiency of locating MB2 canal in maxillary molar would increase with the use of DOM and ultrasonics. Variations in the skill levels and experience of different operators in using DOM and ultrasonics can influence the outcomes;[1,8,9] hence, all procedures were performed by a single operator. Magnification and variable intensity of light, which is focused down the shaft of the optic piece, parallel to the field of magnification by the DOM provides clear view of the pulpal floor, thus leading to easier detection of this small-sized canal orifice. A developmental pattern is suggested for presence of two or more canals in a single root, i.e. a ribbon-shaped isthmus area forms during maturation leaving a larger canal and a smaller canal. Various morphological variations have been identified [Figure 5].[10] In maxillary molars, multiple canals are frequent in the MB root and these additional canals (MB2) may not terminate in independent foramina. Identification of MB2 canal has been found to reduce with increasing age of patients.[7] We were able to locate these small canals easily in our younger patients [Table 1]. Maxillary molars often become pulpally involved due to mesial caries which, in turn, stimulates Tertiary dentin formation or other canal calcifications leading to difficulty in locating the canal. To address these obstacles, "countersinking" is suggested, i.e. variable amount of dentin (1–3 mm) must be removed by troughing along the MB sub-pulpal groove with a distinct orientation toward the mesial direction[11] to uncover completely the orifice and pursue the MB2 canal deeper into the root. Munce discovery burs, round burs, composite finishing burs, and ultrasonics can be used for this purpose. In the present study, we used zirconium nitride coated ultrasonic tips which provide good control while maintaining the cutting efficiency. It has been demonstrated that troughing the chamber floor within 3 mm from the MB canal toward the palatal canal with an ultrasonic tip under DOM makes detection of MB2 canal more successful.[12] In our subjects, MB2 orifice openings were usually found mesial to an imaginary line between the MB and palatal canal orifices and commonly about 2–3 mm palatal to the MB canal orifice. Occasionally, MB2 shared orifice with the main MB canal and was oval in shape. In the present study, 70% of the maxillary first molars possessed MB2 canal. This is consistent with the findings of Buhrley

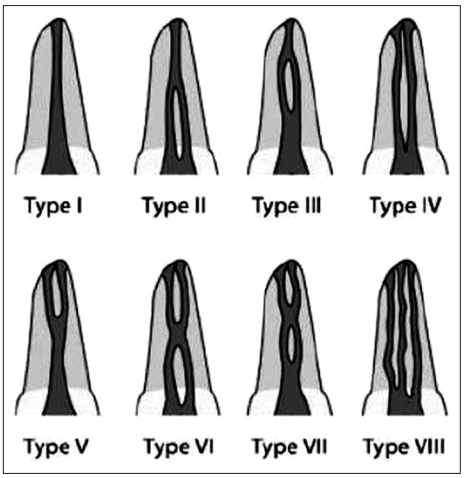

Figure 5: Vertucci's canal configuration

et al.[1] and higher than that reported by Sempira and Hartwell.[13] Negotiation of the MB2 canals was much more challenging than their location. This may be due to the tortuous pathway of some of these canals that can include one or two abrupt curves in the coronal portion as explained by Kulid and Peters.[2] We were unable to accomplish complete negotiation in majority of the canals. Leaving the canal untreated may allow microorganisms to colonize the space, leading to infection and treatment failure. Even partial treatment will enhance the chance of success.

CONCLUSION

The study results suggest that the prevalence of MB2 canal in the maxillary first molar is high, i.e. 70%, and the use of the DOM significantly increased the detection of MB2 canals in permanent maxillary first molars and the use of ultrasonics for troughing further enhanced the ability to detect MB2 canal under DOM. Considering the higher prevalence of MB2 canals in our study as well as other reported studies and additional discoveries of canal orifices by using DOM and ultrasonics in our cases, which translated into clinically significant outcome, we suggest the clinical use of DOM and ultrasonics to improve treatment prognosis.

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