Frequency of second mesiobuccal canal in permanent maxillary first molars using the operating microscope and selective dentin removal: A clinical study

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Abstract

Purpose: The aim of this study was to investigate whether the combination of operating microscope and selective dentin removal increased the frequency of second mesiobuccal (MB2) canal detection in permanent maxillary first molar teeth. **Materials and Methods:** One hundred fifty permanent maxillary first molars indicated for root canal treatment were randomly selected from patients belonging to the age group of 18–45 years irrespective of gender. After access cavity preparation and location of main canals, the MB2 canal orifice was sought in all teeth with an endodontic explorer under direct vision (Stage I), then under magnification with the aid of operating microscope (Stage II) and finally with the combined use of operating microscope and selective dentin removal (Stage III). **Results:** MB2 canals were detected in 36%, 54% and 72% of the teeth in Stages I–III, respectively. **Conclusion:** This study demonstrated that dental operating microscope when used along with adjunctive aids such as selective dentin removal/troughing and good clinical knowledge will increase the ability of dental clinician to locate MB2 canals.

Keywords: Maxillary molar, operating microscope, second mesiobuccal canal

Introduction

Maxillary molar is the tooth with the largest volume and most complex root and root canal anatomy, also possibly the most treated and least understood posterior tooth.[1]

To identify and locate all root canal spaces along with thorough chemomechanical preparation and to achieve a hermetic seal with an inert obturating material in all the portal of exit are the key requisites for successful endodontic therapy.[2,3] Posttreatment disease can be attributed to the presence of any undetected and subsequently unfilled anatomical spaces in the root canal system which can act as a nidus for infection leading to treatment failure.[2]

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Elusive "second mesiobuccal" (MB2) canal is one of the biggest mysteries in endodontics. It has been found that endodontically retreated teeth contain more undetected MB2 canals than 1st time treated teeth, suggesting that failure to locate, debride, and fill existing MB2 canals leads to a poorer prognosis.[4] The second mesiobuccal canal orifice in maxillary molars is usually located either mesial to or in the pulpal groove connecting the main mesiobuccal canal and palatal canals, within 3.5 mm palatally and 2 mm mesially from the main mesiobuccal canal.[5-7]

Traditionally, most endodontic canal detection procedures have relied on the dentist's tactile dexterity, and mental image of the canal system because the ability to visualize the canal orifices is severely restricted.[8] By magnifying and illuminating the grooves in the pulpal floor and differentiating the color differences between the dentine of the floor and walls the surgical operating microscope (SOM), has made canal location easier.[9,10]

The purpose of this study was to evaluate whether the adjunctive use of the SOM and selective dentin removal would increase detection of the second mesiobuccal canals in permanent maxillary first molars.

Materials and Methods

This study was undertaken after gaining ethical clearance from the institutional ethical committee, and the prior informed consent was obtained from all the patients who participated in the study.

Patients included in this study were those with maxillary first molars indicated for root canal treatment belonging to the

age group of 18–45 years irrespective of gender, patients who agreed and signed the informed consent form and systemically healthy patients. Excluded from this study are the retreatment cases, teeth associated with swelling, teeth with open apices, calcifications, and resorptions. A total of 150 maxillary first molars indicated for root canal treatment was included.

After achieving adequate anesthesia and rubber dam isolation, tooth was accessed with sterile Endo access bur (Dentsply Maillefer, Ballaigues, Switzerland). First, the access cavity was prepared in a triangular shape. Mesiobuccal (MB1), distobuccal, and palatal (P) canal orifices were located with the help of endodontic explorer (DG16, Hu-Friedy) and canals were negotiated with 10 or 15 K-files (Dentsply Maillefer, Ballaigues, Switzerland). Using hand instruments and copious irrigation with 3% sodium hypochlorite (Hyposept, UPS Hygienes), an attempt was made to remove the contents of the pulp chamber and root canal space. The coronal portion of each canal orifice was enlarged with Gates Glidden drills #1–#3 (Mani, INC., Tochigi, Japan). Then outline of the access cavity was modified from a triangular to a rhomboidal shape to improve the visibility of the extra canal orifice.

The floor of the pulp chamber was then explored in order to locate the MB2 canal in three stages. Stage I (Direct vision): Initially, the MB2 canal orifice was located with an endodontic explorer under direct vision. The explorer was runned from the main mesiobuccal canal towards the palatal canal but 1–2 mm mesially [Figure 1a and b]. Stage II (Under SOM): The teeth in which the MB2 canal was not located under direct vision, were examined under magnification (×8–×12) using SOM (Opto DM PRO model, Opto Electronics, Sao Paulo. SP, Brazil) with the help of endodontic explorer [Figure 2a-c]. Stage III (Troughing under SOM): The teeth in which the MB2 canal was not located again with magnification, troughing was carried out. Dentine in the pulp chamber was removed within 3 mm from the MB1 canal toward the palatal canal and 1–2 mm mesially, 2 mm deep using a small round bur at low speed under magnification (×8–×12) to locate the MB2 canal. The teeth in which MB2 canal was not located after Stage III were reported as absence of MB2 canal [Figure 3a-c]. Throughout the procedure, copious irrigation was done with 3% sodium hypochlorite solution and normal saline intermittently. After locating the canal orifice, the MB2 canal was negotiated using 06, 08 and 10 K-files. The presence of MB2 canal located was confirmed with working length (WL) determination radiographs. To be considered as a separate second mesiobuccal canal, MB2 was counted only when it was either separate from the MB1 or within 5 mm of the apex when it joined the MB1 during WL determination.

The outcome of each case was recorded during the procedure by the operator. The data were entered in Microsoft Excel [MS office 2007, Windows XP] and the data were analyzed

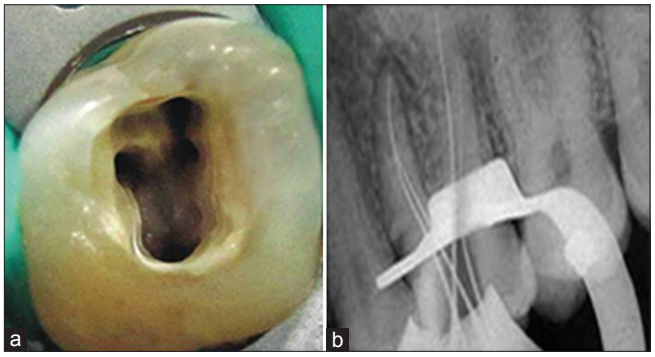


Figure 1: (a) Second mesiobuccal canal located under direct vision. (b) Canal confirmation during working length intraoral peri-apical radiograph

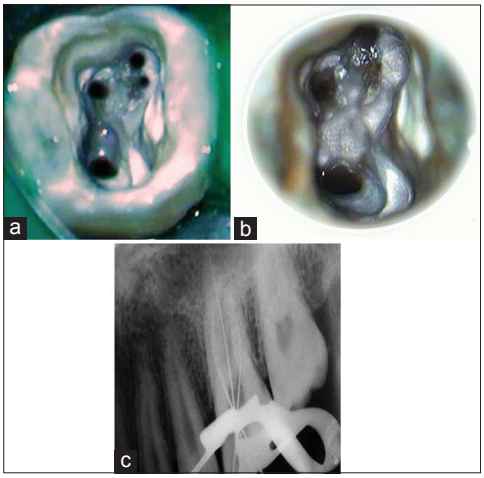


Figure 2: (a) Second mesiobuccal canal located under surgical operating microscope (×8). (b) View under ×20 magnification. (c) Canal confirmation during working length intraoral peri-apical radiograph

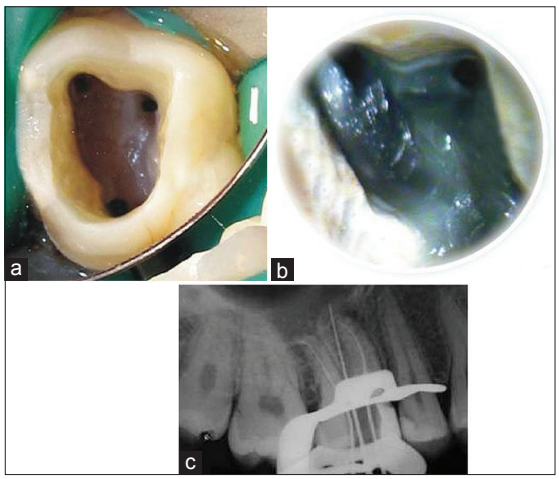


Figure 3: (a) Pulpal floor after troughing under surgical operating microscope to locate second mesiobuccal (MB2) (×8). (b) No MB2 canal was located (×20). (c) No MB2 canal in working length intraoral peri-apical radiograph

using statistical software Stata statistical software (StataCorp. 2007. Stata Statistical Software:Release 10. College Station, TX: StataCorp LP).

Results

The age of the patients was grouped into three groups as 18–25 years, 26–35 years, and 36–45 years and the frequency of MB2 canals were 74%, 73%, and 68%, respectively. Statistical evaluation revealed no significant difference between different age groups ($P = 0.824$).

Second mesiobuccal canals were detected in 73% and 71% of maxillary molars of males and females, respectively, indicating no significant difference between genders with a $P = 0.829$.

Similarly, MB2 canals were detected in 75% and 70% in maxillary first molars of left and right quadrant, respectively. Results were not statistically significant with a $P = 0.539$.

Discussion

The main objective of endodontic therapy is to prevent and cure endodontic disease, apical periodontitis.[2,11,12] However, locating, cleaning, and shaping the entire root canal system may present an uphill battle to endodontists in nonsurgical endodontic treatment.

It is generally accepted that an inability to recognize the presence of and to adequately treat all the canals of the root canal system may be a major cause of the failure of root canal therapy.[7,13-15] The frequency and risk of missed anatomy are strictly linked with the complexity of the root canal system. This is especially true when working on molars.

The morphology of the mesiobuccal root of maxillary molars has been documented as a complex root canal system with fins, isthmuses, transverse anastomoses, and even the presence of a third canal. A second canal in the mesiobuccal root in permanent maxillary molars is one of the common variations.[16]

In vitro studies of the mesiobuccal root canal system are slightly more likely to report two canals in the maxillary first molar than *in vivo* clinical studies. Pomeranz and Fishelberg found MB2 canals in 69% of the 100 teeth examined *in vitro* but could demonstrate its presence in only 31% of 100 teeth examined *in vivo*.[6] The incidence of two canals in the mesiobuccal root was higher in laboratory studies (60.5%) compared to clinical studies (54.7%).[16] The frequency varies widely, also depending on the method used: Whether done with or without dye penetration, radiographically, various sectioning techniques, record reviews, different social groups, different age groups, with or without magnification etc, Limited access and visibility in clinical settings, as well as the risk of perforation, may explain the lower prevalence of MB2 canals as compared with *in vitro* studies.

A clear increase in prevalence may be observed in some clinical studies[14,16-19] and clinical simulation studies[7,20,21] in which MB2 canals were found in >71% of the teeth. This considerable increase has been attributed mainly to improved awareness of the presence of MB2 canals,[19,22] modification in access cavity preparation[8] and use of magnification and improved illumination.[16]

With the use of specialized technology and a modified approach in the treatment of MB2 canals, the clinicians may report a higher success rate in the identification and treatment of these canals. However, there is less number of clinical studies available in the literature regarding the use of magnification to locate extra canals. Therefore, the goal of this clinical study was to report the frequency of MB2 in permanent maxillary first molars and to evaluate the influence of using the SOM and troughing for detection of MB2.

In recent years, SOM introduced in endodontics has provided the operator with significantly improved magnification, and illumination and clinicians have indicated that it facilitates treatment of very fine canals, particularly the MB2 canal.[19] One clinical simulation study by Al Omer *et al*.[23] demonstrated an increase in the number of MB2 canals located from 51% without the use of SOM to 82% with SOM. Hence, it is possible that the use of SOM to enhance the view of the operative field might increase the ability to locate the MB2 canal.

In Stage I, after modifying the access cavity preparation, the MB2 canal orifice was located with an endodontic explorer under direct vision. Here, the explorer was runned from the main mesiobuccal canal towards the palatal canal but 1–2 mm mesially, and MB2 canals were located in 54 (36%) teeth. This is in accordance with studies by Pomeranz and Fishelberg, Hartwell and Bellizi emphasizing the modification in access cavity preparation from routine triangular shape to a more rhomboidal shape for a better view and access to the area between the mesiobuccal and palatal canals.[6,8] Thorough probing of the fissure or groove between these main canals is proposed in order to locate the second MB2.

The teeth, in which the MB2 canal was not located under direct vision, were examined under magnification using SOM with the help of explorer (Stage II) and MB2 canals were located in additional 28 (29%) maxillary first molar teeth. This finding is consistent with the findings of other clinical studies where use of magnification increased the number of MB2 canals detected.[19,24,25]

The orifice of the MB2 canal is small and not easily seen as the orifices of the other main canals in the floor of the pulp chamber. When mesially located, it is often hidden under the shelf of the dentine wall or calcifications in

a small groove. It often has to be exposed by selective removal of dentine.

The teeth in which the MB2 canal was not located in Stage II, troughing was carried out under microscope. Dentine on the pulp chamber was removed within 3 mm from the MB1 canal towards the palatal canal and 1–2 mm mesially, 2 mm deep using a small round bur at low speed under magnification (×8–×12) with a SOM to locate the MB2 canal. 27 (39%) more MB2 canals were located when troughing was carried out under microscope. On an average, The MB2 canal was located either mesial to or directly on the M-P line, within 3.5 mm palatally and 2 mm mesially from the main mesiobuccal canal. Comparable landmarks have been described previously in many clinical reports.[6,7,14,16]

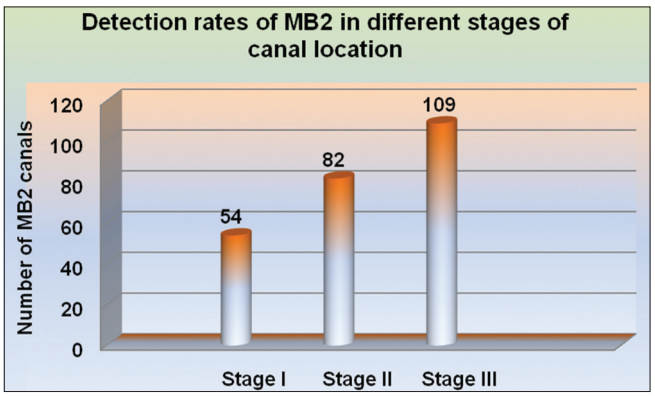
The troughing approach with the help of a small round bur at low speed was performed under the magnification of the microscope in the present study in order to increase the frequency of extra canals. One of the dangers in searching for calcified canals using troughing is the possibility of perforation. However, no perforation was reported in the present study. The SOM gives intimate detail of an area that otherwise would be under-illuminated and under-magnified, requiring guesswork with great caution. MB2 was considered as a separate canal only when it was either separate from the MB or within 5 mm of the apex when it joined the MB during WL determination.

Most of the previous studies considered the second canal to be present in cases where only separate orifices or canals were located initially. Stropko[19] considered an MB2 present if the author was simply able to instrument the canal to a depth of 3–4 mm after troughing. These criteria are consistent with Kulild and Peters[7] *in vitro* report on canals that were present coronally but then dead-ended in 24% of canals. To be considered as a separate second mesiobuccal canal in the present clinical study, the criteria were more stringent as compared to other studies. MB2 was counted only when it was either separate from the MB or within 5 mm of the apex when it joined the MB during WL determination.

In the present study, detection rates of MB2 canals in Stages I-III were 36%, 54%, and 72%, respectively [Table 1] indicating a significant difference between the stages for detecting the MB2 canal ($P < 0.05$, Friedman test). In stage I, MB2 canal was located in only 54 (out of 150) teeth. In stage II, number of MB2 canals detected increased to 82 (out of 150) teeth while in stage III, MB2 canal was located in 109 (out of 150) teeth [Graph 1]. When Stage I (direct vision with explorer) is compared with Stage III (selective dentin removal or troughing under the magnification of operating microscope), it is observed that there is significant increase in number of MB2 canals located in Stage III ($P = 0.0036$). The patients in age group of 36–45 years showed less number of MB2 canals (68%) than patients of age groups 18–25 years (74%) and 26–35 years (73%) [Table 2]. As age advances, there are less chances of locating the second mesiobuccal canals. It can be presumed that with age, the tooth is exposed to various insults like caries, attrition, erosion, etc., leading to calcification of the orifice or canal itself. This is in accordance with other studies by who showed a significant inverse relationship between age and the occurrence of two canals.[16,23] However, the results in the present study were not statistically significant ($P = 0.824$). Furthermore, no significant differences were reported in this study in different genders (males and females) and a side of occurrence with a $P = 0.829$ and 0.539, respectively [Tables 3 and 4].

Conclusion

The results of this study showed that the use of magnification leads to MB2 canal detection rate almost twice than that of



Graph 1: Detection rates of second mesiobuccal in different stages of canal location

Table 1: Detection rates of MB2 canal in different stages of canal location

Stage	Number of canals		Total
	1	2	
I	96	54 (36%)	150
II	68	82 (54%)	150
III	41	109 (72%)	150

Friedman test for repeated measures, Friedman statistics=12.90
P=0.0016 (highly significant). MB2: Second mesiobuccal; 1: One canal in mesiobuccal root; 2: Two canals in mesiobuccal root

Table 2: Frequency of MB2 in various age groups

Age (years)	Total	1	2	
18-25	54	14	40 (74%)	Chi square=0.3868 *P*=0.824 (non significant)
26-35	61	16	45 (73%)	
36-45	35	11	24 (68%)	
Total	150	41	109	

1: One canal in mesiobuccal root; 2: Two canals in mesiobuccal root

Table 3: Frequency of MB2 in males and females

Sex	Total	1	2	
Males	68	18	50 (73%)	Chi square=0.0466
Females	82	23	59 (71%)	*P*=0.829 (non significant)
Total	150	41	109	

1: One canal in mesiobuccal root; 2: Two canals in mesiobuccal root

Table 4: Frequency of MB2 in left and right quadrants

Side	Total	1	2	
Left	68	17	51 (75%)	Chi square=0.3410
Right	82	24	58 (70%)	*P*=0.539 (non significant)
Total	150	41	109	

1: One canal in mesiobuccal root; 2: Two canals in mesiobuccal root

the nonmagnification group. It is imperative for a dentist performing endodontic therapy on maxillary first molars to examine carefully the pulpal floor to locate the orifices of any "extra" canals, especially the second mesiobuccal canal. Therefore, based on these results, more emphasis should be placed on the importance of using magnification to locate the MB2 canals. Their clinical use may improve the treatment prognosis of maxillary first molars.

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