ORIGINAL ARTICLE

Dental Operating Microscope (DOM): An Adjunct in Locating the Mesiolingual (MB2) Canal Orifice in Maxillary First Molars

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ABSTRACT

Objective: The objective of this in vitro study was to evaluate the efficacy of Dental Operating Microscope (DOM) in locating mesiolingual (MB2) canal in maxillary first molars in North Indian population.

Material and Methods: The study utilised 120 freshly extracted human permanent maxillary first permanent molars. An access cavity was prepared and assessed for existence of each orifice including MB2, if the attempt failed to locate the canal by using dental operating microscope (DOM) a trench was prepared using LN-bur, if the attempt failed again, sectioning was carried out using carborundum disc in an axial plane 3 mm below cementoenamel junction to confirm MB2.

Results: 80 (66.6%) specimens out of 120 revealed MB2 canal with unaided vision, whereas with the help of microscope, another 25 specimens revealed MB2 canal thus in 105 (87.5%) samples, second root canal could be visualized. After trench preparation and microscopic evaluation a total of 111(92.5%) teeth revealed MB2, out of which 2 results were found to be false positive on sectioning. In this study on maxillary first molar in north Indian population, MB2 canal was found in 92.5% teeth after trench preparation and adjunctive use of dental operating microscope.

Conclusion: DOM increases the location of MB2 canal significantly. Though, for absolute accuracy, still better techniques are needed.

Keywords: Dental Operating Microscope (DOM), Mesiobuccal Canal, Trench Preparation

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INTRODUCTION

Success of endodontic therapy essentially depends on the accomplishment of all treatment steps, especially the complete removal of microbes and their by products from the root canal system during the cleaning and shaping procedures. For each tooth in the permanent dentition, there is a wide range of variation reported in the literature with respect to the frequency of occurrence of the number and the shape of canals in each root, the number of roots, and the incidence of molar root fusion. The recent influx of current technologies has focused largely on improving the quality of treatment, for example ultrasonic, NiTi and magnification. The introduction of dental operating microscope (DOM) in the field of endodontics is widely accepted as a beneficial aid in improving clinicians' ability to detect root canals orifices particularly in teeth in which lateral canal, additional or accessory canals have broadened. As evident from research the advantage of the microscope over the use of no magnification or loupes has been convincingly enough to justify its application in every endodontic practice.[1-6]

All the permanent teeth exhibit anatomic variations, but permanent first molars are particularly noteworthy for these deviations. The maxillary first molar attracted interest in the early part of the 20th century,[7] with most attention being focused on the mesiobuccal root. One of the biggest mysteries in endodontics has been the elusive mesiolingual (ML) or mesiopalatal (MP), usually known as MB2 canal (2nd mesiobuccal canal). Therefore, in order to achieve successful clinical results, a complete clinical and radiographic examination and a thorough knowledge of the morphology of these teeth is necessary.

Traditionally, most endodontic canal detection procedures have relied on the clinician's tactile dexterity and mental image of the canal system because the ability to visualize the canal orifices was severely limited. To perform a root canal treatment often meant working inside a "black hole" and many results were achieved by chance. This has changed with the utilization of enhanced vision systems in endodontics. Today every challenge existing in the straight portion of the root canal system or even if located in the most apical part can be easily seen, and often solved under the microscope, with magnification and coaxial illumination.[8]

Location of root canal has previously been evaluated *in vivo* and *in vitro* in research articles by using dental loupes, fiberoptic headlamps, scanning electron microscope, and sectioning for microscopic observation. Complete access is absolutely necessary for identification of MB2 orifices and systems. "Finishing" the access cavity eliminates a shelf of overlying dentin, exposing the MB2 orifice.[9]

Magnification is a critically essential element to consistently identify the MB2 orifices. Microscopes afford unsurpassed illumination, magnification, optics, ergonomics, and potential to add a variety of additional accessories, including documentation packages. As Carr[1] stated, the microscope brings the practitioner right onto the pulp chamber floor and brings minute details into clear view. Illumination is significantly improved because the light of a microscope is parallel to the line of sight and will provide two to three times the light of a surgical headlamp. Overall, the operating microscope removes a lot of the guesswork that existed previously in many areas of endodontic therapy.

Limited studies have been undertaken to evaluate the location of MB2 canal in maxillary first molars alone by using dental operating microscope as per available literature, whereas studies have been carried out on identification of second canals in the mesiobuccal root of maxillary first and second molars using magnifying loupes or an operating microscope.[4]

In view of the above facts and literature this study primarily intends to evaluate the adjunctive use of Dental Operating Microscope (DOM) along with the use of ultrasonics in locating all mesiobuccal canal orifices in the mesiobuccal root of freshly extracted first maxillary permanent molars. The present study was carried out with the aim to detect the occurrence of MB2 canal in maxillary first molar in north Indian population and evaluate the effectiveness of DOM in locating MB2 canal with and without trench preparation. This study carries significance since as of today very few studies have been carried out in this perspective in north Indian populations.

MATERIAL AND METHODS

The present study was carried out in the Department of Conservative Dentistry and Endodontics, Saraswati Dental College and Hospital, Lucknow, India. Total of One hundred twenty (n=120) freshly extracted human permanent maxillary first permanent molars teeth with closed apex and without restorations were collected from the Department of Oral and Maxillofacial Surgery. Teeth with incompletely formed open apex, root fracture, extreme canal curvature, and root canal treated teeth, root resorption, teeth with deep restorations were ruled out from the study. The teeth were collected without any bias of age and gender. The teeth were handled as per the safety guidelines of ADA on handling of extracted teeth.[10] Collected teeth were cleaned of visible blood and gross debris. Root surfaces debrided with hand scalar and stored in 10% formalin for 7 days.

Methodology: The freshly extracted teeth were initially stored in 10% formalin for 7 days and were stored in a well-constructed container with a secure lid to prevent leakage and later mounted on the dental chair mannequin (Perfect Dental, Lucknow, India) using a aluminium mould. No isolation of any kind was used. An access cavity was prepared under halogen bulbs using # 2 and #4 Endo Access bur (Maillefer, Dentsply, Switzerland). Initial penetration was made in the exact centre of the mesial pit, with the bur directed toward the palatal by using a high speed handpiece to the depth of dentin. The bur was directed toward the orifice of the palatal canal. When a drop was felt, the pulp chamber was reached. The larger palatal canal was located first after which Safe ended # 0152 Endo-Z bur (Maillefer, Dentsply, Switzerland) was used, keeping it in contact with the floor of the pulp chamber and moved mesiobuccally to the centre of the mesiobuccal cusp. The mesiobuccal canal was explored beneath the cusp tip and the bur was moved distally and slightly palatally to locate the distobuccal canal orifice. A conventional triangular access was modified to a trapezoidal shape to improve access to the additional canals. Final finishing and funneling of cavity walls was done with endo-Z fissure bur. After an adequate access cavity preparation the contents of the pulp chamber were removed using an endodontic excavator and subsequent irrigation with a 2.5% sodium hypochlorite solution. The pulp chamber floor was explored using an endodontic explorer, DG-16 (Maillefer, Dentsply). Dentin overhangs were then removed with swan necked LN groove bur (Maillefer, Dentsply, Switzerland) to open the subpulpal groove and to locate the extra canal orifice. Exploration of the groove connecting the canal orifice was performed with the use of K-files #6, #8 or #10 (Mani, Japan). Prepared specimens were then explored for MB2 in the following sequence (Fig.1):

Table 1: Localization of MB2 Canal at Different Stages (n=120)

S. No.		After Stage 1		After Stage 2		Final Confirmation by Sectioning (Stage 3)	
		No.	%	No.	%	No.	%
1.	Unaided	80	66.7	82	68.3	82	68.3
2.	Microscope	105	87.5	111	92.5	111	92.5
3.	Sectioning	–	–	–	–	109	90.8
χ^2		14.472		22.251		32.350	
P		<0.001		<0.001		<0.001	

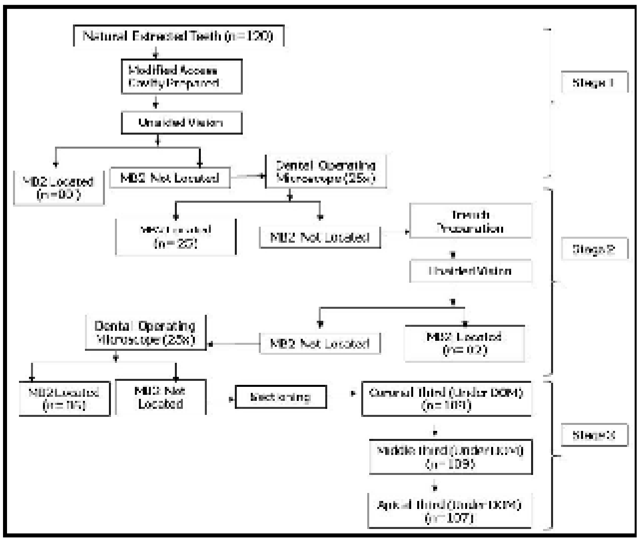

Figure 1: Flow-chart showing various stages of the methodology ('n' showing number of specimens showing MB2 canal).

Stage 1: In the first stage, modified access cavity was assessed for existence of each orifice including MB2 which were recorded when K-files #8 or #10 was pushed into the orifice and was able to stand by itself (Fig. 2). If the attempt failed to locate the canal, the Dental Operating Microscope (DOM) (3D Medisys Operating Microscope, India. Model Number ZOM-3) with 25x magnification was used to negotiate the MB2 canal.

Stage 2: In second stage, if the attempt failed to locate the canal by using DOM a trench was prepared using LN bur which was placed mesial to imaginary line between mesiobuccal and palatal canal upto a distance of 2 mm from the MB orifice. If the MB2 canal was not located then trench preparation was extended by another 0.5 mm (Fig. 3 and 4).

Stage 3: In the third stage, the teeth in which MB2 canal could not be located even after trench preparation, sectioning was carried out using carborundum disc in an axial plane 3 mm below cementoenamel junction and was seen under microscope (Fig. 5). If MB2 canal was not located then sectioning was carried out further 3 mm apically and then seen under microscope (Fig. 6). Even after sectioning in the

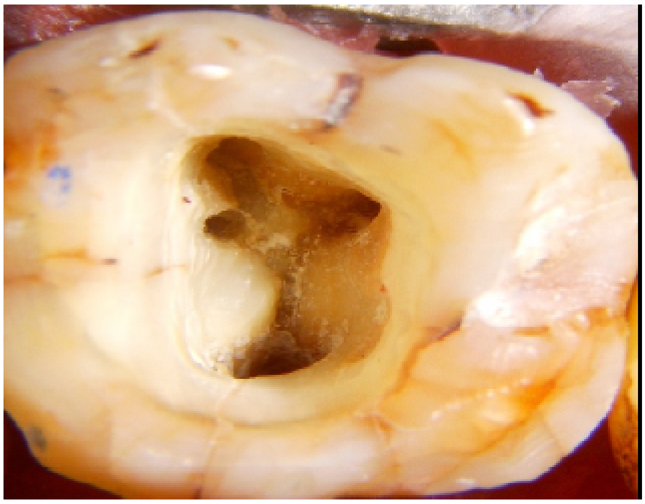

Figure 2: Maxillary molar showing four canals with unaided vision.

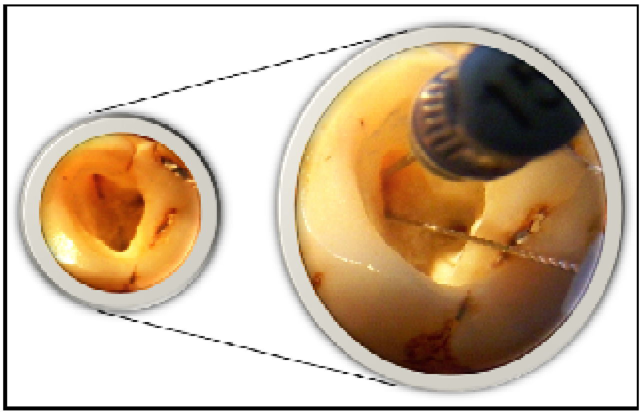

Figure 3: Figure showing placement of files after trench preparation with unaided vision.

Figure 4: Figure showing magnified view of trench preparation.

Figure 5: Section of the mesiobuccal root at the coronal third.

Figure 6: Section of the mesiobuccal root at the middle third.

Figure 7: Section of the mesiobuccal root at the apical third.

middle third, if the MB2 was not located it was sectioned further 3 mm apically and evaluated under DOM (Fig 7). All sections were examined to determine the actual presence or absence of MB2 canal orifices. In this methodology, each tooth served as its own control. The frequency of detection of MB2 was documented for each situation and the data thus obtained was statistically analyzed. Single operator prepared and evaluated all the samples for the presence of MB2 canal at three stages (cavity preparation, trench preparation and sectioning).

Statistical Analysis: Observed data was subjected to statistical analysis using SPSS (Statistical Package for Social Sciences) Version 15.0. The values were represented in Number (%). Chi-square test was used to analyze the results. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of results were evaluated with results of sectioning as the gold standard.

RESULTS

The results obtained at different stages have been shown in Table 1. After stage 1, a total of 80 (66.7%) MB2 canals could be visualized whereas microscopic evaluation showed presence of MB2 canals in 25 more specimens making a total of 105 (87.5%) samples. Statistically, this difference was significant ($p<0.001$). After stage 2, two additional MB2 canals were found, leading to a total of 82 (68.3%) MB2, whereas microscopic evaluation showed presence of MB2 canals in another 6 teeth i.e a total of 111 (92.5%) samples. Statistically, this difference was significant ($p<0.001$).

The final confirmation by sectioning (Stage 3) revealed presence of MB2 canals in 109 (90.8%) samples. On comparing the results of unaided and microscope at different stages revealed, none of the observations to be false positive for MB2 canal after stage 2, however, after trench preparation (Stage 2), though unaided vision did not show presence of any false positive MB2 canal, microscope revealed the presence of 2 false positive MB2 canals.

Fig. 8 shows the diagnostic efficacy of unaided and microscopic location of MB2 canals at different stages. It was observed that after both the stages, unaided vision had a low diagnostic accuracy (75.8% and 77.5% after stage 1 and 2 respectively) while microscope had a higher efficacy (96.7% and 98.3% after stage 1 and 2 respectively). The sensitivity of two techniques at the end of stage 1 and 2 was 73.4% and 75.2% respectively for unaided visualization and 96.3% and

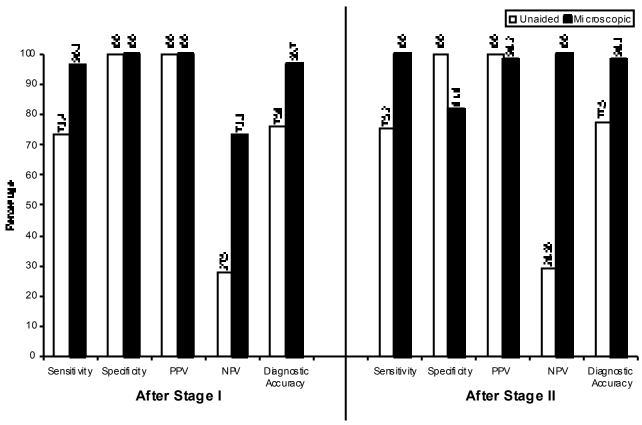

Figure 8: Diagnostic Efficacy of Unaided and Microscopic Location of MB2 Canal at different stages (Sectioning results were taken as Gold Standard).

100% respectively for microscopic visualization. After stage 1, both the techniques had 100% specificity and positive predictive value whereas after stage 2, though unaided visualization had 100% specificity and positive predictive value, microscopic evaluation had a specificity of 81.8% and 98.2% respectively. The negative predictive value of unaided visualization was much lower for both the stages (27.5% and 28.9% respectively for stage 1 and 2) as compared to that of microscopic visualization (73.3% and 100% respectively for stage 1 and 3).

DISCUSSION

Successful endodontic treatment demands an adequate cleaning, shaping and filling of the root canal system. For this, the endodontist must have comprehensive knowledge about root canal morphology. Many types of root curvatures and other anatomical variations may be present in teeth subjected to endodontic treatment. If a root canal is not located, it may reduce the chance of treatment success. For this, the location and negotiation, with subsequent cleaning and shaping, of the root canal system are necessary. Pécora *et al.*[11] affirms that one of the main reasons for the failure of root canal therapy is the lack of sufficient knowledge concerning the anatomy of teeth, both internal and external.

The first maxillary molar is the most bulky teeth in the mouth, and has numerous anatomical variations. The mesiobuccal root presents more anatomical variations, such as the number and disposition of the canals. Presence of a second canal in the mesiobuccal root is probably the greatest stumbling block in successful endodontic result of this tooth. Clinically, the presence or absence of the mesiolingual canal is limited by the conditions in which locating of the orifice is carried out. The ability to locate the mesiolingual canal depends on the skill of the operator, the complexity of the anatomy and the use of high power illumination and magnification techniques, such as that performed with the surgical operating microscope. It is assumed that the inability to locate, instrument, and obturate the second mesiobuccal canal (MB2) could lead to endodontic failure in these teeth[12] and is challenging for the clinicians too, that is why considering all the facts it was decided to take up this study for finding a safe and effective method of locating the MB2 canal by employing DOM and the trench preparation in an north Indian population.

In present study unaided vision without any procedure could visualize 80 out of 109 (73.4%) of MB2 canals. This is relatively a very big number considering the reports in literature, showing the incidence to be ranging from 31% to 69% in both *in vivo* and*in vitro* studies[12-15] even on sectioning. But the findings of Stropko[9] are very much in line with the results in present study who reported location of MB2 canal in 73.2% of molar teeth using routine procedures. In further improvement Stropko[9] has been able to visualize MB2 canal in as many as 93.0% of first molars and 60.0% of second molars by effectively using the operating microscope. The findings in present study could be attributed to the fact that in present study, the prevalence of MB2 canal was observed to be 90.8% on sectioning. No such study except that of Stropko[9] has been reported in literature so far with such high prevalence of MB2 canal. In a recent study by Rathi *et al.,*[16] detection of MB2 canal was done using Dental CT, and an incidence of 57% was observed. The findings of the present study are similar to those of Alaçam *et al.*[5] who have reported a detection rate of 67% after using operating microscope against an overall detection rate of 82% on sectioning. The findings in present study conform to these findings with a high detection rate with unaided vision and an overall high incidence of MB2 canal on sectioning. The variability in MB2 canal detection rate in different studies is an important indicator for an endodontist that makes the localization of MB2 canal an essential part of comprehensive management during procedure. This further emphasizes the use of sophisticated tools and techniques in order to locate the MB2 canal for its presence. Baldassari-Cruz et *al.*[17] have reported that the percentage of second mesiobuccal canal was 82%. All these studies reporting higher prevalence of MB2 canal were performed using magnification. The effectiveness of using a surgical/dental operating microscope has been evaluated by a number of researchers[3,17-20] and they have concluded that the magnification of the operating field increased a MB2 canal detection rate.

In present study, use of an operating microscope without adaptation of further exploratory technique could locate MB2 canal in 105 (87.5%) subjects even at stage I of the procedure. That use of advanced and innovative techniques makes sense to locate the MB2 canal has been proven in literature.[5,16] In present study, trench preparation was used as the second stage strategy to locate and explore the MB2 canal, and it showed positive results in both unaided and microscopic visualization. During second stage, 2 new MB2 canals were located with unaided vision while microscopic visualization yielded addition of 6 new MB2 canals, thus making the proportion of located MB2 canals in 68.3% unaided and 92.5% microscopically visualized maxillary first molars. As regards finding higher incidence of MB2 canals, the prevalence, location and extent of MB2 canal might vary in different populations.[21]

The use of ultrasonics along with operating microscope increased the sensitivity by 7%.[5] Though in present study trench preparation yielded in an improvisation to locate MB2 canal to the tune of only 1.6% for unaided and 5% in microscope aided vision. However, during this course a slight loss in specificity (1.8%) was observed in microscope aided vision. The localisation of MB2 canal can be improved by experience and skillful use of manevouring as done in present study where trench preparation helped in getting a clue of

MB2 canal which could be explored further during operating microscope visualization. The innovation in manouvering the canal has also been reported by Weller and Hartwell[22] who suggested that if the initial access is changed from a classical triangular shape to a more rhomboidal shape, the probability of finding the MB2 canal increases.

Despite these promising findings, on sectioning, results in 2 cases detected to be having MB2 canal on microscopy revealed to be false positive. In literature no such report is available to the best of our knowledge. The incidence of false positivity could be attributed to the lack of professional experience and operator skill as the procedures were done by postgraduate students having limited exposure. Stropko[9] too has attributed professional skill and experience as two major driving factors to locate MB2 canal effectively. Another reason could be the high prevalence rate of MB2 canals in present study. With such high rate of localization, the operators were prompted to explore and diagnose more and more MB2 canals, even at slightest of indication. Qualification of operators can be attributed to differences in over or under diagnosis of a finding.[5] Several factors that could interfere with the total or partial negotiation of MB2 canals could be debris, dentinal debris produced with the pathfinding instrument, the presence of anatomical variations, diffuse calcifications, and pulp stones.[23]

Even though in 80 of the teeth MB2 could be detected with a modified access cavity and unaided vision, still the significance of the other 25 teeth in which the MB2 was detected with the use of microscope cannot be underestimated. After the third stage of using microscope with trench and sectioning the number of teeth with MB2 increased from 80 (66.7%) in the first stage to 111 (92.5%) in third stage, which is a statistically significant. This study highlights the adjunctive use of magnification with use of advanced and innovative techniques to locate MB2 canal in first maxillary molar. The microscope is helpful in finding the additional canals which are not visible with unaided vision, however, the modification in cavity preparation and trench preparation to locate these canal orifices are of utmost importance. The use of innovative techniques needs to be handled with caution as it can compromise with the specificity of the diagnosis. Skill acquisition and further studies on the innovative techniques are warranted.

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