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An In-Vivo Study to Validate the Internal Anatomic Findings, obscured by Unaided Eye suggesting Presence of Extra Canal in Mesio Buccal Root of Maxillary First Molar with Various Magnification Aides: An Original Research Study

Dr. Apoorva Gupta[1], Dr. Zaryab Ateeque Momin[2], Dr. Ayushi Goyal[3], Dr. Swetalina Paul[4], Dr. Ansu Ann Alex[5], Dr. Rahul Maria[6]

[1]Reader, Department of Conservative Dentistry and Endodontics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India (Corresponding Author)

[2]Senior Lecturer, Department of Conservative Dentistry and Endodontics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India

[3]Senior Lecturer, Department of Conservative Dentistry and Endodontics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India

[4]PG Resident, Department of Conservative Dentistry and Endodontics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India

[5]PG Resident, Department of Conservative Dentistry and Endodontics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India

[6]Professor, Department of Conservative Dentistry and Endodontics, Bhabha College of Dental Sciences, Bhopal, Madhya Pradesh, India

Corresponding Author: Dr. Apoorva Gupta

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KEYWORDS

Internal Anatomic Findings, Unaided Eye, Extra Canal, Mesio Buccal Root, Maxillary First Molar, Magnification Aides, Loupes, Microscope

ABSTRACT:

Aim: To validate the internal anatomic Findings, obscured by unaided eye suggesting presence of extra canal in mesio buccal root of maxillary first molar with various magnification aides.

Materials and Methods: A total of 60 patients were selected for the study and prior informed consent was obtained from all patients. The presence of MB2 canal in maxillary first molar was observed using radiographic, visual, magnification diagnostic aids. Digital radiograph of the maxillary first molar with the bisecting angle technique was taken. Another radiograph with the mesial and distal angulation was taken. After achieving adequate anaesthesia and rubber dam isolation, tooth was accessed with sterile Endo access bur Rubber dam was applied. Access cavity preparation was initiated with round bur BR 41(Mani). Pulp tissue was debrided with the help of endodontic excavator. Access cavity was irrigated using sodium hypochlorite 3%. The pulp chamber was then dried and dentinal map was followed to locate the root canal orifice.

Results: In this research, we utilized SPSS software for our statistical analysis. Total 60 teeth were first detected by unaided eyes, out of 60 teeth MB2 canal was detected only in 10 teeth by unaided eye. The remaining 50 teeth were detected by surgical loupes method, in that out of 50 teeth, MB2 canal was detected in only in 22 teeth. Remaining 28 teeth were detected by dental operating microscope, in that out of 28 teeth, MB2 canal was detected in 26 teeth. In 2 teeth MB2canal was not detected by any methods. The data obtained was subjected to statistical analysis with the consult of a statistician. The data so obtained was compiled systematically.

Conclusion: Our study concluded that the adjunctive use of the higher magnification increases the ability to locate MB2 canal in maxillary molars.

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Introduction

Knowledge of dental root internal morphology has been a complex and extremely important issue regarding the planning and execution of endodontic therapy.[1-2] It has fascinated researchers and clinicians for variety of reasons. The maxillary first molar has one of the most complex root and canal anatomy.[3] It has the largest volume, and has exhibited a frequent radicular anatomy of 3 roots and 3 to 7 canals. Besides that, their roots could be ovoid, which has increasingly interfered in the visualization and detection of additional canals especially during radiographic procedures.[1-3] Most endodontic canal detection procedures have relied on the doctors tactile dexterity and mental image of the canal system.[6] currently, technological advances have been developed and different techniques have been introduced to facilitate the assessment of internal anatomic variations of dental roots, For this purpose, magnification usage in daily clinic could potentialize and facilitate the localization and handling of additional canals.[1] The surgical operating microscope provides the clinician with superior lighting and magnification.[7] Studies have shown that when the operator experience had been increased as a result of regular use of an operating microscope, the prevalence of detection of additional canals increased to 93%.It is very possible that magnification and illumination will increase one's ability to locate the second mesiobuccal canal in maxillary molars.[6] Magnification has been found to increase the detection rate of additional canals from 17.2% with the naked eye, to 62.2% with loups, and 71.1% using the surgical operating microscope.[6] The purpose of this study is to evaluate occurrence of second mesiobuccal canal in maxillary first molar under unaided eyes and on magnification in an in vivo, clinical setting.

Aim: The aim of the study is to validate the internal anatomic Findings, obscured by unaided eye suggesting presence of extra canal in mesio buccal root of maxillary first molar with various magnification aides.

Objectives: 1.To determine the presence of extra canal in mesiobuccal root. 2. To compare frequency of extra canal with Unaided eyes and loupes. 3. To compare frequency of extra canal with Unaided eyes and microscope. 4. To compare frequency of extra canal with Loupes and microscope.

Materials and Methods

Patients indicated for root canal treatment were selected from the outpatient department (OPD). A detailed medical and dental history was taken. The inclusion criteria enlisted male and female patients in age group of 18 to 50 years with intact maxillary first molar teeth, teeth without calcified pulp chamber, with no modification in morphology and indicated for root canal treatment. Whereas the exclusion criterion stated male and female patients not falling in the age group of 18 to 50 years, fractured tooth, cracked tooth, teeth radiographically showing calcified pulp chamber, morphologically altered tooth and tooth not indicated for root canal treatment.

Clinical Procedure

This study was undertaken after gaining ethical clearance from the institutional ethical committee. A total of 60 patients were selected for the study and prior informed consent was obtained from all patients. The presence of MB2 canal in maxillary first molar was observed using radiographic, visual, magnification diagnostic aids. The method for determining the presence MB2 was as follows:

Radiographic Method: Digital radiograph of the maxillary first molar with the bisecting angle technique was taken. Another radiograph with the mesial and distal angulation was taken.

Visual Method: After achieving adequate anaesthesia and rubber dam isolation, tooth was accessed with sterile Endo access bur (Dentsply) Rubber dam was applied. Access cavity preparation was initiated with round bur BR 41(Mani). And then with the help of nonend cutting bur access cavity was refined to its conventional shape and modified to remove the mesial shelf of dentin. Pulp tissue was debrided with the help of endodontic excavator. Access cavity was irrigated using sodium hypochlorite 3%. The pulp chamber was then dried and dentinal map was followed to locate the root canal orifice. Root canals were located with the help of endodontic explorer DG16. 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.

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Stage II (Under Surgical Loupes): The teeth in which the MB2 canal was not located under direct vision, were examined under Surgical loupes (2.5x) then exploration was done with the help of endodontic explorer and ultrasonic tips.

Stage III Under DOM): The teeth in which the MB2 canal was not located under direct vision and loupes were examined under dental operating microscope (25x).

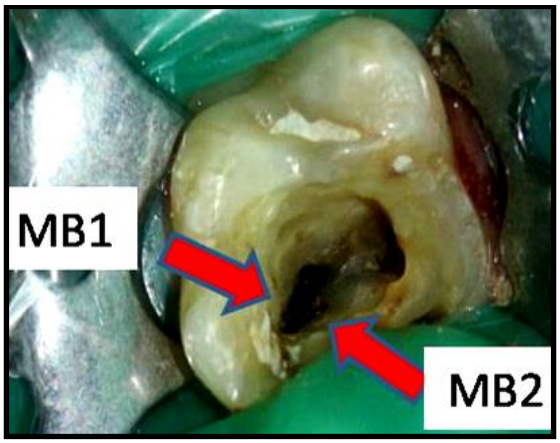

Fig 1: Photographic Representation of Access Cavity Showing Presence of MP2 Canal with Unaided Eye

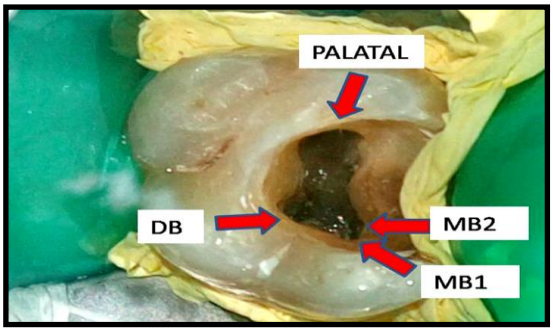

Fig 2: Photographic Representation of Access Cavity Showing Presence of MB2 Canal with Surgical Loupes

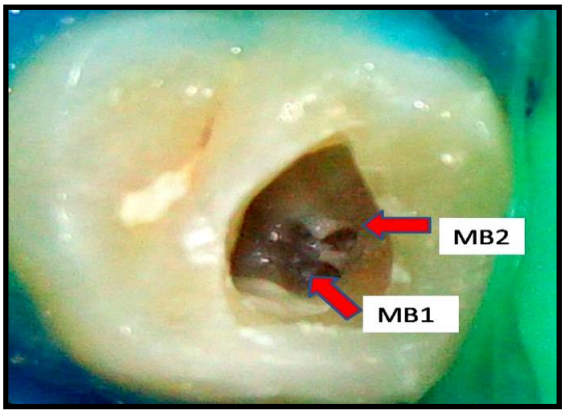

Fig 3: Photographic Representation of Access Cavity Showing Presence of MB2 Canal under DOM

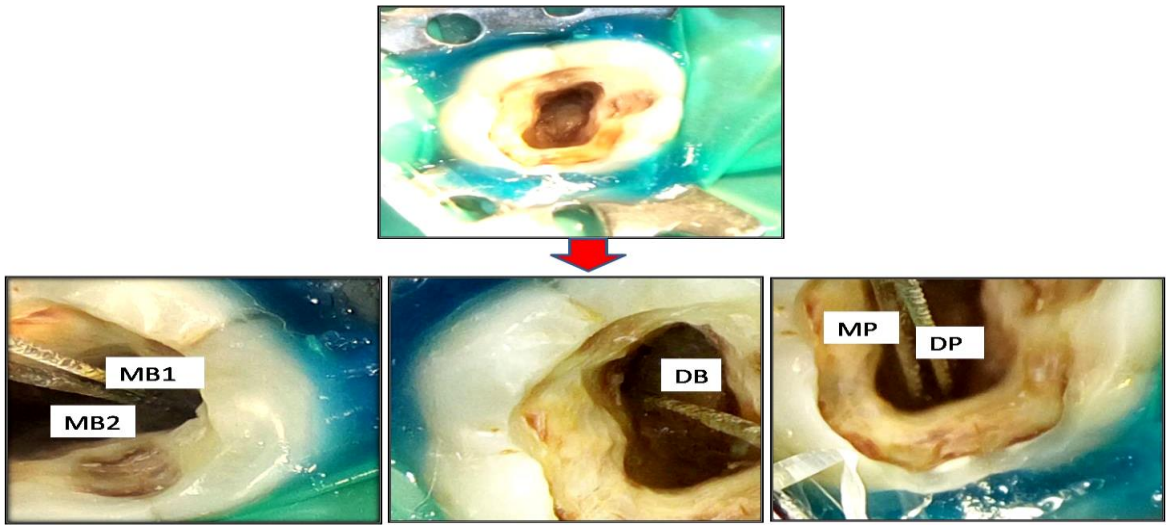

Fig 4,5,6,7: Photographic Representation of Access Cavity Showing Presence of Five Orifices with DOM

Statistical Analysis and Results

In this research, we utilized SPSS software version 22.0 for our statistical analysis. This approach allowed for a comprehensive comparison of categorical data, guaranteeing that our findings truly represent the trends and connections within the dataset. The following result were obtained when compare the efficiency of unaided

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eye, surgical loupes and dental operating microscope in locating an extra canal in the mesiobuccal root of the maxillary first molars in patients undergoing root canal treatment for detection of second mesiobuccal canal using un aided eye, surgical loupe, and dental operating microscope. 60 teeth were first detected by unaided eyes, out of 60 teeth MB_2 canal was detected only in 10 teeth by unaided eye. The remaining 50 teeth were detected by surgical loupes method, in that out of 50 teeth, MB_2 canal was detected in only in 22 teeth. Remaining 28 teeth were detected by dental operating microscope, in that out of 28 teeth, MB_2 canal was detected in 26 teeth. In 2 teeth MB_2canal was not detected by any methods. The data obtained was subjected to statistical analysis with the consult of a statistician. The data so obtained was compiled systematically. A master table was prepared and the total data was subdivided and distributed meaningfully and presented as individual tables along with graphs. Statistical procedures were carried out in 2 steps: Data compilation and presentation Statistical analysis Statistical analysis was done using Statistical Package of Social Science (SPSS Version 22; Chicago Inc., USA). Data comparison was done by applying specific statistical tests to find out the statistical significance of the comparisons. Quantitative variables were compared using mean values and qualitative variables using proportions. Significance level was fixed at $P \leq 0.05$. Table 1 reveals comparison in detection of MB_2 canal in 60 first molar by unaided eye, surgical loupes method & Dental Operating Microscope. There was statistically highly significant difference found in detection of MB_2 canal in 60 first molar teeth by unaided eye, surgical loupes method & Dental Operating Microscope. (p=0.001). Table 2 reveals diagnostic accuracy of surgical loupes method in comparison to Unaided Eye among first molar in detection of MB_2 Canal. Diagnostic accuracy of surgical loupe method was 44.0% as compare to unaided eye (11.66%). There was statistically highly significant difference found in detection of MB_2 Canal between surgical loop method & unaided eye. (p=0.002) Table 3 reveals diagnostic accuracy of Dental Operating Microscope method in comparison to Unaided Eye among first molar in detection of MB_2 Canal. So, diagnostic accuracy of Dental Operating Microscope method was 92.8 % as compare to unaided eye (16.66%). There was statistically highly significant difference found in detection of MB_2 Canal between surgical loop method & unaided eye. (p=0.001).

Table 1: Detection of MB_2 canal in 60 first molar teeth by unaided eye, surgical loupes method & Dental Operating Microscope

MB_2 Canal Detected	**Unaided Eye N=60**	**Surgical Loupes Method N=50**	**Dental Operating Microscope N=28**
Yes	10	22	26
No	50	28	02
Total	60	50	28
Diagnostic Accuracy	16.66%	44.0%	92.8%
Chi Square Test Value	45.6%		
Significance ‘p’ Value	0.001(HS)		

Table 2: Diagnostic Accuracy of surgical loupes method & Unaided Eye among first molar in detection of MB_2 Canal

MB_2 Canal Detected	**Unaided Eye, N=60**	**Surgical Loupes, N=50**
Yes	10	22
No	50	28
Total	60	50
Diagnostic Accuracy	16.66%	44.0%
Chi Square Test Value	9.88	
Significance ‘p’ Value	0.002(HS)	

Graph 1: Diagnostic Accuracy of surgical loupes method in comparison to Unaided Eye among first molar in detection of MB_2 Canal

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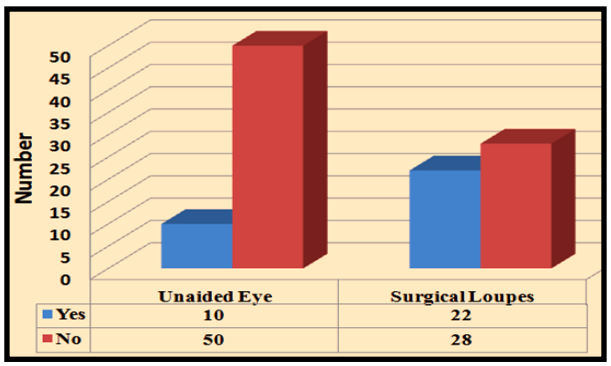


Table 3: Diagnostic Accuracy of Dental Operating Microscope method in comparison to Unaided Eye among first molar in detection of MB_2 Canal

MB_2 Canal Detected	Unaided Eye, N=60	Dental Operating Microscope, N=28
Yes	10	26
No	50	02
Total	60	28
Diagnostic Accuracy	16.66%	92.8%
Chi Square Test Value	45.8	
Significance 'p' Value	0.001(HS)	

Graph 2: Diagnostic Accuracy of Dental Operating Microscope method in comparison to Unaided Eye among first molar in detection of MB_2 Canal

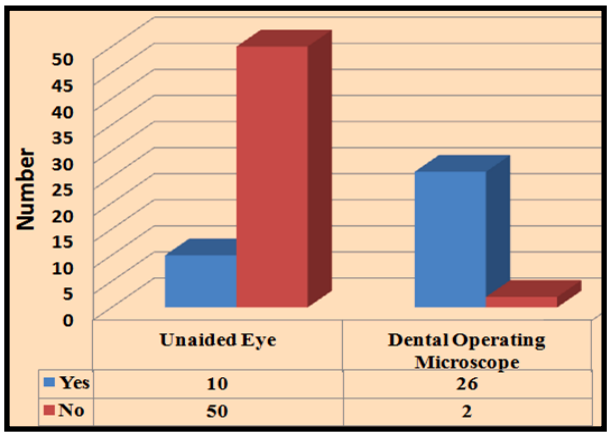
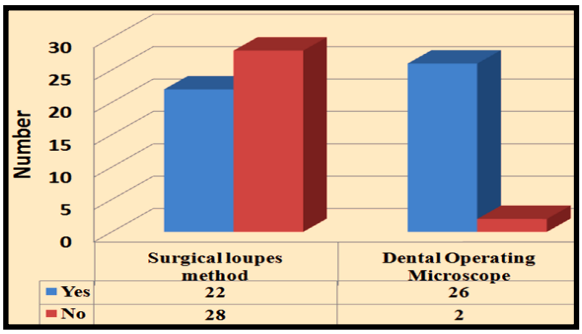


Table 4: Diagnostic accuracy of Dental Operating Microscope in comparison surgical loupes method to among first molar in detection of MB_2 Canal

MB_2 Canal Detected	Surgical Loupes N=50	Dental Operating Microscope N=28
Yes	22	26
No	28	02
Total	50	28
Diagnostic Accuracy	44.0%	92.8%
Chi Square Test Value	18.1	
Significance 'p' Value	0.001(HS)	

Graph 3: Diagnostic accuracy of Dental Operating Microscope in comparison surgical loupes method to among first molar in detection of MB_2 Canal



Discussion

The main purposes of endodontic treatment is to clean and disinfect root canal systems in order to reduce the number of microorganisms and extract necrotic tissue, and finally to obturate this system and thus prevent recontamination (Del Fabbro *et al.*, 2007).[44] The major cause of endodontic failure when treating the first maxillary molar is failure to debride the entire root canal system, which usually occurs because the clinician was unable to detect additional root canals.[48] It was reported that remnants of pulp tissue can be a reservoir for the growth of microorganisms, which may affect and compromise treatment outcomes.[49-50]

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According a study by Pomeranz and Fishelberg[51], clinicians are aware that the mesiobuccal root often contains two canals; however, the second canal (MB2) is often not observed.[52] Therefore, the ability to locate all canals in the root canal system is an important determinant of successful endodontic treatment. The intricate complexity of morphology of root canal system has attracted the attention of researchers and clinicians for the past many years. This owes to realization of the fact that a thorough understanding of morphology will ensure the success of endodontic therapy. One of the goals of non-surgical root canal treatment is location and debridement of all canals whenever possible.[53-55] In the treatment of maxillary molars, locating and negotiating a second mesiobuccal (MB2) canal in the mesiobuccal (MB) root may have implications to the long-term prognosis.[56] Maxillary molars often have two canals in the mesiobuccal root, as described by Hess.[57] in 1925. In 1969, Wiene et al.[58] suggested that inability to locate, instrument, and obturate the MB2 canal could lead to endodontic failure. The anatomy of the roots of the maxillary first molars is very complex. Locating the MB2 canal is thus a challenge for the clinician in achieving successful treatment of maxillary molars. If the prevalence of the MB2 is high in a population, time should be devoted to its location and treatment.[6] In an *in vivo* study by Hartwell and Bellizi[52], the prevalence of the MB2 canal was as low as 18.6%; however, an *in vitro* study by Kullid and Peters noted a prevalence of 95.2%.[59] There are differences among reports in the research methodology used. Some studies investigated extracted teeth *in vitro*; others were performed in a clinical setting. Different methods for locating the MB2 result in varying prevalences. In 1973, Seidberg et al.[60] and Pomeranz and Fishelberg.[61] reported the results of studies performed *in vitro* and *in vivo*. The *in vitro* study of Seidberg et al. reported that 62% of 100 teeth had an MB2 canal, whereas the *in vivo* study found that 33.3% of 201 teeth had an MB2 canal. The *in vitro* study of Pomeranz and Fishelberg revealed that 69% of 100 teeth had an MB2 canal, whereas the *in vivo* study reported that 31% of 100 teeth had two canals. 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. It is possible that the use of an operating microscope or loupes to enhance the view of the operative field might increase the ability to locate the MB2 canal. Traditionally, most endodontic canal detection procedures have relied on the doctor's tactile dexterity and mental image of the canal system, because the ability to visualize the canal orifices was severely limited. This has changed with the utilization of enhanced vision systems in endodontics. The use of surgical headlamps and dental loupes has evolved into the use of the surgical operating microscope.[6] Root anatomy complexity is undermined in available literature, and its emphasized that the clinician should understand its possible variations (al Shalabi *et al*., 2000; Prabhakar *et al*., 2013; Abarca *et al*., 2014; Jiménez *et al*., 2015; Vaillard Jiménez *et al*., 2015). The canal system of the maxillary first and second molar is complex and difficult to study. It is reported that the mesiobuccal (MB) root presents the greatest variation and many studies have stressed the need to be aware of the presence of extra canals in this root (al Shalabi *et al*.). The presence of a second canal in the MB root (MB2) is reported to be between 18% and 95% (Bauman *et al*., 2011). This wide range is due to the designs and methods used in these studies (Peeters, Suardita, & Setijanto, 2011) and could also be associated with ethnic differences, gender and age of the study populations (Cleghorn *et al*.). It is possible that if one had a greatly enhanced view of the operating field via the DOM or loupes, the ability to locate the MB2 canal would increase.[6] The aim of the study is to validate the internal anatomic Findings, obscured by unaided eye suggesting presence of extra canal in mesio buccal root of maxillary first molar with various magnification aides. In the present study before starting the following protocol Morphologic variation in the anatomy of the root canal system was considered at the beginning of a treatment. Each case, independent of the type of tooth, was examined clinically and radiologically in a thorough manner to detect possible anatomic anomalies. Endodontic treatment was initiated with proper preparation to allow access to the cavity, which could ease the process of investigating and successfully detecting all root canal orifices. The following protocol was followed for all cases. The outline form of access cavity was dictated by the canal anatomy. Traditionally, the outline form for maxillary first molars was triangular. The points of the triangle extend to the mesiobuccal, distobuccal and palatal line angles. The MB2 canal lies on an imaginary line from the mesiobuccal orifice to the palatal orifice or just

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slightly mesial to this line. So the access cavity was extended more mesially. Hence, the outline form needs to be more trapezoidal in shape in order to extend the access cavity mesial to the location of the MB2canal .The access cavity was confined to the mesial portion of the occlusal table and in most cases, the oblique ridge was not crossed unless necessary to remove caries or an existing restoration. The shelf of dentine overlying the MB2 canal needs to be removed. This shelf of dentine can easily be removed using a vertical pulling motion from under the shelf. This can be done by using a long-shank slow speed round bur (size no 2 or slightly larger) or a specially designed endodontic ultrasonic tip. This colour difference creates a distinct junction where the walls and floor of the pulp chamber meet. If this junction cannot be seen, it is an indication that the entire roof of the chamber has not been removed. Since the MB2 canal is the smallest of the four canals, it is often the first canal to calcify coronally. When you are attempting to locate canals, your bur should not be cutting on white areas, which could result in perforation, but rather focusing on the grey pulpal floor. The DG16 endodontic explorer was used to probe along the development groove, palatal to the MB orifice, to see if a catch can be detected. If no catch can be detected, you will need to slowly trough/ lower the pulpal floor using a long-shank slow speed round bur or a ultrasonic tip. When using these instruments, it is beneficial to be working dry to allow for maximum visibility. Also, the dentinal debris that is removed is often pushed into the orifice of the MB2 canal, making it appear white and more visible. In addition a small amount of sodium hypochlorite in the pulp chamber was used to see effervescence. The organic tissue in the MB2 canal causes these bubbles.[62] According to Corcoran, et al.2007 the examiner's ability to locate root canals is largely dependent on clinical experience. Other possible explanation is that the removal of dentin excess from the canal entrances, as recommended by Kulild and Peters.[59] Also contributed to the similarity between the visual, loupe and microscope methods. Other findings have also suggested that difficulties in locating MB2 canals are primarily associated with the presence of calcifications.[25,65,66] Another reason as to why there was statistically highly significant difference when comparing DOM and loupe, and loupe and unaided eye in locating MB2 is "The Resolving Power of Human Eye." Resolution is nothing but the ability to distinguish two objects that are very close together, are two distinct objects rather than a single object. The results of this study show that the use of magnification leads to a MB2 detection rate approximately three times that of the non-magnification group and that the use of no magnification results in the location of significantly fewer MB2 canals. Based on these results, more emphasis should be placed on the importance of using magnification for locating the MB2 canal.

Summary

There are some inherent problems with a clinical study of this kind. One is the variability of the teeth. Some teeth are more difficult to treat than others for various reasons and these differences cannot be sorted out before and to create a level playing field for each magnification group. Another problem is that some participants may be less determined to locate a hidden canal than others. It is possible that, in some instances, the most important factor in locating the MB2 canal is not the magnification but the persistence of the operator. The results of this study show that the use of magnification leads to a MB2 detection rate more than that of the non magnification group. The use of no magnification results in the detection of significantly fewer MB2 canals. Of particular interest is that there was statistically highly significant difference between locating the MB2 with the use of the microscope and using loupes. Based on these results, more emphasis should be placed on the importance of using higher magnification in locating the MB2 canal.

Conclusion

Combined with the knowledge of root canal system anatomy, magnification and illumination, along with the use of other aides can definitely increase the chance of locating additional canals, thereby increasing the rate of success of endodontic therapy. Our study demonstrated that the adjunctive use of the higher magnification increases the ability to locate MB2 canal in maxillary molars.

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