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DETECTION OF 2ND MESIOBUCCAL CANAL IN PERMANENT MAXILLARY 1ST MOLAR USING VARIOUS VISUALIZATION METHODS: AN IN-VITRO STUDY

Dental Science

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ABSTRACT

Aims and objectives: This in-vitro study was done to compare and evaluate the detection rate and time taken to detect 2nd mesiobuccal canal in permanent maxillary 1st molar using Direct Vision, Dental Loupes, Dental Operating Microscope [DOM]. **Methodology:** In this in-vitro study,30 extracted permanent maxillary first molars were selected with inclusion and exclusion criteria.Pre operative CBCT was taken and the results were kept blinded from the principal investigators.Access cavities were prepared following standard endodontic protocols.MB2 canal detection was carried out using three visualization methods-direct vision, dental loupes, and DOM.The time taken for the MB2 canal detection using each method was recorded and statistically analysed by one-way ANOVA under IBM SPSS version 26. **Results:** The MB2 canal detection rates under Direct Vision, Dental Loupes, DOM were similar. Time taken for detection of MB2 canal was the least when done under Microscope followed by Dental Loupes and highest under Direct vision. The time taken for detection of MB2 canal among the three methods was found to be statistically significant($p<0.001$).All the 3 methods were able to find MB2 canal which was later confirmed by CBCT pre operative analysis. **Conclusion:** Though the detection rates were similar for DOM, Dental Loupes and Direct Vision, the time taken for detection of MB2 canal varied significantly. Advanced visualization techniques improve clinician's efficacy, promotes ergonomic working posture and reduces operator fatigue.

KEYWORDS

CBCT, maxillary first molar, MB2 canal, dental loupes, Dental Operating Microscope [DOM].

INTRODUCTION:

Successful endodontic treatment depends upon complete debridement, disinfection, and obturation of the entire root canal system. The mesiobuccal root of the maxillary first molar frequently contains a second canal (Mb2), which is often difficult to locate and negotiate (Weine et al., 1969)1.Vertucci (1984)2 reported a high incidence of multiple canal configurations in the mesiobuccal root, emphasizing the complexity of its internal anatomy. Failure to identify and treat the MB2 canal has been identified as a major cause of endodontic failure and post-treatment disease (Hoen and Pink, 2002)3.The introduction of magnification aids such as dental loupes and dental operating microscopes has significantly improved visualization of the pulpal floor and canal orifices (Buhrley et al[4]., 2002 and Stropko, 1999)5.Costa et al6 in 2019, stated that the overall incidence of missed canal accounts to 12%, of which the highest frequency of untreated canal was found in maxillary molars (57%).Study by Blattner et al[7] in 2010 and Mirmohammadi et al8 in 2005 showed that CBCT sensitivity for detecting an MB2 canal was 96%, specificity was 100%, and total accuracy was 98%.Baratto Filho et al9 in 2009 and Studebaker et al[10] in 2017 stated that CBCT can be used as reliable tool for the identification of MB2 canal during initial treatments, retreatments, and treatment of maxillary molars through full-coverage crowns.

CBCT11 is a reliable mode of imaging to visualize an individual tooth or dentition and to create 3D images of the area to be visualized. Dental Loupes allows better identification of the pulp chamber floor anatomy, which could lead to locating MB2 canal that were not visible to naked eye. Dental Operating Microscope allows precise visualization of tiny anatomical structure including narrow, hidden, atypically positioned or calcified MB2 canal. Therefore, this in-vitro study was designed to compare and evaluate the detection rate and time taken to detect 2nd mesiobuccal canal in permanent maxillary first molars.

Materials and methodology:

Inclusion and exclusion criteria were mentioned in Table.1

Table .1

Inclusion criteria	Exclusion criteria
Teeth with no developmental anomalies	Teeth with previous endodontic treatment
Teeth with fully formed apices	Teeth with root fracture or damage
Teeth with three distinct roots	Teeth with restoration
No root fracture, resorption, or external defect	Teeth with extensively carious or damaged crowns
Tooth with minimally damaged crown	Inadequate root anatomy
Teeth must be non-endodontically treated	Teeth with open apices.
No calcification and no restorative material	Teeth with internal or external root resorption

Materials used:

The materials used in this in-vitro study included thirty extracted human permanent maxillary first molar teeth. Access cavity preparation was performed using a round carbide bur #2 (Mani) and a fissure carbide bur #57.Canal negotiation was carried out with a DG-16 endodontic explorer (Hu-Friedy). Stainless steel K-files of sizes 6, 8, and 10 (Dentsply) were used for canal negotiation. Irrigation was performed using 3% sodium hypochlorite solution (Prime Dental Products Pvt. Ltd., India).

EQUIPMENT USED:

The equipment utilized in this in-vitro study included a Cone Beam Computed Tomography unit (Newtom-Giano HR3D) for radiographic evaluation. Magnification during canal detection was achieved using dental loupes (Stac magnifying loupe-2.5x) and a Dental Operating Microscope (Woodpecker KP Isee 9000) with adjustable magnification ranging from 2x to 12x. An airotor handpiece (NSK PanaAir FX) was used for access cavity preparation and refinement.

PREOPERATIVE CBCT ANALYSIS:

Samples were arranged in templates mimicking the natural arch made using modelling wax. The base of the wax template was made flat enabling the plate to stabilize it on top of the plastic bite plane roughly centered in the focal trough area. The prepared sample plate was then placed onto the bite plane of CBCT unit.To confirm the presence of additional canal, axial section CBCT images were taken with Newtom CBCT unit at 120kVtube voltage, tube current of 5mA, exposure time of 26 seconds, field of vision 80mm and voxel size 0.125mm. The NNT software was used for the image analysis.

METHODOLOGY:

30 extracted permanent maxillary first molar teeth which fulfilled the inclusion and exclusion criteria were selected. Samples were subjected to preoperative CBCT analysis and the results were kept blinded from the principal investigators. The samples were divided into 3 groups of 10 each based on the method used for detection of MB2 canal.

- Group 1: Direct vision
- Group 2: Dental loupes

- Group 3: Dental Operating Microscope

Teeth were mounted in cast stone and rhomboidal access cavities were made with #2 round bur and #57 fissure carbide bur. In Group 2, access cavities were prepared under magnification using magnifying loupes. In Group 3, access cavities were prepared under magnification using dental operating microscope.

Dg 16 endodontic explorer was used to aid in detection of the canals in all the groups. If an MB2 orifice was located in any of the samples, attempts were made to negotiate the canal with 6, 8, or 10 K-files and the findings were compared with CBCT analysis.

RESULTS:

Statistical analysis

Data collection was done using MS Excel and statistical analysis was carried out using IBM SPSS version 26. Descriptive statistics and inferential statistics were performed.

Inter group comparison was done using the one-way ANOVA.Intra group comparison was done using the chi-square test.

MB2 canal detection was assessed by three independent examiners using direct vision , dental loupes and Dental Operating Microscope . Table 2 shows distribution of MB2 canals among total samples.The overall detection rate was found to be similar among the three visualization methods. Statistical analysis using one-way analysis of variance (ANOVA) showed no statistically significant difference in detection rates among direct vision, dental loupes, and dental operating microscope ($p > 0.05$).

However, a difference was observed in the time required for MB2 canal detection. The mean time taken was highest with direct vision, followed by dental loupes, and lowest with the dental operating microscope [table.3]. One-way ANOVA demonstrated that the time taken to detect MB2 canal in permanent maxillary 1st molar using Direct Vision, Dental Loupes, Dental Operating Microscope was statistically significant ($p < 0.05$).

Use of magnification significantly reduced the time required to locate the MB2 canal. The dental operating microscope enabled quicker identification due to enhanced illumination and magnification.The results highlights indicate that the dental operating microscope demonstrated superior efficiency in MB2 canal detection by requiring significantly less time compared to dental loupes and direct vision, while dental loupes showed better magnification over direct vision but were inferior to the microscope.These findings indicate that the magnification-assisted methods improved efficiency and reduced operator time during MB2 canal detection.

DISTRIBUTION OF MB2 canals

Method group	Examiner 1 (MB2)	Examiner 2 (MB2)	Examiner 3 (MB2)	Total
Method1: Direct vision	4 (1)	3	3	10
Method 2: Dental Loupes	3	4 (1)	3	10
Method 3: Microscope	3 (1)	3 (1)	4 (2)	10
Total	10	10	10	30

Table.2 TIME TAKEN FOR DETECTION OF Mb2

S.no	Methods	Mean (Sec)	S.D	p value
1	DIRECT VISION	378.4	73.03	< 0.001*
2	DENTAL LOUPES	229.80	58.37	
3	DENTAL OPERATIONG MICROSCOPE	127.70	28.80	

p value < 0.05 is statistically significant

DISCUSSION:

The detection of the second mesiobuccal (MB2) canal was a critical factor influencing the success of endodontic treatment in maxillary first molars. The mesiobuccal root has generated more research and clinical investigation than any other root in the mouth. Our study compares and evaluates the detection rate and time taken to detect 2nd mesiobuccal canal in permanent maxillary 1st molar using Direct Vision, Dental Loupes, Dental Operating Microscope [DOM].

After pre operative CBCT analysis and detection of MB2 canals, all the samples were access opened and were examined for MB2 canal under Direct Vision, Dental Loupes, Dental Operating Microscope (DOM) respectively.

The MB2 detection rates under Direct Vision, Dental Loupes, Dental Operating Microscope were similar. Time taken for detection of MB2 canal was the least when done under Microscope followed by Dental Loupes and highest under Direct vision ($p<0.001$).

Dental Loupes provide better magnification (2x to 4.5x) and improving visibility compared to Direct Vision.They are cost effective, portable and easy to use, making them suitable for routine clinical practice. Their use facilitates easier identification of canal orifices, including the second mesiobuccal canal in maxillary first molars. Dental loupes offer a moderate level of magnification, which improves precision compared to direct vision. They reduce operator strain by promoting better posture and ergonomics during endodontic procedures. In this in-vitro study, dental loupes reduced the time required for MB2 canal detection when compared to direct vision. The portability and ease of use make dental loupes suitable for routine clinical practice. They require minimal setup time compared to the dental operating microscope. Dental loupes enhance hand-eye coordination and operator confidence. They serve as an effective transitional tool for clinicians moving from unaided vision to microscope-assisted dentistry. Dental loupes are cost-effective compared to dental operating microscopes. However, their magnification is limited compared to microscopes. Despite this limitation, dental loupes significantly improve clinical efficiency, represent a practical and effective magnification aid in endodontic practice.

DOM provides high magnification (2.5x to 20x) with coaxial illumination significantly improving canal visualization. It allows identification of fine anatomical details. It enhances detection of the second mesiobuccal (MB2) canal in maxillary first molars. The DOM significantly reduces the time required for MB2 canal identification compared to other visualization methods. Improved illumination aids in identifying developmental grooves and anatomical landmarks. The microscope offers adjustable magnification levels, enabling stepwise exploration during access cavity preparation. It improves precision and accuracy in canal location procedures. The use of DOM enhances operator ergonomics by promoting an upright working posture. It reduces operator fatigue during prolonged endodontic procedures. DOM assisted visualization improves clinical efficiency and procedural confidence. The microscope allows documentation through photographic and video recording. Despite higher cost and setup requirements, its shows more clinical benefits. Overall, the dental operating microscope is considered the gold standard for magnification in endodontic practice.

This results were in accordance with previous studies by Coelho de Carvalho and Zuolo12 in 2000, Gorduysus et al13 in 2001, Karabucak et al14 in 2016, Baldassari- Cruz et al15 in 2002, Schwarze et al16 in 2002, Coutinho Filho et al17 in 2006, Khalinghinejad et al18 in 2017, routine use of magnification, especially Dental Operating Microscope allows conservative access cavity preparation, minimizes unnecessary dentin removal, reduces procedural errors like ledge formation, perforation, instrument separation. DOM promotes ergonomic working posture and reduces operator fatigue.

CONCLUSION:

From the results obtained and within the limits of this study, the following conclusions can be made.The MB2 detection rates under Direct Vision, Dental Loupes, Dental Operating Microscope were similar. Time taken for detection of MB2 canal was the least when done under Microscope followed by Dental Loupes and highest under Direct vision ($p<0.001$).Though the detection rates were similar for Dental Operating Microscope, Dental Loupes and Direct Vision, the time taken for detection of MB2 canal varied significantly. Advanced visualization techniques improve clinician's efficacy, promotes ergonomic working posture and reduces operator fatigue. Routine use of DOM may enhance overall endodontic treatment success rate with minimal working time.

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