ORIGINAL RESEARCH PAPER

Endodontics

KEY WORDS: MB2 Canal, CBCT, Dental Operating Microscope, Ophthalmic Dye

CONFIRMING THE BEST CLINICAL METHOD OF FINDING THE MB2 CANAL IN MAXILLARY FIRST MOLAR – AN IN VITRO STUDY

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ABSTRACT

INTRODUCTION: Maxillary first molar is the largest tooth in terms of total volume and is generally considered the most anatomically complex tooth due to its variation and complex morphology, particularly in the mesiobuccal root.
Throughout the literature, much of the focus of the maxillary first molar has revolved around the mesiobuccal root and the second mesiobuccal canal, which is referred to as either the MB2 or the mesiolingual canal. Although not always located, the MB2 canal is present on average 56.8% of the time when all studies are taken into account. Depending on the study referenced to and the method used, the presence of the MB2 canal ranges from 18.6% to 96.1%. When the MB2 canal cannot be located or properly treated, it may contribute to continuous patient pain or root canal failure.
METHOD: The purpose of this study was to ascertain the best clinical method to detect the MB2 canal in 100 maxillary first molars that has gone through CBCT for confirming the presence of MB2 canal- using 3 independent methods: stage 1, wirect occlusal access; stage 2, direct occlusal access with dye and stage3, direct occlusal access with a dental operating microscope (DOM);
RESULT: The prevalence of an MB2 canal with blinded CBCT volume evaluation was 89% (89/100).
Stage 1, Direct occlusal access of the tooth without magnification, showed an MB2 canal in 45% (45/100) of teeth.
Stage 2, Direct occlusal access with dye, led to an MB2 detection rate of 52% (52/100) of teeth.
Stage 3, Direct occlusal access of the tooth with magnification under dental operating microscope, demonstrated the presence of an MB2 canal 88% (88/100) of the teeth.
When the prevalence of MB2 canals found in Group 1 (45%) was compared with groups 2 (52%), 3 (88%) were all found to be statistically significant ($P = .032$, $P = .002$, and $P < .001$, respectively).
CONCLUSION: In the above study it is seen that using magnification is the best clinical method for searching the MB2 canal in the maxillary first molar.

INTRODUCTION

Endodontic disease could negatively affect the quality of life of patients. The success of endodontic treatment depends on the proper cleaning, shaping, and obturation of the entire root canal system.[1]

The permanent maxillary 1st molars are one of the most frequently endodontically treated teeth and it is ofparticular interest in the field of endodontics because of its variations and complex morphology, particularly in the mesiobuccal root which has been demonstrated dating back to 1925. In fact, the maxillary first molar is the largest tooth in total volume and is generally considered the most anatomically complex tooth.[2]

A high percentage of treatment failures occurs due to the failure to detect the presence and location of the second mesiobuccal canal (Mb2), located in the mesiobuccal root of the 1st maxillary molars which prevents the correct implementation of biomechanical instrumentation, irrigation and obturation.[3]

This canal often goes unnoticed, which can be attributed to the fact that it departs the pulp chamber at a sharp mesial inclination and is then bent again in the distal direction, making its detection highly challenging.[4]

Finding its location in clinical practice is highly complex due to the excessive dentin deposition in the opening of the canal and the difficulty in visually accessing maxillary molars.[3] Therefore,knowledge of the morphology of the root canal system is extremely important in planning endodontic therapy, as its success relies on thelocation of all of the canals that can then be disinfected, shaped, and filled.[5]

Investigators reported varying prevalence of the second mesiobuccal canal of maxillary first molar. The prevalence of a second mesiobuccal canal in the mesial root varies between 26% (Pecora 1992) and 93.5% (Sert & Bayirli 2004). Nikoloudaki et al (2015) attributed these variations to the different methods that were used for the detection of the MB2 canal.[3]

The prevalence of two canals in laboratory studies is higher (60.5%) to that reported in clinical studies (54.7%) (Cleghorn et al 2006).[6]

The purpose of this study was to ascertain the best clinical method to detect the MB2 canal in 100 maxillary first molars that has gone through CBCT for confirming the presence of MB2 canal- using 3 independent methods:

Stage 1:Direct occlusal access

Stage 2: Direct occlusal access with dye
Stage 3: Direct occlusal access under a dental operating microscope (DOM)

MATERIALS AND METHODS

One hundred extracted human maxillary first molars were collected and analyzed.

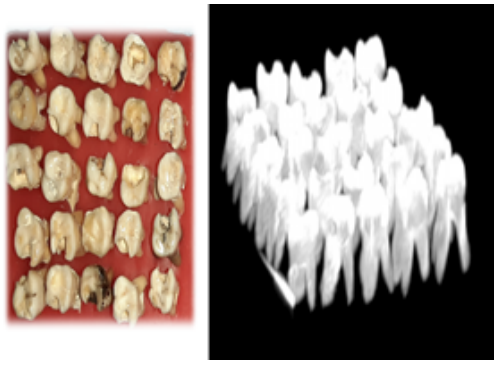
No information regarding age, sex, or clinical history of the studied teeth was available.

Selection specification for teeth included normal crown anatomy, 3 separate roots, fully formed apices, an intact pulpal floor, and no developmental anomalies.

After extraction, the teeth were placed in 5% sodium hypochlorite, debrided of periodontal tissue, and rinsed under running tap water. The teeth were then stored in physiologic saline until the beginning of the experiment.

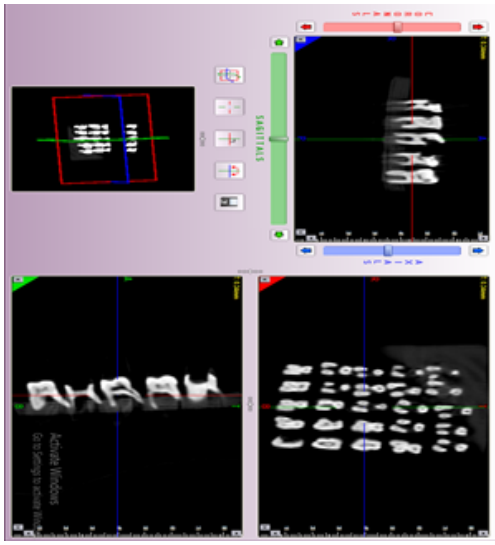
CBCT IMAGING

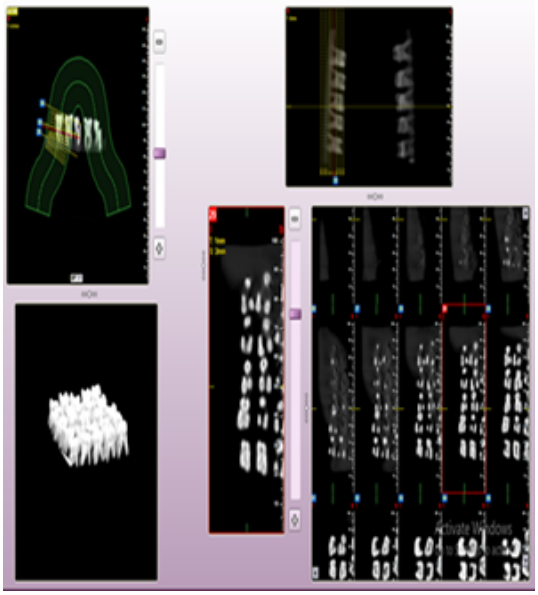
The experimental teeth were numbered from 1 to 100. Teeth were positioned in a wax slab such that the slab consisted of 25 teeth arranged in the configuration of 5 column and 5 rows and there were 4 such slabs. A gutta-percha cone was placed on the right side of the wax slab to identify in the CBCT image, later each slab was scanned with CBCT (Kodak, 9300c, U.S.A). The voxel of 0.2 mm was used with an exposure of 16 min.



The record of the number of canals and their variations was recorded by two examiners, an Endodontist, and a Radiologist.

Both evaluators viewed and manipulated the CBCT volumes independently and were completely blinded from the results of the other evaluations. Initial calibration involved independent viewing and manipulation of CBCT volumes to standardize readings and agreement.





ACCESS OPENING

An access cavity was prepared under light using 2 and #4 Endo access bur (Maillefer, Dentsply, Switzerland).

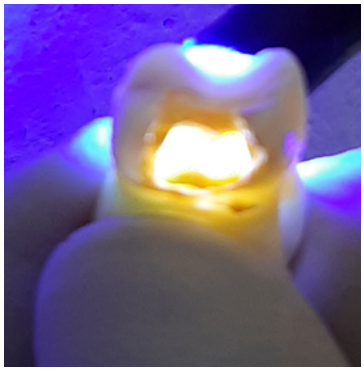
Initial penetration was made in the exact center of the mesial pit, with the bur directed towards the palatal using a high speed hand piece to the depth of dentin. The larger palatal canal was located first after which safe-ended #0152 Endo-Z bur (Maillefer, Dentsply, Switzerland) was used, keeping it in contact with the floor of the pulp chamber and moved mesiobuccally to the center of the MB cusp.

The MB 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, Switzerland). Exploration of 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:

Stage 1: Teeth were checked with naked eye (unaided vision) for second canal in the MB root with the help of explorer and then k-files #6, #8 and #10 and Ethylenediaminetetraacetic acid was used to negotiate MB2 canal. If canal was not located by naked eye, samples were subjected to stage 2.

STAGE 2: The teeth in which we failed to locate MB2 canals were examined with Opthalmic dye, ophthalmic dye, strip was used to apply dye to the area of interest. Firstly saline was collected in the dappen dish, and then ophthalmic strip was dipped in the saline solution. This strip was then placed in the access cavity for around 3 to 5 minutes. This dye was absorbed by the tissue present at the orifice. Blue curing light was then applied from the buccal aspect of the tooth. Dye which was absorbed by the tissue present at the orifice reflects fluorescent color on application of blue light. This helps in locating the MB2 canal.



Following this the teeth in which MB2 canal which could not be traced after Stage 2, we advanced to examination under an operating microscope at 19X magnification (Global Surgical Corporation's G6 microscope, six steps of magnification, magnification range of 2.1x to 19.2x.)

STAGE 3: Magnification method: Using operating microscope gives us the maximum magnification in the clinical setting so the chances of finding MB2 canal is very high. Hence operating microscope would be considered as the final aid for the detection of the MB2 canal. Operating microscope of 19X magnification was used as "gold standard" for detection of MB2 canal in maxillary first molar.

RESULT

The prevalence of an MB2 canal with blinded CBCT volume evaluation was 89% (89/100) assessed by the Endodontist and this value was 86% (86/100) as detected by the Radiologist.

Stage 1: Direct occlusal access of the tooth without magnification, showed MB2 canal in 45% (45/100) of teeth.

Stage 2: Direct occlusal access with dye, led to MB2 detection rate of 52% (52/100) of teeth.

Stage 3: Direct occlusal access of the tooth with magnification under dental operating microscope, demonstrated the presence of an MB2 canal 88% (88/100) of the teeth.

When the prevalence of MB2 canals found in Group 1 (45%) wascompared with groups 2 (52%), 3 (88%) were all found to be statistically significant (P = .032, P = .002, and P < .001, respectively).

DISCUSSION

Canal identification is critical to successful root canal treatment. Ina recent retrospective cohort study, Karabucak et al evaluated theprevalence of missed canals in Endodontically treated teeth using CBCT volumes. They found that when a canal was missed the tooth was 4.38 times more likely to have an associated lesion. Additionally, the MB2 canal was the most frequently missed canal.[7]

The frequency and risk of missed canal anatomy are strictly linked with the complexity of the root canal system.[8]

One potential reason that explains why MB2 canals are frequently missed is that these canals often occur at levels deeper than that of the chamber floor.[9]

Failure to treat extra canals is a risk factor for persistent apical periodontitis since it might harbour microbial biofilm. Therefore, it is prudent to better understand the tooth root morphology by means of 3D imaging technology to anticipate the challenge of root canal treatment. It has been reported that when extra canals in the Mesiobuccal root are suspected, the access cavity should be modified to locate their potential canal orifices.[9]

CBCT is a relatively recent innovation that overcomes many of the limitations of conventional radiography. It has many applications in Endodontics because it's three dimensional images allow inspection of the tooth in the axial, coronal, and sagittal planes. The axial plane is particularly useful in helping the clinician to determine the number of rootcanals and their location relative to one another.[10]

Studies have also shown that CBCT images accurately depict anatomical structures without significant magnification or distortion.[10]

Various techniques have been applied to enable the identification of MB2 canals, such as modification in the access cavity preparation, use of digital radiography technology, or contrast media.[4]

Access cavity modifications and canal detection techniques, in combination with technological advancements in magnification and illumination, have greatly assisted in the detection and treatment of the MB2 canals.[4]

In addition, to the use of bur and explorers to search out the additional hidden orifices, endodontic ultrasonic tips are now commonly employed for the same purpose.[4]

Ophthalmic dyes (e.g. fluorescein sodium, rose bengal) are currently being used in Opthamological diagnostic procedures and for locating damaged areas of the cornea due to injury or disease.[11]

When these dyes come into contact with vital or non-vital pulp tissue they are readily absorbed by the connective tissue elements of the pulp in the chamber and root canal system. When exposed to blue light, these dyes dramatically fluoresce, showing scattered tissue segments that contrast with the surrounding monochromatic dentin. It is this quality that makes them useful in the location of pulp tissue in root canals, especially in those that are calcified and have tissue remnants within.[11]

The success rate of all these efforts combined has been considerably low, whereas with the aid of magnification, the frequency of locating MB2 canals has been greatly enhanced.[4]

Alaçam et al. proposed that operating microscope and ultrasonics when used together effectively increased the identification of MB2 canals in permanent maxillary first molars.[4]

Buhrley et al. in their study showed that the use of magnification increased MB2 detection rate by almost three times when compared to that of non-magnification.[4]

CONCLUSION

From this study it can be concluded that the prevalence of MB2 canal in the maxillary first molar is 89% as found by the CBCT scan.

Clinically direct access opening without magnification can search MB2 canal in 45% of teeth and when dye used, this finding increases to 52% but this finding increases upto 88% when access done under microscopic magnification.

So we can conclude from the above study that using magnification is the best clinical method for searching the MB2 canal in the maxillary first molar.

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