CBCT and microscopic analysis of the incidence of second mesiobuccal canal of maxillary molars

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ABSTRACT

Introduction: The objective of successful endodontic treatment is a complete chemical-mechanical cleaning of root canals and filling. Therefore, a root canal not located represents a possible cause of endodontic failure, due to lack of cleaning and filling. **Objective:** The aim of this study was to determine the incidence of second mesiobuccal (2MB) canal in mesiobuccal roots of maxillary molars, comparing the efficacy of three methods for their identification: Cone beam computed tomography (CBCT), clinical analysis (CA) and operating microscope (OM). **Methods:** The existence of the second mesiobuccal (2MB) canal was evaluated by two examiners in 42 first and second molars without pulp involvement. The teeth were subsequently evaluated by the three methods and later these mesiobuccal roots were sectioned at 3 and 7 mm from the apex in the axial plane and observed with a digital microscope. **Results:** Was revealed the real presence of 10 2MB canals (23.81%). Statistical analysis by McNemar test showed that there was no statistically significant difference ($p < 0.05$) in the efficacy of 2MB canals localization between the three methods. **Conclusion:** None of the three methods made possible the determination of the 2MB canal in all cases, however CBCT showed the better results.

Keywords: Dental Pulp Cavity. Molar tooth. Cone-Beam Computed Tomography. Microscopy.

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Introduction

The objective of successful endodontic treatment is the complete chemical and mechanical cleaning of the root canal system and filling with inert material.[1] Therefore, a canal not located is a possible cause of endodontic failure, result of lack of cleaning and filling.[2]

The morphology of the permanent molars has been studied extensively[1,3-6] reporting the presence of two canals in the mesiobuccal root of maxillary molars[7-18]

Clinical and *in vitro* studies differ as to the prevalence and location of the second mesiobuccal canal (2MB). Its occurrence appears to be greater than 50%,[2,3,5,12,15] having the direct visualization the lowest detection index (40%) for the first and second molars.[14,16,18]

The periapical examination still represents the gold standard for endodontic diagnosis[9] but new techniques have been introduced to facilitate the evaluation of the anatomical variations of the roots, among them the cone beam computer tomography (CBCT). This type of imaging study has several applications in endodontics, including periapical diagnosis, evaluation of root canal anatomy, surgical planning, evaluation of resorption (external and internal), suspected perforation and the diagnosis of dental trauma.[19-22]

Another device that can facilitate the location of root canals as a result of its clear magnification and significant field of view, is the operating microscope (OM).[16] Studies have shown that its use facilitates the detection of 2MB canal *in vitro* and clinically,[5,8,10] the incidence increased to 71.1% when the operating microscope was used.[10]

The objective of this study was to determine the incidence of 2MB canal orifice of first and second molars from clinical analysis (CA), CBCT and OM at *in vitro* environment.

Material and Methods

Sample Selection

After approval by the Ethics Committee in Research of the Hospital for Rehabilitation of Craniofacial Anomalies, University of São Paulo (HRAC-USP) (protocol # 124/2011), 42 extracted teeth were selected, from the Human Teeth Bank of Bauru School of Dentistry. Thirty-four teeth contained existing coronal restorations, without pulp involvement.

Preparation of teeth

All teeth were washed and stored in saline solution until the beginning of the experiment at room temperature.

Evaluation with Cone Beam Computed Tomography

Upon verification of ideal positioning, the 42 teeth were scanned with CBCT (SI i-CAT Imaging Sciences International, Hatfield, PA, USA). The voxel of 0.2 mm was used with an exposure of 20 seconds. During this evaluation, the images were manipulated and analyzed. The record of the number of canals and their variations were recorded by two examiners.

Coronary Opening

The access to the pulp chamber was performed in all teeth by a single operator with round burs (1014 and 1015 KG Sorensen, São Paulo, Brazil) in high speed until reaching the pulp chamber. To remove the pulpal roof was used a conical diamond bur (3082, KG Sorensen, São Paulo, Brazil) also in high speed. Subsequently the access was expanded with the classical outline design. After the palatal, distobuccal and mesiobuccal canals were located, an attempt was made to locate the 2MB using K-file #8 and #10 (Dentsply-Maillefer, Ballaigues, Switzerland) and water irrigation. After recording the location or not of the 2MB canal, there was a negotiation attempt with K-file in the canals found.

Analysis with Operating Microscope

The teeth were evaluated by using MO (Dental F. Vasconcelos, M900, São Paulo, Brazil), with 40X magnification. The location and number of canals were recorded by the examiners.

Sectioning and analysis of the roots with an optical microscope

The mesiobuccal roots of all teeth were sectioned with cutting system (Exakt Technologies Inc, Oklahoma, USA) at 3 and 7 mm below the apex in an axial plane.

By Dino Lite Digital Microscope® AM3013T (Anmo Electronics Corporation, New Taipei, Taiwan) with an increase of 6.4X was verified the actual presence/absence of 2MB in all roots sectioned. (Fig 1).

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Results

After sectioning all the mesiobuccal roots, it was verified the real presence of 10 2MB canals (23.81%). Table 1 shows the number of real canal orifices located with different methods after sectioning all the mesiobuccal roots. The CBCT showed the highest frequency of real canals.

The results of the two examines are shown in Table 2, in which there is the occurrence of 2MB canals for the number of canals found and confirmed after sectioning. The intraexaminer reliability was established using the Kappa coefficient, obtaining a substantial agreement between them.

Statistical analysis with the McNemar test ($p < 0.05$) showed no statistically significant difference between methods to detect the canal orifice in maxillary molars.

Table 3 shows the percentage of 2MB canal found in the literature including the current study.

Discussion

Several studies demonstrate the high frequency of the fourth canal in first and second maxillary molars and its prevalence has been reported and discussed by several authors using a variety of study methods including X-rays, clinical assessments, CBCT microscopy and sectioning of roots.[7-18] However, divergent results regarding the percentages have been reported. These differences result in part to difficulties found in the study of root canals.[2] The CBCT and OM were chosen as methods of identifying the presence of 2MB canal in extracted teeth for its reliability, when compared with other methods such as radiographic evaluation.[3,23] Other methods for 2MB canal identification as the CBCT have been effectively used in endodontics to evaluate the morphology of the root canal. The advantage of CBCT method is to allow the operator to view tomographic slices in different planes, with the possibility of manipulating the images, making a full assessment of the root canal system.[20]

In this *in vitro* study, CBCT positively identified the 2MB canal in five teeth demonstrating their superiority and reliability compared to other diagnostic methods for detecting the presence or absence of the 2MB canal. Although not 100% accurate, CBCT certainly shown as a method for treating root canals according to Matherne et al,[23] that showed results in the identification of a larger number of root canals than the digital images, and this is important, especially in situations where the 2MB canal not been initially treated.

Using the OM provided a better observation and lighting, improving the location of the canal orifices. Despite the low incidence of 2MB canal, several studies, showed the OM importance in the location of the 2MB in first molars and validate its use in pursuit of quality of endodontic treatment.[1,5-8,10,11]

The results of this study also showed that three 2MB canal were detected clinically using only a K-file #10.

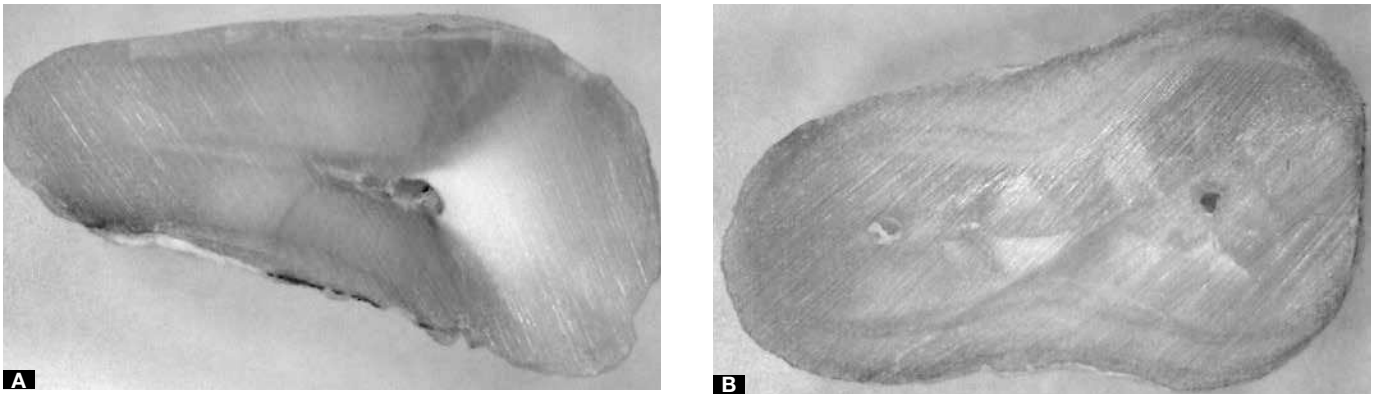

Figure 1. Digital microscopy photographs (6.4X) of two sectioned mesiobuccal roots. **A**) mesiobuccal root showing the presence of only one canal, **B**) mesiobuccal and 2MB which are distinct canals.

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Therefore, highlights the clinical method as a tool to detect the canal orifice of first and second molars in endodontic procedures. Especially when performed by a trained professional with greater morphological and anatomical knowledge, and experience.

The effectiveness of evaluation 2MB canal was defined by the detection of real canals. From this was

Table 1. Distribution 2MB canals successfully detected by cone bean computer tomography (CBCT), clinical analysis (CA) and operating microscope (OM) and their frequency for canals found after sectioning (n = 10).

Methods	# real canals (mean ± Standard deviation)	Frequency
CBCT	5.5 ± 0.70	55.0%
CA	3.0 ± 1.41	30.0%
OM	1.5 ± 0.70	15.0%

Table 2. Number of 2MB canals located by each technique and number of canals confirmed by sectioning of the roots (n = 42).

Methods	Examiner 1		Examiner 1	
	Located	Confirmed by sectioning	Located	Confirmed by sectioning
CBCT	11	6	10	5
CA	11	2	12	4
MO	7	1	13	2

Table 3. Summary of the literature on frequency 2MB canals.

Investigators	YEAR	Molar	Model	%	Total sample
Weine et al	1969	1	*In vitro*	62	208
Pineda	1973	1	*In vitro*	54.3	245
Hartwell e Bellizzi	1982	1 e 2	*In vivo*	18.6 e 9.6	1976
Weller e Hartwell	1989	1 e 2	*In vitro*	39.1 e 21.4	1134
Kulild e Peters	1990	1 e 2	*In vitro*	95.2	83
Fogel et al	1994	1	*In vivo*	71.2	208
Stropko	1999	1 e 2	*In vivo*	73.2 e 50.7	1732
Sempira e Hartwell	2000	1 e 2	*In vivo*	33.1 e 24.3	200
Buhrley et al	2002	1 e 2	*In vivo*	93	660
Baldassari-Cruz et al	2002	1	*In vitro*	90	39
Coutinho Filho et al	2006	1	*In vitro*	90.7	108
Smadi e Khraisat	2007	1	*In vitro*	77.32	100
Alaçam et al	2008	1	*In vitro*	82	100
Hartmann et al	2009	1	*In vitro*	29.2	65
Baratto Filho et al	2009	1	*In vitro* e *In vivo*	67.14 e 53.26	100 e 291
Blattner et al	2010	1 e 2	*In vitro*	68.4	20
Current study	2011	1 e 2	*In vitro*	23.81	42

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established a mean that for CBCT was 5.5. The results suggest that the clinical analysis combined with CBCT increases the detection 2MB canals of first and second molars.

Taking into account the methodology employed and results can be stated that there are no differences between experienced and an inexperienced operator to locate the canal orifices when CBCT was used being that external factors (poor knowledge of anatomy and geometry of irradiation) are eliminated.[21]

The reason CBCT had the highest detection rate of the 2MB canal compared than clinical analysis and OM may be by the use of a classification of permeable or not permeable root canals up to the apex, during the exploration. This factor initially discards a large number of 2MB canals found by the OM and CA by using a K-file only. Therefore, these criteria would be the most likely cause for the average decrease of 2MB canals found, compared to other studies.[7,8,11,15]

In the present study, 42 mesiobuccal roots were sectioned, and the prevalence of ten 2MB canals represents a rate of 23.81%. This is similar to results obtained in previous studies, and suggests the great difficulty to detect 2MB canal of maxillary molars. Since for detection, it is necessary, besides the knowledge of the morphology of the root canal system, training for detection according to the location of typical and atypical canal orifice.[2,3,5,12,14,15,18]

Based on the frequency of canal orifices found in this study, we suggest a special care in the coronary opening to locate the canal orifices in the upper molars through dedication of more time for treatment, use of appropriate techniques and magnification in order to achieve better results and ensure a good prognosis for the endodontic treatment. The non-detection of canals, such as 2MB may contribute to the failure of endodontic treatment, and may cause the need for retreatment and subsequently the surgical solution of the case.

Conclusions

Due to the methodology presented in this *in vitro* investigation, it can be concluded that none of the three methods made possible the location of the 2MB canal in all cases, nevertheless CBCT showed better results in the detection of 2MB canals in molars.

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