Assessment of different clinical methods to identify mesiobuccal root canals of maxillary first molars

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ABSTRACT

Objective: The purpose of this study was to compare if the quantity of MB2 root canals found in the maxillary first molars increased when visualized at unaided eye and, posteriorly, with an Operating Microscope (OM). The influence of the operator's experience to localize the additional root canals was also evaluated. **Methods:** One hundred extracted maxillary first molars were evaluated by specialists in Endodontics and students of Endodontics specialization. Cone-beam computed tomography (CBCT) was used to confirm the quantity of root canals present in the mesiobuccal root and this evaluation was taken as gold standard for this research. The agreement level between examiners and CBCT images was evaluated by Cohen's Kappa Coefficient. **Results:** There were statically significant differences between specialists (k = 0.234) and students (k = 0.009) when using OM. The best agreement levels were achieved in the student group with Clinical Exam (CE) (k = 0.261) and the specialists with OM (k = 0.234). When the comparison was performed between the dentists there was reasonable agreement between the root canals identification methods: CE (k = 0.275) and OM (k = 0.4245). It was observed in the comparison between the evaluated root canals identification methods that there was moderated significance between specialists (k = 0.558) and students (k = 0.454). **Conclusion:** The evaluator experience and the OM employment influenced MB2 root canals identification.

Keywords: Operating microscope. First molar. Cone-beam computed tomography.

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Introduction

The aim of a successful endodontic treatment is the complete sealing of the root canal space and of the apical foramen with an inert sealing material.[1]

The knowledge of the internal tooth anatomy is essential for achieving this purpose, once it does not reproduce the simplicity of the external tooth anatomy. Smadi and Khraisat[2] reported that the maxillary first molar has the highest rate of endodontic treatment failure due to the presence of a second canal in some of the mesiobuccal roots (MB2) when the professional is unable to identify, prepare and fill this canal.

The MB2 occurrence has been related in a relatively high rate (95%).[3,4] Wolcott et al[5] compared the incidence of MB2 in the initial phase of endodontic treatments and retreatments, and found that the incidence of MB2 in the initial phase of endodontic treatment was 59%, while 67% in retreatment. The authors reported that this significant difference to identify and treat the MB2 canals may reduce the success of the endodontic therapy in long term.

Cleghorn et al,[6] assessing 8399 teeth from 34 studies, found 2 canals in the mesiobuccal root in 56.8% and 1 canal in 43.1%. The incidence of 2 canals in the mesiobuccal root was higher in laboratorial studies, 60.5% compared to 54.7% of the clinical studies. The more common use of the Operating microscope (OM) in recent clinical studies has led to an increased prevalence in the clinical detection of the MB2. Mesiobuccal root canal system in *ex vivo* studies are more leaning to show 2 canals in the maxillary first molar than *in vivo* studies, but the incidence seems to be increasing with the use of OM. Two canals leading to one foremen in the mesiobuccal root of the maxillary first molar are quite twice more usual than two canals and two foramens.

The technological advances from the last decade allowed the development and improvement of different techniques that were introduced to favor the evaluation of the internal anatomic variations of dental roots. The dental radiograph, commonly used in the dental practice, provides essential information to the treatment planning, diagnosis and follow up. However, a general problem in Endodontics is the limitation of radiographic images for the two-dimensional aspect and the superposition of the subjacent anatomy with the cortical bone density.[7] Even with the improvements in radiographic films quality and the digital receptors advent, the two-dimensional projection still being one limiting factor in the detection of MB2 in maxillary first molars.[8] On the other hand, the OM has been used in the dental practice in a search for increased visibility and lighting, which would favor the identification and handling of the MB2 in maxillary molars.[9,10]

Another resource is the Cone Beam Computed Tomography (CBCT), which was introduced to assist in three-dimension images visualization and has been used to evaluate the root canal anatomy. This three-dimensional system has a great potential in Endodontics, becoming a valuable resource in the diagnosis and treatment of endodontic issues, mainly, for the details observation, sometimes impossible to see using conventional radiographs.[11,12,7]

The aim of the present study was to compare the detection of additional canals in the mesiobuccal root (MB2) of maxillary first molars using different assessment methods: Clinical exam (CE), Operating microscope (OM) and Cone-beam Computed Tomography (CBCT). The clinical experience influencing the identification of MB2 was also evaluated by a comparison of different evaluators: Specialists in Endodontics and students of specialization in Endodontics.

Material and Methods

One hundred human maxillary first molars that had the mesiobuccal root were selected from the teeth stock.

After the teeth selection, the pulp chamber access was performed using carbide burr #2 (KG Sorensen, São Paulo, Brazil) and Endo-Z burr (Dentsply Maillefer, Ballaigues, Switzerland) at high rotation and under refrigeration.

The teeth were inserted in two acrylic uncolored slabs (210 x 110 x 5.0), previously perforated, letting the apical portion of the mesiobuccal roots positioned at the same level to guarantee the positioning during CBCT.

The teeth were inserted in two rectangle colorless acrylic slabs (210 x 110 x 5.0 mm), previously perforated, so that the mesiobuccal root apices were positioned at the same level to guarantee the poisoning for CBCT. The teeth were organized in five rows of 5 teeth each slab, taking care to dispose the buccal-lingual and mesiodistal axes at the same direction. The lines were identified with letters (A – J) and the rows with numbers (1 – 10) to identify the teeth (Fig 1).

The examination of the MB2 presence or absence was performed by 6 dentists (3 specialists in Endodontics and 3 Endodontics specialization students) where the acquired data was duly registered in a pre-established table.

Clinical exam (CE) evaluation

The presence or absence of MB2 was verified with the aid of Flexo-file #10 (Dentsply Maillefer, Ballaigues, Switzerland) and the data were recorded.

Operating microscope (OM) evaluation

Subsequently, the teeth were examined with the aid of an operating microscope (MC – M1222, D. F. Vasconcellos, São Paulo, Brazil) (Fig 2) at 25X magnification and with Flexo-File #10 (Dentsply Maillefer), with the acquired data also recorded.

Cone-beam computed tomography (CBCT) evaluation

The acrylic slabs with the teeth were fitted to an acrylic base for the correct positioning in the tomograph Cone Beam l-Cat (Imaging Sciences International, Hatfield, PA, USA), using 120,000 kV and 46.72mA. The used scanning parameters were: 40 seconds acquisition time, small field of view (FOV = 6.0 cm), 800 x 800 pixels matrix. The scanning raw data were processed by Xoran-Cat software (Imaging Sciences International,

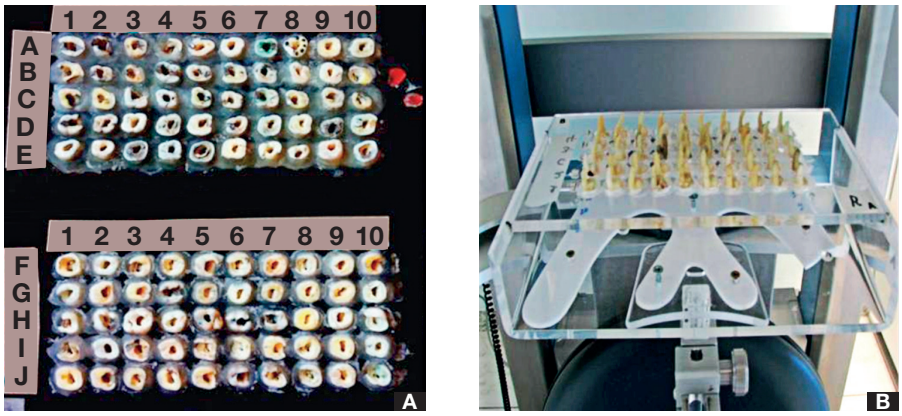

Figure 1. A) Acrylic slabs with teeth identified by lines and rows. **B**) Slab fitted to the acrylic base, in position for tomographic examination.

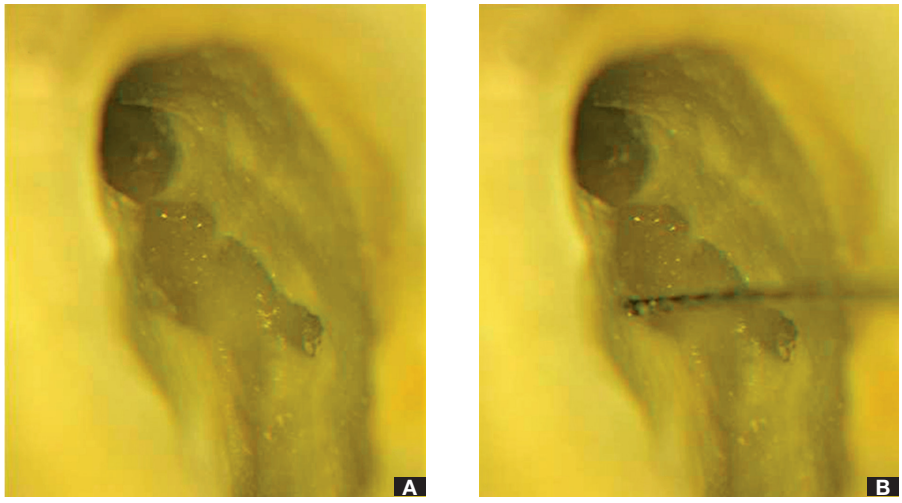

Figure 2. Teeth being examined by means of operating microscope and Flexo-File #10.

Hatfield, PA, USA), with 394 axial slices obtained, which generated DICOM files with 8.97 MB.

The tomographic images obtained were analyzed with Cyclops MedStation (http://www.telemedicina.ufsc.br/cms/index.php?lang=en), in a lightless environment to favor the visualization of the same distortions and the data were recorded. The CBCT images were used to confirm the number of canals present in the maxillary first molars mesiobuccal root. This evaluation was used as gold standard (Fig 3).

Statistical analysis

The specialists and students evaluations were gathered to the analysis. When there was discordance between them, the value with higher frequency was used. The analysis was constituted of 500 evaluations, 400 performed by the dentists, and 100 by CBCT.

The level of concordance between examiners and the comparison with the CBCTs were evaluated by Cohen's Kappa Coefficient. The classifications of the Lapp values followed the information preconized by Landis and Koch.[13] The analysis was performed with software Microsoft Excel 2011 (Microsoft Corporate, Redmond, WA, USA) and SPSS 17 (SPSS Inc., Chicago, IL, USA).

Results

The results showed that specialists found a higher quantity of teeth with 2 canals in the mesiobuccal root than the students and the control group, regardless the identification method used (Table 1). In the CE exam, the specialists found 86 teeth with the MB2 canal, while the students found 62 teeth. Using OM, the specialists found 88 teeth with the presence of MB2 and the students found 60 teeth. The CBCT showed the presence of MB2 in 78 teeth.

There were statistically significant differences between the specialists (k = 0.234) and the students (k = 0.009) when using OM. The best agreement levels were found in the students group using CE (k = 0.261) and specialists using OM (k = 0.234). The lowest agreement level with the control group was seen in the students group using OM (k = 0.009).

The comparison between dentists showed reasonable agreement between CE and OM methods (k = 0.275 and 0.245, respectively). Comparing the identification methods it is observed that there was moderated agreement between the specialists (k = 0.558) and students (k = 0.454). The results of this study are described in Table 2.

Figure 3. Axial slice of a tomographic image showing the presence of MB2 in a specimen.

Table 1. Frequencies distribution of 100 specimens evaluated by CBCT, CE and OM.

Canals	CBCT	CE		OM	
		Specialists	Students	Specialists	Students
1	22	14	38	12	40
2	78	86	62	88	60

Table 2. Results description of Cohen's Kappa coefficient for pared comparison.

		CE		OM	
		Specialists	Students	Specialists	Students
CBCT		0.129	0.261	0.234	0.009
CE	Specialists		0.275	0.558	0.206
	Students			0.364	0.454
OM	Specialists				0.245

Discussion

Since the 1990's, the OM and the CBCT started to be used in Dentistry, aiding to locate and, consequently, to treat root canals. Since then an exceptional level of care is taken in cases previously considered untreatable or of doubtful prognosis. Hess and Zurcher,[14] in a reference study from 1925, related the existence of MB2 in maxillary molars. In 1969, Weine et al[3] observed during the evaluation of endodontic prognosis that the failure in maxillary molars treatment occurred with high frequency in the mesiobuccal root region. Based in this observation, the authors studied and discovered that teeth with a fourth canal occurred more often than the ones with three canals (51.5% versus 48.5%, respectively).

Especially in the maxillary first molar, it is observed that the endodontic treatment failure happens commonly associated to the incapability of MB2 canal location,[15,3] although actually locating this canal is easier once new technologies were developed and inserted, as OM and CBCT.[15,16,17]

The OM use effectiveness for MB2 canal detection, in *ex vivo* and *in vivo* studies, compared to unaided eye, have been evaluated in several studies with diversified methodologies. Sempira and Hartnell, in an *in vivo* study using 200 maxillary molars, aided by OM observed the identification of MB2 increased by 30%. These values agree with the obtained by Coutinho Filho et al,[10] who found increased rate of canals localization from 53.7 to 87.96% when submitted to OM magnification. Carvalho and Zuolo[18] used 204 first and second molars extracted and found 641 canals without OM and 50 additional canals when magnification was applied, an increase of 7.8%. These results agree with the obtained in this research, where specialists using OM localized 4% more MB2 canals, similar values also found by Alaçam et al,[19] who found 5 additional MB2 canals from 100 teeth when using OM. Buhrley et al[20] performed a clinical study with specialists in Endodontics, reporting an increase of 71.1% for MB2 localization. In the present study there was an increasing in the localization of MB2 canals when submitted to OM examination, evaluated by specialists when compared to students. Baldassari-Cruz et al[21] found that 51% of the MB2 from 39 extracted maxillary molars were located with only explorer and dental mirror, and 82%, 12 additional canals found, when using OM. These studies confirm the results obtained in this research by the specialists group, which had an increase in the number of canals found when aided by the OM.

Disagreeing with these results, Görduysus et al[22] worked without visual magnification in 45 extracted maxillary teeth and localized the MB2 canal in 42 teeth (93%), and the use of OM increased the detection in just one tooth (96%). Similar results were found in the present study by the students group, where the OM was not critical for locating additional canals, on the contrary decreasing 12% when using the microscope. However, the students found 68% of the canals from a sample of 100 teeth. It can be concluded that the clinical experience is an important factor to the localization of additional canals.

Buhrley et al[20] stated that several factors may influence the low incidence of MB2 canals found when compared to *ex vivo* studies, including clinical environment, limited visibility and access, perforation risk, tooth position in the arch, general tooth condition (caries, restorations and prosthesis), patient's age and his/her tendency to stand a longer clinical session. Besides, the dentist experience might determine the quantity of root canals found. It is possible that, in some cases, the most important factor for canals identification is the professional persistence and not the image magnification. This might be a possible explanation to the low rate of MB2 canals found by students using OM in the present study. Due to the lower clinical experience and, consequently, lower contact with these canals, maybe the students had not already acquire the specialist persistence in the ceaseless search for additional canals.

In many cases, the MB2 identification might be facilitated by the presence of a sulcus, being the removal of a little quantity of dentin necessary in these cases. The use of OM in this phase aids in the identification and clinical detection of MB2,[23,22] once the OM light is parallel to the vision line and two to three times higher than the reflector, improving significantly the clinical vision of the pulpal chamber.[9]

Baldassari-Cruz et al[21] reported that different ways to access might increase the frequency of MB2 identification. The OM is very useful to execute this task, combined with the root canal system morphological knowledge and amplified vision of the area, allow the

professional to achieve maximum results. This is confirmed by the increased number of MB2 canals found by specialists using the OM in the present study.

Coutinho Filho et al[10] state that the ability to identify MB2 canal rely on the professional skill, the anatomical complexity and the use of good lighting and magnification, similar to the conditions offered by OM. This statement is confirmed by this study, where the specialists using OM identified a higher number of additional canals.

New radiographic modalities are demonstrating viable applications to Endodontic, aiding the treatment of root canals. One is CBCT, which proves very useful to visualize the root canal morphology.[24,16] Blattner et al[15] evaluated the root canal identification ability with CBCT and concluded that this technology aided the identification of the presence or absence of MB2 with precision in 78.95% of the sample.

Kottor et al[25] described a case report where the authors found 7 canals in a maxillary first molar. The clinical detection was made by the OM and the confirmation with CBCT, since the initial diagnosis was done with a periapical radiography, which had not showed any anatomical variation. Based in these researches where the authors confirm the reliability in the identification of additional canals, we used CBCT as gold standard for the present study.

Conclusion

It is clear that for the identification of MB2 canal, the evaluator's experience and the clinical methods used influence the search for canals, although no method alone is 100% reliable. Several methods may be used to locate the additional canals, increasing successful maxillary first molars endodontic treatments.

References

1. Huang CC, Chang YC, Chuan MC, Lai TM, Lai JY, Lee BS, et al. Evaluation of root and canal systems of mandibular first molars in Taiwanese individuals using cone-beam computed tomography. J Formos Med Assoc. 2010 Apr;109(4):303-8..
2. Smadi L, Khraisat A. Detection of a second mesiobuccal canal in the mesiobuccal roots of maxillary first molar teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;103(3):e77-81.
3. Weine FS, Healey HJ, Gerstein H, Evanson L. Canal Configuration in the mesiobuccal root of the maxillary first molar and its endodontic significance. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1969;28(3):419-25.
4. Seidberg BH, Altman M, Guttuso J, Suson M. Frequency of two mesiobuccal root canal in maxillary permanent first molars. J Am Dent Assoc.1973;87(4):852-6.
5. Wolcott J, Ishley D, Kennedy W, Johnson S, Minnich S. Clinical investigation of second mesiobuccal canals in endodontically treated and retreated maxillary molars. J Endod. 2002; 28(6):477-479.
6. Cleghorn BN, Christie WH, Dong CCS. Root and root canal morphology of the human permanent maxillary first molar: a literature review. J Endod. 2006;32(9): 813-21.
7. Patel S, Dawood A, Ford TP, Whaites E. The potential applications of cone beam computed tomography in the management of endodontic problems. Int Endod J. 2007;40(10):818-30.
8. Bauman R, Scarfe W, Clark S, Morelli J, Scheetz J, Farman A. Ex vivo detection of mesiobuccal canals in maxillary molars using CBCT at four different isotropic voxel dimensions. Int Endod J. 2011;44(8):752-8.
9. Sempira HN, Hartwell GR. Frequency of second mesiobuccal canals in maxillary molars as determined by use of an operating microscope: a clinical study. J Endod. 2000; 26(11):673-674.
10. Coutinho Filho T, Cerda RSL, Gurgel Filho ED, Deus GA, Magalhães KM. The influence of the surgical operating microscope in locating the mesiolingual canal orifice: a laboratory analysis. Braz Oral Res. 2006;20(1):59-63.
11. Cotton TP, Geisler TM, Holden DT, Schwartz SA, Schindler WG. Endodontic applications of cone beam volumetric tomography. J Endod. 2007;33(9):1121-32.
12. Kottor J, Velmurugan N, Surendran S. Endodontic management of a maxillary first molar with eight root canal system evaluated using cone-beam computed tomography scanning: a case report. J Endod. 2011;37(5):715-9.
13. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33(1):159-74.
14. Hess W, Zurcher E. The anatomy of the root canals of the teeth of the permanent and deciduous dentitions. New York: William Wood ; 1925.
15. Blattner TC, George N, Lee CC, Kumar V, Yelton CD. Efficacy on cone-beam computed Barrows MJ, BeGole tomography as a modality to accurately identify the presence of second mesiobuccal canals in maxillary first and seconds molars: a pilot study. J Endod. 2010;36(5):867-70.
16. Baratto Filho F, Zaitter S, Haragushiku GA, Campos EA, Abuabara A, Correr GM. Analysis of the internal anatomy of maxillary first molars by using different methods. J Endod. 2009;35(3):337-42.
17. Schwarze T, Baethge C, Stecher T, Geurtsen W. Identification of second canals in the mesiobuccal root of maxillary first and second molars using magnifying loupes or an operating microscope. Aust Endod J. 2002;28(2):57-60.
18. Carvalho MCC, Zuolo ML. Orifice locating with a microscope. J Endod. 2000;26(9): 532-4.
19. Alaçam T, Tinaz AC, Genz O, Kayaoglu G. Second mesiobuccal canal detection in maxillary first molars using microscopy and ultrasonics. Aust Endod J. 2008;34(3):106-9.
20. Buhrley LJ, EA, Wenckus CS. Effect of magnification on locating the MB2 canal in maxillary molars. J Endod. 2002;28(4):324-7.
21. Baldassari-Cruz LA, Lilly JP, Rivera EM. The influence of dental operating microscopes in locating the mesiolingual canal orifices. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002;93(2):190-4.
22. Görduysus MO, Görduysus M, Friedman S. Operating microscope improves negotiation of second mesiobuccal canals in maxillary molars. J Endod. 2001;27(11):683-6.
23. Wolcott J, Ishley D, Kennedy W, Johnson S, Minnich S, Meyers J. A five-year clinical investigation of second mesiobuccal canals in endodontically treated and retreated maxillary molars. J Endod. 2005;31(4): 262-4.
24. Estrela C, Bueno MR, Azevedo BC, Azevedo JR, Pécora JD. A new periapical index based on cone beam computed tomography. J Endod. 2008;34(11):1325-31.
25. Kottor J, Velmurugan N, Sudha R, Hemamalathi S. Maxillary first molar with seven root canals diagnosed with cone-beam computed tomography scanning: A case report. J Endod. 2010;36(5):1-7.