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ORIGINAL ARTICLE

Efficacy of clinical and radiological methods to identify second mesiobuccal canals in maxillary first molars

ALLAN ABUABARA[1], FLARES BARATTO-FILHO[2], JULIANA AGUIAR ANELE[2], DENISE PIOTTO LEONARDI[2] & MANOEL DAMIÃO SOUSA-NETO[3]

[1]*City Hall of Joinville, Health Division (Glòria), Joinville (SC), Brazil,* [2]*Master's Program in Clinical Dentistry, Positivo University, Curitiba, Brazil, and* [3]*Faculty of Dentistry, University of Sao Paulo, Ribeirao Preto, Brazil*

Abstract

Introduction. The success of endodontic treatment depends on the identification of all root canals. Technological advances have facilitated this process as well as the assessment of internal anatomical variations. The aim of this study was to compare the efficacy of clinical and radiological methods in locating second mesiobuccal canals (MB2) in maxillary first molars. ***Methods.*** Fifty patients referred for analysis; access and clinical analysis; cone-beam endodontic treatment of their maxillary first molars were submitted to the following assessments: analysis; access and clinical analysis; cone-beam computed tomography (CBCT); post-CBCT clinical analysis; clinical analysis using an operating microscope; and clinical analysis after Start X ultrasonic inserts in teeth with negative results in all previous analyses. ***Results.*** Periapical radiographic analysis revealed the presence of MB2 in four (8%) teeth, clinical analysis in 25 (50%), CBCT analysis in 27 (54%) and clinical analysis following CBCT and using an operating microscope in 27 (54%) and 29 (58%) teeth, respectively. The use of Start X ultrasonic inserts allowed one to detect two additional teeth with MB2 (62%). According to Vertucci's classification 48% of the mesiobuccal canals found were type I, 28% type II, 18% type IV and 6% type V. Statistical analysis showed no significant differences ($p > 0.5$) in the ability of CBCT to detect MB2 canals when compared with clinical assessment with or without an operating microscope. A significant difference ($p < 0.001$)was found only between periapical radiography and clinical/CBCT evaluations. ***Conclusion.*** Combined use of different methods increased the detection ofthe second canal in MB roots, but without statistical difference among CBCT, operating microscope, Start X and clinical analysis.

Key Words: *molar, molar abnormalities, molar analysis, molar anatomy and histology, cone-beam computed tomography*

Introduction

Permanent maxillary first molars have been reported to present important variations in terms of root canal morphology. The number of root canals in these teeth may range from 2–8 [1–3]. Based on Vertucci's [4] classification, the mesiobuccal (MB) root canal anatomy of maxillary first molars can be classified into eight types: type I, one single canal that extends from the pulp chamber to the apex; type II, two separate canals leaving the pulp chamber and merging near the apex, forming a single canal; type III, a canal that leaves the pulp chamber, divides into two within the root and merges again into a single canal; type IV, two separate and distinct canals that extend from the pulp chamber to the apex; type V: a canal that leaves the pulp chamber and divides into two near the apex, with distinct apical foramina; type VI: two separate canals that leave the pulp chamber, merge in the body of the root and re-divide close to the apex, with distinct apical foramina; type VII: one canal that leaves the pulp chamber, divides and merges again within the body of the root canal and finally re-divides into two distinct canals short of the apex; and type VIII: three separate and distinct canals extending from the pulp chamber to the apex.

Technological advances have been developed and different techniques have been introduced to facilitate the assessment of internal anatomical variations of the root canal system. Cone-beam computed tomography

Correspondence: Dr. Flares Baratto-Filho, PhD, Positivo University, Rua Prof. Pedro Viriato Parigot de Souza, 5300 - Campo Comprido - Curitiba - PR - CEP - 81280-330, Brasil. E-mail: fbaratto1@gmail.com

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(CBCT) and the use of operating microscopes has facilitated the localization and handling of additional canals, especially the second mesiobuccal canal (MB2) frequently present in maxillary first molars [3,5–7]. In addition, studies have shown that increased operator experience in the use of an operating microscope is associated with a higher prevalence of detection of additional canals [7,8].

The aim of this study was to compare the efficacy of clinical and radiological methods in locating and classifying MB2 canals in maxillary first molars based on Vertucci's [4] classification.

Materials and methods

The present prospective study was approved by the Research Ethics Committee of Positivo University, Curitiba (PR), Brazil.

Fifty patients referred for endodontic treatment of their maxillary first molars were submitted to the following sequence of assessments: periapical radiographic analysis; access and clinical analysis; CBCT analysis; post-CBCT clinical analysis; clinical analysis using an operating microscope; and clinical analysis after Start X ultrasonic inserts (Denstply-Maillefer, Ballaigues, Switzerland). The following inclusion criteria were taken into consideration during patient selection: need for endodontic treatment of permanent first molar, aged between 16–65 years and no previous endodontic treatment.

One single experienced endodontist carried out the clinical and radiological analyses in all patients. For calibration purposes and to assess data reliability, inter-examiner calibration was performed before the beginning of the study using CBCT-based anatomical diagnoses, with the participation of an oral and maxillofacial radiologist. For inter-examiner calibration the oral and maxillofacial radiologist and the endodontist examined 10 CBCT images of maxillary first molars at two distinct moments within a 1-month period. These images had been previously selected and showed first maxillary molars with different morphologies (3, 4, 5 and 6 root canals). Kappa results for inter-examiner variability were >0.78.

An initial periapical radiograph was taken from each patient using an X-ray film positioner (Indusbello, Londrina, Parana, Brazil). The number of roots and visible root canals and other morphological features were analyzed and the data were recorded. Then, patients were submitted to CBCT (i-CAT, Imaging Sciences International, Hatfield, PA) using the following parameters: 6 cm field of view, 40 s of X-ray exposure, a voxel size of 0.12 mm and a 14-bit gray scale [9].

After the periapical X-ray analysis, surgical access was performed. Pulp extirpation was performed and the canal was thoroughly debrided under irrigation with 10 ml of 2.5% sodium hypochlorite solution. Root canal negotiation was performed in three stages: visual analysis, tactile analysis using an endodontic probe and tactile analysis using a #10 K-file (Maillefer, Ballaigues, Switzerland). The presence of MB2 canals was confirmed using K-files when they reached the working length (electronic working length determination). All results obtained during this first clinical analysis were recorded.

CBCT analysis

After endodontic access classification and the first clinical analysis, the endodontist evaluated CBCT images and determined the number of roots, the number of root canals, the presence of MB2 canals and other morphological aspects. MB root canals were classified according to Vertucci's [4] all data were recorded.

Post-CBCT clinical analysis

After CBCT analysis, a second clinical analysis was performed following the same sequence described above. All data were recorded.

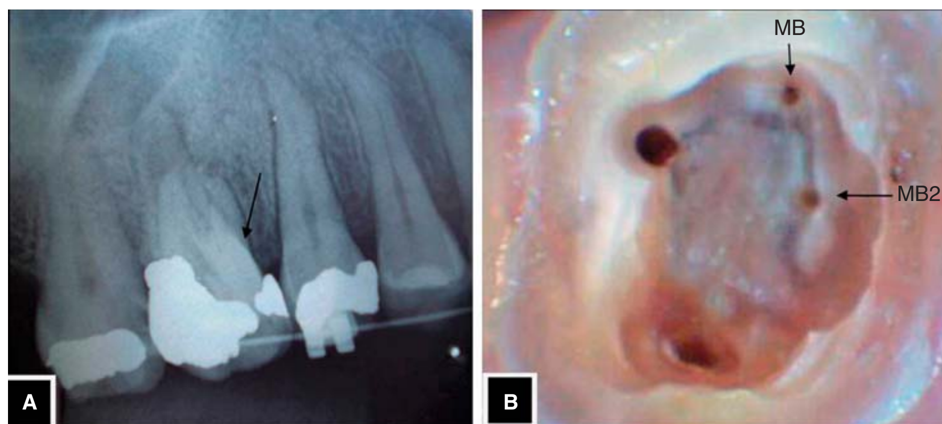

Figure 1. Maxillary first molar with 4 canals: (A) Initial periapical radiograph showing two canals in the MB root (arrow); (B) MB and MB2 canals in the MB root.

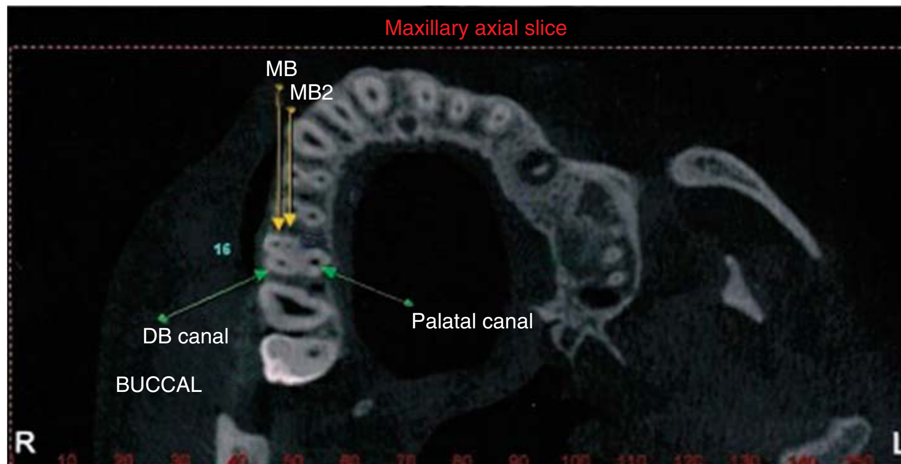

Figure 2. CBCT analysis showing two canals in the MB root: MB and MB2.

Operating microscope analysis

Upon completion of post-CBCT clinical analysis, a third clinical analysis was performed, now using a clinical operating microscope (Opto Dm 2003 General® Surgical Microscope, Miami, FL). The analysis was performed following the same sequence described above. The data obtained in this analysis were also recorded.

Whenever the presence of a MB2 canal was not confirmed, a Start X®ultrasonic tip #2 (Denstply-Maillefer, Ballaigues, Switzerland) was used in the floor of the pulp chamber (MB2 area). All data were assessed using Friedman's test and multiple comparison statistical analyses (Nemenyi test).

Results

A total of 50 teeth were examined. Periapical radiographic analysis identified MB2 canals in four (8%) teeth (Figure 1A) and the first clinical analysis (after endodontic access) in 25 (50%) (Figure 1B). CBCT analysis identified 27 (54%) teeth with MB2 canals (Figure 2). Post-CBCT clinical analysis and analysis with the aid of an operating microscope allowed one to identify the MB2 canal in 27 (54%) and 29 (58%) teeth, respectively. Finally, the use of Start X ultrasonic inserts detected two additional teeth with MB2 (31 teeth; 62%) (Figures 3A and B). Table I shows the results of all stages. According to Vertucci's[4] classification, the final MB2 results, after the Start X application, were as follows: 48% type I, 28% type II, 18% type IV and 6% type V (Table II).

Statistical analysis revealed no statistically significant differences ($p > 0.5$) in the ability of CBCT to detect MB2 canals when compared with clinical analysis with or without an operating microscope. A statistically significant difference ($p < 0.001$) was observed only between periapical radiography and clinical/CBCT analyses.

Discussion

According to the literature review carried out by Cleghorn et al. [10], which included laboratory studies (*in vitro*), clinical root canal system anatomy studies (*in vivo*) and clinical case reports of anatomical abnormalities, the incidence of MB2 root canals is 56.8%, compared with 43.1% of one MB canal,considering an average of all studies reviewed by the authors. Our finding of 62% of MB2 is therefore compatible with the literature.

For the present study, a search was conducted on the PubMed database (US National Library of Medicine

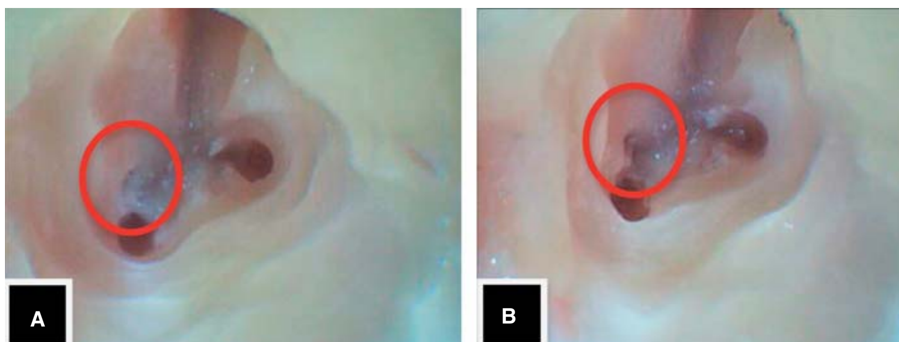

Figure 3. Maxillary first molar with four canals: (A) Before and (B) after mesiobuccal canal preparation with Start X application.

Table I. Results of periapical radiographic, clinical, CBCT, clinical post-CBCT, clinical operating microscope and clinical operating ultrasound evaluations of the additional canals in the maxillary first molars.

	Periapicalradiography	Clinical	CBCT	Clinical post-CBCT	Clinical operating microscope	Clinical operating ultrasound
2 canals (MB2)	4 (8%)	25 (50%)	27 (54%)	27(54%)	29 (58%)	31(62%)
1 canal	46 (92%)	25 (50%)	23(46%)	23(46%)	21(42%)	19 (38%)

and the National Institutes of Health),on August 5, 2011, using the descriptors (Cone-Beam Computed Tomography), (molar) and subheadings (abnormalities; analysis; anatomy and histology). Forty-three references were retrieved, of which 10 were found to describe maxillary first molar root canal anatomy (four case reports and six original articles) [3,11-19]. Among such studies, one used a CBCT scanner in an Indian population and identified two MB root canals in 48.2% of the maxillary first molars evaluated [15]. Two similar studies conducted in Chinese populations detected MB2 canals in 52% of the teeth [16,19]. Blattner et al. [18], using a CBCT scanner (i-CAT), identified the presence of MB2 canals in 57.9% of the teeth, compared with 68.4% detected with *in vitro* analysis (clinical sectioning analysis). Those authors concluded that there were no statistically significant differences in the ability of CBCT to detect MB2 canals when compared with clinical sectioning. Michetti et al. [17] compared CBCT reconstructions of root canal systems with histological sections. The authors found a very strong correlation between data acquired via CBCT and histological sections. As it can be observed, in most researches only a single method was used to assess the presence of MB2, while in this study such presence was verified through different methods in a single sample, showing similar results.

Baldassari-Cruz et al. [20] have evaluated the use of a dental operating microscope compared with unaided vision (without loupes or head-lamps) in the detection of MB2 canal orifices in MB roots in extracted maxillary molars. According to those authors, an operating microscope increased detection of MB2 canals from 51 to 82%, corroborating the results of the present study. Buhrley et al. [7] have reported frequencies of 71, 63 and 17% of MB2 canals *in vivo* in maxillary first molar teeth with the use of microscopes, dental loupes or no magnification, respectively. The authors found no significant differences in the frequency of MB2 detection when using a microscope or dental loupes [7].

Table II. Final results according Vertucci's [4] classification.

Vertucci's classification	Configuration	Number of cases	Percentage
Type I	1	19	38
Type II	2-1	16	32
Type III	1-2-1	0	0
Type IV	2	12	24
Type V	1-2	3	6
Type VI	2-1-2	0	0
Type VII	1-2-1-2	0	0
Type VIII	3	0	0

The identification and location of MB2 canals in MB roots of maxillary molars can be extremely challenging. Different methods of access have been shown to increase the frequency of MB and MB2 canal detection [7]. A new system was recently introduced by Dentsply and called Start X. According to the manufacturer, this system is used to prepare access cavity and location of canal openings. The complete system has five ultrasonic instruments based in a simple concept: one tip to one clinical indication. Basically, the five tips are: Start X #1–Acess cavity wall refinement; Start X #2–MB2 canal scouter; Start X #3–canal opening scouter; Start X #4–metal post removal; Start X #5–to remove calcifications of pulp chamber floor. This study used the Start X #2 according to the manufacturer instructions and the location of MB2 was increased, but with no statistical difference when compared to operating microscope and clinical analysis.

An adequate endodontic access method, combined with knowledge of root canal system morphology and enhanced visualization of the area, allows the operator to achieve maximum results [7]. In this study, MB2 detection was increased by the use of CBCT scans, an operating microscope and ultrasound tips. However, statistically significant differences ($p < 0.001$) were found only between periapical radiography and clinical/CBCT evaluations. Corcoran et al. [8] showed that the operator experience may improve the endodontic treatment success. According to the results of the present study, the clinical analysis was similar to CBCT scans, operating microscope and ultrasonic tips for detection of MB2 canals. On the contrary, Alaçam et al. [21] concluded that the combined use of the operating microscope and ultrasonics increased the detection of MB2 canals in maxillary first permanent molars. These controversial results can be explained by the experience of the operator or the sample size. In relation to Vertucci's[4] classification, Zhang et al. [22]evaluated the root canal anatomy of maxillary molars and found 14% type II, 70% type IV and 16% type V. These results were different from this study, which found 48% type I, 28% type II, 18% type

IV and 6% type V. Probably these controversial results are due to the sample size or the population assessed.

Based in the results of this study, an operating microscope and ultrasound tips for detection of MB2 canals can be used in daily clinical use and CBCT should not be used as a routine exam, being indicated only when problems occur in locating of MB2.

Conclusion

The results of this study have shown that the combined use of different methods increased the detection of second canal in MB roots, but without statistical difference among CBCT, the operating microscope, Start X and clinical analysis. Most MB root canals identified were type I, according to Vertucci's [4] classification.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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