



Mesiolingual Canal Prevalence in Maxillary First Molars assessed through Different Methods

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ABSTRACT

Aim: Evaluate the prevalence of mesiolingual canal prevalence orifice in mesiobuccal roots of maxillary first molars using five methods of visualization.

Materials and methods: About 73 first permanent maxillary molars were analyzed. Visual clinical analysis of the presence of the fourth canal was performed using a straight endodontic exploratory probe (EXDG16[®]) and a K10 manual file (SybronEndo[®]). Dental elements that were not located on the fourth canal were analyzed with the aid of a magnifying glass (Zeiss[®]) with a 2.5-fold increase and those teeth in which the fourth canal was not found went through the examination with clinical surgical microscope (OPTO[®]) with magnification of 20 times with both the explorer and endodontic file. Next, a periapical radiography of the teeth was performed in the teeth in which the mesiolingual canal was not yet found to observe the presence or absence of the fourth canal. Afterward, the teeth in which the canal was not yet located were scanned using the microtomography equipment (SkyScan[®]), at 100 kV and 100 μ A, with an isotropic resolution of 16 μ m.

Results: The mesiolingual canal was located in 70 teeth (95.8%) and in only 3 teeth it was not identified.

Conclusion: The visual method in the fourth canal search has limitations, whereas the composite magnifying glass, the clinical surgical microscopy, and the computerized microtomography are efficient methods for locating the fourth canal in the upper first molars.

Clinical significance: The anatomical complexity of the first maxillary molars is one of the factors that leads to high failure

rates in the endodontic treatments of this group of teeth. In most clinical situations, the mesiolingual canal goes unnoticed by professionals, since conventional radiographs do not always allow the visualization of all root canals. Determining an effective method for locating the mesiolingual canal is of paramount importance to the success of endodontic treatment.

Keywords: Composite magnetic, Computerized microtomography, Mesiolingual canal, Radicular anatomy.

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INTRODUCTION

The knowledge of the root canals' morphology and their anatomical variations are of fundamental importance for the success of endodontic treatment. The anatomical complexity of the first upper molars is one of the factors that leads to high failure rates in endodontic treatments of this group of teeth, due to the nonlocation of the mesiolingual canal.

The success of endodontic treatment depends on a good cleaning, proper modeling, and root canal sealing. Thus, if a canal is not found, it may decrease the chances of treatment success.¹⁻⁵ Therefore, one must have knowledge about the morphology of the canals, since anatomical variations may be present.^{1,4,6}

The first upper molars mesiobuccal root is flattened in the mesiodistal position,⁷ and this flattening can determine the presence of two narrow canals: The mesiobuccal and the mesiolingual, and the latter presents itself generally in lingual position, in relation to the mesiobuccal canal.³

In most clinical situations, the mesiolingual canal goes unnoticed by professionals, even by the good

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endodontist, since conventional radiographs do not always allow the visualization of all root canals, since they offer a two-dimensional image of an object that presents three-dimensional one. In addition, one canal is vestibular and the other is palatine of the root, with overlapping of images, which makes the radiographic visualization difficult.⁸

In order to facilitate the location of the mesiolingual canal, a consequence of the wide variation of the anatomy in the first upper molars, some methods have been proposed, such as the use of computerized microtomography, besides magnification with composite magnifying glass and surgical clinical microscope.

The most widely used image magnification system in clinical practice is magnifying glasses. This is due to the ease of handling and lower cost if compared with the clinical microscope. The magnifying glasses were initially introduced in the medical area for ophthalmologic use and were subsequently adapted for dental use.⁹

The surgical clinical microscope was introduced in endodontics to facilitate surgical and nonsurgical treatment,¹⁰ which can be used by clinicians and specialists from different areas, assisting in the diagnosis and treatment of dental procedures. Therefore, its use made possible a better analysis of the teeth favoring the visualization and location of the root canals. One of the main justifications is given by the greater illumination and visual magnification of the surgical area, thus providing higher success rates and quality of endodontic treatments.

Clinical procedures in endodontics depend on the surgeon's tactile sensitivity. Moreover, endodontic treatments are often performed in the dark.¹¹ Since the ability to locate the mesiolingual canal depends on the surgeon's ability, anatomical complexity, the use of high power lighting systems and magnification, the operative clinical microscope presents itself as an appropriate alternative¹ and a good option to improve radicular canal location.⁷ Although the clinical surgical microscope is an excellent method commonly used for the magnification of the surgical area in endodontic procedures, its application cannot be overestimated, since, even with the magnification and improvement of illumination, anatomical structures can remain unnoticed.¹²

In addition to the use of the surgical clinical microscope and composite magnifying glasses, which promote greater magnification of the surgical area, other methods of detection of the mesiolingual canal, such as computerized microtomography, have been used in endodontics, being an option in the treatment of radicular canals.

Computerized microtomography is an imaging technique widely used in endodontics as it provides a detailed three-dimensional view of the internal radicular anatomy,

thus enabling the selection of more adequate techniques that favor higher success rates of endodontic treatment.¹³

The advent of three-dimensional imaging has provided the clinician with an increased perception of tooth morphology. The nondestructive approach of computerized microtomography makes it possible to study anatomy more accurately and at the same time overcome technical deficiencies of prior study. Another advantage of this method is that the internal anatomy of the teeth can be reconstructed and observed at various angles.¹⁴

Knowledge of the anatomy and its diversities, together with the use of technologies, such as the surgical microscope, ultrasound, and computerized tomography, can increase the success rates of endodontic treatment, since they aggregate visual magnification, lighting, and safe flaring of dental structures and three-dimensional visualization of the dental elements.¹⁵

Several authors have conducted studies with different methodologies to analyze the prevalence of the fourth canal in the upper first molars. When visual clinical analysis was used, the prevalence ranged from 29.2 to 62%.^{1,7,16-19} Already, studies that used the composite magnifying glass obtained a prevalence of 46.2%,³ and another 63.9%,¹⁸ using magnification of 3.5 and 2 times respectively. However, when using clinical microscopy, studies obtained a prevalence of 52.3 to 96%, when magnification was used between 8 and 25 times.^{1,3,7,17,19-21}

Several studies have demonstrated the high prevalence of a fourth canal in maxillary first molars when using alternative methodologies, among which we can highlight the radiographs,²⁰ the computerized microtomography,¹⁴ the flaring with drills on the pulp chamber floor,^{7,16,21} ultrasound,⁵ the combination of the surgical microscope with ultrasound,¹⁷ histological analysis,³ and decalcification.¹⁸ Therefore, this study aimed to evaluate the prevalence of the mesiolingual canal in mesiobuccal roots of the first permanent maxillary first molars, through the use of different evaluation methods.

MATERIALS AND METHODS

The sample calculation of this study was based on previous studies,^{17,19} considering margin of error of 5% and confidence level of 95%, resulting in 74 maxillary first molars (1^oMS), which were collected in a tooth bank. The Ethics Committee on Research in Human Beings approved this study, with the number 37518114.9.0000.5349.

The first permanent human maxillary first molars extracted by different reasons were randomly chosen, and, as inclusion criteria, teeth with complete root formation, without previous endodontic treatment, with cavities, restored or healthy were selected. The selection was based on the peculiar characteristics of the external



Fig. 1: Composite magnifying glass used in this study (Carl Zeiss®)

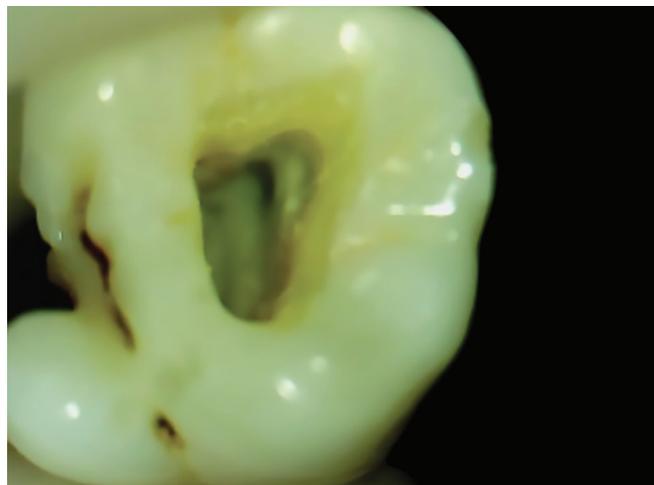


Fig. 2: View with surgical microscope 30× (OPTO Dental®), of a permanent first molar, indicates the presence of the fourth mesiolingual canal

anatomy, such as crown form and number of occlusal cuspidies, enamel bridge aspect, root number, diameter, and tooth size. A tooth had to be excluded from the sample because it had an extensive pulp nodule. A coronary opening was performed with a spherical diamond drill 1016 (KG Sorensen®, Cotia, São Paulo, Brazil) in high rotation until reaching the pulp nodule. In order to remove the pulp chamber roof, the Endo-Z drill (Microdont®, São Paulo, São Paulo, Brazil) was used at high speed. Afterward, the dental elements were numbered with an overhead pen (PILOT® 2.0 mm).

Visual clinical analysis of the number of existing canals was performed using a straight endodontic exploratory probe (Hu-Friedy EXDG16®, Chicago, Illinois, USA) and a K10 manual file (SybronEndo®, São Paulo, São Paulo, Brazil). The dental elements that had not been located in the fourth canal were transferred to the second analysis with the aid of a composite magnifying glass [(Fig. 1) Carl Zeiss®, Jena, Thuringia, Germany] with an increase of 2.5×. Both methods employed had direct reflector illumination. Subsequently, the unidentified remaining was examined using a surgical microscope (OPTO Dental®, model DM2003, São Carlos, São Paulo, Brazil) with magnification of 20× (Fig. 2). Both evaluations were performed using the endodontic exploratory probe (Hu-Friedy EXDG16®) and the K10 manual file (SybronEndo®). Next, periapical radiographs (E-Speed—Carestream, Carestream Dental LLC, Atlanta, Estados Unidos) were taken with radiographic films identified with their respective tooth number in the lingual/palatal direction, only teeth without mesiolingual canal orifice identification in order to locate them, considering that canals may be present and the cervical third may be calcified (Fig. 3). For this, the teeth were positioned in a device, specially shaped so that the angulation, in the incidence of disto-eccentric of 20° was standardized.



Fig. 3: Periapical X-ray of a permanent first permanent first molar indicates the presence of the fourth mesiolingual canal (sample # 10)

The focal distance was 34 cm and the exposure time was 0.50 seconds, in the Gnatus® device (Ribeirão Preto, São Paulo, Brazil) 70× with 70 kVp and 7 mA. Processing was performed in a darkroom containing developer and Kodak® fixative (Rochester, New York, USA), following the temperature–time method. Radiographic analysis was performed with the aid of a light box to visualize the number of canals. Afterward, the teeth which had not been located the canal were scanned using the microtomography equipment (SkyScan 1172, SkyScan b.v.b.a., Aartselaar, Antwerp, Belgium), at 100 kV and 100 μA, with an isotropic resolution of 16 μm (Fig. 4).

A single operator previously trained to use the proposed systems performed all evaluations.

RESULTS

A total of 73 teeth were evaluated through visual clinical analysis, where 41 (56.1%) presented the mesiolingual canal. The 32 teeth in which it was not possible to visually

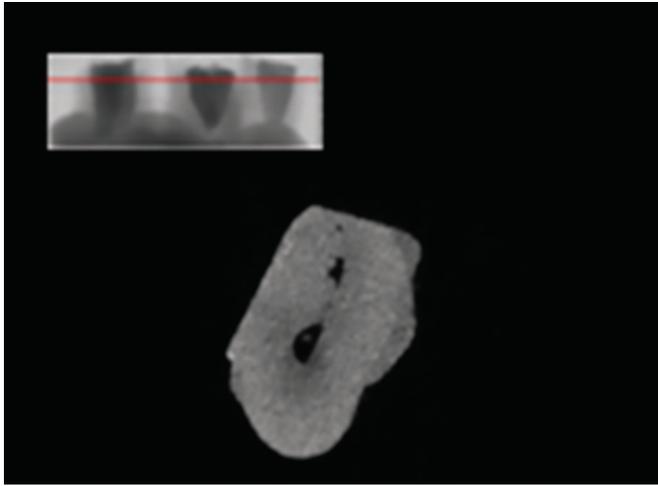


Fig. 4: Axial section view of the cervical third of computerized microtomography of a first permanent maxillary first molar indicates the presence of the fourth mesiolingual canal of smaller diameter

locate the mesiolingual canal were submitted to inspection with a composite magnifying glass (Fig. 1), so that the presence of the fourth canal in 11 teeth (71.2%) was verified. The remaining 21 teeth were submitted to analysis with a surgical microscope (Fig. 2), and the mesiolingual canal was identified in 11 (86.3%) of those. Finally, the remaining 10 teeth were analyzed with periapical radiographs in the vestibulopalatine sense (Fig. 3), where 4 (91.7%) presented the fourth canal, while the remaining 6 teeth were analyzed by computerized microtomography (Fig. 4), being identified the mesiolingual canal in 3 (95.8%). Of the 73 teeth analyzed, the prevalence of the mesiolingual canal in the mesiobuccal roots was 95.8% (70 teeth), and in only 3 teeth the fourth canal was not found.

DISCUSSION

Despite the great knowledge of clinicians and specialists on the anatomical complexity of the maxillary molars, the location of all root canals is decisive for the success of endodontic therapy. Corroborating this, it is observed that the great failure rate may be due to the fact that the fourth canal is not located in the maxillary molars.²²

The results presented demonstrated the importance of the magnified image for the location of the mesiolingual canal. The prevalence of the fourth canal was 95.8%, and in only 41 of the 73 teeth analyzed (56.1%) it was possible to visually locate it, without the support of image magnifiers.

Studies already published in the literature present variations on the prevalence of the mesiolingual canal of the upper first molars. This discrepancy probably occurs due to the diversity of the methodologies used, since *in vivo* studies report lower rates of the presence of the fourth canal when compared with *in vitro* studies. Such event is due to the difficulties faced clinically, such as

method of visualization, access, and positioning of the tooth when evaluated *in vivo*. In contrast, the *in vitro* studies present higher prevalence of the fourth canal in the upper first molars, due to the greater ease of visualization,²³ justified by the condition of not being present in the dental arch.

Our results are in agreement with similar studies,^{1,16-18} which obtained an incidence between 51 and 62%, when the fourth canal prevalence was assessed through visual clinical analysis in maxillary first molars. When the location of the fourth canal was evaluated with the aid of the composite magnifying glass Zeiss®, the mesiolingual canal was located in 11 additional teeth in relation to the visual clinical analysis, with an incidence of 71.2%. These results are in agreement with a study carried out by Smadi and Khraisat,¹⁸ when they used magnifying glasses with 3.5 magnification and detected a prevalence of 63.9% of the fourth canal in the maxillary first molars. In contrast, the study by Schwarze et al³ obtained results different from ours, where the authors found a prevalence of 46.2% of the fourth canal. We understood that this result was different from ours as they used a magnifying glass with a magnification of 2 times, and we, in the present work, used the magnifying glass at 2.5 times magnification.

In addition to visual clinical analysis and analysis with composite magnifying glass, other methods were used in the present study. The prevalence of 86.3% was verified through the surgical clinical microscope. These results are in agreement with those obtained in other studies,¹⁹ where the prevalence was 82%, when used a magnification of 25 times. Contrasting with our results, studies^{1,7,17} identified a lower prevalence of the fourth canal that ranged from 52.3 to 74%, when magnification was used between 12.5 and 25 times. These results may be justified by the calcification of the cervical third at the entrance of the canals as explained in previous research.²²

On the contrary, it should be pointed out that the results found by Schwarze et al³ detected a higher prevalence than our findings, where these authors found 92.3% of teeth with the presence of the fourth canal. It is important to highlight that these authors used magnification of 8 times. Such larger results may have been provided by the removal of dentin from the floor of the pulp chamber with the aid of drills. The use of the surgical microscope allowed greater magnification and illumination of the field, facilitating the visualization and, consequently, the location of the orifices of the root canals.

In this *in vitro* study, the radiographic measurements identified the incidence of 91.7% of mesiolingual canals. The radiographic method in the search of the mesiolingual canal in the mesiobuccal root of maxillary first molars presents limitations, since it does not always allow the visualization of all the root canals, as it offers a

two-dimensional image of a three-dimensional object. In addition, one canal is located by vestibular and the other by palatine of the root with overlapping of images and hindering the visualization of the fourth canal clinically, since it is a two-dimensional image.

The results obtained through the analysis with computerized microtomography show a prevalence of 95.8%, totaling three more teeth, so we can consider microtomography as the definitive method for the location of the fourth canal. Our results are in agreement with the findings of Verma and Love,¹⁴ which also detected a high incidence of two root canals in the mesiobuccal root of maxillary first molars, with a 90% prevalence index.

With the advancement of age, there is an increase in the deposition of dentin on the root canal orifices, as well as in the cervical thirds, making visualization difficult and consequently reducing the location of these canals.²² We suggest the use of computerized microtomography to evaluate the presence of the fourth canal, as this is a precise, accurate, and efficient method.

According to the prevalence of the fourth canal found in the present study, it is suggested that the use of techniques that use magnification is of extreme importance in order to provide a more adequate endodontic treatment, reducing, therefore, the rates of failure.

CONCLUSION

In view of the above, based on the results obtained and according to the methodology applied in this study, it was possible to conclude that the visual method in the search of the fourth canal has limitations. The composite magnifying glass, operative microscopy, and computerized microtomography are more efficient methods to locate the fourth canal in the maxillary first molars.

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