JNT - FACIT BUSINESS AND TECHNOLOGY JOURNAL - ISSN: 2526-4281 - QUALIS B1
ANO 2025 – MÊS DE ABRIL - FLUXO CONTÍNUO – Ed. 61. Vol. 1. Págs. 3-13
DOI: 10.5281/zenodo.15303396

MESIOBUCCAL ROOT VOLUME AND THE PRESENCE OF THE SECOND MESIOBUCCAL CANAL IN A BRAZILIAN SUBPOPULATION

André Luis Alves BORGES
Universidade Federal Rio Grande do Norte Federal University (UFRN)
E-mail: andreborgez@gmail.com
ORCID: http://orcid.org/0000-0003-3174-8882

Romulo de Oliveira SALES-JUNIOR
Universidade Estadual Paulista (UNESP)
Faculdade de Odontologia, Araçatuba (FOA)
E-mail: romulo.sales@unesp.br
ORCID: http://orcid.org/0000-0002-4638-7971

Hébel Cavalcanti GALVÃO
Universidade Federal Rio Grande do Norte Federal University (UFRN)
E-mail: hebel.galvao@yahoo.com.br
ORCID: http://orcid.org/0000-0002-1092-1992

João Eduardo GOMES-FILHO
Universidade Estadual Paulista (UNESP)
Faculdade de Odontologia, Araçatuba (FOA)
E-mail: joao.eduardo@unesp.br
ORCID: http://orcid.org/0000-0001-5994-2287

Antonione Santos Bezerra PINTO
Universidade Estadual do Piauí (UESPI)
E-mail: antonione182@hotmail.com
ORCID: http://orcid.org/0000-0002-6577-2816

Carlos Alberto Monteiro FALCÃO
Universidade Estadual do Piauí (UESPI)
E-mail: falcao@phb.uespi.br
ORCID: http://orcid.org/0000-0001-7787-0280

Maria Ângela Arêa Leão FERRAZ
Universidade Estadual do Piauí (UESPI)
E-mail: angelaferraz@phb.uespi.br
ORCID: http://orcid.org/0000-0001-5660-0222

ABSTRACT

Identifying anatomical variations in the mesiobuccal root of maxillary first molars is essential for endodontic success. This study evaluated the presence of a second canal in

this root and its correlation with root volume in a Brazilian subpopulation. A total of 142 CT scans of maxillae were analysed for volumetric assessment and canal identification. Root volume was calculated using InVersalius, and the second canal was identified with OnDemand3D Dental.Ink. Pearson's chi-squared test and the Mann-Whitney test ($p < 0.05$) were applied using R2 Commander. A total of 284 maxillary first molars were analysed, with a mean volume of 98.888 mm^3 for tooth 16 and 94.093 mm^3 for tooth 26. The second mesiobuccal canal was present in 77.11% of the teeth. No statistical association was found between its presence and root volume or between the mean volumes of teeth 16 and 26. While vestibular root volumes showed no significant differences, the mesiobuccal root volume was significantly higher in males. In conclusion, in this Brazilian subpopulation, there was no correlation between the presence of a second mesiobuccal canal and root volume variations in maxillary first molars.

Keywords: Root canal. Computed tomography. Volume.

INTRODUCION

Teeth have numerous variations in their anatomical characteristics, making it necessary to study their morphology in detail. Even with advances in endodontic studies, root canal knowledge remains a challenge due to the anatomical variability that needs to be interpreted and recognized. It should be noted that in adverse situations, outside the norm, the dentist's knowledge and commitment to the subject are essential to contribute to success and avoid failure of endodontic procedures (Jang et al,2019; Lima et al, 2018).

The radiographic examination is fundamental in endodontics, mainly in the diagnosis, to identify and visualize basic anatomical structures of the dental element and to plan the interventions that the treatment requires. However, conventional radiographs are limited by their distortions and overlapping structures (Barbhai et al, 2022; Sales-Junior et al, 2023; Tay et al, 2022).

These limitations have led to the emergence of cone beam computed tomography (CBT), which uses a cone beam of X-rays that, through a 360º rotation around the region of interest, acquire a varied set of two-dimensional images that are then analyzed by

specific software that generates a volumetric three-dimensional image without the presence of distortions (Nasseh; Al-Rawei, 2018).

This imaging method is essential for visualizing anatomical structures, including root canals, quickly and non-invasively, guaranteeing better image quality and detail than conventional radiography. However, despite its advantages, this tool is not yet routinely used in dentistry. One of the factors influencing this is the high cost of the equipment required to perform the tests (Lima et al, 2018).

Upper molars have a low success rate for endodontic treatment, which may be related to radiographic misinterpretation and the limitations of conventional radiography, as well as the complexity of the root canal systems. It is known that the incidence of second root canals in the mesiobuccal root and their prior identification is a determinant of the success of endodontic treatment in these teeth (Mufadhal;Madfa, 2023; Magalhães et al, 2022).

A study on the internal anatomy of the maxillary first molars indicated an incidence of the second mesiobuccal canal (SMBC) of 82.3%. In these situations, CBCT is a valid tool to locate the MBC in cases where its clinical location was not possible (Falcão et al, 2016). Given this, there is a report that the identification of the MBC with CBCT was 90% higher (Kajan et al, 2018).

Considering that the root canal system is highly complex and has many variations, there are no studies that address the volumetric analysis of the mesiobuccal root and the presence of SCMB. Obtaining this relationship for endodontics can shed light on the presence of SCMB when planning difficult cases. Therefore, the null hypothesis of this study is that there is no correlation between the mesiobuccal root volume of the maxillary first molar and the presence of SCMB. Therefore, the purpose of this study is to evaluate the presence of SCMB in maxillary first molars correlated with mesiobuccal root volume on CBCT in a Brazilian subpopulation.

MATERIALS AND METHODS

Ethical Aspects

This study was conducted with the approval of the Research Ethics Committee of the State University of Piauí, under opinion number 4.626.527. Being characterized as a

cross-sectional and quantitative study in a database in a Diagnostic Center of Dental Radiology in the city of Parnaíba, Piauí carried out with a cone beam computed tomography machine (Instrumentarium Orthopantomograph OP300 3D, United States) with a field it of view (FOV) of 6x4 cm and with a voxel size of 0.25 millimeters.

Samples, data collection and analysis.

The sample of this study was based on a census sample of the entire population of the database, including 950 TCCBs that had a complete maxilla with the necessary image quality for analysis without distinction of age and sex. We excluded 808 TCCBs that showed the absence of at least one upper first molar, and extensive pathological processes with evidence of caries, periapical lesions, and facial trauma. Thus, a total of 142 examinations were used as the sample for tabulation and analysis of the findings.

The analysis of the examinations was carried out in two stages under low light conditions and independently by two investigators who were previously trained/calibrated in the use of the software, with an inter-observer agreement of at least 0.8 according to the kappa index.

In the first step, the volume of the mesiobuccal root of teeth 16 and 26 was obtained using InVesalius version 3.1 (Technology Information Center, Campinas, Brazil) (www.cti.gov.br/invesalius) through axial slices, with the location of the mesiobuccal root and with the intersection of the slices, the region from the furcation to the apex of the root of the tooth under study in the multiplanar reconstructions (Figure 1) was manually segmented to obtain the final volume. In the second step, the open-access software OnDemand3D Dental. Ink (Cybermed OEM Version Wrapper, Korea) was used to evaluate each CBCT with multiplanar reconstruction (MPR) (Figure 2), enlarging the image in the axial, coronal, and sagittal planes. In the axial, coronal, and sagittal planes, lines were placed in the mesiobuccal root to observe the presence of the canal in this root.

Figure 1: A - Axial section with the intersecting cross tool marking the furcation region of the first maxillary molar; B - Sagittal section to complete the marking; C - Coronal section.

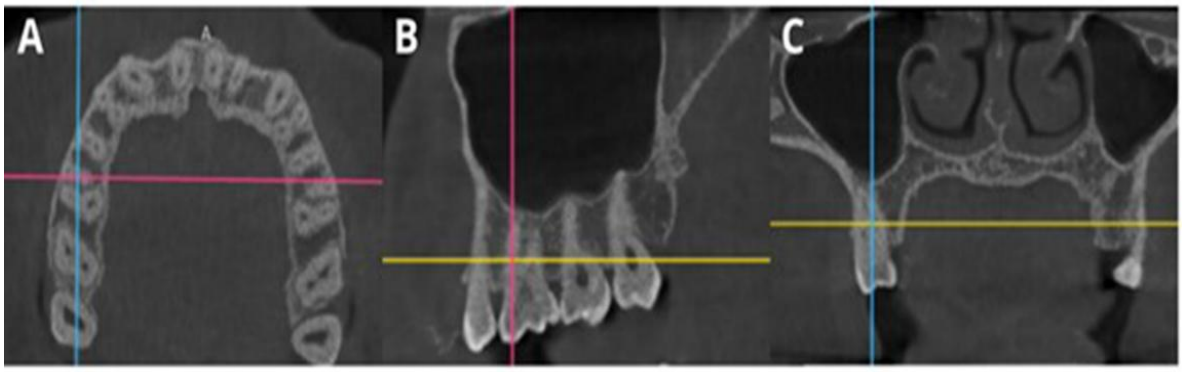
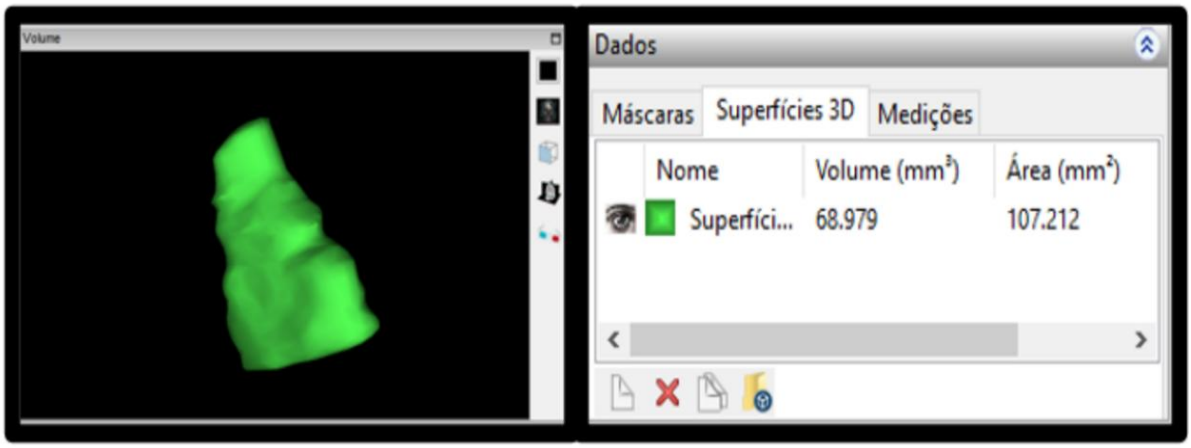


Figure 2: A- 3D view of the mesiobuccal root, manually segmented to obtain volume. B- Data box generated by the programme with volume in mm3.



Statistical Analysis

Information on root volume and presence of SCMB was stored in a tabular format in Microsoft Excel©. For statistical analysis, the intersection between variables (root volume, presence/absence of SCMB, and sex) was applied through contingency tables using Pearson's chi-squared test ($p < 0.05$); and the Mann-Whitney test was used for non-parametric data ($p < 0.05$) using the resources of the free software R2 Commander (version 1.6.0).

Results

In the 142 TCCBs, the first 284 upper molars (16 and 26) were obtained, the average of which was 98.888 mm3 (DP: + 26.679) for tooth 16 and 94.093 mm3 (DP: +

23.408) for tooth 26 (Table 1), and a volumetric average was obtained for each sex (Table 2).

Table 1: Root volume average of teeth 26 and 16

Analyzes	Teeth 26	Teeth 16
Average	94,093*	98,888
Standard error	1,964	2,239
Median	89,397	98,074
Standard deviation	23,408	26,679

*All numerical data are in mm3.

Table 2: Volumetric mean according to the patient's gender.

Analyzes	Male		Female	
	Teeth 26	Teeth 16	Teeth 26	Teeth 16
Average	100,409*	105,065	90,660	95,531
Standard error	3,418	3,877	2,332	2,690
Median	96,342	106,569	87,883	93,945
Standard deviation	24,172	27,416	22,372	25,802

The second canal in the root was present in 77.11% of the teeth analyzed, in tooth 16 in 73.94% and tooth 26 in 80.28% (Table 3).

Table 3: Incidence of SCMB.

Presence of SCMB	SCMB present n* (%*)	SCMB absent n (%)	Total n (%)
Teeth 16	105 (73,94)	37 (26,05)	142 (100)
Teeth 26	114 (80,28)	28 (19,71)	142 (100)
Total	219 (77,11)	65 (22,88)	284 (100)

*n – Amount of data; % - Percentage.

In the incidence of the presence of the SCMB, the data showed that there was no evidence of a statistical association between the presence of the second mesiobuccal canal and root volumes above the mean of teeth 16 (X2=0.24, df = 1, p-value = 0.62) and 26 (X2=0.17, df = 1, p-value = 0.68), and there was no incidence by sex (Table 4).

Table 4 - Presence of SCMB according to sex.

Presence of SCMB	Male		Female		Total n (%)
	SCMB present n* (%*)	SCMB absent n (%)	SCMB present n (%)	SCMB absent n(%)	
Teeth 16	40 (80)	10 (20)	65 (70,65)	27 (29,34)	142 (100)
Teeth 26	45 (90)	5 (10)	69 (75)	23 (25)	142 (100)

*n – Amount of data; % - Percentage.

Finally, there was no statistically significant difference between the vestibular root volumes of teeth 16 and 26 (p= 0.11), with mean values of 98.888 mm3 (SD: + 23.408) and 94.093 mm3 (SD: + 26.679), respectively. A statistical difference was observed between the vestibular root volumes of teeth 16 and 26 equivalent between the sexes (p-value = 0.02 and p-value = 0.03), with higher values in males.

DISCUSSION

The complex anatomy of root canals in maxillary first molars makes successful endodontic therapy a challenge (Carrion et al, 2022; Syed et al, 2022). Therefore, the literature searches for imaging techniques such as CBCT to determine their location, as it is extremely difficult in two-dimensional images and clinically due to the various anatomical variations and pulpal calcifications (Clegharn et al, 2007; Guo et al, 2014; Mufadhal; Madfa; 2023; Somma et al, 2009). According to Zhang et al. (2017), the SCMB, when present, is atresia and curved, making it difficult to perform procedures and visualize.

Based on the gap that there are no studies that correlate the volume of the mesiobuccal root and the presence of SCMB, added to the importance of locating the SCMB, there was the motivation for the present study, obtaining an acceptance of the null hypothesis.

The results of this study, infer the calculation of the volume of the mesiobuccal root, from its manual segmentation, giving an average of 98.888 mm3 for tooth 16 (maxillary first molar) and 94.093 mm3 for tooth 26 (maxillary second molar). By obtaining the average volume of each root, a correlation was made with the presence of SCMB, but for the first time, it was observed that there was no relationship between the

increase or any change in volume with the presence or absence of SCMB. However, in one study, only in the axial section of the CBCT, it was observed that the buccal-palatal width of the mesiobuccal root with SCMB and the mean root level were significantly greater than in teeth without SCMB (Dibaji et al, 2022).

The incidence of SCMB in this study was 77.11% of the upper first molars, with 73.94% in tooth 16 and 80.28% in tooth 26. In a systematic review of several studies on the anatomy of SCMB, it was found that this percentage of incidence can vary from 30% to 90% depending on the ethnicity and sample of each study (Barbhai et al, 2022) and the present study has a percentage within the range of evidence of these studies. This variation in incidence can be explained by the variability of anatomical studies in terms of race, genetics, sample size and diagnostic methods and their quality for accuracy of location (Lee et al, 2020; Yanik et al, 2022).

When the data were then related to gender, no statistical relationship was observed for the presence of SCMB, and this evidence has been observed in other clinical studies (Alsaket et al, 2020; Mufadhal; Madfa; 2023; Onn et al, 2022; Syed et al, 2022; Zhang et al, 2011). However, the study by Onn et al. (2022) discusses that there may be a higher prevalence in males, based on the explanation that females have a higher incidence of demineralization and cortical bone loss, making it difficult for the lack of contrast on imaging studies to prevent the localization of SCMC. Although there is no consensus in the literature on this difference between the sexes, it is thought that it may also be influenced by sample variability and ethnicity (Barbhai et al, 2022).

On the other hand, it has been found that there is a significant difference in the volume of the mesiobuccal roots between females and males, showing that facial morphological characteristics, and especially the teeth, can vary according to age, sex and facial biotype (Almeida Barbhai et al, 2014). As well as research confirming that males have larger average dimensions in elements 16 and 26, which corroborates the results of the present study (Fernandes Barbhai et al, 2016; Pandey; Ma; 2016).

This study has limitations because it is a cross-sectional study that started with a large number of examinations included in the database, but for the analyses in question, only a few TCCB were actually used for the sample population studied, requiring further studies in the Brazilian population with a larger sample using a large repository of imaging examinations. Nevertheless, the study has an impact and highlights the

importance of the clinical applicability of CBCT as a non-invasive, reliable and accurate reproducible technique to obtain a study of anatomical variations in a three-dimensional way (Dibaji et al, 2022; Mufadhal;Madfa; 2023; Onn et al, 2022). This method has been shown to be a precise tool for locating the SCMB, as it facilitates the interpretation of the mesiobuccal root sectioned in the evaluation planes with high resolution (Aktan et al, 2016; Bello et al, 2018; Onn et al, 2022).

CONCLUSION

It is concluded that in this Brazilian subpopulation there is no correlation between the presence of the second canal in the mesiobuccal root of maxillary first molars and volume variations. Regarding sex, there is no difference between the presence of the canal and the sex of the patient, but the volume of the mesiobuccal root was greater in males.

REFERENCES

AKTAN, A. M.; YILDIRIM, C.; CULHA, E.; DEMIR, E.; ERTUGRUL CIFTCI, M. Detection of Second Mesiobuccal Canals in Maxillary First Molars Using a New Angle of Cone Beam Computed Tomography. **Iran J Radiol**, 2016; 13(4):3115.

ALMEIDA, F. J. M.; KNUTSSON, K.; FLYGARE, L. **The effect of CBCT on therapeutic decision-making in endodontics**. Dentomaxillofac Radiol, 2014; 43(4):20130137.

ALSAKET, Y. M.; EL-MA'AITA, A. M.; AQRABAWI, J.; ALHADIDI, A. Prevalence and Configuration of the Second Mesiobuccal Canal in the Permanent Maxillary First Molar in Jordanian Population Sample. **Iran Endod J**, 2020; 15(4):217-220.

BARBHAI, S.; SHETTY, R.; JOSHI, P. et al. Evaluation of Root Anatomy and Canal Configuration of Human Permanent Maxillary First Molar Using Cone-Beam Computed Tomography: **A Systematic Review. Int J Environ Res Public Health**, 2022; 19(16):10160.

BELLO, M. C. et al. Diagnostic efficacy of four methods for locating the second mesiobuccal canal in maxillary molars. **Iran Endod J**, 2018; 13(2):204-208.

CARRION, S. J.; COELHO, M. S.; SOARES, A. J.; FROZONI, M. **Apical periodontitis in mesiobuccal roots of maxillary molars**: influence of anatomy and quality of root canal treatment, a CBCT study. Restor Dent Endod., 2022 Sep 19; 47(4): e37.

CLEGHORN, B. M.; CHRISTIE, W. H.; DONG, C. C. S. The Root and Root Canal Morphology of the Human Mandibular First Premolar: **A Literature Review. J Endod**., 2007 May; 33(5):509–16.

DIBAJI, F. et al. Evaluation of the relationship between buccolingual width of mesiobuccal root and root canal morphology of maxillary first molars by CBCT. **Dent Res J (Isfahan)**., 2022; 28;19:5.

FALCÃO, C. A. M. et al. **Frequência do canal mesiopalatino em primeiros molares superiores permanentes visualizados por meio de tomografia computadorizada**. Acta Odontol. Latinoam, 2016; 29(1):54-59.

FERNANDES, L. C. C. et al. Odontometric analysis of molars for sex determination. **Braz J Oral Sci**, 2016; 15(1):35–8.

GUO, J. et al. Evaluation of Root and Canal Morphology of Maxillary Permanent First Molars by Cone-beam Computed Tomography. **J Endod**, 2014; 40(5):635–639.

JANG, Y. E. et al. **Frequency of non-single canals in mandibular premolars and correlations with other anatomical variants**: an in vivo CBCT study. BMC Oral Health, 2019; 19(1):1-9.

KAJAN, Z. D. et al. Accuracy of CBCT in Comparison with Standard Method in Evaluating Root Canal Morphology: An In Vitro Study. **Iran Endod J**, 2018; 13(2):181–7.

LEE, S. J. et al. A CBCT study of the prevalence and location of the second mesiobuccal root canal in maxillary molars. **Restor Dent Endod**, 2020; 45(4):46.

LIMA, C. O. et al. Evaluation of root canal morphology of maxillary premolars: a CBCT study. **Aust Endod J**, 2018; 45(2):196–201.

MAGALHÃES, J. et al. Morphological Study of Root Canals of Maxillary Molars by CBCT. **Sci. World J**, 2022.

MUFADHAL, A. A.; MADFA, A. A. **The morphology of permanent maxillary first molars evaluated by CBCT among a Yemeni population**. BMC Oral Health, 2023; 23(1):1-12.

NASSEH, I.; AL-RAWI, W. **Cone beam computed tomography**. Dent Clin, 2018; 62(3):361-391.

ONN, H. Y. et al. Prevalence of mesiobuccal-2 canals in maxillary first and second molars among the Bruneian population - CBCT analysis. **BDJ Open**, 2022; 8(1):32.

PANDA, N.; MA, M. S. Evaluation of sexual dimorphism in maxillary and mandibular canines using mesiodistal, labiolingual dimensions, and crown height. **Indian J Dent Res**, 2016; 27(5):473.

SALES JUNIOR, R. de O.; GOMES FILHO, J. E.; ALMEIDA, W. C. de; FREITAS, S. A. P.; FALCÃO, C. A. M.; FERRAZ, M. Â. A. L. Study of anatomical variations in premolars by cone beam computerized tomography in a radiologic clinic in Piauí. **Revista de Ciências Médicas e Biológicas, Salvador,** v. 22, n. 1, p. 24–29, 2023.

SOMMA, F. et al. Root canal morphology of the mesiobuccal root of maxillary first molars: a micro-CT analysis. **Int Endod J**, 2009; 42(2):165–174.

SYED, G. A. et al. CBCT Evaluation of Canal Morphology of Mesiobuccal Root of Maxillary Molars in Saudi Subpopulation. **J Pharm Bioallied Sci**, 2022; 14(1):410-414.

TAY, K. X. et al. Influence of CBCT on Endodontic Treatment Planning: **A Systematic Review. J Dent**, 2022, 104353.

YANIK, D.; NALBANTOĞLU, A. M. **Dentin thickness at danger zone and canal morphology of maxillary molars**. Acta Stomatol Croata, 2022; 56(1):50-60.

ZHANG, R. et al. Uso da CBCT para identificar a morfologia dos dentes molares permanentes superiores em uma subpopulação chinesa. **Int Endod J**, 2011; 44:162–9.

ZHANG, Y. et al. Assessment of the Second Mesiobuccal Root Canal in Maxillary First Molars: A CBCT Study. **J Endod**, 2017; 43(12):1990–6.