FREQUENCY OF THE MESIOPALATAL CANAL IN UPPER FIRST PERMANENT MOLARS VIEWED THROUGH COMPUTED TOMOGRAPHY

Carlos A.M. Falcão[1,2], Verbena C. Albuquerque[1], Neusinárya L.S. Amorim[1], Sérgio A.P. Freitas[1], Tanit C. Santos[1], Francisca T.C. Matos[1], Maria A.A.L. Ferraz[1,2]

[1] *Dentistry Department. School of Dentistry, University Center Uninovafapi, Brazil*
[2] *Dentistry Department.School of Dentistry, State University of Piauí, Brazil*

ABSTRACT
The success of any endodontic therapy depends on factors such as correct diagnosis and prognosis. Unawareness or failure to locate additional canals, such as the mesiopalatal canal in the upper first molar, may lead to unsuccessful treatment. Hence, it is valid to consider all the resources available for locating this anatomic structure, e.g. the Cone-Beam Computed Tomography (CBCT). The purpose of this study was to verify the frequency of mesiopalatal canals in upper first permanent molars through computed tomography. Tomography images from a digital archive of a diagnostic imaging center were analyzed. Eighty (80) upper right first molars were assessed through CBCT in axial cross sections at 6mm and 3mm from the root apex; 40 were females and 40, males, randomly chosen. The results revealed that the mesiopalatal canals were present in 56.25% of the sections at 6mm from the root apex, and in 23.75% at 3mm from the apical limit. CBCT scan has proved to be a valid resource for locating mesiopalatal canal, especially in cases where location was not feasible through clinical means.

Key words: *Computed tomography, endodontics, root canal.*

FREQUÊNCIA DO CANAL MESIOPALATINO EM PRIMEIROS MOLARES PERMANENTES SUPERIORES VISUALIZADOS EM TOMOGRAFIA COMPUTADORIZADA

RESUMO
O sucesso do tratamento endodôntico depende de fatores como o correto diagnóstico e prognóstico. O desconhecimento ou a não localização de canais adicionais, como o canal mesiopalatino no primeiro molar superior, pode levar ao insucesso do tratamento. Portanto, é válido considerar todos os recursos para localização desta estrutura anatômica, dentre eles a tomografia computadorizada cone beam (TCCB). O presente trabalho teve como objetivo verificar a frequência do canal mesiopalatino em primeiros molares permanentes superiores através da tomografia computadorizada. Os exames analisados fazem parte do arquivo digital de uma clínica de diagnóstico por imagem particular. Foram avaliados 80 primeiros molares superiores direitos em cortes axiais a 6 e 3 milímetros do ápice radicular observados nas TCCB, sendo 40 em pacientes do gênero feminino e 40 do gênero masculino escolhidos aleatoriamente. Os resultados revelaram que o canal mesiopalatino está presente em 56,25% dos cortes a 6mm do ápice radicular e em 23,75% a 3mm do limite apical. TCCB eu um recurso válido para localização do canal mesiopalatino, sobretudo nos casos em que não foi possível a sua localização clínica.

Palavras-chave: *Tomografia computadorizada, Endodontia, Canal radicular.*

INTRODUCTION

Success in endodontic therapies depends on factors such as correct diagnosis and prognosis, which in turn, depend on clinical criteria and knowledge of the root canal systems anatomy. Frequently, ignoring the presence of any additional canal may lead to unsuccessful treatment as this may cause secondary infection. Root canal systems can be complex and difficult to evaluate. Recognizing their multiple anatomic variations, whether under normal conditions or not, reduces the chances of failure during endodontic procedures.[1]

The morphology of upper first permanent molars has been extensively studied. They usually have three roots and three or four canals but there are variations that may include one, four or five roots.

Cases with five or six canals have also been reported.[2,3] Hence, being acquainted with variations in root canal systems is highly relevant for an efficient treatment.[4]

Tools for visual magnification, such as magnifying glasses and surgical microscopes, are resources critical for practitioners to identify extra canals.[2] So much so considering that the difficult location of mesiopalatal canals is worsened due to its proximity to mesiovestibular canals and to a limited ability for viewing it through radiographic exams.[5,6]

Computed Tomography (CT) scans are alternative supplementary techniques, and may be crucial for any correct diagnosis of presence of fourth root canals in mesiovestibular roots of upper first permanent molars. Cone-Beam Computed Tomography (CBCT) scans, are more advantageous as patients are exposed to lower levels of radiation doses. Effective doses of CBCT may be as low as those of conventional panoramic X-Ray and considerably lower than those of medical computed tomography scans (MCT). When prescribed, CBCT 3D images should supplement 2D conventional radiographic techniques as the benefits derived from these two systems need to be exploited.[7]

Failure to locate mesiopalatal canals of upper first molars may cause a significant increase in failure rates in endodontic procedures. Hence, all of the resources available for locating such anatomical details are to be taken into account, including CBCT. Thus, it is considered relevant to assess the frequency of such canals through axial sections in CBCTs.

MATERIALS AND METHODS

The study included Cone-Beam Computerized Tomography of maxillae in patients with different indications and having their upper first molars in place. CBCTs form part of the digital archive of a diagnostic imaging center in Teresina Piauí, State of Piauí, Brazil. The upper first right molars of subjects were assessed. The sample included 80 tomography scans: 40 in female patients, and 40 in male patients whose ages were chosen at random. Upper left first molars (26) were assessed when upper right first molars (16) were missing in the subjects or when upper right first molars had undergone endodontic treatment.

Images were assessed through a specific software (ICAT CHORAN), in a 32" high resolution display, in an environment with low luminosity levels, and researchers were allowed 10-minute breaks for every 20 tomography scans being assessed.

Axial sections located at 3mm and 6mm from the root apex were reconstructed and then assessed for identifying presence or absence of fourth root canals in mesiovestibular roots of upper first permanent molars (16). The presence of fourth root canals was detected through two axial sections at 3mm and 6mm from the apex.

Category variables, presence of the fourth root canal in first molars permanent (16 and 26) and gender were analyzed through percentage readings; numerical variables, such as age, were analyzed in terms of average and standard deviation.

The results were exhibited in tables and in tomography images. This research was classified as a minimal risk survey, as per Provision 466/12 of the National Heath Council, the regulatory authority of research in human beings. The project was approved by the Ethics and Research Committee of UNINOVAFAPI (Teresina, State of Piauí, Brazil), as per protocol CAAE 10930012.2.0000521.

Statistical Analysis

A Qui-Square test was performed for verifying the existence of any link between the presence of the fourth canal, gender and age range with an α significance level of 5%.

RESULTS

From the 80 upper first permanent molars that were analyzed, tomography images showed that 56.25% had mesiopalatal canals in the axial section at a 6 mm distance from the root apex. (Table 1). In axial sections at a 3 mm distance from the root apex 23.75% have root canals (Table 2).

Tables 3 and 4 show frequency of mesiopalatal canals at 3mm and 6mm from the root apex according to gender and age range. No significant differences were observed ($p>0,05$) between the presence of fourth canals at 3mm and 6mm and age range and gender.

DISCUSSION

Prior knowledge of root canal anatomy enables an easier and more accurate detection of any kind of canal during endodontic treatment. The recent use of CBCT has enabled performing 3D global analyses that are non-destructive for the external and internal morphology of root canal systems.

Table 1: Prevalence of Mesiopalatal Canals in Upper First Permanent Molars at 6mm from Root Apex.

		6mm from Apex					
		Yes		No		Total	
		Nº	%	Nº	%	Nº	%
Tooth	16	39	60,00	26	40,00	65	100,00
	26	6	40,00	26	60,00	15	100,00
	Total	45	56,25	35	43,75	80	100,00

Source: Pesquisa direta p=0,16

Table 2: Prevalence of Mesiopalatal Canals in Upper First Permanent Molars (16) & (26) at 3mm from Root Apex.

		3mm from Apex					
		Yes		No		Total	
		Nº	%	Nº	%	Nº	%
Tooth	16	15	23,08	50	76,92	65	100,00
	26	4	26,67	11	73,33	15	100,00
	Total	19	23,75	61	76,25	80	100,00

Source: Pesquisa direta p=0,77

Table 3: Prevalence of Fourth Canals at 3mm from Root Apex, as per Gender and Age Range. Teresina (PI), 2013.

				3mm from Apex											
				Yes				No				Total			
				Nº	%	Avrge.	Strd. Dev.	Nº	%	Avrge.	Strd. Dev.	Nº	%	Avrge.	Strd. Dev.
Gender*	Males	Age	- than 30	1	12,50			7	87,50			8	100,0		
		Range	30 to 40	1	12,50			7	87,50			8	100,0		
		(years)	+ than 40	8	32,00			17	68,00			25	100,0		
	Females	Age	- than 30	3	60,00			2	40,00			5	100,0		
		Range	30 to 40	-	-			5	100,0			5	100,0		
		(years)	+ than 40	6	20,69			23	79,31			29	100,0		
	Total *	Age	- than 30	4	30,77			9	69,23			13	100,0		
		Range	30 to 40	1	7,69			12	92,31			13	100,0		
		(years)	+ than 40	14	25,93			40	74,07			54	100,0		
	Age					44	12			46	14			45	13

Source: Pesquisa direta. * p> 0,05

The morphology of upper first permanent molars has been extensively reviewed. These molars have three roots and three or four canals. Other variations include one, four or five roots. Cases with five, six or seven canals have also been reported. [2-3,8,] On the other hand, the second channel of the mesiobuccal root may be called fourth canal[1, 4], the second canal in the mesiovestibular root - MV2[9] . Yet, it is considered that the most adequate name for it is "mesiopalatal" as the correct position of the entry of the canal in the upper first molar is in fact mesiopalatal[8].

Table 4: Prevalence of Fourth Canals at 6mm from Root Apex, as per Gender and Age Range. Teresina (PI), 2013.

				6mm from Apex											
				Yes				No				Total			
				Nº	%	Avrge.	Strd. Dev.	Nº	%	Avrge.	Strd. Dev.	Nº	%	Avrge.	Strd. Dev.
Gender*	Males	Age	- than 30	7	87,50			1	12,50			8	100,0		
		Range	30 to 40	5	62,50			3	37,50			8	100,0		
		(years)	+ than 40	16	64,00			9	36,00			25	100,0		
	Females	Age	- than 30	3	60,00			2	40,00			5	100,0		
		Range	30 to 40	2	40,00			3	60,00			5	100,0		
		(years)	+ than 40	12	41,38			17	58,62			29	100,0		
	Total *	Age	- than 30	10	76,92			3	23,08			13	100,0		
		Range	30 to 40	7	53,85			6	46,15			13	100,0		
		(years)	+ than 40	28	51,85			26	48,15			54	100,0		
	Age					43	13			48	13			45	13

Source: Pesquisa direta. * p> 0,05

Unsuccessful endodontic procedures are associated with different factors. Among such factors, there is failure to detect all the root canals for lack of knowledge of the internal molar configuration or for difficulty in viewing the entry level of root canals, due to anatomic variations or calcification in the pulp cavity. Recognizing anatomical variations decreases the rate of failure and of unsuccessfulness in endodontic procedures, thus assuring a good prognosis for treatment.[9,10]

In lateral and accessory canals , or in a delta morphology, where instruments have no access the use of chemical substances may be necessary. If this is a significantly important factor during preparation stage of root canals, it is even more important to locate any root canal. Failure to locate and treat a fourth root canal may be the link between coronal leakage and the presence of microorganisms in the apical area.[11.]

The results from this survey are consistent with research done with CBCT. Blattner *et al*[12], identified mesiopalatal canals in 57.9% of the cases; Kim *et al*[13] identified fourth canals in 63.59% of the cases in a Korean population and Baratto Filho *et al.*[14], 67.14%, while Somma *et al* [10], detected mesiopalatal canals in 80% of the cases by using micro-tomography. Blattner *et al*[12] reported higher prevalence levels in root slices (*ex-vivo*), where mesiopalatal canals were positively identified in 68.4% of the samples. Notwithstanding, CBCT has proved to be a relevant auxiliary tool for locating mesiopalatal canals (*in vivo).*

Research studies have reported that more than 50% of mesiopalatal canals are united in the apical area and end in a single foramen[8, 15] . Domark *et al*[16] reported that 69% of the cases with mesiopalatal canals ended in two or more different foramina. This research reported that 56% of mesiovestibular roots that had two canals at 6 mm from the apex presented only one single canal at 3 mm from the apex in CBCT scans. This may be due to the convergence of canals, and this may clinically justify the high success rate of endodontic treatment practices in upper first molars where mesiopalatal canals were not located. CBCT has the unique ability of rendering high resolution images of different views, and of avoiding any overlapping of adjacent structures, and of identifying canal unions.

As regards age ranges, the higher prevalence of presence of mesiopalatal canals at 6 mm from the root apex was in patients of age less than 30 years (76.92% accounted for females and 60%, for males), and that this rate decreased with age increase. In patients between 30 and 40 years of age, prevalence of mesiopalatal canals was 53.85% for both males and females; in patients of more than 40 years old, both male and female, the prevalence rate was 51.85%. Even though literature states that the shape, size and number of root

canals depend on age due to dentine deposition , which turns canals smaller and thinner may be total obliterated[13, 16,17], we did not find any statistically significant difference.

CBCT should not be used as routine practice in endodontic treatments since it exposes patients to a significant dose of radiation, and has a high cost[18,19]. Yet, this resource may be an alternative when, despite a correct procedure, successful treatment is not achieved and mesiopalatal canals may not viewed with conventional X-Ray.

It is concluded that mesiopalatal canals were found in 56.25% of upper first molars with the methodology used. There was no statistical difference when gender was considered and CBCT scan has proved to be a valid resource for locating mesiopalatal canal, especially in cases where location was not feasible through clinical means.

CORRESPONDENCE
Dr.Carlos Alberto Monteiro Falcão
University Center - UNINOVFAPI
Rua Vitorino Ortiges Fernandes, 6123
Bairro do Uruguai. CEP: 64057-100
Teresina-PI - Brazil
falcaoendo@hotmail.com

REFERENCES

1. Santos M, Costa Junior S, Meohas E, Adriano SLT, Oliveira GR, THULER, CES. Estudo Anatômico da Incidência do Canal Mesiopalatino em Primeiros Molares Superiores com Acesso Convencional ou Através de um Desgaste na Região de sua Embocadura. Caderno UniFOA 2010; 13: 39-47. URL: http://web.unifoa.edu.br/cadernos/edicao/13/39.pdf
2. Cunha RS, Davini F, Fontana CA, Miguita KB, Bueno CES. O conceito microsonics: primeiro molar superior com cinco canais – relato de caso. RSBO 2011; 8:231-235. URL: http://univille.edu.br/account/odonto/VirtualDisk.html?action=readFile&file=v8n2a15.pdf&current=/RSBO_-_v.8_-_n.02-_abril-junho_2011
3. Kottoor J, Velmurugun N, Sudna R, Hemamalath, S. Maxillary first molar with seven root canals diagnosed with cone-beam computed tomography scanning: A case report. J Endod 2010; 36:915-921.
4. Abuabara A, Schreiber J, Baratto Filho F, Cruz GV, Guerino, L. Análise da anatomia externa no primeiro molar superior por meio da tomografia computadorizada cone beam. RSBO 2008; 5:38-40. URL: http://pesquisa.bvs.br/brasil/resource/pt/lil-489546
5. Hartmann MSM, Patric F, Baratto Filho F, Fariniuk LF, Limongi O, Pizzatto E. Clinical and microscopic analysis of the incidence of a fourth canal and its trajectory in the maxillary first molar. RGO 2009; 57:381-384. URL: http://www.revistargo.com.br/viewarticle.php?id=1315
6. Falcão CAM, Falcão LF, Falcão DF, Silva PRA. Avaliação da capacidade de localização do canal mesiopalatino em molares superiores através de microscopia operatória. [Abstract]. Pesq. Bras. Odontoped. Clin. Integr 2008; 8: 3. URL: www.sbpqo.org.br/snpqo/anais_2008.pdf
7. Costa CCA, Moura-Neto C, Koubik ACGA, Michelotto ALC. Aplicações clínicas da tomografia computadorizada cone beam na endodontia. Rev. Inst. Ciênc. Saúde 2009; 27:279-286. URL: http://bases.bireme.br/cgibin/wxislind.exe/iah/online/?IsisScript=iah/iah.xis&src=google&base=LILACS&lang=p&nextAction=lnk&exprSearch=550812&indexSearch=ID
8. Ferreira POM, Ferreira EL, Fariniuk LF, Baratto Filho F, Sayão SMS. Análise radiográfica da trajetória do quarto canal no primeiro molar superior. RSBO 2007;4:12-15. URL: http://webcache.googleusercontent.com/search?q=cache:Z0lO24o8I2oJ:univille.edu.br/community/depto_odontologia/VirtualDisk.html%3Faction%3DdownloadFile%26file%3Danalise_radiografica_trajetoria.pdf%26current%3D%252FODONTOLOGIA%252FRSBO%252FRSBO_v.4_n.2_novembro_2007+&cd=1&hl=pt-BR&ct=clnk&gl=br
9. Alaçam T, Tinaz AC, Genç O, Kayaoglu G. Second mesiobuccal canal detection in maxillary first molars using microscopy and ultrasonics. Aust Endod J 2008; 34:106-109.
10. Somma F, Leoni D, Plotino G, Grande NM, Plasschaert, A. Root canal morphology of the mesiobuccal root of maxillary first molars: a micro-computed tomographic analysis. Int Endod J 2009; 42:165-174.
11. Sidney RB, Sidney GB, Batista A. Análise clínica e radiográfica da freqüência de um quarto canal na raiz mesiovestibular dos molares superiores. Rev Odontol UnivRibPreto2000;3:67-75.URL: http://www.scielo.cl/scielo.php?script=sci_nlinks&ref=3262830&pid=S0717-95022011000200053000 19&lng=es
12. Blattner T, George N, Lee C, Kumar V, Yelton C. Efficacy of cone-beam computed tomography as a modality to accurately identify the presence of second mesiobuccal canals in maxillary first and second molars: A pilot study. J Endod 2010; 36: 867-870.
13. Kim Y, Lee SJ, Woo J. Morphology of maxillary first and second molars analyzed by cone-beam computed tomography in a Korean population: Variations in the number of roots and canals and the incidence of fusion J Endod 2012; 38:1063-1068.
14. Baratto Filho F, Zaitter S, Haragushiku GA, de Campos EA, Abuabara A, Correr GM. Analysis of the internal

anatomy of maxillary first molars by using different methods. J Endod 2009; 35: 337-342.
15. Zheng Q, Wang Y, Zhou X, Wang Q, Zheng G, Wang DA. Cone-Beam computed tomography study of maxillary first permanent molar root and canal morphology in a Chinese population. J Endod 2010: 36:1480-1484.
16. Domarck JD, Hatton JF, Benisson RP, Hildebolt CF. An ex vivo comparison of digital radiography and cone-beam and micro computed tomography in the detection of the number of canals in the mesiobuccal roots of maxillary molars. J Endod 2013; 39:901-905.
17. Pereira ER, Carnevalli B, Franco De Carvalho EMO. Anatomia do assoalho da câmara pulpar de molares superiores: Parte I. Rev. Odontol. UNESP 2011; 40: 73-77. URL: http://www.revodontolunesp.com.br/files/v40n2/v40n2a04.pdf.
18. Ball J, Barbizam J V, Cohenca N. Intraoperative Endodontic Applications of Cone-Beam Computed Tomography. J Endod 2013; 39: 548-557.
19. Reis AG, Soares R, Barletta FB, Fontanella VR, Mahl CR. Second canal in mesiobuccal root of maxillary molars is correlated with root third and patient age: A cone-beam computed tomographic study. J Endod 2013; 39: 588-592.