Int. J. Morphol.,
41(4):1089-1094, 2023.

Analysis of the Internal and External Morphology of the Mandibular First Molar in a Chilean Sub-Population Using Cone-Beam Computed Tomography

Análisis de la Morfología Interna y Externa del Primer Molar Mandibular en una Subpoblación Chilena Mediante Tomografía Computarizada de Haz Cónico

Matus, D.[1,2]; Arias, A.[1,2]; Navarro, P.[2,3] & Betancourt, P.[1,2]

MATUS, D.; ARIAS, A.; NAVARRO, P. & BETANCOURT, P. Analysis of the internal and external morphology of the mandibular first molar in a Chilean Sub-Population using cone-beam computed tomography. *Int. J. Morphol., 41(4)*:1089-1094, 2023.

SUMMARY: The mandibular first molar (MFM) commonly presents two roots with two canals in the mesial root and one or two canals in the distal root. However, morphological variations have been described in different populations, which must be considered when planning endodontic treatment. The aim of this study was to analyze the internal and external morphology of the MFM in a Chilean sub-population using cone-beam computed tomography (CBCT) images. An in vivo cross-sectional, descriptive, and observational study was conducted using CBCT exams from 351 right and left MFM. The data were analyzed by descriptive statistics using the Chi-Square test for categorical variables, Fisher's exact test, the Mann-Whitney U non-parametric test for two independent samples, and the Wilcoxon non-parametric test for related samples. Of the total sample, 1 root was observed in 2.27 % of the cases, 2 roots in 93.73 %, and 3 roots in 4 %. In relation to the number of canals, 71.23 % of the MFM showed 3 root canals, 16.81 % 4 canals, 9.69 % 2 canals, and 2.28 % 1 canal. Of all the studied cases, 2.3 % had a C-shaped anatomy. In terms of morphology, using Zhang's classification, variant 3 was observed in 71.23 %, variant 4 in 12.82 %, variant 1 in 9.67 %, variant 6 in 4 %, and variant 8 in 2.28 %. In conclusion, the morphology of the MFM is variable in a Chilean sub-population, and these variations must be considered before and during endodontic therapy. CBCT proved to be an effective tool for the in vivo study of tooth morphology.

KEY WORDS: Mandibular first molar; Root morphology; Cone-beam computed tomography; Endodontics.

INTRODUCTION

The success of endodontic therapy is based on the root canal system (RCS) being correctly shaped, disinfected, and obturated (Betancourt *et al*., 2016). Consequently, it is extremely important for the planning of endodontic treatment to consider the internal morphology and the anatomical complexities that directly influence the intervention and its outcome (Silva *et al*., 2013; Kim *et al*., 2015).

The mandibular first molar (MFM) frequently requires endodontic treatment for being the first permanent posterior tooth to erupt, being susceptible early on to decay (Madani *et al*., 2017). It usually presents two well-defined roots with two canals in the mesial root and one or two canals in the distal root (Madani *et al*.; Silva *et al*.). However, different studies have reported variations in its morphology, indicating anatomical complexities such as the presence of isthmuses (Karabucak *et al*., 2016; Kang *et al*., 2020; Kim *et al*., 2016), a third middle mesial canal (Kim *et al*. 2015; Celikten *et al*., 2016), an accessory distal root (Betancourt *et al*. 2022), or a C-shaped morphology (Madani *et al*.). These anatomical complexities are genetically determined and vary according to the ethnic origin of the study population and even among individuals of the same race (Madani *et al*.; Silva *et al*.). The vast number of anatomical variants that the MFM presents poses a constant challenge for the clinician, and these must necessarily be considered before and during endodontic therapy (Demirbuga *et al*., 2013; Tomaszewska *et al*., 2013).

[1] Department of Integral Adult Dentistry, Dental School, Universidad de La Frontera, Temuco, Chile.
[2] Research Center in Dental Sciences (CICO), Endodontic Laboratory, Universidad de La Frontera, Temuco, Chile
[3] Universidad Autónoma de Chile, Chile.
Funding: Diufro proyect DI23-0085

Received: 2023-05-10 Accepted: 2023-06-07

Different techniques have been used to study the internal morphology of the RCS, in particular, the use of cone-beam computed tomography (CBCT) due to its advantages of providing three-dimensional images (Silva *et al*.) without damaging the structure of the tooth or its surrounding tissues and using a smaller radiation dose than conventional computed tomography. As a result, different studies consider it a complementary examination indicated in the diagnosis and endodontic planning stages (Karabucak *et al*.; Betancourt *et al*., 2016).

The morphology of the RCS has generally been catalogued using the classifications by Vertucci or Weine (Gulabivala *et al*., 2002; Kim *et al*., 2013). However, with the incorporation of CBCT, a greater complexity has been detected that these classifications cannot fully encompass. Thus, Zhang *et al*. incorporate new variants into Vertucci's classification, determining 8 variants for maxillary molars and 10 for mandibular molars (Silva *et al*.; Zhang *et al*. 2011 a; Zhang *et al*., 2011 b) (Fig.1).

The aim of this study was to analyze the internal and external morphology of the MFM in a Chilean sub-population using CBCT images.

MATERIAL AND METHOD

Ethical approval: The study was approved by the Scientific Ethics Committee of the Universidad de La Frontera (Protocol N° 038/21). 177 CBCT images from subjects of both sexes, over 18 years of age, were included, in which the presence of one or both MFM with complete root formation was observed. Examinations were excluded in which MFM with endodontic obturation or posts were observed, rehabilitation with fixed prosthesis, calcification of the canals, that have undergone apical or root surgery, or with a root curvature greater than 30°. The Imaging Service of the Faculty of Dentistry, Universidad de La Frontera, Temuco, Chile, provided the imaging examinations.

The CBCT images used were requested previously from the patients as part of the examination, diagnosis, and planning of dental treatment between November 2014 and December 2020. A Pax Zenith CBCT unit from Vatech was used (Vatech Co, Gyeonggi-Do, Korea) with the following parameters: 90 kV and 120 mA; FOV 8 x 6 cm, voxel size 0.12 mm. The researchers had no access to patients' personal data aside from their age and sex.

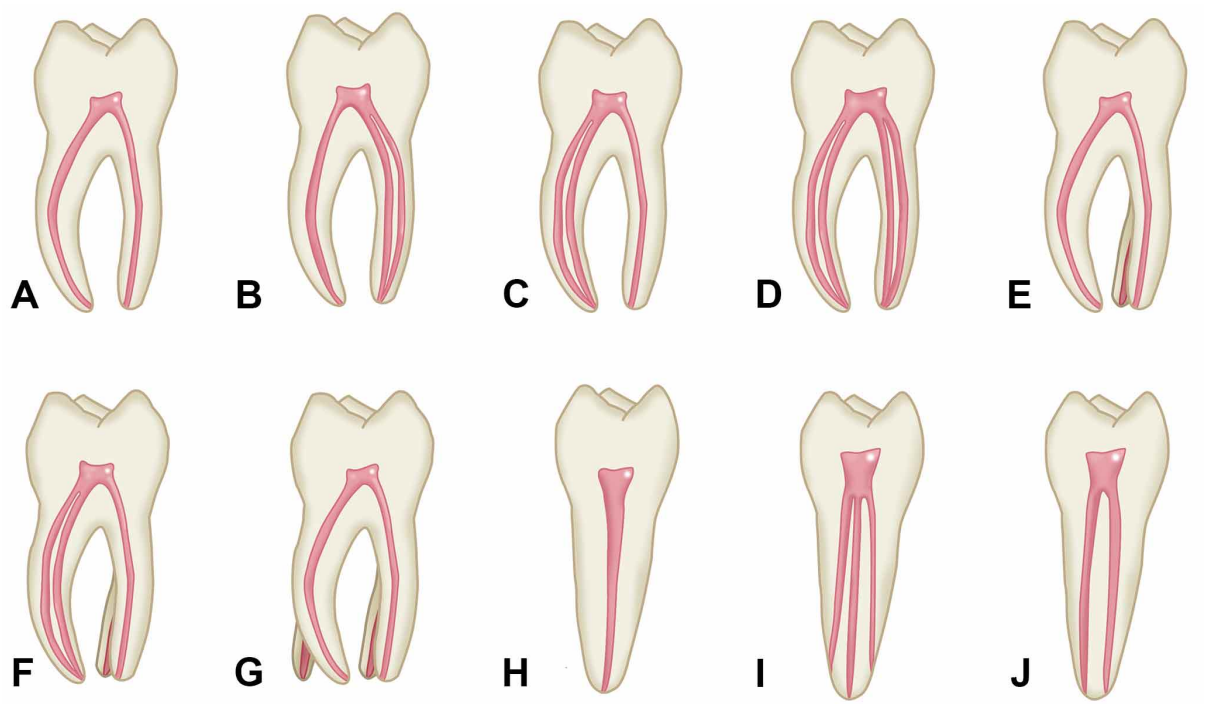

Fig. 1. The 10 variants classified by Zhang to describe the morphology of the root canal system in mandibular molars: A) two separate roots, mesial and distal roots, with one canal in each; B) two separate roots, with one canal in the mesial root and two in the distal root; C) two separate roots, with two canals in the mesial root and one in the distal root; D) two separate roots, with two canals in the mesial root and two in the distal root; E) three separate roots; mesial, distovestibular, and distolingual with one canal in each root; F) three separate roots with two canals in the mesial root and one in the distovestibular and distolingual roots; G) four separate roots: mesiovestibular, mesiolingual, distovestibular, and distolingual with a canal in each root; H) one root with a single canal; I) one root with three canals; and J) one root with two canals.

An *in vivo* cross-sectional, descriptive, and observational study was conducted using CBCT examinations of 351 MFM, of which 177 were left (tooth 3.6), and 174 were right (tooth 4.6). The images were processed with the Ez 3D 2009 software, projected on a LED screen, LG 42LE4300-SA, and analyzed by 2 endodontists after inter-observer calibration. The calibration process consisted of analyzing 20 CBCT of MFM separately on 3 occasions with a 1-week interval between observations. When it was not possible to reach a consensus, the decision was made by a specialist in radiology with experience in endodontics.

The observation was made using the following methodology: the MFM was located and a coronal-apical exploration was done of the entire length of the root. For this, the transverse plane was rectified, orienting the sagittal and coronal slices parallel to the longitudinal axis of the root. Sections of the image in the axial plane were obtained at 0.5 mm intervals and a thickness of 1 mm for all the samples using multiplanar reconstruction (MPR). MPR constructs a three-dimensional model by overlapping the structures with a 1mm thickness. The exploration followed the axial axis of each tooth to determine the number of roots and canals. Then, the vertex of each root was located, and the tomography advanced coronally in 2 mm slices, thus performing an apical-coronal exploration.

The (i) number of roots, (ii) number of canals, (iii) prevalence of C-shaped canals, and (iv) root canal configuration were determined in each sample. The RCS was also catalogued according to the classification by Zhang *et al*. (Zhang *et al*. 2011 a), considering the distribution by side and sex.

Statistical analysis. The data collection was recorded on a Microsoft Excel® spreadsheet. A descriptive data analysis was performed to determine absolute frequency, percentage frequency, and double-entry tables. The Kolgomorov-Smirnov test of normality was also performed. The applied statistical tests were the Chi-Square test for categorical variables, Fisher's exact test, the Mann-Whitney U non-parametric test for two independent samples, and the Wilcoxon non-parametric test for related samples. The IBM SPSS statistics program (version 23.0) was used for the data analysis. A value of $p < 0.05$ was chosen as the threshold for significance.

RESULTS

Number of roots. The percentages observed in the total sample for the number of roots were: 1 root in 2.27 % of the cases, 2 roots in 93.73 %, and 3 roots in 4 %. The distribution was as follows: in tooth 3.6, one root in 2.3 %, 2 roots in 93.7 %, and 3 roots in 4 % of the cases. Meanwhile, in tooth 4.6, there was one root in 2.3 %, 2 roots in 91.4 %, and 3 roots in 6.3 % of the cases. The two-root configuration was the most prevalent, with statistically significant differences (p=0.046).

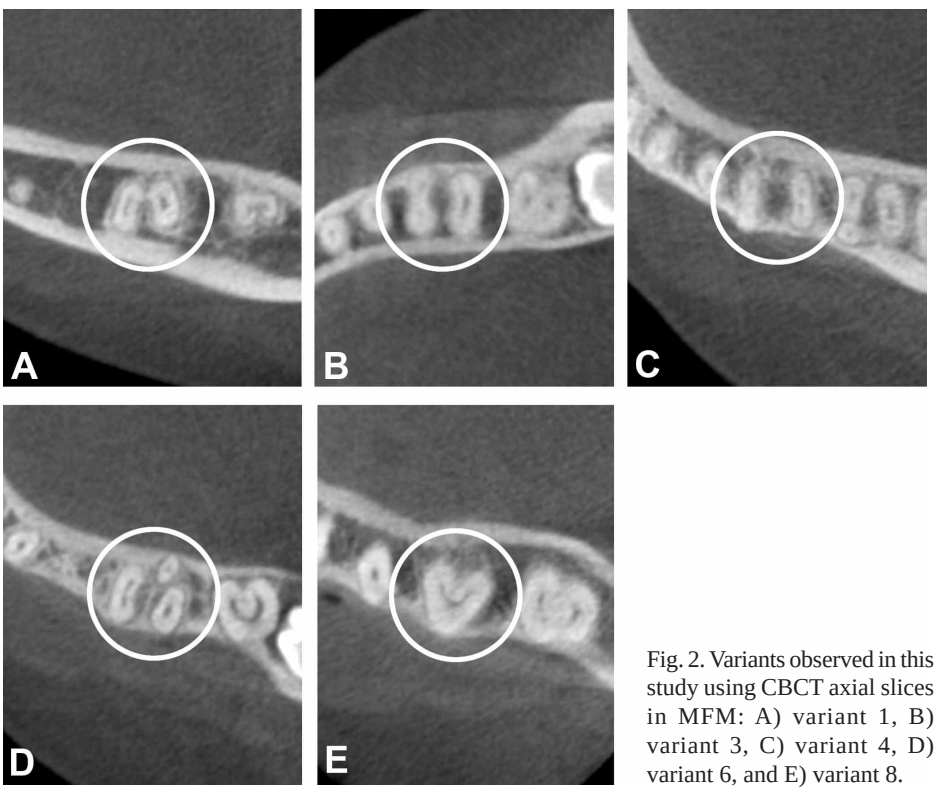

Fig. 2. Variants observed in this study using CBCT axial slices in MFM: A) variant 1, B) variant 3, C) variant 4, D) variant 6, and E) variant 8.

Number of canals. Of the total sample, 71.23 % of the MFM showed 3 root canals, 16.81 % 4 canals, 9.69 % 2 canals, and 2.28% 1 canal. Among the women, 44.16 % of the teeth presented 3 canals, 9.12 % 4 canals, 6.84 % 2 canals, and 0.57% 1 canal. Among the men, 27.07 % of the MFM presented 3 canals, 7.70 % 4 canals, 2.85 % 2 canals, and 1.71% 1 canal. In terms of side, 3 canals were most prevalent on both the right (71.75 %) and left (70.69 %) (p>0.05).

C-shaped canal. The prevalence was 2.3 % of the total cases studied, distributed in 6 men and 2 women. Its appearance was homogenous on both sides of the arch ($p > 0.05$) (Fig. 2E).

Variant. Of the total sample, 71.23% presented variant 3 (Fig. 2B), 12.82 % variant 4 (Fig. 2C), 9.67% variant 1 (Fig. 2A), 4 % variant 6 (Fig. 2D), and 2.28 % variant 8. Statistically significant differences were found between variant 3 and the other variants ($p= 0.003$).

In tooth 3.6, the most prevalent variant was 3 (71.8 %), followed by 4 (14.1 %), 1 (7.9 %), 6 (4 %), and 8 (2.3%). In both the men and women, variant 3 was the most prevalent, being homogenously distributed on the left and right sides (Table I).

In tooth 4.6, variant 3 was the most prevalent, with 70.7 %, followed by variants 1 and 4, both with 11.5 %, variant 6 with 4 %, and finally, variant 8 with 2.3 % (Table I).

Table I. Summary of the distribution by sex of the variants observed in teeth 3.6 and 4.6.

		Tooth 3.6					Tooth 4.6					
		Variant 1 (2 canals) (2 roots)	Variant 3 (3 canals) (2 roots)	Variant 4 (4 canals) (2 roots)	Variant 6 (4 canals) (3 roots)	Variant 8 (1 canal) (1 root)	Total	Variant 1 (2 canals) (2 roots)	Variant 3 (3 canals) (2 roots)	Variant 4 (4 canals) (2 roots)	Variant 6 (4 canals) (3 roots)	Variant 8 (1 canal) (1 root)	Total
Female		8	79	14	3	1	105	16	76	12	3	1	108
		4.5 %	44.6 %	7.9 %	1.7 %	0.6 %	59.3 %	9.2 %	43.7 %	6.9 %	1.7 %	0.6 %	62.1 %
Male		6	48	11	4	3	72	4	47	8	4	3	66
		3.4 %	27.1 %	8.2 %	2.3 %	1.7 %	40.7 %	2.3 %	27.0 %	4.6 %	2.3 %	1.7 %	37.9 %
Total		14	127	25	7	7	177	20	123	20	7	4	174
		7.9 %	71.8 %	14.1 %	4.0 %	2.3 %	100 %	11.5 %	70.7 %	11.5 %	4.0 %	2.3 %	100 %

DISCUSSION

The morphological complexity of the RCS varies in different populations (Tomaszewska *et al*.; Vaz de Azevedo *et al*., 2019). Ahmed *et al*. (2007) suggested that the morphology of the MFM is racially and genetically determined, which reinforces the need to examine its variations in different racial groups (Gulabivala *et al*.). Internal and external morphological variations in the tooth pose clinical challenges when planning and performing the intervention (Madani *et al*.; Nur *et al*., 2014; Tomaszewska *et al*.; Kim *et al*.,2016). The omission of canals and the inadequate chemomechanical preparation can result in bacterial proliferation with a persistent apical inflammatory response leading to treatment failure (Celikten *et al*., 2016; Madani *et al*.; Nur *et al*.; Zhang *et al*., 2011b).

In the present study, a detailed analysis was made of the RCS of the MFM using CBCT in a Chilean sub-population. CBCT makes it possible to see an area in three planes, as it is a non-invasive tool with broad applications in endodontics and in the analysis of tooth anatomy (Madani *et al*.; Nur *et al*.; Silva *et al*.).

The MFM usually has two roots: a mesial and a distal (Celikten *et al*.). Demiburga *et al*. (2013) described this anatomy in 95.8 %, similar to what was reported by Madani *et al*., who found it in 96.7 % (Madani *et al*.). In our study, 93.7 % of the teeth had 2 separate roots, similar to the previously described percentages.

As a variation of this morphology, the presence of a third root in a distolingual position is described, known as RE, identified in our study in 4 %, a lower percentage than described by Zhang (Zhang *et al*., 2011a), who observed it in 29 % in an Asian population and higher than the report by Demirbuga *et al*. (2013) in 2.06 % in a Turkish population. These differences are due to the different study populations, since the presence of a third root is uncommon in Caucasian (British, Dutch, German, Finnish, and other Europeans), Eurasian, and Indian populations, reporting a frequency below 5 %. On the other hand, the RE is considered a common variation in populations with Asian features, such as Chinese, Inuit, and Native Americans, being noted in them between 5 and 40 % (Silva *et al*.; Gulabivala *et al*.). As a result, Gulabivala *et al*. (2002) mention it as a genetic trait and not a developmental anomaly in this population (Demirbuga *et al*.; Madani *et al*.; Nur *et al*.; Plotino *et al*., 2013).

In relation to the number of canals, it is accepted that the MFM

typically has 3 canals, two located in the mesial root and one in the distal root (Celikten *et al*.; Demirbuga *et al*. 2013; Plotino *et al*.). This is related to the observation in this study, where three canals were the most prevalent for both the right and left MFM. 71.23 % of the MFM presented 3 root canals, 16.81 % 4 canals, 9.69 % 2 canals, and 2.28 % 1 canal. This is similar to the study by Demirbuga *et al*. (2013), who located 3 canals in 79.9 % of the MFM, 4 canals in 15.4 % and 2 canals in 4.25 %. On the other hand, they observed 5 canals in 0.24 %, and a single canal in 0.12 %. Unlike that report, we did not observe any MFM with 5 canals in the present work. The presence of 4 canals in 16.81 % indicates the need to look for it once the cleaning and debridement of the pulp chamber and main canals are complete.

C-shaped canals are more frequent in mandibular second molars and mainly in the Asian population (Madani *et al*.; Vaz de Azevedo *et al*.; Gulabivala *et al*.). In our study, the prevalence was 2.3 % of all the cases studied, which agrees with the report by Vaz de Azevedo *et al*., who described this configuration as being present between 0.16 % and 10 % in MFM. However, this range varies in relation to the study population and the method used for the analysis (Vaz de Azevedo *et al*.).

In relation to the canal morphology, in this study, the decision was made to use Zhang's classification, which is based on the one by Vertucci and incorporates variants to describe the morphology observed in three-dimensional images. Of the 351 MFM observed, 71.23 % presented variant 3, similar to the report by Silva *et al*., who found this configuration in 74 % in their study of a Brazilian population (Silva *et al*.).

CONCLUSIONS

The results of this study reported a high prevalence of 2 roots (93.7 %) and three canals (71.23 %), which corresponds to Zhang's variant 3. However, the possibility of finding a third distolingual root (6.27 %) and C-shaped canal (2.3 %) must also be considered. CBCT is a useful tool for studying internal and external tooth morphology. Knowledge of the anatomy of the RCS and its variations in different populations and ethnic groups is fundamental when planning and performing endodontic treatment.

ACKNOWLEDGEMENTS. The authors are grateful for DIUFRO project DI23-0085. This project was partially funded by the Research Directorate of Universidad de La Frontera.

MATUS, D.; ARIAS, A.; NAVARRO, P. & BETANCOURT, P. Análisis de la morfología interna y externa del primer molar mandibular en una subpoblación chilena mediante tomografía computarizada de haz cónico. *Int. J. Morphol., 41(4)*:1089-1094, 2023.

RESUMEN: El primer molar mandibular (MFM) comúnmente presenta dos raíces con dos canales en la raíz mesial y uno o dos canales en la raíz distal. Sin embargo, se han descrito variaciones morfológicas en distintas poblaciones, las que se deben tener en consideración al momento de planificar el tratamiento endodóntico. El objetivo de este estudio fue analizar la morfología interna y externa del MFM en una sub población chilena mediante el uso de imágenes de tomografía computarizada Cone Beam (CBCT). Se realizó un estudio transversal, descriptivo y observacional *in vivo* empleando exámenes CBCT de 351 MFM tanto derechos como izquierdos. Los datos se analizaron mediante estadística descriptiva empleando la prueba Chi-Cuadrado para variables categóricas, el test exacto de Fisher, la prueba no paramétrica de U-Mann-Whitney para dos muestras independientes y la prueba no paramétrica de Wilcoxon para muestras relacionadas. Del total de la muestra se observó 1 raíz en un 2.27 % de los casos, 2 raíces en 93.73 % y 3 raíces en un 4 %. En relación al número de canales un 71.23 % de los MFM mostraron 3 canales radiculares, un 16.81 % 4 canales, un 9.69 % 2 canales y un 2.28 % 1 canal. Del total de los casos estudiados un 2.3 % se presentó anatomía en forma de C. En relación a la morfología, empleando la clasificación de Zhang, se observó en un 71.23 % la variante tipo 3, en un 12.82 % la variante tipo 4, en un 9.67 % la variante tipo 1, en un 4 % variante tipo 6 y en un 2,28 % variante tipo 8. En conclusión, la morfología del MFM es variable en una subpoblación chilena y estas variaciones deben ser consideradas antes y durante la terapia endodóntica. El CBCT demostró ser una herramienta eficaz para el estudio *in vivo* de la morfología dentaria.

PALABRAS CLAVE: Primer molar mandibular; Morfología radicular; Tomografía computarizada Cone Beam; Endodoncia.

REFERENCES

Ahmed, H. A.; Abu-bakr, N. H.; Yahia, N. A. & Ibrahim, Y. E. Root and canal morphology of permanent mandibular molars in a Sudanese population. *Int. Endod. J., 40(10)*:766-71, 2007.

Betancourt, P.; Arias, A.; Matus, D.; Navarro, P.; Garay, I. & Fuentes, R. Prevalence of radix entomolaris in mandibular first molars by Cone-Beam computed tomography in a southern Chilean Sub-population. *Int. J. Morphol., 40(2)*:414-9, 2022.

Betancourt, P.; Navarro, P.; Muñoz, G. & Fuentes, R. Prevalence and location of the secondary mesiobuccal canal in 1,100 maxillary molars using cone beam computed tomography. *BMC Med. Imaging., 16*:66, 2016. doi: 10.1186/s12880-016-0168-2

Celikten, B.; Tufenkci, P.; Aksoy, U.; Kalender, A.; Kermeoglu, F.; Dabaj, P. & Orhan, K. Cone beam CT evaluation of mandibular molar root canal morphology in a Turkish Cypriot population. *Clin. Oral Investig., 20(8)*:2221-6, 2016.

Demirbuga, S.; Sekerci, A-E.; Dinçer, A-N.; Cayabatmaz, M. & Zorba, Y-O. Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular first and second molars in Turkish individuals. *Med. Oral Patol. Oral Cir. Bucal., 18(4)*:737-44, 2013.

De Moor, R. J. G.; Deroose, C. A. J. G. & Calberson, F. L. G. The radix entomolaris in mandibular first molars: an endodontic challenge. *Int. Endod. J., 37(11)*:789-99, 2004.

Gulabivala, K.; Opasanon, A.; Ng, YL. & Alavi, A. Root and canal morphology of Thai mandibular molars. *Int. Endod. J., 35(1)*:56-62, 2002.

Kang, S.; Yu, HW.; Shin, Y.; Karabucak, B.; Kim, S. & Kim, E. Topographic Analysis of the Isthmus in Mesiobuccal and Mesial Roots of First Molars in a South Korean Population. *Sci. Rep., 10(1)*:1247, 2020. doi: 10.1038/s41598-020-58364-1.

Karabucak, B.; Bunes, A.; Chehoud, C.; Kohli, MR. & Setzer, F. Prevalence of Apical Periodontitis in Endodontically Treated Premolars and Molars with Untreated Canal: A Cone-beam Computed Tomography Study. *J. Endod., 42(4)*:538-41, 2016.

Kim, S.; Jung, H.; Kim, S.; Shin, SJ. & Kim, E. The Influence of an Isthmus on the Outcomes of Surgically Treated Molars: A Retrospective Study. *J. Endod., 42(7)*:1029-34, 2016.

Kim, Y.; Chang, S-W.; Lee, J-K.; Chen, I-P.; Kaufman, B.; Jiang, J.; Cha, BY.; Zhu, Q.; Safavi, K. E. & Kum, K-Y. A micro-computed tomography study of canal configuration of multiple-canalled mesiobuccal root of maxillary first molar. *Clin. Oral Investig., 17(6)*:1541-6, 2013.

Kim, Y.; Perinpanayagam, H.; Lee, J-K.; Yoo, Y-J.; Oh, S.; Gu, Y.; Lee, S-P.; Chang, S. W.; Lee, W.; Baek, S-H.; Zhu, Q. & Kum, K-Y. Comparison of mandibular first molar mesial root canal morphology using micro-computed tomography and clearing technique. *Acta Odontol. Scand., 73(6)*:427-32, 2015.

Madani, Z. S.; Mehraban, N.; Moudi, E. & Bijani, A. Root and Canal Morphology of Mandibular Molars in a Selected Iranian Population Using Cone-Beam Computed Tomography. *Iran Endod. J., 12(2)*:143-8, 2017.

Nur, B. G.; Ok, E.; Altunsoy, M.; Aglarci, O. S.; Colak, M. & Gungor, E. Evaluation of the root and canal morphology of mandibular permanent molars in a south-eastern Turkish population using cone-beam computed tomography. *Eur. J. Dent., 8(2)*:154-9, 2014.

Plotino, G.; Tocci, L.; Grande, N. M.; Testarelli, L.; Messineo, D.; Ciotti, M.; Glassman, G.; D'ambrosio, F. & Gambarini, G. Symmetry of root and root canal morphology of maxillary and mandibular molars in a white population: a cone-beam computed tomography study *in vivo*. *J. Endod., 39(12)*:1545-8, 2013.

Silva, E.N. L. E. J.; Nejaim, Y.; Silva, A. V.; Haiter-Neto, F. & Cohenca, N. Evaluation of root canal configuration of mandibular molars in a Brazilian population by using cone-beam computed tomography: an *in vivo* study. *J. Endod., 39(7)*:849-52, 2013.

Tomaszewska, I. M.; Skinningsrud, B.; Jarze˛bska, A.; Pe˛kala, J. R.; Tarasiuk, J. & Iwanaga, J. Internal and external morphology of mandibular molars: An original micro-CT study and meta-analysis with review of implications for endodontic therapy. *Clin. Anat., 31(6)*:797-811, 2018.

Vaz de Azevedo, K. R.; Lopes, C. B.; Andrade, R. H. T. L. R.; Pacheco da Costa, F. F. N.; Gonçalves, L. S.; Medeiros Dos Santos, R. & Alves, F. R. F. C-shaped canals in first and second mandibular molars from Brazilian individuals: A prevalence study using cone-beam computed tomography. *PLoS One, 14(2)*:e0211948, 2019.

Zhang, R.; Wang, H.; Tian, Y-Y.; Yu, X.; Hu, T. & Dummer, P. M. H.Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. *Int. Endod. J., 44(11)*:990-9, 2011.

Zhang, R.; Yang, H.; Yu, X.; Wang, H.; Hu, T. & Dummer, P. M. H. Use of CBCT to identify the morphology of maxillary permanent molar teeth in a Chinese subpopulation. *Int. Endod J., 44(2)*:162-9, 2011.

Corresponding author:
Prof. Dr. Pablo Betancourt
Assistant Professor
Research Centre for Dental Sciences (CICO)
Endodontic Laboratory
Universidad de La Frontera
Avenida Francisco Salazar 01145
Temuco
CHILE

E-mail: pablo.betancourt@ufrontera.cl