Prevalence of Radix Entomolaris in Mandibular First Molars by Cone-Beam Computed Tomography in a Southern Chilean Sub-Population

SUMMARY: The aim of this study was to evaluate the prevalence and morphology of radix entomolaris (RE) in the mandibular first molar (MFM) in a southern Chilean sub-population by cone-beam computed tomography (CBCT). Two hundred ten CBCT images of MFM were analysed. To detect the presence of RE, the observation and measurements were standardised, advancing 1 mm to apical from the floor of the pulp chamber to the most apical zone of the tooth. The data were analyzed using descriptive statistics, with a value of P < 0.05 being statistically significant. The prevalence of a third root in the permanent MFM was 5.7 % (12/210). The incidence of RE was the same in male patients (2.9 %) as in female patients (2.9 %) (p=0.324). The occurrence of an RE in the left MFM was 7.3 % (3/41 patients) for male patients and 4.5 % (3/66) for female patients (p=0.398). The right MFM in male patients had an incidence of 8.1 % (3/37) and 4.5 % (3/66) for female patients (p=0.340). When the presence of an RE was compared between the left (5.6 %) and right side (5.8 %), no statistically significant differences were found (p=0.998). The frequency of bilateral three-rooted MFM was 71.43 % (5/7) and 28.57 % (2/7) were unilateral. The prevalence of RE in MFM in a southern Chilean sub-population was 5.7 %. The occurrence was bilateral in the majority of cases and no significant differences were observed by sex or side. The commonest type of RE was Type 1 (83.3 %). The use of CBCT can improve the endodontic treatment outcome.

KEY WORDS: Radix entomolaris; Mandibular First Molar; Cone-Beam Tomography; Morphology.

INTRODUCTION

Knowledge of dental morphology, including variant forms, is fundamental for successful endodontic treatment (Tu et al., 2009). The permanent mandibular first molar (MFM) habitually presents 2 well-defined roots: one mesial characterised by a flattened mesiodistal surface and a widened buccolingual surface; and one distal, in the majority of cases with a broad oval canal or 2 round canals (Vertucci, 1984). However, some variations have been reported in the number of roots present. The principal variant described is the presence of a third accessory root on the lingual face of the tooth, called radix entomolaris (RE) (Bolk, 1915). RE is a supernumerary distolingual root (DL), located lingual respect to the distobuccal root (DB). It is generally shorter than DB root (Calberson et al., 2007) and it may be totally separated from the DB root or fused with it (Carlsen & Alexandersen, 1990).

Failure to identify RE in clinical practice will prevent correct cleaning and disinfection of the root canal system, resulting in a poor endodontic prognosis. Furthermore, biomechanical instrumentation of the RE presents a challenge for the clinician, as it normally presents different degrees of curvature, most frequently to vestibulo-lingual (Abella et al., 2012). Based on the degree of curvature, De

---

414
Moor et al. (2004) suggested a classification with three different types of RE: Type 1: a straight root; Type 2: a curve in the coronal third and straight thereafter; and Type 3: an initial curve in the coronal third of the root canal and a second curve beginning in the middle and continuing to the apical third.

The appearance of this extra root varies according to the study population. A frequency of less than 5% has been reported in Caucasian, African, Eurasian and Indian populations, while in those with Mongoloid features, such as Chinese, Eskimo and native American populations, the frequency of RE varies from 5% to 40% (Gulabivala et al., 2001; De Moor et al.; Tu et al., 2007; Chen et al., 2009; Huang et al., 2010).

In recent years, cone-beam computed tomography (CBCT) has made it possible to view in three dimensions dental anatomical structures which are difficult to view and access (Betancourt et al., 2016). CBCT is a valuable aid as a complementary examination for endodontic diagnosis and treatment. Its advantages include the use of a smaller dose of radiation than conventional computed tomography, and providing more precise details than periapical or panoramic radiography (Abella et al.).

The aim of this study was to evaluate the prevalence and morphology of RE in the MFM in a southern Chilean sub-population by CBCT.

MATERIAL AND METHOD

This study was approved by the Ethics Committee of the Universidad de La Frontera, Temuco, Chile (Protocol n° 038/21). CBCT images were examined of 111 patients of both sexes referred to the radiology unit of the Dental Faculty of Universidad de La Frontera, Temuco, Chile, between November 2014 and December 2020. A cross-sectional observational descriptive study was designed for the present research. The CBCT examinations were applied as part of dental examination, diagnosis and treatment planning. Informed consent was obtained from all the patients whose CBCT images were included in the study. The patients' identities were not revealed to the investigators and the only information to which they had access was age and sex. The images were taken using a PAX Zenith 3D tomograph (Vatech Co, Gyeonggi-Do, Korea), with 120 kV, 10 mA, 24 s acquisition; FOV 8 x 6 cm / 12 x 9 cm, voxel size 0.12 mm. The data were exported in DICOM format in the EZ 3D 2009 software (Vatech, Hwaseong-si, Korea) and projected on a LED screen KDL-42W651A (Sony, Minato, Japan) to observe 3D images of the coronal, mid and apical sections.

Two hundred ten MFM were observed (107 left MFM and 103 right MFM). The inclusion criteria for the CBCT images were: age between 18 and 75 years and complete root formation. The exclusion criteria were: presence of intraradicular post or metal restorations, endodontic treatment implemented, tooth rehabilitated with a fixed prosthesis, presence of calcification in the root canal, evidence of radectomy or periapical surgery, and mandibular molars with anomalies in their development. The images were examined by two specialists in endodontics with experience in CBCT viewing and prior training. The specialists examined 20 previously selected CBCT images of MFM. The observers analyzed the images on three occasions, at one-week intervals. When a consensus could not be reached, a radiology specialist helped in taking the final decision. Interexaminer agreements were calculated by using the Cohen kappa coefficient.

Methodology of Observation. First, the sagittal and coronal sections were oriented in parallel with the long axis of the root, and then sections were obtained in the axial and coronal planes at intervals of 0.5 mm and a thickness of 1 mm for all the samples, using multiplanar reformation (MPR). MPR constructs a three-dimensional model, showing all structures with thickness of 1 mm superimposed on one another. To detect the presence of RE, the observation and measurements were standardised, advancing 1 mm to apical (2 sections of 0.5 mm) from the floor of the pulp chamber to the most apical zone of the tooth (Betancourt et al.). In the sagittal plane, the RE was explored from coronal to apical in order to study the degree of curvature.

Statistical analysis. The data collected were recorded in a Microsoft Office Excel spreadsheet. Descriptive analysis of the data was carried out, determining a frequency distribution table. The Kolgomorov-Smirnov normality test was applied. The Mann-Whitney U non-parametric test for independent samples, Wilcoxon's test for related samples and Pearson's Chi-squared test for qualitative variables were all applied. Data were analysed with the IBM SPSS Statistics programme (version 23.0). A value of p < 0.05 was selected as the threshold of statistical significance.

RESULTS

Prevalence of RE. The 111 patients included in the study presented ages between 18 and 75 years, mean age 27.17 years. The prevalence of a third root in the permanent MFM
was 5.7 % (12/210). The incidence of RE was the same in male patients (2.9 %) as in female patients (2.9 %) (p=0.324). The occurrence of an RE in the left MFM was 7.3 % (3/41 patients) for male patients and 4.5 % (3/66) for female patients (p=0.398). The right MFM in male patients had an incidence of 8.1 % (3/37) and 4.5 % (3/66) for female patients (p=0.340). When the frequency of an RE was compared between the left (5.6 %) (Fig. 1) and right side (5.8 %) (Fig. 2), no statistically significant differences were found (p=0.998). The frequency of bilateral three-rooted was 71.43 % (5/7) (Fig. 3) and 28.57 % (2/7) were unilateral, distributed one on the right side and one on the left. The Kappa index determined agreement between the examiners (p= 0.000) and the strength of agreement was very good (0.885).

**Type of RE.** The commonest type of RE was Type 1 (83.3 %), followed by Type 3 (16.7 %). No Type 2 was seen in the whole sample analysed. In women, 3 cases (100 %) of RE observed in the left MFM were of Type 1, while in men 66.7 % of RE were Type 1 and 33.3 % were Type 3 (p= 0.317). The distribution of RE in the right MFM in women was 100 % Type 1, while in men it was 66.7 % Type 1 and 33.3 % Type 3 (p= 0.317).

---

**DISCUSSION**

The MFM exhibit a wide range of variations in root number and their morphology. The major anatomical variant is the presence of a supernumerary DL root, known as a RE. A high percentage of endodontic treatment failures are due to failure to identify of an “extra” root, preventing correct disinfection and seriously compromising the prognosis of treatment (De Moor et al.). Therefore, an accurate diagnosis of RE in permanent MFM is essential for carrying out correct surgical, periodontal or endodontic treatment (Calberson et al.). One of the clinical signs that may be presented by RE is a more prominent distolingual lobe with cervical convexity (Calberson et al.). However, an altered morphology of the root structure is not always associated with a coronal alteration. Thus, imaging methods are recommended in order to determine the variations of the root canal system.
The frequency of occurrence of RE is currently a subject of discussion, mainly because of the differences in frequency between different populations. One predisposing factor associated with the presence of a third root in MFM is ethnicity. In Asian populations (races of Mongoloid origin) RE is considered a common morphological variation due to the high frequency of its appearance. Several studies have reported a frequency higher than 20 % (Tu et al.; Wang et al., 2010; Zhang et al., 2011), and others even over 30 % (Song et al., 2009; Gu et al., 2010). In the population of India the frequency of a third root ranges between 4.5 % and 13.3 % (Garg et al., 2010), while the reported frequency in Africa is lower than in Asia and India, 3.1 % (Sperber & Moreau, 1998). In Caucasian populations, RE is considered a rare or unusual variant, with a frequency lower than 10 % (Torres et al., 2015). These results demonstrate that the frequency of occurrence of RE varies with respect to the study population and its geographical location. However, there is little information on the genetic influence on the appearance of a third accessory root. Rodriguez-Niklitschek et al. (2015) carried out a clinical, radiological and genetic study of a double RE in a Chilean patient. They concluded that the genetic factor is one of the most probable causes of the appearance of RE. Genetic studies should be the focus of future research using appropriate methodologies.

Different methodologies have been used to assess the morphological variations of MFM. The technique most commonly used in vitro is diaphonization. This is a very precise technique, however the tooth has to be extracted for its study. Periapical radiography is the most frequently method used in vivo for endodontic diagnosis and treatment planning (Garg et al.). However, it provides only a two-dimensional view of the structures, which limits the possibility of observing an extra root. It must also be considered that this technique is sensitive both to the superposition of other structures (e.g. the zygomatic arch or tooth roots) as well as the skill of the operator. CBCT and micro-computed tomography (micro-CT) offer great advantages by providing a three-dimensional image of the structure studied in the sagittal, coronal and transverse axes. CBCT is a non-invasive technique, using a lower dose of radiation than micro-CT, and has shown a high level of accuracy in the location of morphological structures (Betancourt et al.). Also, CBCT allows reliable comparison of the results of morphological structures as a function of sex and bilateral occurrence in different populations. However, care must be taken with the “artefacts” that may appear in the image, due to metallic elements (restoration of amalgam, intra-radicular posts or dental implants) or even gutta-percha in teeth with endodontic treatment.

The results of the present CBCT study in a southern Chilean sub population, showed a frequency of RE of 5.7 % for permanent MFM, which is higher than the 3 % obtained in an Iranian population (Rahimi et al., 2017), the 2.06 % found in a Turkish population (Demirbuga et al., 2013) and the 2.03 % reported in an Israeli population (Shemesh et al., 2015), all using CBCT. On the other hand, it was much lower than the frequency reported by Tu et al. (2009) (33.3 %) and Zhang et al. (29 %) using CBCT in Taiwanese and Chinese populations respectively. These differences may be due to racial and ethnic characteristics, sample size or selection of cases.

In the Chilean population there are few studies oriented towards the study of this morphological variation. In 2015, Torres et al. reported a prevalence of 6.16 % of RE in MFM in a Chilean sub-population, close to the 5.7 % observed in the present study. Recently, Abarca et al. (2020) did not observe the presence of RE in 510 MFM through CBCT. These differences with our results may be due to the fact that their study sub-population was from another region of the country. Further research should be performed to determine the incidence of RE in Chilean population.

According to sex, no significant differences were found in the distribution of the RE between men and women. These results are similar with those observed in Taiwanese and Israeli populations (Tu et al.; Tu et al.; Shemesh et al.)

The presence of a third root in the MFM habitually occurs bilaterally in patients (De Moor et al.; Huang et al.). In our study, 71.34 % of the RE were bilateral, close to the 68.57 % reported by Tu et al. (2007). This means that if a RE exists on one side, the clinician must consider searching in the contralateral side. The unilateral appearance of the extra third root was homogeneous between the right (5.8 %) and left hemiarch (5.6 %), with no statistically significant difference (p = 0.998). These results disagree with the findings in a Taiwanese population, where incidence of RE was more frequent in the right side (13.01 %) (Tu et al., 2009). There is also a report in a population in Singapore where a greater frequency of RE was found on the left side (Loh, 1990).

The classification of types of RE according to De Moor et al. showed that Type 1 (straight root) was the most prevalent (83.3 %), followed by Type 3 (16.7 %). Special attention must be paid to Type 3, because of the complications that the curvature in the apical third may present for mechanical and disinfection procedures. Furthermore, it should be noted that type 2 was not observed in any of the cases analyzed.
CONCLUSIONS

The incidence of RE in MFM in a southern Chilean sub-population was 5.7 %. The occurrence was bilateral in the majority of cases and no significant differences were observed by sex or side. The commonest type of RE was Type I (83.3 %). The clinician should routinely carry out diagnosis of a possible extra third root in permanent MFM. Finally, we recommend the use of CBCT as a complementary diagnostic method to improve the outcome of endodontic treatment.

ACKNOWLEDGEMENTS

The authors are grateful for DIUFRO project DI21-0034. This project was partially funded by the Research Directorate of Universidad de La Frontera, Chile.

REFERENCES


Torres, A.; Jacobs, R.; Lambrechts, P.; Brizuela, C.; Cabrera, C.; Concha, C. & Pedemonte, M. E. Characterization of mandibular molar...


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

E-mail: pablo.betancourt@ufrontera.cl