VIA MEDICA

ORIGINAL ARTICLE

Folia Morphol.
Vol. 78, No. 1, pp. 163–170
DOI: 10.5603/FM.a2018.0058

ISSN 0015–5659
journals.viamedica.pl

Morphological variations of the mandibular canal in digital panoramic radiographs: a retrospective study in a Chilean population

R. Fuentes[1, 2], A. Arias[1, 2, 3], C. Farfán[4], N. Astete[4], I. Garay[1], P. Navarro[2], F.J. Dias[1, 2]

[1]*Department of Integral Adults Dentistry, Dental School, Universidad de La Frontera, Temuco, Chile*
[2]*Research Centre in Dental Sciences (CICO), Dental School, Universidad de La Frontera, Temuco, Chile*
[3]*Universidad Adventista de Chile, Chillán, Chile*
[4]*Master Programme in Dentistry, Dental School, Universidad de La Frontera, Temuco, Chile*

[Received: 28 February 2018; Accepted: 30 May 2018]

Background: *Morphological variations of the mandibular canal (MC) have been described in literature, so the clinician must be able to recognise them and adapt their treatment accordingly. The aim of this study was to determine the prevalence of morphological variations of the MC using digital panoramic radiographs (DPR) of Chilean patients.*

Materials and methods: *A retrospective study in which 1400 DPR were analysed to identify cases of bifid, trifid and retromolar MC. The radiographs were analysed independently by two examiners who had previously been trained by a specialist in oral and maxillofacial radiology. Inclusion and exclusion criteria were applied to reach a final sample.*

Results: *Nine hundred and twenty-five radiographs were included (599 female, 326 male; mean age 36.1 ± 15.54 years). The prevalence of bifid MC was 11% (n = 102), with no significant differences by sex (p = 0.069). Proportion of bifid MC was higher among younger patients (p = 0.038). Prevalence of morphological variations of type 1 bifid MC was 7.4% (n = 69), type 2 was 2.3% (n = 23), type 3 was 0% (n = 0) and type 4 was 1.1% (n = 10). Prevalence of retromolar canal was 0.9% (n = 8), with no significant differences by sex (p = 0.893) or age (p = 0.371); of these, 2 (0.2%) cases were forward type and 6 (0.6%) cases were retromolar type. No cases of trifid MC were found.*

Conclusions: *Digital panoramic radiographs are useful for detecting morphological variations of the MC; we were able to identify three types of bifid MC as well as retromolar canals. Proper identification of these variations by an easily accessible examination is important for avoiding possible complications in clinical-surgical practice.* (Folia Morphol 2019; 78, 1: 163–170)

Key words: mandibular canal, morphological variations, bifid canal, trifid canal, retromolar canal

INTRODUCTION

The mandibular canal (MC) extends bilaterally from the mandibular foramen to the mental foramen [6, 12, 19]. It runs longitudinally through the spongy tissue of the bone in an anteroinferior direction and describes a concave anterosuperior curve [7, 18]. It contains the inferior alveolar vasculo-nervous bundle (nerve, artery and vein); the nerve is a branch

Address for correspondence: Prof. Dr. R. Fuentes Fernández, ORCID 0000-0002-5895-024X, Dental School, Universidad de La Frontera, Av. Francisco Salazar 01145, Casilla 54-D, Temuco, Chile, tel: 0056 045 2596902, e-mail: ramon.fuentes@ufrontera.cl

of the third division of the fifth cranial pair [9]. This important vasculo-nervous bundle is responsible for the blood supply to and sensory activity of the mandibular teeth, lower lip, adjacent alveolar bone and gum [8, 12]. In radiographs, the MC is observed as a dark linear shadow between two thin, radio-opaque lines (one superior and the other inferior) projected on the bone, which limit the canal [20].

In odontological procedures involving the MC, anaesthesia of the lower teeth may present certain difficulties related with the variability of the canal and its neurovascular content [3]. The MC is vulnerable in procedures like orthognathic surgery, mandibular reconstruction, extraction of third molars or installing dental implants [6], leading to complications such as neurovascular compression with swelling and/or pain [21]. Morphological variations of the MC have been described in medical literature since the 1970s [16], with case reports showing the existence of bifid MC [10, 13], trifid MC [2, 14] and variations such as the so-called retromolar canal [8]. The retromolar canal is an accessory canal which courses superior and lateral of the MC. It may join the MC (in which case it is classified as a sub-type of bifid MC), or terminate at the level of the molars, or simply terminate in an accessory foramen located in the anteroinferior region of the coronoid process, in the retromolar fossa (in which case it is classified as a type of retromolar canal) [11]. Investigation into the origins of these variations has found answers in the embryonic development of the mandible. Chávez-Lomeli et al. [4] suggested that during embryonic development there are three different inferior alveolar nerves which innervate three different areas of the hemi-mandible (anteroinferior teeth, primary molars and permanent molars), which finally fuse to form a single nerve. On this basis, some authors suggest that incomplete fusing of these three nerve branches results in the appearance of a bifid or trifid MC [20, 21, 23, 24].

The prevalence reported of these variations ranges between 0.9% and 34.6% in radiographic studies [8]. The panoramic radiograph is one of the examinations most frequently used in these types of studies and it is a diagnostic tool frequently indicated by dentists, since it provides a general view of the maxillary structures and is not expensive for patients [3]. This panoramic image can provide to the clinician good anatomical information on the location of the inferior alveolar nerve, mental foramen and other important anatomical structures in the mandible [1] and its variations. The clinician must be able to recognise the presence of these variations during preoperative radiographs examination and adapt odontological treatment accordingly to avoid possible complications. For these reasons, the aim of this study was to determine the prevalence of different morphological variations of the MC (bifid, trifid and retromolar) using digital panoramic radiographs (DPR) in a Chilean patients sample.

MATERIALS AND METHODS

This study was approved by the Scientific Ethics Committee (CEC) of Universidad de La Frontera (Folio no. 015/2014). We carried out a retrospective, descriptive study in which we examined a database of 1400 routine DPR (ratio 1:1) of patients attended in the Dental Teaching Clinic of the Dental School of Universidad de La Frontera, Temuco, Chile. The radiographs were taken using standard technique with a PAX-400C orthopantomograph (VATECH, Korea, 2010).

The images examined in the study belonged to patients of known age and sex. The following exclusion criteria were applied: radiographs with distortion or altered contrast, patients aged less than 18 years, presence of teeth in the intra-osseous development stage (apart from third molars), signs compatible with osseous pathology, presence of included teeth, titanium plates or indications of orthognathic surgery in the mandibular area.

For the analyses, all the radiographs were projected in a LED 29" monitor screen with 2560 × × 1080 pixels resolution and analysed independently by two examiners who had previously been trained by a specialist in oral and maxillofacial radiology. The two examiners were also calibrated against one another through examination of 100 radiographs to identify variations in the MC; the agreement between them was calculated using the kappa coefficient (k). The examiners assessed the radiographs separately; where there was disagreement between them, a third examiner was consulted (a specialist in oral and maxillofacial radiology) who took the final decision. In each radiograph the examiners identified the MC and its possible morphological variations described in the literature: bifid or double MC, trifid or triple MC, and retromolar canal. The presence of the so-called Serres canal was not considered in this study, since this canal has a different embryonic origin from the MC. The demographic data (sex and age) of the patients and

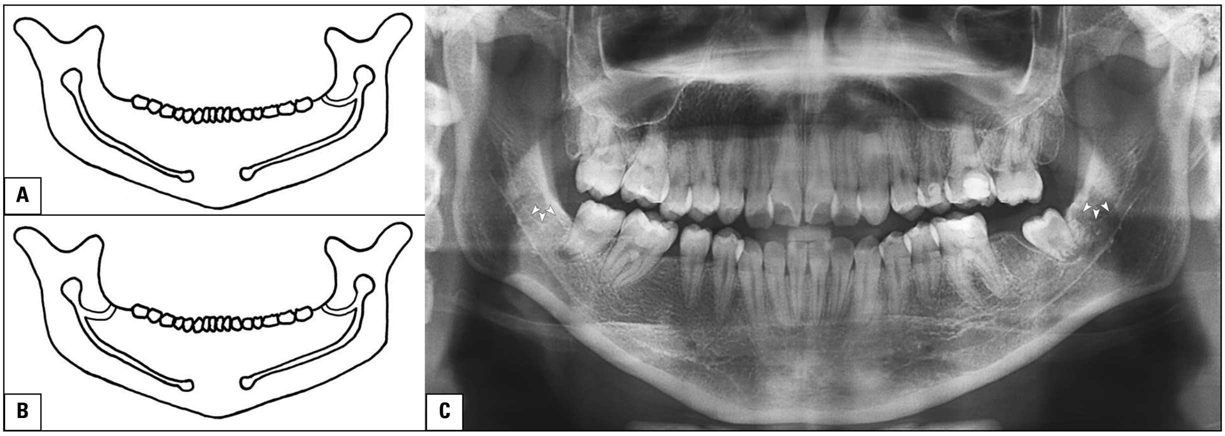

Figure 1. Bifid mandibular canal (MC) type 1 proposed by Langlais et al. [17]. **A.** Unilateral bifid MC extending from the third molar or surrounding area; **B.** Bilateral bifid MC extending from the third molar or surrounding area; **C.** Bilateral bifid MC (arrowhead) identified in an 18-year-old woman.

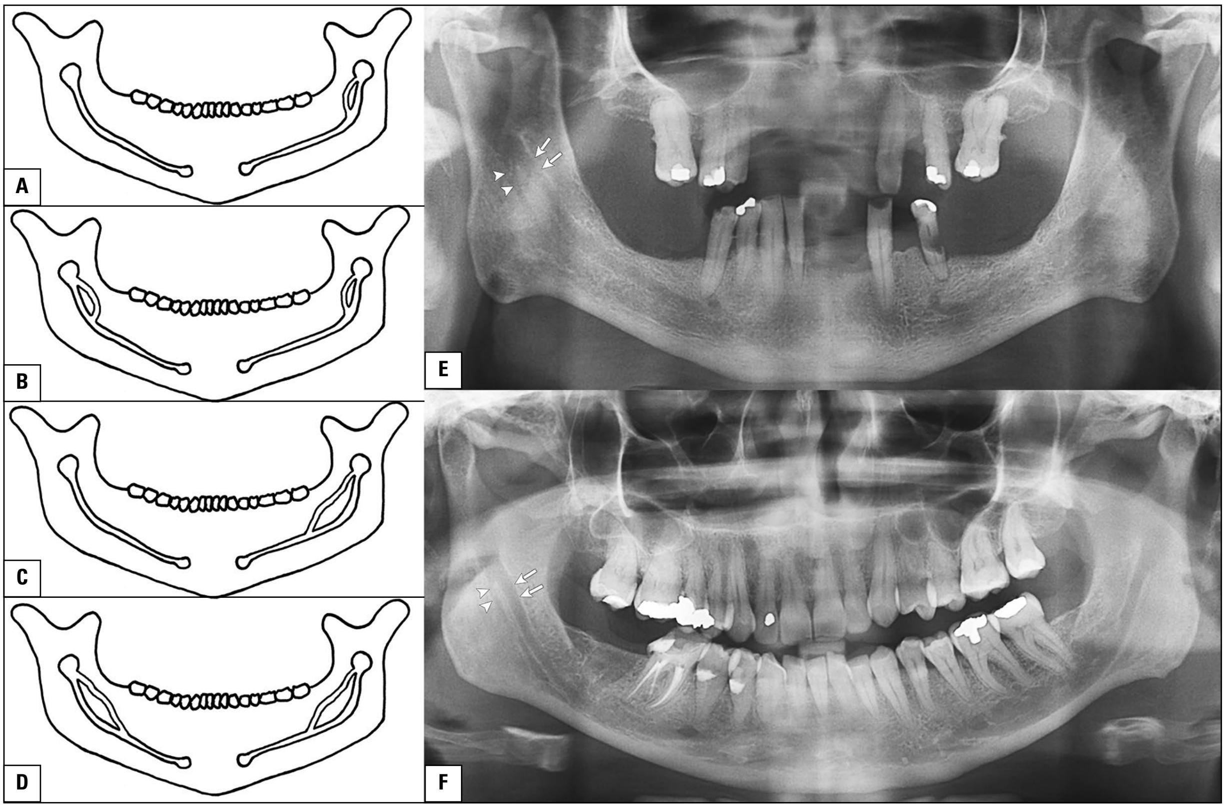

Figure 2. Bifid mandibular canal (MC) type 2 proposed by Langlais et al. [17]. **A.** Unilateral bifid MC limited to the area of the mandibular ramus; **B.** Bilateral bifid MC limited to the area of the mandibular ramus; **C.** Unilateral bifid MC extending to the area of the mandibular body; **D.** Bilateral bifid MC extending to the area of the mandibular body; **E.** Unilateral bifid MC limited to mandibular ramus (arrowhead) identified in a 77-year-old man; **F.** Unilateral bifid MC extending to mandibular body (arrowhead) identified in a 48-year-old woman.

the prevalence of each variation were recorded. We used some of the classifications proposed in the literature for the more prevalent morphological variations of the MC. Bifid MC were sub-classified according to the criteria of Langlais et al. [17] (Figs. 1–3). The retromolar canal was classified using the criteria of Choi et al. [5] (Fig. 4). The prevalence of each of these classifications was also recorded.

Statistical analysis

The data on the prevalence of the different morphological variations of the MC were compared with

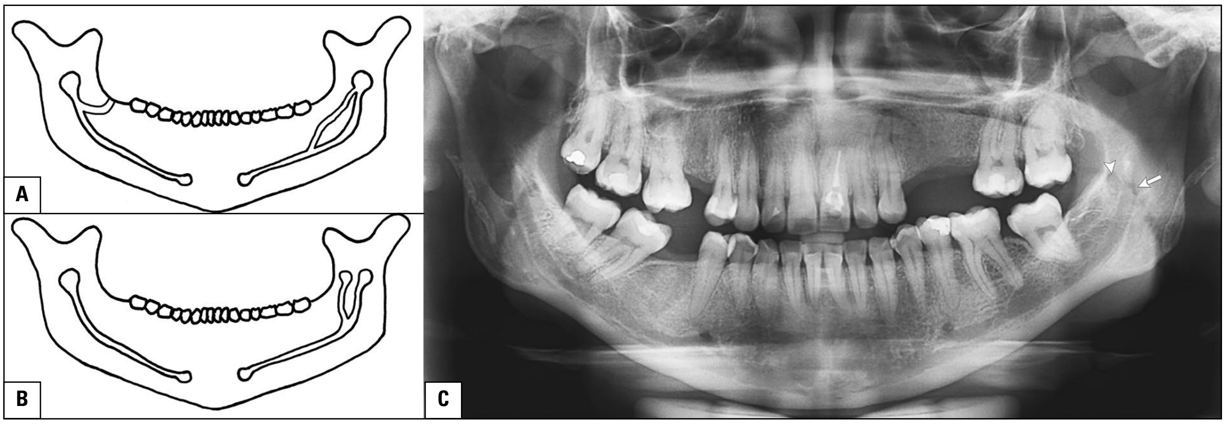

Figure 3. Bifid mandibular canal (MC) type 3 and 4 proposed by Langlais et al. [17]. **A.** Bifid MC resulting from a combination of the type 1 and 2 variants (type 3); **B.** Bifid MC originating from two mandibular foramina (type 4); **C.** Bifid MC type 4 (arrowhead) identified in a 34-year--old woman.

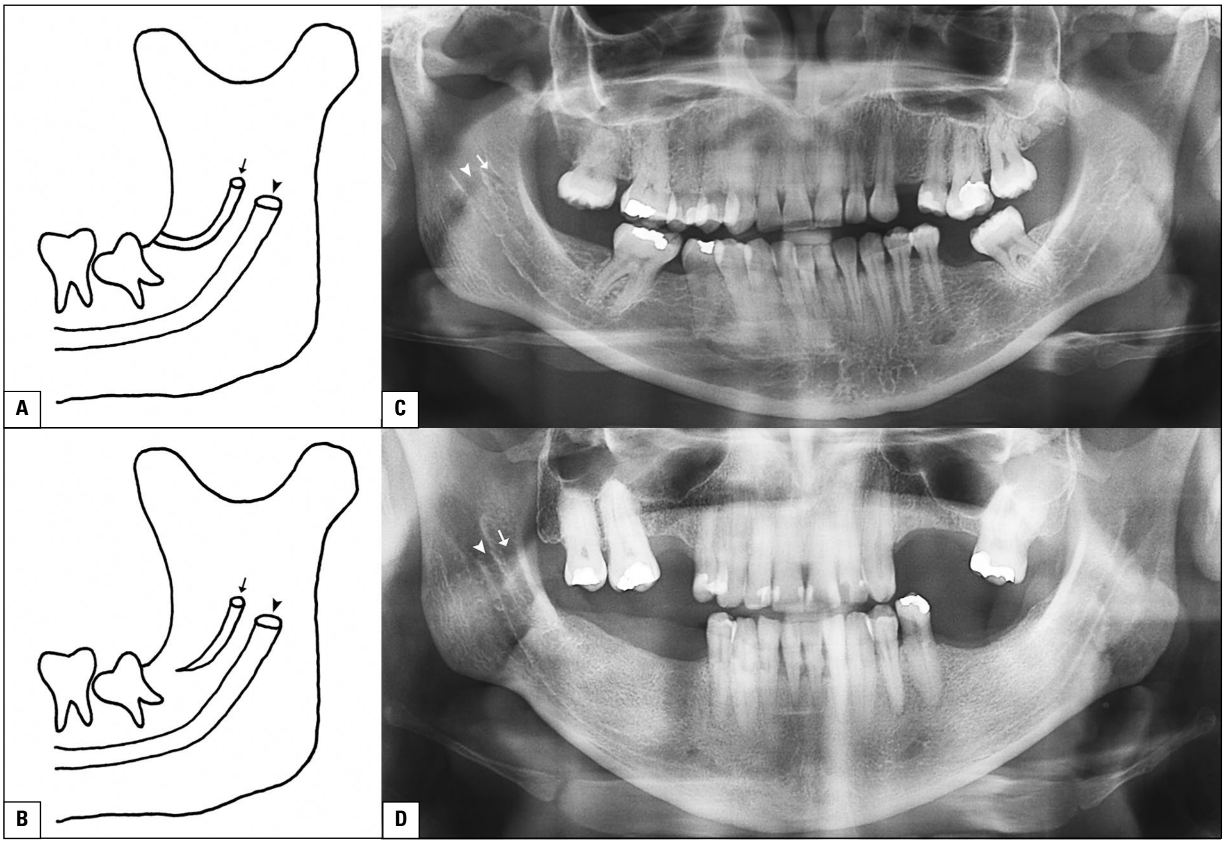

Figure 4. Classification of the retromolar canal according to Choi et al. [5]. **A.** Retromolar canal which enters the mandible through an accessory mandibular foramen (arrow), courses to anteroinferior and terminates in an accessory foramen located in the anteroinferior region of the coronoid process, approximately in the retromolar fossa (retromolar type); **B.** Retromolar canal, which enters the mandible through an accessory mandibular foramen (arrow), courses forwards and laterally to the mandibular canal and terminates close to the roots of the molars (forward type); **C.** Retromolar canal (retromolar type; arrow) identified in a 32-year-old woman; **D.** Retromolar canal (forward type; arrow) identified in a 49-year-old man.

the sex and age of the individuals. Statistical analysis was carried out using the SPSS software v20.0 (IBM SPSS, Chicago, IL, USA). The quantitative data were presented using the mean ± standard deviation; the χ^2 test was applied to contrast the qualitative variables. The threshold of significance was set at $p < 0.05$.

RESULTS

In total, 925 DPR of patients (599 women, 326 men) were analysed. The kappa coefficient to calculate the agreement between the examiners was 99% (very good). The average age of the individuals was 36.1 ± 15.54 years (36.76 ± 15.55 years for females; 34.87 ± 15.49 years for males) in a range from 18 to 86 years. The total prevalence of bifid MC was 11% (n = 102), with no significant differences by sex (p = 0.069) although there was a high percentage of bifid MC cases in women among men (72.5% of the total bifid MC identified). With respect to age, the prevalence was significantly higher among younger patients (p = 0.038), with the 18 to 30 age-range presenting 56.9% of all the bifid MC identified. However, for each sub-classification of bifid MC, no statistically significant differences were found between the different ages (p > 0.05). The prevalence of morphological variations of type 1 bifid MC was 7.4% (n = 69; Fig. 1), type 2 was 2.3% (n = 23; Fig. 2), type 3 was 0% (n = 0; Fig. 3) and type 4 was 1.1% (n = 10; Fig. 3). Table 1 presents the number and percentage of the prevalence of the different classifications of bifid MC identified, grouped by sex and age. Figure 5 presents the distribution of the prevalence of bifid MC by side of the mandible (right, left or bilateral).

The prevalence of retromolar canal was 0.9% (n = 8), with no significant differences by sex (p = 0.893) or age (p = 0.371). Table 2 presents the number and percentage of the prevalence of the two retromolar canal classifications. Of the retromolar canals identified, only 2 (0.2%) cases were the forward type on the right side of the mandible (both in men); while among the retromolar type, 3 (0.3%) cases were identified on the right side, 2 (0.2%) cases on the left side and 1 (0.1%) case was bilateral (only 1 case was found in a man and the rest in women). Figure 5 presents the distribution of the prevalence of the retromolar canal by side of the mandible (right, left or bilateral). No cases of trifid MC were found in this study.

Table 1. Number and percentage of the prevalence of the different classifications of bifid mandibular canal, grouped by sex and age. The chi-squared test was applied to determine statistical differences between the variables

	Total sample	Type 1				Type 2								Type 3	p	Type 4	p	Total
		Unilateral	p	Bilateral	p	Unilateral ramus	p	Unilateral body	p	Bilateral ramus	p	Bilateral body	p					
Sex:			0.247		0.561		0.823		0.276		0.175		0.201		–		0.093	74 (8.1%)
Women	599 (64.8%)	43 (4.6%)		5 (0.5%)		3 (0.3%)		11 (1.1%)		0 (0.0%)		3 (0.3%)		0 (0.0%)		9 (1.0%)		28 (3.0%)
Men	326 (35.2%)	17 (1.8%)		4 (0.4%)		2 (0.2%)		3 (0.3%)		1 (0.1%)		0 (0.0%)		0 (0.0%)		1 (0.1%)		
Total	925 (100%)	60 (6.4%)		9 (1.0%)		5 (0.5%)		14 (1.4%)		1 (0.1%)		3 (0.3%)		0 (0.0%)		10 (1.1%)		102 (11%)
Age [years]:			0.94		0.305		0.354		0.362		0.770		0.759		–		0.618	58 (6.2%)
18–30	438 (47.4%)	36 (3.9%)		7 (0.8%)		2 (0.2%)		6 (0.6%)		1 (0.1%)		2 (0.2%)		0 (0.0%)		4 (0.4%)		25 (2.8%)
31–45	230 (24.9%)	13 (1.4%)		1 (0.1%)		0 (0.0%)		6 (0.6%)		0 (0.0%)		1 (0.1%)		0 (0.0%)		4 (0.4%)		18 (2.0%)
46–60	186 (20.1%)	11 (1.1%)		1 (0.1%)		2 (0.2%)		2 (0.2%)		0 (0.0%)		0 (0.0%)		0 (0.0%)		2 (0.2%)		1 (0.1%)
> 60	71 (7.6%)	0 (0.0%)		0 (0.0%)		1 (0.1%)		0 (0.0%)		0 (0.0%)		0 (0.0%)		0 (0.0%)		0 (0.0%)		
Total	925 (100%)	60 (6.4%)		9 (1.0%)		5 (0.5%)		14 (1.4%)		1 (0.1%)		3 (0.3%)		0 (0.0%)		10 (1.1%)		102 (11%)

DISCUSSION

The present study established the prevalence of morphological variations of the MC in a sample of Chilean patients by exhaustive analysis of DPR. Although these variations are described in the literature as unusual findings, it is by no means rare to encounter them in clinical practice. Much of the literature on the topic is mainly concerned with case reports in order to describe the considerations and possible

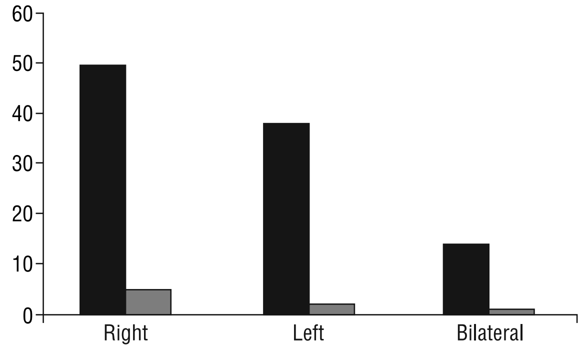

Figure 5. Distribution of the prevalence of bifid mandibular canal (dark stripes) and retromolar canal (light stripes) by side of mandible (right, left or bilateral).

difficulties facing the clinician [2, 6, 10, 13, 24]. In addition, few studies focus on describing these morphological variations of the MC on different samples of populations to report interesting data like morphological configurations and its prevalence.

Panoramic radiography is a routine preoperative examination, widely used by dentists [3], which enables a wide range of variations to be detected. This examination also provides good morphological information for identification of the MC (and its content), mental foramen and other important structures in the mandible [1] without the need for other examinations which, although more precise, are much more expensive for the patient. It is therefore logical to find that cone beam computed tomography (CBCT) is indicated as an examination protocol prior to surgery after indications or suspicions of morphological variations in panoramic radiographs [3]. This is precisely the rational basis for the use of DPR in preference to CBCT for identification of anatomical variation in dental clinical practice, as a first radiographic examination. The information provided by the DPR is sufficient to allow an accurate evaluation in cases of suspected morphological variations of MC. In this regard, Neves et al. [15] compared detection of these variations using panoramic radiographs and CBCT images of the same patients, observing that there were no significant differences in the incidence of cases determined by the two methods. The importance of detecting these variations in some surgical procedures arises from the premise that true bifid MCs, for example, contain nervous and vascular elements which might cause certain complications if care is not taken [11].

Different classification systems exist in the literature for the different configurations that may be found in variations of the MC. The best-known for cases of bifid MC is the classification proposed by Langlais et al. in 1985 [17]; this proposes four types with sub-divisions of types 1 and 2, depending on whether they are unilateral or bilateral and whether they extend through the mandibular ramus and/or body. For cases of retromolar canal, the classification proposed by Choi et al. [5] seems to be the most suitable because of its simplicity. This classification distinguishes two types of retromolar canal on the basis of their origin in two independent mandibular foramina: in one the accessory canal courses forward and laterally to the MC, either joining the MC or terminating at the level of the mandibular molars

Table 2. Number and percentage of the prevalence of the classifications of retromolar canal, grouped by sex and age. The chi-squared test was applied to determine statistical differences between the variables

	Total sample	Retromolar canal				Total
		Forward type	p	Retromolar type	p	
Sex:			0.055		0.339	
Female	599 (64.8%)	0 (0.0%)		5 (0.5%)		5 (0.5%)
Male	326 (35.2%)	2 (0.2%)		1 (0.1%)		3 (0.3%)
Total	925 (100%)	2 (0.2%)		6 (0.6%)		8 (0.8%)
Age [years]:			0.048*		0.523	
18–30	438 (47.4%)	0 (0.0%)		2 (0.2%)		2 (0.2%)
31–45	230 (24.9%)	0 (0.0%)		3 (0.3%)		3 (0.3%)
46–60	186 (20.1%)	2 (0.2%)		1 (0.1%)		3 (0.3%)
> 60	71 (7.6%)	0 (0.0%)		0 (0.0%)		0 (0.0%)
Total	925 (100%)	2 (0.2%)		6 (0.6%)		8 (0.8%)

*Significant differences

(forward type). The other type is an accessory canal with course anteroinferior to the MC, terminating in an accessory foramen in the retromolar fossa (retromolar type). The forward type of retromolar canal has been associated with the classification of bifid MC described by Nortjé et al. [16]. These authors describe the existence of three patterns of division or bifurcation of the MC. Type 1 consists of two canals originating from a single foramen; the inferior canal is generally the longer. Type 2 consists of a bifurcation which generates a short canal extending towards the second or third molar. Finally, type 3 (the least frequent) consists of two canals of similar dimensions apparently originating from independent mandibular foramina which merge into a single canal in the molar region of the mandibular body. In this study we have used the classification proposed by Langlais et al. [17] to categorise our findings, due to its greater standardisation.

The prevalence of bifid MC was 11% (102 patients out of a total sample of 925 radiographs). This is much higher than the prevalence of 0.35% reported by Sanchis et al. [22] in a sample of 2012 radiographs, the prevalence of 0.038% reported by Kim et al. [11] in a sample of 1000 radiographs, or the prevalence of 0.9% reported by Nortjé et al. [16] in a sample of 3612 radiographs. These differences in values may be explained by the quality of the examination used to detect variations in the MC. Thus, studies that report low prevalences of bifid MC (generally less than 1%) use conventional panoramic radiographs [11, 16, 17, 22], in contrast to our study which used digital format radiographs, increasing the clarity and precision of the image. This is proved if we compare the prevalences reported by other studies in which digital radiographs were used, such as Neves et al. [15] who reported a prevalence of 7.4% in a small sample of 127 records, or Kalantar Motamedi et al. [9], who found a prevalence of 1.2% in a sample of 5000 records. Despite these differences, we also observed that among the cases of bifid MC in our study, the most prevalent variation was type 1, with 69 of the 102 cases (67%); a similar finding was reported by Kuczynski et al. [12], who found 50 cases of this variation in the 60 cases of bifid MC (83.33%) identified. The classic study of Langlais et al. [17] mentions that in a total sample of 6000 panoramic radiographs the prevalence of bifid MC was 0.95%, of which the most frequent types were type 2 with 54.4% followed by type 1 with 38.6%. Kalantar Motamedi et al. [9] disagree with the above findings, reporting that the most frequent variations of bifid MC are type 2 with 82%, followed by type 3 with 16.4% and finally type 1 with 1.6%. In respect of the three studies mentioned above it should be noted that apart from the differences in the number of records or radiographs used, they were performed in three ethnically different populations (Iran, United States and Brazil, respectively). In addition, to our best knowledge in this field, the prevalence of morphological variations of the MC has been barely reported in samples of populations from the United States [17], Korea [5, 11], Iran [9], Spain [22], South Africa [16] and Brazil [12, 15]. In this context, our study is a valuable contribution to the knowledge about these variations in a sample of Caucasian South American population.

In our study the prevalence of retromolar canal was 0.9% (8 patients) out of a total sample of 925 radiographs; this was similar to the sample reported by Choi et al. [5], who identified 6 cases of double mandibular foramina with corresponding accessory canal using CBCT, but in a smaller sample of 446 records. Examination by CBCT offers great advantages in sensitivity and precision, which would explain why our study found a low presence of this variation despite analysing a larger number of records. In our study, as in Choi et al. [5], 6 (0.6%) cases of retromolar type were found.

Finally, we would mention that no cases of trifid MC were found in our study; this is an extremely rare anatomical variation, and the evidence in the literature is limited to a few case reports [2, 14]. The diagnosis of morphological variations of MC has an important role in some routine procedures such as local anaesthesia for dental treatment, since the existence of double or triple vasculo-nervous bundle in different canals may cause an insufficient effect and incomplete anaesthesia in some mandibular regions [25].

CONCLUSIONS

This study provides new information on morphological variations of the MC in a sample of Chilean population, in which we identified three types of bifid MC described by Langlais et al. [17] as well as retromolar canals as described by Choi et al. [5]. Digital panoramic radiography proved to be a valuable tool for identifying morphological variations simply and without major investment in technological resources and sophisticated equipment. Digital panoramic radiography offers advantages over conventional radiography (which produces poorer quality images) and CBCT (in which indications or suspicions of the presence of anatomical variations must be treated with caution).

REFERENCES

1. Aps JKM. Number of accessory or nutrient canals in the human mandible. Clin Oral Investig. 2014; 18(2): 671–676, doi: 10.1007/s00784-013-1011-6, indexed in Pubmed: 23743519.
2. Auluck A, Pai KM, Mupparapu M. Multiple mandibular nerve canals: radiographic observations and clinical relevance. Report of 6 cases. Quintessence Int. 2007; 38(9): 781–787, indexed in Pubmed: 17873985.
3. Capote TS, Gonçalves Md, Campos JÁ. Retromolar canal associated with age, side, sex, bifid mandibular canal, and accessory mental foramen in panoramic radiographs of Brazilians. Anat Res Int. 2015; 2015: 434083, doi: 10.1155/2015/434083, indexed in Pubmed: 26366300.
4. Chávez-Lomeli ME, Mansilla Lory J, Pompa JA, et al. The human mandibular canal arises from three separate canals innervating different tooth groups. J Dent Res. 1996; 75(8): 1540–1544, doi: 10.1177/00220345960750080401, indexed in Pubmed: 8906121.
5. Choi YY, Han SS. Double mandibular foramen leading to the accessory canal on the mandibular ramus. Surg Radiol Anat. 2014; 36(9): 851–855, doi: 10.1007/s00276-014-1310-x, indexed in Pubmed: 24817561.
6. de Souza Tolentino E, Silva PA, Pagin O, et al. Uncommon trajectory variations of the mandibular canal and of the mandibular incisive canal: case report. Surg Radiol Anat. 2013; 35(9): 857–861, doi: 10.1007/s00276-013-1138-9, indexed in Pubmed: 23728516.
7. Figún M, Garino R. Anatomía Odontológica Funcional y Aplicada. 2a ed. El Ateneo, Buenos Aires. 2001.
8. Haas LF, Dutra K, Porporatti AL, et al. Anatomical variations of mandibular canal detected by panoramic radiography and CT: a systematic review and meta-analysis. Dentomaxillofac Radiol. 2016; 45(2): 20150310, doi: 10.1259/dmfr.20150310, indexed in Pubmed: 26576624.
9. Kalantar Motamedi MH, Navi F, Sarabi N. Bifid mandibular canals: prevalence and implications. J Oral Maxillofac Surg. 2015; 73(3): 387–390, doi: 10.1016/j.joms.2014.09.011, indexed in Pubmed: 25530276.
10. Karamifar K, Shahidi S, Tondari A. Bilateral bifid mandibular canal: report of two cases. Indian J Dent Res. 2009; 20(2): 235–237, doi: 10.4103/0970-9290.52889, indexed in Pubmed: 19553729.
11. Kim MS, Yoon SJ, Park HW, et al. A false presence of bifid mandibular canals in panoramic radiographs. Dentomaxillofac Radiol. 2011; 40(7): 434–438, doi: 10.1259/dmfr/87414410, indexed in Pubmed: 21960401.
12. Kuczynski A, Kucharski W, Franco A, et al. Prevalence of bifid mandibular canals in panoramic radiographs: a maxillofacial surgical scope. Surg Radiol Anat. 2014; 36(9): 847–850, doi: 10.1007/s00276-014-1298-2, indexed in Pubmed: 24752397.
13. Miloglu O, Yilmaz AB, Caglayan F. Bilateral bifid mandibular canal: a case report. Med Oral Patol Oral Cir Bucal. 2009; 14(5): E244–E246, indexed in Pubmed: 19218898.
14. Mizbah K, Gerlach N, Maal TJ, et al. The clinical relevance of bifid and trifid mandibular canals. Oral Maxillofac Surg. 2012; 16(1): 147–151, doi: 10.1007/s10006-011-0278-5, indexed in Pubmed: 21698363.
15. Neves FS, Nascimento MC, Oliveira ML, et al. Comparative analysis of mandibular anatomical variations between panoramic radiography and cone beam computed tomography. Oral Maxillofac Surg. 2014; 18(4): 419–424, doi: 10.1007/s10006-013-0428-z, indexed in Pubmed: 23975215.
16. Nortjé CJ, Farman AG, Grotepass FW. Variations in the normal anatomy of the inferior dental (mandibular) canal: A retrospective study of panoramic radiographs from 3612 routine dental patients. Br J Oral Surg. 1977; 15(1): 55–63, doi: 10.1016/0007-117x(77)90008-7.
17. Langlais RP, Broadus R, Glass BJ. Bifid mandibular canals in panoramic radiographs. J Am Dent Assoc. 1985; 110(6): 923–926, indexed in Pubmed: 3860553.
18. Latarjet M, Ruiz-Liard A. Anatomía Humana. 2a ed. Médica Panamericana, Buenos Aires. 2004.
19. Leite GM, Lana JP, de Carvalho Machado V, et al. Anatomic variations and lesions of the mandibular canal detected by cone beam computed tomography. Surg Radiol Anat. 2014; 36(8): 795–804, doi: 10.1007/s00276-013-1247-5, indexed in Pubmed: 24337387.
20. Orhan K, Aksoy S, Bilecenoglu B, et al. Evaluation of bifid mandibular canals with cone-beam computed tomography in a Turkish adult population: a retrospective study. Surg Radiol Anat. 2011; 33(6): 501–507, doi: 10.1007/s00276-010-0761-y, indexed in Pubmed: 21161224.
21. Roa I, Arriagada O. Variaciones del Canal Mandibular con Importancia Clínica: Reporte de Caso. Int J Morphol. 2015; 33(3): 971–974, doi: 10.4067/s0717-95022015000300026.
22. Sanchis JM, Peñarrocha M, Soler F. Bifid mandibular canal. J Oral Maxillofac Surg. 2003; 61(4): 422–424, doi: 10.1053/joms.2003.50004, indexed in Pubmed: 12684957.
23. Galdames IS, Matamala DZ, López MC. Canal mandibular accesorio: análisis de su prevalencia y aspecto imagenológico. Av Odontoestomatol. 2011; 27(2): 85–90, doi: 10.4321/s0213-12852011000200004.
24. Wadhwani P, Mathur RM, Kohli M, et al. Mandibular canal variant: a case report. J Oral Pathol Med. 2008; 37(2): 122–124, doi: 10.1111/j.1600-0714.2007.00573.x, indexed in Pubmed: 18197857.