ANATOMICAL VARIATIONS OF MANDIBULAR CANAL: PANORAMIC RADIOGRAPHS EVALUATION

VARIAÇÕES ANATÔMICAS DO CANAL DA MANDÍBULA: AVALIAÇÃO POR MEIO DE RADIOGRAFIAS PANORÂMICAS

Alessandra Soares DITZEL[1]
Ana Paula Tulio MANFRON[2]
Kassandra Assolari COSTA[3]
Luciana Reis AZEVEDO ALANIS[4]

ABSTRACT

Objectives: To evaluate the prevalence of anatomical variations of mandibular canal in panoramic radiographs and to associate the findings with sex and age. **Materials and Methods:** Panoramic radiographs from Radiology Department - PUCPR, were randomly chosen and analyzed. Panoramic radiographs without acceptable standards of density, sharpness and contrast were excluded as well as those with positioning errors and/or non-observance of the jaw canals boundaries. The radiographic interpretation was performed by two radiologists separately according to criteria of presence, location and radiographic appearance of mandibular canal. The Cohen Kappa test evaluated the interrater agreement (k=0.84). **Results:** A total of 1506 panoramics obtained from 944 female and 562 males. The mean age was 42.16 (±16.5) years, ranging from three to 87. Canal anatomic variations were observed in 92 (6.1%) radiographs, type II (59.7%) was the most frequent. There were 46 (3.05%) cases in female patients; 46 (3.05%) cases in males and there was unilateral predominance (83.7%). The ranges of age that showed the highest frequency of anatomic variations of mandibular canals were 33-42 (n=22) and 43-52 (n=24). There was a significant association between the presence of variations and gender (p=0.009) and there was no significant association between presence of variations and age (p>0.05). **Conclusion:** The prevalence of anatomic variation of mandibular canals was 6.1%, significantly affecting more men than in women. Most had unilateral occurrence with predominant type II.

KEY WORDS: mandibular canal, panoramic radiograph, anatomical variation

RESUMO

Objetivos: Avaliar a prevalência de variações anatômicas do canal da mandíbula em radiografias panorâmicas, correlacionando com sexo e idade. **Materiais e Métodos:** Radiografias panorâmicas escolhidas aleatoriamente do acervo do Setor de Radiologia da Clínica Odontológica da PUCPR foram incluídas no estudo. Foram excluídas radiografias panorâmicas sem aceitáveis padrões de densidade, nitidez e contraste; com erros de posicionamento e/ou não observação dos limites do canal da mandíbula. A interpretação radiográfica foi realizada por dois radiologistas separadamente, de acordo com critérios de presença, localização e aspecto radiográfico do canal da mandíbula. O teste de Cohen Kappa avaliou a concordância inter-examinadores (k=0,84). **Resultados:** A amostra foi composta por 1506 panorâmicas, obtidas de 944 pacientes do sexo feminino e 562 do sexo masculino. A média de idade foi 42,16 (±16,5) anos, variando de três a 87. Foi observada variação do canal da mandíbula em 92 (6,1%) radiografias; o tipo II (59,7%) foi o mais observado. Ocorreram 46(3,05%) casos em pacientes do sexo feminino; 46 (3,05%) casos no sexo masculino e houve predominância unilateral (83,7%). Os intervalos de idade que apresentaram maior frequência de variações anatômicas do canal da mandíbula foram 33-42 (n=22) e 43-52 (n=24) anos. Houve associação significante entre presença das variações e sexo (p=0,009), e não houve entre presença das variações e faixa etária (p>0,05). **Conclusão:** Observou-se prevalência de variações do canal da mandíbula em 6,1% das radiografias; a maioria apresentou ocorrência unilateral, sendo predominante o tipo II, afetando significativamente

PALAVRAS-CHAVE: canal da mandíbula, radiografia panorâmica, variaçãoo anatômica

[1] DDS,MSc - Posgraduation program Pontifícia Universidade Católica do Paraná, Curitiba, PR, Brasil.

[2] DDS,MSc,PhD – Faculdade Herrero, Curitiba, PR, Brazil

[3] DDS – Program in Dentristry, Pontifícia Universidade Católica do Paraná, Curitiba, PR, Brasil.

[4] DDS,MSc,PhD – Professor, Graduate Program in Dentristry, Pontifícia Universidade Católica do Paraná, Curitiba, PR, Brasil.

e-*mail* para correspondência: alessandra_sd@hotmail.com

1. Introduction

Damage to the inferior alveolar nerve for third molar extractions and implant placement as well as anesthetic failures have been reported at a frequency to 40 %[1-3]. Since this bundle is routinely related to dental procedures such as anesthesia used for treatment of the lower teeth, third molars removal, as well as in cases of osteotomies and dental implant placement, complications can occur especially where there are anatomical variations of the mandibular canal[4-8].

The mandibular canal usually presents uniform and wide, but may present some anatomical variations, such as accessory canals and/or branches[6-9]. Because of these variations and the importance of this anatomical structure, to protect the neurovascular bundle[10], the mandibular canal has been extensively studied in relation to location aspects and position[11]. The presence of bifid canals is often ignored or not observed[8]. Failure in observation can cause complications to patients[12]; as well as anesthesia problems[13,14], paresthesia, traumatic neuroma and bleeding are cited as complications caused by injury to the neurovascular bundle[7]. Nortjé et al.[15] and Langlais et al.[16] classify these bifurcations according to the location and anatomical configuration evaluating the images on panoramic radiographs. Panoramic radiography stands out among the extraoral techniques enable the interpretation all the maxillomandibular region in a single incidence and presents advantages such as lower radiation dose, lower costs for the patient and easier perform [17].

Of the points raised about the anatomical variations, became relevant their identification on panoramic radiographs in order to avoid misinterpretations that lead to misdiagnosis and treatment failures, so being essential to the success of surgical procedures [4,7,14,18,19].

The aim of this study was to evaluate the prevalence of anatomical variation of mandibular canal in panoramic radiographs, in relation to the presence, classification and laterality of the bifid canals, relating to sex and age.

2. Materials and Methods

The project was approved by the Research Ethics Committee of PUCPR (480468/2013). The study population included patients of Dental Clinic - PUCPR (Curitiba, Paraná, Brazil) from December 2013 to November 2014, whose records were chosen randomly. The sample was calculated considering a confidence level of 95% and maximum margin of error of 3% and assuming a percentage of presence of anatomical variations of P = 50 %. The exclusion criteria were: records that did not contain the following information: age, sex and panoramic radiography. Also excluded radiographs with not acceptable density and contrast patterns, in addition to inappropriate positioning of the patient, and radiographs to present difficulty in observing the canal.

A total of 1,589 panoramic radiographs were analyzed. Were excluded 83 panoramic radiographs due to low technical quality of the panoramic radiograph and/or by not observing the cortical boundaries of the canal. Patient identification- related data were collected from medical records and panoramic radiographs were interpreted regarding the presence of the bifid mandibular canal.

The technique for image acquisition was performed in a standard way: head position with the median sagittal plane perpendicular to the ground and Frankfurt plane parallel to the ground. The films used were 15x24cm (Kodak, Rochester, USA). For the processing of images an automatic processor Multi X 36 (Glunz & Jensen of Brazil, Curitiba, Brazil) was used with developer and fixer (Kodak RP X-OMAT, Rochester, USA).

The radiographs interpretation was performed by two examiners (experts in Dental and Imaging Radiology), separately, in the dark room, using light box Luna (Luna, Cristófoli Medical Equipment CO LTD, Zhejiang, China) and mask. Agreement evaluation between the examiners was verified by statistical test Cohen Kappa ($k = 0.84$).

As variables of study the following data were used: sex, age, presence of bifid mandibular canal, classification, laterality (unilateral or bilateral) and side (right and / or left). The analysis of the mandibular canal was performed by classification recommended by Langlais et al.[16]. The sample was divided into eight groups, divided into nine, to obtain the percentiles.

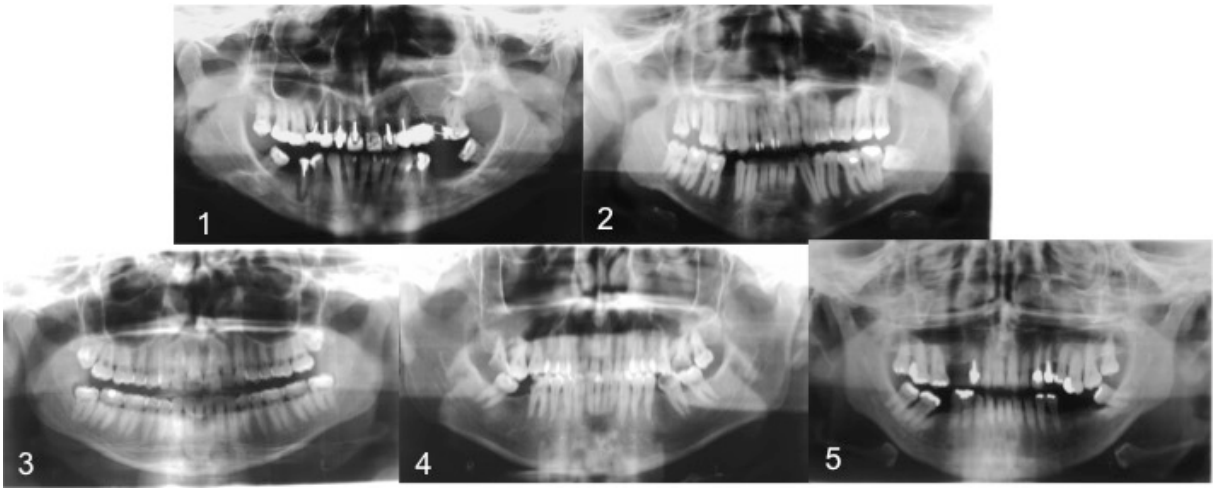
Statistical analysis

The prevalence for each variable was obtained through the distribution of dichotomous or polytomous categorical frequency. Student's t test was used for independent samples in

order to assess the average age of the population studied showed statistically significant differences in relation to sex. For the other variables with nominal scale dichotomous or polytomous verifying according to sex or age dependency was made using the chi-square test. The pairwise comparison of the ratios for all variables according to sex or age range was made using the test differences between two proportions. The significance level for all tests was 5%.

3. Results

The sample consisted of 1506 patients, 944 (62.65 %) females and 562 (37.35%) males, whose panoramic radiographs were evaluated bilaterally. The mean age was 42.16 years (± 16.5), distributed in eight intervals of nine years. In 92(6.1%) radiographs were found anatomical variations of the mandibular canal, 46 (3.05%) women and 46 (3.05%) men. There was a significant difference between the presence of mandibular canal variation and sex ($p = 0.009$). Table 1 shows the distribution of the mandibular canal classification regarding sex. In 1 (1.1%) case was observed the presence of type I and II on the same side (table 1). Figures 1-5 illustrate the radiographs with the different types.



Figures 1-5. 1.Panoramic radiograph of 43-year-old female patient, showed anatomical variation of the mandibular canal, classification, type I, bilateral. 2. Panoramic radiograph of 24-year-old male patient, showed anatomical variation, type II, right side. 3. Panoramic radiograph of 24-year-old female patient, showed anatomical variation, type III. 4. Panoramic radiograph of 24-year-old male patient, showed anatomical variation, type IV, right side. 5. Panoramic radiograph 33-year-old female patient, showed anatomical variation, type I and II , right side.

Table 1: Mandibular canal variation in relation to the classification and sex.

MANDIBULAR CANAL	SEX		Total
	Male	Female	
	n(%)	n(%)	n(%)
Type I	21 (22.8)	10 (10.9)	31 (33.7)
Type II	23 (25.0)	32 (34.7)	55 (59.7)
Type III	2 (2.2)	1 (1.1)	3 (3.3)
Type IV	0 (0.0)	2 (2.2)	2 (2.2)
Type I e II	0 (0.0)	1 (1.1)	1 (1.1)
Total	46 (50)	46 (50)	92 (100)

As the laterality, 77(83.7%) were unilateral cases, 37(40.2%) right side, 40 (43.5%) left side and 15 (16.3%) bilateral. The frequency of anatomical variations of the mandibular canal in relation to the side and the classification is shown in table 2. The age groups most frequent variation of mandibular canal ranges of 33-42 and 43-52 year-old, with 22 and 24 cases, respectively. Table 3 shows the distribution of frequencies of the mandibular canal variations relating to age. There was no significant difference between the presence of anatomical variations of the mandibular canal and age ($p > 0.05$)

Table 2: Frequency of mandibular canal variation in relation to the laterality, sides and classification.

Laterality	Side	CLASSIFICATION					
		Type I	Type II	Type III	Type IV	Type I and II	Total
		n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
Unilateral	Right	16 (17.4)	18 (19.5)	0 (0.0)	2 (2.2)	1 (1.1)	37 (40.2)
	Left	11 (12.0)	29 (31.5)	0 (0.0)	0 (0,0)	0 (0,0)	40 (43.5)
Bilateral		4 (4.3)	8 (8.7)	3 (3.3)	0 (0.0)	0 (0.0)	15 (16.3)
Total		31 (33.7)	55(59.7)	3 (3.3)	2 (2.2)	1 (1.1)	92 (100)

Table 3. Mandibular canal variation relating to age.

	AGE GROUP								
MANDIBULAR CANAL	3 a 12 n (%)	13 a 22 n (%)	23 a 22 n (%)	33 a 42 n (%)	43 a 52 n (%)	53 a 62 n (%)	63 a 72 n (%)	73 a 87 n (%)	TOTAL n (%)
With anatomic variation	61 (4.0)	120 (8.0)	229 (15.2)	290 (19.2)	348 (23.1)	220 (14.6)	103 (6.8)	43 (3.0)	1414 (93.9)
Without anatomic variation	0 (0)	6 (0.4)	19 (1.3)	19 (1.3)	24 (1.6)	16 (1.1)	4 (0.2)	1 (0.01)	92 (6.1)
TOTAL	61 (4.0)	126 (8.4)	248 (16.5)	312 (20.7)	372 (24.7)	236 (15.7)	107 (7.0)	44 (3.0)	1506 (100)

4. Discussion

In the present study, was observed a prevalence of 6.1% (92/1506) of bifid mandibular canal. This result was considerably higher than previous reports: 0.038% (4/1040) [6]; 0.35% (7/2012) [20]; 0.95% (57/6000) [16] and 0.98% (41/2400) [21]. However, other results, 8.3% (85/1024)[22], 7.4% (19/254)[8] and 5% (35/700)[23] came from to the results of this study. In view of that the prevalence of anatomical variations of the mandibular canal varies considerably[4], it is assumed that the explanation for this discrepancy may be due to differences in sample characteristics. In this study, men were more affected when compared to women ($p = 0.009$). These results are not consistent with the findings in the literature reviewed, which shows a higher prevalence in women: Sanchis et al.[20] found a statistically significant and higher prevalence, the seven radiographs showed evidence, all were in women. Other studies[21,24,25] also showed female predominance, however, did not mean a relationship statistically significant. All of these studies[20,24,25] the sample was considerably higher for women. According to the classification of Langlais et al.[16], type II, 55(60%), was found as compared with other types, in the present study. Our results are in agreement with those obtained by Langlais et al.[16] found that type II in 31 (54.5%) cases. But are not consistent with other studies that found a higher prevalence of type I, with the following results: 50 (83.3%)[19], 24 (68.57%)[23] and 18 (41.9%)[24]. In our study, we also observed a case of anatomical variation

not belonging to Langlais classification: type I and II on the same side of the mandible so, an evidence of a trífid mandibular canal. Similar findings were reported by Auluck et al.[13]; and Lopez et al. [26] and Mizbah et al.[7], on CT images. In the present study, the majority of cases were unilateral (83.7%). The results are consistent with studies of Langlais et al. [16] 92% (46/57), Kasabah et al.[21] 73.1% (30/41), Lara et al.[23] 83.3% (25/30) and the findings of Kuczynski et al.[19] who found only unilateral bifid mandibular canals 100% (60/60).

Our results revealed no statistically significant association between the presence of anatomical variations of the mandibular canal and age, but showed higher incidence in the mean age group 33-42 years-old.

Despite the valuable of panoramic radiograph in observing these variations[8], brings some limitations that may contribute to misinterpretation: overlapping structures, inadequate patient positioning and distortion or magnification of the image [25]. Both milohiodea line[20] as milohioideo groove[7] can difficult the interpretation of anatomical variations of the mandibular canal and can mimic the limits of the canal showing a false image. Therefore, it is noteworthy that the findings in the panoramic radiograph represent only evidence[23] and not a confirmation of the real presence of the variation[27]. However it is important to alert professionals of possible changes in the course of the mandibular canal.

Because of the inherent limitations of panoramic technique, many studies have used cone beam computed tomography in assessing to the variations of the mandibular canal[7,8,25,26,28,29]. With CT images, the prevalence show is actually higher, ranging from 15.6 to 69%[26,29], which shows that CT is more accurate when compared to panoramic radiography.

However, when the two techniques were compared on the interpretation of the variations of the mandibular canal, there was no significant difference between both, suggesting the panoramic radiographs as useful in observing this variation[8]. It is important to remember that eventhough a cone beam computer tomography is more accurate than panoramic radiograph, for providing better observation of anatomical structures such as diameter, exact location and direction of the bifid canals in relationship to adjacent structures[7], it has a higher radiation dose to the patient, requiring caution in its indication and can be used for planning surgeries involving the region[7]. Therefore, the panoramic radiograph is still the first choice for probably observation to the bifid mandibular canals. There is a consensus that the mandibular canal is a structure of great importance for the dental practice, since it pass by vital structures such as the inferior alveolatr neurovascular bundle[15,16]. During surgical procedures such as bone windows openings for removal of mandibular third molar,

osteotomies in the posterior mandible of dental implant placement, if the inferior alveolar neurovascular bundle is injured, patient complications can occur as traumatic neuroma, paresthesia, and bleeding[4,7,14,22]. Thus, his observation becomes necessary for planning procedures involving the lower region. Knowledge of these variations is important and provides valuable information for professionals about the success of surgical and anesthetic procedures to be performed[6,13,18].

5. Conclusion

Based on the methodology and the results found, the bifid mandibular canal occurred in 6.1% of radiographs; most cases has predominantly unilateral occurrence type II. Men were significantly more affected than women. There was no statistically significant difference in relation to age.

6. References

1. Yadav P, Kumar VR. Evaluation of local anaesthetic failures in dental practice. J Int Oral Health. 2010;2:16-21.
2. Sarikov R, Juodzbalys G. Inferior alveolar nerve injury after mandibular third molar extraction: a literature review. J Oral Maxillofac Res. 2014;5:e1. doi: 10.5037/jomr.2014.5401.
3. Shavit I e Juodzbalys G. Inferior alveolar nerve injuries following implant placement - Importance of early diagnosis and treatment: a systematic review. J Oral Maxillofac Res.2014;5:e2. doi: 10.5037/jomr.2014.5402.
4. Bogdán S, Pataky L, Barabás J, Németh Z, Huszár T, Szabó G. Atypical courses of the mandibular canal: comparative examinati of dry mandibles and x-rays. J Craniofac Surg. 2006;17:487-91.
5. Naitoh M, Hiraiwa Y, Aimiya H, Gotoh M, Ariji Y, Izumi M, Kurita K, Ariji E. Bifid mandibular canal in Japanese. Implant Dent 2007;16:24-32.
6. Kim MS, Yoon SJ, Park HW, Kang JH, Yang SY, Moon YH, Jung NR, Yoo HI, Oh WM, Kim SH. A false presence of bifid mandibular canals in panoramic radiographs. Dentomaxillofac Radiol. 2011;40:434-8.
7. Mizbah K, Gerlach N, Maal TJ, Bergé SJ, Meijer GJ. The clinical relevance of bifid and trifid mandibular canals. Oral Maxillofac Surg. 2012. doi: 10.1007/s10006-011-0278-5. Epub 2011 Jun 23

8. Neves FS, Nascimento MC, Oliveira ML, Almeida SM, Bóscolo FN. Comparative analysis of mandibular anatomical variations between panoramic radiography and cone beam computed tomography. Oral Maxillofac Surg. 2014;18:419-24. Epub 2013 Aug 24.
9. Neves FS, Rodrigues V, Burgos V, Oliveira C, Campos PSF, Crusoé-Rebello I. Anatomical variations of the mandibular canal in panoramic radiographs: report of clinical cases. Int J Dent Recife. 2009;8:45-49.
10. Heasman PA. Variation in the position of the inferior dental canal and its significance to restorative dentistry. J Dent 1988;16:36-9.
11. Clayes V, Wackens G .Bifid mandibular canal: Literature review and case report. Dentomaxillofac Radiol. 2005;34:55-8.
12. Kaufman E, Serman NJ, Wang PD. Bilateral mandibular accessory foramina and canals: a case report and review of the literature. Dentomaxillofac Radiol. 2000;29:170-5
13. Auluck A, Pai KM, Mupparapu M. Multiple mandibular nerve canals: radiographic observations and clinical relevance. Report of 6 cases. Quintessence Int. 2007;38(9):781-7
14. Wadhwani P, Mathur RM, Kohli M, Sahu R. Mandibular canal variant: a case report. J Oral Pathol Med. 2008;37(2):122-4.
15. 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
16. Langlais RP, Broadus R, Glass BJ. Bifid mandibular canals in panoramic radiographs. J Am Dent Assoc. 1985;110(6):923-6.
17. White SC, Pharoah MJ. Oral radiology: principles and interpretation. 5th ed. Philadelphia: Mosby, 2004.
18. Manikandhan R, Mathew PC, Naveenkumar J, Anantanarayanan P. A rare variation in the course of the inferior alveolar nerve. Int J Oral Maxillofac Surg. 2010;39:185-7.
19. Kuczynski A, Kucharski W, Franco A, Westphalen FH, de Lima AA, Fernandes A. Prevalence of bifid mandibular canals in panoramic radiographs: a maxillofacial surgical scope. Surg Radiol Anat. 2014;36:847-50.
20. Sanchis JM, Peñarocha M, Soler F. Bifid mandibular canal. J Oral Maxillofac Surg. 2003;61:422-4

21. Kasabah S, Modellel Y. Classification of bifid mandibular canals in the Syrian population using panoramic radiographs. East Mediterr Health J. 2014;9;19 Suppl 3:S178-83.
22. Durst JH, Snow JE. Multiple mandibular canals: oddities or fairly common anomalies? Oral Surg Oral Med Oral Pathol. 1980;49:272-73.
23. Lara - Schilling, LJ, Schilling, QA. e San Pedro VJ. Prevalencia de las bifurcaciones del canal mandibular, análisis en radiografias panoramicas digitales. Int. J. Odontostomat. 2010;4:207-13.
24. Rossi PM, Brucher MR, Rockenbach MI. Bifid mandibular canals: panoramic radiographic analysis. Rev Ciênc Méd Campinas. 2009;18:99-104.
25. Correr GM, Iwanko D, Leonardi DP, Ulbrich LM, Araújo MR, Deliberador TM. Classification of bifid mandibular canals using cone beam computed tomography. Braz Oral Res. 2013;27(6):510-6.
26. López-Videla JM, Miranda MV, Rojas MR, Zuluaga CLG. Prevalencia de variables anatómicas en el recorrido de los conductos mandibulares. Estudio mediante tecnología cone beam. Rev Fac Odontol Univ Antioq. 2010;22:23-32.
27. Rouas P, Nancy J, Bar D. Identification of double mandibular canals: literature review and three case reports with CT scans and cone beam CT. Dentomaxillofac Radiol. 2007;36(1):34-8.
28. Fukami K, Shiozaki K, Mishima A, Kuribayashi A, Hamada Y, Kobayashi K. Bifid mandibular canal: confirmation of limited cone beam CT findings by gross anatomical and histological investigations. Dentomaxillofac Radiol. 2012;41:460-5.
29. Kuribayashi A, Watanabe H, Imaizumi A, Tantanapornkul W, Katakami K, Kuribayashi T. Bifid mandibular canals: cone beam computed tomography evaluation. Dentomaxillofac Radiol. 2010;39:235-9.