Frequency of Bifid Mandibular Canals and Their Relationship with the Mandibular Third Molar Teeth: A Cone Beam Computed Tomography Analysis of an Iranian Population

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Abstract

Introduction:
Considering the importance of avoiding the outcomes of injury to the inferior alveolar nerve and its accessory branches, the present study was conducted with the purpose of determining the frequency of bifid mandibular canals using cone beam computed tomography images in an Iranian population.

Materials and methods:
In this cross sectional study, 221 CBCT images were evaluated in terms of presence/absence of BMC. In the case of detection of a bifid mandibular canal, the type of bifidity was identified according to the classification of Langlais et al. Furthermore, the relationship between the BMCs and the apices of the third molar teeth was determined based on a classification formerly developed by Correr et al.

Results:
Among the whole 221 CBCT images evaluated, 6 (2.7%) bifid mandibular canals were detected. The bifidity types were as follows: 4 canals with 1U type, 1 canal with 2UR type and 1 canal with 2BC type. Regarding the relationship of the bifid canals with the mandibular third molar teeth, 1 canal was type A, 4 were type B and 1 was related to a patient not having the third molar teeth. Furthermore, no significant relations were found between the presence of BMCs and the patients' genders (P = 0.67).

Conclusion:
BMCs did not show a remarkable frequency in our study. However, precise evaluation of the patients' radiographic records is mandatory for the detection of BMCs in order to reduce hazardous and unexpected outcomes.

Key words:
•Cone-Beam Computed Tomography •Mandibular Nerve

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Introduction

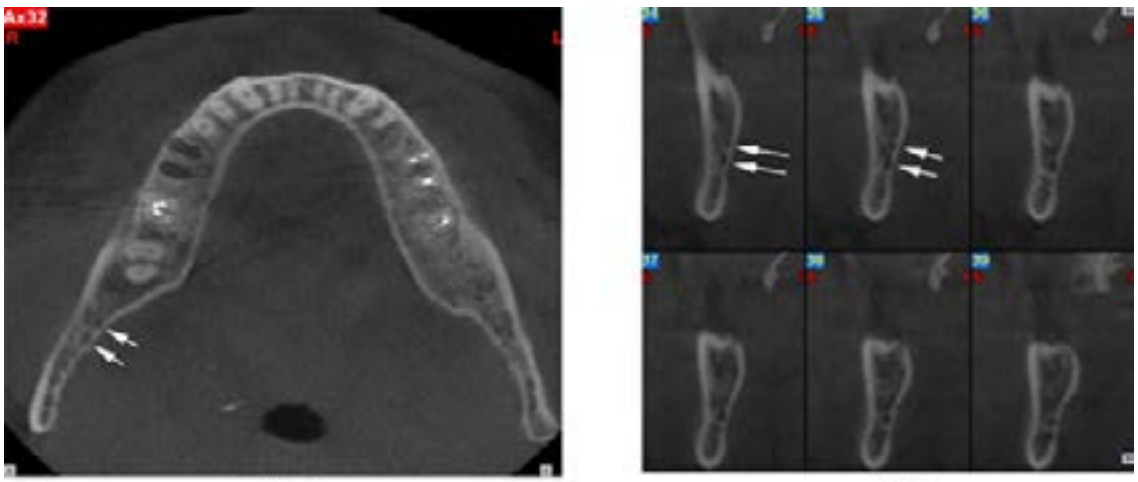
The mandibular canal is a neuro-vascular canal located within the mandible. It contains one of the major branches of the mandibular nerve, namely the inferior alveolar nerve, as well as the inferior alveolar artery and vein. A number of variations exist in the morphology of the mandibular canal, of which surgeons might be unaware or they could be easily

missed in the routine panoramic radiographs.[1-4] The mandibular canal is generally considered as a single structure; nevertheless, various patterns of branching of the neurovascular bundle, including bifid and trifid varieties exist in different mandibles.[5-6] In the dental practice, the possibility of presence of bifid mandibular canals (BMCs) should be of great concern to the practitioners in that an unrecognized accessory branch of the nerve could be the reason for several complications including incomplete anesthesia, paresthesia, sensory disturbance, unexpected severe bleeding, formation of traumatic neuroma, and development of fibrous tissue at the contact site with an implant fixture.[6-7] Previous studies have reported an incidence rate of 0.08 to 8.3% for BMC in panoramic radiographs [8-13] and 10.2 to 58.4% in CBCT images [4,7,14-17] Considering the importance of awareness of the clinicians regarding the prevalence of mandibular canal branches and the fact that no studies by far have used CBCT images in this regard in the Iranian population, the current investigation was aimed at determining the incidence of bifid mandibular canals and their type of bifurcation in an Iranian population using CBCT images.

Materials and Methods

A total number of 221 CBCT images were used for this cross sectional, retrospective study. The CBCT examinations had been previously performed for various purposes including assessment of implant sites or evaluation of impacted teeth, hence no additional radiation exposure was imposed on the patients for the present study. The ethical approval number of this research was IR.GUMS.1396.14 (registered by Guilan University of Medical Sciences). All the images were recruited from the archives of a private oral and maxillofacial radiology center (Rasht, Iran) and acquired by the same New-Tom CBCT device (QR srl company, Verona, Italy) and with the following imaging parameters: voxel size: 0.2-0.24 mm, FOV= 10 × 10 for the standard zoom mode and 22.5 × 22.5 for the full zoom mode. The CBCT images had to be of proper quality and contain the patients' mandibles in their fields of view. Images of patients who had lesions involving the mandible, history of trauma, and history of orthognathic or reconstructive surgery of the posterior areas of the mandible were excluded from the investigation. CBCT examination of each patient was evaluated by two maxillofacial radiologists in the axial, reconstructed panoramic, and cross sectional (with 1mm slice thickness and 1 mm slice interval) planes (Figures 1A, 1B and 2). The aforementioned CBCT imaging planes were assessed in terms of presence/ absence of bifid mandibular canals. Where the two observers reached an agreement regarding the presence of a BMC, the type of bifurcation was identified using the classification of Langlais et al.[11] (Table 1). In case the radiologists did not have the same conclusion with regard to the presence of BMC, the image was excluded from the study.

Figure 1. Bifid mandibular canal on the right side of the mandible with arrows pointing to the branches; (A) axial CBCT image slice, (B) Cross sectional CBCT image slices.



(A) (B)

Furthermore, in patients with the diagnosis of bifid mandibular canals and presence of third molar teeth, the relationship between the bifid canals and the apical thirds of the teeth were determined according to the classification of Correr et al.[18] (Table 2). The relation between patients' gender and the presence of bifid mandibular canals was also evaluated.

Data were transferred to the SPSS software (version 18, Chicago, IL, USA) for the statistical analysis. Absolute and relative frequencies of bifid mandibular canals and their bifurcation types were determined as well as their relationship with the third molar teeth. The relation between gender and bifid canals was assessed using Chi-square test. P values ≤ 0.05 were considered to be statistically significant.

Figure 2. Arrows show a bifid mandibular canal on the right side of the mandible.

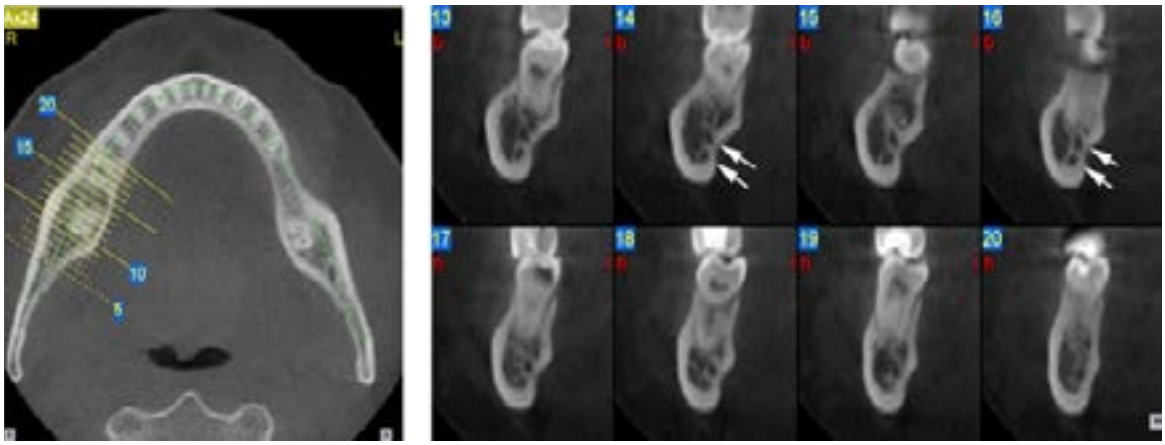


Table 1. Classification of the types of bifid mandibular canals according to Langlais et al.[11]

Type of bifurcation	description
Type 1	Unilateral bifurcation extending to the third molar or immediate surrounding area (1U)
	Bilateral bifurcation extending to the third molar or immediate surrounding area (1B)
Type 2	Unilateral bifurcation extending along the course of the main canal and rejoining it in the mandibular ramus (2UR)
	Unilateral bifurcation extending along the course of the main canal and rejoining it in the mandibular body (2UC)
	Bilateral bifurcation extending along the course of the main canal and rejoining it in the mandibular ramus (2BR)
	Bilateral bifurcation extending along the course of the main canal and rejoining it in the mandibular body (2BC)
Type 3	Combinations of types 1 and 2 (type 1 on one side of the mandible and type 2 on the other side)
Type 4	Two canals each originating from a separate mandibular foramen and then joining to form a single mandibular canal

Table 1. Types of the relation between bifid mandibular canals and the third molar teeth according to the classification of Correr et al. [18]

Type of the relation between bifid mandibular canals and the third molar teeth	Description
A	No association between the bifid canal and the apical third of the third molar teeth
B	Close proximity (but with no contact) of the bifid canal to the apical third of the third molar teeth
C	Intimate contact between the bifid canal and the apical third of the third molar teeth

Results

In the current study, CBCT images of 221 patients (129 females and 92 males) were evaluated. 6 out of the total 221 CBCT images showed BMCs. In other words, the frequency of bifid mandibular canal in our study was calculated to be 2.7%. In the cases with the detection of BMC, 4 (1.8%) were on the right side, 1 (0.45%) was on the left side, and 1 (0.45%) was bilateral. With regard to the types of bifurcation, 4 (1.8%) of the bifurcated canals were 1U type, 1 (0.45%) was 2UR type, and 1 (0.45%) was 2BC type. Considering patients' gender, 4 of the BMCs were detected in the female patients and 2 were found in males. However, the relationship between the presence of bifid canals and patients' gender was not proved to be statistically significant (Table 3). Evaluation of the anatomic relation of the bifid canals with the apical thirds of the third molar teeth revealed that 1 (0.45%) of the bifurcated canals was type "A", 4 (1.8%) were type "B" and in the one case with bilateral BMCs, the third molar teeth were absent on both right and left sides.

Table 3. Absolute and relative frequencies of the bifid mandibular canals according to the patients' genders

Presence/absence of bifid mandibular canal	sex		P value
	Female	Male	
Present	4 (3.2%)	2 (2.2%)	0.67
Absent	125 (96.8%)	90 (97.8%)	

Discussion

Prevalence of bifid mandibular canals has been by far studied by many researchers since failure to properly recognize and localize this anatomic variation could lead to a number of undesirable and hazardous complications during dental procedures.[6-7] In the present study we assessed the prevalence of bifid canals in an Iranian population using CBCT images and at the same time evaluated the types of these bifurcations as well as their anatomic relation with the apices of the mandibular third molar teeth. A wide range of frequencies has been reported for bifid mandibular canals in various studies.[4, 7-17] Table 4 summarizes a number of these studies and the obtained results for the prevalence of bifid mandibular canals. Several factors have been considered to be responsible for the relatively great variation of the incidence rate of BMC among different investigations, some of which are different inclusion criteria, different methods of evaluation, racial differences, and age variations. The lower prevalence of BMCS reported in studies on panoramic images might be due to the technical distortion of this imaging modality as well as superimposition of the adjacent structures which make the detection of fine nerve branches almost impossible in many cases.[7] However, CBCT imaging provides high resolution, distortion-free images in multiplanar views, therefor making the diagnosis of mandibular canal branches much more reliable.[7]

In the present study, the frequency of bifid mandibular canals was calculated to be 2.7%. The wide variation which exists in the prevalence of bifid canals among different studies is most likely related to the variations in the sample sizes, ethnic groups, imaging modalities used, and number and expertise of the observers. In the available literature, the only investigation we found that was previously performed on the Iranian population was that of Kalantar Motamedi et al.[5] In the mentioned study, 5000 panoramic radiographs were evaluated in terms of presence/absence of bifid mandibular canals and the prevalence of bifid canals was shown to be 1.2%. Although a much larger sample has been studied by them compared to our research, the obtained prevalence for bifid mandibular canals is nearly half the frequency value of our study. Panoramic radiography covers a broad area of the jaws; nevertheless, due to its inherent distortion and two dimensional nature, fine radiographic details could be easily missed in this imaging technique. Hence, the lower accuracy of this imaging modality for the detection of BMCS could be explained in that regard. It is noteworthy to mention that Lindh et al.[19] believe that mandibular canals are clearly visible in only 25-64% of the panoramic radiographs. A number of researchers have made classifications of the BMCs since it is believed that various types of bifurcations need different amounts of caution during dental and surgical procedures.[11,20] One of these bifidity classifications belongs to Langlais et al [11], of

which we made use in our study. We found that 66.66% of the bifid canals were type 1 (1U) and 33.32% were type 2 (16.66% 2UR and 16.66% 2BC). Types 3 and 4 of the bifid mandibular canals were not detected in our study. Langlais et al.[11] evaluated 6000 panoramic radiographs and reported that the frequency of BMCs was 38.6% for type 1, 54.4% for type 2, and 3.5% for each of the types 3 and 4. Correr et al.[18] also evaluated 75 CBCT images belonging to patients which were known to have bifid mandibular canals according to the classification of Langlais et al. [11]; they found that 72% of the bifid canals were type 1, 18.7% were type 2, 9.3% were type 3 and no cases of type 4 were detected in their study. It is clearly perceived that in the both mentioned studies the prevalence of types 3 and 4 of BMCs is far less than the types 1 and 2, a finding similar to the results of our study. With regard to the sex distribution of the patients, 4 of the BMCs in our study belonged to women and 2 belonged to men which was not a statistically significant difference based on the Chi-square test (P value = 0.67). Similarly, Kalantar Motamedi et al.[5] and Kang et al.[17] did not find significant differences among female and male patients regarding the presence/absence of BMCs. Considering the location of the BMCs in relation to the apical thirds of the adjacent third molar teeth, we used the classification previously developed by Correr et al.[18] In this regard, 16.66% of the bifid canals were type A, 66.66% were type B and 16.66% were related to a case with bilateral absence of the third molar teeth. Correr et al.[18] performed their investigation on CBCT images of 75 patients with BMCs. They showed that 19% of the cases were type A, 31% were type B and 50% of the bifid canals were type C based on their anatomic relation with the third molar teeth.

Table 4. Summary of a number of studies performed on the prevalence of bifid mandibular canals in various populations

	Number of cases studied	Imaging modality used	Frequency of bifid mandibular canals
Nortje et al [8]	3612	Panoramic	0.9%
Durst and Snow [9]	1024	Panoramic	8.3%
Grover and Lorton[10]	5000	Panoramic	0.08%
Langlais et al [11]	6000	Panoramic	0.95%
Zografos et al [12]	700	Panoramic	0.4%
Sanchis et al [13]	2012	Panoramic	0.35%
Shen et al [14]	327	CT and CBCT	58.4%
Villaca Carvalho et al [4]	300	CT	67.26%
Rashuren et al [15]	500	CBCT	22.6%
Fu et al [16]	173	CT	30.6%
Muinelo-Lorenzo et al [7]	225	CBCT	36.8%
Kang et al [17]	1933	CBCT	10.2%

Conclusion

Considering the frequency value of 2.7% obtained for BMCs in the present study, it seems that this anatomic variation of the mandibular canal is not such a worrisome issue in the Iranian population; however, careful inspection of the CBCT images taken for various clinical purposes is advised in order to avoid the complications associated with unrecognized BMCs. Further studies with larger sample sizes and different age groups are also suggested for achieving more detailed information regarding the BMCs in the Iranian population.

Conflict of Interest

Authors declare no conflicts of interest.

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