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An Analysis of the Anatomy, Variations, and Classification of the Mandibular Canal in Panoramic Radiographs: A Retrospective Study in Population Visiting Outpatient Department

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Abstract

Purpose: This study aimed to evaluate the morphology and variations of the inferior alveolar canal using Orthopantomogram (OPG) and the distribution of variations by gender and classification. **Methods:** 300 panoramic radiographs were analysed for the Bifid Mandibular Canal (BMC). A Microsoft Excel spreadsheet was made, and the information was entered based on the BMC classification, patient age, gender, number of normal mandibular canals, the number of variations (A: lower, B: mesial, C: alveolar, D: retromolar), and the side on which the mandibular canal variation is present. The data was analysed using SPSS v. 23. **Results:** The prevalence of bifid mandibular canal was 10%, and the females showed a higher prevalence than males. The bifid mandibular canal showed more prevalence on the left side, and the most common variation that was found was Class B [Mesial side]. **Conclusion:** To prevent difficulties following surgery, panoramic radiographs are advised for a thorough assessment and identification of the bifid mandibular canals prior to any surgical treatments.

Keywords: Bifid Mandibular Canal, Orthopantomogram, Panoramic Radiographs

1. Introduction

As the name implies, mandibular canals are anatomical features found in the mandible. Bilateral mandibular canals go from the mandibular foramen to the mental foramen in their anatomical sequence. The arteries, veins, and inferior alveolar nerves are carried by these canals[1]. The mandibular canals have a defined anatomical position and content, however, there are a number of anatomical variances in the canal's structure and course. These variants frequently include anterior loops of the mental nerve and bifid mandibular canals. When executing surgical operations affecting the region of the jaw that is home to the mandibular canal, these anatomical variances are crucial. During operations on the jaw, the neurovascular bundle may be severed[2].

The mandibular canals are often one continuous structure[3]. Nonetheless, these canals can exhibit different anatomical differences in different people, such as bifid canal, form variation (oval, round, or pear-shaped), anterior loop, bifurcation in the retromolar canal, etc. If these differences are not noted during the preoperative evaluation of the mandibular regions, they may result in a number of difficulties during the surgical and recovery phases[4].

The inferior alveolar nerve and associated veins conduction via the inferior alveolar canal. According to histological investigations, the mandibular nerve normally follows a primary course, with branches that extend down the jaw to the apicals of the teeth.[5] The associated nerve has numerous minor branches that form various versions of the inferior alveolar canal,

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roughly parallel to the main canal[5-7]. Imaging techniques utilised to visualise the morphology and variations of the inferior alveolar canal include panoramic radiography (OPG), Computed Tomography (CT), and Cone-Beam Computed Tomography (CBCT)[7]. Numerous studies used panoramic radiography to examine the inferior alveolar canal and its variations to classify patients.

The mandibular canal is seen on radiography as a tube-shaped passageway encircled by two radiopaque lines beneath mylohyoid lines[8]. The term "bifid" refers to the existence of an auxiliary canal. Dentists should be aware of the existence of bifid since it is uncommon in the general population. This will help to prevent future issues during and after surgical operations and implant placement. Studies on the topography of the mandible and its variations have become increasingly important in recent years due to the rise in complication rates, particularly with the use of implant applications. The reasons for unexpected nerve branch damage during local anaesthetic application and surgical procedures can be attributed to variations in the inferior alveolar canal.

Furthermore, due to the increased number of osteotomies and other reconstructive procedures, alterations in the inferior alveolar nerve's course may be important for microsurgical anastomoses of the injured mandibular nerve[7,8]. The purpose of this study was to assess the inferior alveolar canal's morphology and variations using OPG as well as the variations' distribution in terms of gender, and classification.

2. Materials and Method

The sample size was calculated based on a study by Dumanlı *et al.*[9] Three hundred OPGs from patients who had attended the KD Dental College and Hospital, Mathura during the previous three years made up the sample for the retrospective analysis. The study comprised appropriately documented radiographs as well as OPGs from patients of both genders who were above 14 years old. Radiographs that were incorrectly recorded, radiographs of patients who had extractions, implants, osteotomies, orthognathic surgeries, orthodontic treatment, reconstructive surgeries, and radiographs with pathologies like cysts and fractures were all excluded from the OPGs. The excluded radiographs included misrepresentations of the tissue structures created by imaging techniques.

The Carestream 8100 device (exposure time 14.1 seconds at 64 KVp and 8 mA) was used to record OPG. From the included OPG, the mandibular canal's morphology and its deviations were noted (Figures 1, 2). A Microsoft Excel spreadsheet was used to record the information based on the patient's age and sex, the number of normal canals, and the number of variations (A: lower, B: mesial, C: alveolar, D: retromolar) based on classification by Freitas *et al.*[10], and the side on which the mandibular canal variation is present. The direction of the split mandibular canal determined the categorization provided by Freitas *et al.*[10] Classes A, B, C, and D are the lower, mesial, alveolar, and retromolar directions, respectively.

The data analysis was done using SPSS version 23 (IBM, Chicago). The percentage frequency of the mandibular canal subtypes discerned in orthopantomograms (OPGs) was computed while considering variables such as age, sex, and the side of BMC (left or right). The classification proposed by Freitas *et al.*[10], along with sex and the localization of BMC presence (right/left and unilateral/bilateral), were used to characterize both absolute and relative frequencies. Employing the Chi-square test, the association between the presence of a bifurcated canal and sex was analyzed, in addition to investigating the correlations among the various sites of bifurcated canals.

3. Results

A sample of n=300 OPGs was analyzed for the bifid mandibular canal, the Bifid mandibular canal was present in 30 OPGs of the study population (10%; 14 males and 16 females) (Table 1). Based on analysis of the position of BMC, it was found that out of 30 bifid mandibular canal cases, 11 were on the right, 14 were on the left, and 5 had BMC on both sides. It was found that in the males and females, the majority of the BMC was on the left side, however, no significant difference was found (Table 2).

Based on the analysis of the distribution of BMC and according to the classification by Frietas *et al.*[10], it was found that the class B mesial direction was more prevalent among all the classes. Among right, left and bilateral positions, it was found that class B was prevalent (Table 3, Figure 3). It was also found that the Class B mesial direction was more prevalent among both genders (Table 4).



Figure 1. BMC orientation toward the alveolar area is classified as a Freitas Class C subtype.



Figure 2. The direction of the BMC toward the lower aspect of the mandibular canal is classified as the Class A Lower direction.

Table 1. Descriptive statistics depicting the prevalence of bifid mandibular canal (BMC) among genders

Gender	Total OPG		BMC Present	
	Count	N%	Count	N %
Male	104	34.7%	14	46.7%
Female	196	65.3%	16	53.3%
Total	300	100%	30	100.0%

4. Discussion

The identification of several varieties of mandibular canal variations in recent research has implications for implant placement, autogenous graft procedures, and orthognathic surgical treatment planning in the affected area. The identification of several varieties of mandibular canal variations in recent research has implications for

Table 2. Descriptive statistics depicting the position of bifid mandibular canal among genders

Gender	Position of bifid mandibular canal						p-value
	Right		Left		Both		
	Count	N %	Count	N %	Count	N %	
Male	5	35.7%	6	42.9%	3	21.4%	0.800
Female	6	37.5%	8	50.0%	2	12.5%	
Total	11	36.7%	14	46.7%	5	16.7%	

Table 3. Distribution of various types and positions of bifid mandibular canal (Based on classification by Freitas *et al.*[10])

BMC classification	Position							
	Right		Left		Both		Total	
	Count	N %	Count	N %	Count	N %	Count	N %
Class A Lower	2	50.0%	2	50.0%	0	0.0%	4	100.0%
Class B Mesial	8	42.1%	7	36.8%	4	21.1%	19	100.0%
Class C Alveolar	1	20.0%	3	60.0%	1	20.0%	5	100.0%
Class D Retromolar	0	0.0%	2	100.0%	0	0.0%	2	100.0%
Total	11	36.7%	14	46.7%	5	16.7%	30	100.0%

Table 4. Descriptive statistics depicting the distribution of various types of bifid mandibular canals among genders

Gender	BMC_Classification (Freitas *et al.*[10])									
	Class A Lower		Class B Mesial		Class C Alveolar		Class D Retromolar		Total	
	Count	N %	Count	N %	Count	N %	Count	N %	Count	N %
Male	2	14.3%	8	57.1%	4	28.6%	0	0.0%	14	100.0%
Female	2	12.5%	11	68.8%	1	6.3%	2	12.5%	16	100.0%
Total	4	13.3%	19	63.3%	5	16.7%	2	6.7%	30	100.0%

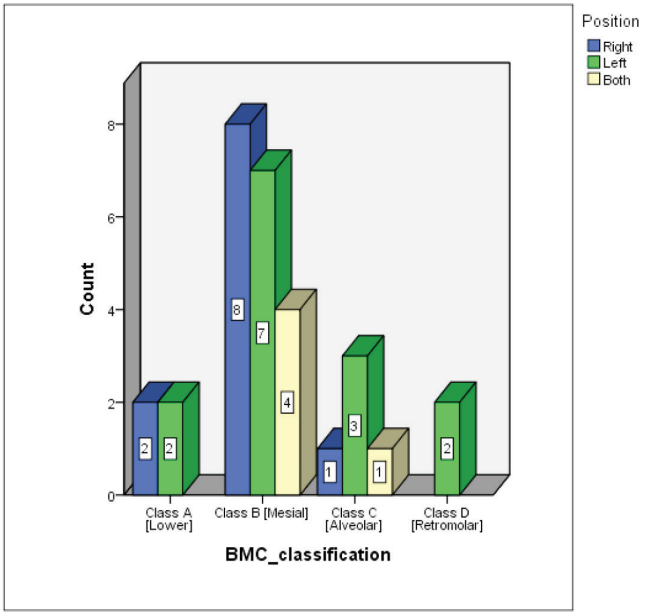


Figure 3. Distribution of various types and positions of the bifid mandibular canal.

implant placement, autogenous graft procedures, and orthognathic surgical treatment planning in the affected area. Computed tomography, CBCT, and panoramic radiography can all be used to view the mandibular canal. According to Thakur *et al.*[11], OPGs are a valid aid for the evaluation of mandibular canal and correlated variations. To offer patients the best care possible and to avoid difficulties before and after surgical procedures, doctors must be able to identify differences in the inferior alveolar canal.

When Naitoh *et al.*[12] looked into inferior alveolar canal variants in Japanese patients ranging in age from 17 to 78, they found that 79 (64.8%) of the patients had a bifid mandibular canal. 161 (66.5%) out of 242 patients had a bifid inferior alveolar canal, according to Orhan *et al.*[13], the conclusions of this research differ from those of our study. In 1933, individuals ranging in age from 13 to 93 years were studied by Kang *et al.*[14] to determine the distribution and structure of the bifid inferior alveolar canal. 198 individuals (10.2%) in 1933 had the bifid inferior alveolar canal identified. They stated that the most prevalent form of bifid canal is the retromolar canal (52.5%). When compared to the findings of our study, the prevalence of the bifid canal was comparable in this investigation. Furthermore, in our analysis, the mesial canal variation was the most prevalent canal variation.

The research by Manfron *et al.*[15] found no differences between the left and right sides. Lima *et al.*[16] reported that the bifurcated canal was located on the right side and that female inclination was present. Only 1.2% of BMC cases were reported by Kalantar Motamedi *et al.*[17], and there was no correlation between BMC and gender or age. In comparison to our investigation, Sonneveld *et al.*[18]

reported a lower prevalence rate (1.3%) of BMC with a preference for females.

Every variation in the canal was noted in every location—left, right, and bilateral—in our investigation. Even though class B the mesial side was the most prevalent kind and had a left-sided inclination, and females were more prevalent of BMC's, there was no significant difference.

Eliades *et al.*[19] states that because dental implants are more likely to sustain damage during surgical procedures, the mandibular canal and its contents are crucial for both small and large operations. Nerve damage and undetected haemorrhage are potential obstacles. As a result, the surgeon has to be aware of the mandible's bifurcated canals.

5. Conclusion

- The present study suggests that panoramic radiographs are a reliable tool for the assessment of the mandibular canal and associated anatomical variations associated with it.
- Furthermore, panoramic radiographs are suggested for detailed evaluation and identification of bifid mandibular canals before any surgical procedures to avoid postoperative complications.
- However, the present study had few limitations as conventional radiography to properly show these anatomical variations as compared to CT and CBCT.
- Furthermore, the study had a smaller sample size about a particular geographical area.

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