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Retrospective Evaluation Of Mandibular Canal Anatomy And Variations By Cone-Beam Computed Tomography

Mandibular Kanal Anatomisi Ve Varyasyonlarının Konik Işınlı Bilgisayarlı Tomografi İle Retrospektif Değerlendirilmesi

ABSTRACT

Objective: Determining the anatomical localization and variations of the inferior alveolar canal is significant in determining the treatment method to be preferred during the treatment of the patient and having an idea before surgery for possible complications. The present study aimed to determine the anatomy and varieties of the inferior alveolar canal using cone-beam computed tomography (CBCT).

Materials and Method: CBCT images obtained from 300 patients, 168 of whom were female and 132 male, were assessed. The examined inferior alveolar canals were divided into four groups. These were retromolar, anterior canal, dental and buccolingual canals. Statistical analyses of the results were performed using descriptive statistics and chi-square tests.

Results: Bifid canal was detected in 149 (49.2 %) of the patients. 73 (48.99 %) of bifid canals were detected on the right side and 76 (51 %) on the left side. No trifid canals were observed in the evaluated data set. The presence of mandibular canal variation was not associated with gender or age (p> 0.005). When the right-left distribution of the canal variations was assessed, there was no statistically significant (p> 0.005).

Conclusion: Anterior canal (35.6 %) was the most common variation, followed by the retromolar canal (28.2 %), dental canal (25.6 %) and buccolingual canal (10.7 %). According to the results obtained, the possibility of approximately 50% mandibular canal variation should be considered in prosthetic and surgical treatment interventions planned in the relevant regions.

Key Words: Bifid Mandibular Canal, Cone-Beam Computed Tomography, Variation.

ÖZ

Amaç: Mandibular kanalın anatomik lokalizasyonunu ve varyasyonlarını tespit etmek, hastanın tedavisi esnasında tercih edilecek tedavi yöntemini belirlemede ve olası komplikasyonlar için cerrahi öncesinde fikir sahibi olmada büyük bir öneme sahiptir. Bu çalışmada mandibular kanal anatomisini ve varyasyonlarını Konik Işınlı Bilgisayarlı Tomografi(KIBT) kullanarak değerlendirmek amaçlandı.

Gereç ve Yöntemler: 168'i kadın 132'si erkek toplam 300 hastaya ait 300 yarım çeneden elde edilmiş KIBT görüntüleri kullanıldı. İncelenen mandibular kanallar retromolar, ön kanal, dental ve bukkolingual kanal olmak üzere dört gruba ayrıldı. Verilerin istatistiksel analizi tanımlayıcı istatistik ve ki-kare testleri kullanılarak yapıldı.

Bulgular: Hastaların 149(% 49,2)' unda bifid kanal saptanırken trifid kanal saptanmadı. Bifid kanalların 73(%48,99)'ü sağda, 76(% 50, 01)'sı solda tespit edildi. Hastalarda yaş ve cinsiyet ile mandibular kanal varyasyonu varlığının ilişkisine bakıldığında ki-kare testine göre istatistiksel olarak anlamlı bir sonuç bulunamamıştır. Çalışmada değerlendirilen kanal varyasyonlarının hastalarda sağ sol dağılımı incelendiğinde istatistiksel olarak anlamlı bir ilişki görülmedi (p>0.005) (p=0.688).

Sonuç: İncelenen mandibular kanallarda varyasyon görülme prevelansı %49,66 olarak bulundu. En çok ön kanal(%35,6) daha sonra sırasıyla retromolar kanal(%28,2), dental kanal(%25,6) ve bukkolingual kanal(%10,7) gözlendi. Elde edilen sonuçlara göre ilgili bölgelerde yapılması planlanan protetik ve cerrahi tedavi girişimlerinde yüzde 50'ye yakın mandibular kanal varyasyonu görülme ihtimali göz önüne alınmalıdır.

Anahtar Kelimeler: Bifid Mandibular Kanal, Konik Işınlı Bilgisayarlı Tomografi, Varyasyon.

Didem DUMANLI[1]
ORCID: 0000-0001-7409-8096

Gediz GEDUK[1]
ORCID: 0000-0002-9650-2149

Çiğdem ŞEKER[1]
ORCID: 0000-0001-8984-1241

[1]Zonguldak Bülent Ecevit University,
Faculty of Dentistry,
Dentomaxillofacial Radiology Department,
Zonguldak, Türkiye

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İletişim Adresi/*Corresponding Adress:*
Didem DUMANLI,
Zonguldak Bülent Ecevit University,
Faculty of Dentistry,
Dentomaxillofacial Radiology Department,
Zonguldak, Türkiye
E-posta/e-mail: didem.dumanli@hotmail.com

INTRODUCTION

The inferior alveolar canal provides the conduction of the inferior alveolar nerve and related vessels. Histological studies have shown that the mandibular nerve typically follows a major path with branches extending along the mandible to the apicals of the teeth. (1) There are multiple smaller branches of the related nerve approximately parallel to the main canal, these branches form many variations of the inferior alveolar canal (1-3).

Panoramic radiography, CBCT and computed tomography (CT) are used to visualize the anatomy and varieties of the inferior alveolar canal (2). In many studies, classifications were made by examining the inferior alveolar canal and its varieties using panoramic radiographs. Naitoh et al. determined that CBCT was more successful in imaging the inferior alveolar canal and its varieties and used their classification. The classification made by Naitoh et al. (4) has been used in most of the studies to the present day and improvements have been made to it. In recent years, as a result of the increase in complication rates, especially with the widespread use of implant applications, studies on mandibular canal topography and especially its variations have gained great importance.

Variesties of the inferior alveolar canal can account for the causes of the unexpected damage of nerve branches during the application of local anesthesia and surgical operations. In addition, variations in the path of the inferior alveolar nerve may be significant for microsurgical anastomoses of the damaged mandibular nerve as a result of the increased number of osteotomies and other reconstructive operations (3,4).

This study aimed to evaluate the anatomy and variations of the inferior alveolar canal using CBCT and the distribution of inferior alveolar canal variations in age, gender, and jaws.

MATERIAL AND METHODS

All patients' CBCT images, who applied to Zonguldak Bülent Ecevit University between 2021 and 2022 years, were retrospectively examined. The images included in the study were obtained with Veraviewepocs 3D R100 (J Morita, Japan) tomography device using 90 kVp 3mA and 0.125 mm^3 voxel size in 8x10 cm FOV area. In the selected images, all sections taken in the axial, cross-sectional and sagittal planes were examined.

Patients were selected according to certain exclusion and inclusion criteria (registrations of individuals with pathological formations such as cysts, tumors, impacted teeth, and besides image artifacts were excluded.).

CBCT images were evaluated for the presence or absence of a bifid canal and after that, the evaluated canals were divided into 4 main groups based on Naitoh et al.'s (4) classification; retromolar, anterior, dental, and buccolingual canals. Anterior canals were divided into two subtypes as with and without confluence, dental canals were divided into 1st molar, 2nd molar and 3rd molar canals according to the region they split into, and buccolingual canals were divided into two subtypes as buccal and lingual canals (Figure 1). And also, evaluated the distribution of inferior alveolar canal variation by age, gender, and jaws.

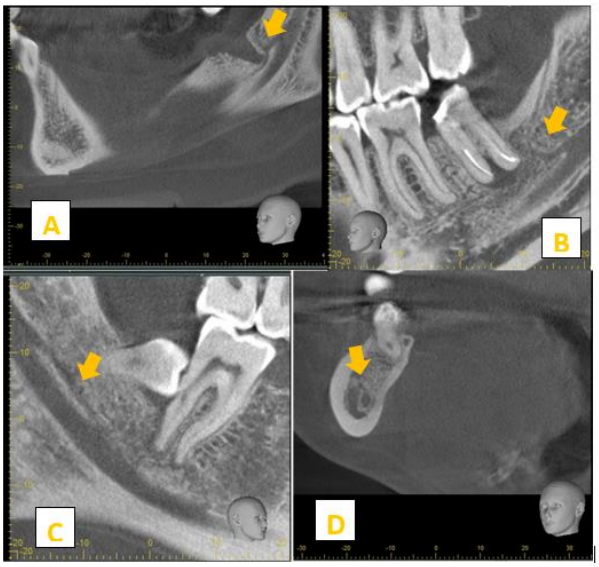

Figure 1. : Retromolar Canal, B: Dental Canal, C: Anterior Canal, D: Buccolingual Canal

The classification made by Naitoh et al.(4) in 2009 is as follows:

Retromolar canal (Type I): It is the type that was described when the foramen of the canal was observed on the bone surface of the retromolar region.

Dental canal (Type III): It is the type classified when the end of the canal reached the root apex of the molar teeth.

Forward canal (Type III): It is the type of canal rising from the upper wall of the inferior alveolar canal. There are two types of variations of the forward canal; with/without confluence to the main mandibular canal.

1. Without confluence: It is the anterior canal that bifurcated from the main mandibular canal in the mandibular ramus region and coursed forward to the second molar region.

2. With confluence: This type of anterior canal is bifurcated from the inferior alveolar canal, coursed anteriorly, and then joined up with the main inferior alveolar canal.

Buccolingual canal (Type IV): It is the canal arising from the buccal or lingual wall of the main mandibular canal. There are two types of variations of the buccolingual canal.

1. Buccal canal: It is the type of canal that bifurcated from the inferior alveolar canal in the mandibular ramus, coursed to the buccoinferior.

2. Lingual canal: It is the type of canal that is bifurcated from the inferior alveolar canal in the mandibular ramus, coursed lingually, and then perforated through the lingual cortical bone (4).

Statistical analyses of the data set were performed using descriptive statistics and chi-square tests. SPSS 22.0 Software Package Program (SPSS 22.0 Software Package Program, Inc. Chicago, IL, USA) was used as statistical software in the study.

RESULTS

CBCT images obtained from 300 patients, 168 female and 132 male, aged between 18-75 were used. The mean age of the patients included in the study was 39.3. The Bifid canal was observed in a total of 149 (49.2 %) patients, 84 (56.3 %) of whom were female and 65 (43.7 %) male, while the trifid canal was not observed. 73 (48.99 %) of bifid canals were detected on the right side and 76 (51 %) on the left side.

The anterior canal (35.6 %) was the most frequently observed, that was followed by the retromolar canal (28.2 %), dental canal (25.6 %), and buccolingual canal (10.7 %), respectively. The most prevalent subtype of dental canal was the type that reached the level of the 3rd molar tooth, the most common type of anterior canal is the with confluence subtype, and the most common type of buccolingual canal is the lingual canal subtype (Table 1). Age ranges, in order to examine the relationship between age and mandibular canal variation, were divided into 3 groups; 18-25 ages, 26-50 ages, and 51-75 ages. Of 149 bifid canals, 57 (48.7%) were observed in the 18-25 age range, 55 (51.4 percent) were in the 26-50 age range, and 37 (48.7%) were in the 51-75 age range. Considering the relationship between age/gender and the presence of inferior alveolar canal variation, no statistically significant result was found. (p= 0.385) When the right-left distribution of the canal variations was assessed, there was no statistically significant. (p= 0.688) (Table 2, 3).

Mandibular canal variation relationship with different decades									
Decades	**Canal variations**								
	Retromolar Canal	**Dental canal 1st molar**	**Dental canal 2nd molar**	**Dental canal 3rd molar**	**Anterior Canal Without confluence type**	**Anterior Canal With confluence type**	**Buccolingual Canal Buccal type**	**Buccolingual Canal Lingual type**	**Total Bifid Canal**
18-25 ages	20	3	4	4	9	10	2	5	57
	17.1 %	2.6 %	3.4 %	3.4 %	7.7 %	8.5 %	1.7 %	4.3 %	48.7 %
26-50 ages	13	3	5	7	9	11	4	3	55
	12.1 %	2.8 %	4.7 %	6.5 %	8.4 %	10.3 %	3.7 %	2.8 %	51.4 %
51-75 ages	9	1	3	8	3	11	1	1	37
	11.8 %	1.3 %	3.9 %	10.5 %	3.9 %	14.5%	1.3 %	1.3 %	48.7 %

Table 1: Mandibular canal variation relationship with different decades.

Relationship between gender with variation subtypes										
		Canal variations								Total
		Retro molar Canal	Dental canal 1st molar aligment	Dental canal 2nd molar	Dental canal 3rd molar	Anterior Canal Without confluence type	Anterior Canal With confluence type	Bucco lingual Canal Buccal type	Bucco lingual Canal Lingual type	
Gender	**Female**	26	2	7	8	9	22	5	5	168
		15,5%	1,2%	4,2%	4,8%	5,4%	13,1%	3,0%	3,0%	100,0 %
	Male	16	5	5	11	12	10	2	4	132
		12,1%	3,8%	3,8%	8,3%	9,1%	7,6%	1,5%	3,0%	100,0 %
Total		42	7	12	19	21	32	7	9	300
		14,0%	2,3%	4,0%	6,3%	7,0%	10,7%	2,3%	3,0%	100,0 %

Table 2: Relationship between gender with variation subtypes.

Relationship between distribution with variation subtypes										
		Canal variations								Total
		Retro molar Canal	Dental canal 1st molar	Dental canal 2nd molar	Dental canal 3rd molar	Anterior Canal Without confluence type	Anterior Canal With confluence type	Bucco lingual Canal Buccal type	Bucco lingual Canal Lingual type	
Distribution	**Right site**	18	4	7	10	13	12	4	5	73
		24,7%	5,5%	9,6%	13,7 %	17,8%	16,4%	5,5%	6,8%	100,0 %
	Left site	24	3	5	9	8	20	3	4	76
		31,6%	3,9%	6,6%	11,8 %	10,5%	26,3%	3,9%	5,3%	100,0 %
Total		42	7	12	19	21	32	7	9	149
		28,2%	4,7%	8,1%	12,8 %	14,1%	21,5%	4,7%	6,0%	100,0 %

Table 3: Relationship between distribution with variation subtypes.

DISCUSSION

The fact that many types of mandibular canal variations have been detected in recent studies affects implant planning, autogenous graft operations and orthognathic surgical treatment planning in the relevant region.

The fact that many types of mandibular canal variations have been detected in recent studies affects implant planning, autogenous graft operations, and orthognathic surgical treatment planning in the relevant region. The mandibular canal can be visualized with panoramic radiography, CBCT, and Computed Tomography. It has been reported that thin radiopaque lines may give imaging errors on panoramic radiographs. Dense trabeculation around the mandibular canal on panoramic radiography can also cause false interpretations (4,5). Detection of inferior alveolar canal variations is important for

clinicians to prevent complications that may occur during and after surgical operations and to give the most appropriate treatment to patients.

Inferior alveolar canal anatomy and variations have been evaluated by CBCT in prevalence studies by many researchers, which have studied patient groups with different demographic characteristics. In these studies, the patients were generally examined in 3 different groups according to the age range.

Naitoh et al., in 2009, examined inferior alveolar canal variations in patients aged 17-78 years in the Japanese population, which reported the presence of a bifid mandibular canal in 79 patients (64.8 %). They reported the most common canal variation was the forward canal (44.3%), followed by the retromolar canal (25.4%), the dental canal (7.4%), and the buccolingual canal (1.6%), respectively. They declared that the forward canal without confluence (63 %) is more common than with confluence type (5%). The most common dental canal was the type that reaches the level of the third molars (4).

Orhan et al. reported the presence of bifid inferior alveolar canal in 161 (66.5 %) of 242 patients on 242 patients whose ages ranged from 17 to 83. They reported 225 (46.5 %) bifid canals in a total of 484 half mandibles. They reported the anterior canal (17.8 %) as the most widespread version of bifid inferior alveolar canal. The type of anterior canal that without confluence was determined more frequently than the type that with confluence. Of the buccolingual canal type, the lingual canal was detected more frequently than the buccal canal. The most common type of dental canal is the one that reaches the level of the third molar (5). These studies show similar results to our study, but the anterior canal type was observed as the most common "with confluence" type in our study.

Kang et al. evaluated the bifid inferior alveolar canal distribution and configuration in 1933 patients aged 13-93 years in their research. The bifid inferior alveolar canal was detected in 198 (10.2 %) of 1933 patients. They reported that the retromolar canal (52.5 %) is the most common bifid canal type. They found that the type of anterior canal that without confluence is more common (6). In this study, the prevalence of the bifid canal was quite low compared to the results of our study. In addition, the most common canal variation was the anterior canal in our study.

Rashsuren et al. reported the prevalence of bifid canals as 22.6 %. They declared the most frequent canal type is the retromolar canal (71.3%), followed dental canal (18.8 %), trifid canal (5.8 %), and anterior canal (4.1 %). They reported that the type of anterior canal that with confluence subtype is more than without confluence subtype. They reported that no case related to buccolingual canal type was encountered (7). When the results of our study are compared with the results of this study, trifid canal was not detected in our study and the most prevlent canal variation was an anterior canal. Similarly, the most common anterior canal type was the with confluence.

In the study of Serindere et al., bifid inferior alveolar canal was observed in 61 (3.05%) of CBCT sections. They found that the most common type of bifid canal is the retromolar canal (8). In the study of Okumuş et al., inferior alveolar canal prevalence was declared 40%. The anterior canal was found to be the most common variation type (48.8 %), followed by retromolar canal (26.2 %), dental canal (12.9 %), buccolingual canal (9.7 %) and trifid canal (2.4 %) (9). Elnadoury et al. used CBCT images obtained from 530 half jaws of 278 patients in the study in 2022. Bifid canals were determined in 181 canals (34 %) and trifid canals in 46 canals (8.7 %) (10).

While the prevalence of bifid canals was quite low in one of the studies, the prevalence in the other two studies was similar to that of our study. This was thought to be due to the size of the selected sample and the fact that it belonged to patients from different regions.

CONCLUSION

The possibility of mandibular canal variation should be considered in prosthetic and surgical treatment interventions planned in the relevant regions. Failure of anesthesia is the most widespread cause in patients with bifid inferior alveolar canals. Since there is a second neurovascular bundle in the bifid canal, complications such as paresthesia and bleeding may occur because this variation cannot be diagnosed. Other surgical methods such as mandibular osteotomy become more complicated in the presence of a second neurovascular bundle. On the other hand, the retromolar area is frequently used as a donor site, retromolar canals may pose a risk when a bone-block is to be taken. Therefore, before surgery CBCT section might be needed for the safe removal of the bone-block from this area, and if there is mandibular canal variation in the evaluated tomography images, it must be included in the radiological reporting.

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