Evaluation of mandibular incisive canal and mental foramen in Turkish population by conical beam computed tomography

Neslihan Yuzbasıoglu[1], Selva Sen[1], H. Emir Yuzbasioglu[2,3], B. Ufuk Sakul[1]

[1] *İstanbul Medipol University, School of Medicine, Department of Anatomy, İstanbul, Turkey*

[2] *Bahcesehir University, Faculty of Dentistry, İstanbul, Turkey*

[3] *BAU International University, Department of Dentistry, Faculty of Medicine, Batumi, Georgia*

SUMMARY

Surgical complications may occur in the interforaminal area when course and morphological features of anatomical structures, which includes neurovascular structures in the mandible, cannot be defined correctly. The aim of this study is to determine the course and morphological characteristics of the mental foramen (MF) and the mandibular incisive canal (MIC) in Turkish society. Cone Beam Computed Tomography (CBCT) is considered the gold standard for dental imaging; therefore, in this study 96 CBCT images were examined retrospectively. The width and the length of the MF, distance from the MF to the alveolar bone crest, lower border of the mandible, angulation of mental canal to buccal bone surface, the length of the MIC, the angle among mental foramen-incisive canal and a horizontal plane parallel to the inferior border of the mandible, and the height of the angle were measured. At the endmost point of the MIC, the distance between the canal and inferior, labial, and lingual borders of the mandible was measured. The most common locations of MF were along the second premolar (23.4%). MIC was absent in 24.4% of the cases. The most common locations of the endmost point of MIC were along the first incisive (35.8%), MIC length was significantly longer in males. Although the structures show variation among individuals, the mean values in Turkish society are similar to the mean values in the literature.

Key words: Mandibular incisive canal – Mental foramen – Anatomy – CBCT – Surgery

INTRODUCTION

The mandible is an important anatomical structure which is associated with dental anesthesia, implant treatment, and reconstructive procedures in dentistry. The mandible is the only movable bone of the facial skeleton and houses inferior teeth. Neurovascular structures course within the canals and foramina of the mandible and reach the target structure or area. Because of this, the anatomical structures of the mandible itself and related to the mandible must be taken into consideration during dental and surgical procedures.

Corresponding author:
Neslihan Yüzbasıoglu. Department of Anatomy, İstanbul Medipol University, Göztepe Neighborhood, Ataturk Street. No. 40, Beykoz- Kavacık, İstanbul, Turkey. Phone: 00 90 212 4534854; Fax: 00 90 212 5317555. E-mail: ncankara@medipol.edu.tr

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The inferior alveolar nerve (IAN) which innervates the inferior teeth is within the mandibular canal. It begins from the mandibular foramen, which is located on the medial surface of the mandibular ramus, then it travels downwards obliquely within the ramus and finally courses anteriorly through the mental foramen (MF) (Haas et al., 2016; Juodzbalys et al., 2010). The mandibular canal bifurcates into the mental canal and the mandibular incisive canal (MIC) after just passing the mental foramen. These canals contain the terminal branches of the inferior alveolar nerve and accompanying vessels (Polland et al., 2001). MIC is the continuation of the mandibular canal within the body of the mandible towards the median plane or mesially (Polland et al., 2001). It begins from the MF, and the incisive nerve and vessels which travel within the MIC reach the anteriorly located teeth (2 incisives and 1 canine) (Pereira-Maciel et al., 2015; Polland et al., 2001). As to the mental canal, it provides the mental nerve and accompanying vessels passing through the superficially located mental area on the face via the mental foramen of the mandible (Polland et al., 2001). The prevalence, size and location of the MIC may be different between races (Apostolakis and Brown, 2012; Kuzmanovic et al., 2003; Li et al., 2013; Ramesh et al., 2015).

The area between two mental foramina is known as the interforaminal area. And this region is accepted as a safe zone for surgical procedures. Also, this region is an ideal site for chin block bone grafting, due to its ideal bone quality and distance from the IAN in comparison to the posterior mandible. The precise location of the bifurcation of the IAN is variational (Caughey et al., n.d.). Any edema, hematoma, infection, traction or compression of the nerve that may occur in this region may cause damage. And the damage of the inferior alveolar nerve and accompanying vessels may cause pain and loss of sensation on the anterior teeth, lips, skin and mucosa (Alyami et al., 2021; Khan et al., 2011; Worthington, 2004). Therefore, the presence, location, dimensions, and direction of the MIC should be elicited when placing implants, planning for the biopsy or removal of any pathology present in the anterior mandible (Caughey et al., n.d.).

Radiological imaging methods guide physicians in determining locations of anatomical structures and density of bone mass. Today, cone beam computed tomography (CBCT) images are frequently referenced by dentists and surgeons in the evaluation of pre-op structures (Phillips et al., 1990; Zhang et al., 2017). Studies in the literature report that the canals within the mandible on CBCT images show high visibility (de Brito et al., 2016).

A detailed anatomical study of the interforaminal region is significant to avoid complications (Tejada et al., 2022). Also, MF has been used as an important landmark for implant surgery, and many variations in these area have been reported (Alshamrani et al., 2021; Wong and Patil, 2018). Surgical complications related to implant surgery in the interforaminal area are likely to be related to failure of the anatomical identification of MF and MIC (Choi et al., 2019). Knowing variation, course and distances between dental roots and morphological features related to canals within the mandible is very important to prevent complications and achieve success during surgery. Because of this, this study aimed to determine the detailed features of these abovementioned canals in the Turkish population.

MATERIALS AND METHODS

This study was approved by the institutional ethics committee. The study was designed as a retrospective analysis of 346 CBCT images taken in a private clinic. All images were taken by the same technician, following a standardized protocol for patient positioning and exposure parameter setting. Some of the cases were eliminated. 185 of the images were not in the proper format, 40 images were poor in quality and 25 images were not in the appropriate age range. In the remaining 96 images (46 female, 50 males, 21-80 ages), the following measurements were performed on a total of 192 hemi-mandible with the Osirix MD software:

1. The visibility of mental foramen was noted as poor, medium, good
2. In the axial view, the width of MF (MF width) (Fig. 1).
3. In the sagittal view, the position of the MF related to the long axis of the adjacent teeth was de-

Fig. 1.- In the axial view, the width of mental foramen (MF width).

termined and the longitudinal length of mental foramen (MF length) was measured (Fig. 2).

4. In the coronal view, as in the study of Von Arx et al. (2013), distance from the superior margin of MF to the alveolar bone crest (MF alveolar crest), distance from the inferior margin of MF to lower border of the mandible (MF mand. border), angulation of mental canal to buccal bone surface (MF-MC angle) were measured (Fig. 3).
5. The visibility of the MIC was noted as none, poor, medium, good.
6. The length of mandibular incisive canal (MIC length) was measured (Fig. 4).
7. A line was drawn from the mental foramen to the endmost point of the MIC. Another line was drawn parallel to the inferior border of the mandible from the endmost point of the MIC. The angle (MF-MIC angle) and distance between these two lines (Angle height) were measured (Fig 5).
8. As in the study of Panjnoush et al. (2016) at the endmost point of the MIC in the last cross-sectional plane, the distance between the canal and inferior (MIC-mand border), labial (MIC-labial) and lingual (MIC-lingual) borders of mandible was measured (Fig. 6). And tooth root where the MIC was ended noted.

The data were presented as mean ± SD, and the prevalence in percentages was calculated for MF and MIC. The groups were compared using the chi-square test for categorical variables. T-test and One-Way ANOVA tests were used to compare quantitative variables. The significance level was accepted as $p < 0.05$ for all tests.

RESULTS

In this study, the average age of individuals was 47.65 ± 15.83 (21-80). Table 1 illustrates the gender and dental status distribution of the individuals.

Table 1. Gender and dental status distribution.

	Female	Male	Total
Edentulous	21 (45.7%)	32 (64%)	53 (55.2%)
Dentulous	19 (41.3%)	10 (20%)	29 (30.2%)
Partial dentulous	6 (13%)	8 (16%)	14 (14.6%)
Total	46 (47.9%)	50 (52.1%)	96

Fig. 2.- In the sagittal view, the position of the MF related to the long axis of adjacent teeth, the length of mental foramen (MF length).

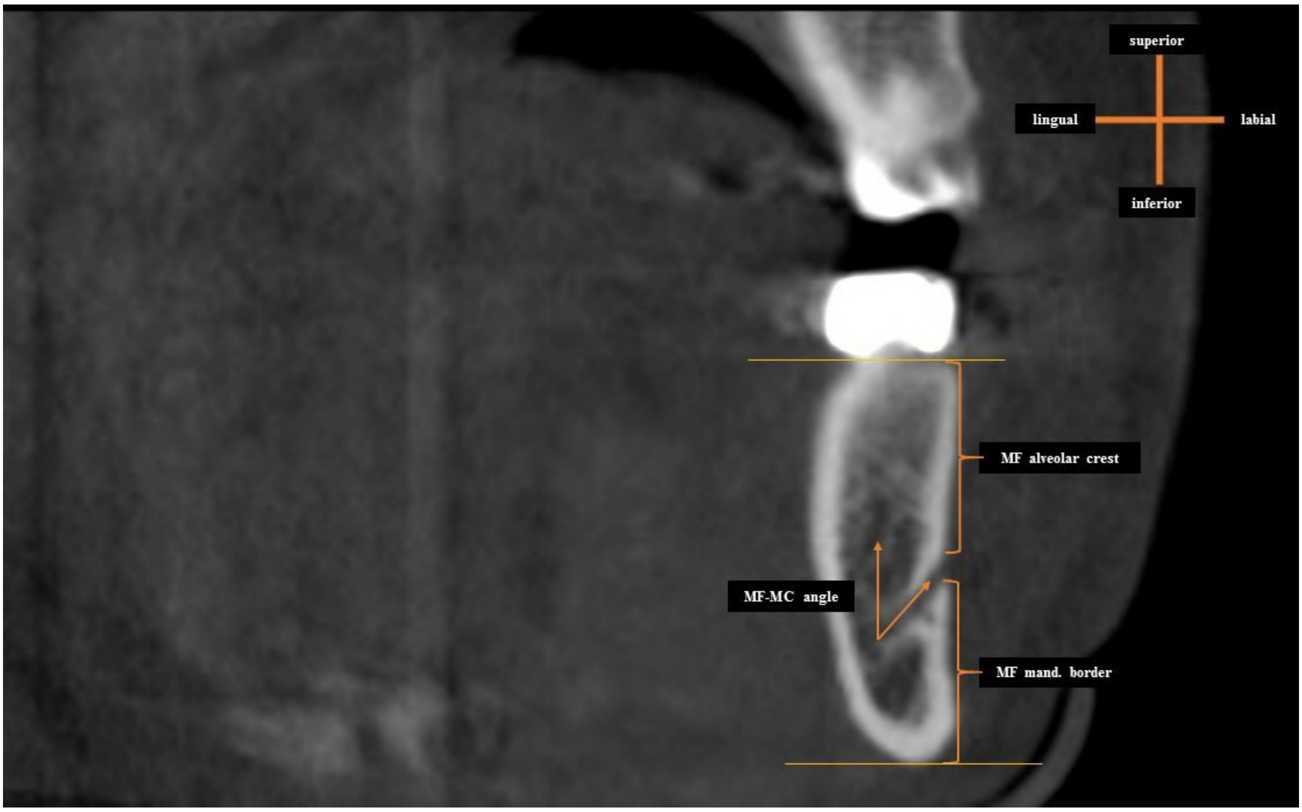

Fig. 3.- Distance from the superior margin of MF to the alveolar bone crest (MF alveolar crest), distance from the inferior margin of MF to lower border of the mandible (MF mand. border), angulation of mental canal to buccal bone surface (MF-MC Angle).

Fig. 4.- The length of mandibular incisive canal (MIC length).

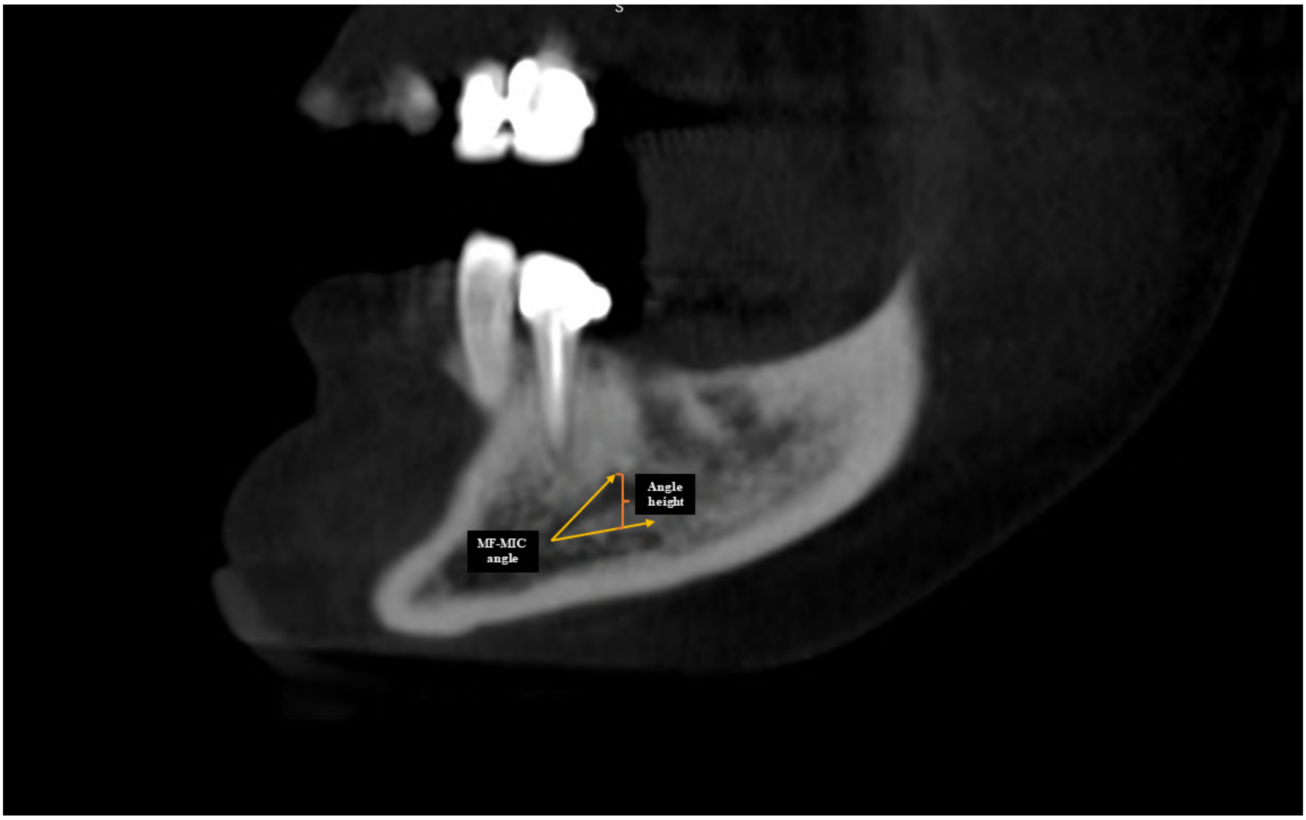

Fig. 5.- Angle among mental foramen- mandibular incisive canal and a horizontal plane parallel to the inferior border of the mandible (MF-MIC angle) and the height of the angle (Angle height).

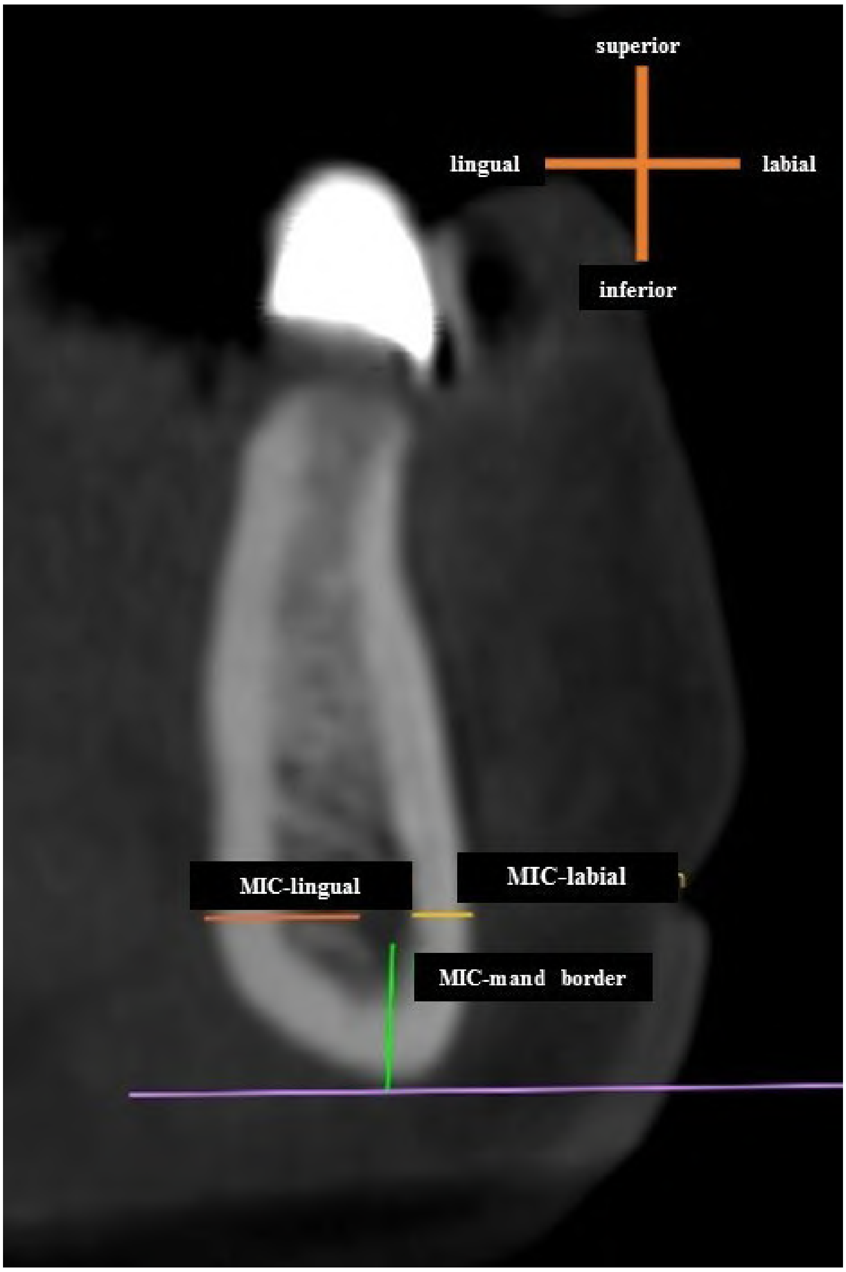

Fig. 6.- At the end most point of the MIC the distance between the canal and inferior (MIC-mand border), labial (MIC-labial) and lingual (MIC-lingual) borders of mandible.

Mandibular Incisive Canal

The visibility of the MIC is shown in Table 2. There was no statistically significant difference between the genders and sides in the presence of the mandibular incisive canal.

The location of the endmost point of the MIC with reference to the adjacent teeth are shown in Table 3. There was no statistically significant difference between the location of the endmost point of right and left MIC according to gender. As regards sides, there was no significant difference; the most common locations of MIC were first incisive on both sides for total cases.

Table 4 shows the mean values and standard deviations of the MIC length, MIC-mand border, MIC-labial and MIC-lingual borders of mandible and MF-MIC angle, and the angle height. There was no statistically significant difference in all parameters between the left and right sides. However, when compared with males and females, a statistically significant difference was found for the length of the left MIC ($p<0.05$): it was longer in males.

There was no statistically significant difference in other parameters according to gender or sides.

Mental Foramen (MF)

The visibility of MF is shown in Table 5. There was no statistically significant difference between the visibility of MF both genders and sides (p>0.05).

The location of MF regarding the long axis of adjacent teeth is shown in Table 6. There was no statistically significant difference between the location of right and left MF with reference to the adjacent teeth according to gender (p>0.05).

Table 7 shows the mean values and standard deviations of the MF width and MF length, MF alveolar crest, MF mand. border, MF-MC angle. A

Table 2. Visibility of mandibular incisive canal (MIC: Mandibular incisive canal).

	Right MIC					Left MIC					Total				
	None	Poor	Medium	Good	Total	None	Poor	Medium	Good	Total	None	Poor	Medium	Good	Total
Female	11 (24.4%)	22 (48.9%)	6 (13.3%)	6 (13.3%)	34 (75.6%)	10 (24.7%)	21 (45.7%)	9 (19.6%)	6 (13%)	36 (75.3%)	22.8%	47.8%	16.3%	13.1%	77.2%
Male	14 (28%)	22 (44%)	6 (12%)	8 (16%)	36 (72%)	12 (24.5%)	17 (34.7%)	12 (24.5%)	8 (16.3%)	37 (75.5%)	26%	40%	18%	16%	74%
Total	25 (26.3%)	44 (46.3%)	12 (12.6%)	14 (14.7%)	70 (73.7%)	22 (23.2%)	38 (40%)	21 (22.1%)	14 (14.7%)	73 (76.8%)	24.4%	43.8%	17.2%	14.6%	75.6%

Table 3. Location of the end point of the mandibular incisive canal with reference to the adjacent teeth.

	Right MIC				Left MIC				All MIC			
	1st incisive	2nd incisive	Canine	1st premolar	1st incisive	2nd incisive	Canine	1st premolar	1st incisive	2nd incisive	Canine	1st premolar
Female	19	6	6	0	19	7	7	0	38	13	13	0
	42.2%	13.3%	13.3%	0%	41.3%	15.2%	15.2%	0%	41.8%	14.3%	14.3%	0%
Male	17	5	9	0	13	10	7	1	30	15	17	1
	34.7%	10.2%	18.4%	0%	26.5%	20.4%	14.3%	2%	30.3%	15.2	17.2%	2%
Total	36	11	15	0	32	17	14	1	68	28	30	1
	37.9%	11.0%	15.8%	0.0%	33.7%	17.9%	14.8%	1%	35.8	14.7	15.8%	1%

Table 4. Measurement parameters of the mandibular incisive canal (MIC: Mandibular incisive canal).

	Right MIC			Left MIC			All MIC (n=147)
	Female (n=35)	Male (n=38)	Total (n=73)	Female (n=36)	Male (n=38)	Total (n=74)	
MIC length	11.39±3.15	12.91±4.09	12.18±3.72	10.10±3.19*	12.85±4.84*	11.51±4.32	11.76±4.14
MIC-mand border	11.43±10.83	12.07±9.48	11.76±10.09	9.57±3.36	12.39±14.26	11.02±10.51	11.31±10.28
MIC-labial	3.10±1.64	3.98±2.13	3.56±1.95	3.32±1.13	3.98±1.51	3.66±1.37	3.58±1.70
MIC-lingual	4.12±1.79	4.56±2.26	4.35±2.04	4.07±1.34	4.96±3.09	4.52±2.43	4.41±2.26
MF-MIC angle	24.92±11.80	23.01±11.77	23.93±11.74*	25.12±12.66	25.70±11.27	25.41±11.89*	24.51±11.93
Angle height	4.62±2.07	4.95±1.98	4.79±2.02	4.33±1.71	5.25±1.99	4.80±1.90	4.76±1.98

* statistically ssignificant difference between the length of the left mandibular incisive canal according to gender (p<0.05)

Table 5. Visibility of mental foramen (MF: Mental Foramen).

	Right MF			Left MF			All MF		
	Poor	Medium	Good	Poor	Medium	Good	Poor	Medium	Good
Female	16 (35.6%)	17 (37.8%)	12 (26.7%)	15 (32.6%)	17 (37%)	14 (30%)	31 (47.7%)	35 (49.9%)	26 (53.1%)
Male	17 (34%)	19 (38%)	14 (28%)	17 (34%)	24 (48%)	9 (18%)	34 (52.3%)	43 (55.1%)	23 (49.9%)
Total	33 (34.7%)	36 (37.9%)	26 (27.4%)	32 (33.3%)	41 (42.7%)	23 (24%)	65 (33.9%)	78 (40.6%)	49 (25.5%)

Table 6. Location of mental foramen (MF: Mental Foramen).

	Right MF			Left MF			Total MF		
	Between 1st and 2nd premolar	1st premolar	2nd premolar	Between 1st and 2nd premolar	1st premolar	2nd premolar	Between 1st and 2nd premolar	1st premolar	2nd premolar
Female	7 (15.2%)	3 (6.5%)	10 (21.7%)	7 (15.2%)	2 (4.3%)	15 (32.6%)	14 (73.7%)	5 (62.5%)	25 (55.6%)
Male	2 (4%)	1 (2%)	12 (24%)	3 (6%)	2 (4%)	8 (16%)	5 (26.3%)	3 (37.5%)	20 (44.4%)
Total	9 (9.4%)	4 (4.2%)	22 (22.9%)	10 (10.4%)	4 (4.2%)	23 (24%)	19 (9.9%)	8 (4.2%)	45 (23.4%)

Table 7. Measurement parameters of mental foramen (MF: Mental Foramen).

	FEMALE		MALE		ALL		Total
	Right	Left	Right	Left	Right	Left	
MF width	2.56±1.04	2.61±0.89	2.74±0.68	2.71±0.82	2.65±0.87	2.66±0.85	2.66±0.86
MF length	2.66±0.85	2.65±0.88	2.91±0.83	2.79±0.79	2.79±0.84	2.72±0.83	2.76±0.84
MF alveolar crest	11.78±4.51	12.83±4.29	11.82 ±3.78	11.99±5.11	11.80±4.13	12.39±4.73	12.10±4.44
MF mand. border	11.97±2.97*	13.09±4.12*	14.92±7.69*	14.93±3.59*	13.51±6.07	14.05±3.95	13.78±5.11
MF-MC angle	63.7 ±12.71	66.87±18.95	66.37±16.53	70.41±16.85	65.10±14.81	68.71±17.88	68.71±17.83

* statistically significant difference between the right and left sides for both genders (p<0.05)

statistically significant difference was only found between the right and left sides for both genders at this distance from the inferior margin of MF to the lower border of the mandible (p<0.05). This distance was longer in males. The mean values of the other parameters were also higher in males, but not statistically significant (p>0.05).

Dental Status

Visibility of MF, and presence and visibility of MIC according to dental status are shown in Table 8. There was a statistically significant difference between the visibility of MF in edentulous and dentulous patients (p<0.05). No statistically significant difference was found between the presence and visibility of the MIC according to the dental status.

Table 9 shows the parameters of the MF and MIC according to the dental status. There was a statistically significant difference right MF-alveolar crest and left MF-MC angle between dentulous and edentulous individuals (p<0.05). The right MF-alveolar crest was lower in edentulous subjects, and it was observed that left MF-MC angle increased to approximately 90 degrees.

There was also a statistically significant difference between MF-MIC angle on both sides and the right MIC-lingual between the dentulous and edentulous individuals (p<0.05). The right MIC-lingual was shorter in dentulous cases.

Table 8. Visibility of mental foramen and mandibular incisive canal according to dental status.

	MF			MIC			
	Poor	Medium	Good	None	poor	Medium	Good
Edentulous	45* 42.5%	44 41.5%	17 16.0%	24 22.6%	44 41.5%	20 18.9%	18 17.0%
Dentulous	11 19.0%	22 37.9%	25* 43.1%	13 22.4%	30 51.7%	9 15.5%	6 10.3%
Partial dentulous	9 32.1%	12 42.9%	7 25.0%	10 35.7%	10 35.7%	4 14.3%	4 14.3%
Total	65 33.9%	78 40.6%	49 25.5%	47 24.5%	84 43.8%	33 17.2%	28 14.6%

* statistically significant difference between the visibility of mental foramen in edentulous and dentulous patients ($p<0.05$)

Table 9. Parameters of the mental foramen and mandibular incisive canal according to dental status.

Dental Status	Edentulous (n=53)		Dentulous (n=29)		Partial dentulous (n=14)	
	Right	Left	Right	Left	Right	Left
MF width	2.63±0.75	2.66±0.85	2.76±0.98	2.74±0.97	2.52±1.10	2.49±0.61
MF length	2.87±1.22	2.74±0.82	2.97±1.02	2.78±0.92	2.57±0.81	2.57±0.77
MF alveolar crest	11.72±8.52*	11.52±4.83	13.91±4.30*	13.6.3±2.83	11.46±2.73	13.14±6.77
MF-mand. border	13.83±7.83	14.11±3.91	12.45±2.73	14.18±4.80	14.47±2.13	13.54±1.53
MF-MC angle	68.90±15.30	75.03±14.22**	58.82±12.71	56.87±16.26**	63.76±12.98	69.33±21.93
MF- MIC angle	16.33±11.90***	17.69±13.08***	28.11±17.66***	28.00±16.633***	15.51±16.40	15.84±15.09
Angle height	3.58±2.55	3.80±2.64	44.68±2.87	4.10±2.19	2.99±2.65	3.09±3.04
MIC length	10.35±6.09	10.17±6.61	8.23±5.88	7.42±4.78	7.26±6.44	6.97±6.15
MIC-mand border	8.68±9.17	7.88±5.10	9.83±13.06	10.37±16.99	08.07±6.52	6.89±6.33
MIC-labial	2.95±2.47	2.97±1.88	2.42±1.12	2.88±2.10	2.34±2.01	2.10±1.86
MIC-lingual	3.97±2.72****	3.87±3.21	2.54±2.06****	3.11±2.35	2.35±2.47	2.79±2.28

Significant difference among with the dentulous and edentulous between:
* right MF to alveolar bone crest distance($p<0.05$).
** left angulation of mental canal to buccal bone surface ($p<0.05$).
*** mental foramen- incisive canal and a horizontal plane parallel to the inferior border of the mandible in both sides($p<0.05$).
****right mandibular incisive canal distance to the lingual border of mandible (MIC-Lingual)

DISCUSSION

Mandibular Incisive Canal (MIC)

Visibility of MIC: Kabak et al. (2017) reported that the overall visibility of MIC on CBCT images was 92%. Panjnoush et al. (2016) reported that it appeared bilaterally in 94% and unilaterally in 3.5%. Brito et al. (2016) reported that in CBCT, MIC is displayed more frequently than panoramic images. Sahman et al. (2014) indicated that CBCT is the gold standard for MIC imaging. In this study, MIC visibility was lower than the literature, approximately 75-77%.

Location of the end point of MIC: Kabak et al. reported that MIC extends to the level of the first incisive root at a rate of 21% and neurovascular structures enter to the tooth root from the MIC through the spaces in the trabecular bone (Kabak et al., 2017). On the other hand, Sahman et al. reported that MIC most frequently terminates between the canine and first premolars (25.1% on the right, 24.6% on the left, 22.6% in women, 27.5% in men) (Sahman et al., 2014). In this study, it was found that the MIC mostly terminated at the level of the first incisive root in Turkish population similar with results of Kabak et al. (2017).

MIC distances: In the literature, MIC length was measured 9.11 mm by Rosa et al. (2013), measured 9.74 mm by Pereira-Maciel et al. (2015), measured an average of 10.48 mm on the right and 10.40 mm on the left by Panjnoush et al. (2016). Pereira-Maciel et al. (2015) measured MIC-mand border 10.25 mm, MIC-labial 4.62 mm, MIC-lingual 6.25 mm and stated that the terminal part of MIC was significantly closer to the buccal face. Panjnoush et al. (2016) reported that MIC-mand. border, MIC-labial and MIC-lingual average distances on the right side were 8.98 mm, 3.63 mm and 3.89 mm, respectively; on the left, 8.62 mm, 3.66 mm, and 4.13 mm, respectively. Both researchers reported that there was no statistically significant difference between gender and sides (Panjnoush et al., 2016; Pereira-Maciel et al., 2015). Similar results were found in our study as well, and there was no significant difference between genders and sides in MIC distances.

Mental foramen (MF)

Visibility of MF: In this study, the localization and dimensions of MF on CBCT images were evaluated, and MF was visualized in all cases. There was no difference between genders and sides (p>0,05).

Localization of MF: In this study, MF was mostly seen at the level of the second premolar root. There was no significant difference between genders and sides (p>0,05).

Variation of additional foramina in the mandible, such as accessory mental foramen (AMF) has been reported in previous studies. The AMF is a smaller foramen that appears in addition to the MF and is continuous with the mandibular canal. Presence of AMF may affect the location of MF and length of the nerve branches. Incidence of AMF is reported as 2.0-13.0%, but we did not observe AMF in our cases (Iwanaga et al., 2015, 2016; Lam et al., 2019).

In a comprehensive study on 663 patients in the literature, it was reported that MF was located between the first and second premolar root mostly (49.2%), and then at the level of the second premolar root at a rate of 39.7% (Goyushov et al., 2018). On the other hand, some researchers report that MF is most commonly found at the second premolar level (Carruth et al., 2015; Panjnoush et al., 2016; Valdec et al., 2019; Von Arx et al., 2013). Direk et al. reported that, unlike the rest of the literature, it was at the level of the first premolar root in all cases (Direk et al., 2018).

In the studies according to the races in the literature, the place of MF has been reported as follows: among the most common first and second premolar roots in the Saudi (Al-Shayyab et al., 2019; Aldosimani et al., 2019; Bello et al., 2018; Velasco-Torres et al., 2017; Zmyslowska-Polakowska et al., 2019), Leh, Jordanian populations and Caucasians; at the level of the second premolar root in Iranian, Lebanese populations and black race (Aoun et al., 2017; Bello et al., 2018; Khojastepour et al., 2015). Kalender et al. reported that it was at the level of the second premolar root, similar to our study, in their study on the Turkish population (Kalender et al., 2012). Carlson et al. reported that the distance of the MF to the premolar teeth differed between the sexes and was closer to the second premolar in women (Gungor et al., 2017). As a result, MF is mostly found at the second premolar root or between the first and second premolar roots in Turkish and other races.

MF dimensions: The studies in the literature have found that the mean length of MF was 2.16-3.55 mm, and the mean width was 3.15-4.42 mm (Bello et al., 2018; Chen et al., 2015; Direk et al., 2018; Dos Santos Oliveira et al., 2018; Goyushov et al., 2018; Gungor et al., 2017; Kalender et al., 2012; Prados-Frutos et al., 2017; Von Arx et al., 2013; Zmyslowska-Polakowska et al., 2019). In the studies according to race, the mean height was 2.87 mm, and the mean width was 3.56 mm in black race (Modi and Arsiwalla, 2019); average measurement was 3.11 mm in height (more in males) in Brazilian population, 3.15 mm in width (Dos Santos Oliveira et al., 2018); the mean height was 3.55 mm in Polish population (more in males on right), and the mean width has been reported to be 4.24 mm (more in males on both sides) (Zmyslowska-Polakowska et al., 2019). Kalender et al. (2012) reported the mean height of MF as 3.7 mm and its mean width as 3.4 mm, and stated that the dimensions of MF were higher in males than females in the study with 3D reconstruction of the mandible in the Turkish race. In our study, however, no statistically significant difference was found between genders and right-left sides in MF dimensions (p>0.05).

The difference between the study by Kalender et al. and ours is due to the method used. Direk et al. found that the height of MF was higher on the right side in both genders (Direk et al., 2018); in all cases Gungor et al. (2017) reported that its width was greater on the right, and Goyushov et al. (2018) reported that MF width was greater only in males.

Distance of MF to upper and lower edge of mandible: The study by Direk et al. (2018) compared the difference between genders according to the age groups; it was found that MF alveolar crest and MF mand. border parameters were higher on right and left sides in men. Gungor et al. (2017) similarly reported that these two distances were lower in women than in men, and they were lower on the right than on the left. In our study, MF mand. border was found greater in men. It is thought that the difference between these values may be due to the skeletal difference between the genders.

Kalender et al. (2012) reported that the MF mand. border parameter varied between 7.9-18.6 mm, with an average value of 12.4 mm in Turkish population. Al-Mahalay et al. (2017) reported mean MF alveolar crest and MF mand. border distance as 14.3 mm and 13.8 mm, respectively.

Dos Santos Oliveira et al. (2018) found the MF alveolar crest distance to be 11.21 mm on average, and reported that there was no difference between genders and sides. In the same study, MF mand. border distance was found to be 12.31 mm on average and there was a significant difference between the genders. Von Arx et al. (2013) reported MF alveolar crest distance as 12.6 mm, MF mand. border distance as 13.2 mm. As a result, considering the data in the literature, MF alveolar crest and MF mand. border distances vary widely among individuals, with average values around 12-13 mm. In our study, these distances were also found in a similar range.

MF-MC angle: In our study, we evaluated the angulation of the MC with the buccal bone face. With the same method used in our study, Von Arx et al. (2013) reported the mean value of this angle as 46.8º (24.2º–81.3º). As stated in the study of Von Arx et al. (2013), we also found that the mental canal is upward oriented since the mean value in our study was also below 90°. We hypothesize that the higher values in our study may be due to racial differences.

Dental Status

In this study, MF was observed in all individuals. There was no significant difference between the right and left sides and genders in MF visibility according to dental status (p>0.05). A significant difference was found between dentulous and endentulous patients in terms of right MF-alveolar crest and left MF-MC angle. It was determined that the MF-alveolar crest distance decreased significantly on the right-side of endentulous patients, and the MF-MC angle parameter was significantly increased, almost 90° on the left side of endentulous patients.

Charalampakis et al. (2017) reported that MF was closer to the alveolar crest than the lower edge of the mandible (mean MF alveolar crest 6.4 mm, mean MF mand. border 12.6 mm) in their study on the edentulous bone mandible. It was also reported that the crest distance was significantly reduced by 0.01 level when the dentulous and edentulous mandibles were compared. Because the differences in the distances in our study were found only unilaterally, new studies should be needed on a larger number of samples in the future.

In this study, there was no significant difference between the right and left sides and genders in MIC visibility according to dental condition. MF-MIC angle on right and left sides was found to be significantly higher in dentulous patients than in endentulous. This suggests that the MIC is more vertically oriented in dentulous individuals. Significant differences were found between dentulous and endentulous patients' right MIC-lingual. This distance was lower in dentulous patients. In the literature, it has been reported that the MIC is larger and more superficial in the alveolar crest in edentulous patients (Caughey et al., n.d.). No study was found in the literature that evaluated the same parameters in our study according to dental condition.

CONCLUSION

As a result, in this study, when we look at the course and morphological features of the MF and MIC, which includes neurovascular structures in the mandible in Turkish society, although these anatomical structures vary among individuals, it has been observed that the mean values in the Turkish population are similar to the mean values in the literature.

In this study, the most common locations of MF were along the second premolar: the total presence of the MIC was 75.6% in all cases. The most common locations of the endmost point of the MIC were along the first incisive. The length of the left MIC was significantly longer in males.

According to the dental status, visibility of MF was the weakest in edentulous, and MIC presence was similar to MF. The right MF alveolar crest was significantly lower and the left MF-MC angle significantly increased to approximately 90 degrees in edentulous.

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