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Original Research Article

Anatomical Study of Mental Foramen Using Cone Beam Computed Tomography in Selected Adult Dentate Kurdistan Patients

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Abstract

Mental foramen is a very important anatomical landmark in dentistry and knowledge about mental foramen is very important because it transfers the mental nerve and vessels. The aim of thisresearch was to study the morphology and morphometry of the mental foramen using cone beam computed tomography in dentate adult Kurdistan patients. Thirty nine cone beam computed tomography were studied to analyze the shape, position, distance, and diameter of mental foramen.

It was found that the most common variation of mental foramen was oval shape, and situated in line between 1st and 2nd premolar, and apical to the apex of associated tooth,and these variations showeda nonsignificant differences with the gender and age. The mean distances from mental foramen to the alveolar crest in the right and left side was 13.37±2.41 and13.60±1.96 mm respectively, and the mean distances from mental foramen to the inferior mandibular borderin the right and left side was10.98±1.97 and10.82±1.95mm respectively. Statistical analysis showed no significant differences regarding the gender and side, but significant difference present regarding age group.

The mesio-lateralmean distance in the right and left side was 3.87±0.85and 3.68 ±0.78 mm respectively. But the superior-inferior distance in the right and left side was 3.17 ±0.85 and3.25 ±1.00 mm respectively. Statistical analysis showed no significant relation present with the gender, age group, and side.Knowing the exact location of the mental foramens and its variations is very important andcan help toplan surgical procedures properly.

Key Words: Anatomy; Mental foramen; Accessory mental foramen; Cone-Beam Computed Tomography; Mandible.

الخلاصة

الثقبة العقلية معلما التشريحية مهم جدا في طب الأسنان والمعرفة حول الثقبة العقليه مهمة جدا لأنها تنقل العصب والأوعية العقلية. الهدف من هذا البحث هو للدراسة الشكليه والمورفومتريه للثقبة العقلية باستخدام مخروط شعاع التصوير المقطعي لمرضىكردستان المسنين البالغين. تم دراسة تسع وثلاثون مخروط شعاع التصوير المقطعي لتحليل الشكل والموقع، وبعد المسافة، وقطر الثقبة العقلية.

وقد وجد أن التباين الأكثر شيوعا للثقبة العقلية كان شكل البيضاوي، وتقع في الخط الفاصل بين الضاحك الاول والثانى، واسفل قمة الأسنان المرتبطة بها، وأظهرت هذه التباينانفروقات غير معنويه مع الجنس والعمر. وكانت المسافات المتوسطة من الثقبة العقلية للقمة السنخية في الجانب الأيمن والأيسر 1.96 ±13.37 و 2.41 ±13.60ملم على التوالي، والمسافات المتوسطة من الثقبة العقلية للحدود الفك السفلي في اليمين واليسار هى1.97± 10.98و95. 1 ± 10.82ملم على التوالي. وأظهر التحليل الإحصائي عدم وجود فرق معنوي فيما يتعلق بالجنس والجانب، ولكن الفارق معنوي فيما يخص الفئة العمرية.

وكانت المسافة–إنسي جانبي في الجانب الأيمن والأيسر هى0.85 ±3.87 و0.78± 3.68 ملم على التوالي. ولكن المسافة العلويةالسفلية في الجانب الأيمن والأيسر كانت0.85 ± 3.17و 1.00 ± 3.25ملم على التوالي. وأظهر التحليل الإحصائي لا وجود لعلاقة معنويه مع الجنس والفئة العمرية، والجانب. معرفة الموقع الدقيق للثقوب العقلية وتبايناتها مهم جدا ويمكن أن تساعد في تخطيط العمليات الجراحية بشكل صحيح.

Introduction

The mental foramen (MF) is located on the lateral aspect of the body of mandible. Ittransmits mental nerves and vessels, and marks the termination of mandibular canal in the mandible through which the inferior alveolar nerve and vessels pass.The mental bundle passes through the MF and supplies blood supply and sensory innervations to the soft tissues of the lower lip, chin, andgingival tissue on the ipsilateral side of the mandible [1].Any foramen in addition to mental foramen in the body of mandible is known as accessory mental foramen (AMF) [2].

The vertical location of the MF varies according to age. In children, it is located closer to the alveolar crest before tooth eruption, and located precisely at 13 to 15mm superior to inferior border of mandible in adult [3]. Some authors studiedthe horizontal position of MF and found that 65% of MFs were present between the second premolar and first molar [4], but others reported thatit present in the line with long axis of second premolar [5]or between the first and second premolar [3].All standard radiological and anatomical text books contain conflicting statements regarding the location and shape of MF [6].The variations are largely influenced by individual, age, gender, race, type of technique used, and degree of alveolar bone resorption[7].

Studying location, size and shape of MF is very important because it will be helpful to localize the important maxillofacial neurovascular bundle.They acts as the important anatomical landmark to facilitate the local anesthetic, surgical, and other invasive procedures for dental surgeons performing any surgical procedure in the mental region of the mandible [8].Cone beam computed tomography (CBCT) enables us to accurately determine the location, shape, and size of the MF as well as the presence of AMF, and allows for an accurate morphometric analysis, andalso provides life-size images where preciselines and measurements can be made easily[9]. The aim of the present research was to study the anatomical characteristic of the MF using CBCT in selected dentate adult patients in Kurdistan region of Iraq, to determine the shape, position with respect to adjacent teeth, distances to the upper and lower borders of the mandible and diameter, in relation to the gender and age of the patient.

Materials And Methods

All CBCTs of dentate adult patients of both sexes, above or equal to 20 years of age,and fulfill the inclusion criteria were gathered from the Oral Diagnostics Department at the College of Dentistry/ Hawler Medical University, Erbil City/Kurdistan Region of Iraq in the period between 2014 and 2016 and have undergone CBCT scans for various medical reasons. All the CBCT scans weretaken by NewtomGiano CBCT 3D imaging(QR Sr- via silvestrini, 20- 37135 verona -Italy). The X-ray source (High Frequency, Stationary Anode: 60-90 kV; 1-10 mA), focal spot (0.5 mm), detector (Flat Panel Amorphous Silicon), X-ray emission time (3.6s - 9.0 seconds), Scan time (18 seconds), reconstruction time (Minimum render time is 15 seconds),Signal grey scale dynamic range(16-bit), effective dose (103 - µSv), field of vision sizes (11 x 8 cm, 11 x 5 cm, 8 x 8 cm, 8 x 5cm and 5 x 5cm), Software (NNT™ with free viewer and sharing application). All CBCT images were of dentate patients and chosen according to the following criteria:

1. All mandibular teeth from the right first molar to the left first molar were

present, with no supernumerary teeth, orthodontics appliance, mandibular dental irregularity, periodontal diseases, or spaces between teeth.

2. The images must be free from any radiolucent or radiopaque lesion in the lower arch.

All CBCT of patients with the following criteria were excluded:

1. Pathology that affected the position of MF and other adjacent landmarks, patients had undergone a previous mandibular surgical procedure or with a history of mandibular fracture.
2. Any missing mandibular teeth from the right 1st molar to left 1st molar to avoid the possibility of teeth drifting towards the missing tooth space.
3. Patients in which the upper premolars were missing because of the possibility of over eruption of the lower premolars.

All measurements were made by a single observer in oblique sagittal plane. For assessmentof intra-observer reliability and reproducibility, CBCTmeasurements of 25 patients were repeated twice. No statisticallysignificant difference was detected. All analyses were studied and all the data were compared between the sides, gender and age for each measurement and information. The parameters measured and studied were as follows:

1. Shapeof MF: The shape of mental foramen was determined as round, oval, or irregular.

2. Position of MF: Horizontal position of the MF on the radiograph was recorded,and for more precise location of MF, the vertical midline of the foramen was considered as a standard point to locate the foramen horizontally as followed [10]:

P1: The foramen situated anterior to the 1st premolar.

P2: The foramen situated in line with the 1st premolar.

P3: The foramen situated anterior to the 2nd premolar between the 1st and 2nd premolar.

P4: The foramen situated in line with 2nd premolar.

P5: The foramen situated anterior to the1st molar between the 2nd premolar and 1st molar

P6: The foramen situated in line with the 1st molar.

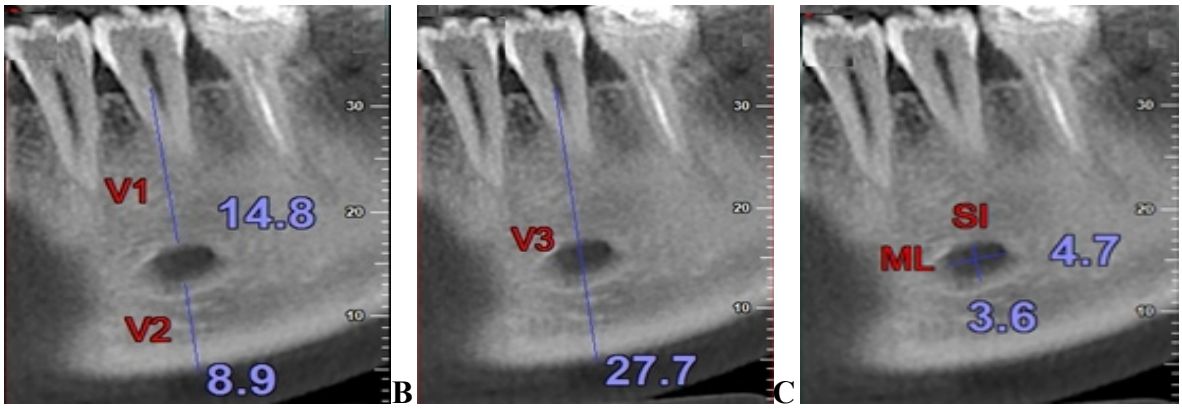
But in vertical plane,the horizontal midline was used as a standard point to mark the position of MF in relation to the apex of associated tooth and registered as superior, overlapping the apex of the related tooth or inferior[1].

3. Distance of MF: The distance between superior limit of the alveolar crest to upper margin of MF (V1), and the distance between lower margins of MF to the inferior limit of mandible base(V2)were measured by drawing vertical line perpendicular to theocclusive surface cutting the center of the mental foramen(Figure-1).

4. Diameter of MF: The foramen horizontal diameter was measured from the medial border to the lateral border of foramen (ML). The distance between superior limit of the alveolar crest to the inferior limit of mandible base (V3) was measured also (Figure-1), and the vertical foramen diameter from the superior border to the inferior border (SI) = V3-(V1+V2).The selected radiographic images were imported by (the DIMAX3 digital software) with specific tools for making linear measurements on images of the mandibular jaw.

Statistical Analysis

Data processing and analysis were conductedusing SPSS statistical software, version 19. Qualitative values were presented via frequency distribution tables, and Pearson's chi square tests were used to compare the difference between genders and age groups in relation to sides.Quantitative variables were presented as mean valuesand standard deviation. The t-test and ANOVA test was used to compare the differencesbetween variables.All tests had a significance levelof 5%.



A B C

Figure 1: Distance (A and B) and diameter (C) of mental foramen.

Results

The MFs were studied on the CBCT images of 39 patients. There were 18 males (mean age 27.55± 5.23 year) and 21females (mean age 27.95 ± 8.10 year). The age ranged from 20 to 49years with a total mean of 27.76± 6.84years. The number of MFs examined was 71 (32 CBCT are bilateral and seven are unilateral), and onlythree cases(4.23%)were seen associated with AMF(Figure -2), one inferior, one at the level of MF, andone superior to the MF examined.

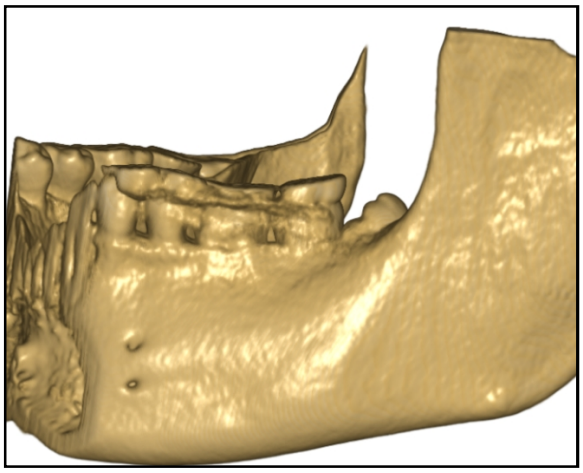


Figure 2: Mental foramen and accessory mental foramen in three-dimensional images.

1. Shape of MF: The oval shape was more than twice greater than round shape. In both sides, statistically a nonsignificant difference between MF shape and gender was seen and MF shape did not change with the age increase (p>0.05)as seen in Table-1.

2. Position of MF:

A. Horizontal: In males and females and in every age group studied, the most frequent horizontal position was (P3) in which the foramen situated between the 1st and 2nd premolar, followed by (P4) in which the foramen situated in line with 2nd premolar. No cases seen at (P1) position in which the foramen situated anterior to the 1st premolar. In both sides, statistically a nonsignificant difference between MF horizontal position and gender was seen and MF horizontal position did not change with age increase (p>0.05)as seen in Table-2.

B. Vertical:Result showed that the most frequent vertical location of the MF was inferior (apical) to the apex of associated tooth, followed by overlap (at the apex), and no cases seen superior or coronal to the apex. In both sides, statistically a

nonsignificant differences present between the more frequent superior–inferior position and the gender or the age groups (p>0.05) as seen in Table-3.

3.Distance of MF: In both sides, the females showed shorter V1and V2 distance than males. Statistical analysis showed no significant differences present between gender (p>0.05), but this difference was significant in relation with age (p<0.05) as seen in Table-4.

4.Diameter of MF: In both sides, the females showed shorter ML and SI diameter than males. Statistical analysis showed no significant differences between genders and age groups regarding these diameters (p>0.05) as seen in Table-5.

The mean V1 distance in the right and left side was 13.37±2.41 and13.60±1.96 mm respectively. But the mean V2 distance in the right and left side was10.98±1.97 and10.82±1.95 mm respectively. Statistical analysis showed no significant differences present between the right and left side (p>0.05) as seen in Table-6.

The mean ML distance in the right and left side was 3.87±0.85and 3.68 ±0.78mm respectively. But the mean SI distance in the right and left side was 3.17 ±0.85 and3.25 ±1.00 mm respectively. Statistical analysis showed no significant differences present between the right and left side (p>0.05) as seen in Table-6.

Table1: Shape of mental foramen (No& %) in relation to gender and age groups.

Variable		Right				*P*-value	Left				*P*-value
		Round	**Oval**	**Irregular**	**Total**		**Round**	**Oval**	**Irregular**	**Total**	
Gender	**Male**	5 (31.25%)	11 (68.75%)	0 (0%)	16 (100%)	0.058	3 (17.65%)	13 (76.47%)	1 (5.88%)	17 (100%)	0.159
	Female	5 (25%)	14 (70%)	1 (5%)	20 (100%)		4 (22.22%)	14 (77.78%)	0 (0%)	18 (100%)	
Age (years)	**20-24**	4 (28.57%)	9 (64.29%)	1 (7.14%)	14 (100%)	0.367	3 (11.54%)	9 (34.62%)	0 (0%)	12 (100%)	0.534
	25-29	1 (9.09%)	10 (90.91%)	0 (0%)	11 (100%)		1 (4.76%)	9 (42.86%)	0 (0%)	10 (100%)	
	>30	5 (45.45%)	6 (54.55%)	0 (0%)	11 (100%)		3 (23.08%)	9 (69.23%)	1 (7.69%)	13 (100%)	

Table2: Horizontal position of mental foramen (No& %) in relation to gender and age groups

Right								*P*-value	Left							*P*-value
Variable	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**Total**		**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**Total**	
Male	0 (0%)	1 (6.25%)	8 (50%)	4 (25%)	3 (18.75%)	0 (0%)	16 (100%)	0.069	0 (0%)	0 (0%)	10 (58.82%)	4 (23.53%)	1 (5.88%)	2 (11.76%)	17 (100%)	0.752
Female	0 (0%)	0 (0%)	14 (70%)	4 (20%)	2 (10%)	0 (0%)	20 (100%)		0 (0%)	0 (0%)	11 (61.11%)	5 (27.78%)	2 (11.11%)	0 (0%)	18 (100%)	
20-24	0 (0%)	0 (0%)	7 (50%)	4 (28.57%)	3 (21.43%)	0 (0%)	14 (100%)	0.537	0 (0%)	0 (0%)	6 (50%)	3 (25%)	2 (16.67%)	1 (8.33%)	12 (100%)	0.475
25-29	0 (0%)	1 (9.09%)	7 (63.64%)	2 (18.18%)	1 (9.09%)	0 (0%)	11 (100%)		0 (0%)	0 (0%)	7 (70%)	2 (20%)	1 (10%)	0 (0%)	10 (100%)	
>30	0 (0%)	0 (0%)	8 (72.73%)	2 (18.18%)	1 (9.09%)	0 (0%)	11 (100%)		0 (0%)	0 (0%)	8 (61.54%)	3 (23.08%)	1 (7.69%)	1 (7.69%)	13 (100%)	

Table3: Vertical position of mental foramen (No& %) in relation to gender and age groups.

Variable		Right				*P*-value	Left				*P*-value
		Superior	Overlap	Inferior	Total		Superior	Overlap	Inferior	Total	
Gender	**Male**	0 (0%)	2 (12.5%)	14 (87.5%)	16 (100%)	0.651	0 (0%)	2 (11.76%)	15 (88.24%)	17 (100%)	0.328
	Female	0 (0%)	5 (25%)	15 (75%)	20 (100%)		0 (0%)	4 (22.22%)	14 (77.78%)	18 (100%)	
Age (years)	**20-24**	0 (0%)	3 (21.43%)	11 (78.57%)	14 (100%)	0.254	0 (0%)	1 (8.33%)	11 (91.67%)	12 (100%)	0.543
	25-29	0 (0%)	3 (27.27%)	8 (72.73%)	11 (100%)		0 (0%)	3 (30%)	7 (70%)	10 (100%)	
	>30	0 (0%)	1 (9.09%)	10 (90.91%)	11 (100%)		0 (0%)	2 (15.38)	11 (84.62%)	13 (100%)	

Table 4: Distances of mental foramen (Mean±SD) in relation to gender and age groups

Variable		Right				Left			
		V1 (mm)	*P*-value	V2 (mm)	*P*-value	V1 (mm)	*P*-value	V2 (mm)	*P*-value
Gender	Male	14.07 ±2.00	0.078	11.58 ± 2.03	0.06	14.02 ±2.18	0.063	11.35± 2.15	0.106
	Female	12.63 ±2.65		10.33 ± 1.75		12.84±1.39		10.27±1.61	
Age (years)	20-24	12.83 ±2.43	0.048	9.95 ±1.56	0.025	13.35±1.70	0.047	9.77±1.14	0.045
	25-29	13.20 ± 2.33		11.46 ±1.29		13.69±1.83		10.9±0.99	
	>30	15.15 ±2.09		12.11 ±2.50		15.22±2.45		12.78±2.88	

Table5: Diameters of mental foramen (Mean±SD) in relation to gender and age groups

Variable		Right				Left			
		ML (mm)	***P*-value**	**SI** (mm)	***P*-value**	**ML** (mm)	***P*-value**	**SI** (mm)	***P*-value**
Gender	**Male**	3.83 ±0.78	0.494	3.22 ±0.95	0.384	3.74 ±1.75	0.482	3.48 ±1.22	0.556
	Female	3.78 ±0.93		3.11 ±0.76		3.63 ±1.47		3.09 ±0.80	
Age (years)	**20-24**	3.83 ±0.90	0.502	2.86 ±0.65	0.311	3.73 ±1.22	0.171	3.49 ±1.06	0.629
	25-29	3.98 ±0.85		3.40 ±1.03		3.92 ±2.01		3.51 ±1.28	
	>30	3.91 ±0.63		3.30 ±0.87		3.87 ±1.21		3.15 ±0.41	

Table 6: Distances and diameter of mental foramen (Mean±SD) in relation to gender and age groups

Variable		Side		
		R (mm)	**L** (mm)	***P*-value**
Distance	**V1**	13.37 ±2.41	13.60± 1.96	0.230
	V2	10.98 ±1.97	10.82± 1.95	0.953
Diameter	**ML**	3.87 ±0.85	3.68 ±0.78	0.617
	SI	3.17 ±0.85	3.25 ±1.00	0.343

Discussion

After reviewing the literature regarding anatomical,morphometric analysis and the relations of MF to important landmark in the mandible based on CBCT, no any research present regarding all these detailed data about MF in a Kurdistan population. So the MFs in the present study were determined on the CBCT images of 39 patients with a mean age of 27.76± 6.84years. The number of MFs examined was 71, and only three (4.23%) were seen associated with AMF.Sekerci et al found that AMFs were seen in 2% of the cases[9]. Ilayperuma et al and Kalender et al found it was present in 3.92% and 6.5% of the cases studied respectively[11, 12]. Khojastepour et alfound that AMF present in 5.1% of the cases studied [13]. These results disagree with that of Juan and Eduardo, they found that AMFs were found in (55.5%) of the cases studied [14].Ethnic variation in relation to AMF has been reported by Sawyer et al[15].

1. Shape of MF: The oval shape represents the highest percentage in the present study.Sheikhi et al[1], Juan and Eduardo [14], Chu et al[16]and Muinelo-Lorenzo et al[17], have also reported the oval shape to be the most commonly found. Fabianfound that the round and oval shapes were reported to gain nearly equal percentages in Tanzanian populations [18]. Sekerci et aland Al-Khateeb et alhave found the predominance of round shape in their study[9,19].

2. Position:

A. Horizontal: The most frequent horizontal position was P3 followed by P4. Statistically a nonsignificant difference between MF horizontal position and gender was seen and MF horizontal position did not change with age increase. Sheikhi et al and Al-Juboori et alfound that the most common horizontal locations of MFs were positions P3 followed by P4, and no significant difference between the horizontal locations of MF and gender, mean age and side were seen[1,20].Haghanifar et alstudy in Iranian population, and Rupesh et alstudy in Indian population also showed that the most frequent location of the mental foramen was position P3, but followed by positions P4 [3,21].

Al Jasser and Nwokufound that MF in Saudi populationpanoramic radiographs is most commonly positioned at P4 and the location of mental foramen was not gender dependent [10].Sekerci et alfound that in males the most frequent horizontal position of the MF was P4, and in females was P3, and found that with advancing age there was a decrease in the frequency of more posterior locations of the MF [9]. Juan and Eduardo found that the most frequent location of the MF in Perú population was P4, followed by positions P5, P3, P6 and P2, and no mental foramen was found in position P1, and a nonsignificant difference present between both sides [14].Khojastepour et al found that most MFs studied are present in line with second premolar in selected Iranian population, and none of the cases the MF was located at P1 or P6[13]. On the right side a nonsignificant relation found between the location and the gender or age, but in the left side a significant relation was found with the gender. Muinelo-Lorenzo et al found that 57.9 % of MFs studied in Spain population was situated in P4 position, and 25.3% of MF was situated P3 position, and P6 showed the lowest percentage [17]. The variations in the results could be attributed to ethnic or race differences [22]. Some authors found that MF is positioned more posteriorly to the second premolar in blacks than in whites [23].

B. Vertical: The result showed that the most frequent vertical location of the MF was inferior to the apex of associated tooth, followed by overlap. There were no significant differences present between the more frequent superior–inferior position and the gender or the age groups. Sekerci et al found that the most frequent vertical

location of the MF in Turkish population was apical to the apex of associated tooth (76%), followed at the apex, then coronal to apex. There was no difference between genders regarding the more frequent superior–inferior position [9].

Sheikhi et al found that the MF in most cases appear apical to the apex of tooth, followed at the apex, then coronal to apex, with significant relation to side and nonsignificant relation with gender and age in both sides[1]. The differences may be related to age changes.

3. Distance: In the present study, the females showed shorter V1and V2 distance than males. Statistical analysis showed no significant differences present between gender ($p>0.05$), but this difference was significant in relation with age ($p<0.05$). The V1 distance in the right and left side was 13.37±2.41 and13.60±1.96 mm respectively. But the V2 distance in the right and left side was10.98±1.97 and10.82±1.95 mm respectively, with a no significant between sides ($p>0.05$). Juan and Eduardo found that the V1 distances on the right and left side were 15.1 ± 2.4 mm and 14.9± 2.1 mm respectively, with a nonsignificant difference ($p>0.05$), and the V2 on the right and left side was13.6 ± 2.0 and 13.9 ±1.8 mm respectively, with a nonsignificant difference ($p>0.05$) [14].

Muinelo-Lorenzo et al found that the V1 distance was 11.42 ± 3.34 mm and the V2 distance was 13.55 ± 1.06 mm, and, significant relation with gender was seen, in which females presented shorter distances [17]. This may be due to gender differences in mandible size. Theyalso found that the V2 distance showed no significant relation with age, but the V1 distance showed significant relation and this distance was shorter in the older age group, perhaps due to bone resorption. Other authors found no influence of age on this distance[24]. The differences between studies may be due to the differences in the method used, they study the MFs in dentate, partially dentate and edentulous patients.

4. Diameter: In both sides, the females showed shorter ML and SI diameter than males. Statistical analysis showed no significant differences between genders and age groups regarding these diameters ($p>0.05$). The ML distance in the right and left side was 3.87±0.85and 3.68 ±0.78mm respectively. But the SI distance in the right and left side was 3.17 ±0.85 and3.25 ±1.00mm respectively. Statistical analysis showed no significant differences present between the right and left side ($p>0.05$).

Some researches using CBCT had reported a mean MF height was ranging from 3.0 to 3.7 mm, and a mean MF width was from 3.2 to 3.4 mm [12,24].Mustafa found that the vertical diameter was ranged from 3.2–5.8 with a mean of 4.5 ± 1.3 mm[2].Juan and Eduardostudy the SI diameter of MF only and found it's ranged between 2 mm to 2.99 mm on both sides [14].Sheikhi et al found that the mean ML diameter of mental foramen was 3.59 ± 2.74 mm in the right side and 3.59 ± 1.17 mm in the left side[1].Muinelo-Lorenzo et alfound that the MFs in adults, presented a mean long diameter and short diameter of 4.44 ± 1.13 mm and 2.92 ± 0.75 mm, and there were statistically significant differences in MF long and short diameters regarding gender, but no influence of age on MF dimensions was seen, and the short diameter was significantly higher on the left side [17]. The differences could be due to different methods used.

Conclusion

The detailed information about the shape, position, distance and diameter of MF, and the relationship between MF and peripheral structures can help surgeons to localize the MF, avoid injury to neurovascular bundles, and to facilitate surgical, local anesthetic, and other invasive surgical procedures.

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