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ASSESSMENT OF THE ANTERIOR LOOP OF THE INFERIOR ALVEOLAR NERVE, AND MENTAL FORAMEN IN A SAMPLE OF EGYPTIAN POPULATION USING CBCT: RETROSPECTIVE STUDY

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ABSTRACT

Aim: To assess the incidence and length of the anterior loop (AL) and the position of mental foramen (MF) in a sample of Egyptian population and to correlate them to sex and age.

Methods: This retrospective study incorporated a random selection of 323 patients who required treatment for various dental issues. Cone beam computed tomography (CBCT)-based features of the incidence and length of AL, the position of MF, the mandibular contour at the MF, mandibular canal (MC) path, and the distance from MF to the alveolar crest (AC) were evaluated and correlated to sex and age.

Results: The most common position of MF was below the second premolar; 45.7% and 62.7% in males and females respectively. The distance from the MF to AC in Males was (14.58±2.88), showing no significant difference from females (14.36±2.64) (p=0.30). The presence of AL (the most common path of MC) was revealed in 52.8%, 60.6% of males and females respectively, revealing statistically significant result (p=0.046). Type B was the most frequent type of mandibular contour at MF, detected at 37.7% in males and 51.9% in females. Positive correlation was significant between it was distance from MF to AC and length of AL (p=0.042).

Conclusion: CBCT scans play a vital role in accurately evaluating the AL and MF, which helps in avoiding nerve damage during surgeries. This research concentrated on the occurrence of the anterior loop in the Egyptian population and highlighted the necessity for personalized treatment strategies.

KEYWORDS: CBCT; Inferior alveolar nerve; Mental foramen; Anterior loop

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INTRODUCTION

Careful planning and detailed knowledge of the anatomical landmarks of the mandible are mandatory before any surgical interventions such as implant placement, open reduction in fractures, extraction of teeth, and root canal treatment in the mandibular anterior region to prevent expected complications and confirm successful results.[1,2,3] It is crucial to comprehend the structure of the inferior alveolar nerve (IAN) and the mental foramen (MF) to prevent nerve damage caused by failing to identify the location and dimensions of the anterior loop (AL) and MF.[1]

Pain or numbness in the areas innervated by IAN are common complications post surgically.[3] The IAN runs through the mandibular canal (MC), which is situated near the lingual cortex of the mandible until it reaches the mesial side of the first molar. From there, it shifts more towards the buccal side until it ends in the MF as a mental nerve where it may form the AL which is defined as the extension of the IAN in a forward direction, beyond the MF, and then returns to emerge from the MF.[4] The assessment of the IAN can be performed using conventional radiographic techniques such as panoramic radiography. However, this two-dimensional (2D) modality is inaccurate due to the magnification factor and the image distortion of the anterior area. In addition, it offers limited information buccolingually.[5]

Cone-beam computed tomography (CBCT) has become a reliable imaging technique because of its improved image quality, measurements accuracy, three-dimensional (3D) analyses, and personalized treatment plans that can be created by the operator to reduce risks and increase treatment effectiveness.[6] As the incidence and length of AL vary among different populations,[7,8] this study aimed to assess the incidence and length of the AL and the position of the mental foramen in a sample of Egyptian population and to correlate them to sex and age.

MATERIALS AND METHODS

Sample calculations

A power analysis was conducted to ensure sufficient power for the statistical test related to the prevalence of the anterior loop. By setting a confidence interval of 95% and a margin of error of 5%, while applying a finite population correction and using a prevalence proportion of 30% based on findings from Jena et al.,[9] the predicted sample size (n) was determined to be 323 cases. Sample size calculation was performed using R statistical analysis software version 4.3.2 for Windows.

Study design and subjects Collection

This retrospective study received ethical approval from the Ethics Committee of Faculty of Dentistry, Cairo University (28324). CBCT scans of 323 adult Egyptian patients (161 females, 162 males) were randomly selected from the Department of Oral and Maxillofacial Radiology database from January 2023 to January 2025. Egyptian dentulous patients ≥20 years were included in this study. Patients with evidence of pathological lesions, trauma, low-quality imaging, or artifacts in the area of interest were excluded.

Image acquisition

The CBCT data were obtained using a Planmeca ProMax 3D device (Helsinki, Finland). The field of view (FOV) was set to either 16 × 16 cm or 20 × 20 cm, with a voxel size of 0.4 mm. Scans were conducted at 90 kVp, with a current range of 8-12 mA, and an exposure time of 13.5 seconds. All images were analyzed by Planmeca Romexis software (version 6.0.0.3.R) on a computer screen. Multiple reconstructed images in different planes (including panoramic, axial, sagittal, and cross-sectional views) were employed to examine the following variables on both sides. The sagittal view was aligned parallel to the mandible on the side being studied by adjusting the axial plane.

1. The position of the mental foramen (MF)

Reformatted panoramic view was used to detect the location of the MF in relation to the roots of the mandibular teeth as following: a) Beneath the first premolar, b) Between the first and second premolars, c) Beneath the second premolar, d) between the second premolar and the first molar, f) Beneath the first molar.

2. The linear distance from the mental foramen (MF) to the alveolar crest (AC)

It is measured on the cross-sectional view from the upper end of the MF to the AC (in mm) using the linear measurement tool of Romexis **(Fig. 1).**

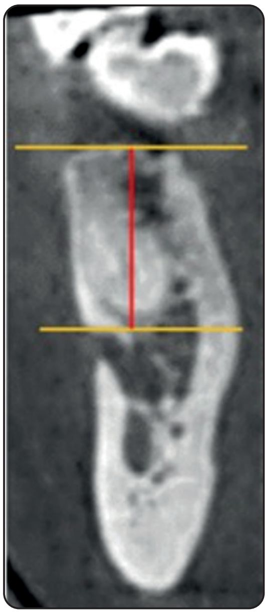

Fig. (1) CBCT, cross-sectional view showing the distance between the alveolar crest (AC) and the upper border of the mental foramen (MF).

3. The mandibular canal (MC) path toward the mental foramen (MF)

The IAN was traced within the MC on successive cross-sectional views using the nerve tracing feature of Romexis. MC path is detected on reformatted panorama and confirmed by sagittal view. The MC path was divided into linear, vertical, and AL following Al-Mahalawy et al.[10] **(Fig. 2).**

4. The presence of the anterior loop (AL)

The AL was considered when the IAN extended beyond the MF, in the anterior and inferior direction, then curved back to the MF **(Fig. 3).**

5. The length of the anterior loop (AL)

It was measured on the sagittal view as a distance from the most anterior point of the AL to the most mesial border of the MF (in mm) **(Fig. 4).** For standardization, two tangential lines to the previous points were drawn perpendicular to the inferior border of the mandible.

6. The shape of mandible at the mental foramen (MF)

On the cross-sectional view at the MF region, the mandibular contour is divided into four types: type A, when the buccal wall was convex and the lingual wall was straight or concave, type B; when the buccal wall was straight or concave and the lingual wall was convex, type C; when both buccal and lingual walls were convex, and type D when both buccal and lingual walls were straight or concave **(Fig. 5).**

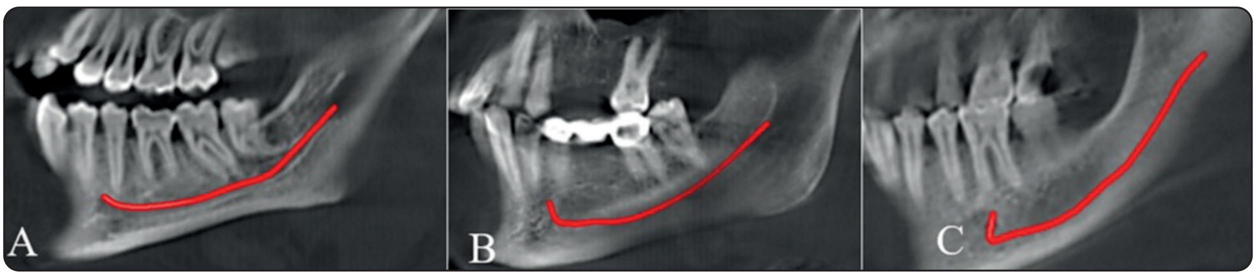

Fig. (2) CBCT, sagittal views showing the mandibular canal (MC) path by tracing the inferior alveolar nerve (IAN). A: Linear path, B: Vertical path, and C: Anterior loop (AL).

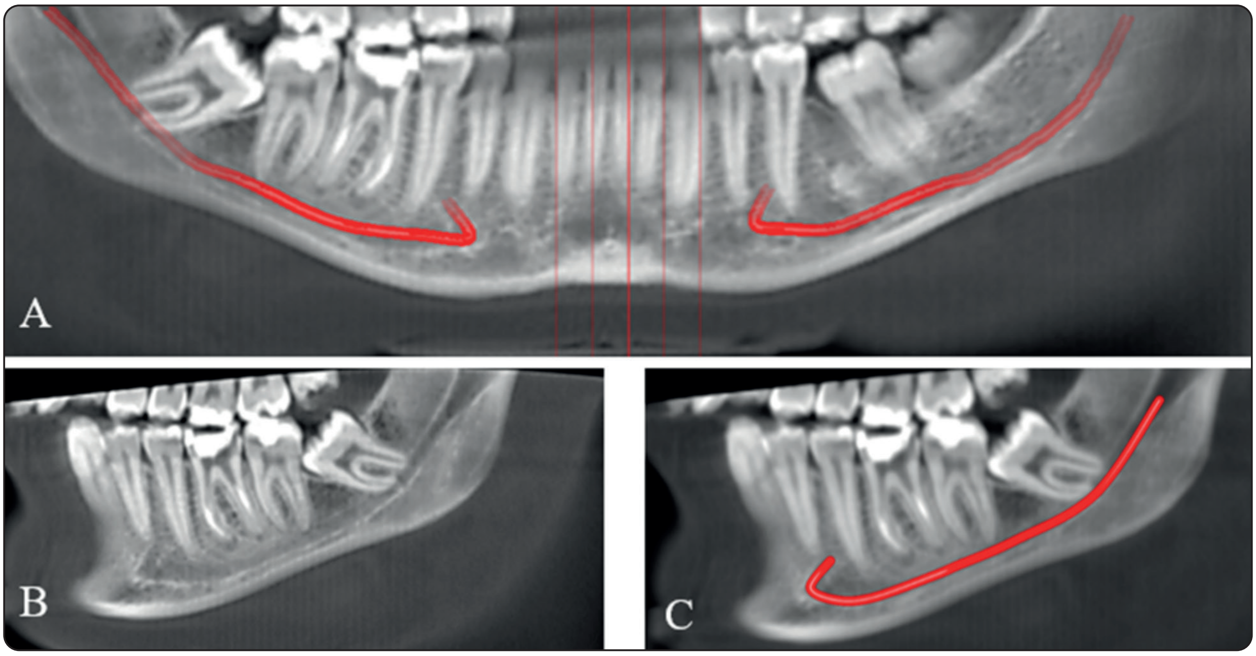

Fig. (3) CBCT images, A: Reformatted panoramic view, B and C; Sagittal views showing the anterior loop (AL) of the inferior alveolar nerve (IAN).

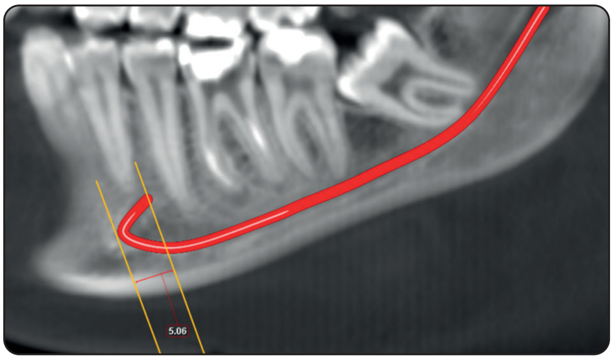

Fig. (4) CBCT sagittal view showing the anterior loop (AL) length of the inferior alveolar nerve (IAN).

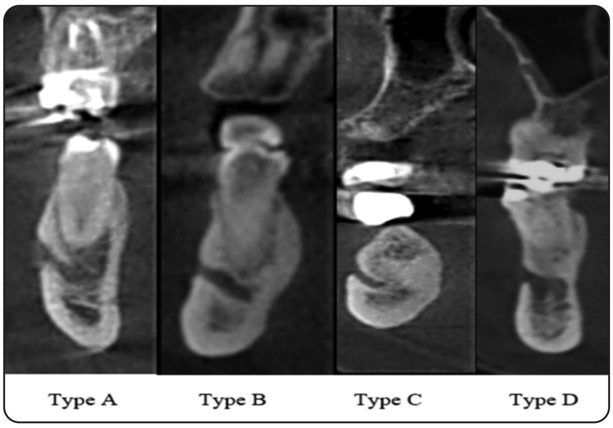

Fig. (5) CBCT, cross-sectional views showing the shapes (types) of the mandible at the mental foramen (MF).

To reduce potential bias and to assess the inter-observer reliability, data collection was conducted randomly and evaluated by two experts, each with over 15 years of experience.

Statistical analysis

Statistical Package for Social Sciences (SPSS) version 20 was utilized for data management and statistical analysis. Mean and standard deviation were used to summarize numerical data. Independent t test was applied to compare right and left sides and, males and females relating to normally distributed numeric variables. Independent t test was also used to compare age according to the incidence of AL. Comparison of age in different categories of position of MF, MC path and the shape of the mandible at the MF were compared using ANOVA test. To assess the inter-observer reliability, ICC was calculated.

Qualitative data were expressed as count and percentage; and were compared using chi square test. The Pearson correlation test is utilized to assess the linear relationship strength between two variables. The correlation coefficient ranges from -1 to 1. A value of -1 indicates a perfect negative linear correlation, 0 signifies no correlation, and +1 represents a perfect positive correlation. The strength of the correlation is interpreted as follows: The absolute value of r: .00-.19 (very weak), .20-.39 (weak), .40-.59 (moderate), .60-.79 (strong), .80-1.0 (very strong). All p-values are two-sided. P-values ≤0.05 were considered significant.

RESULTS

This study comprised 162 males of average age (39.38±13.57 years) and 161 females, with average age (34.52±11.79) years. The inter-observer agreement was excellent (ICC= 0.931). In males, no statistically significant results between right and left sides for all variables except the distance from MF to AC that was statistically significant while, in females, the length of AL was the only variable showed statistically significant result between both sides. Generally, both sides (of males and females together) did not reveal significant difference for all variables.

The position of MF in males was 42.9% between first and second premolars and was 45.7% below the second premolar; compared to 32.3% and 62.7% in females respectively and the difference was statistically significant (p=0.000) between males and females. The distance from the MF to AC in Males was (14.58±2.88), which was statistically not significant from females (14.36±2.64) (p=0.30). The presence of AL was found in 52.8% of males and 60.6% of females, with statistical significance (p=0.046). The length of AL in males recorded (1.61±1.6), which was significantly greater than females (1.22±1.35) (p=0.001). The path of MC in males showed 52.8% as AL, 28.1% as linear and 19.1% as vertical compared to 60.6%; 22.4% and 17.1% in females respectively. The difference between males and females was not significant, with a p-value of 0.122. The mandibular shape at MF was reported at 5.2%, 37.7%, 20.7%, and 36.4% in males and 2.2%, 51.9%; 20.8% and 25.2% in females for type A, type B, type C, and type D respectively. The difference between both sexes was significant (p=0.000) (Table 1) (Fig. 6-9).

TABLE (1) Comparison of males and females on the right side, the left side, and both sides together (Chi square test for qualitative variables, independent t test for quantitative variables).

Variable	Gender	Right				Left				Right + left			
		Males (n=162)		Females (n=161)		Males (n=162)		Females (n=161)		Males (n=324)		Females (n=322)	
The position of mental foramen		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	Below 4	1	0.6	3	1.9	1	.6	2	1.2	2	.6	5	1.6
	Between 4 & 5	66	40.7	47	29.2	73	45.1	57	35.4	139	42.9	104	32.3
	Below 5	74	45.7	104	64.6	74	45.7	98	60.9	148	45.7	202	62.7
	Between 5&6	19	11.7	6	3.7	12	7.4	3	1.9	31	9.6	9	2.8
	Below 6	2	1.2	1	0.6	2	1.2	1	0.6	4	1.2	2	.6
	P value	**.003***				**.023***				**.000***			

Variable	Gender	Right				Left				Right + left			
		Males (n=162)		Females (n=161)		Males (n=162)		Females (n=161)		Males (n=324)		Females (n=322)	
Distance from mental foramen to alveolar crest		**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
		14.79	2.94	14.35	2.56	14.37	2.82	14.36	2.72	14.58	2.88	14.36	2.64
	P value	.157 ns				.959 ns				.30 ns			
The presence of anterior loop		**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
	Yes	86	53.1	95	59	85	52.5	100	62.1	171	52.8	195	60.6
	No	76	46.9	66	41	77	47.5	61	37.9	153	47.2	127	39.4
	P value	.284 ns				.08 ns				**.046***			
The length of anterior loop		**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
		1.63	1.88	1.32	1.42	1.59	1.25	1.13	1.27	1.61	1.60	1.22	1.35
	P value	.102 ns				**.001***				**.001***			
The path of mandibular canal		**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
	AL	86	53.1	95	59	85	52.5	100	62.1	171	52.8	195	60.6
	Linear	47	29	36	22.4	44	27.2	36	22.4	91	28.1	72	22.4
	Vertical	29	17.9	30	18.6	33	20.4	25	15.5	62	19.1	55	17.1
	P value	.383 ns				.210 ns				.122 ns			
The type of the mandible at the mental foramen		**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
	A	9	5.6	4	2.5	8	4.9	3	1.9	17	5.2	7	2.2
	B	64	39.5	85	52.8	58	35.8	82	50.9	122	37.7	167	51.9
	C	32	19.8	32	19.9	35	21.6	35	21.7	67	20.7	67	20.8
	D	57	35.2	40	24.8	61	37.7	41	25.5	118	36.4	81	25.2
	P value	**.049***				**.023***				**.000***			

4; First premolar, 5; Second premolar; 6; First molar; Significance level $p \leq 0.05$, *significant, ns=non-significant

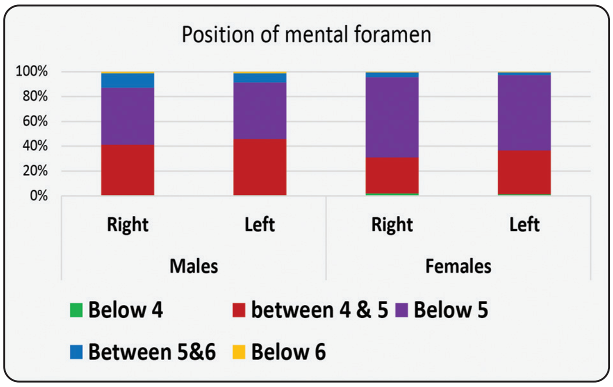

Fig. (6) Bar chart illustrating distribution of the position of the mental foramen (MF) in right and left sides in males and females.

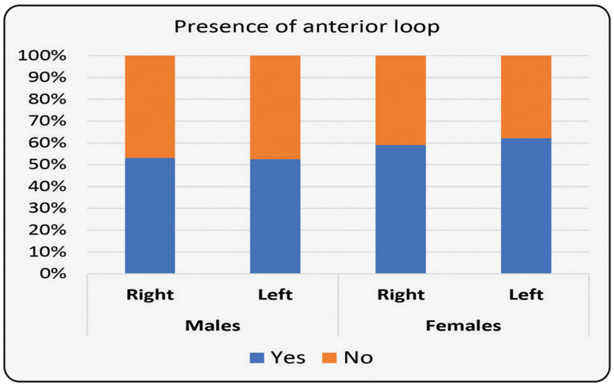

Fig. (7) Bar chart illustrating the presence of anterior loop (AL) in right and left sides in males and females.

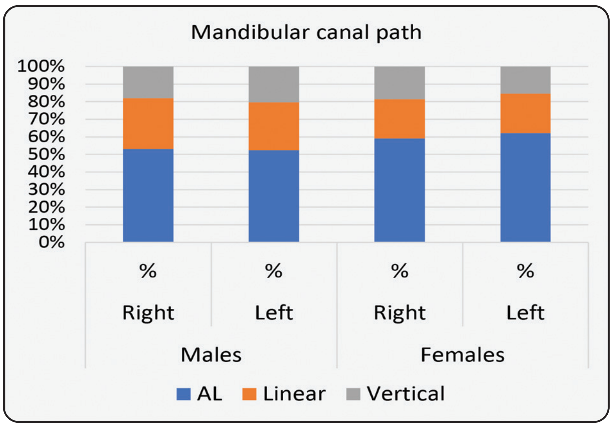

Fig. (8) Bar chart illustrating the distribution of mandibular canal (MC) path in right and left sides in males and females.

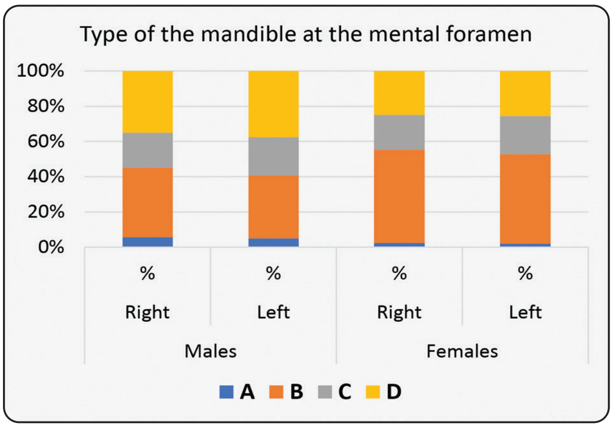

Fig. (9) Bar chart illustrating distribution of the type (shape) of the mandible at the mental foramen (MF) in right and left sides in males and females.

No correlation was revealed between the age and the location of MF, the incidence of AL, the path of MC, or the shape of the mandible at the MF. There was a very weak significant negative correlation between age and the distance from MF to AC (right side) (p=0.001) and length of AL (both right and left sides) (p=0.001 and p=0.028 respectively) and weak significant negative correlation with the distance from MF to AC (left side) (p=0.000) A very weak positive correlation was observed between the distance from MF to AC and the length of AL and it was significant (p=0.042). (Table 2).

TABLE (2) Correlations between age and the quantitative variables (Pearson's correlation test)

		Age	Mental foramen to crest (Right)	Mental foramen to crest (Left)	Length of anterior loop (Right)	Length of anterior loop (Left)
Age	Pearson Correlation		-.191-**	-.220-**	-.186-**	-.122-*
	p-value		.001	.000	.001	.028
	Interpretation		VWN	WN	VWN	VWN
Mental F. to crest (Right)	Pearson Correlation	-.191-**		.792**	.005	.083
	p-value	.001		.000	.926 ns	.137 ns
	Interpretation	VWN		SP	VWP	VWP
Mental F. to crest (Left)	Pearson Correlation	-.220-**	.792**		.094	.114*
	p-value	.000	.000		.093 ns	.042
	Interpretation	WN	SP		VWP	VWP
Length of anterior loop (Right)	Pearson Correlation	-.186-**	.005	.094		.622**
	p-value	.001	.926 ns	.093 ns		.000
	Interpretation	VWN	VWP	VWP		SP
Length. Of anterior loop (left)	Pearson Correlation	-.122-*	.083	.114*	.622**	
	p-value	.028	.137 ns	.042	.000	
	Interpretation	VWN	VWP	VWP	SP	

***Correlation is significant at the 0.01 level* *Correlation is significant at the 0.05 level*

VW= very weak, W=weak, M=moderate, S=strong, VS=very strong, P=positive, N=negative

DISCUSSION

Assessing the mandibular anatomical landmarks plays a vital role in dental practice, ensuring the success of surgical interventions in the mandibular area.[3] This study used CBCT to investigate alteration in MF position, MC path, and the prevalence and length of AL among Egyptian subjects. These findings are clinically significant, enabling dental practitioners to address complex anatomical variations, prevent neurosensory complications, and improve patient care.[1] Moreover, when planning surgeries in the anterior mandible, it is important to take into account factors such as ethnicity, age, and sex.[5,7]

As stated by Benavides et al.,[11] the superiority of the image is more significant when compared with the diagnostic skill of the clinician. A clear image is crucial for accurate diagnosis and treatment planning to reduce complications.[12] Panoramic radiography offers a complete view of the teeth and jaws, yet its usefulness in implant surgery planning is limited due to its 2D nature and resulted distortions horizontally and vertically.[13] In contrast, CBCT produces highly precise anatomical images. CBCT has become the standard of care, and dental implant practices should be equipped with this technology. Unlike panoramic radiographs, CBCT images are free from distortion and magnification. CBCT linear measurements have a minimal error range of 0.1–0.2 mm, whereas panoramic radiographs can have up to 20% image distortion. Research indicates that CBCT-reformatted panoramic images, which are free of superimposition and magnification, are more effective than conventional panoramic radiographs in identifying the mandibular canal.[14]

Generally, this study revealed that there was no significant difference between right and left sides. Both Lu et al.[15] and Wong and Patil[16] found that there was no significant association between the side of the mandible and the length of AL. In contrast, Apostolakis and Brown[17] reported a significantly greater mean length of the AL on the right side. Moreover, Othman[18] found that the incidence of AL was significantly higher in the right side. This result is along with the results of de Couto-Filho et al.[19] and de Brito et al.[20]

The clinical significance of the MC and the MF is due to their neurovascular contents and aiding in administering anaesthesia as reference points. Traumatic injuries to the MF are associated with sensory disturbances in 8.5% to 24% of cases, which can persist for 6 to 16 months following surgical procedures.[21,22] Some studies have examined the MF position, classifying it with reference to the nearest tooth's apex.[23] This study classified the position of the MF following Panjnoush et al.[24] and Shalash et al.[25] based on anteroposterior positioning, comprising five potential locations: beneath the first premolar, between the first and second premolars, beneath the second premolar, between the second premolar and first molar, and beneath the first molar. Cutright et al.[26] suggested that genetic factors contribute to variations in the position of MF, where Africans exhibit a more anterior location compared to Europeans. A systematic review by Barbosa et al.[1] reported that the most frequent place of MF is between premolars followed by below the apex of the second premolar.

This study reported that the location of MF in males was 45.7% beneath the second premolar's apex and 42.9% between the first and second premolars, whilst in females it was 62.7% and 32.3% respectively. This difference was statistically significant ($p=0.000$) between males and females, indicating that the most frequent position of the MF was below the second premolar's apex. Al Dalalah et al.[3] and Ahmed et al.[7] both found that the most common position of the MF in Sudanese and Jordanian populations, respectively, was located below the apex of the second premolar. However, their results indicated that there was no significant difference in the position of the MF based on sex.

These findings differed from those of Velasco-Torres et al.[27] who found that the MF was most frequently positioned between the first and second premolars. As well, Al Qahtani,[2] Kqiku et al.,[28] and Von Arx et al.[29] reported that the MF were found between the first and second premolars in an Austrian, Swiss, and Saudi population respectively.

Observers found it more straightforward to identify the AL using CBCT as it allowed them to examine the loop from various sections and views.[30] de Couto-Filho et al.[19] and Kuzmanovic et al.[31] concluded that using conventional panoramic radiographs to identify the AL resulted in a high rate of false outcomes. Kaya et al.[30] noted that reformatted panoramic view provided clearer images than cross-sectional views. However, Vujanovic-Eskenazi et al.[32] held a different opinion, stating that the loop was best detected using a parasagittal view. This range of viewpoints highlights a key advantage of CBCT regarding its ability to offer multiple viewing options, enabling clinicians to select the most reliable and precise method for assessment. In this study the IAC was traced on cross-sectional views, then assessed on panoramic and sagittal views.

Previous studies,[10,24,33-41] reported variable incidences of AL, ranging from 7% to 94%. These discrepancies can be attributed to differences in study populations, selection criteria, and methodological approaches. However, it is important to mention that these inconsistencies in results cannot be solely explained by racial factors, as conflicting results have been observed even within studies of the same populations.[33,37,41,42] These discrepancies suggest that the chosen methodology significantly influences study outcomes. Imaging modality plays a key role, as previous studies[19,32,43,44] show a higher prevalence of AL detected in CBCT images compared to panoramic images. The current study identified a statistically significant difference ($p=0.046$) in the occurrence of AL between males and females. Specifically, 52.8% of males and 60.6% of females presented this feature. This finding is consistent with the research conducted by do Carmo Oliveira et al.[45] which also reported a higher prevalence of AL in females. The authors attributed this observation to the thin cortical bones in females. In contrast, Nikkerdar et al.[5] reported that AL was significantly more common in males. It is also consistent with previous studies.[24,42,46-49] Nevertheless, other studies[38,39,41] have demonstrated that there is no significant difference between males and females.

Previous research on both cadavers and living subjects has shown that AL length ranged from 0.4 to 9 mm.[16,31,50,53] The significant discrepancies in the recorded lengths emphasize the critical need for a meticulous examination of CBCT scans. By customizing treatment plans for each individual patient, we can significantly reduce the risk of nerve damage and ensure safer outcomes.[27] This observation indicates that for the majority of individuals, maintaining 5 mm distance mesially to the MF reduces the risk of complications associated with AL damage during invasive procedures.[5]

This study revealed that the mean AL length is significantly greater in males, measuring 1.61 mm compared to just 1.22 mm in females. Such a notable difference highlights the importance of sex-specific considerations in future research. Importantly, these findings are aligned with the established work of AlQahtani[2] and Vujanovic-Eskenazi et al.[32] who reported mean AL lengths of 1.59 mm and 1.61 mm, respectively, through the use of advanced CBCT imaging. Similarly, many studies[40,42,49,51,54] have reported a higher length of the AL in males. However, others[1,16,38,39,47,48,55,56] reported that no significant difference in AL length between males and females. Uchida et al.[51] highlighted a connection between height of the individual and AL length, demonstrating that taller individuals, especially males, tend to have longer ALs. This finding underscores the importance of considering physical stature in discussions of AL variations. In a different perspective, Benninger et al.[57] suggested that race plays a significant role in anatomical differences in AL. However, challenging this viewpoint, Wong and Patil[16] found no meaningful relationship between race or sex and AL length. This highlights the complexity of anatomical variations and the need for further investigation into the factors that truly influence AL.

To avoid perforation of the buccal or lingual cortical bone during drilling, implants should be positioned in alignment with the mandible's contour.[55] Watanabe et al.[58] categorized mandible shapes into three types; A, B, and C with type B being the most prevalent (58–74%) and type C less common (17–36%). The present study corroborates this, revealing that males and females showed type B at 37.7% and 51.9% respectively. Goller Bulut and Köse[55] agreed with our results as B type was the most common type, however, Quirynen et al.[59] found type C to be the most frequent at 69.5%. The discrepancy between these studies may be attributed to ethnic variations.

This research failed to demonstrate a statistically significant difference (p=0.30) between males and females regarding the distance from the MF to AC. Males exhibited an average distance of 14.58 ±2.88mm, whilst females showed 14.36 ±2.64mm. However, Nikkerdar et al.,[5] Ahmed et al.,[7] and Al-Mahalawy et al.[10] noted a significant greater distance in males, attributing this to larger mandibular dimensions in men indicating that proper planning determines the suitable size for each individual case. Nikkerdar et al.[5] noted that the distance from the MF to AC was less than that reported by Al-Mahalawy et al.[10] and Haktanir et al.[60] It is worth mentioning that Al-Mahalawy et al.[10] excluded edentulous patients, potentially explaining their higher reported value.

This study indicated that the MC path was 28.1% linear and 19.1% vertical in males, compared to 22.4% linear and 17.1% vertical in females. The difference between males and females was not statistically significant (p=0.122). This supports the research conducted by Al Dalalah et al.[3] which revealed that there were no significant differences between both sexes in the pathway of the MC. Furthermore, Nikkerdar et al.[5] emphasized that the linear pattern is the predominant configuration of the canal, followed by the vertical pattern. Additionally, Iyengar et al.[61] and Al-Mahalawy et al.[10] also found that the linear pattern was the predominant configuration.

The present study revealed a very weak negative correlation between age and the length of AL on both sides (p=0.001 for right and p=0.028 for left). This contrasts with the assertions made by de Oliveira-Santos et al.[47] and do Nascimento et al.[49] who claimed that patient age does not seem to affect the AL length. Also, corresponding to Ahmed et al.,[7] no correlation was revealed in this study between age and the position of mental foramen. In agreement with Nikkerdar et al.,[5] there was a weak negative correlation between age and the distance from MF to AC, this is likely due to alveolar bone loss in older individuals.

CONCLUSION

This study highlights the important role of using the proper imaging modality to detect and assess the anatomical landmarks in the anterior mandible before any surgical intervention. Considering the variability of results, utilizing CBCT is essential for effectively diagnosing, planning, and assessing the MF and AL in each unique case. This approach ensures personalized care and optimal outcomes for patients.

DECLARATIONS

Ethics approval and consent to participate

The study was approved by the ethic committee, faculty of Dentistry, Cairo university (code number 28324).

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflict of interest

The authors declare that they have no competing interests.

Author Contributions

OM. Data collection and analysis + manuscript writing and revision

HW. Data collection and analysis + manuscript writing and revision

AM. Data collection + manuscript revision

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