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Original Article

Patterns of mental foramen and anterior loop in patients attending Qassim University: A cone beam computed tomography-based cross-sectional study

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ABSTRACT

Background: The mental foramen (MF) is a crucial anatomical landmark in the lower jaw, providing a passage for nerves and blood vessels. Variations in its location, shape, and size can impact dental procedures and surgical outcomes, with global variations affecting approximately 60% of the population. Understanding these variations is essential to reduce surgical risks and improve patient outcomes in dental practices. **Objective:** The study aimed to identify the pattern of MF and anterior loop (AL) in patients attending Qassim University, using Cone Beam Computed Tomography (CBCT) to assess its prevalence, classification, and distance from the mandibular border. **Methods:** A retrospective study was conducted at the College of Dentistry, Qassim University, with 371 participants selected by simple random method. Data collection involved CBCT scans evaluated independently by a radiologist and a maxillofacial surgeon, with inter-examiner agreement ensured through calibration. Statistical analysis used SPSS® software version 21, with Chi-square and Fisher's exact tests for significance, and the Kappa test for inter-observer bias. Ethical approval was obtained from the institutional ethics committee. **Results:** The study involved 340 participants, with 68.8% males and 31.2% females. The most prevalent right-side classification was Type I (52.6%), followed by Type II (31.8%) and Type III (15.6%). The left side showed a similar distribution with Type I at 48.8%, Type II at 31.5%, and Type III at 19.7%. Most MF were directed upward (93.8% on the right side and 93.5% on the left side). The most common pattern for the MF was the straight pattern (67.5%), with the AL (18.8%) and perpendicular patterns (13.7%) being less common. **Conclusion:** The study found significant variations in MF patterns, the most common being the straight pattern. Although there was no significant association between gender and classification, a significant association was observed between bilateral occurrence and left-side classification.

Keywords: Anatomical variations, anterior loop, cone beam computed tomography, dental surgery, mental foramen

Introduction

The mental foramen (MF), a key anatomical landmark in the lower jaw, provides a passage for nerves and blood vessels. Its variations in location, shape, and size across different populations can impact dental procedures and surgical outcomes.[1] Globally, about 60% of the population may experience variations in the position of the MF, posing risks during dental surgeries and increasing the likelihood of nerve damage.[2] Accurate knowledge of its position is crucial in dental surgery to minimize complications and improve patient outcomes.[3] Failure to accurately identify the MF can lead to complications such as nerve damage, altered sensation, and post-surgical neuropathic pain. This is particularly critical in implant placement, where incorrect positioning may result in implant failure or prolonged post-operative discomfort. Understanding these variations can help clinicians in pre-operative planning to avoid such complications. In Saudi Arabia, where dental procedures are on the rise, understanding these variations is critical for enhancing surgical safety and customizing treatment plans for each patient.[4]

These patterns can vary significantly across different populations, emphasizing the need for dental practitioners to understand local variations to reduce the risk of complications during procedures and ensure better patient outcomes.[5] Recent studies on the patterns of the mental nerve offer valuable insights for dental professionals. A 2022 study by Sferlazza *et al*. identified the straight pattern as the most common, followed by the anterior loop (AL) and perpendicular patterns.[1] Similarly, a study by Gakonyo in India found a high prevalence of the straight pattern, with other patterns occurring less frequently.[2] These findings underscore the importance of dental practitioners understanding these variations to reduce the risk of complications during procedures, ultimately leading to improved patient outcomes.[6]

The present study at Qassim University aimed to identify the pattern of MF and AL in patients attending Qassim University, using Cone Beam Computed Tomography (CBCT) to assess its prevalence, classification, and distance from the mandibular border. CBCT was chosen over conventional imaging techniques due to its superior ability to provide high-resolution, three-dimensional visualization of anatomical structures. Unlike panoramic radiography, which may introduce distortion and overlap of adjacent structures, CBCT enables precise localization of the MF and AL with minimal artifacts. This accuracy is essential for pre-surgical planning in implantology, nerve block administration, and other invasive dental procedures. The need for such studies arises from the potential risks associated with dental surgeries, including nerve damage, which can lead to post-operative complications.[7] By examining the MF's position, shape, and size, this study seeks to improve surgical safety and assist dental practitioners in customizing treatment plans to minimize risks and ensure optimal patient outcomes.[8,9]

Materials and Methods

The study was a retrospective study conducted at the Department of Radiology, College of Dentistry, Qassim University. Ethical clearance was obtained from the institutional ethics committee and the university's Institutional Review Board (IRB) with order number 24-84-22 before conducting the study. All CBCT scans were kept confidential, with only the research group allowed to access or view patient scans. The study aimed to identify the prevalence of AL in patients attending Qassim University using CBCT, categorize the pattern of the MF, and assess its position and distance from the mandibular border.

The Mental nerve paths were classified in to three types, type 1 absence of loop, Y-shaped anatomy with the incisive branch, as wide as the main branch, this branch of mental nerve leaves posterior to MF, Type 2 absence of loop and T-shaped branching of incisive nerve as wide as main nerve and mental nerve leaves perpendicular to the opening of MF Type 3 presence of anterior loop Y-shaped anatomy with the incisive branch as narrow as the main branch, mental nerve branch out from the inferior alveolar nerve anterior to MF [Figure 1].

The study lasted four months, with a sample size calculation was done using G*Power (Version 3.1). CBCT image evaluation was performed over a period of 2 months, with each image assessed independently by two calibrated observers. Calibration sessions were conducted before data collection, ensuring an inter-examiner agreement rate of at least 80%. The data extraction and verification process took approximately 4 weeks, followed by statistical analysis. The observed proportion of AL was used for the sample size calculation.[10] This resulted in a total of 371 participants selected through simple random method and was sufficient to have a 95% chance of correctly rejecting the null hypothesis of no differences between expected and observed proportions.

The sample included patients from the Saudi population with the presence of permanent molars and all teeth present in the mouth. Individuals with mixed dentition or lesions obscuring the MF region were excluded from the study. Additional exclusion criteria included cases with prior mandibular trauma, a history of orthognathic surgery, radiographic artifacts affecting visualization, and severe bone resorption. The inclusion criteria ensured that only individuals with fully erupted permanent dentition and no pathological conditions affecting mandibular anatomy were considered, making the sample representative of a typical adult population. The data collection methods involved CBCT scans to evaluate the MF and AL. CBCT scans were acquired using a standardized imaging protocol, with a voxel size of 0.16 mm, field of view of 15 × 8.5 cm, and slice thickness of 1 mm. The scans were performed using Sirona Dental Systems GmbH, Bensheim, Hessen, Germany, used with Sidexis–XG software, with exposure parameters set at 98 kVp, 3–6 mA, and exposure time 14 s/2–5 s. The region of interest included the mandibular premolar region bilaterally, with axial, sagittal, and coronal slices assessed for optimal visualization of the MF and AL. All images were reconstructed using Sidexis–4 to ensure consistency in measurement and classification. Two observers – a radiologist and an oral and maxillofacial surgeon – assessed the CBCT scans

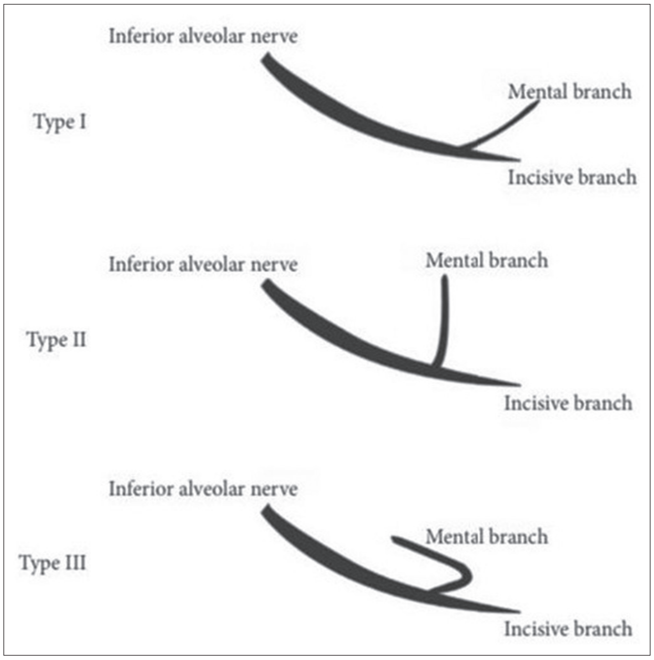

Figure 1: Describes the different types of mental nerve paths

independently. The specialist was calibrated by the radiologist based on an 80% inter-examiner agreement. All measures were taken to maintain confidentiality and anonymity, with only patient file numbers recorded in the data collection sheets. In cases where CBCT scans were incomplete, unclear, or lacked the required anatomical structures, they were excluded from the analysis. In addition, any missing patient demographic data were cross-verified with institutional records to maintain dataset completeness. The obtained data were recorded in a Microsoft Excel sheet and analysis plan was carried out using SPSS® software version 21 with the application of Chi-square and Fisher's exact tests while $P < 0.05$ was considered as statistically significant. Inter-observer bias was evaluated using the Kappa test.

Results

The study involved a total of 340 participants, with a greater representation of males (68.8%) compared to females (31.2%) [Figure 2]. The majority of the participants were aged 25 and under (38.5%), followed by those aged 26–40 (32.4%). Participants aged 41–55 accounted for 19.4%, while the smallest group comprised those aged 56 and older (9.7%) [Figure 3]. The classification of the right side showed that the most common type was Type I (52.6%), followed by Type II (31.8%), with Type III being the least common (15.6%). Similarly, on the left side, Type I was the most prevalent (48.8%), followed by Type II (31.5%), and Type III (19.7%) [Figure 4]. Regarding bilateral occurrence,

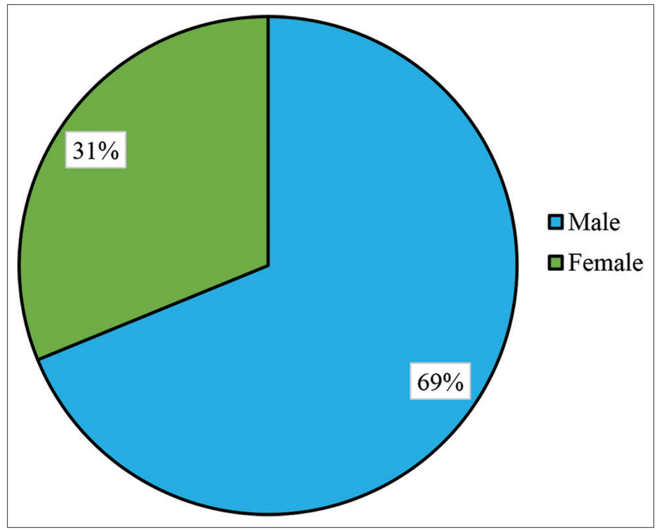

Figure 2: Gender distribution of study participants

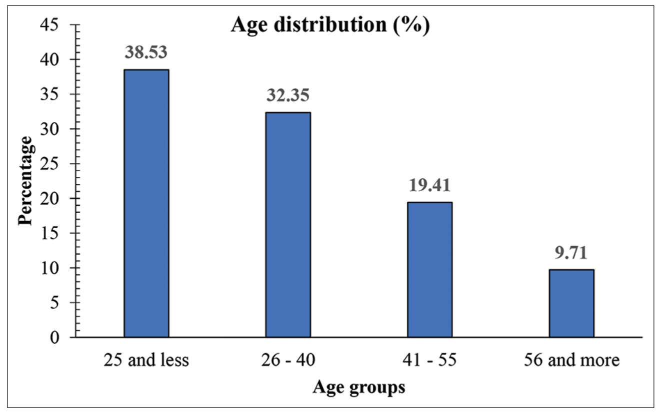

Figure 3: Age distribution of study participants

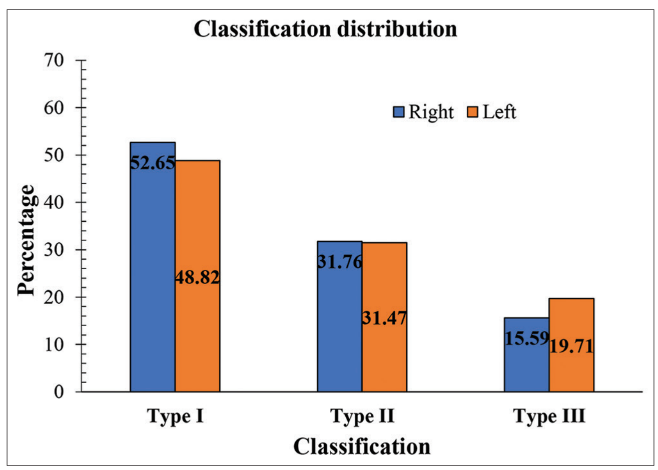

Figure 4: Classification of type of study participants by different sides

the majority of the participants had bilateral patterns (75.9%), while 24.1% did not [Figure 5]. In terms of direction, the vast majority of mental foramina on the right side were directed upward (93.8%), with only 6.2% directed downward [Figure 6]. A similar pattern was

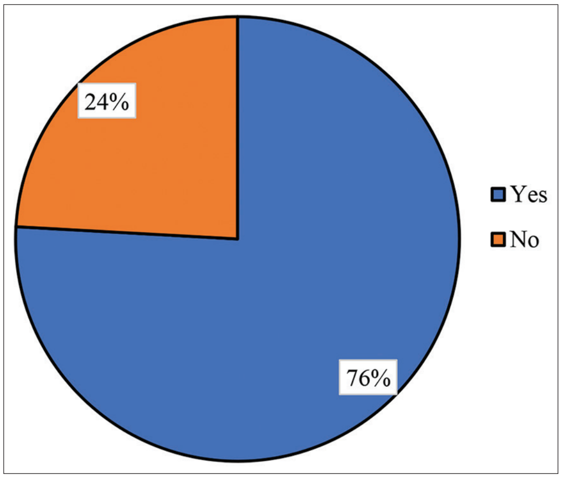

Figure 5: Distribution of bilateral presence in study participants

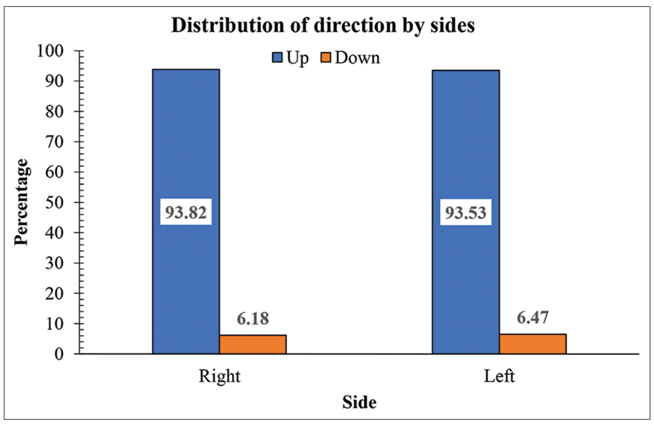

Figure 6: Direction by different sides

observed on the left side; with 93.5% directed upward and 6.5% directed downward [Table 1].

In Table 2, the descriptive statistics of continuous variables provide information about the distribution of age in the study participants, as well as the MF distances from the inferior border (IB) in the right and left sides. Participants ranged from 10 to 66 years of age, with a mean age of 33.78 years (SD = 13.51), suggesting that the sample consisted of a variety of ages. The minimum distance of the MF to the IB was 3.50 mm on the right and 5.65 mm on the left, whereas the maximum distance was 13.56 mm on the right and 11.87 mm on the left, with a mean of 7.63 mm ± 1.86 on the right and 8.45 mm ± 1.91 on the left. The minimum distance was 3.50 mm, a maximum of 12.40 mm, a mean of 7.46 mm, and a standard deviation of 1.80 mm on the left side.

Table 3 examines the association between right-side classification type and various demographic and clinical variables. The distribution of right-side classification types among males and females shows that Type I is the most common pattern for both genders. Among males, 50.4% had Type I, 31.6% had Type II, and 17.9%

Table 1: Frequency distribution of the variables (*n*=340)

Variable	*n*	%
Gender		
Male	234	68.8
Female	106	31.2
Age groups		
25 and less	131	38.5
26–40	110	32.4
41–55	66	19.4
56 and more	33	9.7
Right-side classification type		
Type I	179	52.6
Type II	108	31.8
Type III	53	15.6
Left-side classification type		
Type I	166	48.8
Type II	107	31.5
Type III	67	19.7
Bilateral		
Yes	258	75.9
No	82	24.1
Right-side direction		
Up	319	93.8
Down	21	6.2
Left-side direction		
Up	318	93.5
Down	22	6.5

Table 2: Descriptive statistics of continuous variables

Variable	Minimum	Maximum	Mean	SD
Age in years	10.00	66.00	33.78	13.51
Right-side distance of MF to IB (mm)	3.50	13.56	7.63	1.86
Left-side distance of MF to IB (mm)	3.50	12.40	7.46	1.80

MF: Mental foramen, IB: Inferior border

Table 3: Association of right-side classification with different variables

Variable	Right-side classification type						Total	Chi-square, (*P*-value)
	Type I		Type II		Type III			
	n	%	*n*	%	*n*	%	*n*	
Gender								
Male	118	50.4	74	31.6	42	17.9	234	3.390, (0.184)
Female	61	57.5	34	32.1	11	10.4	106	
Age groups								
25 and less	68	51.9	44	33.6	19	14.5	131	2.256, (0.895)
26–40	61	55.5	30	27.3	19	17.3	110	
41–55	35	53.0	21	31.8	10	15.2	66	
56 and more	15	45.5	13	39.4	5	15.2	33	
Bilateral								
Yes	143	55.4	76	29.5	39	15.1	258	3.515, (0.172)
No	36	43.9	32	39.0	14	17.1	82	
Right-side direction								
Up	168	52.7	100	31.3	51	16.0	319	0.811, (0.667)
Down	11	52.4	8	38.1	2	9.5	21	
Left-side direction								
Up	167	52.5	99	31.1	52	16.4	318	2.475, (0.290)
Down	12	54.5	9	40.9	1	4.5	22	

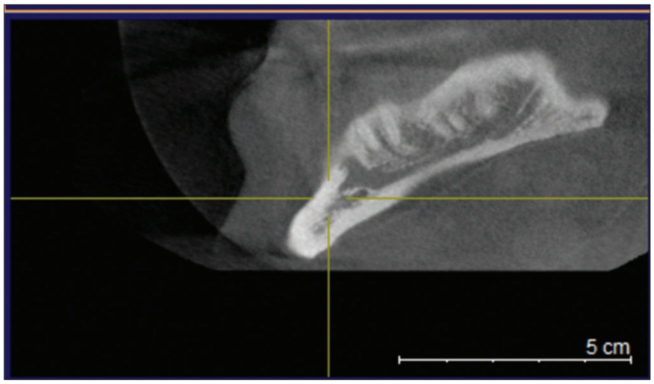

Figure 7: Left-side type 1

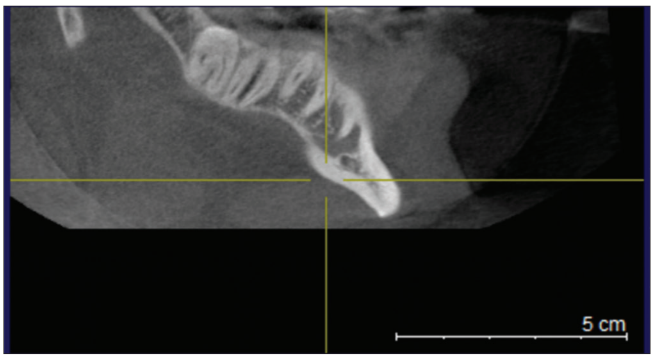

Figure 8: Right-side type 1

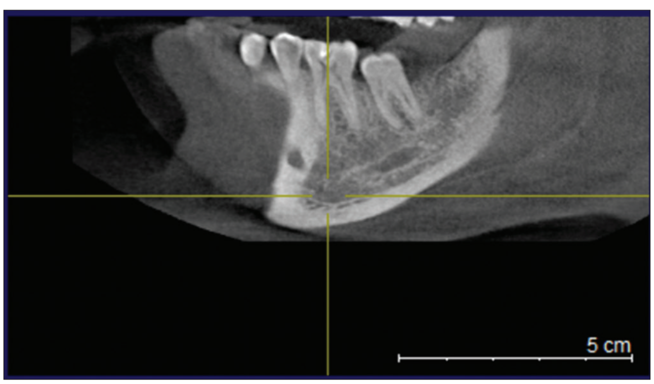

Figure 9: Left-side type II

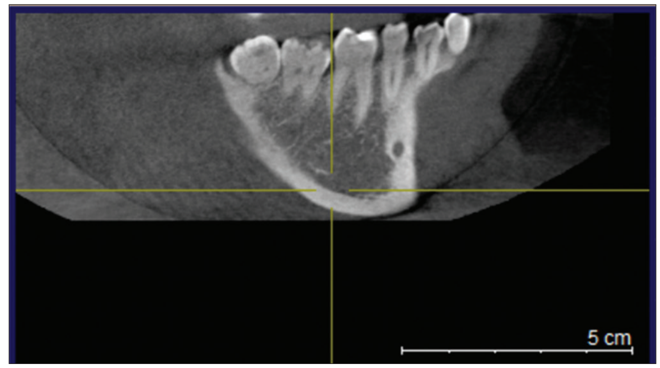

Figure 10: Right-side type II

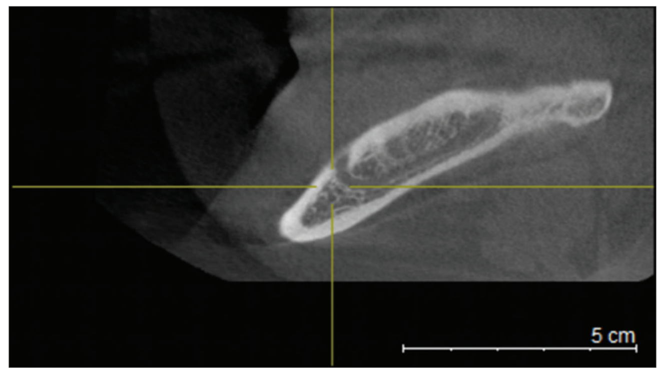

Figure 11: Left-side type III

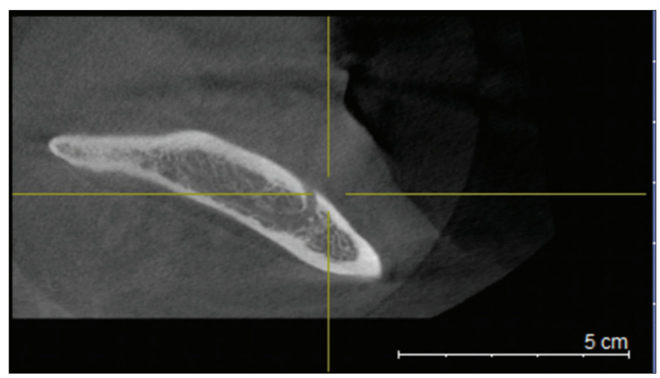

Figure 12: Right-side type III

had Type III. For females, the distribution was 57.5% for Type I, 32.1% for Type II, and 10.4% for Type III. The Chi-square statistic of 3.390 with a P-value of 0.184 indicates that this difference is not statistically significant, suggesting no strong association between gender and right-side classification. Examining the distribution of right-side classification across different age groups, Type I remained the most prevalent across all groups. In the 25 and less age group, 51.9% had Type I, 33.6% had Type II, and 14.5% had Type III. The other age groups had similar trends, with slight variations. The Chi-square statistic of 2.256 with a P-value of 0.895 shows no significant association between age groups and right-side classification [Figures 7-14].

Among those with bilateral patterns, 55.4% had Type I on the right side, 29.5% had Type II, and 15.1% had Type III. For those without bilateral patterns, the distribution was 43.9% for Type I, 39.0% for Type II, and 17.1% for Type III. The Chi-square statistic of 3.515 with a $P = 0.172$ suggests no significant association between bilateral occurrence and right-side classification. For participants with the right-side direction pointing upward, the distribution was 52.7% for Type I, 31.3% for Type II, and 16.0% for Type III. For those with a downward direction, it was 52.4% for Type I, 38.1%

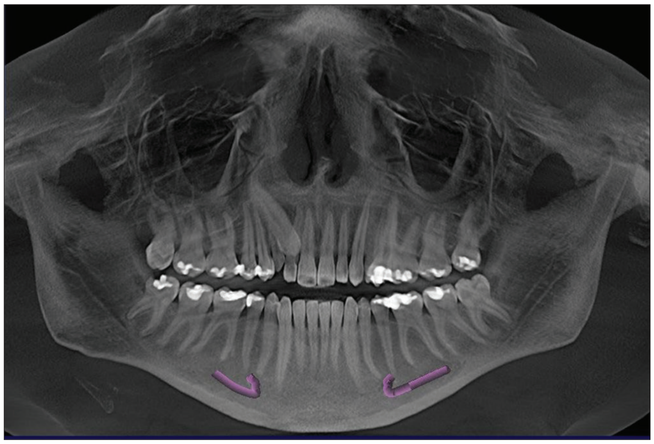

Figure 13: Tracing for type III

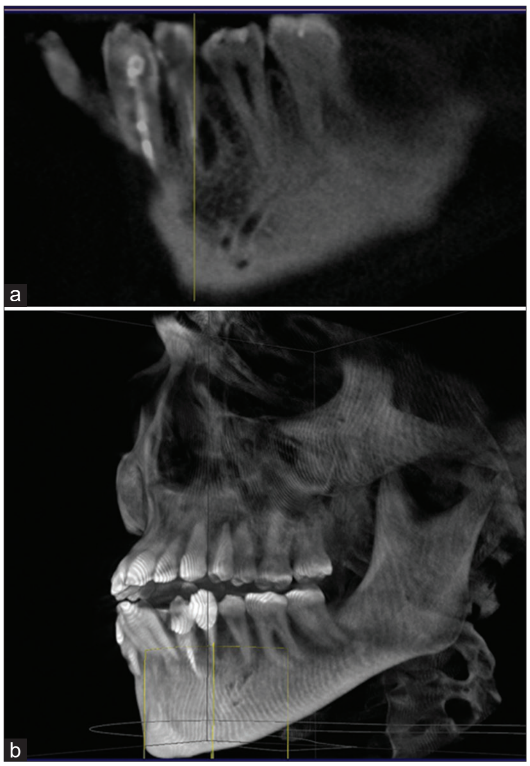

Figure 14: (a) Three foramina, (b) 3D reconstructed image showing three foramina

for Type II, and 9.5% for Type III. The Chi-square statistic of 0.811 with a $P = 0.667$ shows no significant association between right-side direction and right-side classification. Similarly, among participants with the left-side direction pointing upward, the distribution was 52.5% for Type I, 31.1% for Type II, and 16.4% for Type III. For those with a downward direction, the distribution was 54.5% for Type I, 40.9% for Type II, and 4.5% for Type III. The Chi-square statistic of 2.475 with a $P = 0.290$ indicates no significant association between left-side direction and right-side classification.

Table 4: Association of left-side classification with different variables

Variable	Left-side classification type						Total	Chi-square, (*P*-value)
	Type I		Type II		Type III			
	n	%	*n*	%	*n*	%	*n*	
Gender								
Male	110	47.0	75	32.1	49	20.9	234	1.167, (0.558)
Female	56	52.8	32	30.2	18	17.0	106	
Age groups								
25 and less	59	45.0	42	32.1	30	22.9	131	2.388, (0.881)
26–40	58	52.7	33	30.0	19	17.3	110	
41–55	34	51.5	21	31.8	11	16.7	66	
56 and more	15	45.5	11	33.3	7	21.2	33	
Bilateral								
Yes	143	55.4	76	29.5	39	15.1	258	22.36, (0.000*)
No	23	28.0	31	37.8	28	34.1	82	
Right-side direction								
Up	156	48.9	101	31.7	62	19.4	319	0.258, (0.879)
Down	10	47.6	6	28.6	5	23.8	21	
Left-side direction								
Up	157	49.4	97	30.5	64	20.1	318	2.303, (0.332)
Down	9	40.9	10	45.5	3	13.6	22	

$P<0.05$ is marked by *, which implies significant difference

Table 4 explores the association between left-side classification types and various demographic and clinical variables. Regarding gender, the distribution of left-side classification types shows that males had Type I at 47.0%, Type II at 32.1%, and Type III at 20.9%. For females, the distribution was 52.8% for Type I, 30.2% for Type II, and 17.0% for Type III. The Chi-square statistic of 1.167 with a $P = 0.558$ indicates no significant association between gender and left-side classification. Looking at the age groups, the distribution of left-side classification shows Type I is the most prevalent in most groups, with varying percentages. For the 25 and less age group, 45.0% had Type I, 32.1% had Type II, and 22.9% had Type III. The 26–40 group showed Type I at 52.7%, Type II at 30.0%, and Type III at 17.3%. Other age groups followed similar trends. The Chi-square statistic of 2.388 with a $P = 0.881$ shows no significant association between age groups and left-side classification.

For bilateral occurrence, there is a noticeable variation in left-side classification. Among those with bilateral patterns, 55.4% had Type I, 29.5% had Type II, and 15.1% had Type III. However, among those without bilateral patterns, the distribution changed: 28.0% had Type I, 37.8% had Type II, and 34.1% had Type III. The Chi-square statistic of 22.36 with a $P < 0.05$ (marked by an asterisk) indicates a significant association between bilateral occurrence and left-side classification. Examining the right-side direction, the classification distribution showed minimal variations. For participants with the right-side direction pointing upward, Type I was at 48.9%, Type II at 31.7%, and Type III at 19.4%. For those with the right-side direction pointing downward, the distribution was similar, with a Chi-square statistic of 0.258 and a $P = 0.879$, indicating no significant association between right-side direction and left-side classification.

The distribution for the left-side direction indicated a slight difference. For those with an upward direction, Type I was at 49.4%, Type II at 30.5%, and Type III at 20.1%. Among those with a downward direction, the distribution varied, with Type I at 40.9%, Type II at 45.5%, and Type III at 13.6%. The Chi-square statistic of 2.303 with a $P = 0.332$ suggests no significant association between left-side direction and left-side classification.

Discussion

The present study from Qassim University involved 340 participants, with a gender distribution of 68.8% males and 31.2% females. The majority of participants were aged 25 and under (38.5%), followed by those aged 26 to 40 (32.4%). In terms of classification, the most common pattern seen on the right side was Type I (52.6%), followed by Type II (31.8%), and Type III (15.6%), with a similar distribution on the left side. Bilateral occurrence was observed in 75.9% of participants, and the MF direction was predominantly upward (93.8% on the right side and 93.5% on the left side). In contrast, the review by Sferlazza et al. provided a broader analysis of various neurovascular canals and foramina, including the lateral lingual foramen (LLF) and its vascular connections, highlighting its role in anastomoses with the submental and inferior alveolar arteries.[1] The average age group was 35.29 ± 10.14 years, with most participants in the 18–35 age range (57.3%). The most prevalent mental nerve pattern was the straight pattern (67.5%), followed by the AL pattern (18.8%) and the perpendicular pattern (13.7%), similar to the present study. Although there were similarities in the observed MF patterns, the Sferlazza *et al*. study did not detail the bilateral occurrence or direction, highlighting potential areas for further exploration.[1]

In the present study, the age range spanned from 10 to 66 years, with a mean of 33.78 years, while the distance from the MF to the IB on the right side varied from 3.50 mm to 13.56 mm (mean of 7.63 mm), and on the left side, from 3.50 mm to 12.40 mm (mean of 7.46 mm). These findings highlight the slight variation in the right-side distance. Laher *et al*.'s study provided linear distances to the mandibular borders, with the upper border distance ranging from 9.1 mm to 19.2 mm (mean of 14.3 mm) and the lower border distance from 8.75 mm to 16.6 mm (mean of 13.8 mm), suggesting a broader range.[3] In addition, Laher *et al*. reported on the prevalence of inferior alveolar canal patterns, finding that linear patterns were most common (46.2%), followed by perpendicular (38.6%) and AL (15.2%).[3]

The present study focused on the association between right-side classification type and various demographic and clinical variables, revealing that Type I was the most common pattern among both males and females, with no significant association between gender and right-side classification (Chi-square statistic of 3.390, $P = 0.184$). There was also no significant association across age groups, bilateral occurrence, or right-side direction, suggesting that these factors do not strongly influence the right-side classification of the MF. In contrast, the study by Sferlazza *et al*. found a similar lack of significant association between gender and subtypes of looping patterns, supporting the notion that gender may not significantly impact the occurrence of these patterns.[1] However, contrasting results from other studies, like those by Greenstein and Tarnow and Salsabilla *et al*., indicate that associations between gender and AL prevalence can vary, with Salsabilla *et al*. observing a higher prevalence of AL in males and on the left side.[5,6] While the present study found no significant association between age and MF classification, age-related changes in mandibular morphology could still influence anatomical variations. Bone remodeling, resorption, and changes in cortical thickness occur progressively with aging, particularly in edentulous patients or those with significant alveolar bone loss. However, in individuals with well-maintained dentition, the position of the MF remains relatively stable due to preserved bone integrity. Studies have suggested that the mandibular canal and associated foramina may be more susceptible to positional shifts in older populations due to physiological remodeling processes.[10]

The present study and the study by Laher *et al*. provide insights into the classification of MF and its associations with various demographic and clinical factors.[3] The present study found that the most common left-side classification type for males was Type I (47.0%), with no significant association between gender and left-side classification ($P = 0.558$). However, there was a significant association between bilateral occurrence and left-side classification ($P < 0.05$). Regarding MF position, the most common location was below the apex of the second pre-molar (52.8%), with some scans showing MF between the first and second pre-molar (29.6%). Laher *et al*. also reported that 38.7% of MF were 1–3 mm from the nearest root apex, with statistically significant results indicating a preference for the position below the apex of the second pre-molar on the left side for females (P = 0.023).[3] In addition, the most common IAC pattern was linear (46.2%), with the perpendicular pattern (38.6%) and the AL (15.2%) following. These findings offer a comprehensive view of MF classifications, positions, and patterns, highlighting areas of statistical significance and demonstrating the diverse patterns that can occur in different studies.[11]

The MF and AL are important anatomical regions that pose challenges in the planning of implants and other surgical procedures. CBCT imaging plays a critical role in pre-operative implant planning, as it allows for precise localization of the MF and AL, ensuring safer implant placement and reducing the risk of nerve injury. For instance, CBCT enables the identification of variations in MF position and trajectory, allowing practitioners to adjust implant angulation accordingly. In addition, in nerve block administration, CBCT assists in determining the optimal site for local anesthesia, minimizing the likelihood of failed anesthesia or inadvertent nerve trauma. In oral surgical procedures, particularly third molar extractions and mandibular osteotomies, pre-operative CBCT scans can help prevent iatrogenic complications by providing a detailed 3D visualization of anatomical structures. The present study also shows the frequency of an AL (18.8%) which can increase the risk of nerve impingement with implant placement, and thus initial evaluation with CBCT should be performed before surgical interventions. In addition to this, posterior mandible implant placement needs a great deal of planning because the implant positioning relative to the MF can lead to implant failure or post-operative nerve complications.

In addition, precise localization of the MF is critical for the successful administration of anesthesia. Not being able to locate its exact position and subsequently anesthetizing that region can lead to a lack of complete anesthesia during various dental procedures, leaving the patients in perpetual discomfort. The knowledge that the MF is most often found beneath the second pre-molar (52.8%) would be helpful for the clinician in developing more efficient nerve block techniques for enhanced anesthetic device objectives, the present study validates this. CBCT has transformed treatment planning in implantology and maxillofacial surgery by offering precise measurements of bone density, foramen location, and surrounding neurovascular structures. Unlike conventional radiographs, CBCT eliminates distortion and superimposition, allowing for more accurate assessments of bone morphology. This is particularly advantageous in cases of advanced atrophy, where traditional imaging may fail to provide sufficient detail. The integration of CBCT into routine pre-surgical evaluations ensures greater procedural accuracy, reduced surgical errors, and enhanced patient safety. Future advancements in artificial intelligence-driven CBCT analysis may further streamline treatment planning and predictive analytics for patient-specific surgical interventions.

A key limitation of the present study is its relatively small sample size of 340 participants, which may not comprehensively represent the broader population's variations in MF patterns. This limitation could lead to reduced generalizability of the results, with possible selection bias due to focusing on patients attending Qassim University. Future studies should aim to include a more extensive and diverse sample, encompassing different regions and demographics, to identify a broader range of MF patterns and ensure more accurate conclusions.[12-14] In addition, exploring the clinical implications of these variations through longitudinal studies could provide valuable insights into the changing trends and impacts of MF patterns on dental surgeries and patient outcomes.[15-17]

Conclusions

The results of this study indicate that the most prevalent pattern for the MF is the straight pattern, with the AL pattern and perpendicular pattern occurring less frequently. The classification type on the right side showed that Type I was the most common, followed by Type II and Type III, a similar distribution observed on the left side. There was no significant association between gender and either the right-side or left-side classification, suggesting that gender might not be a strong predictor of these patterns. However, there was a significant association between bilateral occurrence and left-side classification, indicating that the presence of bilateral patterns could influence classification types. The vast majority of MF on both sides was directed upward, with only a small proportion directed downward. This study's results contribute to the understanding of the MF's patterns, offering valuable insights for dental practitioners and guiding safer and more effective dental procedures. Despite the limitations, the findings emphasize the importance of recognizing variations in the MF to minimize surgical risks and improve patient outcomes. Further research with larger and more diverse samples could expand these conclusions and enhance the generalizability of the results.

Authors Contributions

Conceptualization, AA. and FA.; methodology, FA.; software, AIA.; validation, AIA., FA. and SHK.; formal analysis, AIA.; investigation, FA.; resources, AIA.; data curation, AA.; writing/original draft preparation, FA.; writing – review and editing, AIA.; visualization, AA.; supervision, FA; project administration, AA.;. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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