



ORIGINAL RESEARCH

ASSESSMENT OF MIDLINE MANDIBULAR LINGUAL FORAMEN DIAMETER USING CBCT

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Abstract

Background: The midline mandibular lingual foramen (MLF) is an important anatomical structure in the anterior mandible due to its association with vascular structures that may cause significant bleeding during surgical procedures. Variations in its diameter may influence the risk of intraoperative complication.

Objective: This study aimed to assess, using cone-beam computed tomography (CBCT), the gender and age-based distribution of midline mandibular lingual foramen diameters classified as ≤ 1 mm and >1 mm.

Materials and Methods: A retrospective cross-sectional study was conducted on CBCT scans of patients obtained from radiological center in Sana'a city. The diameter of the midline lingual foramen of mandible was evaluated and categorized into two groups: ≤ 1 mm and >1 mm. The prevalence of each category was compared between genders and age groups.

Results: Midline lingual foramina with diameters ≤ 1 mm were observed in 52 (29.4%) of males and 125 (70.6%) of females. In contrast, midline lingual foramina with diameters >1 mm were identified in 122 (56.2%) of males and 95 (43.8%) of females. So, larger foramina were more prevalent in males, whereas smaller foramina were more common in females.

Conclusion: The distribution of midline lingual foramen diameter demonstrates a clear gender-based pattern, with males exhibiting a higher prevalence highlight the importance of careful preoperative CBCT assessment, particularly in male patients whereas the age does not show a significant effect.

Keywords: Mandible, Midline lingual foramen, Diameter, CBCT

1. INTRODUCTION

The mandible is a fundamental component of the craniofacial skeleton that play a crucial role in the mastication, speech, and facial aesthetics. Due to its functional importance and accessibility, the mandible is frequently subjected to various surgical and restorative procedures. The anterior region of the mandible, particularly the interforaminal area, has traditionally been regarded as relatively safe zone for surgical interventions owing to the absence of the inferior alveolar nerve. Nevertheless, this region contains several

ital anatomical structures that warrant careful evaluation^{1,2}.

The anterior mandible is of great importance for surgical interventions such as dental implant placement, donor site for block bone graft, genioplasty and other surgeries involving the symphyseal area of mandible. So, accurate preoperative assessment of the midline lingual foramen has become essential. Previous studies have reported considerable anatomical variation in the size and prevalence of the MLF, suggesting that larger foramina may be associated with a higher risk of intraoperative bleeding³.

The midline lingual foramen (MLF) is a small anatomical opening located on the lingual surface of the mandibular symphysis, typically in the midline region. It serve as a conduit for neurovascular structures, most commonly branches of the sublingual and submental arteries⁴.

Despite its small size, the midline lingual foramen (MLF) is of considerable clinical importance, as injury to these vessels may cause severe hemorrhage, hematoma in floor of the mouth and potential airway compromise^{5,6}.

Cone-beam computed tomography (CBCT) has emerged as a reliable imaging modality for the evaluation of mandibular anatomical structures due to its high spatial resolution, three-dimensional visualization with relatively low radiation exposure and allow precise identification and measurement of the lingual foramen. Unlike conventional two-dimensional imaging, Unlike conventional two-dimensional imaging, CBCT enables clinicians and researchers to detect, measure, and classify the size and location of the MLF with greater accuracy, improving diagnostic confidence and facilitating safer surgical planning².

Although several studies like⁷⁻¹¹ have investigated the morphology of the midline lingual foramen, limited data are available regarding the distribution of the midline lingual foramen diameter when classified into clinically relevant categories. Some population showed statistically larger foramina in males than females, but there remains a need for more focused research comparing diameter of MLF in particular, gender and age differences when categories the diameters into $\leq 1\text{mm}$ and $>1\text{mm}$ across different samples and ethnicities⁹.

This lack of consensus highlights the need for further studies to clarify the relationship between midline lingual foramen diameter according to gender and age.

Therefore, this study aims to assess the diameter of the midline mandibular lingual foramen using CBCT and to evaluate its distribution according to gender and age groups in Yemeni population; given the potential clinical relevance of larger foramina during surgical procedures in the anterior mandible and enhance the safety of surgical procedures in this region.

2 MATERIALS AND METHODS

Study characteristics:

The purpose of this study was to evaluate the prevalence of midline lingual foramen diameter and its association with gender and age groups using CBCT. It is a retrospective cross-sectional study was conducted using CBCT to avoid the complication during surgical procedures.

The study included all cases meeting in the study criteria based on cone-beam computed tomography and were archived in radiographic centers in Sana'a, Yemen.

All scans were acquired as part of routine patient care and not specifically for research purpose.

CBCT images were evaluated according to gender (male and female) and age groups of (<30 , $30-39$, $40-49$, or ≥ 50 years).

Study Sample:

A total of 200 CBCT scans were retrospectively selected from the database of the Department of Oral and Maxillofacial Radiology centers in Sana'a city, Yemen.

Inclusion criteria:

- 1- Clear CBCT images of anterior mandible (symphysis region).
- 2- CBCT of adult patients aged 18 years and above.
- 3- Absence of pathological lesions, fractures, or surgical defects.

Exclusion criteria:

- 1- Presence of pathology such as cyst, tumors, or others that affecting the mandibular symphysis.
- 2- Sever bone resorption that could impact the identification of the midline lingual foramen.

CBCT Imaging Protocol:

All CBCT scans were acquired using the same CBCT unit (Vatech, Korea) to ensure standardization of imaging parameters.

The imaging parameters with the following exposure setting: field of view, $5*5$, $5*8$, $8.5*8.5$, $8.5*12$ and $9*12$ cm; tube voltage, 90 kVp; tube current, 4.0 mA; scan time, 24 seconds; and isotropic voxel size, 0.160-0.200 mm for full mouth scan and 0.060-0.020 mm for others. according to the manufacturer's guidelines.

The scans were reconstructed and analyzed using the proprietary CBCT software of Ez3D-I that provided by the manufacturer. Multiplanar reconstruction views (axial, sagittal, and coronal) were used for accurate identification and measurement of the midline lingual foramen.

Image Analysis and Measurement Procedure

The midline mandibular lingual foramen was identified on the lingual surface of the mandible in the midline region as radiolucent opening. Identification was performed primarily on sagittal and axial views, with confirmation on coronal sections when necessary to ensure continuity with a lingual canal as showed by black arrow in the (Figure 1)



Figure 1. Identification of Midline Lingual Foramen

The diameter of the midline lingual foramen was measured perpendicular to the long axis of the lingual canal at its widest point of entering using the linear measurement tools available in the CBCT software (Ez3D-i software). Magnification and slice thickness adjustments were applied as needed to enhance measurement accuracy. Measurements were recorded in millimeters (mm). The diameter of midline lingual foramen was clarified with black arrow in the (Figure 2)

For analytical purposes, the measured diameters were categorized into two groups:

- 1) ≤ 1 mm
- 2) > 1 mm

This classification was adopted based on previous CBCT studies that reported increased clinical risk associated with larger lingual foramen diameters.



Figure 2. Diameter of Midline Lingual Foramen

Reliability of Measurements

All measurements were performed twice by the researcher with help from a technician who experience in

Statistical Analysis

The collected data were entered into a statistical software package for analysis. Descriptive statistics were used to calculate frequencies and percentages for categorical variables.

The association between gender and midline lingual foramen diameter category (≤ 1 mm and > 1 mm) was evaluated using the Chi-square test. The level of statistical significance was set at $P < 0.05$.

Ethical consideration:

An ethical approval was received from the medical ethical committee of the faculty of dentistry, Sana'a University (OMFS:4/10/2024).

3.RESULTS

Among the 200 CBCT scans were evaluated in the present study. The sample comprised adult individuals of both genders 90 (45%) of males and 110 (55%) of females, representing a wide age range (< 30 , 30-39, 40-49, and ≥ 50 years).

A total of 394 midline lingual foramen were identified in the study sample. As multiple foramina could be present in a single case, all analyses were conducted per foramen. Therefore, the total number of detected lingual foramina was 394 representing 100%

The diameter of the midline lingual foramen of the mandible was successfully measured in all 200 CBCT scans. For analytical and clinical relevance, the diameters were categorized into two groups ≤ 1 mm and > 1 mm. This categorization enabled assessment of the distribution of potentially low risk versus high risk foramina in relation to gender and age groups.

3.1 The Comparison of the Diameters of MLF by Gender:

Of total samples, there were statistically significant differences in which most of MLF were observed with a diameter of > 1 mm in 217 (55%) of scans. as the P value was (0.000). This results highlights the importance of routine preoperative radiographic assessment of the anterior mandible.

There were statistically significant differences in the diameter of MLF between males and females in which the diameter of MLF ≤ 1 mm was more in female 125 (70.6%) than males 52 (29.4%). Conversely, in the diameter of MLF > 1 mm was greater in males 122 (56.2%) than females 95 (43.8%). as the P value was (0.000). This results indicate that smaller midline lingual foramina were more prevalent in females, whereas larger foramina were more frequently observed in males. Table 1

Table 1. Diameter of MLF by gender

Diameter	≤ 1		> 1		Total	P value
	Male	Female	Male	Female		
MLF	52 (29.4%)	125 (70.6%)	122 (56.2%)	95 (43.8%)	394 (100%)	0.000
Total	177 (45%)		217 (55%)			

Chi-Square Test

3.2 The Comparison of the Diameter of MLF by Age:

There were no statistically significant differences in diameter of MLF by age in which most of MLF >1 were presented in 81(37.3%) of subjects in the age of < 30 years followed by 50 (28.2%) in the age of 30-39 years, 42 (23.7%) in the age of 40-49 of years then 24 (13.6%) in the age of ≥ 50 of years, whereas most of MLF ≤ 1 were presented in 61(34.5%) in the age of < 30 of years followed by 62 (28.6%) in the age of 30-39 of years, 46 (21.2%) in the age of 40-49 of years, then 28 (12.9%) in the age of ≥ 50 of years . as the P value was (0.911). These findings indicate a gradual decrease in the prevalence of smaller diameter of MLF with increasing age. **Table 2**

Table 2. Diameter of MLF by Age Groups

Diameter	≤ 1				> 1				Total	P value
	<30	30 to 39	40 to 49	≥ 50	< 30	30 to 39	40 to 49	≥ 50		
MLF	61 34.5 %	50 28.2 %	42 23.7 %	24 13.6 %	81 37.3%	62 28.6 %	46 21.2 %	28 12.9 %	394 100%	0.911
Total	177 (45%)				217 (55%)					

Chi-Square Test

4. DISCUSSION

The present study aimed to evaluate the diameter of the midline lingual foramen of the mandible (MLF) according to gender and age, using a clinically relevant diameter threshold of ≤1 mm and >1 mm. The findings demonstrated a statistically significant association between MLF diameter and gender, while no significant association was observed between MLF diameter and age groups.

4.1 The prevalence of MLF diameter according to gender:

The diameter of MLF influences on the degree of risk of hemorrhage and was established in previous studies as (≤1 mm: Lower risk of hemorrhage; >1 mm:

higher risk of hemorrhage). In this study, there was statistically significant differences in which the most of MLF diameter in the current study was >1 mm in 217 (55.0%). These results support the study reported by³ with 75% of MLF diameter >1 mm. In contrast to the current study, the lowest of MLF diameter ≥ 1mm were showed in the studies reported by¹² with 13.2%,¹³ with 28.1%, with 28%,¹⁴ and with 36.84%¹⁵.

In the present study, a statistically significant differences were observed in the distribution of midline lingual foramen diameter between males and females when using a clinically classification of (≤1 mm and >1 mm). These findings revealed a distinct gender-based pattern, with larger foramina (>1 mm) occurring more frequently in males in 122 (56.2%), while smaller

foramina (≤ 1 mm) predominated in females in 95 (43.8%). These results support the study reported¹⁶ in which larger foramina presented in males (26.44%) than females in (16.38%) and by¹⁷ in which the MLF diameter > 1 mm was observed in males (56.2%). These differences may be explained by ethnicity, sample size, different of measurements used and anatomic variations. Based on the extent of the current search, no studies were found that reported the contrary to those of the present study and this reinforces the significance of the present study.

From a clinical perspective, the identification of midline lingual foramina exceeding 1mm is particularly relevant, as larger foramina may transmit larger vascular bundles and increase the likelihood of significant bleeding during implant placement, genioplasty, or bone harvesting procedures. Therefore, gender-based anatomical differences should be considered during preoperative planning.

The use of CBCT in this study allowed accurate visualization and classification of the midline lingual foramen, reinforcing its value as a diagnostic tool for risk assessment prior to surgical intervention, especially in male patients.

4.2 The prevalence of MLF diameter according to age groups:

In the present study, no significant age-based differences were observed in the diameter distribution of the midline lingual foramen using a clinically relevant classification of (≤ 1 mm and > 1 mm). Although variation in frequency was observed across age categories, these differences did not reach statistical significance. These suggest that the diameter of the midline lingual foramen is likely established during early skeletal development and remains relatively stable throughout adulthood.

Based on the extent of the current search, limited information were found that reported the similarity and contrary to those of the present study and this reinforces the significance of the present study.

5. RECOMMENDATIONS, LIMITATIONS AND CONCLUSION

Conclusion

Within the limitation of this CBCT-based study, the diameter of the midline lingual foramen showed a clear gender-based distribution. Foramina with diameters ≤ 1 mm were more common in females, whereas foramina exceeding 1mm were more frequently observed in males. These findings underscore the importance of preoperative CBCT evaluation to identify clinically significant anatomical variation. In contrast to the gender, there was no significance observed in the age-based distribution.

Recommendations

- 1- Preoperative CBCT assessment of the anterior mandible is recommended prior to surgical procedures to identify the size of midline lingual foramen.
- 2- Particular attention should be given to male patients, as they demonstrate a higher prevalence of foramina diameter greater than 1mm.
- 3- Clinicians should consider the presence of larger midline lingual foramina as a potential risk factor for intraoperative bleeding.

Limitations

- 1- The retrospective design of the study limits the ability to establish causal relationships.
- 2- Limited sample size.
- 3- The study focused solely on diameter classification and did not evaluate other anatomical parameters such as canal length or vertical position.

DECLARATIONS

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Competing interests

The authors have no competing interests to declare.

Ethical Approval

The study was approved by the appropriate ethics committee and conducted according to relevant guidelines and regulations.

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