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Retrospective Assessment of Gender Differences in Mental Foramen – CBCT study

Dr Induja Murugesan, Dr Devika Pillai, Dr Hari Priya A, Dr Dhanvanth M, Dr Devika Pillai,

[1]*Post Graduate Student,Saveetha Dental College,*

Saveetha Institute of Medical and Technical Sciences,

Saveetha University,Chennai, India.

[2]*Senior Lector and Professor, Oral Medicine and Radiology,*

Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences,

Saveetha University,Chennai, India.

[3]*Senior Lector and Professor, Oral Medicine and Radiology,*

Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences,

Saveetha University, Chennai, India.

[4]*Senior Lector and Professor Oral Medicine and Radiology*

Priyadarshini Dental College and Hospital

Chennai, India.Corresponding author:

[5]*Senior Lector and Professor, Oral Medicine and Radiology, Saveetha Dental College,*

Saveetha Institute of Medical and Technical Sciences,

Saveetha University,Chennai, India.

Abstract

Background: The mental foramen is found on both sides of the mandible bone. It serves as a passage for mental vessels and nerves. In forensic anthropology, the morphology of the mental foramen can aid in determining sex, estimating age, and identifying different races. This study focuses on using cone beam computed tomography to analyze the morphology of the mental foramen to establish gender and its application in forensic odontology. To analyze sexual dimorphism in the Chennai population by using CBCT (3-D) imaging to study the mental foramen.

Materials And Methods: A total of 200 CBCT images were analyzed to assess the opening angle of the mental foramen, the distance from the superior border of the mental foramen to the lower border of the mandible (SLM), and the distance from the inferior border of the mental foramen to the lower border of the mandible (ILM) using Kodak software analysis. Two examiners tested and recorded the results using Galileos 3D software.

Results: The average opening angle of the mental foramen was 21.4 degrees for males (ages 18-50) and 20.4 degrees for females (ages 18-50). The mean SLM distance was 14.2 mm for males and 13.6 mm for females, while the mean ILM distance was 10.0 mm for males and 9.6 mm for females. Overall, the opening angle, SLM distance, and ILM distance were greater in males than in females.

Conclusion: The distance between the mental foramen and the lower border of the jaw shows significant sexual dimorphism. A bilateral assessment of SLM and ILM in both sexes can serve as an effective tool for gender

discrimination.

Keywords: CBCT, mental foramen, sex determination, forensic dentistry

Introduction

The mental foramen (MF) is located mostly on the anterolateral side of the jaw. It is often located between the first and second lower premolars, as well as between the upper and lower borders of the jaw (1). The mental nerve, a branch of the inferior alveolar nerve, acts as the lower lip, labial mucosa, lower anterior, and premolar teeth. An auxiliary mental foramen refers to any foramen in the mandible that exists in addition to the main MF. It typically transmits auxiliary nerves to the teeth (2). Surgeons must be aware of the precise position of the mental foramen and its surrounding tissues during invasive procedures in the oral and maxillofacial region. This allows for better diagnostics, surgery, and local anesthesia (3). The mental foramen varies in size, shape, and position. Mental foramen can be circular or oval, with diameters ranging from 2.5 to 5.5 mm (4)

The mental foramen serves as a passage for the mental nerve and blood vessels, playing a crucial role in dental and maxillofacial surgery (5). Variations in the size, shape, and position of the mental foramen have been noted between genders, with males typically exhibiting a larger and more posteriorly positioned foramen compared to females (6). These differences have been attributed to sexual dimorphism, where distinct physiological and anatomical traits are observed between males and females (7).

Cone Beam Computed Tomography (CBCT) has revolutionized dental and maxillofacial imaging by providing three-dimensional visualization of anatomical structures with high accuracy and low radiation exposure (8). This imaging modality allows for precise measurements of craniofacial features, making it an ideal tool for assessing the morphological differences in the mental foramen between genders (9).

Previous research has demonstrated that CBCT can be effectively used to evaluate the mental foramen and identify gender-specific characteristics. A study by Lopes et al. (2010) revealed significant differences in the position and dimensions of the mental foramen between males and females, suggesting its utility as a reliable gender indicator (10). Similarly, Gupta et al. (2013) found that the vertical and horizontal dimensions of the mental foramen, as well as its distance from the alveolar crest and the base of the mandible, could be used to predict gender with a high degree of accuracy (11).

Despite these promising findings, the application of CBCT in gender identification requires further validation across diverse populations to account for potential variations due to ethnic and environmental factors. This retrospective study aims to explore the efficacy of CBCT in gender identification by analyzing the anatomical characteristics of the mental foramen in a diverse sample population. By examining CBCT scans, we seek to identify significant differences in mental foramen parameters between males and females, contributing to the advancement of forensic methodologies and enhancing our understanding of sexual dimorphism in craniofacial structures.

Methods And Materials

This retrospective imaging study was approved by the Institutional Review Board of Saveetha Dental College under the approval number IHEC/SDC/OMED-2105/23/098. Using past research, the sample size was estimated for a power of 80 and a 5% confidence interval. The decision was made to include 200 samples. The inclusion and exclusion criteria for the study are listed in Table 1.

Inclusion Criteria	**Exclusion Criteria**
Ideal CBCT images of fully dentate patients	The presence of metallic artifacts

Either sex	Pathology in the mental region, jaw fracture
Between the ages of 20 to 80 years	low-resolution quality of CBCT images.

Table 1: Inclusion and exclusion criteria for the samples

Two examiners utilized Galileos 3D software to calculate and record the opening angle of the mental foramen, the distance from the superior border of the mental foramen to the lower border of the mandible (SLM), and the distance from the inferior border of the mental foramen to the lower border of the mandible (ILM). The exposure parameters were adjusted according to the patient's age and build, with settings ranging from 90-110 kilovoltage peak (kVp) and 8-10 milliamperage (mA).

The study thoroughly analyzed 200 Cone Beam Computed Tomography (CBCT) series, consisting of 100 images each of males and females. It focused on measuring specific distances in the mandible region, particularly from the superior to the mental foramen (SMF) to the lower border of the mandible (LBM) and from the inferior to the mental foramen (IMF) to the LBM, based on the superior and inferior margins of the mental foramen. Additionally, the opening angle of the mental foramen was assessed by using a cross-sectional slice as a reference. This method involved drawing two lines to illustrate the angle. The first line was drawn horizontally, connecting the peak of the lower cortical bone edge of the mental foramen. The second line was drawn obliquely, extending from the peak to the upper cortical bone (Figure 1 and Figure 2).

Fig 1: measurements of mental foramen

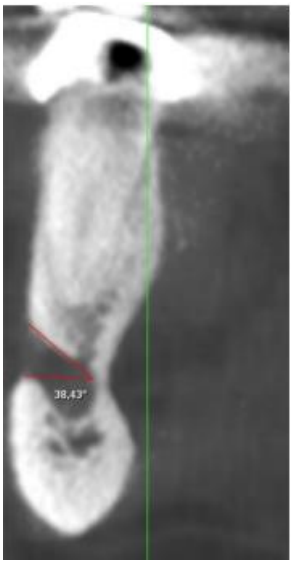

Fig 2: measurements of the angle of mental foramen

Statistical analysis

The acquired data were recorded, tabulated, and statistically analyzed using the Statistical Product and Service Solutions (SPSS) (version 23.0; IBM SPSS Statistics for Windows, Armonk, NY). Discriminate function analysis was used to identify characteristics that distinguish between males and females, and it is increasingly used for sex identification based on skeletal measures. P-values < 0.05 were considered significant.

Result

200 CBCT pictures were analyzed, with 100 each for males and females. The mean distance from superior to the mental foramen to the lower border of the mandible (SMF-LBM) in males was 15.63mm, whereas in females it was 13.96mm. (Table 1). Males had an average distance of 12.62 mm from the inferior to the mental foramen to the lower border of the mandible (IMF-LBM), while females had an average of 10.82 mm. (Table 2). Figure 3 depicts a bar graph of the SMF-LBM and IMF-LBM between genders, complete with error bars. The average distance from angles was 28.4^{o} for men and 30.01^{o} for women (table 3).

	No. of subjects	**Mean**	**Std deviation**	**Std error mean**	**95% confidence interval range**
Male	100	15.63	1.79	0.179	1.173 – 2.17
Female	100	13.96	1.77	0.177	1.173 – 2.17

Table 1: SLM for males and females

	No. of subjects	**Mean**	**Std deviation**	**Std error mean**	**95% confidence interval range**
Male	100	12.62	1.91	0.191	1.27 – 2.32
Female	100	10.82	1.87	0.187	1.27 – 2.32

Table 2: ILM for males and females

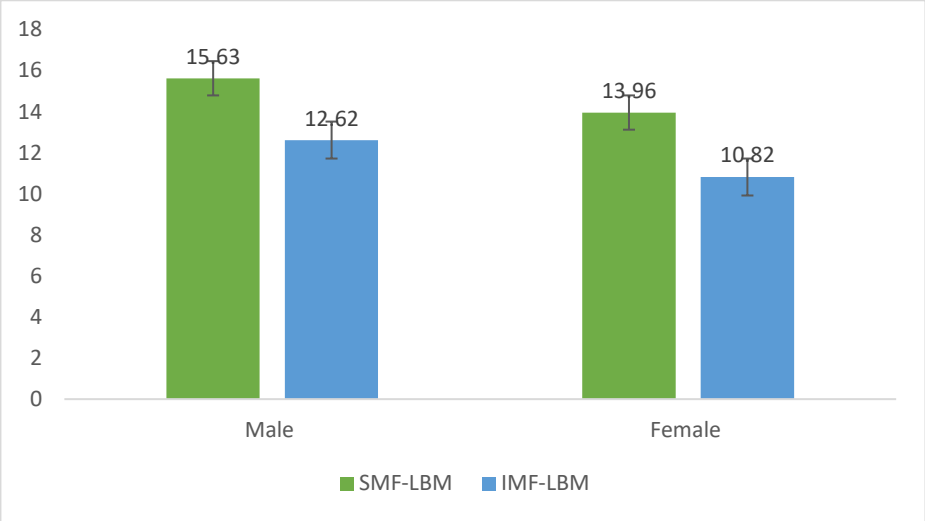

Figure 3: The bar graph representation of the SMF-LBM and IMF-LBM between the genders with the error bars is given

	No. of subjects	Mean	Std deviation	Std error mean	95% confidence interval range
Male	100	28.64	10.15	1.01	-4.14 – 1.39
Female	100	30.01	9.68	0.96	-4.14 – 1.39

Table 3: angles for both males and females

Figure 4: The mean distance from angles in genders

When comparing the distance between SMF-LBM, IMF-LBM, and angles, there was a significant difference ($p<0.001$) between males and females

Discussion

This study aimed to evaluate the potential of Cone Beam Computed Tomography (CBCT) in identifying gender based on the anatomical characteristics of the mental foramen. Our findings indicate that specific parameters of

the mental foramen, such as its size, shape, and position, exhibit significant sexual dimorphism, which can be utilized for gender differentiation in forensic investigations.

While alveolar bone resorption occurs above the MF, the distance between the MF and the bottom border of the jaws remains usually constant throughout life (12). Yosue and Brooks identified four types of radiographic appearances for MF (13).
1. Continuous type: The mental canal connects to the mandibular canal.
2. Separate type: the foramen is separated from the mandibular canal and appears as a radiolucency with a distinct border of condensing bone.
3. Diffuse type: the foramen has an unclear boundary.
4. Unidentified type: the foramen cannot be seen. The study focused solely on the easy-to-identify distinct kind of radiography. Previous studies found that males had greater mean S-L and I-L values than females. These findings align with our results (14). Previous studies discovered that the mean value of I-L does not show sexual dimorphism (15). The current investigation found that males had a considerably higher mean value of I-L, consistent with previous findings by Amorim et al (16). The study population's racial variety may account for the observed discrepancy in mean values.

The results of this study align with previous research that has demonstrated differences in the morphology of the mental foramen between males and females. A morphometric study using panoramic radiographs for gender prediction revealed that the distance between the mental foramen and the basal bone of the mandible was significantly greater in males than in females on both sides. (17).

While this study provides valuable insights into the use of CBCT for gender identification, several limitations must be acknowledged. The sample size was relatively small, and the study population may not be representative of all ethnic and geographic groups. The importance of considering population-specific variations in the mental foramen, suggests that differences in diet, environment, and genetics could influence its morphology.

Future research should focus on expanding the sample size and including diverse populations to validate the applicability of CBCT for gender identification globally. Additionally, exploring other craniofacial features in conjunction with the mental foramen could enhance the accuracy and reliability of gender determination methods. The integration of advanced machine learning algorithms and artificial intelligence in analyzing CBCT data may also offer promising avenues for further enhancing forensic analysis

Conclusion

This study demonstrates the efficacy of CBCT in gender identification through the analysis of the mental foramen. The significant differences in mental foramen characteristics between males and females support the use of CBCT as a reliable tool in forensic and archaeological contexts. As imaging technology continues to advance, CBCT is poised to play an increasingly vital role in forensic anthropology, providing accurate and non-invasive solutions for gender identification.

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