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Morphometric Analysis of the Mental Foramen of Dry Human Mandibles and its significance

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Abstract:

Introduction: The mental foramen (MF) is an oval or circular opening on the body of the mandible where the mandibular canal terminates. It is an exit for the mental nerve and blood vessels, which are terminal branches of inferior alveolar nerve, artery, and vein. The mental nerve provides innervations of the lower teeth, lip, gingival, and lower face. The MF is an important anatomical landmark during osteotomy procedures, anesthetic nerve blocks, and prevention of neurovascular complications after invasive procedures on the lower jaw. Its anatomy is also useful in evaluating the morphometric symmetry of the mental triangle, microscopic and macroscopic morphology, bone remodeling activity, and paleoanthropologic features of the facial skeleton in different populations.

Material and Method: Totally, 350 bones were studied in 2 years duration. The study was carried out in the Department of Anatomy, Index Medical College Hospital & Research Center over a period of 2 year. The position of mental foramen was studied using an instrument known as digital Vernier Calliper (in mm) while shape was analysed visually. Position of mental foramen was calculated using Statistical package for social sciences (SPSS) software.

Results: In our study, the mean and standard deviation of Distance from symphysis menti to medial margin of mental foramen was found to be (26.42±0.32) on right side and (25.35±0.31) on left side. In our study, the mean and standard deviation of Distance from posterior border of ramus of mandible to lateral margin of mental foramen was found to be (66.32±0.64) on right side and (65.25±0.57) on left side. In our study, the mean and standard deviation of Distance from symphysis menti to posterior border of ramus of mandible was found to be (96.46±0.94) on right side and (95.36±0.87) on left side. In our study, the mean and standard deviation of Horizontal diameter of foramen was found to be (3.62±0.02) on right side and (3.56±0.01) on left side.

Conclusion: Knowledge of the position of the mental foramen and the number of accessory mental foramen in a heterogeneous Indian population will prevent mental nerve damage during surgery. This study is the first comprehensive description of the mental foramen in the our population and its ancestry subgroups. The observations in this study could also be very useful in forensic anthropology in the our population. However, the morphometric analysis of the vertical and horizontal position of mental foramen and the relative positions of the accessory mental foramen in the mandible of our populations warrant further research.

Keywords: Mandible, Mental foramen, Accessory mental foramen; mental nerve.

Introduction

Mandible is the largest, hardest and the most durable bone of the skull, which has various morphological features which show changes with reference to age, sex and race. [1] The mandible is a Latin word which means lower jaw that serves for the reception of the lower teeth and gives insertion to the muscles of mastication. It is the only movable bone of the skull articulating with the temporal bone at the synovial temporo - mandibular joint [2].

The mental foramen (MF) is an oval or circular opening on the body of the mandible where the mandibular canal terminates. It is an exit for the mental nerve and blood vessels, which are terminal branches of inferior alveolar nerve, artery, and vein. [3] The mental nerve provides innervations of the lower teeth, lip, gingival, and lower face [4].

The MF is an important anatomical landmark during osteotomy procedures, anesthetic nerve blocks, and prevention of neurovascular complications after invasive procedures on the lower jaw. [5] Its anatomy is also useful in evaluating the morphometric symmetry of the mental triangle, microscopic and macroscopic morphology, bone remodeling activity, and paleoanthropologic features of the facial skeleton in different populations [6].

In the present forensic scenario, dismemberment or mutilation of the body has become the frequent method to conceal the identity of the victim. Thus, identification of human skeletal remains becomes important. [7] When entire adult skeleton is available for analysis, identification is relatively easy, but in cases of mass disasters where usually fragmented bones are found, identification becomes very difficult with the available parts of skeletal remains. [8]

In such cases, sex determination using bone fragments makes identification easier. Even though this can be done with almost every bone of the human skeleton, past studies indicate that skull is the most dimorphic and easily sexed portion of skeleton after pelvis, providing accuracy up to 92%. [9] But in cases where intact skull is not found, mandible can be considered as it is a component of the skull.

In addition, due to the close proximity of many neurovascular structures to the mandible, knowledge of the morphological features of the mandible such as the mental foramen, ramus of mandible, becomes important for the oral and maxillofacial surgeons in all aspects of reconstructive craniomaxillo-facial surgeries. [10] As mental foramen is an important landmark for various surgical procedures, anaesthetic interventions, soft tissue excisions and biopsy, knowledge of its morphology becomes important not only for maxillofacial surgeons, but also for all medical professionals. Hence, this study was made.

Material and Methods

The present study was designed as a comparative and descriptive study, which was started after obtaining ethical clearance from institutional ethical committee. Totally, 350 bones were studied in 2 years duration. The study was carried out in the Department of Anatomy, Index Medical College Hospital & Research Center.

Inclusion criteria

Normal adult human mandibles with intact alveolar processes and without any apparent damage or congenital anomaly was included in the study.

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Exclusion criteria

- Abnormal human mandible with incomplete alveolar processes, with congenital or Pathological anomalies, damaged specimen, pediatric mandibles were excluded from the study.
- Defective and broken specimens were excluded from the study.
- Totally edentulous mandibles with absorbed alveolar margins were excluded from this study.

Methodology followed during study

For measurement of various parameters of our study, mandible was placed on the horizontal plane and the lower border of mandible interact with greatest force as vertical pressure is applied to the second molar teeth.

The shape of mental foramen in dry human adults was analyzed by visual examination of the both sides of the mandible.

For measuring position of mental foramen in mandible of both sides following are the considerations in our study: position of mental foramen from symphysis menti, position of mental foramen from posterior border of ramus of mandible and position of mental foramen from inferior border of the body of mandible. Position was measured using Digital Vernier Calliper (in mm).

INSTRUMENT USED:

The parameters were measured with the help of a Digital Vernier calliper. A caliper is a device used to measure the distance between two opposing sides of an object. A caliper can be as simple as a compass with inward or outward - facing points. The tips of the caliper are adjusted to fit across the points to be measured, the caliper is then removed and the distance read by measuring between the tips with a measuring tool, such as a ruler. A refinement now popular is the replacement of the analog dial with an electronic digital display on which the reading is displayed as a single value.

We observed the position, shape, and number of MF. We measured the distance of MF (in mm) from various landmarks including symphysis menti, alveolar crest, posterior border of the ramus of mandible, and lower border of mandible with digital vernier caliper and calculated the size of mental foramen.

- WY: Distance from symphysis menti to medial margin of mental foramen.
- XZ: Distance from posterior border of ramus of mandible to lateral margin of mental foramen.
- WX: Distance from symphysis menti to posterior border of ramus of mandible.
- HD: Horizontal diameter of foramen $= WX - (WY + XZ)$.

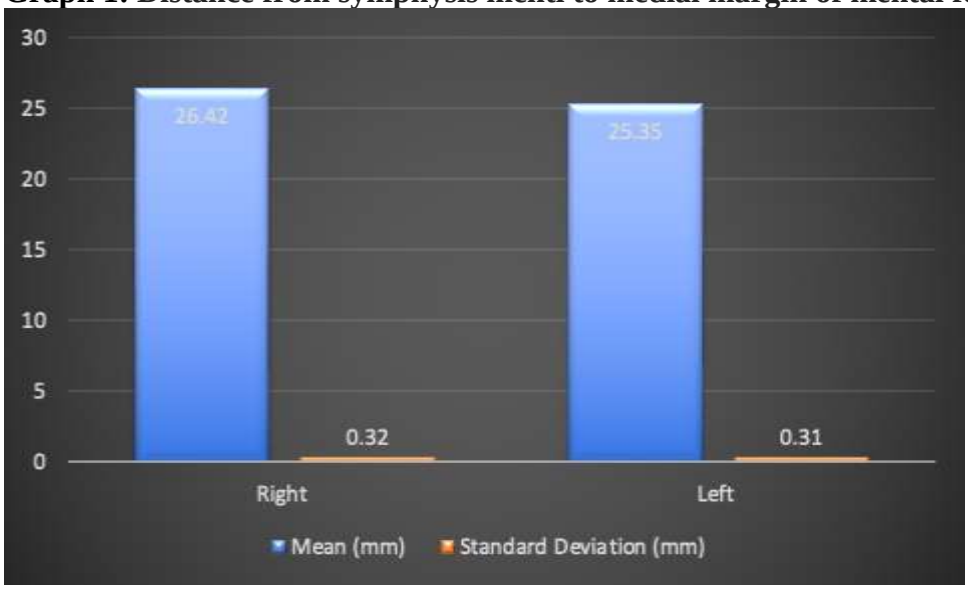
Figure 1: Mental Foramen

Statistical analysis

Mean and standard deviation of the position of mental foramen was calculated using Statistical package for social sciences (SPSS) software for comparison.

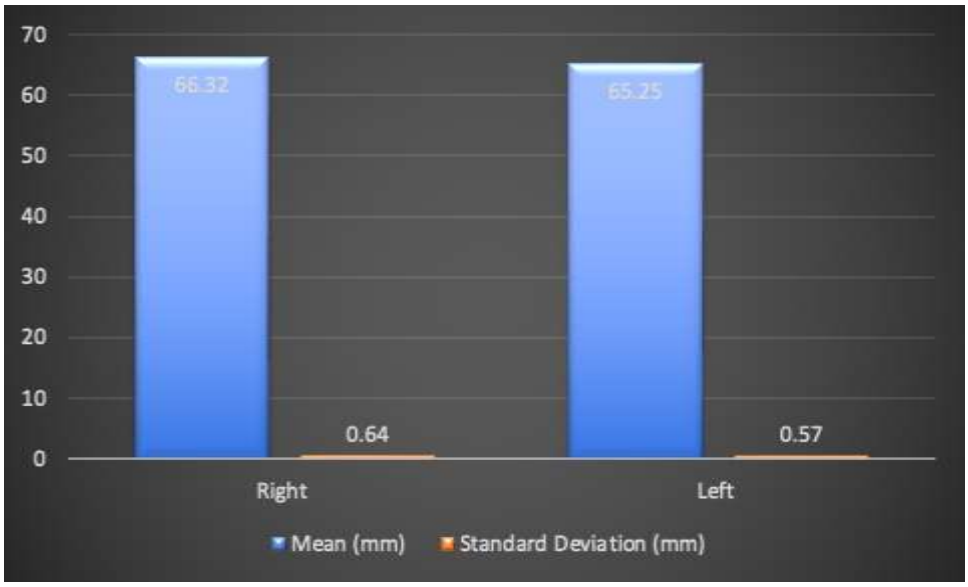
Results

Graph 1: Distance from symphysis menti to medial margin of mental foramen.



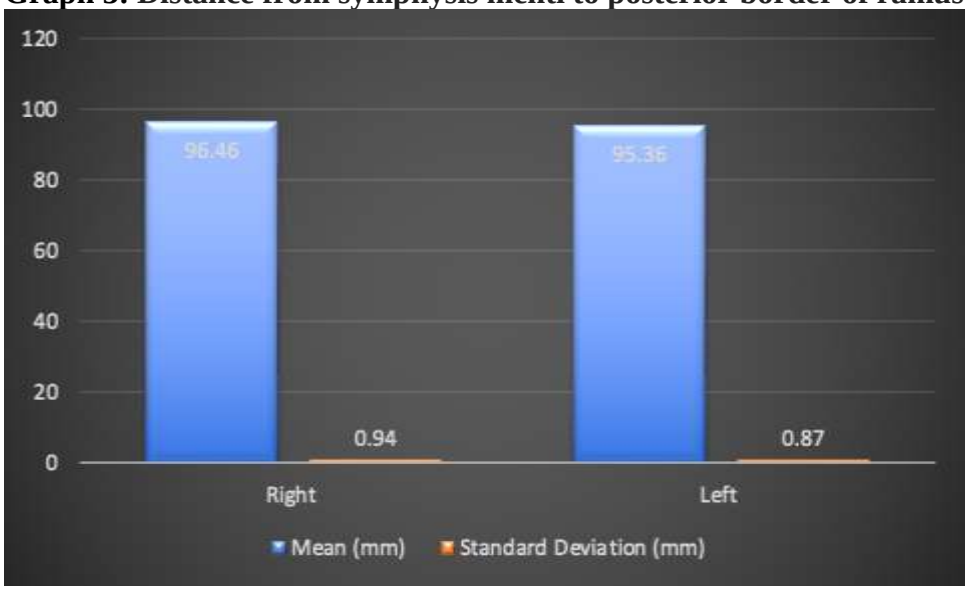
In our study, the mean and standard deviation of Distance from symphysis menti to medial margin of mental foramen was found to be (26.42±0.32) on right side and (25.35±0.31) on left side. (**Graph** 1).

Graph 2: Distance from posterior border of ramus of mandible to lateral margin of mental foramen.



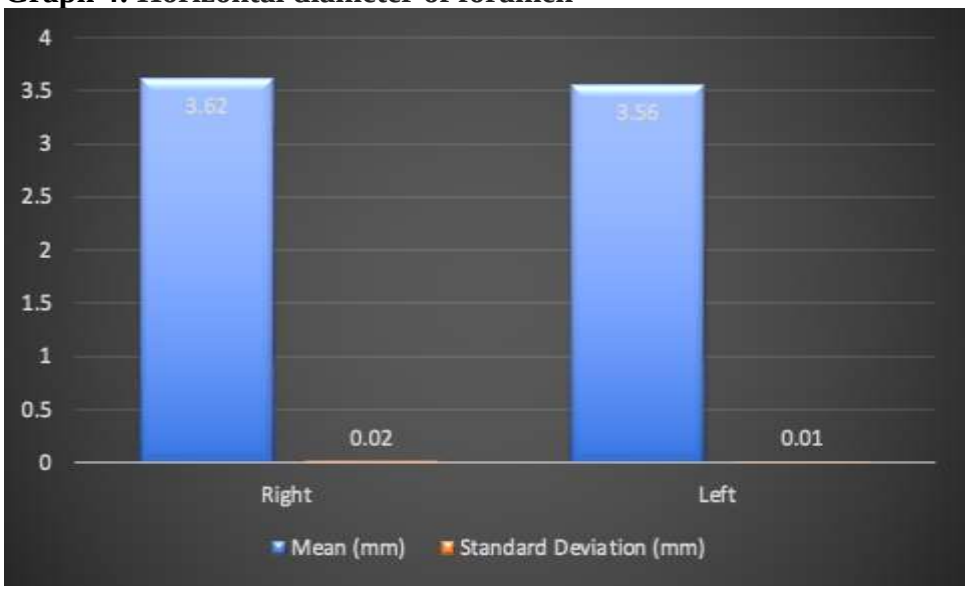
In our study, the mean and standard deviation of Distance from posterior border of ramus of mandible to lateral margin of mental foramen was found to be (66.32±0.64) on right side and (65.25±0.57) on left side. (**Graph** 2).

Graph 3: Distance from symphysis menti to posterior border of ramus of mandible.



In our study, the mean and standard deviation of Distance from symphysis menti to posterior border of ramus of mandible was found to be (96.46±0.94) on right side and (95.36±0.87) on left side. (**Graph** 3).

Graph 4: Horizontal diameter of foramen



In our study, the mean and standard deviation of Horizontal diameter of foramen was found to be (3.62±0.02) on right side and (3.56±0.01) on left side. (**Graph** 4).

Discussion

The MF is often involved in certain steps of maxillofacial surgeries. It is especially important to identify its boundaries and to preserve it during surgery, trauma, and local anesthesia. [11-16] The location and appearance of the MF are often determined by assessing some variables using panoramic radiography. Although it is recommended to cautiously use panoramic radiography for exact measurements and comparisons, previous studies have shown that there is a close relationship between the radiographic position of the MF and the skull. The position of the MF in relation to the mandibular body is probably more precise, and is not affected by factors such as malocclusion, mesiodistal width of the tooth, race, nutrition, and age. [17]

Additionally, MF position and position symmetry are important anatomical landmarks, critical in forensic or medico legal cases because of the established racial variation among different population groups. Significant differences exist in the position, shape and symmetry of the MF among various ethnic groups and populations; because of this, the variation in the position of MF has been documented either according to the age, sex and race or in combinations, in different geographical regions and within the inhabitants of the same geographical area (Hasan). However, in most studies, the position of this foramen is assessed in relation to the teeth, as this is simpler to use in clinical applications. [18]

In the present study, we found clear ancestry- and sex-specific differences in the position of the MF not previously reported. Position IV of the MF is shown as the most prevalent in South African subpopulations. Positions III and IV were commonly observed in males and females respectively. However, in terms of ancestry and sex, position II was commonly observed in the males of ED while position III was observed in AD and MD males and ED female subpopulations; signifying differences in MF position between the South African males AD and MD and their ED counterparts as well as among the females of the various subpopulation groups. These variations may be the result of varying degrees of genetic

admixture between ancestral groups. However, globally, previous studies have shown that PIII and IV are the commonly reported MF positions. [19]

In this study, an oval shape of MF was the most common across population groups and ancestry and is in line with most international previous reports. The high frequency of occurrence of the oval shape is similar to what was reported in India. Factors responsible for predominant oval shape of MF are not clearly known, but may be unrelated to the embryonic factors operating during the development of the mandible and feeding patterns. About 23.84 % of the studied population presented with multiple MF reaching a maximum of 3 AMFs in AD and MD populations. But, the presence of 1 AMF was frequent across the subpopulation groups. [20]

Hauser and De Stefano [21] stated that the different variants may have occurred due to the epigenetic traits, as they could be the products of the genetically determined growth processes of other tissues, which had affected the bone formation. Subsequently, they undergo modifications during ontogeny and variable degrees of expression. Thus, the variations in the position, shape, number and size of the MF depends on the gene modification.

The incidence of AMF varies in the literature. Singh and Srivastav [22] observed AMF in 13% mandibles; Gershenson et al. [23] examined 525 dry mandibles and reported that 4.3% mandibles had a double mental foramen and 0.7% mandibles had triple mental foramen; however, Serman [24] reported the incidence of AMF to be 2.7%. In the present study, we observed an AMF in 7/105 (6.6%) mandibles. An AMF is due to branching of mental nerve prior to its passing through mental foramen. Thus, the verification of the existence of an AMF would prevent nerve injury during periapical surgery.

Conclusion

Knowledge of the position of the mental foramen and the number of accessory mental foramen in a heterogeneous Indian population will prevent mental nerve damage during surgery. This study is the first comprehensive description of the mental foramen in the our population and its ancestry subgroups. The observations in this study could also be very useful in forensic anthropology in the our population. However, the morphometric analysis of the vertical and horizontal position of mental foramen and the relative positions of the accessory mental foramen in the mandible of our populations warrant further research.

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