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Original Research Article

Study of Anatomical Variations of Mental Foramen in Dry Adult Human Mandibles

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Abstract

Background*:** The mental foramen (MF) and accessory mental foramen (AMF) are the strategically important landmarks during surgical interventions and anaesthetic nerve blocks procedures involving the mental nerve. Mental foramen is known as the ventage of the mandible and is an important mark of the face for carrying out many diagnostics and surgical processes along with anesthetic procedures of the face. Thus, the present study is designed with an aim to get insight knowledge of position and shape of mental foramen in dry adult human mandible. ***Methods: Totally, 45 bones were studied in 2 years duration. The study was carried out in the Department of Anatomy of Ayaan Institute of Medical Sciences. The position of mental foramen was studied using an instrument known as digital Vernier Caliper (in mm) while shape was analyzed visually. Position of mental foramen was calculated using Statistical package for social sciences (SPSS) software. ***Results:*** The present study showed that the position of mental foramen from symphysis menti and posterior border of ramus of mandible was more from right side than left side and found to be insignificant while position of mental foramen from inferior border of body of mandible was more from left side than right side and found to be insignificant for right side while significant for left side. The shape of mental foramen from right side was found to be (Oval shape – 62.3% and round shape – 37.77%) while for left side (Oval shape–68.8% and round shape – 31.1%). ***Conclusions:*** Hence, mental foramen plays a pivotal role in performing major facial surgeries and is an important landmark for several facial procedures performed.

Keywords: Anatomical Variations Mental Foramen Adult Human Mandibles.

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 [1]. 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 paleo anthropologic features of the facial skeleton in different populations [2].

The MF is usually located in the body of the mandible at an equal distance from the superior and inferior border below or between the apex of the first and second premolar [3]. The direction of opening of the foramen from the inferior alveolar has been shown to be pointing posteriorly outward and upward [4]. Variability in the location of MF has been documented in different literature with the tendency of being more posterior in blacks than in whites and between the second premolar and first molar [5]. A study on Tanzanian population revealed that the most frequent locations for MF were below the apex of the second premolar and between the 2nd premolar and 1st molar. The MF was asymmetrically located between the right and left sides and predominantly oval. The direction of opening was mostly superior and poster superior and rarely labial, mesial, or posterior [6]. Another study on Zimbabwean population found that the MF was mostly oval shaped and the frequency of occurrence was highest below the lower 2nd premolar on the right side and

between 2nd premolar and 1st molar on the left side [7]. In a study done on Malawian population, the MF was found to be oval in shape, oriented poster superiorly, and located inferior to the 2nd premolar tooth and bilaterally symmetrical in a majority of cases. Its vertical position was slightly below the midpoint of the distance between the lower border of the mandible and the alveolar margin [8].

Any foramen in addition to MF in the body of mandible is known as accessory mental foramen (AMF) and it tends to exist in the apical area of the first molar and posterior or inferior area of the mental foramen. As AMF is due to branching of mental nerve before passing through MF, its shape, size, and verification of its existence would prevent accessory nerve injury during periapical surgery [9]. The potential severe complication of injury of the accessory mental foramen (AMF) is sensory disturbance of the lower lip [10]. Studies [11] have reported AMF incidence to range from 1.4% to 9.7% with an exception of one on Japanese population, which reported very high incidence of 12.5% [12]. The distances between MF and AMF were reported to range between 0.67mm and 5.74mm [13]. Ethnic variations in relation to AMF have also been reported [14]. Absent AMF is a more common variation than MF absence in humans and the frequent reasons for absence may range from atrophy, posttraumatic fibrosis, osteoblastic hyperplasia, geriatric bony resorption, or congenital agenesis [15].

Hence location, size, shape, position, and incidence of MF and AMF would facilitate the dental surgeon to apply nerve block in different surgical procedures involving lower jaw. The anatomical research reports on variations in anthropometrics of MF and AMF between race and geographical location signifying the need to establish local values. Currently there are no established values on MF and AMF for Moinabad population. Therefore, this study is aimed at evaluating anthropometrics of MF and AMF in Moinabad adult human mandibles to establish specific MF and AMF anthropometrics of Moinabad population in order to make a gateway to add them to the medical literature.

METHODS

The present study was designed as a comparative and descriptive study, which was started after obtaining ethical clearance from institutional ethical committee. Total 40 bones were included in the study for consideration. Unknown mandibles with intact alveolar sockets removed from cadavers and unknown mandibles from storage room of dry adult mandibles were obtained in 2 years. Thus, a total of 40 mandibles were obtained from the Department of Anatomy after getting permission.

Inclusion criteria

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

Exclusion criteria

Abnormal human mandible with incomplete alveolar processes, with congenital or Pathological anomalies, damaged specimen, pediatric mandibles were excluded from the 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.

STATISTICAL ANALYSIS

The statistical analysis was evaluated as mean and standard deviation. The mean and standard deviation of mental foramen (left and right side) were calculated. It was done using SPSS software and $p>0.05$ was considered insignificant while $p<0.05$ was considered significant.

RESULTS

The mean and standard deviation of mental foramen (left and right side) were calculated.

Table-1: Comparison of mean and SD of position of mental foramen from symphysis menti (right and left side).

Side	Position of MF from symphysis menti Mean±SD (n=45)	p-value
Right	24.84±2.3	0.87
Left	23.91±2.1	0.74

In our study, the mean and standard deviation of the mean and standard deviation of position of mental foramen from symphysis menti was found to be (24.84±2.3) on right side and (23.91±2.1) on left side. The distance from right side was more than the left side and was found insignificant ($p>0.05$ for both sides) (Table 1).

Table-2: Comparison of mean and SD of position of mental foramen from posterior border of ramus of mandible (right and left side).

Side	Position of MF from posterior border of ramus of mandible Mean SD (n=45)	p-value
Right	61.21± 6.3	0.56
Left	61.01±6.1	0.98

The mean and standard deviation of position of mental foramen from posterior border of ramus of mandible was found to be (61.21± 6.3) on right side and (61.01±6.1) on left side. The distance from right side was more than the left side and was found insignificant (p value >0.10 for left side and p>0.0900 for right side) (Table 2).

Table-3: Comparison of mean and SD of position of mental foramen from inferior border of body of mandible (right and left side).

Side	Position of MF from inferior border of body of mandible Mean SD (n=45)	p-value
Righ	11.83±1.7	0.83
Left	11.71±1.3	0.04

The mean and standard deviation of position of mental foramen from inferior border of body of mandible was found to be, (11.83±1.7) on right side and (11.71±1.3) on left side. The distance from right side was less than the left side and was found insignificant for right side while significant for left side (p>0.05) for right side and p value 0.004 for left side) (Table 3).

Table-4: Comparison of shape of mental foramen

Shape	Right side		Left side	
	(n=45)	Percentage	(n=45)	Percentage
Round	17	37.7	15	31.1
Oval	28	62.3	31	68.8
Total	45	100	45	100

The shape round and oval of mental foramen was also compared for both the sides and the results for right side (Oval shape – 62.3% and round shape – 37.77%) while for left side (Oval shape – 68.8% and round shape – 31.1%) (Table 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 [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 [17]. 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 [18]. 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. 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 [19].

In maxillofacial surgical manoeuvres, knowledge of the precise position of MF is critical for accurate local anaesthesia essential in dental procedures and as well safeguard against mental neurovascular bundle damage during oral surgical procedures. The lack of consistent anatomic landmarks and inability to clinically palpate the mental foramen during clinical manoeuvres may explain the intense attention the subject has received from researchers using either advanced radiographic imaging techniques, cadaveric or dry human materials [20]. In India, due to inherited admixed ancestry arising from colonization, there is a diverse genetic constitution of the population implying a great variability in the skeletal stature and structure of the different racial groups. Consequently, variation in the anthropological parameters is important in identification of skeletal remains in forensic and/or medico legal cases. Besides, success of surgical procedures requiring mental nerve block for the different subpopulation groups is contingent on accurate knowledge of the MF position, shape and number and position symmetry existing in these subpopulation groups. The importance of this study among the heterogeneous South African population therefore cannot be over emphasized.

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 Indian populations. 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.

As anatomical landmarks, MF position and position symmetry are important and helpful in forensic or medico legal cases population groups. The distinct in symmetry and asymmetry identified amongst the AD subpopulation group (as against MD and ED subpopulations) suggests genetic influence on these parameters which is very important in clinical practice for successful mental nerve block. Nevertheless, there was no significant difference in the symmetric analysis of MF amongst male and female ($p = 0.059$) and between ancestry ($p = 0.455$) [23].

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 [24]. The high frequency of occurrence of the oval shape is similar to what was reported in Bosnia and Herzegovina, North India and South India [24, 25]. 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. Unlike earlier reports [26], this study shows that there are 2 (2 %) and 3 (0.46 %) AMFs present in the South African population. Naturally, an AMF occurs from the branching of the inferior alveolar nerve prior to the formation of the mental canal [27]. Ignorance of its existence may result in unforeseen damage to the neurovascular bundles or unsuccessful men- tal nerve block. Consequently, the application of Champy techniques in maxillofacial surgery in the South African population will more likely affect the mental nerve. Furthermore, the high prevalence of one AMF in AD and MD populations is consistent with an earlier report on African population by Eboh & Oliseh probably suggesting genetic influence from African ancestry in this case. The results were compared with similar studies in the last decade as presented in Table III.

In the last decade various reports on the position of MF (Table IV) have mostly utilized radiographic imaging techniques. Very few of these authors reported the frequency of MF position and position symmetry in the different studied populations [28].

The most common shape of the foramen reported was oval similar to our study, still, the only study that reported the frequency of position symmetry presented a very high frequency (85 %) compared to our study [29]. The results from studies of MF using radiographic imaging techniques are consistent with the results of our present study, confirming that there is a relationship between the radiographic position of the MF and the skull [31]. Actually, the results from these studies on the frequency of AMF occurrence was limited to only 1 AMF, with no similarity in the frequency of occurrence of 1 AMF in our studied population. This discrepancy may be due to the poor visualization of AMF on 2-dimensional imaging techniques, especially when the diameter of AMF is less than 1.5 mm [33].

CONCLUSION

Knowledge of the position of the mental foramen and the number of accessory mental foramen in a heterogeneous South African population will prevent mental nerve damage during surgery. This study is the first comprehensive description of the mental foramen in the South African population and its ancestry subgroups. The observations in this study could also be very useful in forensic anthropology in the South African 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 South African populations warrant further research.

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