

A local reference value for the mental foramen in adult Sudanese: A 3D computerized tomography based study

Khalid Mohammed Ahmed¹, Caroline Edward Ayad¹, Samih Awad Kajoak²

¹College of Medical Radiological Science- Sudan University Of Science And Technology, Khartoum-Sudan

²College of Applied Medical Science, Diagnostic Radiology Department, Hail University-Saudi Arabia.

Abstract: The mental foramen (MF) is located on the anterior surface of the mandible. It permits passage of the mental nerve and vessels. Studying the morphological variation of (MF) helps to localize the mental nerve to prevent complications during surgery. (MF) character varied considerably among ethnic groups, although, determination the norms is essential, however no study was conducted in Sudanese. The aims of this study are to establish local reference for (MF) width for Sudanese as well as to study the age and gender related difference and to compare the measurements with other populations.

The present study was carried out in the Radiology department-Military Hospital, Khartoum –Sudan on 160 adult Sudanese with mean age is 35.26years old. Three dimensional computerized tomography was obtained for the facial bone .The Mandibles were observed for the right and left of (MF) width.

In our study we observed that the (MF) mean width were 4.28 and 3.53 mm for right and left sides. The (MF) differs between the two genders significantly at $p \leq 0.035$ and 0.010 for right and left sides in respectively .A significant changes in (MF) width were detected in different age groups for both right and left sides. New equations were established to identify the (MF) width as local reference for Sudanese population of known age. The present analysis revealed variations in width of MF of Sudanese from other populations. The (MF) width differs according to age and gender.

Keywords: Mental foramen, Morphometry, Computerized Tomography

I. Introduction

Anatomically, there is one mental foramen (MF) on each side of the mandible through which passes the mental artery, vein and the mental nerves, the larger of the two terminal branches of the inferior alveolar nerve. The number of mental nerves can vary in individuals and in different races. [1,2] The (MF) is a strategically important landmark during osteotomy procedures, anesthetic nerve blocks and prevention of neurovascular complications after invasive procedures on the lower jaw. Its anatomy is important for evaluating the morphometry of the (MF) in different populations.[3] Different studies were obtained regarding the morphometric characteristics of the (MF); in so doing depicting variable racial tendency. [4]In Africans; the (MF) was observed to exhibit dimorphism; the average size of the short axis of the foramen was 3.97mm in the male 3.87 mm in the female mandibles.[5] These measurements were statistically similar to another study on mandibles from Alagoas state.[6].In Asian /Japanese population the (MF) was observed to have largest horizontal diameter ranged between 3.25-3.32mm [6] In Sri Lankans; the mean transverse diameters of the foramen were 3.31mm [7] while in Israelis; the (MF) average diameter was of 2.37 mm.[8]In Turkish; the horizontal diameter of the (MF) was 2.93 mm on the right side and 3.14 mm on the left side. [6]

Racial variances in mandibular dimensions have been studied among several Caucasian, African, Asian, and Arab populations.[9-12] An important landmark in carrying out the mental or incisive nerve block is the mental foramen [13] The position of this foramen has also been studied, with racial differences again being found [14-19] What is not known, is whether there are significant variations on these mandibular landmarks(MF) in Sudanese patients compared with those already reported. There are no apparent published reports on its relative short axis in Sudanese populations.Although the variations appears according to the ethnic groups, this study aims to measure the MF width and to find out the variations related to age and gender using 3D CT done for adult Sudanese population as well as to compare the findings with other populations and to establish a local reference for Sudanese regarding the MF width.

II. Materials and Methods

2.1 Equipment:

The equipment required is CT Toshiba Aquilion(64slices) and three dimensional reconstruction system with parameters is used as below: Kv=120 ,mA=300, Time =0.75sec ,mAs =225 ,Slice thickness=3mm-5mm

2.2 Methods of data measurement:

This is a descriptive analytical study that deals with scanning patients head (brain and facial structures).The study selected 160 patients (males and females) with CT (64slices). Axial projection was applied with brain protocols as well as sagittal views for facial protocols. All of these protocols used two dimensional as localizer and Digital Imaging and Communications in Medicine (DICOM) files were rendered into three-dimensional reconstruction using Anatomize Invivo5 software. The width of the mandible foramen right and left were measured.

2.3 Sample.

The study population was composed of both genders presenting to the CT unit of Military Hospital in Khartoum during the period from December 2013 to June 2016.The sample size consisted of 160 patients with different age and gender (92males and 68 females)The radiographs that were clinically diagnosed as normal mandible were included. Any abnormality of mandible for example: fractures, infection, tumors and other mandible diseases were excludes

2.4 Technique:

The patients were positioned supine on the CT examination table and head is rested on head holder while removing all metallic and jewelry, straps and pillow were used to help in maintaining the correct positioning , the scan started from base of the skull and end inferior to mental protuberance as well as image were produced in axial projection. Three dimensional volume rendering technique was applied to reconstruct the image data of patients (analytical software) uses several types of reconstruction algorithm with different planes .

2.5 Ethical Consideration

- No identification or individual details were published.
- No information or patient details were disclosed or used for reasons other than the study

III. Results

Table 1: shows the classification of age classes presented in frequency and percentages

	Frequency	Percentages (%)
15-24	39	24.4
25-34	36	22.5
35-44	51	31.9
45-54	23	14.4
55-64	8	5.0
65+	3	1.9
Total	160	100 %

Table 2: shows the mean and standard deviation of patients ages, Right and left Foramen Width/(MM)

	Age/Years	Right Foramen Width/(MM)	Left Foramen Width(MM)
Mean	35.2625	4.2881	3.5338
Std. Deviation	12.33112	2.30409	.57263
Minimum	15.00	3.10	2.40
Maximum	75.00	5.10	5.20

Table 3 :Independent Samples Test shows the difference between the genders for both right and left foramen width

Group Statistics					
	Gender	N	Mean	Std. Deviation	P-value
Right Foramen Width	Male	92	4.2348	.62025	0.035
	Female	68	4.3603	3.47375	
Left Foramen Width	Male	92	3.6337	.57480	0.010
	Female	68	3.3985	.54513	

Table 4 . Descriptive Statistics both right and left foramen width classified according to age groups

		N	Mean	Std. Deviation	Minimum	Maximum	P-value
Right Foramen Width	15-24	39	4.3718	.41292	3.70	5.70	.028
	25-34	36	4.5333	.67146	3.10	5.80	
	35-44	51	3.8039	.38934	3.30	4.80	
	45-54	23	5.0957	5.95792	3.20	32.40	
	55-64	8	3.6500	.24495	3.40	4.20	
	65+	3	4.0000	.10000	3.90	4.10	
	Total	160	4.2881	2.30409	3.10	32.40	
Left Foramen Width	15-24	39	3.6308	.38468	3.10	4.50	.000
	25-34	36	4.0500	.75043	2.40	5.20	
	35-44	51	3.2745	.38306	2.50	4.20	
	45-54	23	3.2391	.35896	2.40	3.70	
	55-64	8	3.2000	.21381	2.90	3.60	
	65+	3	3.6333	.05774	3.60	3.70	
	Total	160	3.5338	.57263	2.40	5.20	

Table 5 . Correlation coefficient between the right mandibular foramen width with age .Significant at $p \leq 0.005$

		Correlations		
Model		Unstandardized Coefficients	t	Sig.
		B		
	(Constant)	4.343	7.824	.000
	Age	-.002	-.105	.017

The New Established Equation to predict the right mandibular foramen width for Sudanese with known age. $R^2=0.084$

Right mandibular foramen width= 4.343+(AgeX-0.002)

Table 6 . Correlation coefficient between the left mandibular foramen width with age .Significant at $p \leq 0.005$

		Correlations		
Model		Unstandardized Coefficients	t	Sig.
		B		
	(Constant)	4.025	30.583	.000
	Age	-.014	-3.953	.000

The New Established Equation to predict the left mandibular foramen width for Sudanese with known age. $R^2=0.090$

Left mandibular foramen width=4.025+(AgeX-0.014)

IV. Discussion

When reviewing the literature regarding morphometric analysis of the MF based on multi-slice computed tomography, no detailed data has been found. The current study provides new data on the width of the MF in a Sudanese population. When practicing dental surgery, orthodontic treatments, maxillofacial trauma, and orthognathic procedures such as a mandibular body osteotomy, in order not to cut or damage the mental nerve, it is important for the operator to know exactly the morphology of MF. [20] Tables 1 and 2 show the classification of age classes presented in frequency and percentages as well as the mean values of the right and left MF width measured for Sudanese.

Radiography is the non-invasive method for diagnosis and treatment planning of major surgical procedures of the mandible. [21] Panoramic radiographs usually are limited due to horizontal overlap of teeth [22] distortion and magnification in orthopantomogram techniques cannot be eliminated, in addition, as the bone density increases, the foramen becomes more difficult to identify and may not be seen clearly. CT has been the first option for diagnosis, surgical planning, and treatment of osseous trauma injuries due to its high specificity and sensitivity. [23] As a result of recent advances in computer hardware and software; 3D imaging by CT scans of craniofacial anomalies is routinely used by most medical centers to define the unique individual aspects of complex anatomy, plan interventions and follow results [24]

Therefore, we utilized CT images because they have certain advantages in diagnostic medicine. In our series of 160 CT images, the width of the MF has been measured; it was found that there is a significant difference between the males and females for both right and left MF width at $p \leq 0.035$ and 0.010 respectively (Table 3). Studies have mentioned that the MF morphology, varies not only according to age [25] gender [26,27] and ethnicity; [28,29] but even within the same race; in different geographic regions [30,31,32] and within the inhabitants of the same geographic area [33].

Age difference was also been evaluated and it was found that the age can affected significantly the measurements of MF width (Table 4). One of the most striking characteristics of the Sudan is the diversity of its people. The Sudanese are divided into multiple ethnic groups and subgroups. Identifying ethnic groups in Sudan was made more complicated by the multifaceted character of internal divisions. Largest ethnic category comprises those considering themselves Arabs, but category internally split by regional and tribal loyalties and affiliation to various groups. Major groups are Nubians and nomadic Beja dwelling in parts of North Africa, and Fur in west. Southern groups include Dinka form the largest portion of the national population (Black), Nuer, and numerous smaller Nilotic and other ethnic groups. Therefore characterization of MF for each tribe is essential. However we characterize MF for Sudanese living in Khartoum State and not considering their origin or tribe which may consider as limitation in our study.

A new equation to predict the right mandibular foramen width for Sudanese living in central Sudan at the capital (Khartoum) with known age was established.

Right mandibular foramen width = $4.343 + (\text{Age} \times 0.002)$, $R^2 = 0.084$. For the left mandibular foramen width: Left mandibular foramen width = $4.025 + (\text{Age} \times 0.014)$, $R^2 = 0.090$, these are presented in (tables 5 and 6).

The measurements of Sudanese differ from other populations. Data from various ethnic groups including Tanzanian, Thai, Chinese, British, Saudi Arabian vary regarding the characterization of MF. A review by Green (1987) [18] demonstrated a clear racial trend in the characterization of the MF [34] According to Mbajjorgu et al. (1998) [15], in 32 mandibles of black adults from Zimbabwe had mentioned that MF was either round or oval. We suggest that this may be a factor that may change the MF width. Oliveira Junior et al. (2009) [6] reported that the shape was found to be oval with Larger diameter in the horizontal direction. Regarding the size of the mental foramen and according to Chung et al. (1995) [35]; horizontal opening of MF was 2.4 mm and Apinhasmit et al. [36] reported the average horizontal opening was 2.8 mm. Oguz & Bozkir (2002) [37] did measurements in 34 dry mandibles of people from Turkey. The horizontal dimension of MF was 2.93 mm on right side and 3.14 mm on left side. Souaga et al. [26] studied 61 dry mandibles. The average sizes of the short axes of foramina were 3.97 mm for males while dimensions of female mandibles was 3.87 mm. The present observations brought out average horizontal dimension of MF to be 4.29 mm on right side and 3.53 mm on the left side. This was considered to be greater than other previously studied populations.

V. Conclusion

The present analysis revealed variations in width of MF of Sudanese from other populations. The MF width differ according to age and gender

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