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Original Article

Evaluation of Morphometric Variations in Mental Foramen and Prevalence of Anterior Loop in Jammu Population – A Cone Beam Computed Tomography Study

Satvinder Singh[1], Jahangir Ahmad[2], Imran Malik[3]

[1]Associate Professor, Department of Oral Medicine and Radiology, Indira Gandhi Government Dental College, Jammu, Jammu and Kashmir, India, [2]Registrar, Department of Oral Medicine and Radiology, Indira Gandhi Government Dental College, Jammu, Jammu and Kashmir, India, [3]Dental Surgeon, Department of Dental Surgeon, Indira Gandhi Government Dental College, Jammu, Jammu and Kashmir, India

Abstract

Introduction: The mental foramen (MF) opens on the lateral aspect of the mandible near the premolar region on both sides of the mandible. The portion of inferior alveolar nerve (IAN) present anterior to the MF, before exiting the canal, is referred to as the anterior loop (AL) of the IAN. These anatomical variations cannot be evaluated by conventional imaging techniques. Cone beam computed tomography (CBCT) provides three-dimensional, reliable images of maxilla–mandibular region. Hence, it plays an important role to detect and evaluate these anatomical variations and to prevent intra- and post-operative complications.

Materials and Methods: This retrospective observational study includes 500 CBCT images of the mandible. The average size, location, shape of MF, and presence of AL were assessed in sagittal, tangential, and axial sections.

Results: Out of 500 CBCT scans analyzed, 264 scans (52.8%) were of males and 246 scans (49.2%) belonged to females. The mean size of MF as measured in the sagittal sections was found to be 3.65 mm in height and 2.75 mm in length. The most common position for the MF related to the mandibular teeth in this study was between first and second premolars in 290 CBCT images (56.6%). A majority of the MF were oval in shape (n = 328, 65.6%), followed by round shape. The presence of AL of IAN was found in only 28% of cases in this study.

Conclusion: Considering these variations in MF and AL, the use of CBCT seems necessary for better evaluation and treatment planning.

Key words: Mental foramen, Anterior loop, Cone beam computed tomography, Mandibular anatomy, Morphometric variations

INTRODUCTION

The mandibular branch of the trigeminal nerve has many divisions, one of which is the inferior alveolar nerve (IAN). The mental nerve (MN) is a branch of the IAN that exits the mandible through the mental foramen (MF).[1] The MF is a channel-like opening that is narrow at the base and wide at the top through which the MN exits the mental canal.[2] Because of the position of the MF and MN relative to the root apices of mandibular posterior teeth, damage to this nerve may occur during both non-surgical and surgical endodontic procedures, presenting as paresthesia.[3] Commonly, panoramic radiography and cone beam computed tomography (CBCT) are used for preoperative assessment by clinicians. Anatomic complexity of the MF region is not limited to variations in its location and dimension. The presence of 3 other elements – the anterior loop of the inferior alveolar canal, accessory mental foramina, and the lateral lingual foramen and its associated canal – can further complicate the MF region.[4] Pre-surgical evaluation of the anatomical variations in

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Corresponding Author: Dr. Jahangir Ahmad, Department of Oral Medicine and Radiology, Indira Gandhi Government Dental College, Jammu, Jammu and Kashmir, India.

the MF and AL prevents these complications. There are several imaging modalities that can be used to detect and measure the anterior loop. These are panoramic radiography, CBCT, spiral computed tomography, and magnetic resonance imaging.[5] These variations cannot be evaluated by conventional imaging techniques because of their magnification and image distortion. CBCT provides three-dimensional (3D) reliable images of maxilla–mandibular region.[6]

The objectives of this study were to evaluate the variations in MF with respect to its position and dimensions and also to evaluate the prevalence of AL of the IAN using CBCT.

MATERIALS AND METHODS

This retrospective observational study includes 500 CBCT images which were collected from the Archives Department of oral medicine and radiology.

The inclusion criteria for the CBCT scans were the presence of first and second premolars on both sides of the mandible and patients older than 18 years. All the CBCT scans were obtained from centers with a Genoray Pappaya 3D CBCT machine with exposure parameters of 120 kV, 15 mA with Theia3D Software.

The exclusion criteria for the CBCT scans were the presence of any pathology, fracture, supernumerary, or impacted teeth in the mandible.

CBCT images were analyzed in different sectional planes – sagittal, tangential, and axial. The acquired images were analyzed. The parameters evaluated were as follows:

i. The average size (length and height) of MF on the right and left sides of the mandible [Figure 1]
ii. The location of MF in relation to the mandibular premolars [Figure 2]
iii. Shape of MF
iv. Presence of AL of the IAN canal [Figure 3]
v. Variations in the dimensions and location of MF with respect to gender.

The anteroposterior position of MF was recorded as follows:

a. Below first premolar,
b. Between first and second premolars,
c. Below second premolar,
d. Between second premolar and first molar.

The dimensions of MF were measured as the length and height of the foramen in the sagittal sections. The

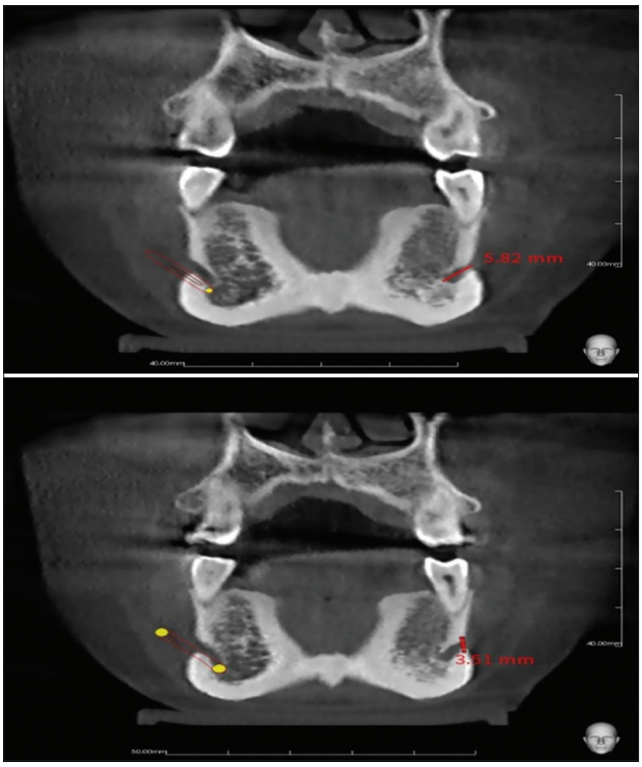


Figure 1: Height and length of mental foramen

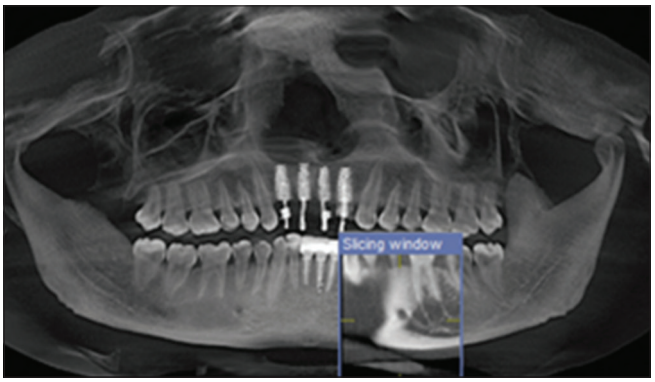


Figure 2: Position of mental foramen

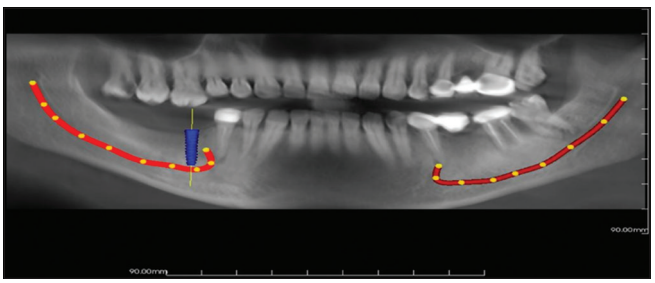
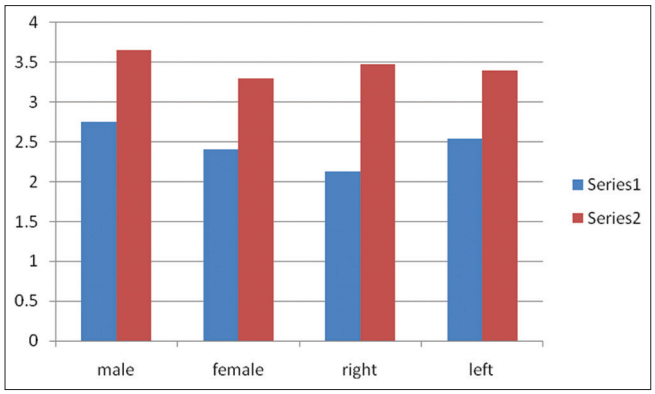
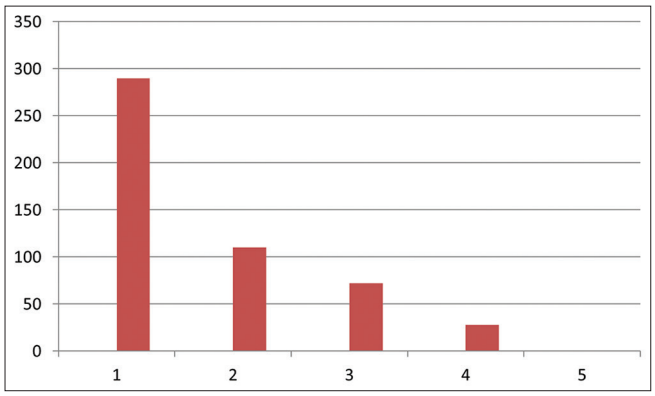


Figure 3: Anterior loop of inferior alveolar nerve canal

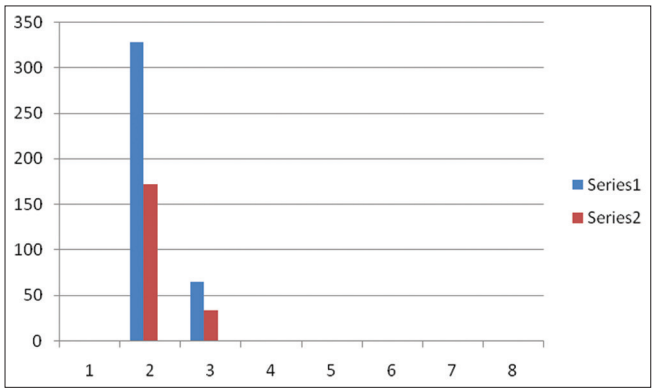
prevalence of AL was assessed based on the unilateral or bilateral presence of this structure. A descriptive statistical analysis was conducted for the total sample. Interobserver variability was assessed using the Kappa test.



Graph 1: Morphometric measurements of mental foramen related to the side. Series 1 = mean length Series 2 = mean length



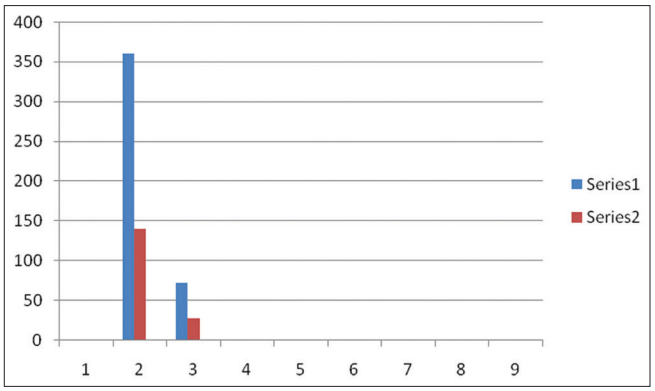
Graph 2: Position of mental foramen



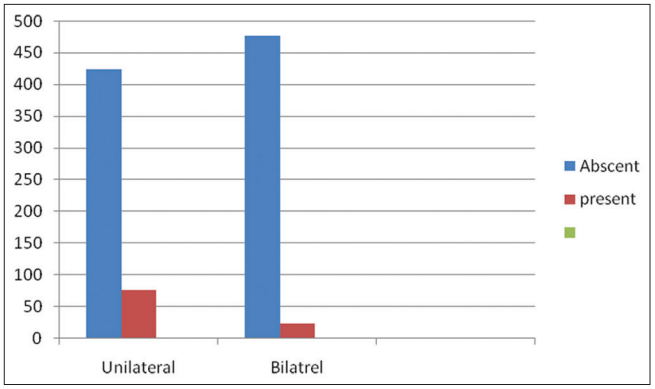
Graph 3: Series 1: Oval Series 2: Round

RESULTS

Out of 500 CBCT images of the MF, 264 scans (52.8%) wereof males and 236 scans (47.2%) belonged to females, The meansize of MF as measured in the sagittal sections was found to be3.65 mm in height and 2.75 mm in length in males and 3.30 mmin height and 2.41 mm in length in females. The mean size ofthe foramen [Table 1, Graph 1] was found to be on theright side (length 2.13 mm and height 3.48 mm) compared tothe left side (length 2.54 mm and height 3.40 mm).



Graph 4: Distribution of subjects based on anterior loop. Series 1: Frequency Series 2: Percentage



Graph 5: Distribution of subjects based on unilateral or bilateral loop

Table 1: Morphometric measurements of mental foramen related to side and gender

Gender/side/total	Length/height (mm)	Mean	Range
Male (*n*=264)	Length	2.75	1.8–4.3
	Height	3.65	2.1–4.6
Female (*n*=246)	Length	2.41	1.6–3.9
	Height	3.30	1.8–4.8
Right (*n*=250)	Length	2.13	1.8–4.6
	Height	3.48	1.9–4.3
Left (*n*=250)	Length	2.54	1.8–4.5
	Height	3.40	1.8–4.8

Table 2: Position of mental foramen

Position	Frequency	Percentage
Between 1st and 2nd premolar (1)	290	56.16
Below 2nd premolar (2)	110	22
Below the 1st premolar (3)	72	14.4
Between 2nd premolar and 1st molar (4)	28	5.6

Table 3: Shape of the mental foramen

Shape	Oval	328	65.6
	Round	172	34.4
	Total	500	100

The most common position [Table 2, Graph 2] for the MFrelated to the mandibular teeth in this study was betweenthe first and second premolars in 290 CBCT images (56.16%),followed by below the second premolar in 110 images (22%),below the first premolar in 72 images (14.4 %), and wasfound in 28 images (5.6 %) between second premolar and first molar .

A majority of the MF were oval [Table 3, Graph 3] (n = 328,65.6 %) followed by round shape (*n* = 172, 14.4 %).

Thepresence of AL of inferior alveolar nerve was found in only 28 % (*n* = 140) of cases in this study. [Table 4, Graph 4].

Out of 500 CBCT images, AL was unilateral in 15.2%(n = 76) and bilateral in 4.8% (*n* = 24) of the scans [Table 5, Graph 5].

DISCUSSION

The IAN supplies all the mandibular teeth, and its terminal branches are the incisive nerve, the one which runs inside the canal, and the MN, the one which leaves the MF and supplies sensation to the lower lip, buccal mucosa in front of the MN, and the skin of the chin ventral to the MF.[7] The intraosseous course of MN has been a debated subject for longer period in the literature but more of it in the point of theoretical analysis [Table 6].

In the field of maxillofacial imaging, there is an increasing demand for CBCT because of its good image quality, volumetric analysis, short scan times, and relatively less radiation dose than other conventional medical CTs. Hence, the anatomical variations can be evaluated using CBCT.[6]

The average height and length of the MF in the present study were 2.1–4.6 mm and 1.8–4.3 mm, respectively, which were similar to the values reported by Von Arx *et al*.[8] using CBCT (3.0 mm and 3.2 mm, respectively) and the values reported by Dos Santos Oliveira *et al*. (3.11 mm and 3.20 mm, respectively). In addition, both Von Arx *et al*., and Dos Santos Oliveira *et al*.[9] found that the MF was larger in men than in women. This difference between the genders was also found in this study for the MF in sagittal CBCT images, and men presented higher average values of MF (height 2.1–4.6, length 1.8–4.3 mm) than women (height 1.6–3.9 mm and length 1.8–4.8 mm).

The location of MF was greater between the first and second premolar region with 56% of total CBCT images. The more prevalent shape of MF was oval. The AL was detected only in 28% of total scans. Similar findings of the MF position were reported by Olasoji *et al*.[10] in Nigerian adults and Rupesh *et al*.[11] in Indian populations. Ilayperuma *et al*.[12] (2009) in Sri Lankan mandibles and Ngeow and Yuzawati (2003) in Malay populations also found MF most commonly between the premolars, whereas studies in Turkish populations (Kalender *et al*.,[13] 2012; Gungor *et al*., 2006) showed more variation and accessory foramina. (Kalender *et al*. 2012; Gungor 2006).

Table 4: Distribution of subjects based on the anterior loop

		Frequency	Percentage
Anterior loop	Absent	360	72
	Present	140	28
	Total	500	100

Table 5: Distribution of subjects based on unilateral or bilateral loops

Anterior loop	Unilateral	Bilateral
Absent	474	476
Present	76	24

Table 6: Comparative findings on morphometric variations and anterior loop in different populations

Author/Population	Findings	Remarks
Wadu *et al*. 1997	Variability in intraosseous course of MN	Morphological variability reported
Von Arx *et al*. 2013	MF mean size 3.0 x 3.2 mm	Larger in males
Dos Santos Oliveira 2018	MF mean size 3.11 x 3.20 mm	Consistent with Von Arx
Olasoji *et al*. 2004	MF commonly between premolars	Nigerian adults
Rupesh *et al*. 2011	MF between premolars	Indian population
Ilayperuma 2009	MF between premolars	Sri Lankan population
Kalender *et al*. 2012	Accessory foramina observed	Turkish patients
Al-Mahalawy *et al*. 2017	MF below 2nd premolar, AL least common (15.2%)	Saudi population
Lu *et al*. 2015	AL present in 85.2%	Higher prevalence than our study
Sheikhi and Kheir 2016	MF commonly oval	Iranian population
Wang *et al*. 2017	MF commonly apical to 2nd premolar (59%)	Chinese cadavers
Al-Shayyab *et al*. 2015	Round MF commonest	Iraqi population
Neiva 2004; Greenstein 2006	Stressed MF & AL in implant planning	Clinical importance highlight

Al-Mahalawy *et al*.[14] assessed 302 CBCT scans of Saudi population and concluded that MF was commonly found below the apex of the second premolar and the AL was regarded as the least common pattern in Saudi population (15.2%) which is agreement with this study.

Lu *et al*.[15] assessed 366 CBCT scans and identified AL in 85.2% of cases which is in disagreement with this study. Sheikhi and Kheir[16] assessed 180 CBCT scans in Iranian population and observed that the most common shape of the MF was oval which is in agreement with this study. According to Rios *et al*., the quality of the image is more important than the clinician's diagnostic ability and thoroughness.

Wang *et al*.[17] assessed 100 Chinese cadaver mandibles and reported that the most common location of MF among the Chinese population was apical to the second premolar (59%). Panoramic studies on various populations such as Kenyan African (Mwaniki and Hassanali, 1992), Malay (Ngeow and Yuzawati, 2003), Krudish (Al-Talabani *et al*., 2008), and Bareilly Indian (Alok *et al*., 2016) also indicated MF in line with the second premolar. Al-Shyayab *et al*.[18] (2015) found round MF as the most common shape in Iraqi population, differing from the present findings.

In implant dentistry, morphometric studies (Neiva *et al*., 2004; Greenstein and Tarnow, 2006) strongly emphasize the clinical importance of MF and AL in surgical planning, reinforcing the necessity of CBCT evaluation to prevent neurosensory complications (Neiva, 2004)[19] (Greenstein, 2006).

CONCLUSION

This study recommends the clinician to use CBCT for better evaluation of the anatomical and morphological variations in MF in the interforaminal region during surgical interventions. The CBCT is a good diagnostic technique for assessing the presence of AL of IAN.

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