Original Article

Anatomical Variation in the Location of Mandibular Foramen with Age Using Cone Beam Computed Tomography

Anatomical Variation of Mandibular Foramen Using Cone Beam CT

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ABSTRACT

Objective: To use cone-beam computed tomography images to assess the mandibular foramen's location in relation to age.

Study Design: Cross-sectional retrospective study examined the hospital records.

Place and Duration of Study: This study was conducted at the Radiology Department of Khyber College of Dentistry (KCD), in Peshawar, Pakistan 4th November 2021 to 3rd May 2022.

Methods: 1000 CBCT radiographs from patients treated over a two-year period were examined in the initial radio-anatomical investigation. The shortest distance between the mandibular foramen (MF) and Point A, Point P, Point MI, Point MN, and Point O were measured. Ratios were also computed to ascertain the MF's location in relation to these anatomical landmarks. For all data statistical analysis, a significance level of $P \leq 0.05$ was used.

Results: 134 mandibular foramens are associated with people between the ages of 15 and 70, with an average age ± (SD) of 39.81±14.71 years. The measured mean distances were 17.29, 12.54, 18.70, and 32.43 from the mandibular foramen to Point A, Point P, Point MI, Point MN, and Point O respectively. The MF was found about 3.65 mm above point O. The average measurement between point A and point P was 49.36 mm, whereas the average measurement between point MI and point MN was 50.60 mm. The computed ratios for AMF/AP and MIMF/MIMN were 0.58 and 0.37 mm. The investigation's findings demonstrated that the location of the mandibular foramen varied statistically significantly among age groups.

Conclusion: The mandibular foramen's location varied dramatically with age, according to the study's findings.

Key Words: Mandibular Foramen, Orthognathic, Cone Beam Computed Tomography

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INTRODUCTION

On the inside surface of the mandibular ramus, there is an uneven opening known as the mandibular foramen.[1] The key area for the inferior dental nerve block, which offers regional anaesthetic for various surgical operations in the lower jaw, is where the IAN invades the MF[2]. The location of the MF varies greatly depending on the population and can change with age even in the same person on both sides[3].

The identification of the mandibular foramen and IAN is required prior to the osteotomy of the ramus of the mandible, and these procedures should be performed with caution to avoid injury[2]. It is very common for IAN block to fail or for ramus to fracture in such orthognathic procedures and they are most commonly caused through being uncertain regarding the precise location of the MF in different age groups, races, or ethnicities. The IAN block's predicted failure rate is between 5 & 15%[4] and 15 to 20%[5]. According to[6] this failure rate could be as high as 45%. Failure of IAN block might occur due to lack of definite anatomic landmarks, anatomical differences such as mandibular foramen located superior or inferior to its normal position; and improper anesthesia method that may be due to limited mouth opening, a needle placed too anterior or posterior to the normal location[7].

The MF location have been determined by different authors using different methods such as, dried human mandibles[8], panoramic radiographs[9,10], CT scan[7] and CBCT to locate mandibular foramen[2-6,11-13]. CBCT offers better accurate localization of many anatomical features and there is less distortion of image as compared to plain radiograph. Moreover, it has higher accuracy, more resolution, less scan time, and decreased radiation dose in comparison with typical CT imaging[2].

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To our knowledge till date no studies have been carried out among the local population on this subject. The current investigation aims to pinpoint the exact position of the MF. Dental surgeons may use the findings of this study to detect the mandibular foramen, which will enable them to select an easy-to-reach target area for the IANB, lowering the risk that it will fail in the majority of patients. This study's findings will also define a safe zone for extra-oral mandibular ramus osteotomy treatments, reducing the possibility of harm to the inferior alveolar nerve in individuals having these procedures.

METHODS

The Institutional Review Board (IRB) of the prime foundation gave its approval to this cross-sectional retrospective study, on 10 Sep. 2021 (Approval no: Prime/IRB/2021-358). Ethical approval for data collection was granted by RRB-KCD vide notification No. 3065/RRB/KCD dated 3rd November 2021.The study was carried out in Peshawar. CBCT images were collected from Khyber College of Dentistry's radiology department (KCD). Khyber College of Dentistry (KCD) is a referral hospital in Peshawar, and its health services are available to all patients from KPK of varying socioeconomic backgrounds. In the supervision of an oral and maxillofacial surgeon, the observer interpreted CBCT images. The Radiology Department of Khyber College of Dentistry (KCD) presently has the CBCT radiographs studied in this study. Planmeca Romexis software was used to import CBCT images into the computer CBCT pictures of individuals between the ages of 15 and 70 had been included in this investigation, however radiographs of patients with asymmetrical faces, pathological lesions in the mandibular ramus, or those who had bilaterally absent or malpositioned mandibular first molars were not included. The senior radiology technician obtained the CBCT images at KCD in accordance with the manufacturer guidelines and a stringent, standardised scanning methodology. These radiographs were produced using a cone beam computed tomography scanner with an exposure period of 9 seconds and a voxel size of 400 m approx. depending on the FOV. To prevent inter-observer variations, the same examiner evaluated all the cone beam computed tomography images. Additionally, they were assessed under standard viewing conditions, which included enhancing radiograph clarity by modifying the brightness and opacity settings. The investigator got training to identify the MF and other mandibular landmarks prior to doing the radiographic examination, using a set of cone beam computed tomographic images that were not a part of the research. The calibration training procedure included hands-on discussion sessions and demonstrations of mandibular CBCT landmark identification techniques as well as demonstrations of the steps involved in determining the distances between mandibular landmarks using the CBCT software. Axial, sagittal, cross-sectional and panoramic views were used to locate MF. The mandibular landmarks used in past studies and the location of the MF were measured using the software ruler to estimate their distances (in millimeters)[2,6,11-13].

Among the landmarks were the anterior border's deepest point on the ramus (A), the deepest point of ramus' posterior border (P), the mandibular first molar's occlusal plane (O), the most superior point of curvature of the mandibular notch (MN), the most inferior point of mandibular incisura (MI),

The subsequent calculations involved the following measurements and ratios:

- The shortest path AP: To ascertain the ramus's horizontal dimension between positions A and P.
- To find the height of the ramus, take the shortest MIMN distance (between points MI and MN).
- The MF's horizontal placement is described by the AMF/AP ratio.
- MIMF/MIMN ratio describes the vertical position of the MF.

Each participant's mandibular foramen was evaluated bilaterally, and its location as well as the patient's MRN number and age was noted on the proforma. Based on their ages, the participants were then separated into the following four groups (Table 1).

Statistical Assessment:

• The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS), version 20.

• To analyse data, descriptive statistics were employed.

• In order to ascertain whether the age groups differed noticeably from one another, a one-way ANOVA test was employed.

• $P \leq 0.05$ was designated as the statistical significance level for the test.

RESULTS

All Cone beam computed tomographic images of patients treated over a 2-year period were investigated in this radioanatomical investigation. A total of 1000 cone beam computed tomographic images were initially evaluated, and of them, 100 CBCTs met the requirements for inclusion in the research. The mandibular foramen of each CBCT image was evaluated mean age ± (SD) of patients were 39.81±14.71 years (range =15-70 years).

Table 1: Age groups included in this study.

Groups	Age
Young adults	From 15 to 25 years
Adults	From 26 to 40 years
Middle age	From 41 to 60 years
Elderly	From 61 to 70 years

To determine if age-related changes were statistically significant, a one-way ANOVA test was used. ($P \leq 0.05$).

Young adults (15-25 years old) had the lowest MIMF, MNMF, OMF, and MIMN values (Table: 2).

PMF and AP values were lowest in adults (26-40 years) while this group showed highest values of MIMF /MIMN ratio (Table: 2).

Middle age group (41-60 years) showed lowest values of AMF and AMF/AP ratio (Table: 2).

AMF, PMF, MIMF, MNMF, OMF, AP, MIMN AND AMF/AP ratio were higher in elderly patients (61-70 years) while MIMF/MIMN ratio decreased in this age (Table: 2).

Values of MIMF, MNMF, MIMN AND MIMF/MIMN ratios differed significantly among different age groups. Nevertheless, there was no age-related statistically significant variation in the levels of AMF, PMF, OMF, AP, or AMF/AP ratio (Table: 2).

Table No.2: The average distance between MF and numerous mandibular landmarks among different age groups

Age Groups		N	Mean ± Std. Deviation (mm)	P value*
Distance from point A to point MF (A-MF)	15-25	112 (56%)	17.31±2.45	0.262
	26-40	74 (37%)	17.36±2.93	
	41-60	12 (6%)	16.23±3.57	
	61-70	2 (1%)	20.07±1.78	
	Total	200	17.29±2.71	
Distance from point P to point MF (P-MF)	15-25	112 (56%)	12.50±2.57	0.097
	26-40	74 (37%)	12.29±2.62	
	41-60	12 (6%)	14.11±1.94	
	61-70	2 (1%)	14.47±2.22	
	Total	200	12.54±2.58	
Distance from point MI to point MF (MI-MF)	15-25	112 (56%)	18.17±3.41	0.046
	26-40	74 (37%)	19.13±3.81	
	41-60	12 (6%)	20.64±3.36	
	61-70	2 (1%)	21.28±4.97	
	Total	200	18.70±3.62	
Distance from point MN to point MF (MN-MF)	15-25	112 (56%)	31.53±5.06	0.034
	26-40	74 (37%)	33.49±5.21	
	41-60	12 (6%)	33.61±5.38	
	61-70	2 (1%)	36.94±4.86	
	Total	200	32.43±5.21	
Distance from point O (mandibular first molar's occlusal plane) to point MF (O-MF)	15-25	112 (56%)	3.39±2.62	0.290
	26-40	74 (37%)	4.00±2.60	
	41-60	12 (6%)	3.60±1.48	
	61-70	2 (1%)	5.62±2.73	
	Total	200	3.65±2.57	
Distance between points A and point P (AP)	15-25	112 (56%)	29.41±3.19	0.325
	26-40	74 (37%)	29.13±2.84	
	41-60	12 (6%)	29.76±2.42	
	61-70	2 (1%)	32.94±2.31	
	Total	200	29.36±3.02	
Distance between points MI and MN (MIMN)	15-25	112 (56%)	49.36±5.45	0.002
	26-40	74 (37%)	51.75±5.99	
	41-60	12 (6%)	53.87±6.94	
	61-70	2 (1%)	57.69±1.21	
	Total	200	50.60	
The AMF/AP ratio	15-25	112 (56%)	0.58±0.09	0.519
	26-40	74 (37%)	0.58±0.12	
	41-60	12 (6%)	0.54±0.09	
	61-70	2 (1%)	0.61±0.10	
	Total	200	0.58±0.10	
The MIMF/MIMN ratio	15-25	112 (56%)	0.37±0.07	0.003

	26-40	74 (37%)	0.38±0.09	
	41-60	12 (6%)	0.38±0.04	
	61-70	2 (1%)	0.16±0.21	
	Total	200	0.37±0.08	

Table No.3: The average distances between various mandibular landmarks and the MF.

The average distances between various mandibular landmarks and the MF.	**MEAN (mm)**
Distance from point A to point MF (A-MF)	17.29
Distance from point P to point MF (P-MF)	12.54
Distance from point MI to point MF (MI-MF)	18.70
Distance from point MN to point MF (MN-MF)	32.43
Distance from point O (mandibular first molar's occlusal plane) to point MF (O-MF)	3.65
Distance between points A and point P (AP)	49.36
Distance between points MI and point MN (MIMN)	50. 60
The AMF/AP ratio	0.58
The MIMF/MIMN ratio	0.37

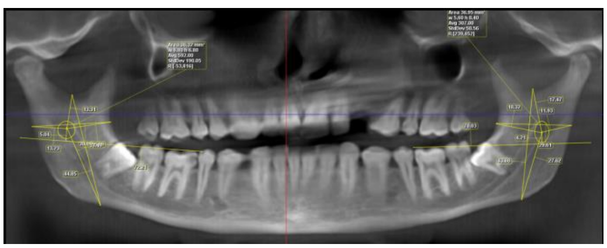

Figure No.1: The shortest distance from the MF to numerous mandibular landmarks on panoramic view of CBCT.

DISCUSSION

The noninvasive way to locate the mandibular foramen precisely is by radiographs, which are essential in oral and maxillofacial surgery[2]. The recommended radiographic method for accurately identifying and examining the mandibular foramen is cone beam computed tomography (CBCT) due to its several advantages over plain films. Many dentists have found CBCT's diagnostic ability to be beneficial. CBCT can express fine structures due to its small voxel size, and it has a lower radiation dose than a conventional mulitislice CT scan. It also requires less tube voltage and current than conventional CT[11].

According to the current investigation, the average distances from the MF to point A, point P, point MI, point MN, & point O were measured to be 17.29, 12.54, 18.70, 32.43, and 3.65 mm, respectively (Table: 3). According to a study by[2] on Jordanians, the average distances between the MF and the ramus's anterior and posterior margins, the mandibular incisura, and the mandibular notch were 17.51mm, 13.16mm, 19.28mm, and 25.66mm respectively. The MF was situated 4.52 mm above the occlusal plane.[2]

The mean vertical height of the ramus was 50.60mm in this study (Table: 3). Nevertheless, this height was measured as 49.4mm in a study done by da Fontoura et al., in 2002.[14]

There were statistically significant differences in the current study in the values of the MIMF, MNMF, MIMN, and MIMF/MIMN ratios across the various age groups, but not for the AMF, PMF, OMF, AP, or AMF/AP ratios. The lowest values of MIMF, MNMF, OMF, and MIMN were found in young adults. Adults had the lowest PMF and AP levels, but they had the greatest MIMF/MIMN ratios. The AMF and AMF/AP ratio were lowest in the middle-aged group. Elderly patients had increased levels of AMF, PMF, MIMF, MNMF, OMF, AP, MIMN, AND AMF/AP ratio, whereas MIMF/MIMN ratio decreased at this age (Table: 2). In a research done on adults under the age of 40, it was observed that the MF's position in regard to landmarks did not vary with age.[11]

The MF was 3.65 mm above the occlusal plane in this study. Previous research found the MF to be 2.5-3.6 mm above the occlusal plane of the molars.[15], and no statistically significant changes in the MF's location with advancing age were seen. Adults had the MF 4.2 mm above the occlusal plane**.**

CONCLUSION

The location of the mandibular foramen was determined using landmarks from CBCT scans.

The location of the mandibular foramen varied dramatically with age, according to the research findings.

Author's Contribution:

Concept & Design of Study:	Asma Sattar
Drafting:	Naheed Imran, Muhammad Ishfaq
Data Analysis:	Sana Arbab, Munawar Aziz Khattak, Imran Khattak
Revisiting Critically:	Naheed Imran, Asma Sattar
Final Approval of version:	Asma Sattar

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