Original Article

Anatomical Variation in the Position of Mandibular Foramen with Side of the Arch Using Cone Beam Computed Tomography

CT Scan Locate the Mandibular Foramen Based on Arch Side

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ABSTRACT

Objective: Cone-beam computed tomography images were used in this investigation to locate the mandibular foramen based on the arch side.

Study Design: This retrospective cross-sectional analysis examined hospital data.

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

Methods: A radio-anatomical inquiry was conducted to assess 1000 CBCT photographs from patients who received evaluation during a two-year period. All statistical analyses of the data sets were conducted at a $P \leq 0.05$ level of significance.

Results: Each CBCT scan included measurements of the mandibular foramens on both sides of the jaw, for 200 mandibular foramens in total (100 on the left and 100 on the right). With a range of 15 to 70 years, the mean age was 39.81±14.71 years. The experiment's findings demonstrated that the left or right side of the arch had no bearing on where the mandibular foramen was located.

Conclusion: The investigation's findings demonstrated that the arch side had no bearing on where the mandibular foramen was located.

Key Words: Inferior alveolar nerve, Mandibular Foramen, CBCT

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INTRODUCTION

The mandibular foramen is an irregular opening located on the mandibular ramus' inside surface. For the IANB, that provides local anesthetic to a number of lower jaw procedures, the site where the IAN crosses the mandibular foramen is critical[1]. Depending on the population, the placement of the mandibular foramen might alter on both left and right sides as an individual grows[2].

Before undergoing an osteotomy of the ramus of the jaw, the mandibular foramen and IAN must be identified; great care must be used throughout these procedures to avoid damage[1].

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In these orthognathic surgeries, as the surgeons usually do not know the precise placement of the mandibular foramen in different racial or ethnic groups and age ranges, Failure of the IAN block or fracture of the ramus is very common. It is estimated that five to fifteen percent of instances will result in an IAN block malfunction[3] or in fifteen to twenty percent of cases[4]. According to a study, this failure rate might reach 45%. IAN block failure can be caused by anatomical variations, such as the mandibular foramen being positioned above or below its normal position, inadequate anesthetic procedures, such as putting a needle too anteriorly or posteriorly to the normal placement, and a lack of identifiable anatomic landmarks[5].

Several authors have used a variety of methods, including dried human mandibles, to pinpoint the location of MF[6], Orthopantomography[7,8], computed tomography scan[5], and Cone beam computed tomography for identifying the mandibular foramen [1,9-11]. Compared to a simple radiograph, CBCT produces more accurate results and has less picture distortion when it comes to localizing various anatomical characteristics. Additionally, it scans more quickly, is more precise, comprehensive, and emits less radiation than traditional CT imaging[1].

As far as we are aware, no local population research has been conducted on this subject. Finding the MF's location is the aim of this investigation. In order to choose an easily accessible target site for IANB and lessen the likelihood of it failing in most of patients, dental surgeons may utilize the study's findings to pinpoint the mandibular foramen. Additionally, the results of this study will reduce the risk of inferior alveolar nerve damage in patients by providing a secure site for extraoral osteotomies of the ramus.

METHODS

Permission to conduct this cross-sectional retrospective analysis was granted by the Prime Foundation's Institutional Review Board (IRB) on September 10, 2021 (approved number: Prime/IRB/2021-358). RRB-KCD approved the ethical data collection in notification No. 3065/RRB/KCD, which was issued on November 3, 2021. Peshawar was the site of the research. The CBCT photos were provided by KCD's radiology department. All KPK patients, regardless of their financial status, can receive medical care at KCD which is a referral hospital. The observer was instructed by an OMFS specialist to evaluate cone beam computed tomographic radiographs. The CBCT radiographs used in this investigation are currently on exhibit in the Khyber College of Dentistry's (KCD) radiology department. The computer was loaded with CBCT pictures using the Planmeca Romexis application. Patients having pathological lesions in the ramus of the jaw, asymmetrical faces, or Mandibular first molars that were either absent or misaligned on both sides were excluded, but CBCT pictures of males and females aged 15 to 70 were included. Following stringent, standardized scanning protocols and the manufacturer's guidelines, a senior radiology technician at KCD took the CBCT radiographs. The CBCT scanner was used to create these radiographs., with a voxel size of around 400 m, depending on the field of view (FOV), and an exposure duration of nine seconds. Each cone beam computed tomography image was evaluated by the same examiner to avoid observer variability. They were also evaluated under normal viewing conditions, which included adjusting the brightness and opacity settings to improve radiograph clarity. Before conducting the radiography inquiry, the investigator was instructed to recognize the mandibular foramen and other landmarks in the mandible using a series of cone beam computed tomographic pictures. Examples of mandibular CBCT landmark identification, practical discussion sessions, and guidance on using the CBCT application to ascertain the distances between mandibular landmarks comprise the calibration training approach. MF was located using axial, sagittal, cross-sectional, and panoramic images. The mandibular landmarks utilized in the prior study were evaluated using the ruler in the Planmeca Romexis application and their lengths were estimated (in mm) with the MF(2).

The markers included the following:

1. The deepest points of the ramus's anterior border A and posterior border P,
2. The mandibular notch's superior point of curvature (MN),
3. The mandibular incisura's most inferior point (MI), and
4. The occlusal plane of the mandibular first molar (O).

The following measures and ratios were employed in the ensuing computations:

- Ramus's height was determined using the smallest measurement MIMN (between coordinates MN and MI).
- AMF/AP ratio was used to estimate the mandibular foramen's horizontal position, while MIMF/MIMN ratio was has been employed for determination of its vertical position.

Mandibular foramen were examined bilaterally in each participant’s radiograph, and their positions, together with The proforma was filled out with the patient's MRN number, geographical location, and gender.

Statistical Assessment:

• SPSS version 20 was used to conduct the statistical analyses.

• To establish whether the differences between the left and right sides were statistically significant, an independent t-test was conducted.

• Statistical significance for both tests were determined at $P < 0.05$

RESULTS

Every CBCT of patients who received treatment during the span of two years were analyzed radio-anatomically. 100 CBCTs out of a total of 1000 were determined to fit the study's inclusion requirements. Each CBCT image's mandibular foramen was assessed on mandible's both sides, totaling 200 mandibular foramens (100 on the mandible's right side and 100 on its left). With a range of 15–70 years, the mean age (SD) is 39.81±14.71 years.

The differences between the two sides of the arch were compared using independent t tests. ($P \leq 0.05$).

The average separation between the MF and different mandibular markers on the arch's left and right sides is as follows:

The position of MF did not differ statistically significantly on either side of the arch in this study (Table 1). The mean distances for AMF, PMF, MNMF, OMF, MIMN, and the AMF/AP ratio were greater on the mandibular right side, the left side however had higher mean distances for MIMF and AP, However, These changes were not statistically significant, as indicated by $P > 0.05$. MIMF/MIMN ratio was the same on both sides of the arch, as Table 1 demonstrates.

Table No. 1: The mean distance of the MF from various mandibular markers on both sides of arch:

	Right (mm) N=100	Left (mm) N=100	P value*
	MEAN ± Std. Deviation	MEAN ± Std. Deviation	
The distance (A-MF) between points A and MF	17.38±2.80	17.20±2.63	0.894
The distance (P-MF) between points P and MF	12.10±2.75	12.98±2.32	0.106
The distance (MI-MF) between points MI and MF	18.38±3.51	19.03±3.72	0.583
The distance (MN-MF) between points MN and MF	33.32±5.05	31.55±5.23	0.927
The distance from point O (The lower first molar's occlusal plane)) to point MF (O-MF)	3.82±2.72	3.48±2.41	0.192
The AP distance (between points A and P)	29.09±3.11	29.64±2.93	0.839
The distance MIMN (between locations MI and MN)	50.95±5.93	50.25±5.90	0.834
The AMF/AP ratio	0.58±0.11	0.58±0.09	0.106
The MIMF/MIMN ratio	0.37±0.08	0.37±0.08	0.866

DISCUSSION

Radiographs are a noninvasive method for determining the mandibular foramen's precise location, that is essential knowledge in oral and maxillofacial surgery[1]. CBCT is regarded as the radiographic method of choice for precise identification and investigation of mandibular foramen since it offers numerous benefits over simple films.[10]. Many dentists have lauded CBCT's diagnostic potential. Due to the smaller voxel size of CBCT, it can express fine structures and uses less radiation than a traditional mulitislice CT scan. In comparison to conventional CT. Additionally, it requires less tube voltage and current[9].

On the right side, the average distance between the anterior and posterior borders was 29.09±3.11, while on the left side, it was 29.64±2.93. (Table: 1). The right and left mandibular widths were 30.23 ± 2.15 mm and 30.02 ± 2.0 mm, respectively. Both the left and right 60 dry human mandibles exhibited mandibular widths of 30.02 ± 2.0 mm and 30.23 ± 2.15 mm, respectively. according to a 2020 study by Amjad et al[12].

The ramus had a mean vertical height of 50.60mm in this study. However, same height was recorded at 49.4mm in a study conducted by[13].

The right and left sides of MF's location did not differ statistically significantly, according to this research. While the mean distances of the AMF, PMF, MNMF, OMF, MIMN, and the right side of the mandible had a higher AMF/AP ratio than the left. Nevertheless, these variations were not statistically significant (P > 0.05As seen in Table 1, the MIMF/MIMN ratio was the same on both sides of the mandible. This is consistent with what is now understood about the variations in MF position between the arch's two sides[1,14,15].

The MF in this study was 3.65 mm above the plane of the occlusal plane. According to a study, The MF was situated 2.5–3.6 mm above the molars' occlusal plane[16], there was no indication that the location of the MF changed statistically significantly as people aged. According to[17], in adults, the MF is above the occlusal plane by 4.2 millimeters.

CONCLUSION

This study's findings demonstrated that the mandibular foramen's placement was unaffected by the arch side.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Asma Sattar, Muhammad Ishfaq
Drafting or Revising Critically:	Imran Khattak, Aiman Shaheryar, Munawar Aziz Khattak, Sana Arbab
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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