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# Assessing the significance of mandibular foramen location in radiotherapy planning for the Iraqi population: A cone beam computed tomography study

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ABSTRACT

**Background:** The mandibular foramen is a critical anatomic landmark of the mandible. Understanding the mandibular foramens position is critical in many dental procedures. Knowing the precise position of the mandibular foramen improves the achievement of the anesthetic procedure. The aim of this study is to evaluate difference in mandibular foramen position according to age, gender and side.

**Materials and methods:** 56 panoramic images for patients with normal occlusion was reconstructed from cone beam computed tomography from the radiology archive in specialist dental center in Diyala. Distance from mandibular foramen to mandibular notch, mandible's inferior border, ramus's anterior border, and ramus's posterior border was measured for both right and left side. These measurements were categorized by age, gender and side.

**Results:** Gender and age had no significant difference on distance from mandibular foramen to mandibular notch, the inferior border of the mandible, and the anterior border of the ramus while it had significant difference on the ramus's posterior border on both right and left side with p value (0.0001) for both sides according to gender and p value (0.0008) for right side, p value (0.0013) for left side according to age. The selected measurements show no significant difference when side was compared.

**Conclusion:** Gender, age and side have no affected on the position of mandibular foramen except the distance from mandibular foramen to posterior border of ramus had significant difference according to gender and age.

**Keywords:** Mandibular foramen; Age; Gender; Cone beam computed tomography; Radiotherapy

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## INTRODUCTION

The Mandibular Foramen (MF), which runs through the mandible, is a bone canal. This bony canal is accessible from the mandibular ramus's inner side. The inferior alveolar nerve, artery, and vein are located within the mandibular foramen. The inferior alveolar artery provides the majority of blood to the mandible, gums, teeth, and lower jaw nerves [1]. Clinically, the MF cannot be palpated therefore specific landmarks are used to pinpoint its location. Landmarks that can be used to determine the position of the MF include the occlusal plane, the anterior border of the ramus, and the external and internal oblique ridges [2]. Understanding the mandibular foramen is essential in dental and jaw surgery. It is critical to understand that the inferior alveolar nerve and vessels are housed in the mandibular foramen in order to avoid complications, the inferior alveolar nerve, for example, can be damaged during implantation or dental extraction of the third molar tooth [3].

Anesthesia techniques for the jaws differ. It is simple to provide anesthesia in the maxilla, but there may be some difficulties in the mandible. The most common technique failure in inferior alveolar nerve block anesthesia is incorrect needle placement due to incorrect anatomic structure location in MF [4].

The mandibular foramen receives the anesthetic right above it, although the impact is frequently insufficient if the surgeon misjudges the foramen's anatomical placement or if it has been displaced [5].

Regardless of the operator's skill, the importance of locating the MF relative to anatomic structures that are convenient to use cannot be overstated [6].

During dental procedures, the inferior alveolar nerve is frequently blocked [7]. Usually, the inferior alveolar nerve is blocked before it passes through the MF. The inferior alveolar nerve block can be identified by the pterygomandibular raphe and the coronoid notch [8]. To successfully numb the sensory territory of the inferior alveolar nerve, typically, a local anesthetic is administered in this space between the two structures [9].

In this study panoramic images reconstructed from Cone Beam Computed Tomography (CBCT) were used to locate the position of MF and the study aimed to demonstrate the effect of gender, age and side on the position of MF.

## MATERIALS AND METHODS

The samples composed of 56 dentate patients (22 male and 34 female), age ranged between (20-55) years old, the total sample including patients attended specialist dental center in Diyala for CBCT investigation for different diagnostic purposes.

The image of patients used in this study included patient with normal occlusion without history of trauma, facial asymmetry, fracture and cystic lesion.

The New Tom Giano CBCT (16 cm × 14 cm field of view, voltage of 110 kv, exposure time of 24 seconds, electrical current of 5-7 mA) used in this study. The mandibular foramen was assessed in the region where the mandibular canal ended, and the images used in this investigation were rebuilt in a panoramic view. Measurements that included in this study were done on both sides.

**Linear measurements:**

- The distance from the anterior border of the ramus (A) to the Mandibular Foramen (MF) (AMF) line 1.
- The distance from the posterior border of ramus (P) to Mandibular Foramen (MF) (PMF) line 2.
- The distance from the most inferior border of ramus (I) to the Mandibular Foramen (MF) (IMF) line 3.
- The distance from the mandibular notch (N) to the Mandibular Foramen (MF) (NMF) line 4 as shown in Figure 1.

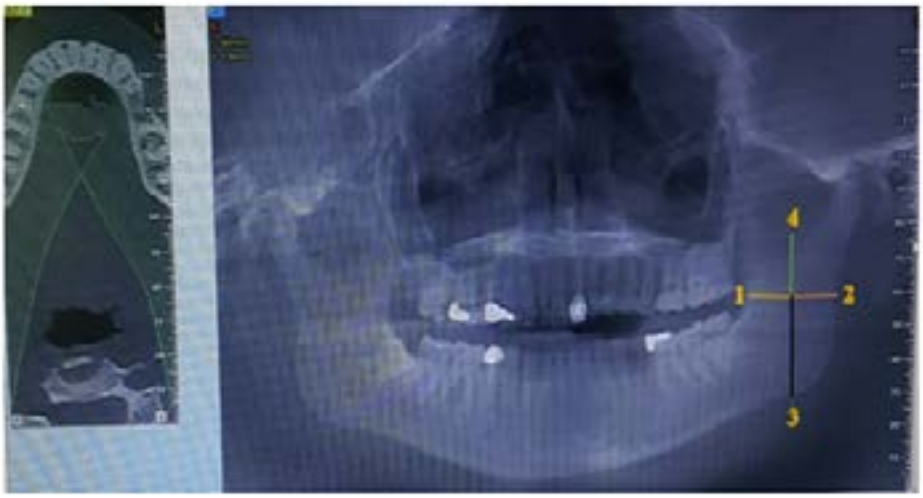


**Fig. 1.** Image of linear measurements included in the study.

## Statistical analysis

To identify the impact of various factors on study parameters, the Statistical Analysis System-SAS (2018) program was utilized. In this study, meaningful comparisons between means were made using the T-test and the Least Significant Difference (LSD) test (Analysis of Variance-ANOVA).

## RESULTS

According to the study's findings, there was no gender difference in the distance from the mandibular Notch (N) to the MF (N-MF) with p values of (0.110) for the right side and (0.102) for the left side (Table 1).

**Tab. 1.** Comparison between male and female in N-MF in right and left side.

| Measurement | Gender | Mean ± SE | | T-test (P-value) |
|---|---|---|---|---|
| | | Right side | Left side | |
| N-MF | Male | 19.03 ± 0.80 | 17.99 ± 0.60 | 1.355NS (0.094) |
| | Female | 16.61 ± 0.52 | 16.75 ± 0.44 | 1.256NS (0.355) |
| | T-test (P-value) | 1.474NS (0.110) | 1.499NS (0.102) | -- |
| NS: Non-Significant. | | | | |

The distance from the MF to the anterior border of the ramus (A-MF) was not statistically different between the gender, with p values of (0.654) for the right side and p value (0.882) for the left (Table 2). The results for the distance from the MF to the inferior border of the mandible (I-MF) were the same; there was no gender difference in these parameters with a p value (0.187) for the right side and p value (0.107) for the left side (Table 3).

**Tab. 2.** Comparison between male and female in A-MF in right and left side.

| Measurement | Gender | Mean ± SE | | T-test (P-value) |
|---|---|---|---|---|
| | | Right side | Left side | |
| A-MF | Male | 16.09 ± 0.97 | 15.99 ± 0.96 | 1.72NS (0.561) |
| | Female | 15.82 ± 0.76 | 15.82 ± 0.76 | 1.37NS (0.688) |
| | T-test (P-value) | 2.191NS (0.654) | 2.091NS (0.882) | -- |
| NS: Non-Significant. | | | | |

**Tab. 3.** Comparison between male and female in I-MF in right and left side.

| Measurement | Gender | Mean ± SE | | T-test (P-value) |
|---|---|---|---|---|
| | | Right side | Left side | |
| I-MF | Male | 14.84 ± 0.68 | 15.05 ± 0.66 | 1.36NS (0.307) |
| | Female | 13.55 ± 0.54 | 13.62 ± 0.46 | 1.25NS (0.64) |
| | T-test (P-value) | 1.726NS (0.17) | 1.532NS (0.107) | -- |
| NS: Non-Significant. | | | | |

For the distance from the MF to the Posterior border of the Ramus (P-MF), it was differed significantly between the gender with p values (0.0001) for the right and left side (Table 4).

**Tab. 4.** Comparison between male and female in P-MF in right and left side.

| Measurement | Gender | Mean ± SE | | T-test (P-value) |
|---|---|---|---|---|
| | | Right side | Left side | |
| P-MF | Male | 32.29 ± 0.86 | 32.73 ± 0.87 | 1.47NS (0.729) |
| | Female | 27.37 ± 0.45 | 27.12 ± 0.57 | 1.50NS (0.673) |
| | T-test (P-value) | 1.790** (0.0001) | 2.008** (0.0001) | -- |
| ** (P ≤ 0.01), NS: Non-Significant. | | | | |

**Tab. 5.** Comparison between age groups in N-MF in right and left side.

| Measurement | Age groups (year) | Mean ± SE | | T-test (P-value) |
|---|---|---|---|---|
| | | Right side | Left side | |
| N-MF | 18-30 | 17.31 ± 0.77 | 17.06 ± 0.67 | 1.59NS (0.692) |
| | 31-40 | 17.53 ± 0.58 | 17.04 ± 0.54 | 1.38NS (0.711) |
| | 41-55 | 18.01 ± 1.33 | 17.86 ± 0.73 | 1.41NS (0.328) |
| | LSD value (P-value) | 2.309NS (0.941) | 1.847NS (0.707) | -- |
| NS: Non-Significant. | | | | |

In terms of age, there is no significant difference in the distance between the MF and inferior border of the mandible (I-MF), with p values of (0.250) for the right side and (0.327) for the left (Table 6).

**Tab. 6.** Comparison between age groups in I-MF in right and left side.

| Measurement | Age groups (year) | Mean ± SE | | T-test (P-value) |
|---|---|---|---|---|
| | | Right side | Left side | |
| I-MF | 18-30 | 27.90 ± 0.83 | 27.90 ± 0.99 | 2.05NS (0.641) |
| | 31-40 | 30.20 ± 0.92 | 30.33 ± 0.89 | 1.84NS (0.588) |
| | 41-55 | 29.89 ± 0.95 | 29.75 ± 1.38 | 1.91NS (0.702) |
| | LSD value (P-value) | 3.207NS (0.25) | 2.474NS (0.327) | -- |
| NS: Non-Significant. | | | | |

Additionally, there was no significant difference in the MF to Anterior border of Ramus (A-MF) distance, with p values of (0.198) for the right side and (0.148) for the left (Table 7).

**Tab. 7.** Comparison between age groups in A-MF in right and left side.

| Measurement | Age groups (year) | Mean ± SE | | T-test (P-value) |
|---|---|---|---|---|
| | | Right side | Left side | |
| A-MF | 18-30 | 13.50 ± 0.66 | 13.42 ± 0.67 | 1.35NS (0.831) |
| | 31-40 | 13.71 ± 0.72 | 13.89 ± 0.64 | 1.55NS (0.752) |
| | 41-55 | 15.53 ± 0.81 | 12.33 ± 0.79 | 1.586NS (0.7255) |
| | LSD value (P-value) | 2.126NS (0.198) | 2.187NS (0.148) | -- |
| NS: Non-Significant. | | | | |

Additionally, there was no significant difference in the MF to Anterior border of Ramus (A-MF) distance, with p values of (0.198) for the right side and (0.148) for the left (Table 8).

**Tab. 8.** Comparison between age groups in P-MF in right and left side.

| Measurement | Age groups (year) | Mean ± SE | | T-test (P-value) |
|---|---|---|---|---|
| | | Right side | Left side | |
| P-MF | 18-30 | 17.59 ± 0.99 | 17.02 ± 0.87 | 2.03NS (-0.266) |
| | 31-40 | 16.50 ± 0.82 | 16.94 ± 0.85 | 2.18NS (0.195) |
| | 41-55 | 12.09 ± 0.67 | 12.33 ± 0.79 | 1.07NS (0.746) |
| | LSD value (P-value) | 2.699** (0.0008) | 2.576** (0.0013) | -- |
| **(P ≤ 0.01), NS: Non-Significant. | | | | |

Comparison the selected measurements between two side (right and left), our results shows that there was no significant difference between measurements according to side for both male and female as shown in Tables 1-8.

## DISCUSSION

Inferior Alveolar Nerve Block Anesthesia (IANBA) is the primary method for administering local anaesthetic to teeth. There are a number of reasons why the inferior alveolar nerve cannot be anesthetized, including improper anesthetic technique and anatomical differences [10]. In IANBA, ramus osteotomy, and surgery of the mandibular ramus's posterior angle, the anatomic location of the Mandibular Foramen (MF) is crucial [11]. This study investigated the anatomical variation of the MF position according to gender, age and side.

Park and Lee study the location of MF on different malocclusion patients. They discovered that there was no gender-related significant difference in the site of MF in patients with normal occlusion and this result is consistent with the results of our study which shows that the gender had no significant difference on the distance from MF to mandibular notch, anterior border of ramus and inferior border of mandible but regarding to the distance from MF to the posterior border of ramus, our study shows that there was significant difference in this parameter according to gender with mean value higher in female than male and we can explain this result by noting that adult men have a posterior ramus that is bent at the level of the molars' occlusal surfaces, but females have a straight juvenile form or may bend above the occlusal level close to the neck of the condyle [12-15].

Correa et al., examine the location of the mandibular foramen in different facial shape and he discovered that the position of MF according to sex did not differ significantly, which is agreed with our results.

Inconformity with our study's findings, Hayagreev et al., found that the position of MF will vary with sex. Movahhed et al., also

found different location of MF according to sex. These two studies were based on the comparison between the ages of less than 20 years and reinforced the difference in the MF location as a result of difference in mandibular growth at this age as mandibular growth rates in female are faster than that of the males. Our study relied on comparing the ages of more than 20 years.

Regarding to age, our study shows that age-related differences in the distances between the MF and the mandibular notch, the inferior border of the mandible, and the anterior border of the ramus were insignificant. Shokri et al., evaluate the position of the MF on CBCT and the results demonstrate no appreciable changes in the MF's position with age, and this is in line with the findings of our study [16].

Our result agreed with the study made by Feuerstein et al., who conclude that when studying the position of MF, it was believed that all patients shared a similar mandibular foramen position.

In contrast with our study, Hayagreev et al., found that the position of MF was vary with age. However, as previously mentioned, this study dealt with ages less than 20.

The result of our study shows that age significantly affected how far the MF was from the posterior edge of the ramus. We can explain this by noting that the angle of the mandible is acute in youth and becomes obtuse with age.

Our study dealt with the comparison of the selected measurements in relation to the side (right and left). The findings reveal that there was no significant difference in selected measurements according to side. This outcome is in line with the findings of the research done by Feuerstein et al., who conclude that there was no discernible difference in position of MF on the left and right side. Findik et al., also conclude no different in location of MF according to side and this result come accordance with our study.

Kilarkaje et al., study the location of MF and the results shows that the position of the mandibular foramen maintains absolute bilateral symmetry in human mandibles and these results come agree with our study.

## CONSLUSION

This study included assessment the value of finding the MF for the block of the inferior alveolar nerve and it dealt with determining the difference in the location of MF according to gender, age and side. The study shows that the gender and age had no effect on the distance between the MF and the mandibular notch, the ramus's anterior border, and the mandible's inferior border but the age and gender had effect on the posterior border of ramus. Also, there is no different in the position of MF between right and left side of one individual.

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