RESEARCH ARTICLE

Enhancing IANB success: Panoramic guidance for locating mandibular foramen

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Abstract

Objective: To explore the spatial relationship of the mandibular foramen with occlusal plane and the anterior border of the ramus using orthopantomograms.

Method: The cross-sectional, observational retrospective study was conducted at the Department of Operative Dentistry and Endodontics, Armed Forces Institute of Dentistry, Rawalpindi, Pakistan, from June 1 to December 1, 2023, and comprised panoramic radiographs containing both mandibular molars of patients aged 18-65 years. Reference points included the anterior border of the ramus, the most anterior-superior point of the mandibular foramen, and the occlusal plane. Distances from the mandibular foramen to the occlusal plane and the anterior border of the ramus were recorded on both sides. Comparisons were made with respect to age and gender. Data was analysed using SPSS 23.

Results: Of the 201 patients, 122(60.7%) were males and 79(39.3%) were females. The overall mean age was 40.04±12.76 years (rang: 18-65 years). Based on the panoramic radiographs, the recommended site for inferior alveolar nerve block was approximately 3.88mm above the occlusal plane and 19.35mm from the anterior margin of the ramus. The maximum and minimum distances from the mandibular foramen to the occlusal plane were 9.70mm and -3.11mm, respectively. The mean distance between mandibular foramen and the occlusal plane on the right was 4.01±1.712mm, and it was 3.75±1.676mm of the left. The mean distance from mandibular foramen to ramus on the right was 19.31±2.336mm, while it was 19.38±2.424mm on the left.

Conclusion: Panoramic radiographic guidance could improve the success rate of the inferior alveolar nerve block by precisely locating the mandibular foramen in relation to key anatomical landmarks.

Keywords: Mandibular foramen, Occlusal plane, Inferior alveolar nerve block. (JPMA 75: 735; 2025)

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Introductio

Achieving effective pain control in mandibular teeth is of paramount importance in the field of dentistry, which is primarily done through adequate use of local anaesthesia[1] for inferior alveolar nerve block (IANB). During IANB, the local anaesthetic agent diffuses through the tissue space, ultimately reaching just before the point of entry of the inferior alveolar nerve into the mandibular foramen (MF).[2] The occlusal plane (OP) of mandibular posterior teeth, pterygomandibular raphe, and the anterior and posterior border of ramus are used as reference points during IANB administration clinically.[3] Nevertheless, studies reveal a wide range of failure rates, spanning from 30% to 81%, underscoring instances where IANB-induced anaesthesia may prove to be ineffective.[4-8]

Various factors have been implicated for the failure of local anaesthesia, such as psychological factors, inadequate mouth opening, nerve sensitivity, anatomical divergences, like ramal flaring, variations in width and height of the mandibular ramus, and the intricacies of precise injection administration.[9] Furthermore, localised pathological changes, like inflammation, can impede the anaesthetic agent's ability to effectively reach and block the nerve. Technical factors, like intravascular injection, rapid administration of injection, and improper needle placement, can also add to anaesthesia failure.[9]

Keeping in mind these complexities, scientists have suggested using panoramic radiographs in pinpointing the location of MF, a critical anatomical landmark for the precise administration of IANB.[10] Additionally, panoramic radiographs allow for the identification of anatomical variations, like accessory MF and the proximity of the mandibular canal to the mandibular teeth.[10,11] Also, when dealing with age-related shifts in the position of the mandibular canal, which can lead to ineffective IANB, these radiographs serve as invaluable aids in determining the exact location of the canal.[12]

The current study was planned to accurately determine the location of MF in relation to OP and the anterior border of the ramus.

Materials and Methods

The cross-sectional, retrospective observational study was conducted at the Department of Operative Dentistry and

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Endodontics, Armed Forces Institute of Dentistry (AFID), Rawalpindi, Pakistan, from June 1 to December 1, 2023. After approval from the institutional ethics review board, the sample size was calculated using the World Health Organisation (WHO) calculator[12] with expected proportion of patients having MF above OP to be 87% on the right side.[13] The power of the study was set at 80%, and level of significance at 5% with $p<<0.05$ being considered significant. The sample was raised using convenience sampling technique. The sample comprised panoramic radiographs containing both mandibular molars of patients aged 18-65 years who presented with third molar impactions, or multiple carious lesions, and for other orthodontic treatment. The radiographs had a high resolution with a 1:1 scale (100%) and were taken using radiographic unit Sirona Orthophos XG 2D/3D system (Sirona Dental Systems GmbH, Fabrikstraße 31, 64625 Bensheim, Germany) with specific exposure settings of 68KV, 6mA and 14.4 seconds. Panoramic radiographs showing artifacts, previous surgical manipulation of any disease or trauma, and radiographs of patients having craniofacial deformities were excluded. The radiographs were obtained from institutional archives. The reference points used by Lasemi et al.[14] were considered to measure the distance from MF to OP and the anterior border of the ramus. After recording the measurements, the values were analysed for association with age and gender.

Data was analysed using SPSS 23. Data was expressed as mean and standard deviations frequencies and percentages, as appropriate. Mean values were compared using the t-test for normally distributed data. Stratification for age and gender was done using a two-way analysis of variance (ANOVA). Chi-square test was used to assess the significance of association. P<0.05 was considered statistically significant.

Results

Of the 201 patients, 122(60.7%) were males and 79(39.3%) were females. The overall mean age was 40.04±12.76 years (range: 18-65 years).

The mean distance of the mandibular foramen from the occlusal plane was 4.01±1.712mm on the right and 3.75±1.676mm on the left (p=0.010). The overall mean position was calculated to be approximately 3.88mm above the occlusal plane. The mean distance from MF to ramus on the right was 19.31±2.336mm, while it was 19.38±2.424mm on the left (p=0.633). The overall mean distance from mandibular foramen to ramus was 19.35mm. (Table 1). The maximum and minimum distances from the mandibular foramen to the occlusal plane were 9.70mm and -3.11mm, respectively, with an average recommended site for IANB being approximately 3.88mm above the occlusal plane (Table 1).

Male subjects exhibited a slightly higher mean MF-OP distance on both the right 4.22±1.724mm and left 3.77±1.662mm sides compared to female subjects having 3.68±1.653mm on the right, and 3.71±1.706mm on the left (p>0.05) (Table 2). Similarly, no significant gender differences were found in the MF-ramus distance on either

Table-1: Comparison of mean MF distance to OP and ramus on the left and right sides.

Groups	Minimum (mm)	Maximum (mm)	Mean±SD (mm)	*p*-value
Right MF-OP	-3.11	9.40	4.01±1.712	0.010
Left MF-OP	-2.03	9.70	3.75±1.676	
Mean MF-OP	3.88mm			
Right MF-Ramus	12.85	26.02	19.31±2.336	0.633
Left MF-Ramus	14.39	29.27	19.38±2.424	
Mean MF-Ramus	19.35mm			

MF: Mandibular foramen; OP: Occlusal plane; SD: Standard Deviation.

Table-2: Comparison of mean MF distance with respect to gender.

Groups	Minimum (mm)	Maximum (mm)	Mean±SD (mm)	*p*-value
Gender (n=122 for Male, n=79 for Female)				
Male Right MF-OP	0	9.16	4.22±1.724	0.333
Male Left MF-OP	0	9.70	3.77±1.662	0.572
Female Right MF-OP	-3.11	9.40	3.68±1.653	0.333
Female Left MF-OP	-2.03	7.89	3.71±1.706	0.572

MF: Mandibular foramen; OP: Occlusal plane; SD: Standard Deviation.

Table-3: Comparison of mean MF distance in relation to age.

Groups	Minimum (mm)	Maximum (mm)	Mean±SD (mm)	*p*-value
Age Group (n=81 for 18-35, n=120 for 36-65) (years)				
Age 18-35 Right MF-OP	0.97	9.40	4.16±1.899	0.323
Age 18-35 Left MF-OP	0	9.06	3.99±1.655	0.091
Age 36-65 Right MF-OP	-3.11	8.40	3.92±1.715	0.323
Age 36-65 Left MF-OP	-2.03	9.70	3.58±1.676	0.091

MF: Mandibular foramen; OP: Occlusal plane; SD: Standard Deviation.

Table-4: Position of MF with respect to OP (n=201).

Groups	Above occlusal plane	At occlusal level	Below occlusal level
Right MF	196 (97.5%)	4 (2%)	1 (0.5%)
Left MF	194 (96.5%)	5 (2.5%)	2 (1%)

Cross-tabulation of MF position and OP.

MF Position with OP	Above Occlusal Plane	At Occlusal Level	Below Occlusal Level	Total	Chi-square	p-value
Right MF	196 (97.5%)	4 (2%)	1 (0.5%)	201	0.4547	0.7966
Left MF	194 (96.5%)	5 (2.5%)	2 (1%)	201	-	-
Total	390	9	3	402	-	-

MF: Mandibular foramen; OP: Occlusal plane; SD: Standard Deviation.

side (p>0.05).

Younger patients aged 18-35 years had a slightly greater mean MF-OP distance on the right side 4.16±1.899mm compared to older patients aged 36-65 years 3.92±1.715mm (p>0.05) (Table 3).

Most MF were located above OP, with 196 (97.5%) on the right side and 194 (96.5%) on the left side. There was no significant association between the side and the position of the MF relative to OP (p=0.7966) (Table 4).

Discussion

Administering an effective IANB in patients can be challenging. Key landmarks for performing an IANB include the external oblique ridge, coronoid notch, pterygomandibular raphe, and the OP on the same side. The MF, situated on the medial aspect of the ramus, is shielded anteriorly by lingula. By adhering to these landmarks, local anaesthesia can be delivered near the MF.[15] Nonetheless, it is vital to take note of the fact that the area of the MF can change because of elements like nationality, age and, surprisingly, on the two sides of the same individual.

All encompassing radiographs, like orthopantograms, offer significant preoperative data and work with simple appraisal. They consider the assessment of the two irregularities and typical varieties in physical milestones, including the lingula and MF. Having an exact comprehension of the MF area is pivotal while directing an IANB utilising standard methodology.[14]

In the current study, the mean distance from the MF to the level of occlusion was 4.01±1.712 on the right side (range: -3.11-9.40). On the left side, the mean distance was 3.75±1.676 (range: -2.03-9.70) (p=0.010).

The mean distance between the MF and the anterior border of the ramus on the right side was 19.31±2.336 (range: 12.85-26.02). On the left side, the mean distance was 19.36±2.42 (range: 14.39-29.27) (p=0.633).

Afsar et al.[14] emphasised that while the MF can be localised in orthopantomograms, its relationship with clinically tangible and radiographically apparent bony milestones shifts generally among people. Their 1998 study on Caucasians reported a mean distance of 20.263mm from the MF to the anterior border of the ramus, differing from the current findings by almost 1mm. They also noted that the distance from the MF to the OP averaged 1.964mmcompared to the current measurements of 4.02mm on the right side and 3.75mm on the left. It is worth noting that their reference point was the centre of the MF,[14] whereas the current study utilised the most antero-superior point of the MF.

In 2007, Kositbowornchai et al.[16] adopted the lingula as their reference point in a study involving dry mandibles. They concluded that the distance from the lingula to the anterior border of the mandibular ramus on pantomograms measured 23.240mm and 63.820mm. Additionally, the distance from the lingula was, on average, 10mm above the OP. These measurements deviated from the current results due to the use of the lingula as the reference point.

Trost et al.[17] conducted a study in 2009, finding that the MF averaged 17mm from the anterior border of the ramus compared to the current measurement of 19mm. They also observed a significant gender-related difference in the distance from the MF to the OP, which aligns with the current findings. Furthermore, the distance from the anterior border of the ramus to the MF showed no significant variation with respect to age, gender or mandibular side.

Nicholson et al.[15] revealed that the MF in majority (75%) cases was situated below the OP level, while 22.5% were at the same level, and 12.5% were found above it. In contrast, the current findings indicated that only 1% of MFs were below the OP, 97% were above it, and 4% were at the same level.

The earlier study[15] focussed on 80 dry mandibles of adult humans of Indian origin, rather than radiographs, and concluded that the significant variability in MF location may occasionally lead to difficulties in achieving an effective IANB.

The current study has limitations of being observational in nature and lacking clinical correlations. These limitations include a relatively small sample from a single centre raised retrospectively, limiting the generalisability of the findings. Future studies utilising cone beam computed tomography (CBCT) data could offer invaluable insights into the precise localisation of the relevant landmarks. Besides, the study was conducted in a specific geographical region within Pakistan. Given the potential for anatomical variations across different regions or ethnic groups, the results may not be fully applicable to other populations. Panoramic radiographs offer a useful tool for locating MF, but they may introduce some degree of distortion, which could slightly affect the precision of measurements. Recommendations for future studies should include larger, more diverse populations from different regions of Pakistan to enhance the generalisability of the findings. Additionally, local clinicians would benefit from further training in interpreting panoramic radiographs to improve IANB

success. Longitudinal studies are also recommended to assess the long-term outcomes of these imaging-guided procedures.

Conclusion

In the Pakistani population, MG was found to be positioned approximately 4mm superior to OP and 19mm from the anterior border of the ramus.

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Author Contribution:
MZ: Concept, design, data collection, analysis and interpretation.
ZMK: Drafting, revision, integrity of the data and opinions.
ASK: Revision and final approval.
JAS: Drafting and final approval.
NAR: Data analysis, interpretation and providing administrative, technical and material support.