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Panoramic Radiographic Relationship of the Mandibular Foramen to the Anterior Border of the Ramus and Occlusal Plane as an Aid in Inferior Alveolar Nerve Block

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The location of the mandibular foramen (MF) on digital panoramic radiographs can be an important guide for clinicians when administering the inferior alveolar nerve block (IANB) for dental anesthesia of the mandible. This study, aimed to assess the location of the MF relative to the anterior border (AB) of the ramus and the occlusal plane (OP) from digital panoramic radiographs. An observational case series study was conducted on digital panoramic radiographs from the oral and maxillofacial radiology department archives of patients at least 18 years of age with a 1:1 scale (100%). The samples had to have at least 2 lower molar teeth on both sides without any blurring, previous fracture of the ramus or other artifacts. The distance of the MF to the OP and the AB of the ramus was measured using a caliper. The role of age and gender were also analyzed statistically using the 2-way analysis of variance test. One hundred ninety-four digital panoramic radiographs were included in the analysis. The findings showed that the vertical distance of the MF to the OP was a maximum of 14.52 mm and a minimum of -3.0 mm (mean 4.32 ± 2.34 mm). The distance of the MF to the AB of the ramus was a maximum of 25.52 and a minimum 9.68 mm (mean 16.48 ± 3.28 mm). Based on these findings, the IANB target site for injection should be approximately 5 mm above the OP and approximately 16.5 mm beyond the AB of the ramus to achieve successful anesthesia of the mandible via standard IANB in an Iranian population.

Key Words: Panoramic radiography; Nerve block; Anesthesia, local; Inferior alveolar nerve.

Panoramic radiographs may help clinicians in administering the inferior alveolar nerve block (IANB)¹ by providing information about the location of the mandibular foramen (MF)²⁻⁴ as the anesthetic solution should be deposited around the inferior alveolar nerve (IAN) prior to entrance in the foramen.⁵ Accurate knowledge of the location of the foramen may reduce the possibility of an unsuccessful injection.^{6,7}

Differing populations and ethnicities, however, may provide different results. For example, Hekmatian et al⁸ studied panoramic and cephalometric radiographs of Iranian adults to determine the accuracy of panoramic radiography in defining the location of MF. In their study, the distance of the occlusal plane (OP) and anterior border (AB) of the ramus to the center of the MF were used as 2 reference landmarks. The distance from MF to the AB of the ramus was measured to be approximately 20 mm and the vertical distance from center of the foramen to the OP was approximately 5.6 mm based on panoramic radiographs.⁸ In contrast, Afsar et al⁹ in a Canadian study found that the distance from the MF to the AB of the ramus was approximately 20 mm and the MF to the OP to be approximately 1.9 mm.

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Table 1. The Position of MF to the OP, According to the Jaw Sides*

Side	Number	MF Above OP	MF Below OP	MF Same Level as OP
Right	194	87%	3%	10%
Left	194	87.7%	3%	9.3%

* MF indicates mandibular foramen; OP, occlusal plane.

The aim of this study was to assess the location of the MF relative to the OP and the AB of the ramus in an adult Iranian population.

METHOD AND MATERIALS

An observational case series study was designed to assess digital panoramic radiographs that had been taken for evaluating third molar impactions and other conditions between the years 2014 and 2015. Studied radiographs included all patients at least 18 years of age. Age and gender were also recorded.

Inclusion Criteria

To be included in the study, the radiographs had to be digital, include at least 2 mandibular molar teeth on both the right and left sides, have a 1:1 scale (100%) of high resolution and be taken by a Vila radiographic unit (Italy) with 68 KV, 6 mA, 14.4-s exposure.

Exclusion Criteria

Radiographs were excluded if study subjects were below 18 years of age, had previous ramus fracture or pathologic conditions, were blurred, had artifacts or were not digital with a 1:1 scale. All digital panoramic radiographs studied were obtained from the oral and maxillofacial radiology department archives, and the measurements of the panoramic radiographs were checked by an oral and maxillofacial radiologist.

Reference Points

Three anatomic sites on the panoramic radiographs were used as reference points: (a) AB of the ramus; (b) most superior–anterior point of the MF; and (c) the OP.

The distance from the MF to the OP (vertical distance from the most anterior–superior point of the MF to the most eminent point of the cusps of the lower molar teeth) and AB of the ramus (deepest point in the concavity of AB of the ramus) were determined and traced. Linear measurements were calculated in millimeters using a caliper. The distance from MF to the OP and the AB of the ramus in the samples were determined and the role of age and gender were also analyzed statistically using the 2-way analysis of variance test.

RESULTS

The results showed that of the 194 digital panoramic radiographs that met the inclusion criteria, the vertical distance of MF to the OP was a mean of 4.32 ± 2.34 mm with a maximum of 14.52 mm and a minimum of -3.0 mm. There were no significant differences between the right and left side distances from the MF to the OP and in 97% of cases, the MF was either above or at the same level as the OP (Table 1).

The distance from the MF to the AB of the ramus was a mean of 16.48 ± 3.28 mm with a maximum of 25.52 mm and a minimum 9.68 mm. There were no significant differences between the right and left side distances from the MF to the AB of the ramus or the OP (Table 2).

Likewise, there were no significant differences between the distances from the MF to the AB of the ramus or the OP based on age, 18 to 35 years old and over 35 years old (Table 3). However, the difference in mean values of measurements from MF to OP between males

Table 2. Distance From Mandibular Foramen to the Anterior Border of the Ramus and Occlusal Plane According to Jaw Side

	Number	Minimum	Maximum	Average	SD	P Value
Right mandibular foramen to the occlusal plane	194	0.0	14.52	4.32	2.34	0.078
Left mandibular foramen to the occlusal plane	194	0.0	13.31	3.99	2.11	
Right mandibular foramen to the anterior border of the Ramus	194	10.56	25.52	16.48	3.28	0.368
Left mandibular foramen to the anterior border of the Ramus	194	10.12	25.3	16.37	3.12	

Table 3. Effect of Age on the Distance From the Mandibular Foramen to the Anterior Border of the Ramus and the Occlusal Plane for Each Jaw Side

Age	Number	Minimum	Maximum	Average	SD	P Value
Over 18 and Below 35						
Right mandibular foramen to the occlusal plane	154	−3.0	9.46	4.29	2.03	0.337
Left mandibular foramen to the occlusal plane	154	−3.0	10.01	3.93	2.01	0.321
Right mandibular foramen to the anterior border of the Ramus	154	9.68	25.52	16.48	3.3	0.961
Left mandibular foramen to the anterior border of the Ramus	154	10.34	25.3	16.42	3.17	0.757
Over 35						
Right mandibular foramen to the occlusal plane	40	−2.0	14.52	4.45	3.3	0.337
Left mandibular foramen to the occlusal plane	40	−2.0	13.31	4.20	2.47	0.321
Right mandibular foramen to the anterior border of the Ramus	40	11.33	24.42	16.50	3.25	0.961
Left mandibular foramen to the anterior border of the Ramus	40	10.12	21.34	16.22	2.94	0.757

and females was statistically significant, with females showing a MF closer to the OP (Table 4). There was no significant difference in distance between the MF to the AB based on gender.

DISCUSSION

Panoramic radiographs provide valuable information and easy assessment preoperatively.¹⁰ Abnormalities and normal variations of anatomical landmarks, including the lingula and MF, may be evaluated before administering local anesthesia.¹ Knowledge of the location of the MF is important when performing IANB via the standard approach.^{2,4} This study aimed to determine the location of the MF in relation to the OP and AB of the ramus, the 2 landmarks most commonly used for IAN block injection.

COMPARISON OF STUDY FINDINGS

We found that the distance of the MF to the OP to be a mean of 4.32 ± 2.34 mm (minimum of −3.0, maximum 14.52 mm) and the MF distance to the AB of the ramus to be a mean of 16.48 ± 3.28 mm (minimum of 9.68

mm, maximum 25.52 mm). However, a number of other studies have found variations from our findings.

Afsar et al⁹ stated that the MF can be localized in panoramic radiographs but its relation to clinically palpable and radiographically visible bony landmarks is highly individualized.⁹ Their 1998 study on Caucasians found that the distance from the MF to the AB of the ramus measured 20.2 ± 3 mm, which differed from our findings by approximately 4 mm. Also, they found that the distance from MF to the OP averaged 1.9 ± 4 mm, while ours averaged 4.32 ± 2.34 mm. However, it should be noted that they used the center of the MF as the point of reference while in our study, the most superior–anterior point of the MF was used; this may account for the approximately 3 to 4 mm of discrepancy from the MF center.⁹

Kositbowornchai et al¹ in 2007 used the lingula as a reference. They reported that the distance from the lingula to the AB of the ramus on panoramic radiographs was 23.24 ± 3.82 mm. The distance from the lingula was an average of 10 mm above the OP.¹ These findings varied from our results because of use of the ligula as the reference point. Additionally, his study was performed on dry mandibles. They stated, however, that a strong positive correlation existed in evaluating the distances obtained on panoramic radiographic and landmarks on dry mandibles.

Table 4. Effect of Gender on the Distance From Mandibular Foramen to the Anterior Border of the Ramus and the Occlusal Plane for Each Jaw Side

Gender	Number	Minimum	Maximum	Average	SD	P Value
Female						
Right mandibular foramen to the occlusal plane	103	−2.0	11.76	3.96	2.10	0.003
Left mandibular foramen to the occlusal plane	103	−2.0	8.69	3.64	1.90	0.029
Right mandibular foramen to the anterior border of the Ramus	103	9.68	25.52	16.66	3.89	0.764
Left mandibular foramen to the anterior border of the Ramus	103	10.12	25.30	16.63	3.59	0.608
Male						
Right mandibular foramen to the occlusal plane	91	−3.0	14.52	4.75	2.55	0.003
Left mandibular foramen to the occlusal plane	91	−3.0	13.31	4.77	2.26	0.029
Right mandibular foramen to the anterior border of the Ramus	91	11.99	22.88	16.30	2.43	0.764
Left mandibular foramen to the anterior border of the Ramus	91	11.33	24.97	16.10	2.47	0.608

Hekmatian et al⁸ reported that the distance from MF to the OP and the AB of the ramus on panoramic radiographs was 5.66 ± 2.02 mm and 19.97 ± 3.17 mm, respectively. Their results varied from our study with slightly greater distances despite the fact that it was done on the same ethnicity as our study population. This variation is most likely due to the landmark used for reference as we used the most superior–anterior point of the MF, whereas they used the center of the MF and hence their measurements were approximately 1 to 3 mm greater.

A study by Trost et al¹⁰ in 2009 found the MF averaged 17 mm from the AB of the ramus, which is in close agreement with our study. Trost et al¹⁰ also showed that there was a significant difference between genders in relation to the distance of the MF to the OP, which was also similar to our findings. Additionally, the distance from the AB to the MF was not significantly different with regard to age, gender, or mandibular side.¹⁰

Nicholson¹¹ had results different than many of these identified studies. He found that the MF was predominantly below (75%) the OP, sometimes at the same level of the OP with (22.5%) and rarely above (12.5%) the OP.¹¹ In contrast, we found that the MF was only 3% below the OP, 75% above it, and 12% at same level. However, Nicholson¹¹ studied 80 dry, adult human mandibles of East Indian ethnic origin, not radiographs. He concluded that the marked variability in the position of the MF may be responsible for the occasional failure to block the IAN.

We found that there was no significant difference with regard to distance from reference landmarks on the left and right sides of the jaw or with age, but a significant difference was found with regard to gender. This is consistent with the results of a previous study done by Enlow et al.¹² They stated that in adults, the rate and speed of growth is higher in men; thus craniofacial dimensions in this gender are greater (5%–9%) in comparison to women.¹²

LIMITATIONS

A limitation of our study is that we only assessed the distance of the MF to the OP and AB radiographically without clinical correlation. We also did not perform a Cone Beam Computed Tomography (CBCT) assessment, which is more accurate as it was not deemed practical or ethical to take CBCT solely for the purpose of IANB placement. In the future, if conventional digital panoramic radiographs and CBCT are both available for presurgical evaluation, a correlation study could

incidentally be performed to evaluate the relationship between digital panoramic radiographs and CBCT.

CONCLUSION

Based on the findings of this study done on an Iranian population, the IANB target site for injection should be approximately 5 mm above the occlusal plane and approximately 16.5 mm beyond the anterior border of the ramus to achieve successful IANB anesthesia by the standard technique. These findings may vary in children and in those with craniofacial anomalies, extremes of stature, and different ethnicities.

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