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The location of the mandibular foramen as a guide in mandibular block anesthesia in children by age: A radiographic analysis

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Abstract

Knowing the correct location of the mandibular foramen (MF) is a significant factor in the success of inferior alveolar nerve block (IANB). The primary clinical guide for this anesthesia in children with continued growth and development may be the location of MF. The present study was carried out retrospectively on panoramic radiographs of children aged 5-14 years. Three linear measurements were performed on panoramic radiographs to evaluate the distance of the MF to the occlusal plane (OP), anterior border of the ramus (ABR), and mandibular base (MB). The participants' ages were divided into five groups: (G1) 5-6 years, (G2) 7-8 years, (G3) 9-10 years, (G4) 11-12 years, and (G5) 13-14 years. The results revealed a statistically significant increase in the mean values from G2 to G4 in all measurements. However, it was determined that there were no statistically significant differences between G1 and G2 and between G4 and G5 by the mean measurement values, respectively. Besides, the results of the measurements did not significantly differ by sex. Overall, it was concluded that MF was slightly below OP under 8 years of age and moves in the poster superior direction until the permanent dentition period. This result may guide clinicians in IANB in children.

Keywords: mandibular foramen, panoramic radiography, children, inferior alveolar nerve, local anesthesia

1. Introduction

Pain management is a far-reaching consideration in behavioral management in pediatric dental care. The first method in pain management is still local anesthesia practice. The inferior alveolar nerve must be blocked when deep restoration or surgery is required on mandibular permanent or primary teeth (1-3).

Preventing pain seems essential for a child to have a positive experience during a dental visit, build trust and cooperation, and enjoy future visits (4). An inferior alveolar nerve block (IANB) is the prevalently adopted technique in children, but it is famous for its high failure rates (5). Yet, the exact location of the mandibular foramen (MF) must be detected to achieve success in the IANB (6). The MF, formed at the beginning of the mandibular canal and covers the mandibular nerve and vessel, is an anatomical structure located slightly above the center of the inner surface of the mandibular ramus (7, 8).

The most common causes of failure of the IANB are lack of anatomical knowledge, lack of a specific anatomical landmark, variations in mandibular ramus sizes, and changes in the location of the MF (9). Panoramic radiography is an advantageous imaging method in children and the disabled and patients with sensitivity to the gag reflex, as well as offering less radiation exposure compared to intraoral radiography (10). On panoramic radiography, the mandibular canal appears radiolucent as a curved plane extending from the MF to the mental foramen. On the other hand, it is reported that panoramic radiography, which is more cost-effective than other imaging methods, helps clinicians identify anatomical landmarks, particularly in developed countries (e.g., MF) (11).

Considering the common failure rates of IANB in children, knowing the exact anatomical location of the MF becomes important to ensure successful anesthesia of IANB during dental procedures in these patients. On the other hand, relevant studies in the literature suggest the location of the MF differs by race and age (12, 13). Although the MF in children is expected to be located lower than in adults during the primary dentition, there are some contra versions about its location in children (14).

Although the literature hosts many studies on the location of the MF in children and adolescents, it is evident that the previous findings highly differ; therefore, further research is needed (12, 13, 15-17).

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Ultimately, this study aimed to reveal the location of the MF in a Turkish pediatric sample from the Eastern Mediterranean region by the occlusal plane (OP), the anterior border of the ramus (ABR), and the mandibular base (MB) using panoramic radiographs. Thus, it was intended to guide clinicians about the correct location of the MF while applying anesthesia to pediatric patients.

2. Materials and Methods

The Clinical Research Ethics Committee of Sutcu Imam University granted ethical approval to the study (No: 2021-17). The present research retrospectively employed panoramic radiographs taken during dental examinations of children who applied to Sutcu Imam University, School of Dentistry, Pedodontics Clinic between 2019-2020.

No additional radiographs of the children were needed in this study. The imaging was taken by the same staff following the proper shooting techniques of the device. The analyses were performed on the panoramic radiographs of the determined sample with complete posterior teeth and those with high image quality without exposure and positioning errors. Nevertheless, the following cases were excluded from the study: patients with low-image quality radiographs, craniofacial syndrome, temporomandibular joint disease, missing posterior teeth, supernumerary teeth, dental agenesis, orthodontic treatment, surgical treatment, trauma, and pathology in the maxillofacial region.

The radiographs were taken by the same staff on the GENDEX GDP -700 (Magnification 1.3) device at 66 Kv, 6.3 mA 14 sec. in the child module following the manufacturer's recommendations. The relevant measurements were made in Adobe Photoshop CS6.

The pediatric patients were divided into five groups by age: Group 1 (G1): 5-6-year-olds, Group 2 (G2): 7-8-year-olds, Group 3 (G3): 9-10-year-olds, Group 4 (G4) 11-12-year-olds, and Group 5 (G5) 13-14-year-olds.

The points and planes in the studies by Apaydın and Shukla were taken as reference in this study (Fig 1.) (15, 18).

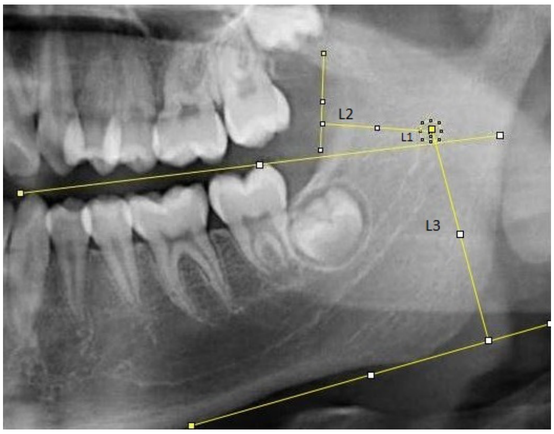

Fig 1. The locations of L1, L2, and L3 on a panoramic radiograph

An experienced oral and maxillofacial radiologist performed all measurements on the radiographs in mm. Since there were no differences between the measurements by right and left areas in the previous studies, the left area was considered while taking the measurements from the patients (18-20).

Meanwhile, to test the reliability of the measurements, the distances were remeasured among 1/10 of the participants two weeks after the main measurements.

L1: MF-OP distance

L2: MF-ABR distance

L3: MF-MB distance

Considering the reference article, a Cohen's d value of 1.13 was settled to be sufficient for deciding a finding to be significant (15). For the total sample size, it was calculated that 85% power would be achieved when 15 participants were recruited for each group. In this study, 30 children (15 girls, 15 boys) were included in each age group. The analyses were performed on the Jamovi (Version 1.0.4) software. The normality of distribution was checked through the Shapiro-Wilk test. The normally distributed data were analyzed using a one-way analysis of variance (ANOVA) with Tukey's multiple comparison tests to compare the locations of the MF by sex and age. Finally, Pearson's correlation test was performed to reveal the associations between the continuous variables. Correlation analysis was performed on repeated within-observation measurements. In all the analyses, a *p*-value <0.05 was considered statistically significant.

3. Results

Intra-observer correlation coefficients ranged from 0.90 to 0.92 for all the measurements (robust positive correlation).

We evaluated panoramic radiographs of 30 patients (15 boys, 15 girls) in each age group, 150 children in total. The results revealed that the measurements did not differ by sex (Table 1).

Table 1. Comparison of the location of the mandibular foramen by gender, one-way anova test (p<0.05)

Locations	Male	Female	P value
L1	1.54±1.26	1.43±1.57	0.611
L2	15.7±2.36	15.08±2.49	0.087
L3	23.59±2.48	23.1±2.78	0.213

The same superscript letters indicate no significant difference within row lines (p>0.05)

There were no significant differences between G1 and G2 and between G4 and G5 by the mean L1 value, respectively (p>0.05). However, the results revealed a significant increase in the mean L1 value from G2 to G4 ($p < 0.05$).

There were no significant differences between G1 and G2 and between G4 and G5 by the mean L2 value, respectively ($p > 0.05$) Nevertheless, it was found that the mean L2 value significantly increased from G2 to G4 ($p < 0.05$).

There were no significant differences between G1 and G2 and between G4 and G5 by the mean L3 value, respectively ($p > 0.05$). Nevertheless, it was found that the mean L3 value significantly increased from G2 to G4 ($p < 0.05$).

The mean values and standard deviations by age group are shown in Table 2.

Table 2. Comparison of the locations of the MF by age, one-way ANOVA and Tukey post-hoc tests ($p < 0.05$)

Locations	5-6 years (G1)	7-8 years (G2)	9-10 years (G3)	11-12 years (G4)	13-14 years (G5)
L1	-0.15±1,43[a]	-0.36±0.98[a]	1.07±0.51[b]	1.99±0.56[c]	2.59±0.59[c]
L2	13.11±1.12[a]	13.14±1.88[a]	14.69±1.48[b]	16.81±1.82[c]	15.18±2.17[c]
L3	19.22±2.34[a]	20.48±1.34[a]	22.56±2.30[b]	23.99±1.32[c]	25.26±1.29[c]

The same superscript letters indicate no significant difference within row lines ($p > 0.05$)

4. Discussion

It is estimated that the locations of the mandibular lingula and foramen may change on the ramus of growing children. Therefore, considering variability in the location of the MF may reduce the incidence of injection failure in pediatric patients (13).

In this study, the MF was slightly located below the OP among those under 8 years of age while being above the OP in the patients 9 years and older. Similarly, the previous research reported that the MF is below the OP in children under 8 years of age (3, 12, 17). Yet, some other studies demonstrated it to be at or above the OP at the beginning of mixed dentition (1, 2, 15, 18, 20). Akbari et al. recommended needle insertion in the same plane as the OP among 7-8-year-olds, while it was recommended to enter from a distance of approximately 2 mm in the 9-10 and 11-12 age groups. They attributed this situation to the incompleteness of teeth among those under eight years of age (1). Accordingly, it can be recommended the injection be made slightly below the OP in children under eight years of age in the INAB application.

The previous research also determined a gradual increase in the distance from the MF to the OP from the early primary dentition to the permanent dentition (2, 13, 15, 18, 20). In this study, it was determined that L1 (MF-OP distance) increased gradually from 7-8 years to 11-12 years, but there was no statistically significant increase at the beginning of early mixed dentition (G1-G2) and permanent dentition (G4-G5). Poonacha et al., on the other hand, reported that the location of the MF shows a slight change with age. In their study, they also found both an increase and a decrease in MF-OP distance (21). Altunsoy et al. evaluated the location of MF in children and adolescents aged 8-18 years through CBCT and, unlike this study, concluded insignificant differences between different age groups by MF-OP distance (16). Contrary to the findings of this study, Afsar et al. concluded that the linear distance between the MF and the OP does not differ significantly by age (9). Similarly, a recent study by Feuerstein et al. with 4-23-year-olds concluded that the location of the MF does not differ significantly by age (22).

On the other hand, although there were no significant differences between 5-6 years of age and 7-8 years of age and between 11-12 years of age and 13-14 years of age by L2 (MF-ABR distance) and L3 (MF-MB distance), it was discovered that the MF increased gradually from 7-8 years to 11-12 years, In the literature, some studies reported an age-associated increase in MF-MB distance (18, 20, 23). It was previously asserted that vertical position changes in the MF may be related to child maturation resulting in enlargement of the ramus and bone formation at the lower border of the mandible (19). It was also suggested that the horizontal location of the MF in children is more inferior-anterior in the ramus of the mandible than in adults and that the MF approaches posterosuperior more with age (15, 20, 21, 23). However, Altunsoy et al. discovered that the distance of the MF from the ramus anterior does not change by age (16).

Nevertheless, no significant differences were found between the measurements by sex. Similarly, the literature previously reported that sex does not have a substantial impact on these distances (15, 19, 22, 23). On the other hand, except for the measurements between the OP and the MF, Altunsoy et al. determined that MF-mandibular lower border and MF-ABR distances are significantly greater in girls than in boys (16). Movahhed also found that the location of MF differed by sex and that it was below the OP in boys and above the OP in girls at the age of 9 years. This situation was attributed to different growth patterns between boys and girls (3).

This study recruited the patients' panoramic radiographs. Although there are studies showing that linear measurements with cone beam computed tomography (CBCT) give precise results for measurements in the region oral and maxillofacial, panoramic radiographs with less radiation are advantageous in pediatric patients (24).

In conclusion, it was discovered that the MF is located below the OP under 8 years of age, and moves in the poster superior direction until the permanent dentition period, which had better be considered by clinicians in IANB.

Conflict of interest
The authors declare no conflict of interest

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Authors' contributions
Concept: K.T.T., A.S.O., Design: K.T.T., A.S.O., Data Collection or Processing: K.T.T., A.S.O., Analysis or

Interpretation: K.T.T., Literature Search: K.T.T., A.S.O., Writing: K.T.T., A.S.O.

References

1. Akbari F, Ghoochani TZ, Sharifi-Rayeni A, Hos-seini MS, Askary A. The Use of Panoramic and Cephalometric Images to Guide Needle Placement for Inferior Alveolar Nerve Block in 7- to 12-Years-Old Children. Dent Hypothe-ses. 2019;10:40-6.

2. Krishnamurthy NH, Unnikrishnan S, Ramach-andra JA, Arali V. Evaluation of Relative Po-sition of Mandibular Foramen in Children as a Reference for Inferior Alveolar Nerve Block using Orthopantamograph. J Clin Diagn Res. 2017;11(3):71-74.

3. Mohavved T, Makarem A, Imanimoghadd-am M, Anbiaee N, Sarrafshirazi AR, Shakeri MT. Locating the mandibular foramen rela-tive to the occlusal plane using panoram-ic radiography. J Appl Sci. 2011(11)573–8.

4. Chandran S, Peedikayil FC, Chandru TP, Kottayi S, John S. Relative position of man-dibular foramen in 4–9-year-old children: A retrospective study. SRM J Res Dent Sci. 2021;12(1):13-6.

5. Park H-S, Lee JH. A comparative study on the location of the mandibular foramen in CBCT of normal occlusion and skeletal class II and III malocclusion. Maxillofac Plast Reconstr Surg. 2015;37(25):1-9.

6. Kilarkaje N, Nayak SR, Narayan P, Prabhu LV. The location of the mandibular foramen maintains absolute bilateral symmetry in mandibles of different age-groups. Hong Kong Dent J. 2005;2:35–7

7. Potocnik I, Bajrović F. Failure of inferior alveolar nerve block in endodontics. Endod Dent Traumatol. 1999;15:247–251.

8. Thangavelu K & Kannan, et al. Significance of localization of mandibular foramen in an Inferior alveolar nerve block. J Nat Sci Bioi Med. 2012;3(2):156-60.

9. Afsar A, Haas DA, Rossouw PE, Wood RE. Radiographic localization of mandibu-lar anesthesia landmarks. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998;86(2):234-41.

10. Molander B, Gröndahl HG, Ekestubbe A. Quality of film-based and digital panoramic radiography. Dentomaxillofac Radiol. 2004;33(1):32-36.

11. Patil K, Guledgud MV, Bhattacharya PT. Reliability of panoramic radiographs in the localization of mandibular foramen. J Clin Diagn Res. 2015;9(1):ZC35–38.

12. Ezoddini Ardakani F, Bahrololoumi Z, Zangouie Booshehri M, Navab Azam A, Ayatollahi F. The position of lingula as an index for inferior alveolar nerve block injection in 7-11-year-old children. J Dent Res Dent Clin Dent Prospects. 2010;4(2):47-51.

13. Kanno CM, de Oliveira JA, Cannon M, Car-valho AA. The mandibular lingula's position in children as a reference to inferior alveolar nerve block. J Dent Child (Chic). 2005;72(2):56-60.

14. Mc Donald RE, Avery DR, Dean JA. Dentistry for the child and adolescent. 8th ed. Mosby: Elsevier; 2008:11-12.

15. Apaydın B. K. Çocuklarda mandibular foramenlerin panoramik radyograflardaki konumu ve okluzal düzlemle ilişkisi. Selcuk Dent J. 2020;7(1):54-58.

16. Altunsoy M, Aglarci OS, OK E, Nur BG, Gungor E, Colak M. Localization of the mandibular fo-ramen of 8-18 years old children and youths with cone-beam computed tomography. J Pediatric Dent. 2014;2(2):44–48

17. Pereira PN, Fernandes A, Gugisch RC, Zaroni FM, Franco A, Rebellato NLB. Radiographic assessment of the mandibular foramen in children: focus on anesthetic procedures. Arch Oral Res 2013;9(3):279-83.

18. Shukla RH, Tiku A. Correlation of Mandibu-lar Foramen to Occlusal Plane as a Clinical Guide for Inferior Alveolar Nerve Block in Children: A Digital Panoramic Radiograph-ic Study Contemp Clin Dent. 2018;9(3):372-375.

19. Tsai HH. Panoramic radiographic findings of the mandibular foramen from deciduous to early permanent dentition. J Clin Ped. Dent. 2004 Spring;28(3):215-9.

20. Akman H, Surme K. Locating mandibular foramen in children of different age groups using panoramic radiography. Czas Stomatol. 2021;74(3):172-176.

21. Poonacha KS, Shigli AL, Indushekar KR. Relative position of the mandibular foramen in different age groups of children: a radiographic study. J Indian Soc Pedod Prev Dent. 2010;28(3):173-8.

22. Feuerstein D, Costa-Mendes L, Esclassan R, Marty M, Vaysse F, Noirrit E. The mandibu-lar plane: a stable reference to localize the mandibular foramen, even during growth. Oral Radiol. 2020 ;36(1):69-79.

23. Eryiğit Ö, Turamanlar O, Mehmet Ü, Kaçar E. Pediatrik Populasyonda Foramen Mandibulae Lokalizasyonunun Üç Boyutlu Bilgisayarlı Tomografi İle Değerlendirilmesi. Sağlık Akademisi Kastamonu. 2019;4 (3) :225-242.

24. Pinsky H, Dyda S, Pinsky R, Misch K, Sarment D. Accuracy of three-dimensional measurements using cone-beam CT. Dentomaxillofac Radiol. 2006;35:410-416.