RESEARCH ARTICLE

A Cone Beam Computed Tomographic Study on the Location of Mandibular and Mental Foramen in Indian Pediatric Population

Nimisha Vathariparambath[1], Navin Hadadi Krishnamurthy[2], Nagarathna Chikkanarasaiah[3]

Abstract

Aim: To determine the location of mandibular foramen (MF) and mental foramen (MeF) in 8–18-year-old children using cone beam computed tomography (CBCT).

Materials and methods: Hundred CBCT images of children (8–18 years) were evaluated to determine the shortest distance from MF to the anterior border of ramus (A), posterior border of ramus (P) and inferior border of the mandible (MI), most superior point of the curvature of mandibular notch (MN), occlusal plane of the mandibular permanent molars (O), and the distance from MeF to lower border of mandible (BM) and to the alveolar crest (AC).

Results: There was a statistical increase in A-MF, P-MF, MI-MF, MN-MF, and O-MF values with age. MF was found to be 3.53 mm below the occlusal plane in 8–11-year-old children, and it reaches the occlusal plane by 12–14 years of age, and it moves posterior-superiorly 3.58 mm above the occlusal plane in 15–18-year-old individuals. AC-MeF value decreases whereas the BM-MeF value increases with age and there was a significant difference based on sex.

Conclusion: The location of the MF is just posterior to the middle of the ramus, it reaches the level of the occlusal plane by the age of 12–14 years, and MF and MeF are shifting posterior-superiorly with increasing age.

Clinical significance: The awareness of localization of MF and MeF is of greater importance when administering regional anesthesia in mandible, especially in children. Its position varies according to gender and age, especially during growth spurts. Failure to achieve proper nerve block leading to repeated injection of the local anesthetic solution will not only pose a behavior problem in children but can also lead to systemic toxic level of anesthetic solution being administered. Its accurate position enables more effective local anesthesia and improves child cooperation, minimizing the risk of complications.

Keywords: Cone beam computed tomography, Mandibular foramen, Mental foramen.

International Journal of Clinical Pediatric Dentistry (2022): 10.5005/jp-journals-10005-2413

Introduction

In pediatric dentistry, pain management is a crucial component to achieve optimum patient cooperation. Local anesthesia is still a safe and effective approach for pain management, especially inferior alveolar nerve block (IANB), which is essential for achieving local anesthesia for mandible.[1] The position of the MF and MeF varies greatly among individuals of the same ethnicity, age, and even within the same individual on both sides. This difference is crucial for administering a local anesthetic to the mandible, particularly in very young patients, as their growth and development have a significant impact on it.[2–7] Due to the risk of providing the local anesthetic solution above the recommended safe dose and the potential for the child to exhibit negative behavior, repeatedly injecting the local anesthetic solution into children who have failed IANB can be a laborious procedure.[1]

For decades, dental diagnosis and treatment planning have relied on two-dimensional (2D) imaging techniques like periapical, panoramic, and cephalometric radiography. However, there are significant issues with diagnosis and treatment planning with this 2D representation as it fails to address the whole details. A genuine paradigm change is signaled by the adoption of CBCT in dentistry, which is especially used to image the maxillofacial region, but its utility in pediatric dentistry has not yet been fully investigated.[8] The location of MF and MeF in Indian children of various age groups using CBCT has only been evaluated in very few number of research.[6,9]

[1–3]Department of Pedodontics and Preventive Dentistry, RajaRajeswari Dental College & Hospital, Bengaluru, Karnataka, India

Corresponding Author: Nimisha Vathariparambath, Department of Pedodontics and Preventive Dentistry, RajaRajeswari Dental College & Hospital, Bengaluru, Karnataka, India, Phone: +91 9620274870, e-mail: nimmi.nimm@gmail.com

How to cite this article: Vathariparambath N, Krishnamurthy NH, Chikkanarasaiah N. A Cone Beam Computed Tomographic Study on the Location of Mandibular and Mental Foramen in Indian Pediatric Population. Int J Clin Pediatr Dent 2022;15(4):422–427.

Source of support: Nil

Conflict of interest: None

Taking into account the potential for variation in the size and positioning of the MF and MeF, the aim of this study was to assess the relative position of the MF and MeF in the south Indian pediatric population using CBCT.

Materials and Methods

Cone beam computed tomographic images of children between the ages of 8 and 18 years were used in this retrospective study. Images were taken for valid diagnostic reasons like ankylosis of the primary tooth hindering the eruption of permanent teeth, impaction, supernumerary tooth, ectopic eruption, and orthodontic reasons were retrieved from the database of RajaRajeswari Dental College & Hospital. Approval from the ethical committee for the study was obtained (RRDC&H/PG-241/2017-18). A total of 200 MF and MeF were analyzed on various parameters. With the use of OnDemand 3D and SCANORA software. CBCT images were reconstructed (CBCT apparatus: SCANORA 3D, SOREDEX, Finland). The right and left MF and MeF of each patient were analyzed. The patient's age and sex were recorded, and the subjects were divided into three age groups based on a mixed dentition growth spurt and a prepubertal growth spurt. Group I consists of children aged 8–11 years; group II of children aged 12–14; and group III of children aged 15–18. Images were then assessed to locate the MF and MeF.

Sample Size Estimation

$n = Z_{2(1-\alpha)}pq/e^2$

$Z(1 - \alpha) = 1.96$ (for 95% confidence interval), $p = 0.45$, $q = 1 - p$
e (margin of error) = 0.10, $N = 95.07$ rounded off to 100
$N = 100$ (total sample size)

Inclusion Criteria

Good qualities of the image with the following criteria were selected.

- CBCT image of individuals between the ages of 8 and 18 years.
- The premolar and molar areas on the right and left sides of the mandible.
- Minimal to no periapical infection or root resorption in the teeth.
- No congenital or developmental defects in the mandible.
- No history of trauma or fracture to the mandible.

Interpretation of Images

Using the CBCT machine's OnDemand 3D and SCANORA software, all of the images were evaluated and measured. For locating the MF and the MeF, panoramic and coronal images were used, respectively.

Identification of MF

- Along the inferior alveolar canal, a panoramic image was reconstructed. Location of MF and other anatomical landmarks were identified, and the distance between these landmarks was measured (Fig. 1). Distance between MF from different landmarks in the mandible.[5]

Identification of MeF

- The following measurements were noted after reconstructing the coronal view of MeF (Fig. 2).

MF-A	The shortest distance between the anterior border (A) and the MF.
MF-P	The shortest distance between the posterior border (P) and MF.
MF-MI	The shortest distance between the inferior point of the mandibular incisura (MI) and MF.
MF-MN	The shortest distance between the most superior point of the curvature of the mandibular notch (MN) and MF.
MF-O	The distance between the straight line of the cusps of the mandibular permanent molars (O) and MF.

To compare the superior and inferior positions of the MeF, three tangents were created, one at each of the superior margins of the MeF, the AC, and the BM, and the following measurements were recorded (according to Sheikhi and Kheir 2016).[10]

MeF-AC	Distance between MeF to the alveolar crest.
MeF-BM	Distance between MeF to the base of the mandible.

Distance between MeF from different landmarks in the mandible.

Statistical Analysis

Independent Student's *t*-test, Student's paired *t*-test, one-way analysis of variance (ANOVA) followed by Tukey's *post hoc* analysis were utilized to compare the various linear distances associated with MF and MeF based on the various age groups. The level of significance was fixed at 0.05. Statistical Package for Social Sciences (SPSS) v.22 (IBM Corp.) for Windows was used to analyze the data.

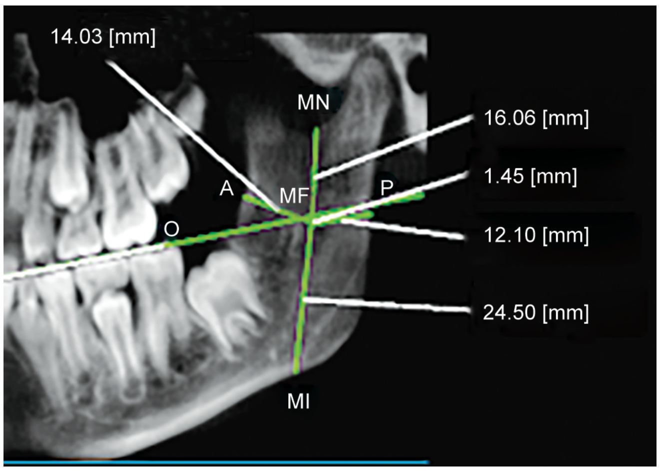

Fig. 1: Assessment of MF using CBCT: landmarks used in the present study

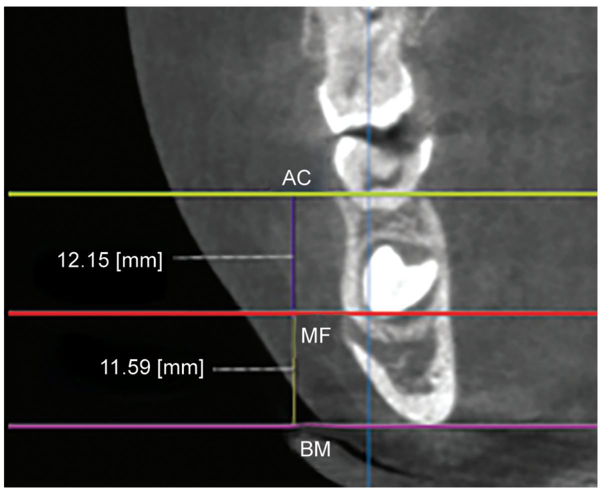

Fig. 2: Assessment of MeF using CBCT: location of the MeF. Landmarks used in the present study. The superior margin of the MeF, the AC, the BM

Results

Table 1 shows the mean distance of different anatomical landmark points in relation to MF based on age (one-way ANOVA test followed by Tukey's *post hoc* analysis). The A-MF ($p = 0.04$), P-MF ($p < 0.001$), MI-MF ($p < 0.001$), MN-MF ($p < 0.001$), and O-MF ($p = 0.001$) values increase significantly with age. In children aged 8–11 years, MF was found to be 3.53 mm [standard deviation (SD) 1.35 mm] below the occlusal plane of erupted permanent molar. For 12–14-year-old children, MF has advanced posterior-superiorly, and it reaches the occlusal plane around 13 years and is about 3.58 mm (SD 107 mm) above the occlusal plane in 15–18-year-old groups. In the horizontal plane, the position of MF is more posterior to the midpoint of the anteroposterior width of the ramus.

The location of MF does not differ significantly on the right and left sides among males and females, and it maintains bilateral symmetry (Figs 3 and 4). Based on sex, the location of MF does not differ significantly, and there was a notable difference in the location of MeF from the base of the mandible. The location of the MeF did not differ significantly from the alveolar crest, and the distance was more in males than that in females (Table 3).

Age significantly affected the values of the AC-MeF and BM-MeF ($p < 0.001$), and the AC-MeF value significantly dropped from 12.12 mm (SD 1.02) in group I to 10.56 mm (SD 1.37 mm) in group II (Table 2) and 10.68 mm (SD 1.10 mm) in group III. There was a substantial rise in the BM-MeF value from 12.85 mm (SD 1.30 mm) in group I to 13.59 mm (SD 1.18 mm) in group II and 14.90 mm (SD 1.50 mm) in group III.

Discussion

Determining the precise anatomic location of the MF and MeF is crucial to preventing any negative effects, such as hemorrhage and long-term neurologic damage brought on by the transection of the neurovascular bundle during the administration of local anesthesia or surgical procedures in the mandible.[11] Due to its precise positioning, local anesthetic works better, and the child's health and cooperation are improved. The mandible is found to go

Table 1: Anatomical landmark points in relation to MF using one-way ANOVA test followed by Tukey's *post hoc* analysis

Points	*Age groups*	*N*	*Mean*	*SD*	*Min*	*Max*	*p-value*	*Significant difference*	*p-value*
A-MF	8–11 years	32	13.97	1.46	10.8	17.1	0.04*	A1 vs A2	0.72
	12–14 years	33	13.65	2.01	10.3	17.2		A1 vs A3	0.25
	15–18 years	35	14.61	1.41	11.5	17.5		A2 vs A3	0.04*
P-MF	8–11 years	32	11.67	1.48	8.2	15.2	<0.001*	A1 vs A2	<0.001*
	12–14 years	33	13.34	1.94	9.5	16.7		A1 vs A3	0.35
	15–18 years	35	12.24	1.56	9.6	15.8		A2 vs A3	0.02*
MI-MF	8–11 years	32	21.47	1.66	18.3	24.7	<0.001**	A1 vs A2	0.43
	12–14 years	33	22.05	2.22	17.8	27.4		A1 vs A3	<0.001**
	15–18 years	35	26.31	1.65	21.3	30.4		A2 vs A3	<0.001**
MN-MF	8–11 years	32	14.08	1.94	11.6	18.8	<0.001**	A1 vs A2	<0.001**
	12–14 years	33	16.50	1.75	12.0	19.8		A1 vs A3	0.03*
	15–18 years	35	15.29	1.99	11.5	21.2		A2 vs A3	0.03*
O-MF	8–11 years	32	–3.53	1.35	–6.2	–1.3	<0.001**	A1 vs A2	<0.001**
	12–14 years	33	–0.43	2.26	–3.9	3.7		A1 vs A3	<0.001**
	15–18 years	35	3.58	1.07	1.4	5.6		A2 vs A3	<0.001**

*$p < 0.05$ statistically significant; **$p < 0.001$ is highly significant; SD, standard deviation

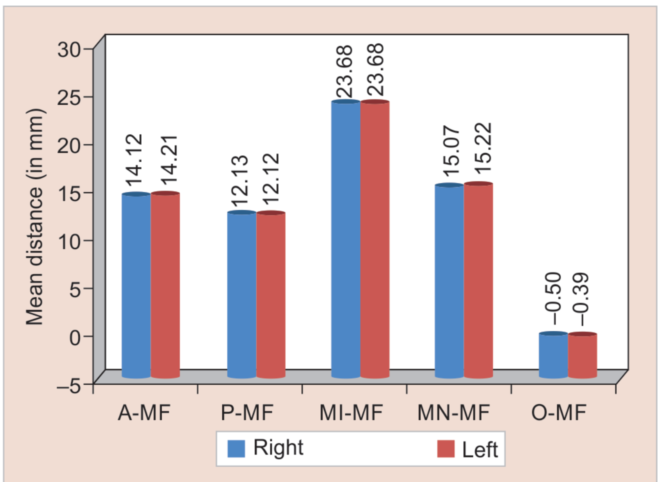

Fig. 3: Location of MF based on side among males. Mean distance (in mm) at different anatomical landmark point's in relation to MF between right and left sides among males

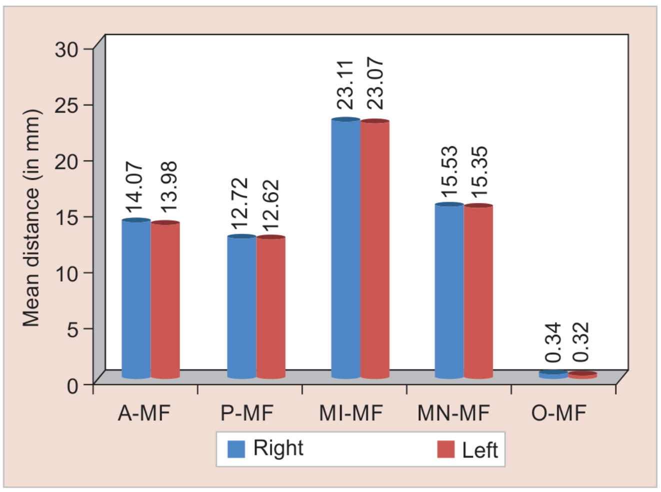

Fig. 4: Location of MF based on side among females. Mean distance (in mm) at different anatomical landmark points in relation to MF between right and left sides among females

Table 2: Anatomical landmark points in relation to MeF using independent Student's *t*-test

Points	*Gender*	*N*	*Mean*	*SD*	*Mean difference*	*t-test*	*p-value*
AC-MF	Males	45	11.22	1.22	0.22	0.792	0.43
	Females	55	11.00	1.47			
BM-MF	Males	45	14.22	1.53	0.75	2.431	0.02*
	Females	55	13.47	1.54			

*Statistically significant; SD, standard deviation

Table 3: Localization of MeF based on age-wise comparison of mean distance of difference

Points	*Age groups*	*N*	*Mean*	*SD*	*Min*	*Max*	*p-value[a]*	*Significance difference*	*p-value[b]*
AC-MF	8–11 years	32	12.12	1.02	9.4	13.6	<0.001*	A1 vs A2	<0.001*
	12–14 years	33	10.56	1.37	7.8	12.8		A1 vs A3	<0.001*
	15–18 years	35	10.68	1.10	9.1	12.8		A2 vs A3	0.91
BM-MF	8–11 years	32	12.85	1.30	11.3	15.4	<0.001*	A1 vs A2	0.07
	12–14 years	33	13.59	1.18	11.2	15.6		A1 vs A3	<0.001*
	15–18 years	35	14.90	1.50	11.2	18.6		A2 vs A3	<0.001*

*Statistically significant; SD, standard deviation; [a] *p*-value obtained by One-way ANOVA; [b] *p*-value obtained by Tukey's HSD post hoc analysis

through a continuous remodeling phase in a developing person, and distinct anatomical parts display varied differential growth patterns.[5] In particular, the anterior border of the ramus and the crest of the alveolar bone, where it indirectly affects the position of the MF and hence the anesthetic procedure in mandible. Tooth emergence and tooth loss are the most significant factors that contribute to the bone remodeling process.[1,2,3,5,12]

Conventional radiographic methods, such as panoramic, lateral oblique, and cephalometric radiography, have frequently been used in studies to pinpoint the location of the MF and MeF; however, these methods have some drawbacks, including magnification of image, superimposition, and a lower diagnostic value.[13]

For analyzing anatomical landmarks, CBCT has been regarded as the "gold standard" since it offers an imaging solution without any projection mistakes brought on by magnification and superimposition issues.[14,15]

There have been very few studies done on the anatomical location of the MF and MeF in the pediatric population of India.[1,9] Therefore, the purpose of this study was to locate the MF and MeF according to age, sex, and side utilizing anatomical landmarks on CBCT images.

In this study, we found that A-MF ($p = 0.04$), P-MF ($p = 0.001$), MI-MF ($p = 0.001$), MN-MF ($p = 0.001$), and O-MF ($p = 0.001$) values increased statistically with age (Table 1). Altunsoy et al.[5] used CBCT to analyze children and adolescents between the ages of 8 and 18 years, and the study found that P-MF, MI-MF, and MN-MF values significantly increased with age. He also found that MN-MF, MI-MF, and A-MF values in females were statistically greater than those in males, whereas, in our study, we found that P-MF, MN-MF, and O-MF values were higher in females. We also found that superior-inferiorly between the MN to the MF (MN-MF) distance was 14.08 mm (SD 1.94 mm), which increased in group II and decreased to 15.29 in group III. The disparity in regional growth at various jaw angles during Hellman's stages of dental development may help to explain it.[1]

The radiographic study by Poonacha et al.[9] using orthopantomogram in growing children between 3 and 13 years of dental age concluded that the mandible and its growth did not alter the position of the MF, both vertically and horizontally, concerning different landmarks, which was in contrast to our findings. Tsai[16] reported a variation in the distance between MF and anterior and posterior border of mandible, which was in agreement with our study.

According to research by Krishnamurthy et al.[7] using panoramic radiographs on children aged 7–12, MF is located posterior to the midpoint of the anteroposterior width of the ramus and is reported to be 13.0–13.9 mm from the deepest point of the coronoid notch for the 9–10-year age group which supports our study.

In an anatomical study by Thangavelu et al., it was found that from the coronoid notch, MF is situated at an average of 19 and 5 mm inferior to the midpoint of the condyle to inferior border distance.[17]

Similar to our findings, Afsar et al.,[18] Hetson et al.,[19] Mwaniki et al.,[20] and Oguz and Bozkir[21] reported that the MF was positioned just posterior to the center of the ramus. Contrary to our findings, Hayward et al.[22] and Bremer[23] claimed that the MF was situated in the third quadrant of the ramus.

In our study, it was discovered that in 8–11-year-old children, the MF was located 3.53 mm (SD 1.35 mm) below the occlusal plane of erupted permanent molars; at 12–14 years of age, it reached the occlusal plane and moved posterior-superiorly with age, in 15–18-year-old individuals the foramen was about 3.58 mm (SD 107 mm) superior to the occlusal plane (Table 1). In a study by Pereira et al. looking at children aged 4–12 years, it was discovered that MF was identified in 65% of instances below the occlusal plane.[24] By the age of 13, MF ascends superiorly above the occlusal plane; according to Ashkenazi et al., this supports our research.[25] In contrast to the results of our investigation, Afsar et al. came to the conclusion that there was no change in the distance between the MF and occlusal plane.[18] Nevertheless, research by Hwang et al. found that at age 3, the MF was situated 4.12 mm below the occlusal plane. It had reached around the level of the occlusal plane by the age of 9. In an adult group foramen moves superiorly about 4.16 mm above the occlusal plane.[26] According to research by Kilarkaje et al., MF maintained bilateral symmetry similar to our study findings (Figs 1 and 2).[13]

The MeF was located bilaterally symmetrically, and the age effect on the AC-MeF and BM-MeF values was substantial ($p < 0.001$) (Table 3). According to a study by Kalender et al. using CBCT images, the distance between the MeF and the lower border of the mandible was higher in males, which is in accordance with this study (Table 2).[27]

The AC-MeF value significantly decreased from 12.12 mm (SD 1.02) in group I and 10.68 mm (SD 1.10 mm) in group II, and 10.56 mm (SD 1.37 mm) in group III (Table 2). Similar outcomes were found by Kalender et al. in their research.[27] There was a considerable rise in the BM-MeF value from 12.85 mm (SD 1.30 mm) in group I to 13.59 mm (SD 1.18 mm) in group II and 14.90 mm (SD 1.50 mm) in group III. The majority of the MeF, according to Gershenson et al., was situated across the first deciduous molar root.[28] According to the results of our study, the MeF was often found between the first and second primary molars, and their position shifted superiorly with age.

As demonstrated in this study and earlier investigations, the distance between the MF and MeF to the landmarks can change as a result of the increase in the sagittal size of the mandibular structures with age.

Therefore, it is challenging to assert that there is a definite value for any distance or ratio of the MF, and this value can change in different populations. These variances may be due to differences in growth, demography, and/or measurement methods. According to the data, the MF is situated just posterior to the center of the ramus, it advances to the occlusal plane of the molars at 13 years of age and then moves posterosuperiorly, and the A-MF, P-MF, MN-MF, MI-MF, and O-MF values rise with age. As people age, the MeF shifts posterosuperiorly while MF and MeF preserve bilateral symmetry.

Conclusion

- The location of MF and MeF preserves bilateral symmetry, and their locations differ depending on age and gender, as well as the size, width, height, growth, and development of each individual in different age groups.
- The MF is situated just posterior to the middle of the ramus, and there is an age-related increase in A-MF, P-MF, MI-MF, MN-MF, and O-MF values.
- Children aged 8–11 years were found to have MF 3.53 mm below the occlusal plane of the erupted permanent molars, reaching the mandibular occlusal plane at 12–14 years of age, moving posterior-superiorly with age, and 3.58 mm above the occlusal plane in those aged 15–18 years.
- There was a significant decline in the AC-MeF value and a significant increase in the BM-MeF value with age.
- The current study shows that CBCT can accurately reveal information regarding the anatomical location of MF and MeF.

Limitations

The radiographs used in our study were taken from a database, which made it impossible to evaluate each subject's nutritional state or general health, both of which have an impact on their growth and development. Additionally, this study failed to evaluate the MF and MeF's position on ethnic grounds other than the South Indian population.

It will be necessary to perform additional studies in the future based on the localization of MF and MeF from various anatomical landmarks using CBCT on large patient populations.

Clinical Significance

When delivering local anesthetic to the mandible, especially in children, understanding the location of the MF and MeF is very crucial. Its location changes with age and gender, particularly during growth spurts. Children may exhibit behavioral issues due to frequent injections of the local anesthetic solution if an effective nerve block is not achieved. Additionally, systemic hazardous levels of anesthetic solution may be provided. Its precise positioning permits more effective local anesthetic, better child cooperation, and reduces the likelihood of complications.

Orcid

Nimisha Vathariparambath https://orcid.org/0000-0001-5982-2269

References

1. Braga RRS, Silva LMT, Galvanini PA, et al. Analysis of the mandibular foramen position and its implications to the inferior alveolar nerve block. Rev Odontol Bras Central 2014;23(67):181–184. DOI: 10.36065/robrac.v23i67.754
2. Gray H, Williams PL. (editor), Gray's Anatomy—The Anatomical Basis of Medicine and Surgery. 38th ed. New York: Churchill Livingston; 1995. p. 578.
3. Fehrenbach MJ, Herring SW. Bone, Illustrated Anatomy of the Head and Neck. 4th ed. Washington: Elsevier; 2002. p. 65–70.
4. Suragimath A, Suragimath G, Murlasiddiah SK. Radiographic location of mental foramen in a randomly selected population of Maharashtra. J Indian Acad Oral Med Radiol 2016;28:11–16. DOI: 10.4103/0972-1363.189989
5. Altunsoy M, Aglarci OS, Ok E, et al. Localization of the mandibular foramen of 8-18 years old children and youths with cone-beam computed tomography. J Pediatr Dent 2014;2(2):44–48. DOI: 10.4103/2321-6646.137677
6. Benham NR. The cephalometric position of the mandibular foramen with age. ASDC J Dent Child 1976;43(4):233–237.
7. Krishnamurthy NH, Unnikrishnan S, Ramachandra JA, et al. Evaluation of relative position of mandibular foramen in children as a reference for inferior alveolar nerve block using orthopantamograph. J Clin Diagn Res 2017;11(3):ZC71–ZC74. DOI: 10.7860/JCDR/2017/25453.9585
8. Dhillon JK, Kalra G. Cone-beam computed tomography: an innovative tool in pediatric dentistry. J Pediatr Dent 2013;1:27–31. DOI: 10.4103/WKMP-0028.117440
9. 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):173–178. DOI: 10.4103/0970-4388.73798
10. Sheikhi M, Kheir MK. CBCT assessment of mental foramen position relative to anatomical landmarks. Int J Dent 2016;1–4. DOI: 10.1155/2016/5821048
11. Patil K, Guledgud MV, Bhattacharya PT. Reliability of panoramic radiographs in the localization of mandibular foramen. J Clin Diagn Res 2015;9(5):ZC35–ZC38. DOI: 10.7860/JCDR/2015/11641.5893
12. Gungor K, Ozturk M, Semiz M, et al. A radiographic study of location of mental foramen in a selected Turkish population on panoramic radiograph. Coll Antropol 2006;30(4):801–815.
13. Kilarkaje N, Nayak SR, Narayan P, et al. The location of the mandibular foramen maintains absolute bilateral symmetry in mandibles of different age-groups. Hong Kong Dent J 2005;2:35–37.
14. Cantekin K, Sekerci AE, Miloglu O, et al. Identification of the mandibular landmarks in a pediatric population. Med Oral Patol Oral Cir Bucal 2014;19(2):e136–e141. DOI: 10.4317/medoral.18980
15. Przesmycka A, Tomczyk J. Differentiation of root canal morphology—a review of the literature. Anthropol review 2016;79(3):221–239. DOI: 10.1515/anre-2016-0018
16. Tsai HH. Panoramic radiographic findings of the mandibular foramen from deciduous to early permanent dentition. J Clin Pediatr Dent 2004;28(3):215–219. DOI: 10.17796/jcpd.28.3.gt48634942137234
17. Thangavelu K, Kannan R, Kumar NS, et al. Significance of localization of mandibular foramen in an inferior alveolar nerve block. J Nat Sci Biol Med 2012;3(2):156–160. DOI: 10.4103/0976-9668.101896

18. Afsar A, Haas DA, Rossouw PE, et al. Radiographic localization of mandibular anesthesia landmarks. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;86(2):234–241. DOI: 10.1016/s1079-2104(98)90131-7
19. Hetson G, Share J, Frommer J, et al. Statistical evaluation of the position of the mandibular foramen. Oral Surg Oral Med Oral Pathol 1988;65(1):32–34. DOI: 10.1016/0030-4220(88)90187-9
20. Mwaniki DL, Hassanali J. The position of mandibular and mental foramina in Kenyan African mandibles. East Afr Med J 1992;69(4):210–213.
21. Oguz O, Bozkir MG. Evaluation of location of mandibular and mental foramina in dry, young, adult human male, dentulous mandibles. West Indian Med J 2002;51(1):14–16.
22. Hayward J, Richardson ER, Malhotra SK. The mandibular foramen: its anteroposterior position. Oral Surg Oral Med Oral Pathol 1977;44(6):837–843. DOI: 10.1016/0030-4220(77)90027-5
23. Bremer G. Measurements of special significance in connection with anesthesia of the inferior alveolar nerve. Oral Surg Oral Med Oral Pathol 1952;5(9):966–988. DOI: 10.1016/0030-4220(52)90050-9
24. Pereira PDN, Fernandes Â, Gugisch RC, et al. Radiographic assessment of the mandibular foramen in children: focus on anesthetic procedures. Arch Oral Res 2013;9(3):279–283.
25. Ashkenazi M, Taubman L, Gavish A. Age-associated changes of the mandibular foramen position in anteroposterior dimension and the mandibular angle in dry human mandibles. Anat Rec 2011;294(8):1319–1325.
26. Hwang TJ, Hsu SC, Huang QF, et al. Age changes in location of mandibular foramen. Zhonghua Ya Yi Xue Hui Za Zhi 1990;9:98–103.
27. Kalender A, Orhan K, Aksoy U. Evaluation of the mental foramen and accessory mental foramen in Turkish patients using cone-beam computed tomography images reconstructed from a volumetric rendering program. Clin Anat 2012;25(5):584–592. DOI: 10.1002/ca.21277
28. Gershenson A, Nathan H, Luchansky E. Mental foramen and mental nerve: changes with age. Acta Anat 1986;126(1):21–28. DOI: 10.1159/000146181