Available online at *www.ujpronline.com*
Universal Journal of Pharmaceutical Research
An International Peer Reviewed Journal
ISSN: 2831-5235 (Print); 2456-8058 (Electronic)

RESEARCH ARTICLE

EVALUATION OF THE RELATIVE POSITION OF THE MANDIBULAR FORAMEN IN YEMENI CHILDREN AS A REFERENCE FOR INFERIOR ALVEOLAR NERVE BLOCK USING AN ORTHOPANTAMOGRAPH

Jamal Hezam Al-Nomair[1], Eman Abdullah Al-Homaidi[1], Abdul Qader Mohammed Qasem Zabara[1], Khaled A AL-Haddad[1], Hassan Abdulwahab Al-Shamahy[2,3], Hussein Shoga Al-Deen[1]

[1]*Orthodontics, Pedodontics and Prevention Department Faculty of Dentistry, Sana'a University, Yemen.*
[2]*Department of Basic Sciences, Faculty of Dentistry, Sana'a University, Republic of Yemen.*
[3]*Medical Microbiology and Clinical Immunology Department, Faculty of Medicine and Health Sciences, Sana'a University.*

Article Info:

Article History:
Received: 23 March 2024
Reviewed: 6 May 2024
Accepted: 29 June 2024
Published: 15 July 2024

Cite this article:
Al-Nomair JH, Al-Homaidi EA, Qasem Zabara AQM, -Haddad KA, Al-Shamahy HA, Al-Deen HS. Evaluation of the relative position of the mandibular foramen in Yemeni children as a reference for inferior alveolar nerve block using an orthopantamograph. Universal Journal of Pharmaceutical Research 2024; 9(3): 51-56.
http://doi.org/10.22270/ujpr.v9i3.1117

***Address for Correspondence:**
Dr. Hassan A. Al-Shamahy, Department of Basic Sciences, Faculty of Dentistry, Sana'a University, Republic of Yemen. Tel: +967-1-239551; E-mail: *shmahe@yemen.net.ye*

Abstract

Aim and objectives: A crucial component of managing a kid dentistry patient's behavior is pain control. For mandibular teeth, the most used local anesthetic method is inferior alveolar nerve block (IANB). So, an effective IANB anesthetic requires knowledge of the mandibular foramen's location. Using digital panoramic radiography pictures, the mandibular foramen's position in relation to the occlusal plane and the deepest point of the anterior border of the ramus was assessed in a sample of Yemeni children aged 4 to 12.
Materials and Methods: This retrospective study consisted of 501 orthodontic charts that were analyzed and divided into three groups: Group 1: 4-6 years, Group 2: 7-9 years and Group 3: 10-12 years. The OPGS were traced directly on radiographic films and measurements were taken from the mandibular foramen to the occlusal level and to the deepest point of the anterior border of the ramus, respectively, on the right and left sides of the mandible. Data were analyzed and the mean and SD were determined and compared for different gender, age groups and side (right/left).
Results: Male participants showed slightly higher mean distance values for MF-AB-Right compared to females (16.276±2.03 mm VS 15.952±1.82), but the contrast was not statistically significant. The study found significant differences in the mean MF distances of ABR between the 10-12 year age group and the 4-6 year age group (16.518±1.86 mm VS 15.487±1.95 mm), (p=0.0001). The mean OP-MF distances for the 10-12 year age group were also significant, with significant differences observed in the right side and left side.
Conclusion: The results were similar for the total children, regardless of gender. The study suggests that the mandibular foramina position may vary among different age groups. For inferior alveolar nerve block, the needle should be inserted slightly below the OP in 4-6 years old girls and at the same level of OP in 7-9 years old girls, and 4-6 years old boys.
Keywords: Inferior alveolar nerve block; Mandibular foramen; Occlusal plane; orthopantamograph.

INTRODUCTION

An essential component of treating pediatric dental patients' behavior is pain control1. Consequently, a youngster who has a bad experience during a surgical operation or restoration may become uncooperative and develop anxiety about receiving dental care in the future[1,2]. Pediatric dentistry offers a range of therapeutic approaches and pain management techniques. One method that is frequently used to manage pain is local anesthetic. When it comes to mandibular tooth anesthesia, the inferior alveolar nerve block (IANB) is the most frequently utilized nerve block in pediatric patients. Consequently, the position of the mandibular foramen must be known in order to perform an effective IANB anesthesia. The external oblique ridge, coronoid notch, pterygomandibular raphe, and the occlusal plane on the ipsilateral side are the landmarks taken into account for IANB[1,2]. The mandibular lingula (ML), a bony tongue-like protrusion, protects the mandibular foramen on the medial aspect of the mandibular ramus from the anterior direction. The anesthetic solution is administered as close to the mandibular foramen as feasible by adhering to these markers. Nonetheless, a number of studies demonstrate that the position of the mandibular foramen changes on the right and left sides in individuals of different ages and ethnicities[1,3]. When a needle is placed near the mandibular foramen to deposit an anesthetic agent solution close to the nerve, IANB works well. The technique has a significant failure rate even though it is frequently employed in everyday dental procedures[4]. There is a reported failure rate of between 15 and 30%. There are two main factors involved in IANB failure: the first is accessory innervation, and the second, and more common, is incorrect placement of the needles due to incorrect assessment of landmarks. This causes bleeding, damage to the neurovascular bundle, fractures, and necrosis of the mandibular branch, among other risks during this procedure. Consequently, a thorough understanding of the anatomy of the mandible is necessary. Essentially, one must ascertain the location of the mandibular foramen in relation to the occlusal plane in order to provide quick, effective, and safe local anesthetic. The position of the mandibular foramen (MF) in children is still up for question, although it is known that as a kid grows its location changes. In primary dentition, a lower level of the MF than in adults is thought to be the norm[5,6]. One noninvasive technique for pinpointing the precise location of the mandibular foramen is panoramic radiography (OPG). The mandibular canal is visible as a radiolucent line on this curved plane tomographic technique, which enables more precise localization in both horizontal and vertical dimensions. OPG is inexpensive and easy to obtain even though it is magnified[15].

To the best of the authors' knowledge, no literature has been published on the position of the mandibular foramen in Yemeni youngsters, despite a number of research[8-11] that have been conducted on the anatomy of the mandibular canal in Yemen. Therefore, this study used digital panoramic radiographs to assess the relative position of the mandibular foramen in a sample of Yemeni children.

MATERIALS AND METHODS

Between February 2021 and January 2023, an analytical cross-sectional study was carried out in the pediatric and preventive dentistry department at Sana'a University in Yemen (Time allowed for master's clinical work). The study only included panoramic radiographs with the best viewing and diagnostic quality from patients aged 4 to 12. The study's radiographs were previously obtained for a variety of diagnostic uses. High diagnostic grade radiographic pictures with a suitable mandibular occlusal plane and no significant anatomical abnormalities are required in order to be included in the study. Excluded from the study were radiographs with low image quality, patients with a history of craniofacial trauma, temporomandibular joint disorders, cranio-cervical disorders, orthodontic treatment, and patients whose mandibular occlusal plane was affected by the presence of supra-erupted or immersed mandibular teeth or by the absence of posterior teeth. From the pool of 614 images evaluated, totaling 501, met the inclusion criteria of the study. All panoramic radiographs done by Al-Waleed radiology center and recorded by a single orthopantamogram machine, Pax-i 3D Green (model name: PHT-60CFO), 3D CT, Panoramic, and Cephalometric imaging system manufactured by Vatech Company, Korea.

The parameter settings were 50-99 KV, 4-16 mA, while the scan time was 13.5-10.1 seconds and the image magnification was 1.43 constant. The radiographic images were viewed and manipulated on the computer monitor and then printed by a hard copy printer (EPSON L805).

Three age groups 4-6 years, 7-9 years, and 10-12 years were created from the subjects. The age and gender descriptive statistics for the study groups are displayed in Table 1. Each subject's panoramic radiograph was thoroughly inspected on both the right and left sides before being directly traced on a film that had adequate light. Anatomic reference points and planes were then manually marked using a pen and ruler. The mandibular foramen's most superior-anterior point (P1) is one of the reference points. The deepest point on the ramus's anterior border (P2). The occlusal plane, which passes across the cusp tip of the fully erupted molar and that of the canine, was sketched using the reference points. A horizontal line that is parallel to the orbital plane and passes through points (P1) and (P2). To determine MF's relative position to the mandibular occlusal plane, the perpendicular distance between (p1) and the occlusal plane was determined. The linear measurement of MF's relative position was obtained by measuring the horizontal line from the anterior edge of the ramus's deepest point. A single examiner used pens and a millimeter ruler to measure values in millimeters and draw all of the dots and lines on both sides. In order to assess the dependability of the examiner, 10% of photos were chosen at random, the study variables were measured, and then the same sample was measured again two weeks later without the subjects' age or gender being known. Version 25 of the Statistical Package for the Social Sciences (SPSS) was used to statistically analyze the data. For each measurement, descriptive statistics were computed, including the mean values and corresponding standard deviations (SDs). A paired samples t-test was used to compare the mean values of the measurements on the right and left sides. $p<0.05$ was designated as the level of statistical significance.

Ethical approval: The Medical Ethics Committee of Sana'a University's Faculty of Dentistry provided ethical approval. All information was kept private, including patient identity and radiological images.

RESULTS

Of the 614 raw images, 113 were excluded for reasons including distorted radiographs causing difficulty in determining reference points. Inter-examiner and inter-examiner agreements assessed using paired sample statistics were 98.4%. . The final study sample included a total of 501 (1002 sides) imaging studies with 238 males and 263 females, with a mean age of 9.32±2.18 (mean±SD) years (Table 1). Male participants showed slightly higher mean distance values for MF–AB-Right (16.276±2.03 mm) compared to females (15.952±1.82) but the contrast was not statistically significant (*p*=0.062). Also, males showed slightly higher MF-AB-right distance values (16.013±1.96 mm) compared to females (15.906±1.90) but the contrast was not statistically significant (*p*=0.54). Also, there was no significant difference in right or left OP-MF between males and females (Table 2).

Table 1: Distribution of ages and gender.

Age group	N	Male N (%)	Female N (%)	Age (mean±SD)	Median age
4 – 6 years	76	37 (15.5%)	39 (14.8%)	5.57±0.60	6.0
7 – 9 years	174	75 (31.5%)	99 (37.6%)	8.16±0.78	8.0
10 – 12 years	251	126 (52.9%)	125 (47.5%)	11.07±0.86	11.0
Total	501	238 (100%)	263 (100%)	9.23±2.18	10.0

Table 2: Comparison of the distances between males and females.

Variable	Side	Male (n= 238)	Female (n = 263)	*p* value
AB–MF (mm)	Right	16.276±2.03	15.952±1.82	0.062
	Left	16.013±1.96	15.906±1.90	0.540
OP–MF (mm)	Right	1.462±2.82	1.404±2.83	0.826
	Left	2.827±2.79	2.398±2.75	0.085

p value: independent sample t-test for comparison between males and females

Considering the comparison of the distances between the right and left sides of the mandibular foramen, the mean MF distances of the ABR for the right were 16.104±1.93 mm versus 15.955±1.93 mm and the difference was not significant (*p*=0.5). While the OP measured on the right was 1.439±2.82 versus 2.609± 2.78 for the left and the contrast was highly significant (*p*<0.0001) (Table 3). The same results were also found in the separate male group or female group. Taking into account the comparison of distances between age groups for the total number of children (Table 4). The mean MF distances of ABR for the 10-12 year age group to the right side were 16.518±1.86 mm versus 15.487±1.95 mm for the 4-6 year age group and the discrepancy was significant (*p*=0.0001). While there were no statistically significant differences with the age group 7-9 years (*p*=0.31). The mean MF distances of ABR for the 10-12 year age group to the left were 16.399±1.88 mm versus 15.303±1.78 mm for the 4-6 year age group and the discrepancy was significant (*p*<0.0001). While there were no statistically significant differences with the age group 7-9 years (*p*=0.24). Taking into account the comparison of distances between the age groups (Table 4) for the mandibular foramen, the average OP-MF distances mm for the age group 10-12 years to the right were 2.177±2.93 mm versus 0.072±2.27 mm for the age group 4-6 years and the variance was Significant (*p*<0.0001).

Table 3: Comparison of the distances between the right and left sides of the mandible.

Variable	Side	Gender				*p*	Total	*p* value
		Male (n= 238)	*p*	Female (n= 263)				
AB–MF (mm)	Right Left	16.276±2.03 16.013±1.96	0.5	15.952±1.82 15.906±1.90		0.536	16.104±1.93 15.955±1.93	0.5
OP–MF (mm)	Right Left	1.462±2.82 2.827±2.79	<0.0001	1.404±2.83 2.398±2.75		<0.0001	1.439±2.82 2.609±2.78	<0.0001

There were also significant differences with the age group 7-9 years, equal to 0.959±2.55 mm, compared to 0.072±2.27 mm for the group 4-6 years, and the difference was significant (*p*=0.0097). The mean MF distances of OP-MF (mm) for the 10-12 year age group to the left were 3.601±2.77mm versus 1.408±2.43mm for the 4-6 year group and the discrepancy was significant (*p*<0.0001). While there were no significant differences with the age group 7-9 years (*p*=0.41) (Table 4). Table 5 and Table 6 compare the position of the mandibular foramina for the three age groups of children between males and females and the results were similar to those described for the total children in Table 4.

DISCUSSION

One of the most erratic anatomical landmarks, MF's position is determined by mandibular growth and the corresponding dimensions alterations of the ascending ramus[12]. A child's growth and development have a significant impact on the location of the mandibular foramen. A developing person's mandible is shown to go through a continuous phase of remodeling. Differential growth patterns vary throughout areas.

Teeth eruption and shedding are important factors in the process of bone remodeling, especially at the anterior border of the ramus and the crest of the alveolar bone. These factors also indirectly affect the position of the mandibular foramen and, consequently, the need for the IANB procedure in children. To prevent anesthesia failure during the block anesthetic treatments of the inferior alveolar nerve, it is crucial to precisely find the mandibular lingual and mandibular foramen[14]. We used panoramic radiographs to explore the anatomic position and relationship of MF with other mandibular characteristics, as well as potential changes that may occur with aging and across genders, because they offer a decent visibility of the anatomical components in the mouth region.

Table 4: Comparison of the distances between the age groups.

Variable	Age group (Yrs)	Number	Distance	*p* value
ABR–MF (mm) Right	4 – 6	76	15.487±1.95	Reference
	7 – 9	174	15.770±1.89	0.31
	10 – 12	251	16.518±1.86	0.0001
ABR–MF (mm) Left	4 – 6	76	15.303±1.78	Reference
	7 – 9	174	15.593±1.91	0.24
	10 – 12	251	16.399±1.88	<0.0001
OP–MF (mm) Right	4 – 6	76	0.072±2.27	Reference
	7 – 9	174	0.959±2.55	0.0097
	10 – 12	251	2.177±2.93	<0.0001
OP–MF (mm) Left	4 – 6	76	1.408±2.43	Reference
	7 – 9	174	1.681±2.38	0.41
	10 – 12	251	3.601±2.77	<0.0001

Table 5: Comparison of the distances between the age groups for male children.

Variable	Age group (Yrs)	Number	Male (n= 238)	*p* value
ABR–MF (mm) Right	4 – 6	37	16.176±2.02	Reference
	7 – 9	75	15.723±2.14	0.23
	10 – 12	126	16.631±1.89	0.26
ABR–MF (mm) Left	4 – 6	37	15.730±1.90	Reference
	7 – 9	75	15.520±2.11	0.6
	10 – 12	126	16.385±1.82	0.04
OP–MF (mm) Right	4 – 6	37	0.162±2.15	Reference
	7 – 9	75	1.054±2.78	0.09
	10 – 12	126	2.083±2.85	0.0001
OP–MF (mm) Left	4 – 6	37	1.716±2.20	Reference
	7 – 9	75	1.723±2.39	1.0
	10 – 12	126	3.802±2.81	<0.0001

Similar techniques have been applied in a number of other studies to examine the location of MF and how it relates to other bony landmarks. Furthermore, no appreciable differences were observed between the radiographic and dry mandible approaches in other investigations assessing the position of the MF. The occlusal plane of the mandibular teeth and the deepest point on the anterior border of the ramus were taken into consideration in this study to evaluate the relative position of the mandibular foramen in the juvenile population. It can be estimated that the height at which to insert the needle to provide the local anesthetic by measuring the vertical distance between the mandibular foramen and the occlusal plane. On the other hand, the horizontal distance for needle insertion can be estimated using the measurement taken from the deepest point of the coronoid notch. The current study showed that the position of the mandibular foramen significantly (*p*=0.05) changed vertically and horizontally with age in both genders. Such a pattern has been agreed upon by other authors, such as Krishnamurthy *et al*[1]., and Upadhyay *et al*.[17]. In addition, a CBCT study conducted by Madiraju *et al*.[18], in Saudi children showed that there was a significant shift in the MF position from below the OP in younger children to the level of OP at age 9 years and then moved above the OP with age. The results of the current study varied when compared to a study by Feuerstein *et al*., among Caucasian[19] that concluded, The location of MF was considered to be similar in all ages patients's from 4 years old to 23 years old, and this result is in contrast to the facts that in growing children, the mandible undergoes a constant phase of remodeling[13]. Different areas exhibit deferential growth patterns, eruptions, and shedding of teeth that affect the bony remodeling at the anterior border of the ramus and crest of the alveolar bone, which has an indirect effect on the position of the mandibular foramen in children.

According to the study's findings, MF was found to be slightly above the occlusal plane in 10–12 year old girls and 7-9, 10–12 year old boys, and slightly below the occlusal plane in 4-6 year old girls and at the same level of the occlusal plane in 7-9 year old girls and 4-6 year old boys. In contrast to these results, Shukla and Tiku's investigation in the Asian population revealed that, in children aged[5-7], the position of MF was marginally above the occlusal plane. Furthermore, Movahhed *et al.*,[21] conducted a study on children aged 7 to 10, and they recommended that IANB be given to boys and girls aged 7-9, 7-8, and above the occlusal plane for ages greater than that for both genders. Furthermore, a Brazilian study including children aged 7 to 10 years found that inferior alveolar anesthetic for both genders should be given at least 6 mm above the occlusal plane, with the mandibular lingula serving as the reference point[22].

Table 6: Comparison of the distances between the age groups in female children.

Variable	Age group (Yrs)	Number	Female (n = 263)	*p* value
ABR–MF (mm) Right	4 – 6	39	14.833±1.66	Reference
	7 – 9	99	15.806±1.68	0.002
	10 – 12	125	16.416±1.82	<0.0001
ABR–MF (mm) Left	4 – 6	39	14.897±1.59	Reference
	7 – 9	99	15.648±1.75	0.014
	10 – 12	125	16.424±1.95	<0.0001
OP–MF (mm) Right	4 – 6	39	-0.013±2.40	Reference
	7 – 9	99	0.887±2.36	0.056
	10 – 12	125	2.248±3.02	0.0001
OP–MF (mm) Left	4 – 6	39	1.115±2.62	Reference
	7 – 9	99	1.649±2.39	0.24
	10 – 12	125	3.380±2.73	<0.0001

The current study confirms previous research that has shown variations in the linear measurements of the mandible between the right and left sides. These variations have been attributed to variations in the regional growth of the jaws at different directions during Hellman's stages of dental development[4,13,17]. On the other hand, Madiraju *et al.*,[18] found no discernible difference between the left and right sides in Saudi children. In the present study, there was no gender deference in the measurements of MF-OP and MF-ABR for both right and left sides (Table 2 to Table 5); similar results were observed by Upadhyay *et al.*,[17] and Madiraju *et al.*,[18] where there is no difference between male and female in the values concerning the location of mandibular foramen in the measurements of MF-OP and MF-ABR for both right and left sides.

Limitations of the study

Current study's drawback stems from the fact that the radiographs were taken from the database, making it unable to evaluate each subject's overall health and nutritional state. The child's overall health and nutritional status have a significant impact on the growth and development of bones. Other factors that could be relevant include differences in jaw growth patterns between different ethnic groups, the precision of the radiography equipment, magnification factors, appropriate patient positioning, recognition of landmarks on radiographs, and, most importantly, the highly individualistic recognition of landmarks intraorally during IANB. The present study did not assess the soft tissue thickness at the needle insertion point; instead, it predicated the mean distance of the MF from the ABR only on bony anatomical markers. The measurements obtained from panoramic radiographs recorded using the approach given may not be as precise as those obtained from three-dimensional computed tomography images.

CONCLUSIONS AND RECOMMENDATIONS

The results were similar for the total children, regardless of gender. The study suggests that the mandibular foramina position may vary among different age groups. For inferior alveolar nerve block, the needle should be inserted slightly below the OP in 4-6-year-old girls and at the same level of OP in 7-9-year-old girls and 4-6-year-old boys. While it should be inserted above the OP in 10-12 year'-old girls and 7-9, 10-12 year-old boys. For all age groups of Yemeni children, the mandibular foramen is not symmetrically positioned on both sides.

It is necessary to conduct additional research evaluating the mandibular foramen's position in children across different age groups using cutting-edge diagnostic tools like CBCT imaging and other cutting-edge technology. Further research covering the entirety of Yemen should also be conducted.

ACKNOWLEDGEMENTS

The authors express their gratitude to Yemen and the Sana'a University Faculty of Dentistry for their gracious assistance and collaboration.

AUTHOR'S CONTRIBUTIONS

Al-Nomair JH: writing original draft, literature survey. **Al-Homaidi EA:** methodology, conceptualization. **Zabara A, AL-Haddad KA:** formal analysis, review. **Al-Shamahy HA, Shoga Al-Deen H:** investigation, conceptualization. Final manuscript was revised and approved by all authors.

DATA AVILIABILITY

The empirical data used to support the findings of this study are available from the corresponding author upon request.

CONFLICT OF INTEREST

None to declare.

REFERENCES

1. Krishnamurthy NH, Unnikrishnan S, Ramachandra JA, Arali V. 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:ZC71-4. *https://doi.org/10.7860/JCDR/2017/25453.9585*
2. Shukla RH, Tiku A. Correlation of mandibular foramen to occlusal plane as a clinical guide for inferior alveolar nerve block in children: A digital panoramic radiographic study. Contemp Clin Dent 2018 Jul-Sep;9(3):372-5. *https://doi.org/10.4103/ccd.ccd_73_18*
3. Epars JF, Mavropoulos A, Kiliaridis S. Changes in the location of the human mandibular foramen as a function of growth and vertical facial type. Acta Odontol Scand 2015;73:375-9. *https://doi.org/ 10.3109/00016357.2014.968871*
4. Phukan AH, Mathur S, Sachdev V. Relative changes in position of mandibular foramen in 3–13-year-olds in relation to inferior alveolar nerve block. Int J Ane Rel 2018;2(1):1-8.
5. Potocnik I, Bajrović F. Failure of inferior alveolar nerve block in endodontics. Endod Dent Traumatol 1999;15:247–51. *https://doi.org/ 10.1111/j.1600-9657.1999.tb00782.x*
6. Malamed S. Techniques of mandibular anesthesia in Handbook of local anesthesia, 5th ed. St Louis: Mosby; 2004.
7. Kapoor S, Sandhu A, Singla A, Sandhu S. Topographic anatomy of mandibular foramen in different age groups using panoramic radiographs. Eur J Anat 2018; 22:27-35.
8. Alkohlani FHA A S, Alhadi YAA, Alasbahi AA, and Al-Shamahy HA. Anatomical pattern course of mandibular canal and its foramina location on sample of Yemeni patients using cone beam computed tomography. Universal J Pharm Res 2023, 8(1):1-6. *https://doi.org/10.22270/ujpr.v8i1.895*
9. Al-Shamahi NYA, Abbas AMA, Al-Shamahy HA, *et al*. Radiographic assessment of the course and visibility of the mandibular canal by panoramic radiography. Universal J Pharm Res 2020, 5(5):1-6. *https://doi.org/10.22270/ujpr.v5i5.481*
10. Bamashmoos KAO, Alhasani AH, Al-Akwa AAY, Zabara A, Al-Shamahy HA, Al-deen H, Al-labani MM. Prevalence of premature loss of primary teeth at the age of 6-10 years in Sana'a city, Yemen. Universal J Pharm Res 2020; 5(4):1-6. *https://doi.org/10.22270/ujpr.v5i4.439*
11. Alhadi YAA, Al-Shamahi NYA, AL-Haddad KA, Al-Shamahy HA, *et al*. Maxillary sinus septa: Prevalence and association with gender and location in the maxilla among adults in Sana'a city, Yemen. Universal J Pharm Res 2022; 7 (3):1-6. *https://doi.org/10.22270/ujpr.v7i3.775*
12. Cavalcanti MG, Yang J, Ruprecht A, Vannier MW. Validation of spiral computed tomography for dental implants. Dentomaxillofac Radiol 1998; 27:329-33.
13. 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;28:173-8. *https://doi.org/10.4103/0970-4388.73798*
14. Zhou C, Jeon T-H, Jun S-H, Kwon J-J. Evaluation of mandibular lingula and foramen location using 3-dimensional mandible models reconstructed by cone-beam computed tomography. Maxillofac Plast Reconstr Surg 2017; 39:30. *https://doi.org/10.1186/s40902-017-0128-y*
15. Tsai HH. Panoramic radiographic fndings of the mandibular growth from deciduous dentition to early permanent dentition. J Clin Pediatr Dent 2002 Spring;26(3):279-84. *https://doi.org/10.17796/jcpd.26.3.962294087538050m*
16. Kositbowornchai S, Siritapetawee M, Damrongrungruang T, *et al*. Shape of the lingula and its localization by panoramic radiograph versus dry mandibular measurement. Surg Radiol Anat 2007;29:689-94. *https://doi.org/10.1007/s00276-007-0270-9*
17. Upadhyay S, Poudyal S, Mahanta SK, Bali H, Luitel A, Niroula D. Relative position of mandibular foramen for inferior alveolar nerve block in children: A digital panoramic radiographic study. J Kathmandu Med Coll 2021;10(4):181-7.
18. Madiraju GS, Mahabob N, Bello SM. Morphometric analysis of mandibular foramen in Saudi children using cone-beam computed tomography. J Pharm Bioall Sci 2021; 13:S1717-22. *https://doi.org/10.4103/jpbs.jpbs_356_21*
19. Feuerstein D, Costa-Mendes L, Esclassan R, Marty M, Vaysse F, Noirrit E. The mandibular plane: A stable reference to localize the mandibular foramen, even during growth. Oral Radiol 2020;36:69-79.9- Mc Donald A. Dentistry for the child and adolescent, 8th ed. St Louis: Mosby; 2004.
20. Chandran S, Peedikayil FC, Chandru TP, Kottayi S, John S. Relative position of mandibular foramen in 4–9-year-oldchildren: A retrospective study. SRM J Res Dent Sci 2021;12:13-6.
21. Movahhed T, Makarem A, Imanimoghaddam, Anbiaee N, Sarrafshirazi AR, Shakeri MT. Locating the mandibular foramen relative to the occlusal plane using panoramic radiography. J Appl Sci 2011;11:573-8. *https://doi.org/10.3923/jas.2011.573.578*
22. Kanno CM, de Oliveira JA, Cannon M, Carvalho AA. The mandibular lingula's position in children as a reference to inferior alveolar nerve block. J Dent Child (Chic) 2005;72:56-60.