

ASSESSMENT OF POSITION, SHAPE AND RADIOGRAPHIC APPEARANCE OF THE MENTAL FORAMEN IN TERMS OF GENDER: A RADIOGRAPHIC STUDY

Sherouk Khalifa* 

ABSTRACT

Aim: To assess the position, shape and radiographic appearance of the mental foramen in terms of gender using digital panoramic radiography.

Materials and methods: 100 digital panoramic images of dentulous Egyptian patients of known sex (50 males and 50 females) and of age older than 18 years old were included in the present study. The mental foramen was assessed on digital panoramic images regarding the medio-lateral and superio-inferior positions, the shape and the radiographic appearance. The data obtained were subjected to statistical analysis in correlation with gender.

Results: The most common medio-lateral position in males was at level of the second premolar (46%) while in females was between the first and second premolars (40%). Superioinferiorly, the most common position in males (86%) and females (90%) was below the level of the apices of the lower premolars. Regarding the shape of the mental foramen, the oval shape was the most common in both males (44%) and females (40%) and for the radiographic appearance, both the separated and diffuse types were the most common and of equal distribution in case of males (38%) while the continuous type was the most common in females (40%). The distributions of males and females showed statistically significant difference only regarding the medio-lateral position between the lower second premolar and the first molar.

Conclusion: Statistically, there was significant difference between males and females only regarding the medio-lateral position between the lower second premolar and the first molar.

KEYWORDS: Position, shape, mental foramen, gender, panoramic radiography

* Associate Professor, Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Cairo University

INTRODUCTION

The mental foramen is a bilateral anatomical funnel like landmark in the mandibular body that opens at the buccal surface of the mandible in oblique direction through which the mental nerve and vessels emerge. The mental bundle provides nerve supply, nutrition and drainage to the skin and mucosa of the lower lip, cheeks, chin, and the mucosa of the vestibular gingival tissues of the inferior incisor, canine and premolar teeth. Mediolaterally, it is usually located between the lower premolars or near the apex of the lower second premolar, however due to anatomical variations among humans, mental foramen could be detected in other positions ranging from the apex of the lower canine to the apex of the mesiobuccal root of the lower first molar. Superioinferiorly, it is usually detected midway between the inferior border of the mandible and the alveolar bone crest and lies in the same vertical plane as the infraorbital foramen. In addition the position can be affected by factors like gender and ethnicity ⁽¹⁻⁹⁾.

Accurate assessment of the position and shape of the mental foramen is of a very important clinical significance as this would help in performing successful local anesthesia to the terminal branches of the mandibular nerve. Moreover, it may reduce the risk of complication like paresthesia and bleeding in the mental region, which may occur due to traumatizing the mental bundle during many oral surgical procedures such as osteotomy, implant placement, endodontic treatment and other surgical procedures involving the mental area ^(5-8,10,11).

Knowing the normal variations of the position of the mental foramen is of great importance, since such variations are common, and can lead to complications during surgical procedures related to the mental region and some of these complications may accompany the patient forever placing the dentist at a mediolegal consequences ^(9, 12,13). Similarly, the shape of the mental foramen

on radiographs shows variations. It commonly appears as an oval or circular radiolucency, while other shapes, such as the irregular type, have been reported in other individuals ⁽⁶⁾.

Since the position of the mental foramen must be properly assessed before performing surgical procedures involved with regions related to the foramen, radiography is considered a must for the localization of the mental foramen since its position cannot be determined by clinical examination. The image of the mental foramen is not easily depicted on intraoral radiographs due to its position at the lower edge of the periapical film hence does not allow complete visualization of the foramen. Also it is difficult to properly place the film intraorally in cases of patients with small mouth, or those with large mandibular tori, shallow floor of mouth or malaligned teeth. Moreover, due to the path of the mental canal that runs in an oblique direction in the mesiodistal and infero-superior planes, it is not always properly observed in a periapical radiograph ^(2,13). Panoramic radiography is the most commonly used technique for assessment of the position of the mental foramen in regular dental practice since it allows accurate localization of the mental foramen both horizontally and vertically, and in comparison to other recent radiographic techniques, panoramic radiography is less expensive and with more availability and less radiation dose to the patient ^(2,14,15).

The aim of the present study was to assess the position, shape and radiographic appearance of the mental foramen in terms of gender using digital panoramic radiography.

MATERIALS AND METHODS

This is a retrospective study that comprised a total of 100 digital panoramic images of Egyptian patients who required panoramic radiography for routine examination or for purposes of seeking dental treatment. The selected images were for patients of known sex (50 males and 50 females)

and who were older than 18 years old. No ethical clearance was needed since the selected images were taken from the medical record system and retrospectively evaluated. All digital panoramic images included in the present study were made by the same panoramic machine (Planmeca Proline XC with Dimax 3 X-ray system, PLANMECA OY, Helsinki, Finland) with exposure parameters 60-80 kVp, 4-12 mA and 2.5-18 sec. according to patient's age and size. Visualization and assessment of the position and other features of the mental foramen on the digital panoramic images were done using Planmeca Romexis® for windows version 3.8.3 (COPYRIGHT PLANMECA).

Digital panoramic images with the following criteria were excluded:

- Patients younger than 18 years old
- Pathologic lesions or periodontal diseases involving the mandible
- Unerupted or missing lower posterior teeth (except for the lower wisdom tooth)
- The presence of supernumerary teeth or severe malalignment at the area of the lower posterior teeth
- Images with poor quality

Four variables were assessed for each digital panoramic image; the medio-lateral position, the superio-inferior position, the shape and the radiographic appearance of the mental foramen.

The position of the mental foramen was assessed on the digital panoramic images as follows:

Medio-Lateral position (horizontal position):^(5,8)

Position 1: foramen between the canine and the first premolar

Position 2: foramen situated in line with the first premolar

Position 3: foramen between the first and second premolars

Position 4: foramen situated in line with the second premolar

Position 5: foramen between the second premolar and the first molar

Position 6: foramen situated in line with the first molar

In order to locate the position of the mental foramen mediolaterally, lines were drawn parallel to the long axis of the canine, the first and second premolars as well as the first molar and the position of the foramen was recorded according to these lines (Figure 1).

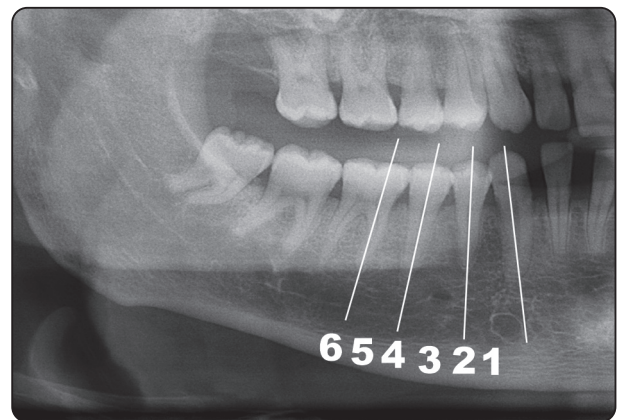


Fig. (1): Cropped digital panoramic image showing the medio-lateral position of the mental foramen; position 1: between the canine and the first premolar, position 2: in line with the first premolar, position 3: between the first and second premolars, position 4: in line with the second premolar, position 5: between the second premolar and the first molar and position 6: in line with the first molar

Superio-Inferior position (vertical relationship between mental foramen and root apices of the lower premolars):⁽⁸⁾

Position A: Mental foramen is positioned above the level of apices of the lower premolars

Position B: Mental foramen is positioned at the level of apices of the lower premolars

Position C: Mental foramen is positioned below the level of apices of the lower premolars

In order to locate the position of the mental foramen superoinferiorly, a horizontal line was drawn at the level of the apices of the first and second premolars and the position of the foramen was recorded according to this line (Figure 2).

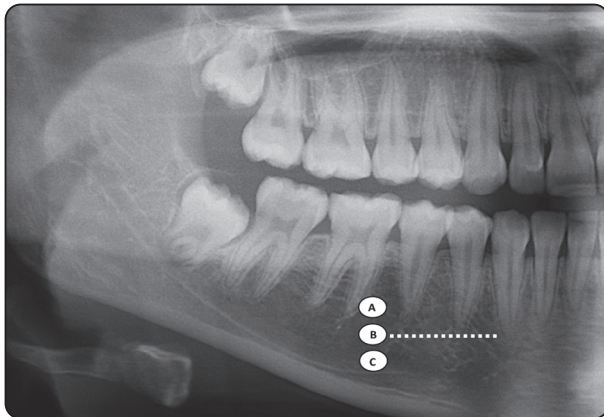


Fig. (2): Cropped digital panoramic image showing the superoinferior position of the mental foramen; position A: above the level of apices of the lower premolars, position B: at the level of apices of the lower premolars and position C: below the level of apices of the lower premolars

The shape of the mental foramen was assessed on the digital panoramic images as follows:⁽¹⁴⁾

Shape 1: Round

Shape 2: Oval

Shape 3: Irregular

The radiographic appearance of the mental foramen was assessed on the digital panoramic images as follows:⁽¹⁵⁾

Type 1: Continuous

Type 2: Separated

Type 3: Diffuse

Type 4: Unidentified

To characterize the radiographic appearance of the mental foramen on the digital panoramic images; a foramen which showed continuity with mandibular canal was considered type 1 (continuous), a foramen

separated from mandibular canal was considered type 2 (separated), a foramen with indistinct borders was considered type 3 (diffuse) and a foramen that cannot be identified on panoramic images under ordinary exposure and viewing conditions was considered type 4 (unidentified).

The assessment was performed by one oral and maxillofacial radiologist with 18 years of experience in oral and maxillofacial radiology field.

Statistical analysis

The position, shape and radiographic appearance of the mental foramen were analyzed in terms of gender. Data were analyzed with SPSS 20.0 statistical package. Chi-square test and Fisher's exact test were applied to determine association. Z test was also applied for comparing two proportions. P-value less than 0.05 indicates statistical significance.

RESULTS

In the present study, 100 digital panoramic images were assessed, out of which 50 were for males and 50 were for females. For each image, four variables were assessed; the medio-lateral and the superio-inferior positions of the mental foramen, the shape of the mental foramen and the radiographic appearance of the mental foramen.

The medio-lateral position of the mental foramen (horizontal position) was found to be at "position 2" in 4% of the males and 4% of females, at "position 3" in 42% of the males and 40% of the females", at "position 4" in 46% of the males and 32% of the females, and at "position 5" in 8% of the males and 24% of the females (Figure 3). There was no incidence for "position 1" or "position 6". There was a statistically non-significant difference of the distributions of males and females according to mediolateral position ($p = 0.142$). The proportions of males and females of all mediolateral position categories were statistically non-significant except for the category of "position 5" where proportion

of females was statistically significantly higher than males (Table 1).

TABLE (1): Hypothesis testing of the proportions of males and females of medio-lateral position categories

	Males	Females	Z	P Value
at 4	4.0%	4.0%	Equal values	
at 4/5	42.0%	40.0%	0.20	0.83888 P > 0.05 NS
at 5	46.0%	32.0%	1.44	0.15124 P > 0.05 NS
at 5/6	8.0%	24.0%	2.18	0.02910 P < 0.05 S

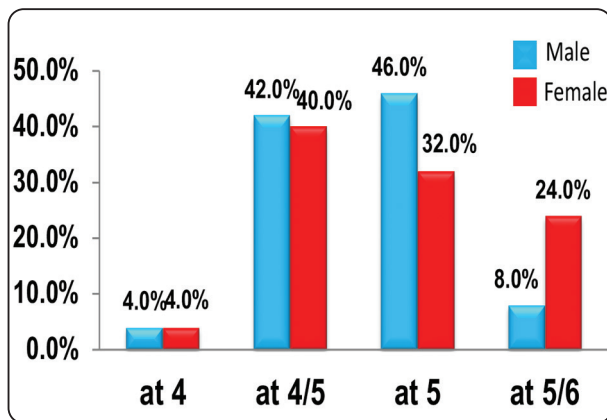


Fig. (3): Distributions according to medio-lateral position for males and females

The superio-inferior position of the mental foramen (vertical relationship between mental foramen and root apices of the lower premolars) was found to be at “position A” in 4% of the males and 2% of females and at “position B” in 10% of the males and 8% of the females and at “position C” in 86% of the males and 90% of the females (Figure 4). There was a statistically non-significant difference of the distributions of males and females according to superio-inferior position ($p = 0.803$) and the proportions of males and females of all superio-inferior position categories were also statistically non-significant (Table 2).

The shape of the mental foramen was found to be “round” in 26% of the males and 36% of females, “oval” in 44% of the males and 40% of the females

TABLE (2): Hypothesis testing of the proportions of males and females of superio-inferior position categories

	Males	Females	Z	P Value
above the apices	4.0%	2.0%	0.59	0.55773 P > 0.05 NS
at the apices	10.0%	8.0%	0.35	0.72677 P > 0.05 NS
below the apices	86.0%	90.0%	0.62	0.53825 P > 0.05 NS

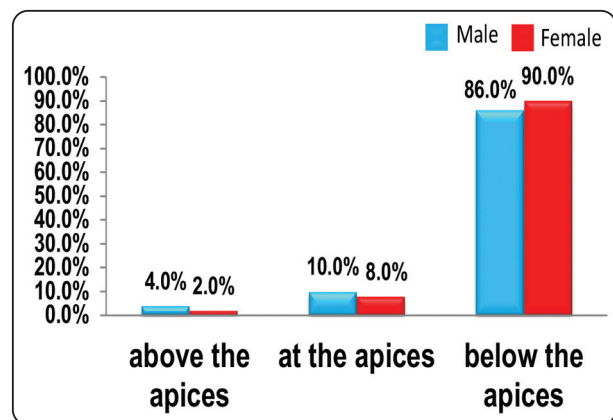


Fig. (4): Distributions according to superio-inferior position for males and females

and “irregular” in 30% of the males and 24% of the females (Figure 5). There was a statistically non-significant difference of the distributions of males and females according to shape ($p = 0.539$) and the proportions of males and females of all shape categories were also statistically non-significant (Table 3).

The radiographic appearance of the mental foramen was found to be “Continuous” in 24% of the males and 40% of females and “Separated” in 38% of the males and 26% of the females and “diffuse” in 38% of the males and 34% of the females. No foramina were appearing to be of the “unidentified” type (Figure 6). There was a statistically non-significant difference of the distributions of males and females according to radiographic appearance ($p = 0.198$) and the proportions of males and females of all appearance categories were also statistically non-significant (Table 4).

TABLE (3): Hypothesis testing of the proportions of males and females of shape categories

	Males	Females	Z	P Value
Round	26.0%	36.0%	1.08	0.27965 P > 0.05 NS
Oval	44.0%	40.0%	0.41	0.68532 P > 0.05 NS
Irregular	30.0%	24.0%	0.68	0.49921 P > 0.05 NS

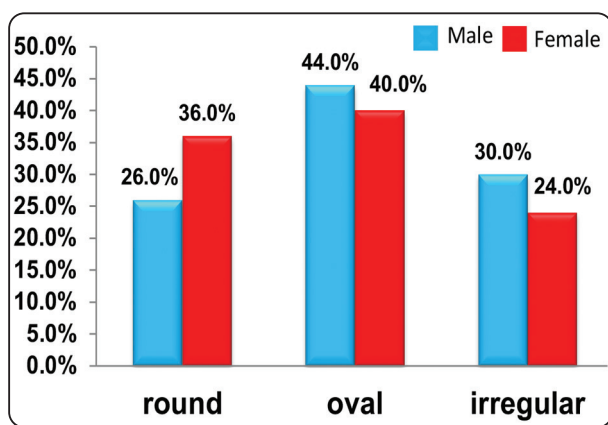


Fig. (5): Distributions according to shape for males and females

DISCUSSION

The literature has shown that proper identification of the mental foramen and accurate knowledge of its position is of great clinical importance concerning successful placement of local anesthesia during dental procedures like endodontic and periodontic treatments as well as performing surgical procedures involving the premolars area as in case of implant placement or orthognathic surgeries. It is of great importance to be aware that the mental foramen shows variations concerning its horizontal and vertical positions, its shape as well as its radiographic appearance to avoid injury of the mental nerve that may lead to paresthesia or sensory dysfunction of the areas supplied by such nerve. Furthermore, the mental foramen has been misinterpreted and confused as periapical radiolucency lesion related to the lower premolars. Accordingly, many authors have emphasized the importance of studying the position and other features concerned with the mental foramen (3,5-7,10,12,14- 16).

TABLE (4): Hypothesis testing of the proportions of males and females of radiographic appearance categories

	Males	Females	Z	P Value
Continuous	24.0%	40.0%	1.71	0.08635 P > 0.05 NS
Separated	38.0%	26.0%	1.29	0.19836 P > 0.05 NS
Diffuse	38.0%	34.0%	0.42	0.67692 P > 0.05 NS

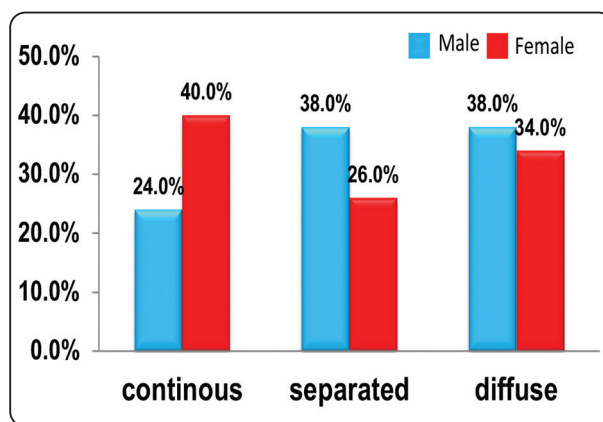


Fig. (6): Distributions according to radiographic appearance for males and females

The clinical significance of the mental foramen and the fact that it cannot be assessed and localized clinically, strengthened the need to identify the foramen and assess its position and other features radiographically. Previous studies that utilized different radiographic techniques for the assessment of the position of the mental foramen have reported that the least errors were accompanied by the digital panoramic radiography. It was also reported that enhancement of visualization of the mental foramen can be performed by using digital panoramic images with software programs. Moreover, it was reported that the panoramic radiography is considered to be the most preferable technique for assessing the position of the mental foramen. Accordingly, the present study conducted the assessment of the position and other features of the mental foramen on digital panoramic images (16- 20).

Since the present study did not aim to assess the symmetry of the mental foramen, assessment of the position, shape and radiographic appearance

of the mental foramen was conducted on only one side of the digital panoramic images. Moreover, Bello et al, who assessed the symmetry of mental foramen, reported that the left and right sides of the subjects showed no difference in the frequency pattern related to the horizontal position of the mental foramina as well as the vertical position and the shape of the foramina which also showed no difference in the frequency⁽¹⁶⁾. Concerning the age, the present study was conducted only on patients with age older than 18 years old, as we required patients with completed skeletal growth⁽⁶⁾.

In the present study, the mental foramen was assessed regarding its position both mediolaterally and superoinferiorly, its shape and its radiographic appearance in terms of gender as the present study was conducted on the digital panoramic images of 50 males and 50 females.

Regarding the medio-lateral position, there were variations between the male and female patients in the present study where the most common position of the mental foramen in males (46%) was at "position 4" followed by "position 3" in 42% of the males. While in females the most common medio-lateral position was at "position 3" (40%) followed by "position 4" in 32% of the females group. Such results come in agreement with Elhassan et al who conducted their study on a group of Libyan patients and found that the most common mediolateral position of the mental foramen in males was "position 4" followed by "position 3" while the opposite was recorded in the female group⁽¹³⁾. Some studies have reported the most common mediolateral positions to be related to "position 3" and the "position 4" where Al-Shayyab et al, Zmyslowska-Polakowska et al, and Popović et al have reported that the most common positions in the males and females was "position 3" followed by "position 4", which meets the results of the present study concerning the females group, while Rungkanawut et al and Parnami et al found that the most common medio-lateral position of

the mental foramen was "position 4" followed by "position 3" in both male and female groups, in accordance to the present study concerning the males group^(6,8,14,18,21). Disagreeing with the present study, Oliveira et al found that "position 3" followed by "position 4" were the most common positions in males while the opposite was recorded in females⁽⁷⁾. On the contrary, other authors reported other positions to be among the most common medio-lateral positions of the mental foramen where Gupta et al and Jayam et al concluded that "position 3" and "position 5" were the most common medio-lateral positions^(2,5). Among the male and female patients included in the present study, neither "position 1" nor "position 6" were reported which was in accordance with Zmyslowska-Polakowska et al who did not record any incidence of "position 1" and "position 6" in their study⁽⁸⁾. In the present study, no significant difference was reported regarding the proportions of males and females in the medio-lateral position categories except "position 5" which showed statistically significant difference ($p=0.029$) between males (8%) and females (24%). Rungkanawut et al also recorded statistical significant difference in relation to gender in their study but it was found regarding "position 4", disagreeing with the results of our study⁽¹⁸⁾. On the other hand, several authors did not report any statistically significant difference in relation to gender regarding the mediolateral position of the mental foramen^(2,5,7,8,14). In the superio-inferior position, the most common was "position C" in both genders where such position was reported in males (86%) less than females (90%), while the second most common was "position B" which was reported in 10% of the males and in 8% of the females. To the far of our knowledge, all studies concerned with the assessment of the superio-inferior position of the mental foramen in males and females reported that, "position C" followed by "position B", were the most common positions of the mental foramen in the vertical plane^(5,8,15,18,21). In the present study, neither of the superio-inferior position categories of

the mental foramen showed statistically significant difference between male and female patients. Similarly, Jayam et al, Zmyslowska-Polakowska et al and Dehghani and Ghanea did not record any statistical significant difference regarding the superior-inferior position of the mental foramen in relation to gender, while Rungkanawut et al found statistical significant difference between males and females regarding “position C”^(5,8,15,18).

The most common shape of the mental foramen in the present study was the “oval” shape in both males (44%) and females (40%) followed by the “irregular” shape in males (30%) and “round” shape in females (36%). The results of the present study concerned with the shape of the mental foramen was in accordance with Bello et al only regarding the most common shape of mental foramen in females which was found to be “oval” and the second most common shape in males which was found to be “irregular”, as recorded in the present study⁽¹⁶⁾. On the contrary, other authors disagreed with the present study regarding the shape of the mental foramen where Al-Shayyab et al, and Popović et al reported that the most common shape of the mental foramen in both males and females was the “round” shape followed by the “oval” shape^(6,14). Again, there was no statistically significant difference regarding the proportions of males and females in any of the shape categories in the present study which was in accordance to Popović et al and Bello et al who also did not report significance difference regarding the shape of the mental foramen in relation to gender in their studies^(14,16).

Concerning the radiographic appearance of the mental foramen, the present study showed both the “separated” and “diffuse” type to be the most common in males with equal distributions (38% for each), while the most common regarding females was the “continuous” type (40%) followed by the “diffuse” type (34%). Regarding the radiographic appearance of the mental foramen, Elhassan et al and Dehghani and Ghanea recorded results that met the present study only in case of the females

group where the “continuous” type was the most common in females as reported in their studies^(13,15). Disagreeing with the present study, Gupta et al reported that the “continuous” type followed by the “separated” type were the most common in males while the “separated” type followed by the “unidentified” type were the most common in females⁽²⁾. In the present study, all radiographic appearance categories also showed statistically non-significant difference regarding the proportions of males and females, agreeing with Dehghani and Ghanea who reported non-significant difference between males and females regarding the radiographic appearance of the mental foramen⁽¹⁵⁾. In contrast, Gupta et al in their study found statistically significant difference regarding the radiographic appearance of the mental foramen in terms of gender⁽²⁾.

According to Zmyslowska-Polakowska et al, the pattern of mental foramen position varies among different populations⁽⁸⁾, that is why the differences among the studies involving the assessment of the position and other features of the mental foramen, including the present study, were most probably due to the different population upon which such studies were conducted. In addition, Dehghani and Ghanea stated that the development and growth are affected by the race and environment of each population that lead to difference in the position of the mental foramen⁽¹⁵⁾. The sample size was a limitation in the present study. A larger sample size would allow for a thorough and more detailed radiographic assessment of the position and other features of the mental foramen.

CONCLUSION

The mental foramen showed variations regarding the medio-lateral and superio-inferior positions, the shape and the radiographic appearance. In terms of gender, there was a statistically significant difference between males and females only regarding the medio-lateral position between the lower second premolar and the first molar.

REFERENCES

- 1- Ceballos F, Gonzalez J, Hernandez P, Deana N, Alves N. Frequency and position of the mental foramen in panoramic X-rays: Literature review. *Int J Morphol* 2017; 35(3):1114-20.
- 2- Gupta V, Pitti P, Sholapurkar A. Panoramic radiographic study of mental foramen in selected dravidians of south Indian population: A hospital based study. *J Clin Exp Dent* 2015;7(4):e451-6.
- 3- Muínelo-Lorenzo J, Suárez-Quintanilla JA, Fernández-Alonso A, Varela-Mallou J, Suárez-Cunqueiro MM. Anatomical characteristics and visibility of mental foramen and accessory mental foramen: Panoramic radiography vs. cone beam CT. *Med Oral Patol Oral Cir Bucal* 2015;20(6):e707-14.
- 4- Luitel A, Rimal J, Maharjan IK, Shrestha A, Tamang R. Localization of mental foramen in panoramic radiographs of 18-30 year olds: A hospital based study. *Kathmandu Univ Med J. Online First*.
- 5- Jayam R, Sameeulla S, Maddhuru R, Vijaykumar B, Suman SV, Praveen KNVS. Assessment of superior-inferior, medio-lateral position and symmetry of mental foramen and its correlation with age and gender among South Indian population using panoramic radiographs. *Int j health sci res* 2018;8(11): 126-30.
- 6- Al-Shayyab M, Alsoleihat F, Dar-Oehn N, Ryalat S, Baqain Z. The mental foramen I: Radiographic study of the anterior-posterior position and shape in Iraqi population. *Int J Morphol* 2015; 33(1):149-57.
- 7- Oliveira R, Rodrigues Coutinho M, Panzarella F. Morphometric analysis of the mental foramen using Cone-Beam Computed Tomography. *Int J Dent* 2018. <https://doi.org/10.1155/2018/4571895>
- 8- Zmyslowska-Polakowska E, Radwanski M, Ledzion S, Leski M, Zmyslowska A, Lukomska-Szymanska M. Evaluation of size and location of a mental foramen in the Polish population using Cone-Beam Computed Tomography. *Biomed Res Int* 2019. <https://doi.org/10.1155/2019/1659476>
- 9- Dosi T, Vahanwala S, Gupta D. Assessment of the effect of dimensions of the mandibular ramus and mental foramen on age and gender using digital panoramic radiographs: A retrospective study. *Contemp Clin Dent* 2018; 9(3): 343-8.
- 10- Chkoura A, El Wady W. Position of the mental foramen in a Moroccan population: A radiographic study. *Imaging Sci Dent* 2013;43:71-5.
- 11- Budhiraja V, Rastogi R, Lalwani R, Goel P, Bose SC. Study of position, shape, and size of mental foramen utilizing various parameters in dry adult human mandibles from North India. *Int. sch res notices* 2013. <https://doi.org/10.5402/2013/961429>
- 12- Thakare S, Mhapuskar A, Hiremutt D, Giroh V, Kalyanpur K, Alpana K. Evaluation of the position of mental foramen for clinical and forensic significance in terms of gender in dentate subjects by digital panoramic radiographs. *J Contemp Dent Pract* 2016;17(9):762-8.
- 13- Elhassan AT, Musrati AA, Ehtiwash NM, Peeran SW, Alzahrani FM. Location of mental foramen in a group of Libyan patients: An orthopantomographic study. *Dent Med Res* 2019;7:45-8.
- 14- Popović J, Bjelaković MD, Gašić J, Marija Nikolić M, Spasić M, Mitić A, Barac R. The mental foramen - Horizontal position and shape in Southeast Serbian population. *J Anthropological Society of Serbia*. 2017;52:75-81.
- 15- Dehghani M, Ghanea S. Position of the mental foramen in panoramic radiography and its Relationship to age in a selected Iranian population. *Avicenna J Dent Res* 2016; 8(1): e25459.
- 16- Bello S, Adeoye J, Ighile N, Ikimi N. Mental foramen size, position and symmetry in a multi-ethnic, Urban Black population: Radiographic evidence. *J Oral Maxillofac Res* 2018;9(4):e2.
- 17- Mohamed A, Nataraj K, Mathew VB, Varma B, Mohamed S, Valappila NJ, Meena AS. Location of mental foramen using digital panoramic radiography. *J Forensic Dent Sci*. 2016; 8(2):79-82.
- 18- Rungkanawut C, Laowattana N, Norasing K, Rengpian A, Tantanapornkul W. Panoramic radiographic assessment of mental foramen position in dental hospital patients, Naresuan university. *NUJST* 2018;26(4):1-8.
- 19- Shaaban A, El-Shall O. Study of age and gender related variations in position of mental foramen of some Egyptians using digital panoramic radiography. *Ain-Shams J Forensic Med Clin Toxicol* 2017; 29: 36-47.
- 20- Malik M, Laller S, Saini S, Mishra R, Hora I, Dahiya N. Mental foramen: An indicator for gender determination - A radiographic study, Santosh University. *J Health Sci* 2016;2(1):12-4.
- 21- Parnami P, Gupta D, Arora V, Bhalla S, Kumar A, Malik R. Assessment of the horizontal and vertical position of mental foramen in Indian population in terms of age and sex in dentate subjects by panoramic radiographs: A retrospective study with review of literature. *Open Dent J* 2015; 9:297-302.