Incidence and Evaluation of Location and Dimension of the Mental Foramen (MF), Accessory Mental Foramina (AMF) and Lingual Foramina (LF) Using Limited Cone-beam Computed Tomography

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Abstract

Introduction: Mental foramen allows the passage of neurovascular bundles containing the mental nerve and arteries to the external surface of the mandible. Therefore, information about the mental foramen (MF) location in periapical surgeries and implant placement is essential. On the other hand, accessory mental foramina (AMF), and lingual foramen (LF) can make this region more complicated. This study aimed to determine the characteristics of these foramina with CBCT.

Methods: In this cross-sectional study, 200 CBCTs from an oral and maxillofacial radiology center were randomly selected and examined. CBCT images were reviewed, and data on the number of MF, AMFs, LF, the position of the MF, AMF, LF (right/left), and its distance from the alveolar crest and adjacent teeth were collected. Chi-squared test, independent t-test, and one-way ANOVA were used to analyze the data.

Results: The prevalence of AMF was 17%. The difference in the prevalence of accessory mental foramina between male and female patients was not statistically significant (P=0.24). Twenty-seven (79.4%) of individuals with AMF had one, and seven (20.6%) had two. Gender had a significant effect on the mean of the maximum size of MF in the vertical dimension (P<0.001) and the distance of MF from the alveolar crest (P<0.001). The prevalence of lingual foramen (LF) was 56%, and the difference in prevalence between male and female patients was not statistically significant (P=0.41). LF in 71.4% of the subjects was located unilaterally, and in 28.6%, it was located bilaterally[1].

Conclusion: In general, the prevalence of AMF in the present study was higher than in previous studies, and its prevalence was not different between men and women.

Keywords: Accessory mental foramina • AMF • CBCT • LF • lingual foramen • mental foramen

Introduction

The mental foramen is a structure in the outer surface of the mandible that allows one of the terminal branches of the inferior alveolar nerve to protrude out of the mandibular body on either side of the jaw. This hole is circular or elliptical in the anterior surface of the mandible. The mental foramen allows the passage of neurovascular bundles containing the mental nerve, arteries, and veins into the external surface of the mandible. The mental foramen contains arteries and nerves that innervate the skin of the chin area, the skin of the lower lip, and the gingival area to the second premolar area. Anatomical variations of the mental foramen have been reported. Accessory mental foramina are among these variations. If the foramen is associated with the mandibular canal, it is called the accessory foramen and is believed to be associated with the mental nerve. If the accessory foramen has no connection to the mandibular canal, it is considered a nutrient foramen that nourishes the bone with capillary contents. AMF is rarely seen with intraoral and panoramic radiographs because it is generally less than 1 mm in size. Visualization of AMFs that are smaller than normal size and the anatomical relationship between AMF and MF and the mandibular canal using spiral CT is difficult due to its low resolution. On the other hand, limited CBCT provides high-resolution images useful for diagnosing AMF and the intraosseous pathway of the mandibular canal and its sub-branches. In different studies, the prevalence of AMF has been reported between 1.4% and 14%. Knowledge of the location of MF and AMF is essential in various dental clinical fields, including local anesthesia injection, incision, and drainage of abscesses, in periapical surgeries, and placement of implants and full-mouth dentures, and periapical surgeries.

In the past, the only way we could determine the location of the MF clinically and accurately was during the elevation of a mucoperiosteal flap at the surgical site. This technique can cause serious damage to the neurovascular bundle, resulting in temporary or permanent paresthesia in the region of innervation, with negative consequences for the patient. Various techniques, such as direct vision, periapical imaging, panoramic radiographs, CBCT, MRI, and ultrasound have been used to detect the location of the mental foramen, of which CBCT has the same accuracy as direct vision. Detection of AMF using CBCT might reduce paresthesia and hemorrhage during surgery in the chin and cheek areas. A study showed that the size and location of MF could be reliably measured using CBCT with limited FOV. According to recent studies, our understanding of neurovascular variability in the mandible is incomplete. Also, due to the importance of the anatomical structures' position and the diversity of its position in different ethnic groups, in this study, the presence and prevalence of mental foramina were investigated using CBCT images. Lingual foramen is divided into two groups according to the distance from the mandibular midline; medial lingual foramen is in the midline and lateral lingual foramen is lateral to the midline. The frequency of LLF is 14–80% and is predominantly 83% in the premolar region. LLF contains a branch of the submental artery, called the "communication branch." It is important to consider that the artery that passes through the lateral lingual foramen will be distributed in the anterior portion of the mandible in the lingual aspect. Considering the importance of the position of mental foramen and its diversity in different racial groups, this study investigated the existence and prevalence of MF, AMF, and LF, using CBCT images have been built around the world. Power Augmented Ram (PAR) is used and it is an important for the take-off of WIG vehicles. The jet engines exhaust gas the air displaced by propellers are directed or ducted. So that they pass underneath the wing to enhance the effect of the air cushion and to create additional lift. Following are the incorporation of the PAR principal by the American, Stewart Warner, in the design of his 1928'compressor' airplane, many subsequent WIG vehicles adopted the concept. The economic benefits and practical applications of ground effect was observed in 1932 [2].

Materials and Methods

The CBCT images in the present cross-sectional analytical study were taken from private radiology clinics, taken for diagnostic and therapeutic purposes. Among the recorded CBCTs, 200 CBCT images were randomly selected and examined by considering the inclusion criteria. The sample size was calculated at n=100 according to the results of previous studies and using the sample volume formula at α=0.05, a test power of 80%, and a prevalence of 7%. For more confidence, 200 items were selected. Inclusion criteria consisted of mandibular CBCT with appropriate quality, presence of all the posterior mandibular teeth except second and third molars, presence of MF, presence of teeth in the normal position, a minimum age of 18 years, and a minimum FOV size of 8 inches to fully cover the mandible. CBCT images with extensive pathological lesions in the posterior mandible, severe mandibular atrophy, a history of mandibular fractures, CBCT images that not included the mandibular lower border, artifacts that affect image quality, the presence of implants in the study area, chronic apical periodontitis preventing the examination of the area, open apex teeth at the posterior mandibular region, severe bone resorption in the posterior mandibular area were excluded from the study. Data were collected using a checklist that included patients' demographic data such as age and sex. Data were also collected from CBCT images, including the number of MF, AMF, and LF and the side of MF, AMF, and LF (right/left), the distance of MF, AMF, and LF from the crest, the distance of MF, AMF, and LF from the apex of the adjacent tooth, and the distance of the central point of AMF from the center of MF. MF, AMF, and LF were examined in axial, coronal, and sagittal views. The research method was approved by Kerman University of Medical Sciences. The necessary permission was obtained to access the registered data of patients in two maxillofacial radiology centers in Kerman, which used the Planmeca Promax 3D model 3D Image Receptor unit (Planmeca, Finland) for diagnostic and therapeutic uses. A total of 200 images that met the inclusion and exclusion criteria were selected. These images complied with the As Low as Reasonably Achievable (ALARA) principle and had good image quality. The images were prepared by the Planmeca unit with limited FOV, with exposure factors of 60–90 kV and 2-15 mA, based on patient characteristics and the manufacturer's instructions. The selected images had a 1920-bit gray spectrum, a voxel size of 0.2 mm, and a cross-section thickness of 0.3 mm. The contrast and brightness were modified to achieve maximum image quality. Before measurements, the tooth angles were arranged in all the planes. The buccal foramina that were smaller than the MF and had a lateral branch of the mandibular canal were identified as AMF, regardless of location. If there was no direct correlation between AMF and MF, this foramen was not considered as AMF. A senior endodontics assistant was trained by a radiologist, and two endodontists checked the accuracy of the information obtained by the endodontics assistant. After reviewing all the CBCT images, the data were recorded in a prepared checklist. The data were analyzed with SPSS 23 using chi-squared test, independent t-test, and one-way ANOVA. Statistical significance was set at $P<0.05$.

In the axial view, the maximum size of the MF in the horizontal axis and in the coronal view, its maximum size was measured in the vertical dimension. The location of the MF and its distance from the adjacent tooth roots in the axial view was determined, and the shortest distance between the upper limit of the MF and the alveolar crest in the coronal view was recorded. The number AMFs, the side of the jaw where the AMF was located, and its location relative to the MF and the closest root apex to the AMF were determined in the axial view. To determine the distance of AMF's center from the center of the MF, the planes were rotated sufficiently to place both foramina in one plane in the coronal view. To determine the shortest distance from the closest apex to the AMF, the planes were modified so that both were in the same coronal plane. Also, the smallest linear distance from the alveolar crest was measured in the coronal view. If LF was present, the number and its location were also determined in the coronal plane based on its relationship to the apex of the teeth in the axial view, along with its distance from the alveolar crest in the coronal view. After reviewing all the CBCTs, the information was recorded in the checklist.

Results and Discussion

All the 200 patients participating in this study had mental foramina; 129 (64.5%) were female, and 71 (35.5%) were male. The mean age of the patients was 36.67±11.23 years (18–73 years). Two male patients had more than two mental foramina. In one patient, there were two mental foramina on the left and one on the right side. In the other patient, there were two mental foramina on the right and one on the left side. On the left side, the highest frequency of MF was 58.2% near the second premolars' apex, and the lowest frequency was 2% near the apex of the first premolars. On the right side, the highest frequency was 60.7% near the apex of the second premolars, and the lowest frequency was 1.5% near the apex of the first premolars. The difference in the frequency distribution of the left MF site based on gender was not statistically significant ($P=0.798$). The highest frequency of MF in men and women on the right side was observed under the second premolars with 56% and 59.7%, respectively. Also, the frequency distribution of the right MF site in men and women did not show a statistically significant difference ($P=0.397$). The highest frequency of MF in men and women at the right side was under the second premolars with 65.8% and 57.4%, respectively. According to Table 1, the difference between the mean of the largest MF size in the horizontal dimension based on gender was not statistically significant ($P=0.138$); however, gender had a significant effect on the mean of the largest MF size in the vertical dimension ($P<0.001$) and the distance of MF from the alveolar crest ($P<0.001$). The mean difference of the largest MF size in the horizontal dimension based on the position of MF ($P=0.118$) and the location of MF ($P=0.979$) did not show a statistically significant difference, and the mean difference of the largest MF size in vertical dimension based on the side of the MF ($P=0.798$) and the MF location ($P=0.804$) did not show a statistically significant difference. The mean distance of MF from the alveolar crest was not statistically significant based on the side ($P=0.087$) and location of MF ($P=0.502$).

AMF

The results of this study showed that the prevalence of AMF was 17% (34 patients). The mean age of patients with AMF was 36.05±11.80, and the mean age of patients without AMF was 36.80±11.14, which was not statistically significant ($P=0.72$). Fifteen patients (21.1%) who had AMF were male, and 19 (14.7%) were female. This difference between male and female patients was not statistically significant ($P=0.24$). Among patients who had AMF, 27 (79.4%) had one, and 7 (20.6%) had two accessory mental foramina. 55.9% of the AMFs were on the left, 32.4% were on the right side, and 11.8% of all cases were on both sides (right and left). Three female patients had two unilateral AMFs. The frequency distribution of left and right AMF in male and female patients did not show a statistically significant difference (left: $P=0.127$ and right: $P=0.774$). The highest frequency of AMF in men on the left side was observed near the second premolars (45.5%); in women, it was near the first molars (58.3%). The frequency distribution of AMF in men on the right side was the same near all the teeth (first premolar, second premolar, and first molar), with 50% near the second molars in women. According to the results presented in Table 2, gender had no significant effect on the distance of AMF from the center of MF ($P=0.24$), the distance of AMF from the alveolar crest ($P=0.19$), and the minimum distance of AMF from the adjacent tooth apex ($P=0.17$). The results presented in the table also showed that the difference between the mean distance of AMF from the center of MF ($P=0.71$), the mean distance of AMF from the alveolar crest ($P=0.49$), and the mean minimum distance of AMF from the adjacent tooth apex ($P=0.92$) were not significantly different based on the placement side. The mean distance of AMF from the center of MF in AMFs that were close to the first molar was higher than AMFs that were close to the first and second premolars, and the difference was statistically significant ($P=0.001$). However, the location of AMF had no significant effect on the distance of AMF from the alveolar crest ($P=0.25$) and the minimum distance of AMF from the adjacent tooth apex ($P=0.25$).

LF

The results showed that 112 subjects (56%) had LF, with 37 (33%) males and 75 (67%) females; the difference between male and female subjects was not statistically significant ($P=0.41$). The mean age of subjects with LF was 36.30±11.30, and the mean age of subjects without LF was 37.14±11.19 years, which was not statistically significant ($P=0.59$). Among subjects with LF, 80 (71.4%) had unilateral, and 32 (28.6%) had bilateral LF. The mean age of subjects with unilateral LF was 36.08 ±12, and the mean age of subjects with bilateral LF was 36.84±9.48 years, which was not statistically significant ($P=0.75$). Among subjects with LF, 39 (34.8%) had LF on the left side, 42 (37.5%) had LF on the right, and 32 (27.7%) had LF on both sides (right and left) (Figure 3).

Table 3 shows the frequency distribution of the teeth closest to the LF on the left and right sides of the mandible by gender. According to the results presented in the table, the difference in the frequency distribution of the teeth closest to the LF on the left and right sides in male and female patients did not show a statistically significant difference (P=0.63 and P=0.27, respectively). Table 4 shows the average LF distance from the alveolar crest based on position, sex, and nearest tooth. According to the results presented in the table, the mean distance of LF from the alveolar crest in male patients was more than in female patients. This difference was statistically significant (P<0.001). average minimum LF distance from adjacent teeth based on position, sex, and nearest tooth. According to the results presented in the table, the mean minimum LF distance from adjacent teeth in male patients was more than in female patients. This difference was statistically significant (P<0.001). The mean minimum LF distance from adjacent teeth was higher in patients whose LF was only on the right side than in patients with LF on the left or both sides, which was also statistically significant (P=0.007). The results presented in the table showed that the difference between the mean minimum LF distance from the adjacent tooth based on the closest tooth to the LF was not statistically significant (P=0.89)[3].

Mental foramen position and number are varied in terms of age, gender, and ethnicity, and even in a similar race in different geographical areas and habitats. The use of CBCT is more accurate than conventional two-dimensional radiographs such as intraoral and panoramic radiographs due to its higher resolution for detecting the location and size of the MF, AMF, and LF and elimination of possible distortion and overlap of the bony trabeculae in conventional radiographs. In one study reported that panoramic and periapical radiographs showed the true position of the mental foramen in <50% of identifiable cases in the skull. It was shown that that CBCT provides better observation of anatomical structures, including location, shape, and relationship with the surrounding area, than panoramic images. According to the results of the present study, the highest frequency of MF in women and men on both left and right sides was observed near the apex of the second premolars. The results showed no significant relationship between mental foramen position and gender.

Most studies in this regard also confirmed the results of this study previously. Consistent with the results of the present study, the most common location of the mental foramen in the Iranian population, studied by CBCT or panoramic views, was reported parallel to the second premolars. However, in other studies, the most common location was between the first and second premolars. Some studies have shown the highest frequency of the mental foramen position along the longitudinal axis of the second premolars In one study, the most common mental foramen position (82.4%) on both sides of the mandible in men and women was between the first and the second premolars. also It was showed that in 49.2% of men, the mental foramen was located along the longitudinal axis of the second premolars, and in 50.9% of women, the mental foramen was located between the first and second premolars. In studies some studies the most common sites of mental foramen were parallel to the second premolar while the most common location of mental foramen in other studies has been reported to be between the first and second premolars. Several investigators have reported that age and gender have no significant effect on the position of mental foramen. These results are a confirmation of the results of the present study. The differences observed in the present study with other studies might be due to differences in the method of visualization of the mental foramen or ethnicity differences in various studies. The mean of the largest size of MF in the horizontal dimension based on gender, the position of MF, and location did not show a statistically significant difference. In male patients, the maximum size of MF in the vertical dimension was significantly higher than in female patients, but based on the position and location of MF did not show a significant difference[4].

Also, the results of the present study showed that the mean distance of MF from the alveolar crest in male patients was significantly higher than in female patients. However, the difference between the mean distance of MF and the crest was not significantly different based on the position and side of MF. A study showed that the mean distance of MF from the alveolar crest on the right and left side was 22.58 and 22.11 mm, respectively. It has been speculated that by aging, the distance of MF from the crest of the mandible would change because of the bone remodeling, which can influence the flap design when surgery is needed in the region. However, we cannot find any association between age and MF distance from the alveolar crest. In the horizontal and vertical dimensions, the maximum dimension of MF in one study was larger in the horizontal dimension than in the present study but smaller in the vertical dimension than in the present study. In other studies, the mean of the maximum size of MF in the vertical and horizontal dimensions was smaller than the present study and reported a large difference from 1.8 to 5.5 mm in the size of these dimensions

The differences observed in other studies compared to the present study might be attributed to ethnic differences. Paying attention to ethnic differences and possible differences in mental foramen position in the Iranian population of this area will be useful in performing dental surgical procedures. The incidence of AMF was estimated to be 17% in the present study. The incidence was slightly higher in men than women, but the difference was not significant. According to the results of the present study, >50% of the cases with AMF were on the left side and 11.8% of the cases were on both sides. The frequency of AMF was reported to range from 1.4% to 14.3%, and in most studies, it has been reported <15%. In different studies, the prevalence of bilateral AMF had a range of 0.5–9.9%.Consistent with our results, another study showed that the prevalence of mental foramen is not statistically significant between men and women. Many studies have shown that the prevalence of AMF is higher in men, with some reporting higher rates in women. The prevalence of AMF in the present study was higher than in other studies. In some studies, the prevalence of AMF was 7%, 6.5%, 10%, and 9.4%. In various studies, unilateral AMF has been reported in 2.2–12% of cases. These differences in prevalence in studies can be attributed to different imaging instruments because panoramic radiography provides a straight view of the curved structure and is not as accurate as CBCT. However, the most important justification for these differences is ethnic differences. The results of the present study showed that the mean distance of the left AMF from the center of the MF was greater than in some other studies; in which this distance was almost similar to the results of the present study. reported that the distance of AMF from the center of the MF was 1.6–4.9 mm, with an average of 2.54 mm. This distance in other studies was from 4.5 to 9.6 mm, with an average of 6.3 mm and from 1.3 to 15.4 mm, with an average of 5.2 mm, respectively. Based on the results of the present study, the distance of AMF from the center of MF, the distance of AMF from the alveolar crest, and the minimum distance of AMF from the apex of the adjacent tooth based on the position and gender were not significantly different. According to one study, dental implants should be placed at least 6 mm away from the mental foramen. Therefore, in clinical conditions, such as implant placement and apical surgery, it is necessary to prescribe CBCT and visualize the location of the mental foramen and the accessory mental foramina. The prevalence of LF in the present study was 56%. The range of occurrence of LF due to different measurement strategies and definition has a wide range from 14% to 80%. Some researchers have reported a distinct lingual foramen in the anterior region of the mandible than the posterior site. In this research, we decided to determine the prevalence of lingual foramen in the posterior region of the mandible due to the analysis of the complexity of this region in apical surgeries. It is advised that the location of the MF, AMF, and LF should be clarified before surgery in this region. Although the prevalence of LF was higher in female patients than in males, this difference was not significant. The prevalence of unilateral LF was higher than bilateral, and in most unilateral cases, they were on the right side. In the study by Von Arx, the frequency of lingual foramina at the right mandibular first premolar area showed the highest frequency (27.5%) and Katakami reported that 39.7% of lingual foramina were on the right side of the mandible near the second premolar. The results of the present study showed no significant relationship between LF position and gender. Both the mean of LF distance from the alveolar crest and the LF distance from the tooth apex on the right were greater than that on the left side. The distance of LF from the alveolar crest was higher in male patients than in females; this difference was statistically significant, but the LF distance from the alveolar crest was not statistically significant based on the mandible side. Also, the results of the present study showed that the mean minimum LF distance from adjacent teeth in male patients was more than female patients and this difference was statistically significant but the mean minimum LF distance from the adjacent tooth based on the position and the nearest tooth was not statistically significant [5].

Conclusion

Overall, the prevalence of AMF in the present study was estimated at 17%. The prevalence of AMF was not different in men and women. More than 50% of the cases of mental foramen were on the left side, and 11.8% were bilateral. Gender had a significant effect on the mean of the maximum size of MF in the vertical dimension and the distance of MF from the alveolar crest. The prevalence of LF in the present study was 56%, which was lower in men than in female patients. Recognizing AMF by using CBCT is important to prevent complications that may occur during and after surgery.

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