Original Article

Radiographic Localization of the Mental Foramen and Mandibular Canal

Farzaneh Afkhami[1]✉, Afshin Haraji[2], Hamid Reza Boostani[3]

[1]Assistant Professor, Department of Endodontics, Faulty of Dentistry, Tehran University of Medical Sciences, International Campus, Tehran, Iran
[2]Associate Professor, Department of Oral and Maxillofacial Surgery, Faulty of Dentistry, Islamic Azad University of Medical Sciences, Tehran, Iran
[3]Private Practitioner, Periodontist, Tehran, Iran

Abstract

Objective: Accurately localizing the mental foramen and mandibular canal is important when administering local anesthesia and performing surgery; therefore, knowing the normal range of the possible locations is essential. Our purpose was to assess the location of the mental foramen and mandibular canal in an Iranian population using panoramic radiography.

Materials and Methods: Standard panoramic radiographies were performed. The positions of 100 mental foramens were evaluated. The distances from the center of the mental foramen to the superior and inferior borders of the mandible and to the apexes of the first and second premolar were measured. The distance of the mental foramens from the mandibular midline and the diameter of the mandibular canal in the mental foramen connection were also measured.

Results: Among 100 mental foramens, 6% were positioned under the first premolar, 24% were between the first and second premolars, 67% were under the second premolar, and the remaining 3% were behind the second premolar. The mean distance from the mental foramen to the mandibular midline was 27.77±3.20 mm. The mean diameter of the mandibular canal in the mental foramen connection was 3.09±0.69mm.

Conclusion: The mental foramen was near the second premolar and the inferior border of the mandible. This information can be used to perform safer mental nerve blocks in surgical interventions.

Key Words: Mandible; Panoramic Radiography; Mandible Radiography; Anatomical Landmarks; Mandibular Nerve

✉ Corresponding author:
F. Afkhami, Department of Endodontics, Tehran University of Medical Sciences, International Campus, Tehran, Iran

farzaneh_afkhami@yahoo.com

Received: 13 June 2013
Accepted: 2 August 2013

Journal of Dentistry, Tehran University of Medical Sciences, Tehran, Iran (2013; Vol 10, No.5)

INTRODUCTION

When administering regional anesthesia, performing periapical and dental implant surgeries, or implementing endodontic treatments in the mandible, it is important to localize the mental foramen to prevent injuries [1]. However, accurately localizing the mental foramen is typically difficult. Its position is generally described as being below the second premolar, but individual variation is common [2].

Although it is often possible to identify the mental foramen radiographically or by palpation, it is essential to have knowledge of the normal range of the possible locations [3,4]. Panoramic radiography is often used in dental practice because it provides an excellent view of the anatomical structures of the teeth, jaws, and temporomandibular joints [5-7]. Additionally, when performing local anesthesia and surgical procedures in the maxillofacial area, it is important to consider the locations of the supraorbital, infraorbital, and mental foramina neurovascular bundles. Understanding this anatomy helps prevent injuries to the neurovascular bundles [3].

Panoramic radiography generates a two-dimensional (2D) image that lacks information in the bucco-lingual direction and magnification in both the vertical and horizontal directions. Computed tomography (CT) provides more precise visualization of the anatomical structures in the oral region [8]. However, panoramic radiographs are more economical and easier to perform and interpret [9]. The image quality of panoramic radiography can be increased using digital panoramic radiography. In particular, visualization of the mental foramina can be further enhanced by evaluating digital panoramic radiographs with software programs.

Panoramic imaging is widely used to evaluate the jaws when planning implant surgeries and for other purposes, but previous studies have reported that the anatomical position of the foramen varies [10,11].

Additionally, the mental foramen may vary in position in different ethnic groups [4] and genders [12].

To date, no systemic or practical studies have been performed to evaluate the appearance and location of the anatomical landmarks of the mental foramen and mandibular canal in the Iranian population. Therefore, the aim of this study was to assess the location of the mental foramen and mandibular canal in an Iranian population using panoramic radiography.

MATERIALS AND METHODS

This cross sectional study was conducted at Mashhad Dental faculty. The patients' panoramic radiographs that were needed for different reasons were taken using Planmeca panoramic set (model PM 2002 CC). If they had our inclusion criteria, their radiographs were included in our study and if not, they were excluded. Standard panoramic radiographs of 18- to 40-year-old patients were reviewed by the radiology department. The exclusion criteria were unclear anatomical landmarks, a history of orthognathic surgery or mandibular orthodontic treatments, previous mandibular fracture, dental disorders, and severe mandibular growth retardation.

The anatomical landmarks included the mental foramen, the radiographic apex of the first and second premolar, the mesial and distal apexes of the first and second molar, the superior and inferior borders of the mandible, and the mandibular midline. The distances were measured between the two mental foramens, from the mental foramen to the midline on each side, and from the center of the mental foramen to the first and second premolar apexes and to the superior and inferior border of the mandible. The diameter of the mandibular canal in the mental foramen connection was measured. The mandibular canal diameter in the bisector of the angle between the inferior and posterior borders of the mandible was measured.

The distances between the mandibular canal and second premolar root apex, first molar mesial and distal root apexes, and second molar mesial and distal root apexes were measured. The distances between the mandibular canal and superior and inferior borders of the mandible was measured in rectangular lines beneath the second premolar root apex, mesial and distal root apexes of first and second molars (Fig 1).

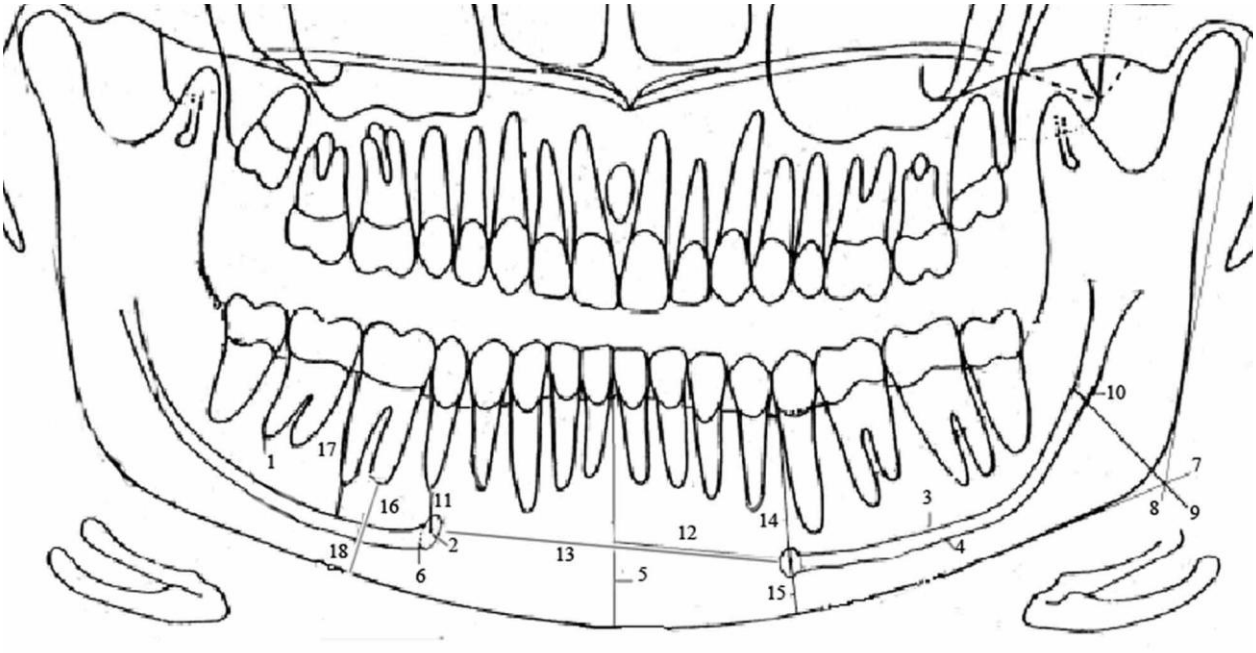

Fig 1. Anatomical landmarks: (1) apex of the distal root, (2) center of the mental foramen, (3,4) superior and inferior borders of the mandibular canal, (5) mandibular midline, (6) mandibular canal diameter in connection with the mental foramen, (7) a line along the inferior border of mandible, (8) a line along the posterior border of the ramus, (9) bisector between 7 and 8, (10) mandibular canal diameter in the mandibular angle, (11) distance between the mental foramen and the apex of the second premolar, (12) distance between the mental foramen and the mandibular midline, (13) distance between two mental foramens, (14) distance between the mental foramen and the superior border of the mandible, (15) distance between the mental foramen and the inferior border of the mandible, (16) distance from the sixth mesial root apex to the inferior border of the mandible, (17) distance from the seventh distal root apex to the superior border of the mandible, (18) distance from the mandibular canal to the inferior border of the mandible at the sixth mesial root apex

All measurements were performed by a standard caliper with 0.05 mm accuracy. The panoramic film magnification was also measured, which was 125% in the vertical dimension for all regions, and 131%, 128%, and 125%, in the horizontal dimension for the incisor, premolar, and molar regions, respectively. Finally, the true distances were estimated by considering these coefficients. The data were analyzed using SPSS software (version 11.2) using Student's t-test and analysis of variance (ANOVA) test. A P value < 0.05 was considered significant.

RESULTS

Among the patients, 64% were female and 36% were male. The mean age was 24.1 ± 5.9 (range: 18-40) years.

One hundred mental foramen positions were evaluated. 6% were positioned beneath the first premolar, 24% were between the first and second premolars, 67% were under the second premolar, and the remaining 3% were behind the second premolar. In 80% of the cases, both mental foramens of the mandible were located in similar positions. The results obtained were shown in Table 1 and 2.

DISCUSSION

Radiography is the only non-invasive method available to plan treatments involving the mandible. Panoramic radiographs are commonly used to screen, diagnose, and select the best possible surgical approach [13]. The location of the mental foramen can change during jaw development [2]. Therefore, the panoramic radiographs of adult patients who had completed their development, were evaluated in this study. Patients missing teeth were excluded from the study, and the evaluation was made according to the premolars and molars that were present.The mandibular canal is of particular importance to dentists and dental specialists because it carries both the dental division of the trigeminal nerve and the nerve supply for the lower lip. For example, dentists must perform inferior alveolar nerve block injections to provide local analgesia during many dental procedures [14]. Panoramic radiography can help locate the mental foramen, through which the nerve supply to the lower lip passes, and the mandibular canal during dental implantations [14]. Failure to protect the mental foramen may lead to permanent loss of normal sensation in the lower lip.

Panoramic radiographs were utilized because of certain advantages over intra-oral radiography.

They include a greater area of hard and soft tissues and the visualized area in continuity that allows for a more accurate localization of the mental foramen in both horizontal and vertical dimensions. The panoramic view is practical in clinical studies because it provides a more accurate picture of the mental foramen in two dimensions [15,16].

On the other hand, periapical radiographs may not show the position of the mental foramen if it is below the film edge [2]. Young adults were studied because during the mixed dentition, the mental foramen may be masked by permanent teeth roots [10]. This study showed that the mental foramen is easily distinguishable in panoramic films, although the increased bone density can make visualization more difficult [10].

Yossue and Brooks described these cases as an 'unidentified type' of mental foramen [16], and these cases were excluded from this study. These findings provide new data about the anatomical characteristics of the mental foramen in an Iranian population.

Table 1. Mean Distance from the Center of the Mental Foramen to Other Landmarks in Males and Females

Mental Foramen Measurements	Male (mm)	Female (mm)	Total (mm)	P Value
Mental foramen to the 1st premolar apex	8.18 ± 2.48	8.15 ± 2.06	8.16 ± 2.58	0.95
Mental foramen to the 2nd premolar apex	5.49 ± 2.67	5.53 ± 2.40	5.72 ± 2.53	0.23
Mental foramen to the mandible midline	28.21 ± 3.06	27.53 ± 3.27	27.77 ± 3.20	0.31
Between the two mental foramens	56.63 ± 4.74	54.80 ± 5.96	55.44 ± 5.61	0.12
Mental foramen to the superior border of the mandible	18.47 ± 2.23	17.44 ± 2.51	17.80 ± 2.45	0.04*
Mental foramen to the inferior border of the mandible	12.01 ± 2.49	10.02 ± 2.01	10.72 ± 2.37	0.00**

In most cases, both mental foramens of the mandible had similar positions. Previous studies in other countries have reported different findings regarding the position of the mental foramen.
In a Nigerian population, Olasoji et al. (2004) reported that the mental foramen was located between the first and second premolars in 34% of the cases and below the apex of the second molar in 24.5% of the cases [17].
In a Malay population, Ngeow and Yuzawati (2003) reported that the mental foramen was located under the second premolar in most cases and between the two premolars in 19.6% of the cases [10].
In Saudi Arabian populations, al Jasser and Nwoku reported that the mental foramen was located under the second premolar in 45.3% of the cases and between the two premolars in 42.7% of the cases [18], and al-Khateeb et al. reported that the mental foramen was located in front of the first premolar in 6.95%, between the two premolars in 83.7%, and behind the second premolar in 9.35% of the cases [19]. In an Indian population, Shankland reported that the mental fossa was located under the second premolar in 75.7% of the cases [20]. In this study, the mental foramen was located under the longitudinal axis of the second premolar in 67% and between the two

Table 2. Mean Vertical Distance from the Mandibular Canal to Other Landmarks in Males and Females

Mandibular Canal Measurements	Male (mm)	Female (mm)	Total (mm)	P Value
Diameter in the mental foramen connection	3.14 ± 0.65	3.06 ± 0,72	3.09 ± 0.69	0.56
Diameter in the mandibular angle	3.59 ± 0.53	3.48 ± 0.60	3.52 ± 0.57	0.35
Distance from the 2nd premolar root apex	4.45 ± 2.4	3.64 ± 2.22	3.93 ± 2.31	0.09
Distance from the first molar mesial root apex	6.57 ± 2.29	5.04 ± 2.49	5.56 ± 2.52	0.005
Distance from the the first molar distal root apex	6.06 ± 2.41	4.71 ± 2.53	5.17 ± 2.56	0.01
Distance from the second molar mesial root apex	4.42 ± 2.24	2.44 ± 1.84	3.12 ± 2.19	0.001
Distance from the second molar distal root apex	3.23 ± 2.39	1.91 ± 1.54	2.36 ± 1.96	0.002
Distance from the superior border of the mandible beneath the second premolar root apex	18.56 ± 2.79	16.95 ± 2.08	17.53 ± 2.47	0.002
Distance from the linferior border of the mandible beneath the second premolar root apex	7.47 ± 2.17	7.02 ± 2.05	7.18 ± 2.09	0.31
Distance from the superior border of the mandible in the first molar mesial root apex	19.86 ± 2.39	17.75 ± 2.02	18.53 ± 2.35	0.001
Distance from the inferior border of the mandible in the first molar mesial root apex	6.27 ± 1.99	5.59 ± 2.15	5.82 ± 2.11	0.04
Distance from the superior border of the mandible in the first molar distal root apex	18.70 ± 2.55	16.98 ± 2.06	17.57 ± 2.37	0.001
Distance from the inferior border of the mandible in the first molar distal root apex	6.05 ± 1.84	5.16 ± 1.62	5.47 ± 1.74	0.01

premolars in 24% of the cases.

The mental foramens had similar bilateral positions in 80% of the patients, while previous studies by Yosue and Brooks [16], al Jasser and Nwoku [18], and al-Khateeb et al. [19] reported similarities in 67%, 80%, and 84.4% of the cases, respectively. Differences in the bilateral positions of the mental foramen may occur if the mental foramen is funnel shaped in the buccal cortex of the mandible [15]. The mental canal passes from the posterior to the superior border of the mandible [14]. Variation in the position of the mental canal seems to be due to developmental disturbances of the mandible during the fetal period [21]. Additionally, the mental foramen position can change due to dental loss and aging. Green also reported that gender influences the position of the mental foramen [21]. Moreover, genetics is an important factor in the morphologic characteristics of dental structures [15]. The mean distance between the anterior border of the mental foramen and the mandibular midline was reported to be 28.06 mm by Wang et al. [22], and our measurement was 27.77 mm. For apical surgeries on the mandibular posterior region, it is important to know the location of the root apices in relationship to the mandibular canal [23]. Denio et al. [24] observed that the root apices of the mandibular second molar and the mandibular second premolar were closest to the mandibular canal, and the measured distances were 3.7 and 4.7 mm, respectively. The mesial root apex of the mandibular first molar was furthest from the canal (6.9 mm). Similar results were noted by Littner et al. [25]. In the present study, the distal root of the second molar was the closest (2.36 mm), and the mesial root of the first molar was the furthest (5.56 mm) root from the mandibular canal.

CONCLUSION

The mental foramen was near the second premolar and the inferior border of the mandible. This information can be used to perform safer mental nerve blocks during surgical interventions in periapical operations and to predict the probability of nerve damage in cases of overfills.

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