Panoramic Radiographic Assessment of Mental Foramen Position in Dental Hospital Patients, Naresuan University

Canin Rungkanawut, Nuttakit Laowattana, Kittithonsit Norasing,
Atikarn Rengpian and Weeraya Tantanapornkul*

Department of Oral Diagnosis, Faculty of Dentistry, Naresuan University, Phitsanulok, Thailand
* Corresponding author. E-mail address: weerayatan@yahoo.com

Abstract

Mental foramen is an important anatomical landmark in mandible. Injury to mental nerve may have a major impact on the patient's quality of life. Accurate identification of the mental foramen is important for diagnostic and treatment procedures. Mental foramen position is varied in different ethnic groups, which having different craniofacial structures. The objectives of the present study were to evaluate the most common position of mental foramen in dental hospital patients, Naresuan University and compare the results with those reported for other populations. Four hundred and sixty-nine digital panoramic radiographs which were selected by using specific criteria and assessed for horizontal and vertical positions of mental foramen. Appropriate descriptive statistics were computed. Statistical significance is defined as $p < 0.05$. The subjects in the present study composed of 153 males and 316 females with mean age of 21.97± 5.54 and 21.52 ± 6.67 years, respectively. The most common horizontal position was found significantly in line with second premolar (50.53%). The most common vertical position was found significantly apical to the apex of dental root (73.46%). The mental foramen was symmetrical in 77.19 and 87.85 percent of patients for horizontal and vertical locations, respectively. According to the present study, the position of mental foramen in a group of Thai population was most commonly in the long axis of second premolar, consistent with previous reported in other ethnic and racial groups. In most cases there was bilateral symmetry in both horizontal and vertical positions.

Keywords: mental foramen, panoramic radiograph, Thai

Introduction

Mental foramen is an important anatomical landmark in mandible. It is the termination of mandibular canal and strongly related to surgical procedures in maxillofacial regions. It transmits the mental nerve, artery and vein, which supplies sensation to the important structures such as soft tissues of the chin, lower lip and gingiva (Ilayperuma, Nanayakkara, & Palahepitiya, 2009). The knowledge of mental foramen position is important in clinical dentistry when administering local or regional anesthesia, orthodontic tooth movement / orthognathic surgery, performing periapical surgery and implant placement in the mental area (Verma et al., 2015). Injury to mental nerve may have a major impact on the patient's quality of life. There are reports about trauma to mental nerve as a result of improper preoperative assessment, which would result in altered sensation from 8.5% to 24% following implant surgeries (Massey, Galil, & Wilson, 2013; Greenstein & Tarnow, 2008). Accurate identification of the mental foramen is important for diagnostic and treatment procedures (Gada & Nagda, 2014). Its position is generally described as being below second premolar (Afkhami, Haraji, & Boostani, 2013). Panoramic radiography provides the good view of the anatomical structures of the teeth, jaws, and surrounding structures such as temporomandibular joints (Jacobs, Mraiwa, Van Steenberghe, Sanderink, & Quirynen, 2004). It generates a two-dimensional image that lacks information in bucco-lingual direction and magnification in both vertical and horizontal directions. Advance imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), cone beam computed tomography (CBCT)

provide three-dimensional image of the maxillofacial regions (Bou Serhal, Jacobs, Flygare, Quirynen, & van Steenberghe, 2002). However, panoramic radiographs are more economical and easier to perform and evaluate (Thanyakarn, Hansen, & Rohlin, 1992). Visualization of mental foramen on panoramic radiograph can be enhanced by evaluating digital panoramic radiographs with software programs (Afkhami et al., 2013).

Mental foramen position is varied in different ethnic groups, which having different craniofacial structures. Previous studies showed the difference in the position, orientation, size, and shape of mental foramen in different ethnics (Ilayperuma et al., 2009; Sankar, Bhanu, & Susan, 2011; Haghanifar & Rokouei, 2009; Chkoura & El Wady, 2013; Al Jasser & Nwoku, 1998). In Thai population, there was a study by Apinhasmit, Methathrathip, Chompoopong, and Sangvichien (2006) They assessed dry skulls of Thai population to determine the size, orientation and the location of mental foramen related to gender and side. However, the number of subjects (sixty-nine adult mandibles) in their study may not enough to use as reference data of Thais. The aim of the present study was to determine the position of mental foramen in horizontal as well as vertical planes on digital panoramic radiographs in a group of Thai population. The results of present study were compared with those reported for other populations.

Material and methods

The present study was conducted in accordance with the Declaration of Helsinki (http://www.wma.net) and that all procedures were carried out with the adequate understanding and written consent of the subjects. The formal approval to perform this study has been obtained from our institution's human subjects review board.

Subjects: All subjects were Thai population coming to Oral Diagnosis and Oral Medicine clinic, dental hospital, Naresuan University from March 2015 to February 2017. Patients requiring digital panoramic radiography for the purposes of impacted tooth determination, pre-orthodontic treatment, etc.

Panoramic radiographs: Panoramic radiographs were taken on a Kodak 9000c Digital Panoramic and Cephalometric System (Carestream Health Inc., Rochester, NY, USA).

Inclusion criteria of panoramic radiograph (Gupta, Pitti, & Sholapurkar, 2015):

1. Presence of mandibular teeth between right first molar and left first molar
2. Appropriate radiographic density and contrast
3. Clearly distinguishable mental foramen on left and right side
4. Normal position of first and second premolars

Exclusion criteria of panoramic radiograph (Gupta et al., 2015):

1. Severe crowding and spacing of lower teeth
2. Presence of radiolucent lesion in the area from right first molar to left first molar
3. Patients undergoing / already underwent orthodontic treatment
4. Fracture line involving parasymphyseal area
5. Undetectable of mental foramen on left or right side of mandible

Determination of mental foramen position: Horizontal and vertical positions of mental foramen were evaluated on panoramic radiographs.

Horizontal position of mental foramen was determined as follows (Figure1)

(Modified from Al Jasser & Nwoku, 1998):

Position 1: Anterior to first premolar

Position 2: In line with first premolar

Position 3: Between first and second premolar

Position 4: In line with second premolar

Position 5: Between second premolar and first molar

Position 6: In line with first molar

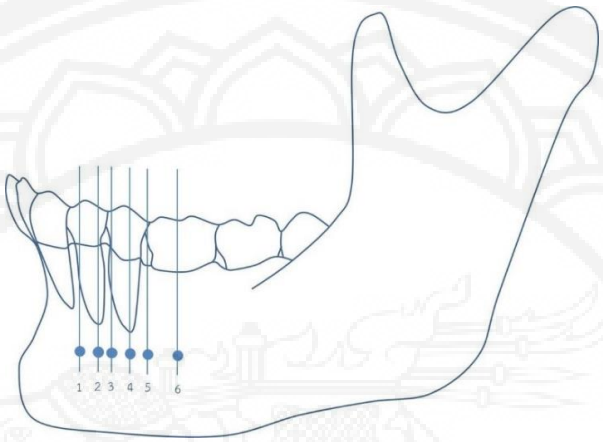

Figure 1 Horizontal position of mental foramen (1: anterior to first premolar, 2: in line with first premolar, 3: between first and second premolar, 4: in line with second premolar, 5: between second premolar and first molar, 6: in line with first molar)

Vertical position of mental foramen was determined as follows (Figure 2) (Modified from Green, 1987):

Position 1: Superior to root apices of the adjacent teeth (the lowermost point of mental foramen is superior to root apices of adjacent teeth at least 1 millimeter)

Position 2: At or in line with root apices of the adjacent teeth (Mental foramen located between the upper and lower line)

Position 3: Inferior to root apices of the adjacent teeth (the uppermost point of mental foramen is inferior to root apices of adjacent teeth at least 1 millimeter)

The closest teeth was considered as the adjacent teeth

Digital images were viewed as original image or image processing were performed for better visibility. The average root length was evaluated to determine vertical position of mental foramen in case the adjacent teeth had obviously different root length. In case there appeared to be multiple foramina, the uppermost and nearest mandibular canal was considered to be true radiographic mental foramen (Yosue & Brooks, 1989).

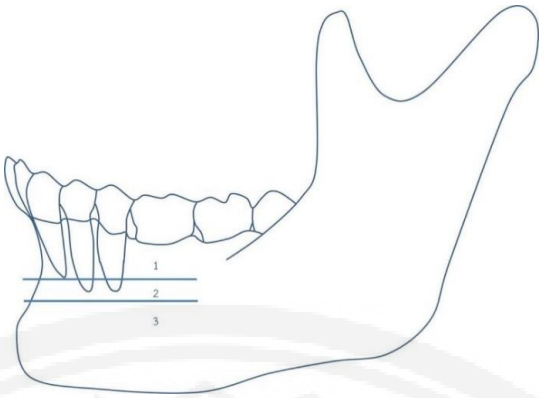

Figure 2 Vertical position of mental foramen (1: superior to root apices of the adjacent teeth, 2: at or in line with root apices of the adjacent teeth, 3: inferior to root apices of the adjacent teeth)

All of the digital radiographs are viewed on the 21 inches LCD monitor, with resolution of 1600x1200 pixels (Dell LCD monitor, Dell Optiplex 990, Dell Inc., Penang, Malaysia). The assessment is performed by one oral and maxillofacial radiologist. With an interval of two months, 100 randomly chosen panoramic radiographs are graded and re-scored for testing intra- observer agreement.

Statistical analysis: Appropriate descriptive statistics were computed. Cohen's kappa test is performed to calculate the intra-observer agreement. All the data are analyzed using the SPSS software package (SPSS for Windows, version 17.0, Chicago, IL, USA). Statistical significance is defined as $p < 0.05$.

Results

The intra-observer agreement of the present study was 98.7 percent, which means excellent agreement. Panoramic radiographs of 469 from 1,530 patients were analyzed. Of these, 153 (32.62%) were males and 316 (67.38%) were females, age ranged from 12-63 years (mean, 21.97± 5.54 and 21.52 ± 6.67 years, respectively). The most common horizontal position of mental foramen was in line with second premolar (50.53%) followed by in between first and second premolar (40.09%) (Table 1).

Table 1 Frequency of horizontal position of mental foramen

Position	Male		Female		Total
	Left	Right	Left	Right	(%)
1	0	0	1	0	1 (0.21)
2	0	0	0	1	1 (0.21)
3	56	49	138	133	376 (40.09)
4	73	78	156	167	474 (50.53) *
5	24	25	21	15	85 (8.75)
6	0	1	0	0	1 (0.21)
Total	153	153	316	316	938 (100)

* $p < 0.05$

Position 1: anterior to first premolar, 2: in line with first premolar, 3: between first and second premolar, 4: in line with second premolar, 5: between second premolar and first molar, 6: in line with first molar

In vertical position, the highest percentage of mental foramen was found to be located inferior to root apices of the adjacent teeth (73.46%) followed by the position at or in line with root apices of the adjacent teeth (Table 2).

Table 2 Frequency of vertical position of mental foramen

Position	Male		Female		Total
	Left	Right	Left	Right	(%)
1	0	0	1	1	2 (0.21)
2	35	35	92	85	247 (26.33)
3	118	118	223	230	689 (73.46)
*					
Total	153	153	316	316	938 (100)

* $p < 0.05$

Position 1: superior to root apices of the adjacent teeth, 2: at or in line with root apices of the adjacent teeth, 3: inferior to root apices of the adjacent teeth

The horizontal position of mental foramen was symmetrical in 77.19% (362 out of 469) of the cases (Table 3). For the vertical position, it was symmetrical in 87.85% (412 out of 469) of cases (Table 4). In addition, the same pattern of mental foramen distribution was found both males and females.

Table 3 Distribution of symmetric horizontal position of mental foramen

Position	Number (%)
1 (anterior to first premolar)	0
2 (in line with first premolar)	0
3 (between first and second premolar)	149 (41.16)
4 (in line with second premolar)	185 (51.10)
5 (between second premolar and first molar)	28 (7.74)
6 (in line with first molar)	0
Total	362 (100)

Table 4 Distribution of symmetric vertical position of mental foramen

Position	Number (%)
1 (superior to root apices of the adjacent teeth)	1 (0.24)
2 (at or in line with root apices of the adjacent teeth)	95 (23.06)
3 (inferior to root apices of the adjacent teeth)	316 (76.70) *
Total	412 (100)

* $p < 0.05$

Discussion

The knowledge of mental foramen position is important for dental professional, both diagnostic and clinical procedures, such as local anesthesia injection, surgical procedures, avoid damage of bone graft, or dental implant treatment plan. It is also useful in interpreting anatomical landmarks in oral pathology and forensics (Neo, 1989). Of the 469 panoramic radiographs in the present study, we found that the most common horizontal position of mental foramen was in line with second premolar (50.53%) followed by in between

first and second premolar (40.09%). Our result was in accordance with Afkhami et al. (2013) and Sankar et al. (2011), even though the different methods of evaluation. They assessed mental foramen position in dry mandibles of a group of Indian population. Their study result, however, was not in accordance with Gupta et al. (Gupta et al., 2015). They analyzed the location of mental foramen on panoramic radiographs of south Indian population and reported that the most frequent horizontal location of mental foramen was between at first and second premolar. The reason of different results even though studied in the same country may be the different methods of evaluation. Chkoura and El Wady (2013) determined the position of mental foramen on panoramic radiographs in a 377 Moroccan population. They concluded that the most common position of mental foramen was in line with second premolar (62.7%). There also have been reports about the position of mental foramen in various populations and ethnics (Ilayperuma et al., 2009; Haghanifar & Rokouei, 2009; Al Jasser & Nwoku, 1998). The results of their studies were either similar or different from ours. The possible reasons for different results between previous studies and ours including the position of the head, the shape of dental arch, tooth position, the use and location of a bite block, and the type of panoramic equipment. To our knowledge, there was a few reports about radiographic vertical position of mental foramen. We found that the position inferior to root apices of the adjacent teeth was most common, which was in agreement with Parnami et al. (2015).

In the present study, we analyzed the position of mental foramen in patients with permanent dentition because in mixed dentition permanent tooth buds obscure the mental foramen. Position of mental foramen was also influenced by the age of the patients. However, we could not classify the position of mental foramen according to the age range because the number of patient in each age range was inequitable. We assessed position of mental foramen on panoramic radiograph because it is screening purpose and commonly used for dental treatment plan. In addition, panoramic radiograph provided the large field of view compared with periapical radiograph, which do not display the position of mental foramen in case that it is below the film edge (Gupta, 2008). Visualization of mental foramen on panoramic radiograph can be enhanced by evaluating digital panoramic radiographs with software programs (Afkhami et al., 2013). Peker, Gungor, Semiz, and Tekdemir (2009) demonstrated that diagnostic performance of conventional and digital panoramic images seems to be equal for the localization of mental and mandibular foramens. The vertical radiographic measurements are generally reliable and correlated with direct measurements in mandible for conventional and digital panoramic radiography.

Three-dimensional imaging modality such as CBCT determines the accurate position of mental foramen. However, it has disadvantages such as radiation dose and cost. For the reason of socioeconomic status of the population in developing countries such as Thailand, panoramic radiograph is the most appropriate modality in the evaluation of entire body of mandible. It allows a more accurate position of mental foramen in both horizontal and vertical dimension (Verma et al., 2015). In addition, a study on dry skulls has shown a close relation with the radiographic position of mental foramen (Yosue & Brooks, 1989). It may be possible that the shift in the actual posteroanterior position of the mental foramen in panoramic radiograph is not significant (Al Jasser & Nwoku, 1998). However, the errors from patient position should be considered one of the factors that effected the normal anatomy appearance on panoramic radiograph.

Conclusion

The most common radiographic position of mental foramen in a group of Thai population was in line with second premolar horizontally, and inferior to root apices of the adjacent teeth vertically. These may be used as reference data of Thais, which were either similar or different from previous studies in various populations.

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