



# The position of the mental foramen towards the alveolar crest using digital panoramic radiographs

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## ABSTRACT

**Objectives:** The rate of mandibular anesthesia failures is higher than maxilla, where the highest percentage is the inferior alveolar nerve block. One alternative action in case of failure is a mental nerve block, located in the mental foramen. Thus, knowledge of the mental foramen anatomy is required to avoid failure in anesthesia. The study is to determine the vertical and horizontal position of the mental foramen, which refers to the crest of the alveolar bone, using panoramic radiographs.

**Materials and Methods:** The type of research that is used is descriptive with a purposive sampling method. The object of research is panoramic radiographs of patients who are in Dentistry Radiology Installation of Dental Hospital Universitas Padjadjaran, Bandung with a total sample of 352

panoramic radiographs. This research measured the vertical and horizontal distances between the mental foramen to the alveolar bone crest between 1st premolar teeth and 2nd premolar teeth.

**Results:** The average value of the vertical distance mental foramen to the alveolar bone crest is 13,43 mm. The average value of the horizontal distance from mental foramen to 1st premolar teeth is 6,97 mm and the horizontal distance from mental foramen to 2nd premolar teeth is 2,80 mm.

**Conclusion:** Mental foramen is closer to the 2nd premolar teeth based on the horizontal position and located below the apex based on the vertical position.

**Keywords:** Mental foramen, alveolar crest, panoramic radiograph, premolar teeth

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## INTRODUCTION

Mandibular anesthesia has a higher failure rate than maxillary anesthesia, where the most common cause of failure is mental nerve block.<sup>1</sup> Anesthesia failure can result in complications such as trismus and hematoma, both of which are uncomfortable for the patient.<sup>2,3</sup> Other than anesthesia, the surgical process in the mandibular region, namely chinplasty involving the mental foramen, has the highest failure rate.<sup>4</sup> It's important to understand the anatomy of the mandibular area, for example, to prevent damage to the neurovascular tissue that passes through the mental foramen.<sup>5</sup>

Measurement of the distance between the mental foramen and the inferior body of the mandible based on age, ethnicity, and gender has been done in several studies in different countries.<sup>6,7</sup> According to American research, the mental foramen on a panoramic radiograph was 28 mm from the mandibular midline and 14-15 mm from the inferior body of the jaw.<sup>7</sup> A research on the position of the mental foramen as observed from vertical and horizontal distances in India by age and gender was published in 2015.<sup>7,8</sup> According to research conducted in India, when viewed from a

horizontal plane, 61 % of mental foramen were parallel to the line of the second premolar, while 72.2 % were positioned inferior to the apex of the second premolar when viewed from a vertical plane.<sup>3,8</sup>

A previous study in Makassar, South Sulawesi, the location of the mental foramen was measured vertically and horizontally as a reference for measuring at the apex of the 1st or 2nd premolar alone, and the research was carried out qualitatively.<sup>9</sup> Clinically, determining the position of a tooth's apex is challenging.<sup>10,11</sup> Given the difficulty of determining the tooth apex, it is hoped that this study, which uses the crest of the alveolar bone, which is not far from the CEJ, will make it easier to apply.<sup>9,12</sup>

The author is interested in using panoramic radiographs to describe the position of the mental foramen to the crest of the alveolar bone between the first and second premolars. Thus, this research aimed to use a panoramic radiograph to determine the vertical and horizontal position of the mental foramen, which refers to the distance to the crest of the alveolar bone as the main guide.



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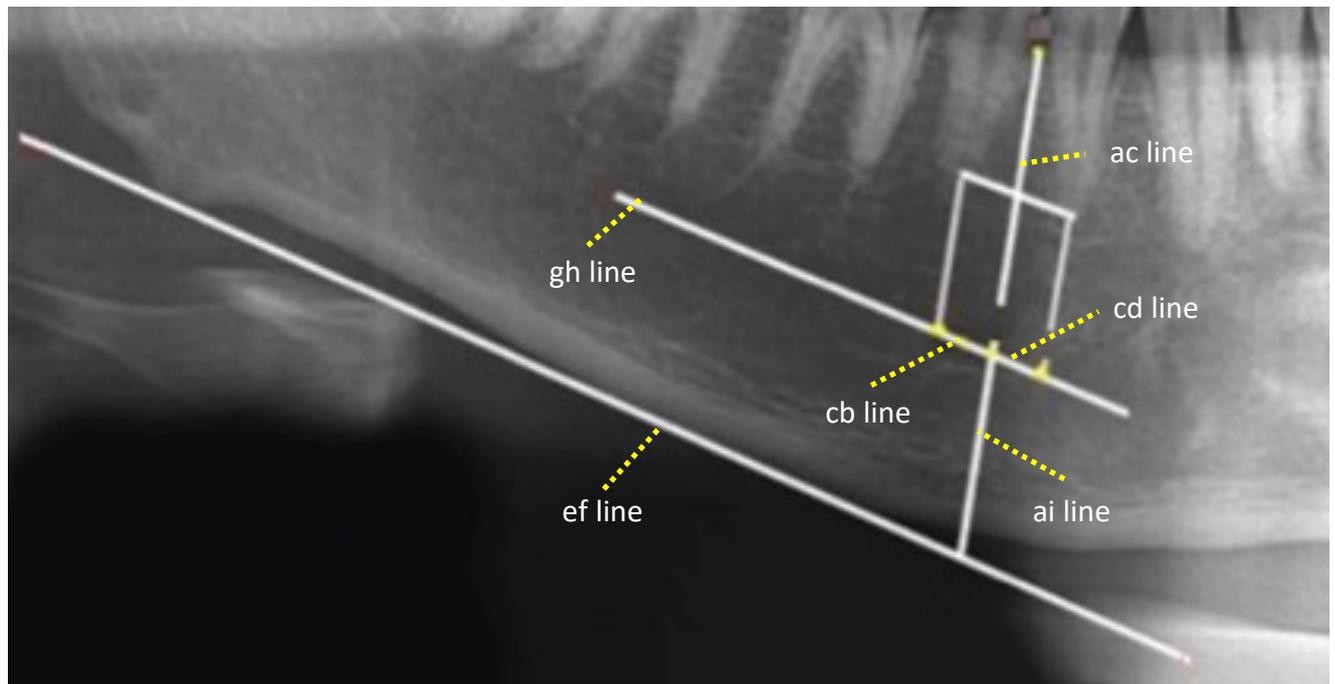
## MATERIALS AND METHODS

The research method used was descriptive research. After receiving permission from the Health Research Ethics Committee Faculty of Medicine Universitas Padjadjaran (KEPK FK Unpad), the research was conducted at Rumah Sakit Gigi dan Mulut Universitas Padjadjaran, Bandung. The population of this study is all secondary data from digital panoramic radiographs taken at the Dental Radiology Installation of the Rumah Sakit Gigi dan Mulut Universitas Padjadjaran, Bandung from July to September 2016.

A purposive sampling method was used to select the sample. The case group had to meet the following criteria: (1) panoramic radiographs of patients aged 20 to 40 years, (2) good quality and clear panoramic radiographs, and (3) a clearly visible mental foramen. The exclusion criteria were: (1) Superimposed appearance with periapical

lesion, (2) Panoramic radiograph with a fractured jaw, and (3) Decreased alveolar crest. A total of 352 pieces of panoramic radiographic data were selected from a total of 600 populations based on the above criteria.

The study assessment was completed by a single person who had calibrated the assessment with a dental radiology specialist previously. Using the EZ-Plux software, this study was conducted by first selecting the toolbar menu, then pulling the horizontal line of the inferior mandibular margin drawn from the outermost point of the inferior mandibular margin to the angle of the mandible (ef line), and finally pulling the vertical line of the alveolar bone crest to the horizontal line of the inferior mandibular margin (ai line), draw a vertical line from the apex of the teeth P1 and P2 to the inferior margin of the mandible, then use 3 points from each outermost point of the mental foramen shape to determine the center of the mental



**Figure 1.** Vertical and horizontal distance measurements of mental foramen in panoramic radiography

**Table 1.** Sample characteristics

| GENDER       | N          | %             |
|--------------|------------|---------------|
| Male         | 159        | 45,17         |
| Female       | 193        | 54,83         |
| <b>TOTAL</b> | <b>352</b> | <b>100,00</b> |

**Table 2.** The results of measurements made from the mental foramen to the alveolar bone crest

| SEX                       | VERTICAL WIDTH (MM)             |               |       | HORIZONTAL WIDTH (MM) |               |      |                     |               |      |
|---------------------------|---------------------------------|---------------|-------|-----------------------|---------------|------|---------------------|---------------|------|
|                           | Alveolar Crest – Mental Foramen |               |       | P1 – Mental Foramen   |               |      | P2 – Mental Foramen |               |      |
|                           | Minimal Value                   | Maximum Value | Mean  | Minimal Value         | Maximum Value | Mean | Minimal Value       | Maximum Value | Mean |
| MALE                      | 10,3                            | 17,5          | 13,76 | 0                     | 10,7          | 7,08 | 0                   | 8,7           | 2,95 |
| FEMALE                    | 10                              | 16,6          | 13,16 | 0                     | 10            | 6,82 | 0                   | 8,4           | 2,68 |
| <b>STANDARD DEVIATION</b> |                                 | 1,91          |       |                       | 2,25          |      |                     | 1,74          |      |
| <b>MEAN</b>               |                                 | 13,43         |       |                       | 6,97          |      |                     | 2,80          |      |

foramen, then make an incision to reveal the center of the mental foramen. Draw a horizontal line through the center of the mental foramen that is parallel to the horizontal line of the inferior margin of the mandible (gh line), then measure the vertical distance from the crest of the alveolar bone to the point of intersection (ac line) in mm, the horizontal distance to tooth P1 (cd line) and the horizontal distance to P2 (cb line) in mm. Only the right side of the body of mandible was measured in this study.

For the final descriptive results, mean and standard deviation score were calculated between male and female patients and all data.

## RESULTS

The study's findings were in the form of sample data that measured the horizontal and vertical distances between the mental foramen and the crest of the alveolar bone. This study was conducted to show the final result of measurement of the mental foramen distance in a descriptive manner. Any statistical tests were not used and applied in the study.

Table 1 shows the sample characteristics: of the study. There were 352 panoramic radiographs of patients in the Dental Radiology Installation of University Padjadjaran Dental Hospital, containing 159 male patients aged 20-40 years with a percentage of 45.17 %, and 193 female patients aged 20-40 years with a percentage of 54.83 %.

Table 2 shows that the average vertical distance of the mental foramen to the alveolar bone crest

between P1 and P2 is 13.43 mm, and the average horizontal distance of the mental foramen to P1 is 6.97 mm and to P2 is 2.80 mm. Table 2 shows that the vertical distance between the alveolar crest and the foramen has a minimum value of 10 mm and a maximum value of 17.5 mm. The minimum value of the horizontal distance of the mental foramen to P1 and P2 is 0 mm, and the maximum value of the horizontal distance of the mental foramen to P1 is 10.7 mm, whereas the horizontal distance between the mental foramen and P2 is 8.7 mm. Table 2 shows that the average vertical distance between the mental foramen and the alveolar bone crest is 13.76 mm in males and 13.16 mm in females. The vertical distance between the mental foramen and the alveolar bone crest is 10.3 mm in males and 10 mm in females, with a maximum of 17.5 mm in males and 16.6 mm in females.

Table 2 also shows the average horizontal distance of the mental foramen to P1 and P2. The average horizontal distance between the mental foramen and P1 in males is 7.08 mm, whereas it is 6.82 mm in females. The average horizontal distance between the mental foramen and P2 in males is 2.95 mm, whereas it is 2.68 mm in females. According to the data, the minimum horizontal distance between the mental foramen and P1, P2 in males and females is 0 mm, whereas the maximum horizontal distance between the mental foramen and P1 in males is 10.07 mm and 10 mm in females. Males have a maximum horizontal distance between the mental foramen and P2 of 8.7 mm, whereas females have a maximum distance of 8.4 mm.

## DISCUSSION

In summary, the sample characteristics showed that there were 352 panoramic radiographs taken between July and September 2016. A total of 159 panoramic radiograph samples of male patients were obtained, with a lower number of male patients than female patients. This study took place between the ages of 20 and 40, which corresponds to Sperber's theory<sup>13</sup> that the speed of growth in the condyle increases during puberty, peaks between the ages of 12 and 14, and normal development and growth of the mandible ceases at the age of 20, so the condition of the mandible is stable between the ages of 20 and 40.<sup>11</sup>

According to the findings of the study, the average value of the vertical and horizontal distances of the mental foramen, which corresponds to the crest of the alveolar bone, is obtained. The average vertical distance of the mental foramen measured from the alveolar bone crest is 13.14 mm. A previous study conducted in Makassar by Matheson et al in 2006 reported that the average distance between the mental foramen and the second premolar CEJ was 15 mm on the vertical axis.<sup>7,11</sup> The usual difference between the CEJ and the alveolar bone is 2 mm, the average vertical distance values found in Matheson et al research and this study are similar. This could be due to the relationship between the location of the mental foramen and intraoral anatomical landmarks, as the majority of the mental foramen are found near the apex of the mandibular second premolar.<sup>11</sup> The position of the mental foramen is also affected by age, with the position of the mental foramen moving inferiorly in adults with erupted permanent teeth.<sup>14</sup>

The mental foramen's average horizontal distance to P1 is 6.97 mm, and the mental foramen's average horizontal distance to P2 is 2.80 mm. This shows that the average horizontal distance for the mental foramen is closer to the P2 than the P1, with an average value of 2.80 mm compared to 6.97 mm for the P1, almost three times larger. The horizontal distance between the mental foramen and P1 was on average greater than the horizontal distance between the mental foramen and P2. The findings of this study support several theories, including those proposed by Warwick, Giblisco, and Cek Dara Manja, who stated that the position of the mental foramen in the horizontal plane will shift posteriorly as the mandible grows and develops, which is usually close to the P2.<sup>14</sup> The findings of this study agree with those of a previous study conducted by Jason in India in 2015, which found that 61 % of mental foramen cases were located below the apex of the second premolar, indicating that the mental foramen was located closer to the P2.<sup>8</sup> The results of this study are also consistent with those of Matheson et al, who found that 52.8 % of the mental foramen are located near the apex of the mandibular second premolars, with the rest located between the first and second premolars.<sup>6,11</sup> Previous research by Oguz et al found that the

mental foramen was located near the second premolars in most of the 34 mandibles of Turkish adults, and only 7 mandibles of Turkish adults had the mental foramen below the apex of the first premolars.<sup>14,15</sup>

The mandibular body which is becoming increasingly elongated in the horizontal direction, has an impact on the position of the mental foramen.<sup>11</sup> The mandibular ramus grows posterior to the mandibular body, causing the mandibular body to lengthen and change the position of the mental foramen in relation to the teeth above. The mental foramen will become more backward as it develops.<sup>13</sup>

The development of the mental foramen in the mandible begins with the development of the mandibular ramus, which is located posterior to the mandible's body. This causes the mandibular body to lengthen, preparing it for the eruption of the permanent molars.<sup>9,11,16</sup> When viewed against the overlying teeth, the elongation of the mandible's body will change the position of the mental foramen. As the mental foramen develops, it will become more posteriorly located. The elongation of the mandibular body, followed by the nerves and blood vessels in the mandibular foramen, causes this change.<sup>9,11</sup> According to age, the vertical distance between the alveolar bone crest and the lower end of the mandibular body varies.<sup>7,11</sup>

The difference in average values between males and females is not significant, but males average values are slightly higher than females, at 13.76 mm and 13.16 mm, respectively. This is in line with the theory that there isn't much of a difference in the position of the mental foramen when viewed by gender; if there is, it's because the processes of growth and development in males and females are slightly different, with males facial growth and development being slightly larger in the vertical direction than females.<sup>17,18</sup>

Males have a vertical distance of 10.3 mm, while females have a vertical distance of 10. Males have a maximum vertical distance of 17.5 millimeters, while females have a maximum vertical distance of 13.16 millimeters. This demonstrates that there are many variations in the growth and development of the mandible in general, so the minimum and maximum values in this study were determined. Even though each individual's jaw is wide or narrow in the horizontal direction and high or short in the vertical direction, the position of the mental foramen follows the growth and development of the teeth.<sup>19</sup>

The study's findings revealed that there was no significant difference between males and females in the average horizontal distance between the mental foramen and the premolars. The average horizontal distance between the mental foramen and P1 in males is 7.08 mm and 6.82 mm in females, while the distance between mental foramen and P2 is 2.95 mm in males and 2.68 mm in females. The mean values for P1 in males are slightly higher than in females in the horizontal distance, while the mean values for P2 in males and females are remarkably similar. In both males and

females, the horizontal distance between the mental foramen and the P1 and P2 was 0 mm. This indicates that in both males and females, the mental foramen is located at the apex of P1 or P2. Males have a maximum horizontal distance to the P1 of 10.07 mm, while females have a maximum horizontal distance of 10 mm, and males have a maximum horizontal distance to the P2 of 8.7 mm, while females have a maximum horizontal distance of 8.4 mm.

The growth of the mandible's body and ramus, modification of mandibular symphysis and condyles, alveolar processes and teeth, and expansion of the alveolar nerves and blood vessels all influence the position of the mental foramen. The wider mandibular arch and craniofacial type, the wider face shape and larger tooth volume, the more posteriorly the mental foramen develops.<sup>19</sup> Males and females have slightly different mandible growth and development. Males have more vertical and horizontal growth and development than females, but the effect on the position of the mental foramen on the teeth is the same in both genders.

Alveolar bone is a component of the jawbone that forms the tooth socket in both the upper and lower jaws. When teeth erupt, alveolar bone is formed to provide attachment to the alveolar bone and form the periodontal ligament. When a tooth emerges, alveolar bone develops simultaneously, then gradually resorbs if the tooth is lost. It appears as a thin layer of radiopaque cortical bone in the area surrounding the tooth on radiographs.

The mental foramen can be seen on a panoramic radiograph. Panoramic radiography is an extraoral radiographic technique that allows the maxilla and mandible, as well as adjacent anatomical structures, to be seen on a single film.<sup>20,21</sup> Panoramic radiographs have been used in numerous studies to determine the location of the mental foramen.<sup>3</sup>

This is the first study at FKG Unpad to use panoramic radiographs to determine the average value of the vertical and horizontal distance of the mental foramen, which refers to the crest of the alveolar bone. As a result, this study has flaws, such as the quality of the panoramic radiographs not being consistent because they were taken by different operators, but they are still of good quality. Panoramic radiographs, on the other hand, only produce two-dimensional images. This study is expected to serve as a fundamental basis for further research into the position of the mental foramen in relation to the alveolar bone crest using advanced radiographic modalities.

## CONCLUSION

According to the findings, the mental foramen is located closer to the second premolars when viewed horizontally and below the apex of the tooth when viewed vertically.

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## FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This research was registered and approved by Research Ethics Committee Faculty of Medicine Universitas Padjadjaran with the registration number of 0718060916. All procedures conducted were in accordance with the ethical standards.

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