Identification of Mandibular Foramen Position Based on Age of RSGM UMY Patients Using Panoramic Radiographs

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Abstract. Mandibular foramen (MF) is the main target of inferior alveolar nerve block (IANB) because it is the place of the inferior alveolar nerve transmission. The MF position can be different between each person due to the growth of the mandible with age. Therefore, it is necessary to identify the MF position based on age to ensure the success of IANB which has 15–20% of failure rate. The purpose of this study was to identify the MF position seen from the age of population in RSGM UMY using panoramic radio-graphy. A total of 330 panoramic radiographs of RSGM UMY's patients aged 10–29 years were selected and categorized based on the age of mandibular development. The identification was carried out vertically (seen from the height of the occlusal plane) using Corel Draw. Data were distributed based on the MF position to the occlusal plane into 3 groups (Position 1: above the occlusal plane, Position 2: parallel to the occlusal plane, Position 3: below the occlusal plane) and were analyzed using descriptive statistical methods. The highest percentage of MF position in each age group was found in Position 3 on both sides of the mandibular canal. The movement of the MF in the remodelling phase is in anterior-posterior direction, so, there is no difference in the MF position based on age. This hopefully can assist in determining the direction of the needle insertion in IANB.

Keywords: Age · Foramen · Mandibula · Panoramic

I. Permana and E. Rochmawati (Eds.): ICOSI-HSN 2022, 55, pp. 316–323, 2022.
https://doi.org/10.2991/978-94-6463-070-1_38

1 Background

The mandibular foramen is an irregularly-shaped foramen located on the medial surface of the upper center of the mandibular ramus [1]. This structure is the entry point for the inferior alveolar nerve, which is the main target in performing the mandibular block anaesthetic technique [2]. Dentists often use the mandibular block anaesthetic technique, especially when they want to perform a mandibular tooth extraction [3]. Although it is one of the most commonly used anaesthetic techniques, it has a failure rate of 15-20% even though it has been performed properly by experienced doctors [4]. One of which is an error made by the operator, such as inserting the anaesthetic needle in wrong injection point [5].

Failure of anesthesia can cause harm to the patients. For example, it can reduce patient's co-operation and can lead to the risk of overdosing, especially in pediatric patients [6]. Other disadvantages such as temporary facial paralysis and trismus can also occur if the injection point is not correct [7]. Thus, it is essential for dentists to identify the exact injection point to successfully perform mandibular block anaesthesia techniques. Dentists must recognize the mandibular foramen position to determine the appropriate injection point [8]. Age differences can influence the position of the mandibular foramen [2].

The position of the mandibular foramen is influenced by the mandible growth, which can occur with age [8]. The increasing distance of the mandibular foramen to the occlusal plane and the length of the gonial point to the mandibular foramen can cause variations in the position of the mandibular foramen based on age [2]. In children, the mandibular foramen position is generally below the occlusal plane. While the position of the mandibular foramen in adolescents is usually parallel to the occlusal plane, the positon of the mandibular plane is higher than the occlusal plane in adults [9]. However, some studies mention that there is no difference found regarding the position of the mandibular foramen with age [10]. Thus, identification of the mandibular foramen position is needed to estimate its position according to age and to minimize the occurrence of mandibular block anaesthesia failure [8].

2 Material and Method

This research was a descriptive observational study using a cross-sectional approach and a semi-blinding method to reduce the occurrence of tendencies during the study. The research used all results of patients' panoramic radiographs from the Radiology Installation of the Dental Hospital, Universitas Muhammadiyah Yogyakarta, from January to March 2021 as the research population. The research sample was selected based on a non-probability sampling method using purposive sampling.

As many as 667 panoramic radiographs were collected for the study population, and 330 panoramic radiographs met the inclusion and exclusion criteria in this study which were designated research samples. The results of panoramic radiographs were included as samples in the study if (1) it is obtained from the Radiology Installation of the Dental Hospital, Universitas Muhammadiyah Yogyakarta, (2) it is obtained from patients aged 10–29 years, (3) it can show a good image of the mandibular foramen on both sides,

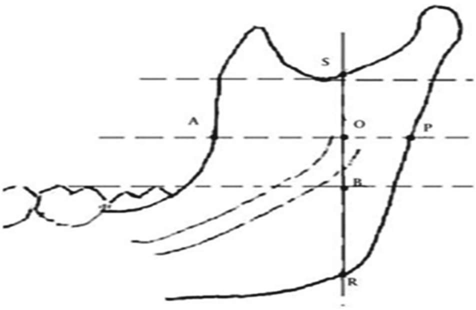

Fig. 1. The reference points in identifying the position of the mandibular foramen using panoramic radiographs [11].

and (4) the panoramic has optimal density, contrast, and minimal distortion. Meanwhile, the results of panoramic radiographs were excluded from the study if (1) there was a pathological condition extended on both sides of the mandible, (2) there was no clear picture of the mandibular foramen, and (3) the panoramic radiographs of a patient who did not have permanent mandibular molars were found.

The reference point used in this study refers to a previous study using seven distances from six reference points by identifying the position of the mandibular foramen. The reference points are the center of the mandibular foramen (O), sigmoid notch (S), the anterior border of the mandibular ramus (A), the posterior border of the mandibular ramus (P), the inferior border of the mandible (R), occlusal plane (B) [11] (Fig. 1).

Based on these reference points, the mandibular foramen position was identified from the vertical direction or based on the height of the occlusal plane. The data were grouped based on the position of the mandibular foramen to the height of the occlusal plane into (1) Position 1 (located above the occlusal plane), (2) Position 2 (located in parallel position with the occlusal plane), and (3) Position 3 (located below the occlusal plane). The data were processed using the descriptive statistical processing method using Microsoft Excel software and presented in the form of tables and diagrams. The Research Ethics Committee has approved this study under the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, issuing the Ethical Clearance (EC) numbered: 038/EC-EXEM-KEPK FKIK UMY/1V/2021.

3 Result

A total of 330 panoramic radiographs met the inclusion criteria. The samples were grouped by the age of mandibular development, as shown in the following table.

Table 1 describes the grouping of samples based on the age of mandibular development into the age group of 10–14 years, namely the age at which the peak of mandibular development occurs. The age group 15–19 years shows the increase of the mandibular length. In the age group of 20–24 year, it presents the decrease of the mandibular growth. Meanwhile, the age group of 25–29 years indicates that the mandibular size is relatively constant [12, 13]. From the table, it shows that most of the subjects were from the age

Table 1. Distribution of samples by the age of mandibular development

Age (years)	n	%
10–14	34	10.30
15–19	49	14.85
20–24	187	56.67
25–29	60	18.18
Total	330	100

Table 2. Distribution of the mandibular foramen position on the right side

Position	10–14 years		15–19 years		20–24 years		25–29 years	
	n	%	n	%	n	%	n	%
1	4	11.76	11	22.45	48	25.67	18	30
2	6	17.65	11	22.45	33	17.65	6	10
3	24	70.59	27	55.10	106	56.68	36	60
Total	34	100	49	100	187	100	60	100

Table 3. Distribution of the mandibular foramen position on the left side

Position	10–14 years		15–19 years		20–24 years		25–29 years	
	n	%	n	%	n	%	N	%
1	6	17.5	13	26.53	47	25.14	18	30
2	8	23.53	11	22.45	42	22.46	7	11.67
3	20	58.82	25	51.02	98	52.40	35	58.33
Total	34	100	49	100	187	100	60	100

group of 20–24 years (56.67%) followed by the age group of 10–14 years (10.30%), the age group of 15–19 years (14.85%), and the age group 25–29 years (18.18%).

Tables 2 and 3 show the distribution of the position of the mandibular foramen in each age group based on the side of the mandibular foramen studied. Table 2 shows the distribution of the position of the mandibular foramen on the right side. The highest percentage of mandibular foramen positions in each age group is in position 3 (located below the occlusal plane), which is as many as 24 in the 10–14 years age group (70.59%), 27 in the age group of 15-19 years (55.10%), 106 in the age group of 20–24 years (56.68%) and 36 in the age group of 25–29 years (60%). Table 3 shows the distribution of the position of the mandibular foramen on the left side. The highest percentage of mandibular foramen positions in each age group is in position 3 (located below the occlusal plane), with as many as 20 in the 10–14 year age group (58.82%), 25 in the age group of 15–19 years (51.02%), 98 in the age group of 20–24 years (52.40%), and 35 in the age group of 25–29 years (58.33%).

4 Discussion

Identification of the position of the mandibular foramen is essential when the dentist wants to perform anesthesia on the inferior alveolar nerve or mandibular block anesthesia [14]. The success of the mandibular block anesthetic procedure depends on the accuracy of positioning the anesthetic needle as close to the structure of the mandibular foramen as possible. So, knowledge about the correct position of the mandibular foramen in each individual can help carry out a more effective anesthetic procedure to minimize the chances of anesthetic failure [8].

The position of the mandibular foramen can vary in each individual. It can be caused by the increase in the mandible length and width that occurs with increasing age [8]. Thus, the sample grouping in this study was based on the age of mandibular development to facilitate researchers in describing the position of the mandibular foramen according to age [12, 13]. A total of 330 panoramic radiographs were used as samples in this study consisting of 34 radiographs of patients aged 10–14 years, 49 radiographs of patients aged 15–19 years, 187 radiographs of patients aged 20–24 years, and 60 radiographs of patients aged 25–29 years. The youngest patient in this study was ten years old because the peak of mandibular development occurred at that age [15]. The panoramic radiographs of patients who did not have permanent molars were excluded from this study because permanent molars were used as a reference point for occlusal height to help the identification of the mandibular foramen position from the vertical direction [11, 16].

Based on the data in this study, it was found that there was a similarity in the position of the mandibular foramen in each age group, as seen using panoramic radiographs. Of the four age groups studied, the third position, which shows the mandibular foramen located below the occlusal plane, occupies the highest position in each age group. This study shows that age does not affect the position of the mandibular foramen in each individual. This study results align with previous research by Lasemi et al. [17], which states that age does not affect the mandibular foramen position. The mandibular foramen position in each individual will always be located in the ventral and inferior two-thirds of the mandibular ramus so that no difference is found to be influenced by age [18]. This study shows that most positions of the mandibular foramen were located below the height of the occlusal plane. Another study states that each individual's mandibular foramen position is located below or parallel to the occlusal plane and not above the occlusal plane [19].

Mandibular growth is related to the anterior movement of the mandibular foramen and the decrease in the gonial angle size that will occur with age. The mandibular foramen moves anteriorly, while the gonial angle decreases with age. The mandibular foramen then moves to the posterior as it moves anteriorly to compensate for the remodelling process that occurs at the anterior border of the mandibular ramus during growth [20]. Thus, there was no change in the mandibular foramen position in the anteroposterior direction during growth, and the mandibular foramen was generally located in half to two-thirds of the entire width of the posterior border of the mandibular ramus in each individual [21]. Therefore, it can be concluded that differences in the mandibular foramen position in each individual can occur if there are craniofacial anomalies, extreme body shape, and different ethnic influences among individuals [17].

Most of the participants in this study were occupied by the population group of age 20–24 years, with 187 participants. Regarding the aforementioned population group, most of the panoramic radiographs taken at the Dental Hospital of UMY from January to March 2021 were used for orthodontic treatment and the need to evaluate the patient's third molar eruption. Thus, there were only 34 panoramic radiographs from aged 10–14 years. Therefore, if the sample size obtained in each study group has the same size, then it is possible to identify any influence of age on the mandibular foramen position in each individual.

5 Conclusion

The mandibular foramen position based on age in the population in Dental Hospital of UMY with the age of 10–29 years was generally found to be below the occlusal plane, and there was no difference in position of the mandibular foramen by age groups. Thus, the dentist can place the anaesthetic needle lower than the height of the patient's occlusal plane to successfully achieve the mandibular block anaesthetic technique.

6 Suggestion

Suggestions that can be proposed for the successful implementation of the mandibular block anaesthetic technique are to position the anaesthetic needle at a lower height than the occlusal plane to reduce the occurrence of anaesthetic failure since the mandibular foramen is generally located below the occlusal plane. Meanwhile, suggestions that can be given for further research on similar topics are to increase the number of samples in certain age groups to be studied so that the number of samples in each group is relatively the same. In addition, further studies using other radiographic projections such as cephalometric radiographic techniques or Cone Beam Computed Tomography (CBCT) can be carried out so that the mandibular foramen position can be identified more clearly on each side.

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