

## LOCATION OF MANDIBULAR FORAMEN IN CORRELATION WITH THE GONIAL ANGLE IN INDIAN POPULATION: A MORPHOMETRIC STUDY FOR SURGICAL PRACTICES

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### ABSTRACT

**Background:** The mandibular foramen, is the emerging point of the neurovascular bundle which makes it fundamental for performing anaesthetic techniques for desensitization of the mandible in oral surgery interventions. The knowledge of position of mandibular foramen is necessary while anaesthetizing palate during periodontal procedures, tooth extractions and maxillofacial surgeries.

**Objective:** The present study was carried out to identify the position and location of mandibular foramen in relation to the angle of mandible (gonial angle) in adult human mandibles of Indian origin .

**Materials and Methods:** The study was conducted on 300 adult human dry skulls of Indian Population. Angle of mandible, Distance of mandibular foramen from angle of mandible and Angle of mandibular foramen with the base of mandible were measured. Measurements were done with Steel measuring tape and Mylometer. The data was Statistically analysed.

**Results and Conclusion:** The Mean value of the angle of mandible (Gonial Angle) was  $121.87^{\circ} \pm 6.22^{\circ}$ . The Mean value of the distance of mandibular foramen from angle of mandible was  $22.78 \pm 4.05$  mm. The angle of mandibular foramen was Mean  $\pm$  standard deviation of  $82.24^{\circ} \pm 6.87^{\circ}$ . The morphometric correlation of the parameters analyzed in the mandibles showed a statistically significant Pearson correlation. Regression line was also derived.

**KEY WORDS:** Anaesthesia, Anatomy, Angle of Mandible, Gonial Angle, Mandibular Foramen, Morphometry.

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### INTRODUCTION

Precise information of location of Mandibular Foramen (MF) is very important in Maxillofacial surgery and dentistry, because it is used for injection of anesthetic solution for Inferior Alveolar (IA) nerve block [1]. Halsted approach is standard and common method of lower teeth anesthesia by blocking of IA nerve. In this approach anesthetic solution is injected in infratemporal space near IA nerve [2]. Malamed reported that it is successful in 80-85% of

patients [3]. However investigations revealed that failure of this method is 29 to 35% of patients [4,5]. It was reported that anatomical variations of MF are one of the main reasons of failure of Halsted approach [6,7]. In the course of life the mandible undergoes substantial morphological and dimensional changes. The angle of mandible varies with age and state of dentition [8]. These changes have been associated with the action of muscles of mastication [9]. The mandibular angle, in

conjunction with other anthropological parameters may be useful as anthropological tools in racial and population diagnosis. The present study was undertaken to evaluate a) the angle of mandible, b) distance between angle of mandible and mandibular foramen c) angle of mandibular foramen. The findings of this study might be useful in providing anthropological data that can also be used in dental and medical practice [10]. Familiarity with the relationships of the mandibular foramen will assist in performing properly a sagittal split of the ramus and will reduce the chance for an unfavorable split while doing Plastic and reconstructive surgeries and implant surgeries.

### MATERIALS AND METHODS

The present study was conducted on 300 Indian adult human mandibles available in Anthropology Museum of the Department of Anatomy, G.S.V.M. Medical College, Kanpur, Uttar Pradesh, India. Mandibles with missing teeth, alveolar bone resorption and malposition of teeth were excluded. It has been reported that the location of the Mandibular Foramen maintains absolute bilateral symmetry in human mandibles, regardless of age [11-14]. Therefore side of the mandible was not taken into consideration.

The metric parameters selected for the study were 1. Angle of mandible (Gonial angle) 2. Distance between mandibular foramen and the angle of mandible. 3. Angle of mandibular foramen from the base of mandible. The angle and the distance were measured with the help of Mylometer, metal scale, protractor and metal divider.

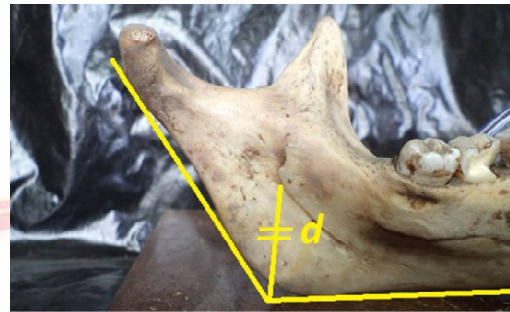
**Angle of mandible ( Gonial angle):** The mandible was placed on the Mylometer with the condyle, the base of the mandible, and a point on the ramus in contact with the device. The mandibular angle was read on the protractor without moving the bone (Figure 1).



**Fig. 1:** Angle Of Mandible (A).

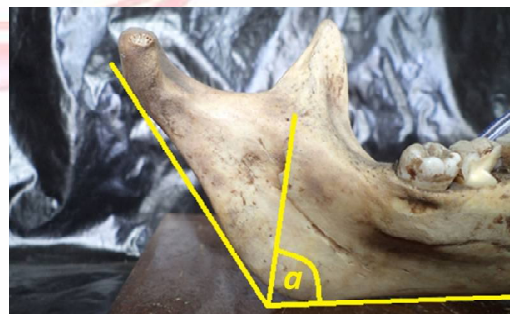
**Distance of mandibular foramen from angle of mandible:** This distance was measured with Steel measuring tape in millimeters (mm.). The zero end of the scale was placed at the junction of two boards of the device and distance between the zero end of scale and the lower border of mandibular foramen near the base of lingula was measured ( Figure 2).

**Fig. 2:** Distance of Mandibular Foramen From Angle of Mandible (d)



**Angle of mandibular foramen with the base of mandible:** This was measured by placing the mandible in close proximity with protractor. The condyle, the base of the mandible & a point on the ramus were in contact with the device. The Angle was taken from the anterior margin of the mandibular foramen (Figure 3).

**Fig. 3:** Angle of Mandibular Foramen From Base (a).



The Statistical Analysis of the data was done. The correlation coefficient between mandibular foramen and angle of mandible was calculated. Regression equation was derived. Besides, the correlation coefficient between angle of mandible and angle of mandibular foramen was also calculated. Regression equation was derived between the two.

### RESULTS

In the study the range of the angle of mandible (A) was from  $101^{\circ}$  to  $138^{\circ}$  with a Mean  $\pm$  standard deviation of  $121.87^{\circ} \pm 6.22^{\circ}$ . It was found that the angle of mandible in 150 mandibles (50%) was in the range of  $121-130^{\circ}$ . (Table 1)

The value of the distance of mandibular foramen from angle of mandible was in the range of 13-34 mm with a Mean  $\pm$  standard deviation of  $22.78 \pm 4.05$  mm. In 130 mandibles (43.33%) the distance was 21-25 mm. (Table-2)

**Table 1:** Measurement of Angle of Mandible (A).

| Range                | Number | Mean $\pm$ S.D.   | %   |
|----------------------|--------|-------------------|-----|
| 101-110 <sup>0</sup> | 12     | 107.75 $\pm$ 2.91 | 4%  |
| 111-120 <sup>0</sup> | 111    | 116.87 $\pm$ 2.59 | 37% |
| 121-130 <sup>0</sup> | 150    | 124.70 $\pm$ 2.56 | 50% |
| 131-140 <sup>0</sup> | 27     | 132.89 $\pm$ 2.04 | 9%  |

**Table 2:** Measurement of Distance of Mandibular Foramen From Angle of Mandible (d).

| Range (mm) | Number | Mean $\pm$ S.D.  | Percentage |
|------------|--------|------------------|------------|
| 11-15      | 7      | 14.00 $\pm$ 0.75 | 2.33%      |
| 16-20      | 82     | 18.45 $\pm$ 1.27 | 27.33%     |
| 21-25      | 130    | 22.77 $\pm$ 1.27 | 43.33%     |
| 26-30      | 70     | 27.30 $\pm$ 1.19 | 23.33%     |
| 31-35      | 11     | 32.18 $\pm$ 1.02 | 3.66%      |

Pearson's Correlation coefficient ( $r_1$ ) was calculated to study relationship between Angle of Mandible (A) with Distance (d) between Mandibular Foramen and Angle of Mandible ( $r_1$ ). Estimated Regression line was also calculated. (Table- 3) Correlation Coefficient ( $r_1$ ) Obtained in the study was -0.58 which denotes strong negative correlation between angle of mandible (A) with the distance (d) of Mandibular Foramen from angle of mandible. With the decrease in Angle of mandible there is increase in Distance of Mandibular Foramen from angle of mandible. Estimated Regression line is-  $d=158.21-1.11A$

d=estimated value of distance of MF from AOM.  
A= value of Angle of Mandible.

**Table 3:** Showing the Range, Mean, S.D, S.E, correlation coefficient and regression line the correlation ( $r_1$ ) between Angle of Mandible (A) and distance (d) of mandibular foramen from angle of mandible.

| Parameters      | Angle of mandible (A) (°)   | Distance of MF from angle of mandible (d) (mm) |
|-----------------|---|--|
| Mean            | 121.87  | 22.78  |
| S.D.            | 6.22  | 4.06   |
| S.E.            | 0.35  | 0.23   |
| $r_1$           | -   | -0.58  |
| $R^2$ in %      | -   | 34%  |
| Regression Line | $d=158.21-1.11A$<br>d=estimated value of distance of MF from Angle of Mandible.<br>A= value of Angle of Mandible. |  |

In the study the range of angle of mandibular foramen was 63-100<sup>0</sup> with a Mean  $\pm$  standard deviation of  $82.24 \pm 6.87$ <sup>0</sup>. In most of the mandibles(48%)the angle of mandibular foramen from base was in range of 81-90<sup>0</sup>, while in 36% of mandibles the angle was in range of 71-80<sup>0</sup>, 9.33% in range of 91-100<sup>0</sup>and 6.66% were in 61-70<sup>0</sup> range (Table 4).

**Table 4:** Measurement of Angle of Mandibular Foramen From Base (a).

| Range               | Number | Mean $\pm$ S.D.  | Percentage |
|---------------------|--------|------------------|------------|
| 61-70 <sup>0</sup>  | 20     | 68.50 $\pm$ 1.93 | 6.66%      |
| 71-80 <sup>0</sup>  | 108    | 77.27 $\pm$ 2.69 | 36%        |
| 81-90 <sup>0</sup>  | 144    | 85.57 $\pm$ 2.91 | 48%        |
| 91-100 <sup>0</sup> | 28     | 94.10 $\pm$ 2.16 | 9.33%      |

Relationship between Angle of Mandible with Angle of Mandibular Foramen from base was checked with Pearson's Correlation coefficient ( $r_2$ ). The Correlation coefficient was +0.44 which indicates strong positive correlation between Angle of Mandible and angle of Mandibular Foramen from base. With the decrease in Angle of Mandible there is decrease in angle of MF from base. Estimated Regression line was also calculated (Table- 5).

Estimated Regression line:  $a = 2.5A - 221.95$

a =estimated value of angle of MF from base.

A= value of angle of mandible.

**Table 5:** Showing the Range, Mean, S.D, S.E, correlation coefficient and regression line and the correlation between Angle of Mandible and angle of mandibular foramen from base.

| Parameters      | Angle of mandible (A) (°)  | Angle of MF from base (a) (°) |
|-----------------|--|-------------------------------|
| Mean            | 121.87   | 82.24                         |
| S.D.            | 6.22   | 6.88                          |
| S.E.            | 0.35   | 0.39                          |
| r               | -  | 0.44                          |
| $R^2$ in %      | -  | 19%                           |
| Regression Line | $a = 2.5A - 221.95$<br>a=estimated value of angle of MF from base.<br>A= value of angle of mandible. |                               |

## DISCUSSION

A deep and efficient anesthesia is essential to Dentistry. Although it is a simple procedure in the maxilla but in mandible it may be associated with some difficulty. The success of this technique depends on the proximity between the anesthetic needle and the mandibular

Racial and regional differences in functional activity of the mandible during the early stages of development may affect its form and hence the mandibular angle [16]. The angle of mandible varies with age and the state of dentition [8]. It ranges from about 170° in children to about 110°- 120° in adolescents and adulthood and then increases to about 130° to 140° in old age[8]. Several authors have shown that the state of dentition (such as tooth eruption, loss of teeth and absorption of the alveolar bone) is an important factor in determining the size of the human mandibular angle [8,17]. In a study elderly edentulous subjects had significantly larger gonial angles (128.4 degrees +/- 6.6) than did the young (122.4 degrees +/- 6.6, P<.001) and older dentate subjects (122.8 degrees +/- 6.6, P<.001).[ 18] In another study in brazil this angle measured 128.25° on the left side and 127.68° on the right side. [19] A brief comparison of value of Angle of mandible in the studies conducted in past is shown in Table 6.

**Table 6:** Showing comparison of different studies on angle of mandible.

| S. No. | Name of Researcher (Year)        | Inference (Angle of mandible) | Population Studied |
|--------|----------------------------------|-------------------------------|--------------------|
| 1      | Zivanovich, (1970)[8]            | 124.05°                       | East African       |
| 2      | RajalakshmiRai, (2007)[10]       | 119°                          | India              |
| 3      | Gabriel AC (1958) [16]           | 122.72°                       | Sydney             |
| 4      | Xie QF, (2004)[18]               | 122.4°                        | China              |
| 5      | J. da Costa de Sousa (2006) [19] | 128.2°                        | Brazil             |
| 6      | Dibbets JMH, (1996)[20]          | 126.4°                        | Germany            |
| 7      | Mbajjorguet al, (1996) [21]      | 125.5°                        | Zimbabwe           |
| 8      | Nagar M, (1996) [22]             | 120°                          | India              |
| 9      | Marzola C at al., (2005) [23]    | 126°                          | Brazil             |
| 10     | Yan Gu, (2007) [24]              | 126.8°                        | Michigan           |
| 11     | Ennes JP, (2009) [25]            | 131°                          | Brazil             |
| 12     | Jalili MR, (2010)[26]            | 118.45°                       | Iran               |
| 13     | Poonacha KS et al, (2010)[27]    | 122°                          | India              |
| 14     | Ashkenazi M, (2011)[28]          | 123.6°                        | Israel             |
| 16     | Shenoy V et al, (2012)[29]       | 124.28°                       | India              |
| 17     | Present study                    | 121.8 ± 6.2°                  | India              |

The mean mandibular angles varies in different racial population groups as is evident from Table 6. The widest mandibular angle was that of the Brazilians(131°)[25]. In a study on Indian population the mean mandibular angle of Indian population was 119°[10]. The present study was carried on adult mandibles and the Mean angle of mandible was recorded as 121.87° which was similar to other studies . The variation from

previous observers found may be due to the ethnic group, the different morphometric technique used, or also to specific aspects such as the biomechanics and physiology characterising and differentiating the groups of people studied [19].

The Angle of Mandible decreased significantly with age and negatively correlated with distance between the MF and each mandibular border [11,30,31]. In the present study a negative correlation between the two i.e angle of mandible and its distance from mandibular foramen was seen. Table 7 shows the comparison with the past studies regarding the distance between mandibular foramen and the angle of mandible.

**Table 7:** Showing comparisons of different studies done to measure distance between mandibular foramen and angle of mandible.

| S. No. | STUDY                         | RANGE    | MEAN     | S.D.      | Angle of Mandible | Population Studied |
|--------|-------------------------------|----------|----------|-----------|-------------------|--------------------|
| 1      | Nagar M, (1996)[22]           | -        | 23.2 mm  | -         | 1200              | India              |
| 2      | Marzola C at al., (2005)[23]  | 14-33 mm | 20.6 mm  | ±3.64 mm  | 1260              | Brazil             |
| 3      | Kilarkaje N, (2005)[14]       | 15-37 mm | 25.1 mm  | ± 4.2 mm  | -                 | Kuwait             |
| 4      | Jalili MR, (2010)[26]         | 22-45 mm | 31.8 mm  | ±4.1 mm   | 118.45            | Iran               |
| 5      | Ferreira RA et al. (2012)[32] | 13-27 mm | 19.17 mm | ±3.32 mm  | -                 | Brazil             |
| 6      | Present study                 | 13-34 mm | 22.7 mm. | ± 4.05 mm | 121.8             | India              |

Gabriel (1958) & M. Nagar et al. (1996) established a correlation that greater the Angle of Mandible, more anterior and higher is the Mandibular Foramen.[16, 22] This was in contrast to the observations of Schafer et al. [33] who described it to be midway between the anterior and posterior border of the ramus. In the present study as well, a positive correlation was seen in the angle of mandible and angle of mandibular foramen ,though specific references for the angle of mandibular foramen were not available in the literature.

### CONCLUSION

It can be concluded from the study that there exists a correlation between the angle of mandible (gonial angle) and the position of mandibular foramen. It was evident that with the decrease in Angle of Mandible there was decrease in angle of Mandibular Foramen and further with the decrease in Angle of mandible there is increase in Distance of Mandibular Foramen from angle of mandible. The knowledge of angle of mandible by gross examination and

more precisely by radiographic techniques may be very much helpful in localizing the Mandibular foramen while giving anaesthesia or performing implant surgeries and other plastic and reconstructive studies. The results may also prove a help in demographic and racial studies.

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**Conflicts of Interests: None**

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