

ORIGINAL ARTICLE

GENDER AND AGE DETERMINATION BY RADIOGRAPHIC ANALYSIS OF THE POSITION OF MENTAL FORAMEN IN NAVI MUMBAI POPULATION

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ABSTRACT

Background - In physical and forensic anthropology the skull is extremely informative with regard to the identification of sex and age of an individual. It plays a vital role in establishing the identity of the deceased. The skull has been described as “The bone and core of the fleshy head and face” Gender and age determination plays a crucial role in the identification of human remains as it narrows the possibility for identification by 50 %. Many studies have observed the gender differences based on height of mandible, gonial angle, bigonial breadth and bicondylar breadth. But few studies have been done on gender and age determination based on the position of mental foramen.

Aim: To evaluate gender and age differences based on the distance from superior and inferior borders of mental foramen to lower border of the mandible, along with height of the mandible in our population.

Material and methods – Retrospective OPGs of subjects aged between 14 to 65 years taken for orthodontic and periodontic purposes were selected for the study. Out of the total 500 radiographs screened, 376 radiographs were considered for the study. The panoramic radiographs of patients were captured using Xtropan 2000 system and digitally processed. The distance from superior border of mental foramen (SMF) and inferior border of mental foramen (IMF) to the lower border of mandible (LBM) and height of mandible (AC – LBM) were measured.

Result - The distance from SMF and IMF to LBM and height of mandible was more in males when compared to females, which was statistically significant which is justifying the sexual dimorphism. Also, values were useful for the deriving formula for age determination.

Conclusion: The distances from SMF and IMF to the LBM and height of the mandible showed significant sexual dimorphism and helps in age determination

Keywords: Age, Gender, mental foramen, mandible, OPG

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INTRODUCTION

Gender and age determination plays a crucial role in the identification of human remains as it narrows the possibility for identification by 50 %. In the adult skeleton, gender determination is usually the first step of the identification process, as subsequent methods for age and stature estimation are gender dependent. The reliability of gender determination depends on the completeness of the remains and the degree of gender dimorphism inherent in the population. When the entire adult skeleton is available for analysis, gender can be determined up to 100% accuracy and age can be determined up to 85%. Skull bones and pelvis have been majorly used in gender identification. The skull is the most dimorphic and easily sexed portion of skeleton after pelvis, providing accuracy rate up to 92%. In physical and forensic anthropology, the skull is extremely informative with regard to the identification of sex and age of an individual. It plays a vital role in establishing the identity of the deceased. No wonder, the skull is described as “The bone and core of the fleshy head and face”. [1]

The mandible is the strongest bone in the human body which lasts the longest in a well-preserved state than any other bone. It also exhibits a high degree of sexual dimorphism. Therefore, the of anatomical and morphological features of the mandible is commonly used by anthropologists and forensic dentists in the determination of gender and age of the person. [2] Many studies have observed the gender differences based on height of mandible, gonial angle, bigonial breadth and bicondylar breadth. But few studies have been done on gender and age determination based on the position of mental foramen.

Among all the anatomical landmarks in human skull, the mental foramen is a paired and a stable landmark of the mandible. It is a funnel-like opening in the lateral surface of the mandible at the end point of the mental canal directed outward, upward and posteriorly. It lies at the apical area of premolars and transmits mental nerves and vessels. [2]

Morphological dimensions of mental foramen can be easily assessed in a living person by taking various intraoral and extraoral radiographs. The mental foramen is fairly well depicted on panoramic radiographs, because it has the advantage of providing, in a single film, the image of both jaws, with a relatively low radiation dose, compared to more sophisticated techniques. [1]

AIMS & OBJECTIVES

The aim of this study was to evaluate age and gender differences based on the distance from superior and inferior borders of mental foramen to lower border of the mandible, along with height of the mandible in local population.

Objectives of the study were –

1. To measure the distance between the alveolar crest to the inferior border of the mandible on right and left side. (AC-LBM)
2. To measure the distance between the superior border of the mental foramen to the lower border of the mandible on the right and left side. (SMF-LBM)
3. To measure the distance between the inferior margin of the mental foramen to the lower border of mandible on the right and left side.(IMF-LBM)
4. To compare the above measurements for gender and age assessment.

MATERIALS AND METHODS

The study was done in our dental College and hospital. Retrospective OPGs of patients aged between 14 to 65 years taken for orthodontic and periodontic purpose were selected for the study. All The panoramic radiographs of patients were captured using Xtropan 2000 system and Fujifilm (IP Cassette) films. Exposure parameters were personalized as per the manufacturer's recommendations during the radiographic exposure and the image was displayed on the digital display monitor.

Inclusion criteria for the selected radiographs were as follows:-

1. Good quality radiographs.
- 2.All teeth in the region of measurement should be present.
- 3.Mental foramen and the borders of the mandible should be distinct, free of artifacts at the site of measurement.

Exclusion criteria includes:

- 1.Radiograph showing craniofacial anomalies and syndromes or history of craniofacial surgeries.
2. Radiograph showing signs of periodontitis or jaw bone disorders
- 3.Impacted teeth in the region of interest.

Out Of the total 500 radiographs screened, 376 radiographs were selected for the study. After locating the Mental Foramen on OPG, tangents were drawn from Superior border of Mental Foramen (SMF), Inferior Border of Mental Foramen (IMF), Alveolar Crest (AC), and Lower Border of Mandible (LBM). Perpendiculars were drawn from tangents SMF, IMF, and AC to the LBM bilaterally using a marker pen. A single observer recorded the measurements from Superior border of Mental Foramen to Lower Border of Mandible, Inferior Border of Mental Foramen to Lower Border of Mandible, and alveolar crest to Lower Border of Mandible (height of mandible) bilaterally using Vernier caliper [Figures 1 and 2].

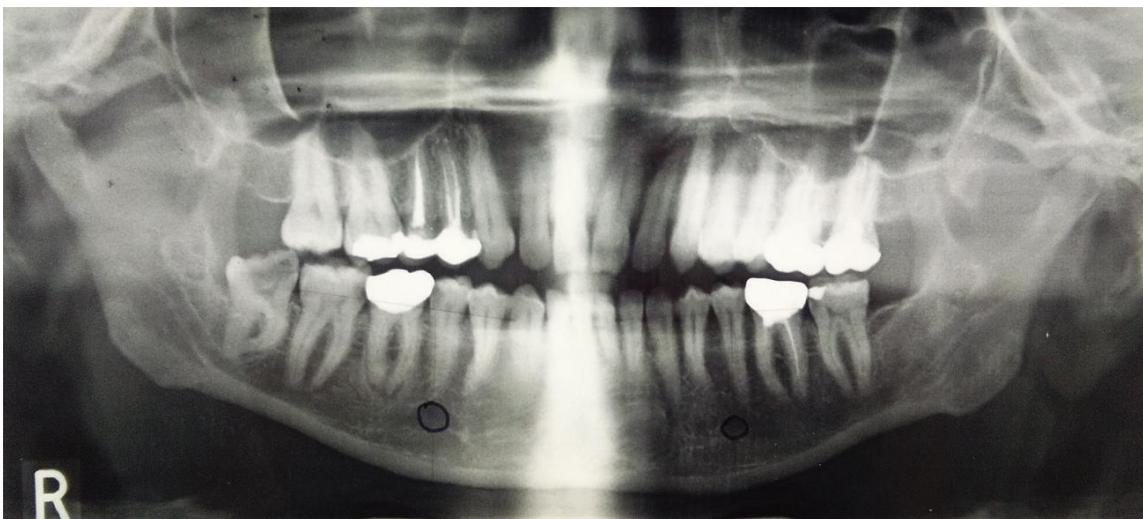


FIGURE 1: Position of Mental Foramen

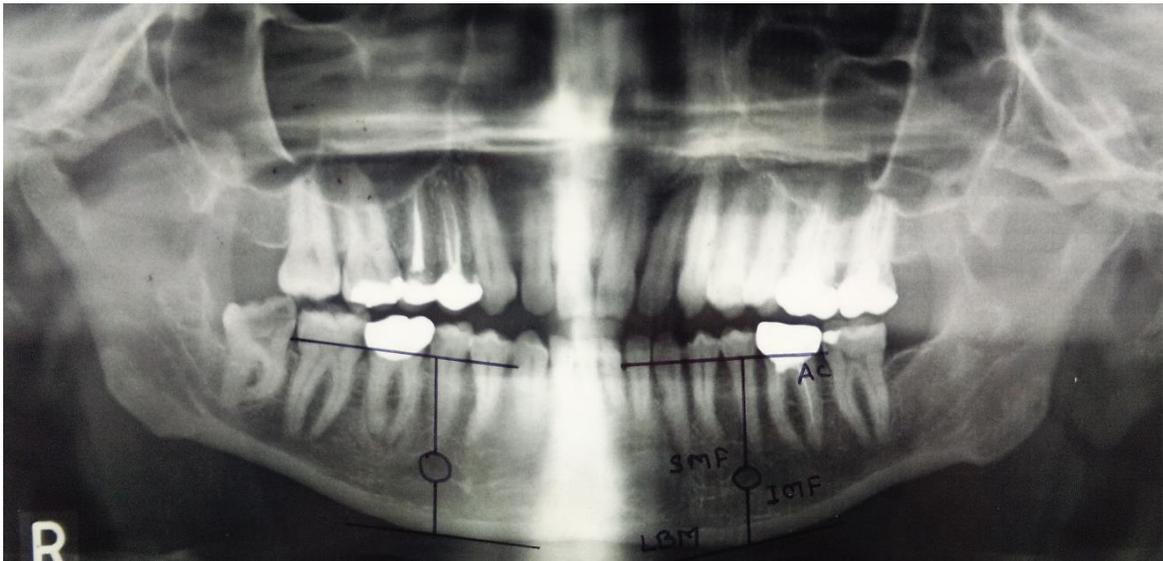


FIGURE 2: Measurements in OPG

STATISTICAL ANALYSIS

Descriptive statistics was used to summarize patient's demographics and survey. The significance level of different parameters between the study groups were carried out using students "t" test, one-way ANOVA test, post hoc test where $p < 0.05$ was considered to be statistically significant and all p values were compared with control group. Linear regression analysis was carried out to determine age of the patients

RESULTS

A total of 376 panoramic radiographs, were analysed, 188 each belonging to males and females respectively. The measurements from AC, SMF, and IMF to LBM were calculated and compared on the right and left side of an individual in both the gender. The mean distance from the superior border of the mental foramen to the lower border of the mandible (SMF-LBM) on the right side in males was 17.57 mm, whereas it was 16.30 mm in females. On the left side, it was 17.40 mm in males and 16.10 mm in females [Tables 1 and 2].

	RIGHT	LEFT	COMBINED
NO OF SUBJECTS	188	188	376
MEAN	17.57	17.40	17.49
SD	1.77	1.62	1.31
SD ERROR	0.1289	0.1185	0.1237
95% confidence interval range	17.3 to 17.8	17.2 to 17.6	17.4 to 17.6

Table 1: SMF-LBM in MALES

	RIGHT	LEFT	COMBINED
NO OF SUBJECTS	188	188	376
MEAN	16.30	16.10	16.20
SD	1.35	1.28	1.31
SD ERROR	0.0985	0.0936	
95% confidence interval range	16.1 to 16.5	15.9 to 16.3	16.1 to 16.3

Table 2 : SMF-LBM in FEMALES

Similarly, the mean distance from the inferior border of the mental foramen to the lower border of the mandible (IMF - LBM) on the right side in males was 12.40 mm, whereas it was 11.44 mm in females. On the left side, it was 12.46 mm in males and 11.61mm in females [Tables 3 and 4].

	RIGHT	LEFT	COMBINED
NO OF SUBJECTS	188	188	376
MEAN	12.40	12.46	12.43
SD	1.25	1.22	1.23
SD ERROR	0.0908	0.0889	0.08985
95% confidence interval range	12.2 to 12.6	12.3 to 12.6	12.3 to 12.6

Table 3: IMF - LBM in MALES

	RIGHT	LEFT	COMBINED
NO OF SUBJECTS	188	188	376
MEAN	11.44	11.61	11.52
SD	1.67	1.30	1.49
SD ERROR	0.1217	0.0946	0.10815
95% confidence interval range	11.1997-11.6803	11.423-11.797	11.3056-11.7344

Table 4: IMF - LBM in FEMALES

When we compared a distance between SMF-LBM and IMF – LBM in males and females the comparison showed the very high significant difference ($P < 0.001$) on both the right and the left sides. [Table 5 and Table 6]

NO OF SUBJECTS	T VALUE	P VALUE	SIGNIFICANCE
RIGHT	7.9837	0.0001	HIGHLY SIGNIFICANT
LEFT	8.1670	0.0001	HIGHLY SIGNIFICANT
COMBINED	8.07535	0.0001	HIGHLY SIGNIFICANT

Table 5: Comparison of SMF-LBM between MALES and FEMALES

NO OF SUBJECTS	T VALUE	P VALUE	SIGNIFICANCE
RIGHT	6.3392	0.0001	HIGHLY SIGNIFICANT
LEFT	6.5632	0.0001	HIGHLY SIGNIFICANT
COMBINED	6.4512	0.0001	HIGHLY SIGNIFICANT

Table 6: Comparison of IMF – LBM between MALES and FEMALES

On comparison the distance from SMF to LBM on the right side in males was slightly more (17.57mm) than the left side (17.40mm), with no significant difference. Similarly, the distance from SMF to LBM on the right side in females was slightly more (16.30 mm) than the left side (16.10 mm), with no significant difference. In contrast, the distance from IMF to LBM on the left side in males was slightly more (12.46 mm) than the right side (12.40 mm), with no significant difference. Similarly, the distance from IMF to LBM on the left side in females was slightly more (11.61 mm) than the right side (11.44 mm), with no significant difference. [Table 7 and table 8]

	T VALUE	P VALUE	SIGNIFICANCE
SMF-LBM	1.0848	0.2787	NOT SIGNIFICANT
IMF – LBM	0.4273	0.6694	NOT SIGNIFICANT

TABLE 7: Comparison of SMF-LBM and IMF – LBM between the right and left sides in males

	T VALUE	P VALUE	SIGNIFICANCE
SMF-LBM	0.9393	0.3482	NOT SIGNIFICANT
IMF – LBM	1.0696	0.2855	NOT SIGNIFICANT

TABLE 8: Comparison of SMF-LBM and IMF – LBM between the right and left sides in females

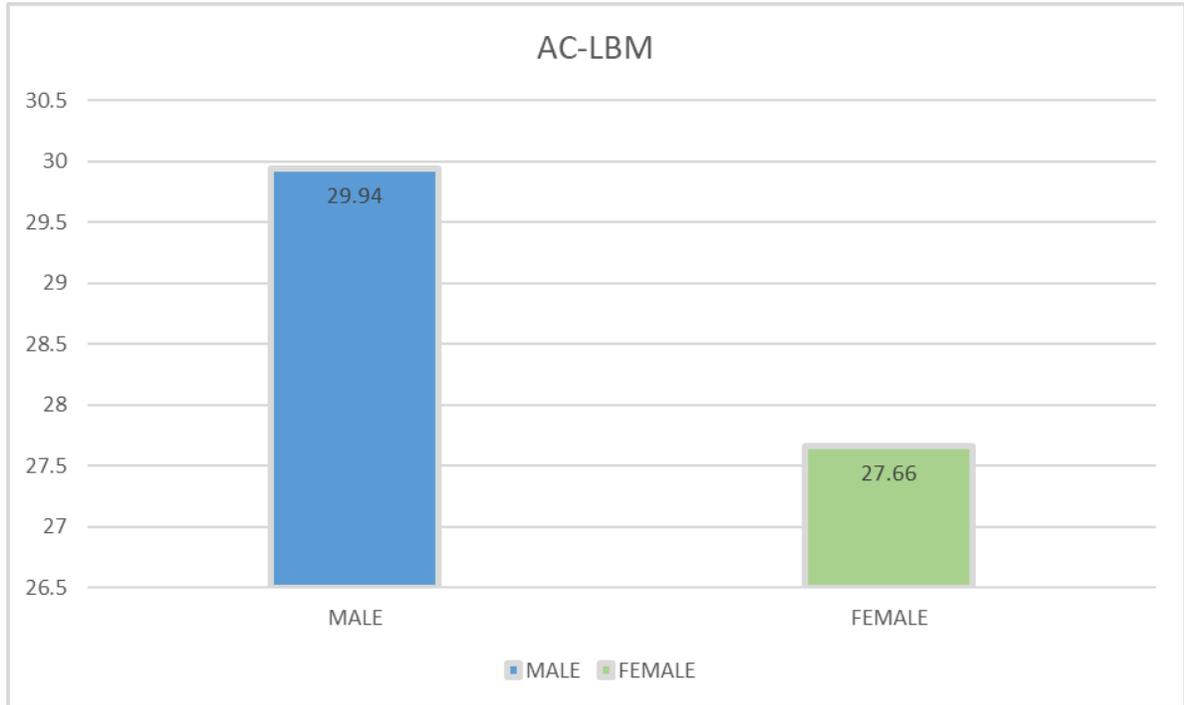
The height of mandible (AC to LBM) in males on the right side was 30.07 mm and on the left side 29.81 mm, where as in females, 27.70 on the right side and 27.61 mm on the left side. The total mean height of mandible in males was 29.94 mm and in females was 27.66 mm, and comparison showed statistically significant differences. [Table 9, Table 10, Table 11 and Graph1]

	RIGHT	LEFT	COMBINED
NO OF SUBJECTS	188	188	376
MEAN	27.70	27.61	27.66
SD	2.28	2.03	2.15

TABLE 9: AC – LBM in females

	RIGHT	LEFT	COMBINED
NO OF SUBJECTS	188	188	376
MEAN	30.07	29.81	29.94
SD	2.43	2.33	2.38

TABLE 10: AC – LBM in males



Graph 1: Comparison of AC – LBM between males and females

	T VALUE	P VALUE	SIGNIFICANCE
AC – LBM	9.7676	0.0001	Highly Significant

Table 11 : Comparison of AC – LBM between males and females

Comparison of AC – LBM on right and left side in males and females did not show any significant difference. (Table 12 and Table 13)

	T VALUE	P VALUE	SIGNIFICANCE
AC – LBM	1.0660	0.2871	Not significant

Table 12: Comparison of AC – LBM between the right and left sides in males

	T VALUE	P VALUE	SIGNIFICANCE
AC – LBM	0.3897	0.6970	Not significant

Table 13: Comparison of AC – LBM between the right and left sides in females

Linear regression of all parameters to determine age in males and females resulted in the following regression formulae:

For Male -

Left side: Age = $(- 9.815) + (- 1.796 \times X1) + (1.864 \times X2) + (5.699 \times X3) + (- 1.489 \times X4) \pm 8.58$ years

Right side: Age = $(- 10.376) + (- 2.016 \times X1) + (- 1.569 \times X2) + (5.547 \times X3) + (- 2.143 \times X4) \pm 9.95$ years.

For Female -

Left side: Age = $(- 8.927) + (- 1.158 \times X1) + (1.556 \times X2) + (5.124 \times X3) + (- 0.798 \times X4) \pm 8.14$ years

Right side: Age = $(- 10.068) + (-2.584 \times X1) + (2.143 \times X2) + (6.012 \times X3) + (-1.055 \times X4) \pm 8.92$ years.

where X1 = AC - LBM, X2 = AC - SMF, X3 = SMF-LBM, X4 = IMF-LBM.

DISCUSSION

Positive identification of the deceased is a very crucial aspect of forensic science in which age and gender determination holds a major role. Sex determination helps to channelize the investigation by deducing the search to half the population, thus conserving both resources and the time required for identification. When the entire skeleton is present, sex and age determination is possible with 100% accuracy. However, in many instances human remains are likely to be obtained in fragmented states.^[3]

The mandible is the strongest bone in the human body and persists in a well-preserved state longer than any other bone. Therefore, mandibular characteristics are extremely useful for determining sex and age.^[4] Daniel Franklin et al., strongly reported that the mandible is a suitable element, both in terms of resistance to damaging taphonomic processes, and potential sex discriminating power, for forensic analysis in Black South African population.^[5]

Wical et al., described that, the distance from the foramen to the inferior border of the mandible remains relatively constant throughout life irrespective of the alveolar bone resorption above the mental foramen.^[6]

Lindh *et al.* in 1995^[7], Guler *et al.* in 2005^[8] and Rai et al.,^[2] also suggested that the stability of this region does not depend on resorption of alveolar process above the foramen. Therefore, the vertical measurements in panoramic radiography are clinically applicable for the quantification of height of alveolar bone in this region.^[2] Because of the stability of the basal bone and mental foramen as the distance from MF to LBM remains relatively constant throughout life. Hence, these landmarks were selected as a point of reference for the present study.

In the present study we observed that all the parameters were i.e AC-LBM, SMF-LBM, IMF – LBM were statistically significant in females when compared to males but were non-significant in right and left in both the genders. The difference in these measurements can be explained by the fact that sexual hormones such as androgen and estrogen leads to the development of morphologic differences in craniofacial skeleton between both the genders, as well as different growth velocities in later adulthood. Adult female's bone growth rate is slower than men's according to Enlow (1982), who also stated that local factors such as masticatory muscles

and masticatory bite force also plays an important role in development of craniofacial skeletal changes.^[9] In the present study, the mean values of SMF-LBM and IMF-LBM were significantly high in males as compared with females, and the results were in accordance with those of Thomas *et al.*,^[10] Mahima *et al.*,^[11] who conducted a study in South Indian population, Chandra *et al.*'s^[2] study conducted in North Indian population, and Catovic *et al.*,^[12] Yosue *et al.*, (1989)^[13], Al Khateeb T. *et al.*,^[14] Cagri *et al.* (2011)^[15] study conducted in different parts of world. In contrast, Kusum *et al.*,^[1] Vodanovic *et al.*,^[16] found that the mean value of IMF to LBM does not exhibit sexual dimorphism. The difference may be due to racial diversity of the study population. But in our study the distance between IMF- LBM is significantly higher in males than females. The distance SMF to LBM did not show any significant difference between the right and left sides. The distance from SMF to LBM, was minimally more on the right side in both males and females and distance from IMF to LBM was minimally higher on left side of both males and females. The results were in accordance with Thomas *et al.*'s study where they found that distances from SMF to LBM and IMF to LBM were same on both sides.^[10] Therefore, the distances SMF to LBM and IMF to LBM from any of the sides can be used as a representative for gender discrimination.

Also, the mean distance from AC – LBM was significantly higher in males than females. The results of the present study are consistent with those done by Thomas CJ *et al.*,^[10] Thakur M,*et al.*,^[4] Suragimath, *et al.*,^[17]. In the present study, height of mandible in the premolar region on the both sides was statistically significant in males and females but the distance was not significant on comparing between the sides in both genders. So, height of mandible in premolar region on either right or left side can be used for gender identification of a person.

In the present study, 95% confidence interval range analysis described that the SMF-LBM in males comes within the range of 17.3015 to 17.6785 mm, and in females it falls within the range of 16.067 to 16.333 mm. The IMF-LBM in males range between 12.253 mm to 12.607 mm and in females it comes within the range of 11.3056-11.7344mm.

These results suggest that if a distance above 17.3015 mm for SMF-LBM and 12.22 mm for IMF-LBM is obtained on the panoramic radiograph; the gender will be male in 95% of the cases. Similarly, if a distance less than 16.067 mm for SMF-LBM and 11.1997 mm for IMF-LBM is obtained, the gender will be female in 95% of the cases. The results were similar to the study conducted on a south Indian population by Mahima *et al.* in 2009,^[11] who described that if a distance above 17 mm is obtained for SMF-LBM and 14.8 mm for IMF-LBM, the gender is male in 99% of the cases. In the same way, if the distance is less than 16.9 mm for SMF-LBM and 13 mm for IMF-LBM, the gender is female^[11].Also, Chandra, *et al.*(2013) conducted a similar study in north Indian population and concluded that if a distance above 16.921 mm for S-L and 11.944 mm for I-L is obtained on the panoramic radiograph; the gender will be male in 95% of the cases. Similarly, if a distance less than 17.032 mm for S-L and 12.384 mm for I-L is obtained, the gender will be female in 95% of the cases.^[2]

Additionally, from the above study, it was observed that the vertical position of the MF varies in different age groups. In younger age groups, it is nearer to the lower border of mandible. In the middle age group, MF is

almost at equidistance from the alveolar crest and lower border of mandible; and in older age group, it lies near to the alveolar crest. These findings were similar with study conducted by Popa et al.,^[18] and Asrani et al.,^[19]. Hence, a relative position of MF was obtained from our study which will help in determining the age of the person.

CONCLUSION

Mental Foramen is a stable landmark in mandible, which serves as a reliable landmark for the determination of age and gender. On the basis of present study, we can conclude that height of the mandible and distances from SMF to LBM and IMF to LBM shows sexual dimorphism along with age variation in the our population. But comparison between right and left sides of an individual do not show any gross differences. So, either right or left side of the mandible can be used for identification of gender and age.

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