

## ESTIMATION OF AGE AND GENDER BY ANALYSIS OF GONIAL ANGLE, MANDIBULAR CANAL, MANDIBULAR FORAMEN AND MENTAL FORAMEN: A CBCT STUDY

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### ABSTRACT

**Background:** As the mandible persists in a well-preserved state longer than any other bone, it can be handy in age and gender assessment. So the aim is to determine the accuracy of the Mandibular canal, Gonial angle, Mandibular foramen & Mental foramen in age and gender estimation using Cone Beam Computed Tomography (CBCT).

**Materials And Methods:** Three hundred CBCT images of male and female mandibles, aged 20 to 70, were categorized into five age groups (60 individuals each). Age and gender were assessed based on the gonial angle, mandibular canal, and vertical positions of the mandibular and mental foramina. **Results:** Significant correlations were found in age assessment through measurements like the distance from the lower border of the mandibular canal to the inferior border of the mandible. For gender determination, the distance from the posterior border of the ramus to the mandibular foramen, the height of the mandible, and the gonial angle showed significant differences across all age groups. **Conclusion:** The positions of the mental foramen and mandibular canal change significantly with age, while the mental foramen, mandibular foramen, and gonial angle are reliable indicators for gender determination.

**KEYWORDS :** Mandibular canal, Mandibular foramen, Mental foramen, Gonial angle.

### INTRODUCTION

All humans have identity in life; compassionate societies demand it. Even after death, one's identity can be recognized. When a person expires, there may be consequences, often financial, that must be dealt with<sup>(1)</sup>. To distinguish between truth and falsehood, forensic science plays an important role that can be generally accepted by the court of law and the general scientific community.

From a dental perspective, dimorphism in the mandible is reflected in its shape and size<sup>(2)</sup>. Its morphological features show changes concerning age, sex, and race. Based on several studies, the features that are very helpful for age and gender determination are mandibular canal, gonial angle, mandibular foramen, and mental foramen. Considering these present study aims to determine the accuracy of mandible in age and gender estimation using CBCT.

### MATERIALS AND METHODS:

The study involved patients visiting the Department of Oral Medicine and Radiology for routine dental issues. It included 300 mandibular CBCT images of males and females aged 20 to 70, divided into five gender-specific age groups: Group I (20-30 years), Group II (31-40 years), Group III (41-50 years), Group IV (51-60 years), and Group V (61-70 years), with 30 subjects in each group.

### Inclusion Criteria:

Mandibular images were included if they clearly showed all parameters: condyle, coronoid, gonion, menton, mandibular foramen, mental foramen, mandibular canal, and the

superior and inferior borders of the mandible.

### Exclusion Criteria:

Images were excluded if the patients had a history of trauma, orthognathic surgeries, tumors, or any anatomical variations.

### PROCEDURE:

The different linear measurements of the human mandible are compared with age and gender by using parameters such as gonial angle, mandibular canal, and vertical position of mandibular & mental foramen. All measurements were expressed in millimeters (mm).

1) **Gonial Angle:** Assessed by tracing a line tangent to the lower border of the mandible and another line to the distal border of the ramus of mandible (figure-1).



**Figure 1:** CBCT Image Showing Measurements Of Gonial Angle In Coronal Section.

2) **Position of mental foramen:** From the superior border of body of the mandible to the superior margin of mental foramen (S-Sm) & from the superior border of body of mandible to the inferior border of the body of the mandible (S-I) (figure-2).



Figure 2: CBCT Image showing measurements of mental foramen (MF) in sagittal section, A) S-Sm, B) S-I

3) **Position Of Mandibular Canal (MC):**

The height of the mandibular canal is measured by drawing a vertical distance from the inferior margin of the mandibular canal to the inferior limit of the base of the mandible (figure-3).

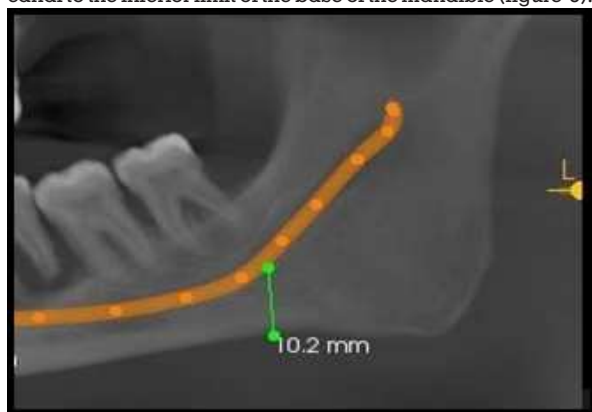


Figure 3: CBCT Image Showing Measurement Of Mandibular Canal In Coronal Section.

4) **Position of Mandibular foramen:** The position of the mandibular foramen is measured in three directions (figure-4):

1. **Superioinferior position(D1):** Vertical distance from the lowest point of the mandibular notch to the mandibular foramen.
2. **Anterioposterior position(D2):** Perpendicular distance from the mandibular foramen to the anterior border of the ramus.
3. **Posterioroanterior position(D3):** Distance from the mandibular foramen to the posterior border of the ramus.

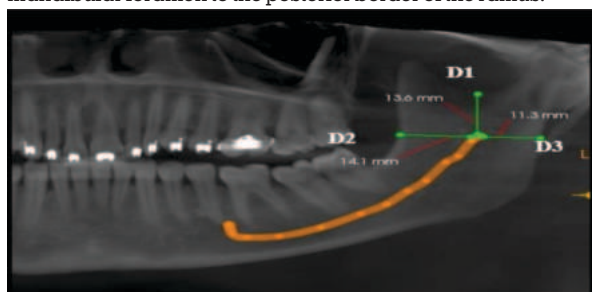


Figure 4: CBCT Image showing measurements of Mandibular foramen in coronal section.

**RESULTS**

**Statistical Analysis**

Data were entered into Excel and analyzed using SPSS V21. Descriptive statistics included means, standard deviations, and percentages. Independent t-tests and ANOVA were performed, with Pearson's correlation for regression analysis;  $p < 0.05$  was considered significant.

A total of 300 subjects aged between 20-70 years were divided into five groups, 60 subjects in each group with equal male and female distribution. The mean age of males and females was similar, suggesting no statistically significant difference in each group using an independent t-test.

The mean and standard deviation of linear measurements related to Gonial angle, S-I, S-sM, D2, MC was calculated in each group and significance is obtained using ANOVA test, p-value obtained is  $< 0.0001$  suggesting statistically significant. The mean and standard deviation of linear measurements related to D1, D3, was obtained in each group, and significance is obtained using ANOVA test, p-value obtained is 0.05, 0.07 suggesting statistically nonsignificant.

Pearson's correlation indicated that all mandibular parameters (gonial angle, mandibular canal, mental foramen, and mandibular foramen positions) were inversely related to age, meaning that as age increases, the parameter values decrease. (Table 1)

Table-1 Pearson's Correlation Coefficient And P-value Among The Total Study Sample.

Parameter	r value	P-value
Gonial Angle	-0.12	0.04
D1	-0.13	0.03
D2	0.16	0.01
D3	-0.12	0.04
Mental Foramen S-mS (in mm)	-0.96	$< 0.0001$
Mental Foramen S-I (in mm)	-0.91	$< 0.0001$
Mandibular Canal	-0.98	$< 0.001$

The regression model was obtained utilizing the Gonial angle, Mandibular canal, Mental foramen, and Mandibular foramen positions were derived to predict the chronological age listed in (Table 2).

Table-2 Regression Equations For Predicting Chronological Age

Parameter ( Linear measurements)	Regression equation
Gonial angle	$GA = 85.091 - 0.316 (GA)$
Mental foramen	$MF = 138.028 - 3.774 * (S-sM (in mm)) - 1.641 (S-I (in mm))$
Mandibular Foramen	$D1 = 54.34 - 0.731 (D1)$ $D2 = 30.415 + 1.026 (D2)$ $D3 = 56.325 - 0.921 (D3)$
Mandibular canal	$MC = 95.531 - 5.322 * (MC)$

The estimated age obtained from the mandibular canal and mental foramen regression equation has shown a significant correlation with chronological age. In contrast, mandibular foramen and gonial angle have no significant correlation between estimated and chronological age.

The mean values for gonial angle, mental foramen (S-I), and mandibular foramen (D3) showed significant differences between males and females. In contrast, the mean distances for mental foramen (S-sM), mandibular foramen (D1, D2), and mandibular canal were not statistically significant. (Table 3)

Table-3 Comparison Of Gender With Parameters Of The Total Subjects.

Parameter	Gender	Mean	Std. deviation	t value	p-value
Gonial Angle	Male	125.74	5.58	-2.32	0.02
	Female	127.18	5.1		
D1	Male	12.66	2.08	0.88	0.4
	Female	12.42	2.24		
D2	Male	14.55	2.08	-0.67	0.2
	Female	14.21	2.24		
D3	Male	12.59	1.88	4.75	<0.001
	Female	11.64	1.59		
S-sM	Male	12.94	2.48	0.78	0.4
	Female	12.72	2.35		
S-I	Male	27.54	3.14	2.55	0.01
	Female	26.62	3.09		
Mandibular Canal	Male	9.52	2.64	0.41	0.7
	Female	9.4	2.47		

**DISCUSSION**

Human identification relies on comparing ante-mortem data (characteristics of a missing person) with post-mortem data<sup>[4]</sup> (features of an unknown body). This process is crucial not only for officially declared deceased individuals but also for investigating crimes, mass disasters, and war atrocities.

While certain skull structures, like the foramen magnum and sinuses, can indicate gender, their preservation post-mortem is often limited. In contrast, the mandible is highly durable, surviving physical trauma and decay, as evidenced by its presence in ancient remains.

The positions of the mandibular foramina and canal are consistent throughout life, remaining unchanged despite bone resorption, making them reliable for identification. Hence, these mandibular characteristics are useful for determining age and gender<sup>[5]</sup>. Gonial angle is a significant angle of the craniofacial complex, also called the angle of the jaw or the mandibular angle<sup>[6]</sup>. The degree of gonial angle could change according to age<sup>[7,8]</sup>, gender, race, and physique. **Linear measurements of gonial angle:** The gonial angle was measured using lines tangent to the lower border of the mandible and the posterior border of the ramus. According to Izard, gonial angle averages vary: 130–150° at birth, 135–140° post-first dentition, 120–130° until the eruption of second molars, and 120–150° in old age. In this study, the gonial angle showed a highly significant p-value (<0.0001). Mean values for groups I, II, and V were higher than for groups III and IV, consistent with findings by Kasat and Shendakar, which suggest that the gonial angle changes with age from more obtuse to less obtuse and back to more obtuse. (Table 4)

**Table-4 Comparison Of Mean Values Of Gonial Angle Among Various Groups**

Group	Gonial Angle		F value	p value
	Mean	SD		
1	127.61	4.91	6.4	<0.0001
2	127.75	5.08		
3	126.16	5.33		
4	123.63	5.11		
5	127.15	5.54		

Linear regression analysis showed a Pearson correlation coefficient of -0.12 for all subjects, with individual group coefficients ranging from -0.2 to 0.21, indicating no significant correlation between chronological and estimated age. This aligns with findings by Chole and Dutra, suggesting that the gonial angle is not influenced by age or dental status.

The overall mean gonial angle was 125.74 ± 5.58° for males and 127.18 ± 5.10° for females, with a significant p-value of 0.02, indicating a higher mean in females. Casey and Emrich<sup>[6]</sup> noted that this difference may be due to males generally having stronger chewing strength, which is associated with a smaller gonial angle.

**Linear Measurements Related To Mental Foramen:**

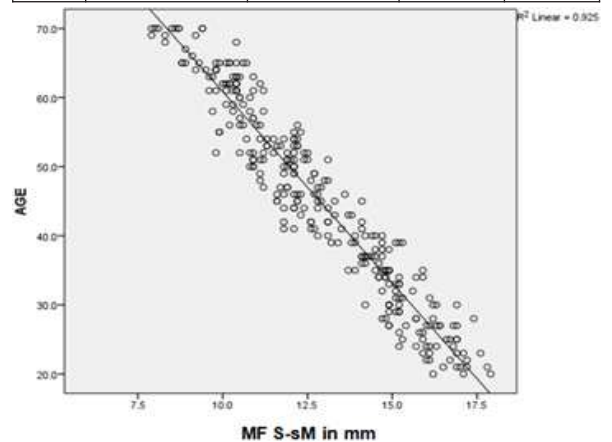
Studies by Wical and scope et al.<sup>[1]</sup>, Lindh et al.<sup>[10]</sup> and Chandra et al.<sup>[11]</sup>, confirmed that the distance between the mental foramen and the inferior border of the mandible is constant, making it a stable landmark. They analyzed the distance between the superior and inferior borders of the mandible (S-I) and from the superior border to the mental foramen (S-sM), finding significant age and gender variations with p < 0.0001 for both measurements. In this study S-I and S-sM were calculated in all the groups, and a p-value of <0.0001 was obtained, suggesting high statistical significance.

Pearson's correlation coefficient was found to be -0.91 and -0.96, respectively. The inverse relationship indicates the decrease in the value with an increase in age, suggesting the changes with age.

The CBCT study by Asrani and Shah<sup>[16]</sup> aligns with the current study, which also found a decline in mean values (S-sM) with age. Pearson's correlation coefficients for S-sM across groups I-V were -0.61, -0.61, -0.49, -0.56, and -0.78, indicating a weaker correlation in groups I and II, likely due to bone deposition until age 40, and a moderate correlation in groups III and IV, suggesting bone resorption with aging. (Table 5) and (Graph 1).

**Table-5 Comparison Of The Mean Position Of S-sM Among Various Groups With Advancement Of Age**

Group	Mental Foramen S-sM ( in mm)		F value	p value
	Mean	SD		
1	16.1	0.86	606.56	<0.0001
2	14.62	0.66		
3	12.40	0.80		
4	11.29	0.81		
5	9.72	0.84		

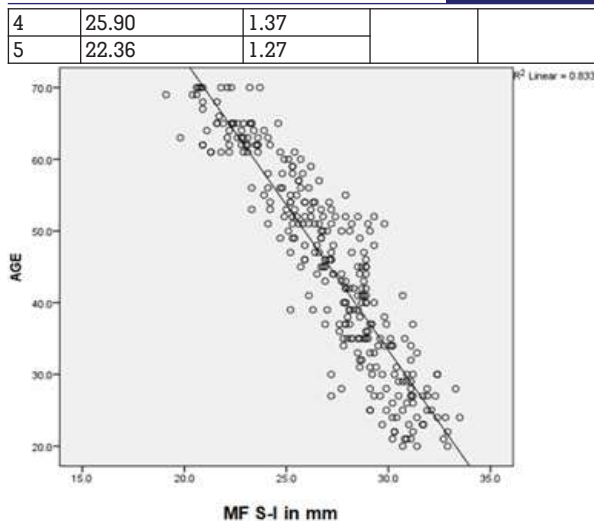


**Graph-1** Scatter plot between the chronological age and S-sM through the mental foramen suggesting a decrease in the value with an increase in the age

A study by Gershenson A et al.<sup>[12]</sup>, shown noted changes in the distance between S-I as the age advances, and these findings were in agreement with the present study. Pearson's correlation coefficient obtained for S-I among various groups such as Group I, II, III, IV, V was -0.25, -0.46, -0.44, -0.39, and -0.44, respectively, indicating a high correlation with chronological age. (Table 6) and (Graph 2)

**Table-6 Comparison Of The Mean Position Of S-I Among Various Groups.**

Group	Mental Foramen S-I (in mm)		F value	p value
	Mean	SD		
1	30.87	1.34	370.38	<0.0001
2	28.80	1.18		
3	27.48	1.26		



**Graph-2** Scatter plot between the chronological age and S-I through the mental foramen suggesting a decrease in the value with an increase in the age

All the age groups in the present study revealed a statistically significant difference between gender with distance from superior border to the inferior border of the mandible, where overall mean values of males were  $27.54 \pm 3.14$  and for females  $26.62 \pm 3.09$  with p-value 0.01 respectively.

**Linear Measurements Of Mandibular Foramen:**

In the present study, the position of mandibular foramen was measured in three directions, Superioinferior position (D1), Anteroposterior position (D2), Posteroanterior position (D3) in all the age groups. The p-value obtained for D1 and D3 were 0.05 and 0.07, suggestive of no statistical significance. Pearson's correlation coefficient was -0.13 and -0.12, respectively. The inverse relationship indicates a decrease in the value as an increase in age. Table 7 and 9 depicts the changes in position of mandibular foramen ( D1, D3) with the advancement of age.

**Table-7 Comparison Of The Mean Position Of D1 among Various Groups.**

Group	Mandibular Foramen(D1)		F value	p value
	Mean	SD		
1	12.42	1.92	2.32	0.05
2	12.98	2.49		
3	12.88	2.52		
4	12.61	2.51		
5	11.81	2.28		

**Table-9 Comparison Of The Mean Position Of D3 Among Various Groups.**

Group	Mandibular Foramen(D3)		F value	p value
	Mean	SD		
1	12.25	1.53	2.19	0.07
2	12.21	1.67		
3	12.47	1.77		
4	12.10	1.78		
5	11.55	2.14		

In D2, the obtained p-value was <0.001, which was statistically significant. Pearson's correlation coefficient was 0.16, suggesting a weaker correlation of chronological age to estimated age. The Table 8 depicts the changes in mandibular foramen (D2) with advancement of age.

In comparing D1, D2, and D3 distances by gender across all groups, D1 and D2 had p-values of 0.4 and 0.2, indicating no statistical significance. However, D3 showed a significant p-value of <0.001. The mean distances for D2 and D3 were greater in males than in females. Shendakar et al. [14] suggest that

stronger masticatory muscles in males contribute to greater muscular tension and bone formation. The differences in mean values imply that the mandibular foramen shifts anteriorly, likely due to bone apposition at the posterior ramus and remodeling at the anterior ramus, promoting anterior growth.

**Table-8 Comparison Of The Mean Position Of D2 Among Various Groups.**

Group	Mandibular Foramen(D2)		F value	p-value
	Mean	SD		
1	13.8	1.52	8.63	<0.0001
2	14.25	1.96		
3	14.77	2.14		
4	13.55	1.99		
5	15.51	2.57		

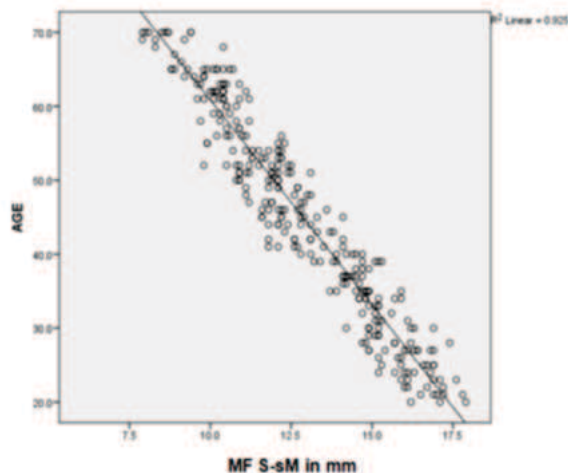
**Linear Measurements Of Mandibular Canal:**

In the present study, the vertical distance of mandibular canal was measured from the inferior margin of mandibular canal to the inferior limit of the inferior border of the mandible showed a highly significant p value, i.e., <0.001, and a decrease in mean values with the advancement of age was noted.

A CBCT study by Nasim Shams et al. [17] aligns with the present study, which showed that individuals over 55 had significantly greater distances than those aged 45-54, likely due to increased basal mandible height from bone deposition along the inferior border in adulthood.

Pearson's correlation coefficient obtained for mandibular canal among overall groups was -0.98. In individual age groups I, II, III, IV, and V were -0.77, -0.77, -0.65, -0.54, and -0.62, indicating a very high significant correlation of chronological to the estimated age.

Table 10 depict the changes of distance from the mandibular canal to inferior border of mandible with the advancement of age and Graph 3 showing a significant correlation between chronological age and position of mandibular canal to inferior border of mandible in age estimation. In this study, the mean distance from the lower margin of the mandibular canal to the inferior border of the mandible was  $9.52 \pm 2.64$  mm in males and  $9.40 \pm 2.47$  mm in females, with a p-value of 0.7 indicating no statistical significance. However, the mean values were higher in males, consistent with Uppal MK et al. [7], who noted that mandibular canal characteristics, including positioning and curvature, differ by gender.



**Graph-3** Scatter plot between the chronological age and mandibular canal distance to inferior mandibular border suggesting a decrease in the value with an increase in the age.

**Table-10 Comparison Of The Mean Position Of Distance From MC To The Inferior Border Of The Mandible Among**

**Various Groups.**

Group	Mandibular Canal		F value	p value
	Mean	SD		
1	13.12	0.73	794.15	<0.001
2	10.94	0.64		
3	9.38	0.75		
4	7.79	0.79		
5	6.08	0.81		

**CONCLUSION**

The current study concluded that there were significant changes in the position of mental foramen, mandibular canal in vertical direction as age advances making them reliable, whereas the mandibular foramen and gonial angle were less accurate in determining age. For gender determination, mental foramen (S-I), Mandibular foramen (D3) and Gonial angle are considered as reliable markers.

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