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Original Research Paper

Gender Determination by Mental Foramen and Height of the Body of the Mandible in Dentulous Patients A Radiographic Study

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Abstract

Distinguishing sex by analyzing the morphological characteristics of bone is important in the field of physical and forensic anthropology. Panoramic radiographs are commonly used in all disciplines of dentistry. This paper emphasizes the determination of sex based on the measurement of the height of the mandible and the position of the mental foramen in dentulous patients on the right side of the orthopantomograph. Orthopantomographs of 102 Dentulous patients were selected for the purpose of the study. The study sample was divided into three groups of less than 25 years, 25 – 50 years and above 50 years. Measurements were made using the reference lines drawn from anatomical landmarks. Four measurements were made on every radiograph on the right side digitally. The data obtained was tabulated and subjected to statistical analysis. The results of the study showed statistically significant difference in comparison of the height of the mandible in males and females ($p<0.05$).

Key Words: Height of the mandible, Panoramic radiograph, Mental foramen, Gender Forensic study

Introduction:

Distinguishing males from females and the differences in ethnic groups by analyzing the morphological characteristics of bone is important in the field of physical and forensic anthropology. The mandible is the strongest bone in the human body and persists in a well-preserved state longer than any other bone. [1]

Therefore, the morphological features of the mandible are commonly used by anthropologists and forensic dentists in the determination of sex. [2] Sex determination from skeletal remains is an important aspect of the osteologic analysis of a given population. [3]

The radiographs are indispensable tools that can also be used in forensic anthropology. The accuracy of measurements on radiographs is based on the quality of the radiographs. [4] The image quality of the panoramic radiograph is increased by the digital panoramic radiography. [5]

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The mental foramen is fairly well depicted in panoramic radiographs. [4] It provides the ability to view the entire body of the mandible and allows a more accurate location of the mental foramen in both horizontal as well as in vertical dimensions. [6] Digital panoramic radiographs can be used to determine vertical height measurements of the mandible. [7]

The aim of the present study was to signify the average measurements from the superior and the inferior borders of the mental foramen to the lower border of the mandible and to the alveolar crest on digital panoramic radiographs on right side in determining the gender.

Objectives:

1. To measure the height of the mandibular body on the right side.
2. To measure the distance between the superior margin of the mental foramen to the inferior border of the mandible on right side.
3. To measure the distance between the inferior margin of the mental foramen to the inferior border of the mandible on the right side.
4. To measure the distance between the superior margin of the mental foramen to the alveolar crest on the right side.
5. To compare the above measurements for gender assessment.

Materials and Methods:

Orthopantomographs of 102 dentulous patients visiting the department of Oral Medicine and Radiology of our college were selected for the purpose of this study.

The radiographs were taken using Orthophos - DS digital panoramic machine. Criteria for selection of radiographs are:

1. All teeth in the region of measurement had to be present.
2. Evidence of alveolar crest resorption in premolar and first molar regions was minimum or absent.
3. Radiographic images of the mental foramen and the borders of the mandible were distinct, free of artifacts in the site of measurement.

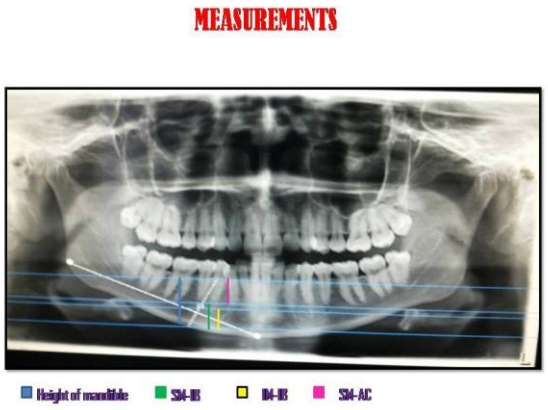
The study sample was divided into three groups of less than 25 years, 25 – 50 years and above 50 years. Each group consisted of 34 radiographs. Two investigators were responsible for selecting the panoramic radiographs and performing the measurements.

Each radiograph was viewed digitally. Measurements were made using the reference lines drawn from anatomical landmarks.

A line joining the most prominent point on the chin the 'menton' and the most prominent point of the angle of the mandible 'joining' was marked using Adobe photoshop.

The mental foramen was identified and marked on the right side. A line perpendicular to this tangent was marked from the inferior mandibular border to the alveolar crest such that it intersected the inferior edge of the mental foramen on the right side. Four measurements were made on every radiograph on the right side digitally: (Fig. 1)

Fig. 1: Measurement



1) The distance from the inferior surface of the mandibular body to the height of the alveolar crest on the right side (height).
2) The distance between the superior margins of the mental foramen to the inferior border of the mandible on the right side (SM to IB).
3) The distance between the inferior margins of the mental foramen to the inferior border of the mandible on the right side (IM to IB).
4) The distance between the superior margin of the mental foramen to the alveolar crest on the right side (SM to AC) – were measured.

The data obtained was subjected to statistical analysis using Turkeys multiple post hoc procedures.

Results:

Present study showed that there was a statistically significant difference in the measurements between males and females on the right side in relation to the height of the mandible, SM to IB, IM to IB ($p = 0.0031^*$, 0.0020^*, 0.0077^* respectively); whereas SM to AC measurements between males and females did not show a statistically significant difference. (p=0.326) (Table 1)

In this study there was no statistically significant difference between males and females with respect to different variables on the right side in an age group of less than 25 years except for the SM to IB measurement which showed a statistically significant difference between the two sexes. ($p=0.0089^*$) (Table 2)

In our study there was no statistically significant difference between males and females with repsect to different variables on the right side in an age group of 25-50 years except for the height of the mandible which showed a statistically significant difference between the two sexes($p=0.0106^*$). (Table 3)

But statistically significant difference was observed between males and females with respect to the measurements of height of the mandible on the right side in an age group of more than 50 years, IM to IB and SM to AC, ($p=0.0032^*$, 0.0365^*, 0.0013^* respectively) whereas SM to IB measurement did not show a statistically significant difference between the two sexes (p=0.4947). (Table 4)

Statistically significant difference was observed in our study in the measurements of height of the mandible and SM to AC in comparison of age groups of less than 25 years and 25-50 years , and on comparison of age groups of 25- 50 years and more than 50 years.

Rest of the variables did not show significant difference between different age groups. (Table 5) Present study also observed

statistically significant difference in the measurements of height of the mandible of males, SM to IB, IM to IB and SM to AC on comparison of age groups of less than 25 years and more than 50 years.

A significant difference was observed in the measurements of height of the mandible, SM to AC on comparison of age groups of 25 - 50 years and more than 50 years. (Table 6)

Similiarly Females also showed Statistically significant difference in the measurements of height of the mandible and SM to AC on comparison of age groups of less than 25 years and more than 50 years. Similar results were obtained on comparing different variables in the age groups of 25- 50 years and more than 50 years. (Table 7)

Discussion:

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 or determining sex. [1]

Wical and Swoope described that despite the alveolar bone resorption above the mental foramen, the distance from the foramen to the inferior border of the mandible remains relatively constant throughout life. [8]

Lindh et al and Guler et al 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 the height of alveolar bone in this region. [9, 10]

Because of the stability of the basal bone and mental foramen, these landmarks were selected as a point of reference for the present study.

In the present study, the mean values of the height of the mandible were significantly high in males as compared with females, and the results were in accordance with those of Cagri Ural et al, Ortman et al and Baat et al. [7, 11, 12]

Mean height of the mandible was significantly higher in males compared to females in the age group of 25-50 yrs and >50yrs. In the present study, the mean values of SM-IB and IM-IB was significantly high in males as compared with females and the results were in accordance with those of other authors. [13, 14] On the contrary, Vodanovic et al [15] found that the mean value of IM-IB does not exhibit sexual dimorphism.

In the present study the mean value of SM-IB was significantly higher in males compared to females in the age group of <25yrs. In the present study the mean value of IM-IB was significantly higher in males compared to females in the age group of >50yrs.

In the present study the mean value of SM-AC was significantly higher in males compared to females in the age group of >50yrs.

In our study comparing different variables (height, SM-IB, IM-IB and SM-AC) in different age groups (<25, 25-50 and >50yrs) showed highly significant values in comparison between males and females of height of the mandible and SM-AC in <25 vs >50 and 25–50 vs >50yrs.

In the present study comparing different variables in different age groups of males showed significant values in comparison between <25 vs >50 and 25-50 vs >50yrs.

In the present study comparing different variables in different age groups of females showed significant values in comparison between <25 vs >50 and 25-50 vs >50yrs.

Conclusion:

It is possible to conclude that the height of the mandible and the distance from the superior margin of the mental foramen to the alveolar crest can be used to determine the gender.

The following conclusions are drawn from this study

- A mean height of 35.4mm and 33.9mm in the age group of <25yrs can be considered as male and female respectively.
- A mean height of 37.5mm and 34.2mm in the age group of 25-50yrs can be considered as male and female respectively.
- A mean height of 32.7mm and 31.0mm in the age group of >50yrs can be considered as male and female respectively.
- A mean distance from the superior margin of the mental foramen to the alveolar crest of 16.2mm and 14.8 mm in the age group of >50yrs can be considered as male and female respectively.

However, large study groups and comprehensive assessment of various other parameters related to the height of the mandible and mental foramen may be required for more definitive and confirmatory results.

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Table 1
Comparison of Males and Females in Different Variables on Right Side

Summary	Height			SM to IB			IM to IB			SM to AC		
	Male	Female	Combined	Male	Female	Combined	Male	Female	Combined	Male	Female	Combined
N	52	50	102	52	50	102	52	50	102	52	50	102
Minimum	30	27	27	14	12	12	11	10	10	14	13	13
Maximum	40	40	40	20	20	20	17	17	17	22	22	22
Mean (mm)	34.54	33.08	33.82	17.08	16.08	16.59	13.88	13.08	13.49	17.42	17.00	17.22
SD	2.40	2.47	2.53	1.33	1.82	1.66	1.37	1.61	1.54	1.76	2.52	2.17
SE	0.33	0.35	0.25	0.18	0.26	0.16	0.19	0.23	0.15	0.25	0.36	0.21
95% CI-Lower Bound	33.87	32.38	33.33	16.71	15.56	16.26	13.50	12.62	13.19	16.93	16.29	16.79
95% CI-Upper Bound	35.21	33.78	34.32	17.45	16.60	16.91	14.27	13.54	13.79	17.91	17.71	17.64
t-value	3.0299			3.1746			2.7204			0.9866		
p-value	0.0031*			0.0020*			0.0077*			0.3262		

Table 2
Comparison of Males and Females in Different Variables on Right Side of less than 25 yrs of Age

Summary	Height			SM to IB			IM to IB			SM to AC		
	M	F	Combined	M	F	Combined	M	F	Combined	M	F	Combined
N	16	18	34	16	18	34	16	18	34	16	18	34
Minimum	32	27	27	14	12	12	11	10	10	15	13	13
Maximum	40	40	40	20	20	20	17	17	17	22	22	22
Mean (mm)	35.38	33.94	34.62	17.75	16.00	16.82	14.56	13.39	13.94	17.6	17.94	17.79
SD	2.78	2.67	2.78	1.73	1.91	2.01	1.63	1.75	1.77	1.96	2.41	2.19
SE	0.69	0.63	0.48	0.43	0.45	0.34	0.41	0.41	0.30	0.49	0.57	0.38
95% CI-Lower Bound	33.89	32.62	33.65	16.83	15.05	16.12	13.69	12.52	13.32	16.58	16.74	17.03
95% CI-Upper Bound	36.86	35.27	35.59	18.67	16.95	17.52	15.43	14.26	14.56	18.7	19.14	18.56
t-value	1.5309			2.7853			2.0121			-0.4201		
p-value	0.1356			0.0089*			0.0527			0.6772		

Table 3
Comparison of Males and Females in Different Variables on Right Side of 25-50 Yrs Age

Summary	Height			SM to IB			IM to IB			SM to AC		
	M	F	Combined	M	F	Combined	M	F	Combined	M	F	Combined
N	18	16	34	18	16	34	18	16	34	18	16	34
Minimum	33	30	30	15	12	12	11	10	10	17	15	15
Maximum	39	36	39	19	19	19	16	16	16	20	22	22
Mean (mm)	35.67	34.19	34.97	17.06	16.00	16.56	13.72	13.06	13.41	18.50	18.19	18.35
SD	1.57	1.60	1.73	0.94	2.31	1.78	1.18	2.08	1.67	1.15	2.26	1.74
SE	0.37	0.40	0.30	0.22	0.58	0.31	0.28	0.52	0.29	0.27	0.56	0.30
95% CI-Lower Bound	34.89	33.33	34.37	16.59	14.77	15.94	13.14	11.95	12.83	17.93	16.98	17.75
95% CI-Upper Bound	36.45	35.04	35.57	17.52	17.23	17.18	14.31	14.17	14.00	19.07	19.39	18.96
t-value	2.7153			1.7835			1.1543			0.5173		
p-value	0.0106*			0.0840			0.2569			0.6085		

Table 4
Comparison of Males and Females in Different Variables on Right Side of >50 yrs Age

Summary	Height			SM to IB			IM to IB			SM to AC		
	M	F	Combined	M	F	Combined	M	F	Combined	M	F	Combined
N	18	16	34	18	16	34	18	16	34	18	16	34
Minimum	30	29	29	15	15	15	11	11	11	14	13	13
Maximum	34	34	34	18	18	18	15	14	15	19	16	19
Mean (mm)	32.67	31.00	31.88	16.50	16.25	16.38	13.44	12.75	13.12	16.17	14.75	15.50
SD	1.50	1.55	1.72	0.99	1.13	1.05	1.10	0.68	0.98	1.30	1.00	1.35
SE	0.35	0.39	0.30	0.23	0.28	0.18	0.26	0.17	0.17	0.31	0.25	0.23
95%CI-Lower Bound	31.92	30.17	31.28	16.01	15.65	16.02	12.90	12.39	12.78	15.52	14.22	15.03
95%CI-Upper Bound	33.41	31.83	32.48	16.99	16.85	16.75	13.99	13.11	13.46	16.81	15.28	15.97
t-value	3.1898			0.6908			2.1824			3.5363		
p-value	0.0032*			0.4947			0.0365*			0.0013*		

Table 5
Comparison of Different Variables in Different Age Groups (<25, 25-50,> 50) on Right Side

Summary	Height				SM to IB				IM to IB				SM to AC			
	<25	25-50	>50	Combined	<25	25-50	>50	Combined	<25	25-50	>50	Combine	<25	25-50	>50	Combined
N	34	34	34	102	34	34	34	102	34	34	34	102	34	34	34	102
Minimum	27	30	29	27	12	12	15	12	10	10	11	10	13	15	13	13
Maximum	40	39	34	40	20	19	18	20	17	16	15	17	22	22	19	22
Mean (mm)	34.6	35.0	31.9	33.8	16.8	16.6	16.4	16.6	13.9	13.4	13.1	13.5	17.0	17.6	15.5	17.2
SD	2.8	1.7	1.7	2.5	2.0	1.8	1.0	1.7	1.8	1.7	1.0	1.5	2.2	1.7	1.4	2.2
SE	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.2	0.4	0.3	0.2	0.2
95%CI Lower Bound	33.7	34.4	31.3	33.3	16.1	15.9	16.0	16.3	13.3	12.8	12.8	13.2	17.0	17.8	15.0	16.8
95% CI-Upper Bound	35.6	35.6	32.5	34.3	17.5	17.2	16.8	16.9	14.6	14.0	13.5	13.8	18.6	19.0	16.0	17.6
F-value	21.3472				0.6072				2.5752				24.2079			
P-value	0.0000*				0.5469				0.0812				0.0000*			
Pair wise comparison by Tukeys multiple posts hoc procedures																
<25 v/s 25-50yrs	0.7745				0.7890				0.3249				0.4065			
<25 v/s >50yrs	0.0001*				0.5197				0.0697				0.0001*			
25-50 v/s >50yrs	0.0001*				0.8999				0.7041				0.0001*			

Table 6
Comparison of Different Variables in Different Age Groups (<25, 25-50, >50) on Right Side of Males

Summary	Height				SM to IB				IM to IB				SM to AC			
	<25	25-50	>50	Combined	<25	25-50	>50	Combined	<25	25-50	>50	Combined	<25	25-50	>50	Combined
N	16	18	18	52	16	18	18	52	16	18	18	52	16	18	18	52
Minimum	32	33	30	30	14	15	15	14	11	11	11	11	15	17	14	14
Maximum	40	39	34	40	20	19	18	20	17	16	15	17	22	20	19	22
Mean (mm)	35.4	35.7	32.7	34.5	17.8	17.1	16.5	17.1	14.6	13.7	13.4	13.9	17.6	18.5	16.2	17.4
SD	2.8	1.6	1.5	2.4	1.7	0.9	1.0	1.3	1.6	1.2	1.1	1.4	2.0	1.2	1.3	1.8
SE	0.7	0.4	0.4	0.3	0.4	0.2	0.2	0.2	0.4	0.3	0.3	0.2	0.5	0.3	0.3	0.2
95% CI-Lower Bound	33.9	34.9	31.9	33.9	16.8	16.6	16.0	16.7	13.7	13.1	12.9	13.5	16.6	17.9	15.5	16.9
95% CI-Upper Bound	36.9	36.5	33.4	35.2	18.7	17.5	17.0	17.5	15.4	14.3	14.0	14.3	18.7	19.1	16.8	17.9
F-value	12.1621				4.2459				3.3004				11.2514			
P-value	0.0001*				0.0199*				0.0452*				0.0001*			
Pair wise comparison by Tukeys multiple posts hoc procedures																
<25v/s25-50yrs	0.9056				0.2478				0.1590				0.2120			
<25 v/s >50yrs	0.0008*				0.0147*				0.0427*				0.0174*			
25-50 v/s >50yrs	0.0002*				0.3834				0.8009				0.0002*			

Table 7
Comparison of Different Variables in Different Age Groups (<25, 25-50, >50) on Right Side of Females

Summary	Height				SM to IB				IM to IB				SM to AC			
	<25	25-50	>50	Combined	<25	25-50	>50	Combined	<25	25-50	>50	Combined	<25	25-50	>50	Combined
N	18	16	16	50	18	16	16	50	18	16	16	50	18	16	16	50
Minimum	27	30	29	27	12	12	15	12	10	10	11	10	13	15	13	13
Maximum	40	36	34	40	20	19	18	20	17	16	14	17	22	22	16	22
Mean (mm)	33.9	34.2	31.0	33.1	16.0	16.0	16.3	16.1	13.4	13.1	12.8	13.1	16.3	17.2	14.8	17.0
SD	2.7	1.6	1.5	2.5	1.9	2.3	1.1	1.8	1.8	2.1	0.7	1.6	2.4	2.3	1.0	2.5
SE	0.6	0.4	0.4	0.3	0.5	0.6	0.3	0.3	0.4	0.5	0.2	0.2	0.6	0.6	0.3	0.4
95% CI-Lower Bound	32.6	33.3	30.2	32.4	15.1	14.8	15.7	15.6	12.5	12.0	12.4	12.6	16.7	17.0	14.2	16.3
95% CI-Upper Bound	35.3	35.0	31.8	33.8	17.0	17.2	16.9	16.6	14.3	14.2	13.1	13.5	19.1	19.4	15.3	17.7
F-value	12.3041				0.0993				0.6555				14.7652			
P-value	0.0001*				0.9057				0.5239				0.0000*			
Pair wise comparison by Tukeys multiple posts hoc procedures																
<25 vs 25-50yrs	0.9360				1.0000				0.8292				0.9344			
<25 vs >50yrs	0.0004*				0.9186				0.4925				0.0002*			
25-50 vs >50yrs	0.0003*				0.9229				0.8502				0.0002*			