

Panoramic radiograph as a forensic aid in age and gender estimation: Preliminary retrospective study

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Abstract

Background: The temporomandibular joint is a hinge joint which is formed by the mandible with articulation of the jaw with the cranium. The morphology of the mandible is evaluated by measuring the gonial angle ramus height and bigonial width.

Aim: The aim of this study to investigate the impact of age and gender on ramus height, gonial angle and bigonial width in the dentulous odisha population using digital panoramic radiographs.

Materials and Methods: A total of 50 dentulous participants (25 males and 25 females) aged between 10 and 80 years were included in this study. The data were collected after comprehensive examination by 1 principal and two coinvestigators.

Statistical Analysis: The mean difference between gender and different age groups was calculated using SPSS version 20.0. Unpaired *t*-test and one-way ANOVA were used for comparison studied parameters according to gender, side and different age groups followed by Tukey's *post hoc* test.

Results: A statistically significant gender difference was seen for gonial angle, ramus height and bigonial width. All the parameters increased with increase in age. This difference was statistically significant on the right side for gonial angle and ramus height.

Conclusion: This study is useful as for age and sex determination using mandible as primary object in forensic odontology.

Keywords: Digital panoramic radiography, forensic odontology, mandible

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Received: 31.10.2017, **Accepted:** 25.04.2018

INTRODUCTION

In adults, anatomical changes of the mandible are perceived to be influenced by the occlusal status and age of the participant. The remodeling of the mandibular bone occurs with age. To evaluate the morphology of the mandible gonial angle, ramus height and bigonial width are measured.^[1,2] Age and systemic component such as

rheumatoid disease along with loss of teeth are considered to change the bone morphology of mandible and the gonial angle. A wider gonial angle is found in edentulous individuals when compared with dentulous individuals.^[3]

These factors are correlated with the function and architecture of the muscles of mastication. Aging causes

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How to cite this article: Bhuyan R, Mohanty S, Bhuyan SK, Pati A, Priyadarshini S, Das P. Panoramic radiograph as a forensic aid in age and gender estimation: Preliminary retrospective study. J Oral Maxillofac Pathol 2018;22:266-70.

Access this article online

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10.4103/jomfp.JOMFP_90_17

change in masticatory function and alters the contractile activity of individuals. The masseter and medial pterygoid muscles decrease with age as masseter and medial pterygoid muscles gets inserted into the region of the gonial angle. The strength of masseter and anterior temporal muscle activity is related with greater posterior facial height, a flat mandibular plane and a small gonial angle.^[4]

Panoramic radiographs are commonly used routine radiographs to assess the jaws. Although the mandible is asymmetrical evaluation of the condylar and the ramus process is possible for measuring vertical differences between both sides as they allow a bilateral view and are adequate for vertical measurements of the mandible. As there is nonlinear variation the different depths can be measured without any controversy on the invalidity of the horizontal measurements.^[5]

MATERIALS AND METHODS

A retrospective study was conducted at our department utilizing digital panoramic radiographs randomly collected from the database MYRAY HYPERION (morphology recognition technology, MYRAY version 2, 1, 0, 10, copyright 2008–2011, Cefla North America, Inc). Nearly 50 participants in the age group between 11 and 79 years with 25 males and 25 females. The sample was divided into seven groups Group A: 10–19 years, Group B 20–29 years, Group C 30–39 years, Group D 40–49 years, Group E 50–59 years, Group F 60–69 years and Group G 70–79 years. Panoramic radiographs showing pathologies, fractures, developmental disturbances of the mandible and edentulous mandible were excluded from the study. Clearance by the Ethical committee of was obtained from Siksha O Anusandhan University. Before commencement of the study principal investigator (PI) was trained in the Department of Oral Medicine and Radiology of the Institution by a gold standard participant expert (GS). Interexaminer reliability between PI and GS was checked with Kappa Statistics (Kappa ≥ 0.80) and intraexaminer reproducibility was also checked (Kappa ≥ 0.9) for all the parameters (1st query).

Ramus width [Figure 1]

The following parameters were measured using mouse-driven method:

- Maximum ramus breadth (A): the distance between the most anterior point on the mandibular ramus and a line connecting the most posterior point on the condyle and the angle of jaw
- Minimum ramus breadth (B): smallest anterior–posterior diameter of the ramus

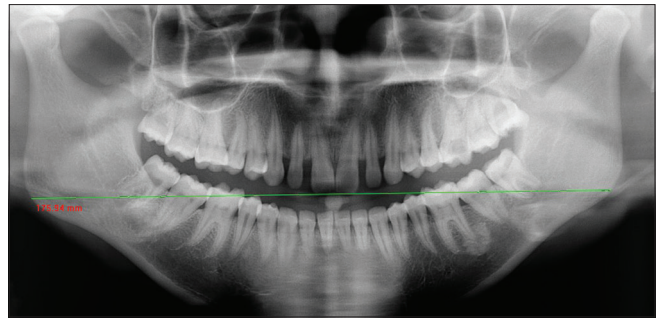


Figure 1: Bigonial width measurement

- Condylar height/maximum ramus height (C): height of the ramus of the mandible from the most superior point on the mandibular condyle to the tubercle, or most protruding portion of the inferior border of the ramus
- Projective height of ramus (D): projective height of ramus between the highest point of the mandibular condyle and lower border of mandible
- Coronoid height (E): projective distance between coronoid and lower border of the mandible.

Gonial angle [Figure 2]

The gonial angles were measured using a method described by Mattila *et al.*^[5]

A line was digitally traced on the panoramic radiographs tangential to the most inferior points at the gonial angle and the lower border of the mandibular body and another line tangential to the posterior borders of the ramus and the condyle. The intersection of these two lines formed the gonial angle, which was measured either on the right or left side depending on the accuracy of the image.

Bigonial width

The bigonial width is the distance between both Gonia (Go). Gonian is the most inferior, posterior and lateral point on the external angle of the mandible.^[5]

It was measured horizontally from the right to left gonion.

All the above measurements were performed using MyRay software and the measurements were compensated to the magnification (19%) of the panoramic machine. All the measurements were made with the observers being blinded to the age and sex of the patient's radiographs.

Statistical analysis

Data were collected for the participants and were analyzed using the SPSS version 20 (SPSS Inc., IL, USA). Unpaired *t*-test was carried out to compare between gender and sides. One-Way ANOVA was used to compare the difference in

the studied parameters according to different age groups followed by Turkey's *post hoc* test.^[1]

RESULTS

The result shows the mean age of all participants was 33.12 ± 15.82. Mean age of males was higher than that of females. Differences were not significant [Table 1] (% of males and females added 3rd query).

The mean of the gonial angle and ramus height on the right side is slightly higher than left side. Males have higher value than females. However, these differences were not statistically significant [Table 2].

Gender difference in gonial angle, bigonial angel and ramus height were statistically significant with (*P* ≤ 0.05). Unpaired *t*-test was used to compare the gender difference between parameters using SPSS version 20. All the differences were found to be statistically nonsignificant [Table 3] (query 2).

The mean values of ramus height, bigonial width and gonial angle in seven age groups. Bigonial width increased with increase in age which is statistically not significant [Table 4].

The gonial angle of males (right) increased with increase in age which is statistically significant.

In case of ramus height in males (right) increased in the second and third decade then decreased with increase in age. SPSS version 20 was used for comparing the parameters. one-way ANOVA was used to compare the difference in the studied parameters according to different age groups. Turkey's *post hoc* test was used to get the significant pairs.

DISCUSSION

Lateral cephalograms were the most popularly used radiograph of choice for measuring the morphological variation of the mandible.^[6] The primary drawback is it does not allow bilateral mandibular measurement

assessment and variation. They also cause superimposition of the ramus, for which orthopantomograms were being used and are a more reliable method of obtaining data. Published studies reveal gonial angle was the parameter with acceptable accuracy and precision in determining gender, which in turn suggests a forensic implication. From a medicolegal point of view, odontology is commonly used to identify human remains. Research into age determination from dental radiographs largely consists of the use of lateral cephalograms and orthopantomograms with the majority of papers investigating the gonial angle and few researching ramus height and bigonial width.^[7]

Panoramic radiographs are coherent and precise for the linear and angular measurements on mandibles.^[6] In the present study, assessment was done to measure the gonial angle, ramus height and bigonial width on digital panoramic radiographs and to compare between gender and different age groups in dentate patients. The mean age of all patients was 33.12 ± 15.82. The mean age of males was higher than that of females; however, differences were not significant.

Table 1: Mean age of all subjects with males & females

	Males	Females	Total	% males	% females
Mean age (SD)	35.04	31.28	33.12	-	-
Age range	(18.52)	(12.34)	(15.82)		
	11-76	11-66	11-76		
11-19	4	4	8	50	50
20-29	10	9	19	52.63	47.36
30-39	4	4	8	50	50
40-49	0	4	4	0	50
50-59	3	2	5	60	40
60-69	3	1	4	75	25
70-79	1	0	1	100	0

Table 2: Gender difference in Gonial angle, Bigonial angel & Ramus height were statistically significant

	Male	Female	Mean
Ramus height			
Right	64.56±1.06	57.16±1.04	60.78±6.37
Left	64.25±1.09	56.72±0.98	60.41±6.34
Bigonial width	162.97±2.34	156.49±2.21	159.66±11.61
Gonial angle			
Right	128.43±2.02	117.10±1.83	122.65±11.04
Left	126.57±1.67	118.51±2.03	122.46±10.03

Table 3: Comparison of difference in gonial angle and ramus height of left and right side

Parameters	Mean difference (%)	Standard error of difference	t	P
Gonial angle				
Right	11.33 (8.8)	2.72	4.16	0.000*
Left	8.05 (6.36)	2.65	3.043	0.004*
Bigonial width	6.48 (3.97)	3.22	2.014	0.050*
Ramus hight				
Right	7.40 (11.46)	1.49	4.96	0.000*
Left	7.53 (11.71)	1.46	5.137	0.000*

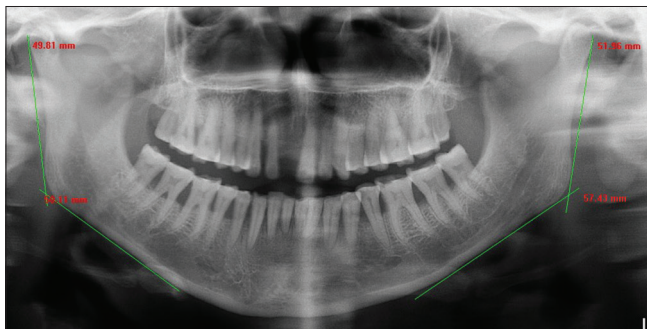


Figure 2: Bigonial angle and ramus height measurement

Table 4: The mean values of ramus height, bigonial width and gonial angle in 7 age groups

Age range group	Bigonial angle			Ramus height						Gonial angle					
	Male	Female	Total	Right			Left			Right			Left		
				Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Group A: 10-19	155.64	168.78	162.21	60.26	57.07	58.67	61.33	55.25	58.29	120.28	122.06	121.17	123.10	114.82	118.96
Group B: 20-29	165.07	152.79	158.61	65.47	56.87	60.94	65.43	56.58	60.77	130.23	116.01	122.75	128.72	119.28	123.75
Group C: 30-39	164.36	158.36	161.36	61.33	58.67	60.00	61.16	57.64	59.40	123.47	120.54	122.00	125.91	121.72	123.82
Group D: 40-49	-	157.41	157.41	-	59.33	59.33	-	58.88	58.88	-	118.80	118.80	-	126.24	126.24
Group E: 50-59	170.09	146.67	160.72	64.54	54.83	60.66	64.67	56.55	61.42	133.51	108.76	123.61	127.27	107.19	119.24
Group F: 60-69	174.25	162.74	164.66	66.67	50.36	60.14	65.29	52.05	59.99	147.11	114.27	126.98	131.73	104.55	114.86
Group G: 70-79	172.52	-	172.52	80.19	-	80.19	73.23	-	73.23	153.44	-	153.44	136.10	-	136.10
ANOVA															
F	1.356	1.991	0.765	9.473	0.921	3.614	1.193	0.562	1.614	5.580	1.640	3.035	1.006	2.309	1.517
P	0.285	0.124	0.602	0.000*	0.488	0.005*	0.139	0.728	0.166	0.003*	0.195	0.014*	0.441	0.083	0.195
Significant pairs (Tukey's Post Hoc test)	-	-	-	Group G v/s group A, B, C, E, F.	-	Group G v/s group A, B, C, D, E, F.	-	-	-	Group G v/s group A, B, C, F.	-	Group G v/s group A, B, C, D, E, F.	-	-	-

A wide range of age was selected (7 age groups), to study the effect of aging on different parameters. Several studies have been done which also conclude same result.^[8,9]

In this study, the mean value of gonial angle and ramus height was slightly higher in the right side when compared to the left side.^[1] However, these differences were statistically in significant which could be due a smaller sample size.^[2] These findings are in accordance with previous studies Ceylan *et al.*,^[6] Although the panoramic radiographs have some limitations, like distortion, magnification the advantage is it's a part of routine examination & thus useful for research purpose does not involve the patient any additional exposure or cost.^[10,11]

Investigations were carried out to determine if there was a correlation between three mandibular parameters and age and gender using measurements of gonial angle, bigonial width and ramus height in orthopantomogram radiographs.

Investigations revealed a correlation in mandibular morphology in both gender and age. It was found that males have a larger ramus height and bigonial width than females but a sharper gonial angle. A general trend in age showed a decrease in ramus height and an increase in gonial angle as age increased emphasizing that sex differences are more pronounced in mandibular ramus than in body.^[12]

The mean of the gonial angle and ramus height on the right side are slightly higher than left side. Females were found to have a significant higher value of gonial angle than their male counterpart; which was analogous to the results obtained by Ghosh *et al.*^[11] and Joo *et al.*^[12]

Where females were found to have a significant higher value of gonial angle than their male counterpart However, our results were not in agreement with Dutra *et al.*,^[13] where no significant difference found between genders. There was a trend of gonial angle increase with age, but it was only significant when 2nd and 3rd decade in our study.^[14]

The study found no significant difference when comparing left and right gonial angles regardless of gender. There was a trend of gonial angle increase with age; however, it was only significant when comparing the 19–29 age groups with the older age groups (40–49, 50–59 and 60–69). This trend was also noted by Ghosh *et al.*,^[11] who concluded that the gonial angle increased with increase in age.

This could be due to regional variation and deleterious habits which is supposedly more prevalent among the males in this region. Thus, gonial angle which is regularly used to determine the rotation of the mandible and to aid in diagnosing growth patterns to depict orthodontic extractions or surgical treatments can further be evaluated among a larger population for better evaluation.

Moreover, this was a hospital-based study and was limited to Odisha population and in particular Bhubaneswar population. Further research should be conducted across other areas and hospitals in Bhubaneswar and Odisha for more significant results. Even one beam computed tomography gives more accurate dimensions and could be used in the future to investigate changes in mandibular morphology.

CONCLUSION

The mean values of the gonial angle and ramus height on the right side were slightly higher than those on the left side;

however, the differences were not statistically significant. Males have higher values of the gonial angle, ramus height and bigonial width compared to female counterparts. Gender differences in bigonial width were not significant, but statistically significant gender differences ($P < 0.05$). Gonial angles and bigonial widths increased with age. Ramus height increased in the second and third age groups then decreases with age.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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