Morphological and Morphometric study of Mandible using Orthopantogram (OPG) in central Indian Population

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Abstract

Introduction: The mandible is the biggest bone responsible for holding the lower teeth in place, assisting in mastication, and forming the lower jawline. The mandible is made up of two parts: the body and the ramus, and it is placed below the maxilla. The lower jawline is formed by a horizontally curved section of the body. The rami are two vertical processes that link the body at the angle of the mandible on either side of the body.

Material and Methods: This study was carried out on 150 digital orthopantogram (OPG'S). A total number of patient's time of life selected between ranges of 20-60 years of age group. The sample was of 150 subjects. Data was collected from college who will come for OPD. Socio-demography, physical findings on examination during admission. Details of patient, parity, age and gender would be recorded.

Results: Mandibular ramus of male Mean (mm)±SD of Minimum ramus breadth was 29.26±3.01 followed by Maximum ramus breadth 34.30±3.31, Maximum ramus height 75.24±5.62, Projective ramus height 69.25±5.54 and Coronoid height 62.49±5.60. Mandibular ramus of female Mean (mm)±SD of Minimum ramus breadth was 27.62±3.62 followed by Maximum ramus breadth 32.36±3.37, Maximum ramus height 70.33±5.34, Projective ramus height 64.20±5.76 and Coronoid height 58.19±5.74. Each of the five variables measured on mandibular ramus using orthopantomograph showed statistically significant gender differences, indicating that ramus expresses strong gender dimorphism.

Conclusion: The present study has suggested that the accuracy of gender determination using mandibular measurements of the Indian population can be improved by deriving a discriminant function, which utilizes a combination of the six respective dimensions. Our study showed that minimum ramus breadth and maximum ramus breadth are most accurate in predicting gender on OPG while projective height was least reliable. Orthopantomogram is a reliable and accurate tool to record the various measurements in order to determine the gender of the given mandible.

Keywords: Mandible, Orthopantogram, Ramus breadth

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Introduction:

Inside the human skull, the mandible is the biggest bone. It is responsible for holding the lower teeth in place, assisting in mastication, and forming the lower jawline. The mandible is made up of two parts: the body and the ramus, and it is placed below the maxilla. The lower jawline is formed by a horizontally curved section of the body. [1] The rami are two vertical processes that link the body at the angle of the mandible on either side of the body. [2] The coronoid and condylar processes engage with the temporal bone on the superior face of each ramus to form the temporomandibular joint, which allows mobility. The mandible is the only skull bone that can move, aside from the ossicles of the ear, the mandible is the only movable skull bone, allowing it to participate in mastication. [3]

The mandible is made up of three parts: the body, two rami, and the mandible. The body, which is the front half of the mandible, is divided into two surfaces and two boundaries. At the angle of the mandible, also known as the gonial angle, the body finishes and the rami begin on either side. [4]

The mandibular symphysis is located near the midline of the external surface and is visible as a slight ridge in adults. The inferior section of the ridge separates and encloses the mental protuberance, a midline depression. The mental tubercle is formed by the elevation of the margins of the mental protuberance. [5] The incisive fossa is a depression lateral to the ridge and below the incisive teeth. The mental foramen is located below the second premolar and is where the mental nerve and arteries escape. From the mental tubercle to the anterior edge of the ramus, the oblique line runs posteriorly. [6]

The median ridge is located in the midline of the internal surface, and the mental spines are located just lateral to the ridge. The mylohyoid line runs from the midline to the alveolar boundary, superiorly and posteriorly. The hollow cavities in which the lower sixteen teeth dwell are contained within the superior alveolar border. The lower jawline is formed by the inferior border, which contains a little groove through which the facial artery travels. [7]

On both sides of the mandible, the ramus contributes to the lateral part. [8] The coronoid and condyloid processes are found on the ramus' superior face. The mandibular notch separates the coronoid and condyloid processes, which are anterior and posterior, respectively. Two processes are contained in the ramus, which is bound by two surfaces and four borders. [9,10]

Material and Methods

Study setting:

The study was carried out on 150 digital orthopantogram (OPG’S).

Sample: A total number of patient’s time of life selected between ranges of 20-60 years of age group. The sample was of 150 subjects.

Data collection:

Data was collected from college who will come for OPD.

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1. Socio-demography, physical findings on examination during admission
2. Details of patient, parity, age and gender would be recorded.

Inclusion criteria:(The following criteria included for the study)

- Patient aged group 20-60 years is included
- High quality OPG'S with respect to angulation and contrast.
- Patients undergoing conventional OPG for diagnostic, surgical, periodontal procedures (for impacted teeth) were included

Exclusion criteria:(The following criteria excluded from the study)

- Patients were excluding from the study if there was evidence of bony disease involving in traumatic history.
- Patients who are disabled with developmental abnormalities also excluded from the study.
- Patients who have undergone surgical intervention in coronoid region.
- Patients with hemifascial malformation.

METHODS

- The Methodological study was under stratified sampling based on age interval, side, and gender and data obtained was subjected to statistical analysis, Chi-square test was followed for evaluation of P value.
- Further the retrospective study was selected and divided into various groups
- i.e. Group I-V with the age range
- Group I-20-29 years
- Group II- 30-39 years
- Group III- 40-49 years
- Group IV- 50-59 years.
- All the OPG'S were recorded by suitable form of panoramic components orthophos method.

The Radiograph thus obtained was subjected for the assessment of various morphological shapes of coronoid process, condylar process and sigmoid notch.
The method for measurement of condylar and coronoid process and sigmoid notch was performed by using Vernier calipers.

Thus, a total of 280 specimens of mandible was assessed and comparison was made for site, age and gender.

Parameters

- **Maximum Ramus breadth**: The distance between the most anterior point on the mandibular ramus and a line connecting the most posterior point on the condyle.
- **Minimum Ramus breadth**: The distance between the most posterior point on the anterior border of the ramus to the most anterior point on the posterior border of the

ramus.

- **Condylar height (maximum ramus height)**: 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 the ramus**: Projective height of ramus between the highest point of the mandibular condyle and lower margin of the bone.
- **Coronoid height**: Projective distance between coronoid and lower wall of the bone.
- **Angle of Mandible**: Angle formed between tangents to inferior border of body and posterior border of ramus of mandible
- Gonial angles (GA): Measured as an angle between a digitally traced line tangential to the most inferior points at the angle and the lower border of the mandibular body and another line tangential to the posterior borders of the ramus and the condyle.

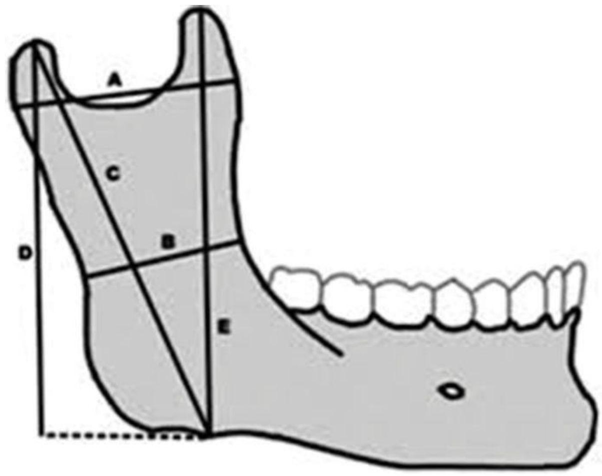

Figure 1: Illustration demostrating various mandibular measurements: A - maximum ramus breadth B - Minimum ramus breadth C - Condylar height D - Projective height E - Coronoid height F - Mandibular Angle

Statistical Analysis

Appropriate statistical methods was applied to research.

Results

Table 1: Distribution of subjects

Groups	Number	Percentage (%)
Group – I (20-29 years)	42	28.0
Group – II (30-39 years)	52	34.6
Group – III (40-49 years)	36	24.0
Group – IV (50-59 years)	30	13.3
Total	150	100

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In Table 1, Group I (20-29 years) were 28%, followed by Group – II (30-39 years) were 34.6%, Group – III (40-49 years) were 24.0% and Group – IV (50-59 years) were 13.3%.

Table 2: The gender distribution among various groups

Groups	Gender			
	Male		Female	
	Number	Percentage (%)	Number	Percentage (%)
Group - I	19	12.6	23	15.3
Group - II	23	15.3	29	19.3
Group - III	17	11.3	19	12.6
Group - IV	9	6.0	11	7.3
Total	68	45.3	82	54.6

In table 2, male of Group I were 12.6%, followed by Group – II were 15.3%, Group – III were 11.3% and Group – IV were 6.0%. On the other hand, among female group I were 15.3%, followed by Group – II were 19.3%, Group – III were 12.6% and Group – IV were 7.3%.

Table 2: Comparison of different parameters of mandibular ramus between male and female.

Parameters	**Male Mean (mm)±SD**	**Female Mean (mm)±SD**	**p-value**
Minimum ramus breadth	29.26±3.01	27.62±3.62	<0.05
Maximum ramus breadth	34.30±3.31	32.36±3.37	<0.05
Maximum ramus height	75.24±5.62	70.33±5.34	<0.05
Projective ramus height	69.25±5.54	64.20±5.76	<0.05
Coronoid height	62.49±5.60	58.19±5.74	<0.05

In table 2, mandibular ramus of male Mean (mm)±SD of Minimum ramus breadth was 29.26±3.01 followed by Maximum ramus breadth 34.30±3.31, Maximum ramus height 75.24±5.62, Projective ramus height 69.25±5.54 and Coronoid height 62.49±5.60.

Mandibular ramus of female Mean (mm)±SD of Minimum ramus breadth was 27.62±3.62 followed by Maximum ramus breadth 32.36±3.37, Maximum ramus height 70.33±5.34, Projective ramus height 64.20±5.76 and Coronoid height 58.19±5.74. Each of the five variables measured on mandibular ramus using orthopantomograph showed statistically significant gender differences, indicating that ramus expresses strong gender dimorphism.

Table 3: Canonical discriminant function for male and female

	Value of discriminant function coefficients		**Sectioning point**	
	Male	Female	Male	Female
Minimum breadth	0.273	0.342	0.497	−0.497
Maximum breadth	2.019	1.824		
Maximum height	1.643	1.732		

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Projective height	0.153	0.043		
Coronoid height	0.432	0.383		
Value of constant	−116.832	−102.363		

In table 3, Value of discriminant function coefficients of Minimum breadth of Male 0.273 and female 0.342. Maximum breadth of male 2.019 and female 1.824. Maximum height Male 1.643 and female 1.732. Projective height of Male 0.153 and female 0.043. Coronoid height of Male 0.432 and female 0.383.

The accuracy for sex determination was obtained using canonical discriminant function coefficient and constant value from the dimensions of mandibular ramus. The estimated sex was calculated using the following equations:

For males = −116.832 + (0.273 × minimum ramus breadth)+ (2.019 × maximum ramus breadth) + (1.643 × maximum ramus height) + (0.153 × projective ramus height) + (0.432× coronoid height)

For females = −102.363+ (0.342 × minimum ramus breadth)+ (1.824 × maximum ramus breadth) + (1.732 × maximum ramus height) + (0.043 × projective ramus height) + (0.383× coronoid height).

The sectioning point was found to be 0.497. The discriminant function value if near to 0.507, then the person is probably male, whereas if it is near to −0.497, then the person is probably female.

Table 4: Table showing percentage (%) accuracy of all parameters towards gender determination

Parameter	% Accuracy
Minimum Ramus Breadth	76.4
Maximum Ramus Breadth	75.8
Coronoid Height	73.2
Condylar Height	72.9
Projective Height	71.5
Mandibular Angle	75.1

In table 4. when the discriminant value was obtained and accuracy of these parameters was calculated, it was found that ramus breadth (minimum and maximum) along with mandibular angle had highest accuracy in sexing the mandible on OPG with rates of 76.4%, 75.8%, and 75.1%, respectively while projective height showed least reliability to predict the gender accurately among the parameters under study with a rate of 71.5%.

Table 5: Table showing summary of descriptive statistical analysis among males and females

Parameter	Males	Females	P	Result
	Mean± SD	Mean± SD		
Condylar Height	57.58±5.73	52.73±5.86	<0.001	Significant
Projective Height	63.32±5.86	57.38±5.53	<0.001	Significant
Mandibular Angle	121.6±7.38	129.5±7.15	<0.001	Significant

Descriptive statistics of all the mandibular ramus parameters on OPG is shown in Table 5. In our study, it was distinctly observed that the mean of Condylar Height of male 57.58±5.73 mm and female 52.73±5.86, Projective Height of male 63.32±5.86 mm, and female 57.38±5.53 mm, Mandibular Angle of male 121.6±7.38 and female 129.5±7.15 was noted and suggested that males had higher values as compared to females, and this was highly significant ($P < 0.001$) after applying independent t-test and hence each variable was a significant predictor in classifying the gender.

Table 6: Table showing summary of Gonial angles analysis between males and females

Parameter	Males	Females	p-value
	Mean± SD	Mean± SD	
Gonial angles	121.53±11.53	139.53±12.63	<0.001
Intergonial width	194.42 ± 18.34	194.32 ± 13.53	>0.05
Bicondylar breadth	15.25±3.63	13.52±3.25	<0.001
Diagonal length of the mandible body	78.4±6.42	72.9±6.34	<0.001

In table 5, the gonial angle formed between the body and ramus is less obtuse than in the female. Mean and Standard deviation of Gonial angles of male 121.53±11.53 and female 139.53±12.63. Mean and Standard deviation of Intergonial width of male 194.42 ± 18.34 and female 194.32 ± 13.53. Mean and Standard deviation of Bicondylar breadth of male 15.25±3.63 ± 18.34 and female 13.52±3.25. Mean and Standard deviation of Diagonal length of the mandible body of male 78.4±6.42 and female 72.9±6.34. All the parameters have higher male measurements than females except gonial angle, which was significantly higher in females than in males.

Discussion

In our study in table 1, Group I (20-29 years) were 28%, followed by Group – II (30-39 years) were 34.6%, Group – III (40-49 years) were 24.0% and Group – IV (50-59 years) were 13.3%. According to Cistulli *et al* Mandible is the last skull bone to cease growth and is sensitive to the adolescent growth spurt. [11] Mandible is the strongest structure of skull because of dense layer of compact bone. It has a vital role because of its sexual dimorphism and radiomorphometric features although it undergoes morphological changes in size and remodeling during growth up to certain age. Dimorphism in mandible is due to size and shape, and male bones are usually large and strong than

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female bones. The stages of mandibular development, growth rates, and its duration vary in males and females and hence useful in differentiating sexes. Various structures of mandible are used for sex determination, out of which ramus is the most sexually dimorphic structure. [12]

In table 2, male of Group I were 12.6%, followed by Group – II were 15.3%, Group – III were 11.3% and Group – IV were 6.0%. On the other hand, among female group I were 15.3%, followed by Group – II were 19.3%, Group – III were 12.6% and Group – IV were 7.3%. Calcagno (1981) and Maat *et al*. (1997) found that accuracy of gender determination was seriously affected by the size of the mandible. Sexual dimorphism exhibited by the skull is mainly dependent upon changes that occur in the male at puberty that reflect increased muscle attachment, whereas the female skull tends to retain pedomorphic features. [13]

In table 3, Value of discriminant function coefficients of Minimum breadth of Male 0.273 and female 0.342. Maximum breadth of male 2.019 and female 1.824. Maximum height Male 1.643 and female 1.732. Projective height of Male 0.153 and female 0.043. Coronoid height of Male 0.432 and female 0.383. In table 3. when the discriminant value was obtained and accuracy of these parameters was calculated, it was found that ramus breadth (minimum and maximum) along with mandibular angle had highest accuracy in sexing the mandible on OPG with rates of 76.4%, 75.8%, and 75.1%, respectively while projective height showed least reliability to predict the gender accurately among the parameters under study with a rate of 71.5%.

In our study in table 4, it was distinctly observed that the mean of Condylar Height of male 57.58±5.73 mm and female 52.73±5.86, Projective Height of male 63.32±5.86 mm, and female 57.38±5.53 mm, Mandibular Angle of male 121.6±7.38 and female 129.5±7.15 was noted and suggested that males had higher values as compared to females, and this was highly significant ($P < 0.001$) after applying independent *t*-test and hence each variable was a significant predictor in classifying the gender. These findings are in agreement with the findings of Hrdlicka et al. [14] Earliest studies on mandible by Morant *et al*. has established the usefulness of mandible for the determination of gender. [15] They found that the gender differences were highest in height of the ramus, thus emphasizing that the differences are more pronounced in mandibular ramus than in body. [16]

In table 5, the gonial angle formed between the body and ramus is less obtuse than in the female. Mean and Standard deviation of Gonial angles of male 121.53±11.53 and female 139.53±12.63. Mean and Standard deviation of Intergonial width of male 194.42 ± 18.34 and female 194.32 ± 13.53. Mean and Standard deviation of Bicondylar breadth of male 15.25±3.63 ± 18.34 and female 13.52±3.25. Mean and Standard deviation of Diagonal length of the mandible body of male 78.4±6.42 and female 72.9±6.34. All the parameters have higher male measurements than females except gonial angle, which was significantly higher in females than in males. Iscan (1998) achieved an accuracy of 81.5% with five mandibular parameters (i.e. bigonial breadth, total mandibular length, bicondylar breadth, minimum

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ramus breadth, and gonion–gnathion) in South African whites, which is comparable with the present study results. [17]

Conclusion

The morphometric analysis of mandibular ramus using digital OPG serves as an important and valuable aid for sex identification up to certain extent although social and environmental factor does influence the development and structure of mandible. The skeletal characteristic varies geographically. The limitations of this study are a failure to consistently designate sex in the subadult range and to assess the gender in edentulous cases. Further studies are recommended on varied population, larger sample size, other imaging modalities, and the measurements shall be carried out by more than two observers as it may result in comparatively better discrimination.

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