ORIGINAL ARTICLE

Sex determination by mandibular ramus: A digital orthopantomographic study

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Abstract

Aims and Objectives: (1) To determine the usefulness of mandibular ramus as an aid in sex determination. (2) To evaluate Anteroposterior | superioinferior angle of mandibular condyle. **Materials and Methods:** A retrospective study was conducted using orthopantomographs of 60 males and 60 females,which were taken using Kodak 8000C Digital Panoramic and Cephalometric System (73 kVp, 12 mA, 13.9 s). The age group ranged between 18 – 45 years. Mandibular ramus measurements were carried out using Master View 3.0 software. The measurements of the mandibular ramus will be subjected to Discriminant function analysis. **Results:** Maximum ramus breadth, Minimum ramus breadth, Condylar height, Projective height of ramus Coronoid height were calculated for both the sexes differently with the formula & analyzed with Discriminant function analysis using Fischer exact test. The P value was statistically significant with the P value < 0.05 for the following parameters Max. ramus breadth, Condylar height and Projective height of ramus. **Conclusion:** Mandibular ramus measurements can be a useful tool for gender determination.

Key words: Mandibualar ramus, orthopantomography, sex

Introduction

Dentofacial radiography has become a routine procedure in the dental, medical, and hospital clinics. Where in radiographs are taken at different periods during the lifetime of large segments of the population.[1] Whereas the determination of sex is an important aspect of forensic anthropology and vital in medico-legal investigations. Among various measures mandibular ramus can be used to differentiate between male and female strongly expresses univariate sexual dimorphism. When skeletal sex determination is considered, metric analyses on the radiographs are often found to be of superior value owing to their objectivity, accuracy, and reproducibility.

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Identification of gender is important in medico-legal and anthropological work. Determination of sex becomes more accurate after attainment of puberty. The differences are well marked in bony pelvis and skull. After both of these bony areas, mandible remains next in the human which will also help us in the identification of age, sex, and race.[2] Humphrey *et al*.[3] emphasized that almost any site of mandibular bone deposition, or resorption, or remodeling for that matter, seems to have a potential for becoming sexually dimorphic. Hence, mandibular condyle and ramus, in particular, are generally the most sexually dimorphic as they are the sites associated with the greatest morphological changes in size and remodeling during growth.

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Among various radiographic technique the orthopantomography (OPG) is still used as one of the measure in determination of sex wherein, the morphology of mandibular ramus is studied.[4]

Hence, this study was taken to understand the sexual dimorphism, using digital OPG.

Aims and objectives

This study aims to determine the usefulness of mandibular ramus as an aid in sex determination.

Materials and Methods

A short retrospective study was conducted of sixty males and sixty females, using orthopantomographs which were taken using Kodak 8000C Digital Panoramic and Cephalometric System (73 kVp, 12 mA, 13.9 s). The age group ranged between 18 and 45 years.

Patients who had full complement of teeth were selected for OPG. Patients with a history of extraction, fracture, and any other severe developmental disturbances leading to variation in the size of mandible were excluded from the study. All the mandibular ramus measurements will be carried out using Carestream Health, Inc, 2010, Kodak 8000C Digital Panoramic and Cephalometric System (73 kVp, 12 mA, 13.9 s) with Master View 3.0 software. The ethical clearance obtained from the Institution Review Board.

The following variables were measured using mouse-driven method by moving the mouse and drawing lines using chosen points on the digital panoramic radiograph [Figures 1 and 2].

- 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 and the angle of jaw[5,6]
- Minimum ramus breadth: Smallest anterior–posterior diameter of the ramus[6]
- 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[6]
- Projective height of ramus: Projective height of ramus between the highest point of the mandibular condyle and lower margin of the bone[6]
- Coronoid height: Projective distance between coronion and lower wall of the bone.[6]

Statistical analysis

The data were analyzed by the discriminant function analysis using Fischer exact test [Table 1].

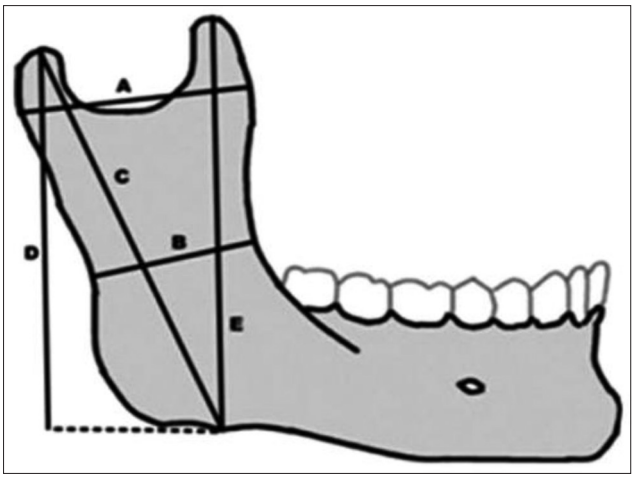

Figure 1: Mandibular ramus measurements with five variables[6]

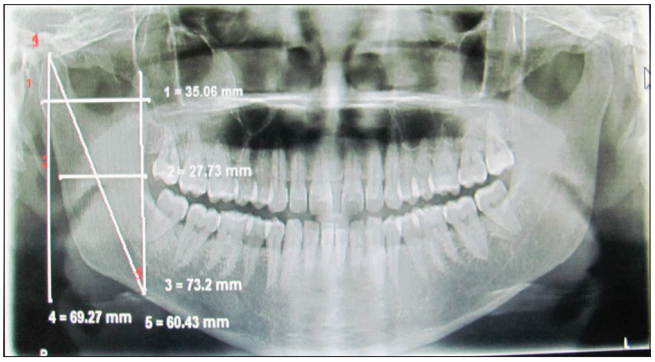

Figure 2: Mandibular ramus measurements of female patient on orthopantomograph

The sex could be determined from calculations using the equations given below : (Table 1) 10

D_{Male}: −185.622 + 1.361 (max. ramus breadth) + 1.087 (min.ramus breadth) + 2.253 (condylar height) − 0.717 (projective height of ramus) + 0.081 (coronoid height)

D_{Female}: −161.761 + 1.276 (max. ramus breadth) + 0.948 (min.ramus breadth) + 2.220 (condylar height) − 0.753 (projective height of ramus) + 0.063 (coronoid height)

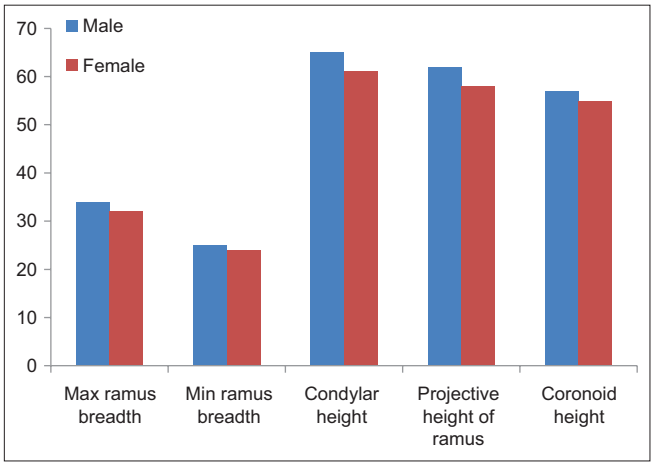

Figure 3: Mean measurements in males and females

Mean measurements between males and females. Mean measurements in males were greater than females are shown in Figure 3.

Descriptive statistics shows mean values were higher in males compared to females. Standard deviation was greater in females compared to males. F-statistic values indicated that highest sexual dimorphism was seen with projective height of ramus and least with minimum ramus breadth.

Maximum ramus breadth, condylar height, and projective height of ramus were statistically significant with $P < 0.05$ as shown in Table 2.

Sex was accurately determined in 32 cases out of sixty male mandibular measurements with prediction accuracy rate of 53%, and sex was accurately determined in 36 cases out of sixty female mandibular measurements with an accuracy rate of 60% [Table 3].

Discussion

Determination of sex by morphological assessment has remained as one of the oldest approaches in forensic anthropology and medico-legal examinations. The method may vary and depend on the available bones and their conditions. The identification of sex is of significance in cases of mass fatality incidents where bodies are damaged beyond recognition. When entire adult skeleton is available for analysis, sex can be determined up to 100% accuracy (pelvis). However, in cases of mass disasters where usually fragmented bones are found, sex determination with 100% accuracy is not possible, and it depends largely on the available parts of skeleton.[7] Skull is the most dimorphic and easily remarked portion of skeleton after pelvis. However, in cases where intact skull is not found, mandible may play a vital role in sex determination as it is the most dimorphic bone of skull. Anthropometry of the face and intraoral regions can help in the field of forensic odontology when common forensic data are unavailable.[8]

Table 1: Linear discriminant function[10]

Variable	Male	Female
Constant	−185.622	−161.761
Maximum ramus breadth	1.361	1.276
Minimum ramus breadth	1.087	0.948
Condylar height	2.253	2.220
Projective height of ramus	−0.717	−0.753
Coronoid height	0.081	0.063

Table 2: Descriptive statistics

	Male		Female		*F*	*P*
	Mean	SD	Mean	SD		
Maximum ramus breadth	34.15	2.73	32.66	4.8	4.320	0.04
Minimum ramus breadth	25.7	2.25	24.74	4.48	2.168	0.144
Condylar height	65.34	4.33	61.69	10.11	6.624	0.011
Projective height of ramus	62.61	4.8	58.82	9.06	8.187	0.005
Coronoid height	57.85	5.77	55	10.24	3.534	0.064

Table 3: Prediction accuracy

	Male	Female	Total	Accuracy (%)
Male	32	28	60	53
Female	24	36	60	60

The disadvantages OPG technique is unequal magnification and geometric distortion, which causes many problems. The vertical dimension as compared to the horizontal dimension is little altered. These distortions are the result of the horizontal movement of the film and X-ray source.[9,10]

The position of the movement object is within the focal trough, the size, and shape of the resultant images keeps changing.[9] Panoramic radiographic technique remains as quite sensitive to positioning errors because of relatively narrow image layer.[11] Objects which are outside the focal trough are blurred, magnified or reduced in sizes which are sometimes distorted. The focal trough shape and location varies with the brand of the equipment used.[9]

A study conducted by Kambylafkas *et al*.[12] concluded that the evaluation of total ramal height is reliable, and an asymmetry of more than 6% is an indication of atrue asymmetry using panoramic radiograph.

In this study, asymmetry noted was 7% using panoramic radiograph.

Dayal *et al*.[13] found mandibular ramus height to be the best parameter in their study, with 75.8% accuracy.

In our study, mandibular ramus height found to be the best parameter with statistically significant with $P = 0.005$.

A study conducted by Saini, *et al*.[6] showed that coronoid height possessed the best potential for sex determination on Indian people with the accuracy of 74.1%, and the combination of it with minimum ramus breadth, maximum ramus breadth, and/or mandibular ramus length will show significant sexual dimorphism with an overall accuracy of 80.2%.

In this study, all five variables that is maximum ramus breadth, minimum ramus breadth, condylar height, projective height of ramus, coronoid height showed prediction accuracy of 53% for males and prediction accuracy of 60% for females.

Another study conducted by Indira *et al*.[14] on mandibular ramus measurements were subjected to discriminant function analysis. Each of the five variables measured on mandibular ramus using orthopantomograph

showed statistically significant sex differences between sexes, indicating that ramus expresses strong sexual dimorphism. The mandibular ramus demonstrated greatest univariate sexual dimorphism in terms of minimum ramus breadth, condylar height, followed by projective height of ramus. Overall prediction rate using all five variables was 76%.

In our study, highest sexual dimorphism was seen with projective height of ramus and least with minimum ramus breadth. Maximum ramus breadth, condylar height, projective height of ramus was statistically significant with the $P < 0.05$.

Shivaprakash and Vijaykumar[15] conducted a study in diagnosing in the sex by observing the mandibular ramus posterior flexure. Sex was accurately determined in 44 cases out of 55 male mandibles with an accuracy rate of 80%, and sex was accurately determined in 35 cases out of 49 female mandibles with accuracy rate of 71%.

In our study, sex was accurately determined in 32 cases out of sixty male mandibular measurements with prediction accuracy rate of 53% and sex was accurately determined in 36 cases out of sixty female mandibular measurements with accuracy rate of 60%.

Conclusion

The mandibular ramus height can be considered another valuable tool in gender determination with the help of OPG. However, further studies with larger sample and less magnification errors are needed to be taken up in future.

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Conflicts of interest
There are no conflicts of interest.

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