



Morphometric Analysis Of Mandible In Dentulous Patients Using Digital Orthopantomogram: An Institute Based Observational Study

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Abstract

Aim:

The aim of this study was to assess the morphological variations in mandibular dimensions using orthopantomograms (OPGs) and to compare these measurements between sexes.

Materials and Methods:

A total of 220 digital OPGs were analyzed from dentate individuals aged between 18 and 65 years. Key morphometric parameters measured included ramal length, ramal width, body length, gonial angle, and condylar and coronoid ramal heights. The collected data were statistically analyzed to evaluate sexual dimorphism.

Results:

The analysis demonstrated significant sexual dimorphism in mandibular measurements, with males exhibiting larger dimensions than females ($p < 0.001$). Ramal length, ramal width, lower ramal breadth, and body length showed strong positive correlations with sex. Although condylar and coronoid ramal heights showed minimal correlation with sex, they remained relevant for morphometric analysis.

Conclusion:

Mandibular measurements, particularly those of the ramus and body, are valuable indicators for sex determination. The study reinforces the utility of OPG-based mandibular assessment in forensic and anthropological applications, reflecting the influence of growth patterns, dietary habits, and masticatory forces on mandibular morphology.

Keywords: NIL

Introduction

Mandible is the largest, strongest and movable part of the skull. Its identification is important in medicolegal and anthropological work.¹ It has a horizontal U-shaped body which is continuous at its posterior end with a pair of vertical rami forming the lower part of the facial skeleton.² In dentate subjects, position of anterior border of the masseter is related to ramus dimensions, mandibular and occlusal plane angles.³ Some authors also suggested that the individuals with

more superior insertion of masseter muscles on the ramus will have short posterior facial height, steep mandibular planes and large gonial angles. These individuals also have relatively short rami.

Knowledge of mandibular dimension is an important consideration during the anthropological studies, age and sex determination and also plays a significant role in treatment of TMJ ankylosis, mandibular distraction,

orthognathic surgeries, cosmetic surgeries, resection of diseased individuals and reconstruction of the defects secondary to any other surgeries.²

Gonial angle forms between two lines, one come in contact with inferior border of mandible and the other is line tangent to ramus and condyle which indicates the mandibular shape according to the relationship between body and ramus.⁴

It is also an indicator of mandibular plane steepness and could be used for predicting facial growth pattern.⁴ Panoramic radiographs (OPG) are the most common extraoral radiographs that provide the maximum details with respect to hard tissue of maxilla and mandible and can be easily saved and stored in database for years.⁵ Because of the fact that the whole mandible including the two rami and condyles is shown on a single panoramic radiograph, it is possible to compare the two temporomandibular joints concerning the general morphology and structural changes.⁶ Morphometric analysis of mandible is also very helpful for sex determination.⁷

So, This study aims to determine the average morphological variation in various dimensions of

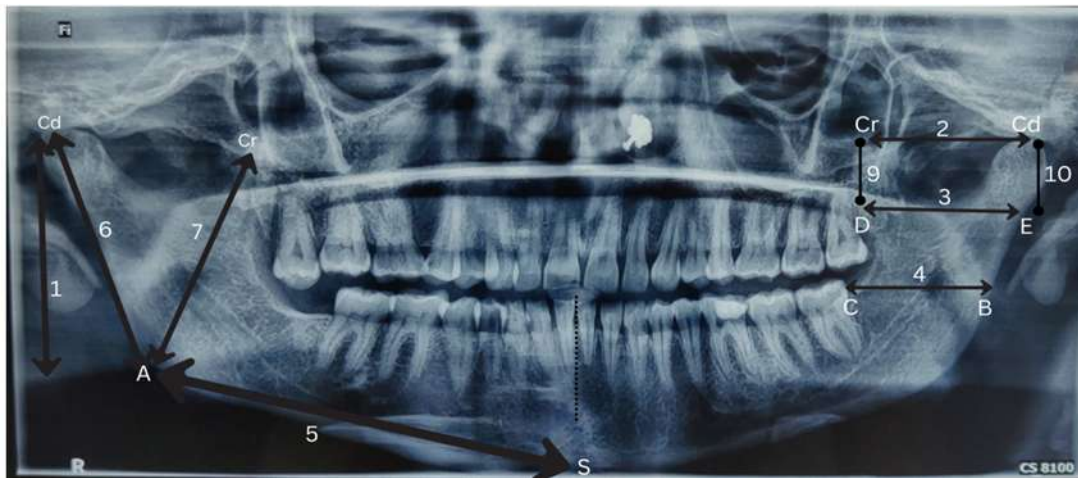
mandible as observed on Orthopantomogram and compare with both sexes.

Materials And Methods

A set of 220 digital orthopantomograms of dentate subjects within the age group of 18–65 years taken for various diagnostic purposes were selected and coded. The digital orthopantomograms with good quality in regard to patient positioning, head alignment, film density, contrast, and clear visible lower border of the mandible, posterior border of the ramus, and condyle will be selected. Unclear anatomical landmarks on the OPG, previous mandibular fracture involving para-symphysis region, dental disorders, and severe mandibular growth retardation, edentulous dentition and history of orthognathic surgery or mandibular orthodontic treatments were excluded from the study.

Single observer readings were computed to avoid any interobserver variations using metallic scale. The mean of right and left side of ramus was calculated on each OPG, and finally the values obtained for males and females will be compared.

Figure 1. Measurements of the mandible on a panoramic X-ray of the jaw



Morphometric Parameters:

1. Length of the ramus of the mandible will be recorded from the angle of the mandible to the head of the mandible.⁷
2. Width of the ramus will be measured from the head of the mandible to the coronoid process.⁷
3. Upper ramus breadth: The horizontal distance between the most anterior to the most posterior point of the ramus passing through the sigmoid notch along a line parallel to the transverse plane.⁵
4. Lower ramus breadth: The horizontal distance between the most anterior to the most posterior point of the ramus at the level of the occlusal plane along a line parallel to the previous one.⁵

5. Length of the body of the mandible will be recorded from the mental protuberance to the gonial angle of the mandible.
6. Condylar ramus height: The distance from the condyle onto the intersection of the orientation line with the inferior border of the ramus.5
7. Coronoid ramus height: The distance between coronion and the intersection of the orientation line with the inferior border of the ramus.5
8. Gonial angle: These will be measured as the intersection 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.5
9. Coronoid length: The distance between the tip of coronid process and the line drawn parallel to the sigmoid notch.
10. Condylar length: The distance between the tip of condylar process and the line drawn parallel to the sigmoid notch.

Figure 2

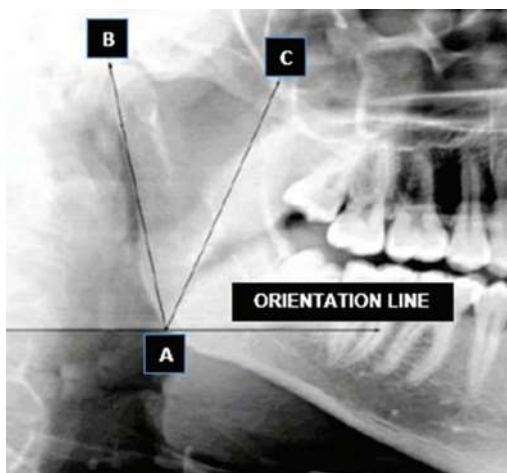


Figure 3

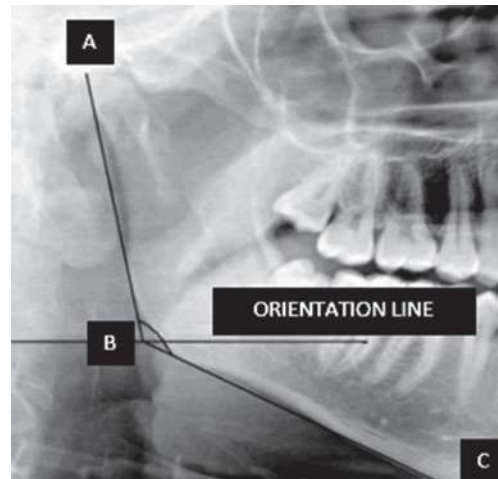


Figure 2: The two linear ramus measurements performed on the digital panoramic image (AB: Condylar ramus height, AC: Coronoid ramus height)

Figure 3: Measurement of the Gonial angle on the digital panoramic image

Stastical Analysis:

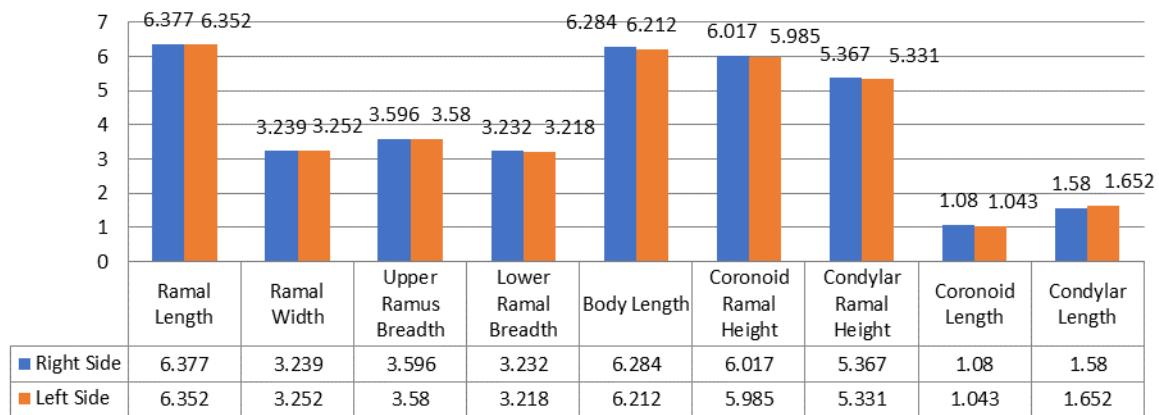
Data will be entered in the excel spread sheet. Descriptive statistics like mean, standard deviation and percentage will be calculated. Inferential statistics like independent (unpaired) t-test along with will be applied, using SPSS (Statistical Package for Social Sciences) version 24. [IBM corp. released 2011] p-

value less than 0.05 will be considered statistically significant. Any other necessary tests will be dealt with analysis based on data as per needed.

Results:

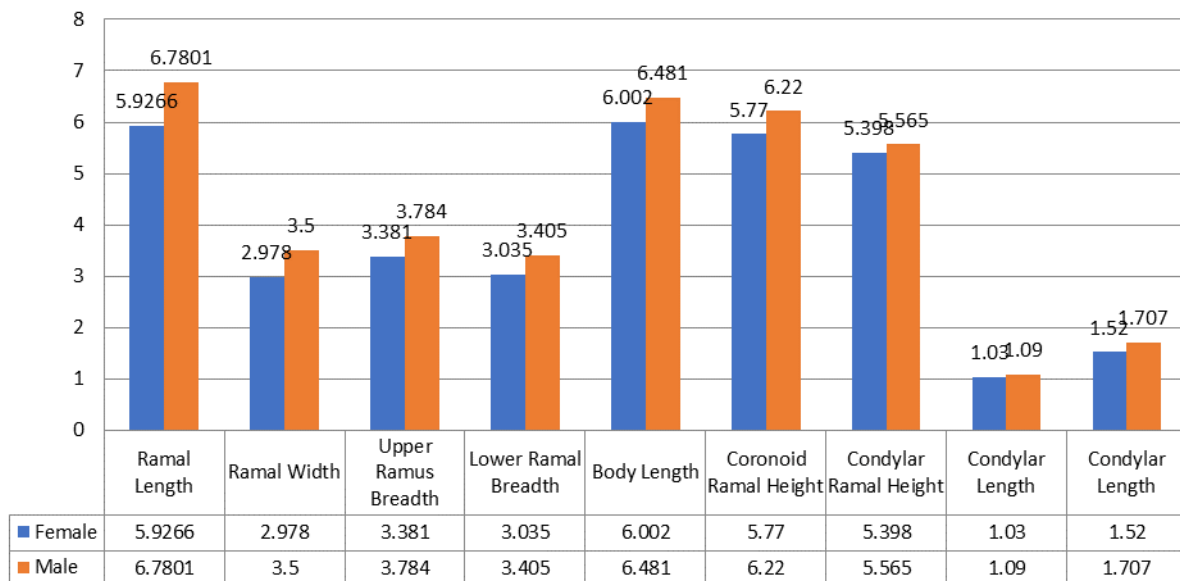
The morphometric analysis of the mandible highlighted minor differences between the right and left sides, with slight variations in ramal length, body length, gonial angle, and condylar angle, while other parameters exhibited near symmetry (GRAPH 1). Conversely, parameters like upper ramus breadth, ramal heights, and angular measurements showed no significant correlation with age.

GRAPH 1: Measurements within different parameters of both the sides (in cms).



Gender-based comparisons revealed significant differences, with males having larger ramal length, ramal width, upper and lower ramus breadth, body length, coronoid ramal height, and condylar angle, all with p-values of 0.001. However, there were no significant gender differences in condylar ramal height, gonial angle, or coronoid angle. These findings suggest that while several craniofacial features exhibit pronounced gender-related differences, others remain similar between males and females (GRAPH 2).

GRAPH 2: Gender wise comparison of different parameters.



Discussion

The mandible is the strongest bone in the skull due to its thick compact bone layer. It plays a crucial role in sex determination because of its distinct radio morphometric characteristics and sexual dimorphism, even though it undergoes size changes and remodelling during growth until a certain age. Sexual dimorphism in the mandible is primarily based on differences in size and shape, with male mandibles typically being larger and more robust than those of

females. As the last bone in the skull to complete growth, the mandible is particularly responsive to the adolescent growth spurt. The timing, rate, and stages of mandibular growth differ between males and females, making it a valuable indicator for sex differentiation. Among the various parts of the mandible, the ramus is considered the most sexually dimorphic and is frequently used in sex determination.⁸

Cross sectional studies have promoted the concept that mandibular ramus and angle could be used as an indicator for gender dimorphism.

In the present study, the dimensions of different parameters on mandibular ramus when correlated with sex; it was distinctly observed that the mean values were significantly higher in males when compared to females and were statistically highly significant ($P < 0.001$). This finding differ with the study of Duthie et al.⁹ which shows no significant difference but matched with the study of Indira et al.¹⁰ ($P < 0.001$) as male bones are generally bigger and more robust.

The length of the right mandibular body was longer than the left in both males and females and a statistically significant relationship between the length of the mandibular ramus and sex was recorded on both sides of the mandible in this study (Graph 1).

Our study suggests, For ramal length, males had a significantly higher mean (6.78) compared to females (5.93), with a p-value of 0.001, indicating a clear difference. This interpretation is similar to Rai et al.,¹¹ Keyayan et al.² (The average length of the ramus of the mandible in male for the right and left sides was 57.40 mm and 58.07 mm respectively while for female this was 51.81 and 52.20 respectively.) and Yassir et al.¹² which suggested that mean values for ramus height reported in this study for females (45.08 ± 4.1 mm) and males (51.41 ± 4.47 mm)

Luca et al.¹⁷ proposed that mastication and dietary habits may influence the growth of the mandible. They recorded that individuals who consumed an abrasive diet had larger jaws in comparison to those that had a soft diet.

In addition, Weiner¹⁸ reported that individuals tend to favour either their right or left side on the basis of their chewing habit and suggested that individuals tend to favour chewing on their right side. In addition, Indira et al.¹⁰ stated that the development of the muscles of mastication may influence the sexual dimorphism of the mandibular ramus as the masticatory forces exerted differ between the sexes.

Consequently, Humphrey et al.¹⁹ stated that almost any site of mandibular bone deposition, resorption, or remodelling has the potential to become sexually dimorphic, therefore the mandibular condyle and ramus present as the specific sites associated with the

greatest morphological changes in size and remodelling during growth.

Conclusion

This study highlights the significance of mandibular morphometric parameters in sex determination. Ramal length, ramal width, lower ramal breadth, and body length showed strong correlations, confirming their reliability. Males had significantly larger mandibular dimensions, emphasizing sexual dimorphism. While condylar and coronoid heights showed minimal correlation, they still contribute to differentiation. These findings support the use of mandibular metrics in forensic and anthropological contexts, with consideration of factors like diet and mastication.

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