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Assessment of gender using condyle-coronoid angle and various linear measurements of Mandibular Ramus in south Indian population: A digital panoramic study

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***Abstract*---**Background: Gender determination is a valuable factor in forensic odontology. Mandible may play a important role in gender estimation as it shows significant dimorphism and is often recovered intact. Mandibular ramus as well as condyle and coronoid have shown

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sexual dimorphism. Digital panoramic radiographs can be used to determine the age and gender. The purpose of the current study was to measure, compare and evaluate the various measurements of mandibular ramus and as well as to assess their usefulness in gender determination. Materials and Methods: 100 panoramic images (50 males and 50 females) of Bagalkot district, Karnataka patients aged (18-58)yrs old were selected. Parameters namely condyle ramus height, coronoid ramus height, condyle coronoid breadth, maximum ramus breadth, minimum ramus breadth, coronoid-condyle angle were taken into consideration, the values were measured and data was analyzed. Statistical analysis was done using SPSS software.Results: In the present study all the measurements of the mandibular ramus on digital panoramic radiographs showed a statistically significant difference between both the genders except maximum ramus breadth and coronoid-condylar breadth which shows statistically insignificant results. Significant difference were noted in terms of condyle-coronoid angle in both genders as well, females have a statistically significant higher mean values than males. Based on the analysis, the present study concludes that the difference between males and females from both sides suggest that mandibular ramus is very much useful in significant gender determination. Conclusion: The results of the study show the measurements of mandibular ramus present high sexual dimorphism and are beneficial in gender determination.

***Keywords*---**gender determination, dimorphism, panoramic radiography, mandible.

Introduction

The identification of gender from human skeletal remains is of significant importance in forensic sciences, especially in criminal investigations as well as in the recognition of missing persons and performing experiments for recreating the lives of ancient populations.[1] Recognition of humans using specific features of teeth and jaws has been used since roman times, because humans show distinct features in jaw and teeth dimensions and morphology of both adults and children, when only bones of head or broken parts jaws are available for gender determination.[2] Gender determination is of significance in cases of mass fatality incidents where bodies are damaged beyond recognition and it depends largely on the available parts of skeleton.[3] Generally, in presence of skeletal elements in good condition, morphological indicators of sexual dimorphism allow a correct diagnosis in more than 95% of cases.[4]

Skull is the most dimorphic and easily sexed portion of skeleton after pelvis. But in cases where intact skull is not found, mandible may play important role in gender determination, as it is the most dimorphic, largest and strongest bone of the skull that is commonly recovered intact.[5] Mandibular ramus can differentiate between genders, as the stages of mandibular development, growth rates and duration are distinctly different in both genders.[5] In addition, masticatory forces exerted are different for males and females, which influence the shape and the size of the mandibular ramus.[6] Similarly variation in condyle-coronoid angle with age, gender, and even dental status has been observed which is supported by radiographic and anthropometric studies.[7]

In the present digital era, dentofacial radiography has become one of the routine procedures in dental and medical hospitals as a part of primary investigations. Large segments of the population have these radiographs taken at different intervals of life, which contributes to the available antimortem data which can further help in identification of human remains.[8] Thus the purpose of the present study was to measure, compare and evaluate various measurements of mandibular ramus and to assess their usefulness in gender determination.

Materials and Methods

Digital panoramic radiographs of 100 patients were obtained (50 males and 50 females) with a age range of 18-58 years from department archives. Since the present study was conducted on radiographs stored in the system, ethical clearance was not applicable. The inclusion criteria were : 1) High quality digital images without any positioning errors. 2) Ideal orthopantomographs of completely dentate patients were selected. Exclusion criteria: Patients with a history of extraction, fracture, developmental disturbances or any other mandibular pathologies leading to variation in the size of mandible were excluded from the study.

The following parameters were measured using mouse driven method (by moving the mouse & drawing lines using chosen points on the digital panoramic radiograph) shown in (Figure 1). using trophy DICOM 6.1.2.0 masterview 4.2.0. Gender wise comparison of mean values of variables was done using Mann Whitney U test. The data was analyzed using SPSS 20 software.

1. Condyle ramus height (A): The distance between the condylion and the inferior border of the ramus.[9]
2. Coronoid ramus height (B): The distance between coronion and the inferior border of the ramus.[9]
3. Condyle-coronoid breadth(C): The distance between the most superior point on the condylion & coronion.[10]
4. Maximum ramus breadth (D): 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.[9]
5. Minimum ramus breadth (E): smallest anterior-posterior diameter of the ramus.[9]
6. Condyle-coronoid angle (F): intersection between the two lines drawn from the condyle and coronion meeting at the deepest point on the mandibular notch.[11]

Results

Comparison of all measurements of mandible in both males and females by applying Mann Whitney U test is shown in (Table 1). We observed that each variable was a significant predictor in classifying a given sample ($p<0.05$) except maximum ramus breadth and condyle-coronoid breadth which were found to be insignificant. The mean values showed that all dimensions were higher for males compared to females except for condyle coronoid angle. (Figure 2) The gender could be determined from calculations using the equations given below (Table 2)

Dmale: -138.41+ 21.92 (condyle ramus height) + 92.12 (coronoid-ramus height)
Dfemale: -107.71 + 19.34 (condyle ramus height) + 81.19 (coronoid ramus height)

For classifying a given sample as male or female, the higher/ maximum value of the two equations is considered. With all the variables in consideration, 83% of the cases were classified correctly (Table 3). In the present study the sectioning point was found to be -1.966 values greater than this sectioning point indicate male & values lesser than this point indicate female (Table 4).

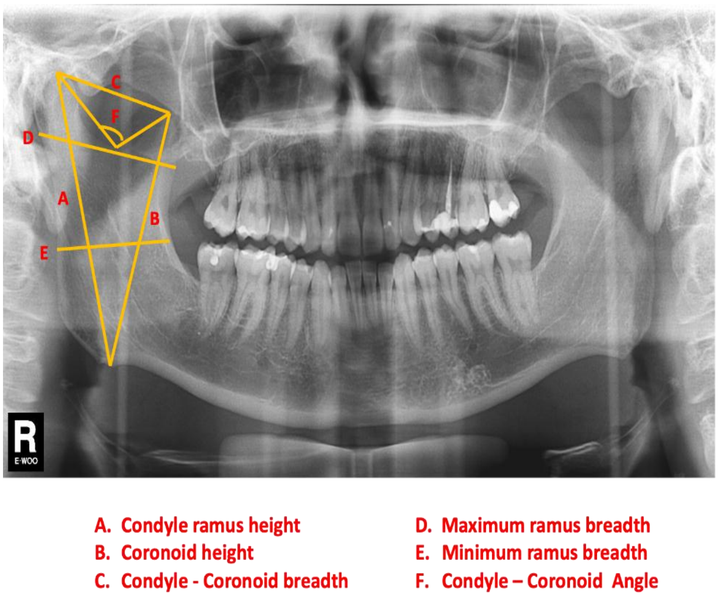

Figure 1: Measuements of mandibular ramus on orthopantomograph

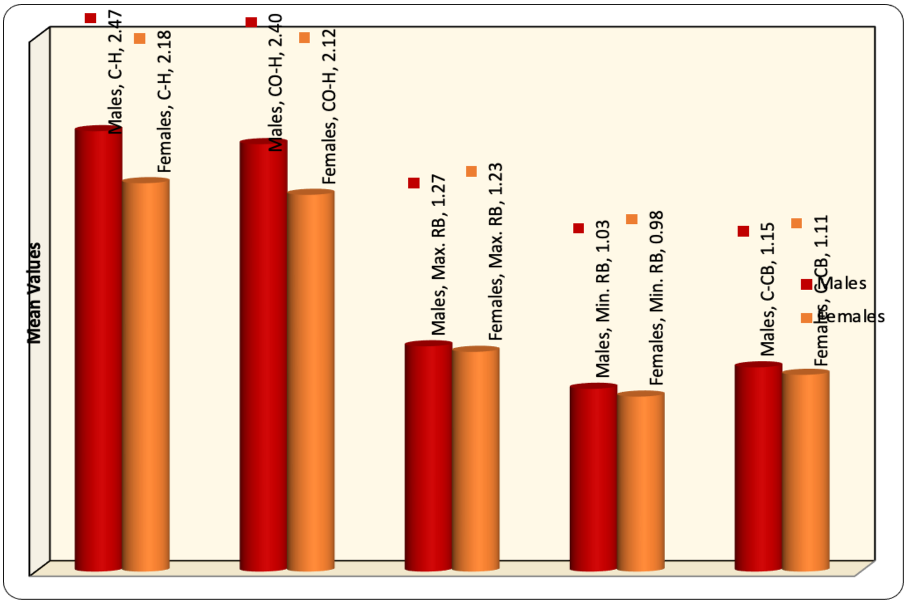

Figure 2: Mean measurements in males and females

Gender wise comparison of mean values of different study variables using Mann Whitney U test							
Variables	Gender	N	Mean	SD	Mean Diff	Z	P-Value
C-H	Males	50	2.47	0.26	0.29	-5.437	<0.001*
	Females	50	2.18	0.27			
CO-H	Males	50	2.40	0.16	0.28	-7.082	<0.001*
	Females	50	2.12	0.15			
Max. RB	Males	50	1.27	0.14	0.03	-1.055	0.29
	Females	50	1.23	0.18			
Min. RB	Males	50	1.03	0.11	0.04	-2.925	0.003*
	Females	50	0.98	0.18			
C-CB	Males	50	1.15	0.13	0.04	-1.983	0.05#
	Females	50	1.11	0.19			
C-CA	Males	50	88.58	8.45	-4.58	-2.134	0.03*
	Females	50	93.15	9.59			

* P value < 0.05- statistically significant

Table 1: Comparison of all measurements of mandible in both males and females by applying Mann Whitney U test

Linear Discriminant Function		
Variables	Males	Females
(Constant)	-138.41	-107.71
C-H	21.92	19.34
CO-H	92.12	81.19

Table 2: Linear discriminant function

Prediction Accuracy				
Gender	Predicted Group Membership		Total	% Accuracy
	Males	Females		
Males [n]	41	9	50	83.0%
Females [n]	8	42	50	
Males [%]	82	18	100	
Females[%]	16	84	100	

Table 3: Prediction accuracy

Discriminant function coefficients for Gender Determination that entered the analysis						
Variables	Unstd. Coeff	Str. Matrix	Std. Coeff	Group Centroids		Sectioning Point
				Males	Females	
C-H	1.311	0.941	0.348	0.983	-0.983	-1.966
CO-H	5.561	0.559	0.855			
(Constant)	-15.613					

Table 4: Discriminant function coefficients for Gender Determination

Discussion

Gender determination from human remains is the foremost and fundamental step in forensics and anthropology, followed by age and stature estimation as both are sex dependant.[12] The identification of gender 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 upto 100% accuracy (pelvis).[13] 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. 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.[13]

Digital OPG's have been widely used by the clinicians as a screening modality for diagnosis of variety of oral diseases. The major advantages of this specialized radiography include a broad coverage, low patient radiation dose, ease of examination and shorter time required to make images while the major drawbacks remain unequal magnification and geometric distortion, ghost images and soft-tissue shadows, and the technique being sensitive to numerous positioning errors.[14]

The selected variables of mandibular ramus were chosen because of less chances of alteration in these variables with advancing age compared to measurements of the body of the mandible. Also there are less geometric errors in the images obtained by digital OPG's in the ramus region compared to midline structures of the mandible. In the present study, mandibular ramus measurements were subjected to discriminant function analysis. Each variable measured on mandibular ramus using OPG showed statistically significant sex differences between genders except maximum ramus breadth and coronoid-condylar breadth which shows statistically insignificant results. The mandibular ramus showed greatest univariate sexual dimorphism in terms of condyle ramus height followed by coronoid ramus height. The condyle-coronoid angles were found to be higher in females than males. Overall prediction rate using all five variables was 83% and similar results were obtained by the studies conducted by Martin and Hrdlicka who stated that measurements of the mandibular ramus height showed greater sexual dimorphism.[15,16]

Dayal et al. found mandibular ramus height to be the best parameter in their study with 75.8% accuracy.[13] A study conducted by Saini et al showed coronoid height possessed the best potential for gender determination in Indian population with the accuracy of 74.1 % and with combination of all variable overall accuracy of 80.2%.[9] A study conducted by Pokhrel and Bhatnagar on dry mandibles of the Indian population concluded mandibular measurements to be highly significant in the prediction of gender in defined population.[17]

The condyle-coronoid angle and condyle-coronoid breadth variables have not been studied widely. In the present study we found condyle-coronoid angle was found to be significantly higher in females compared to males, the reason for this difference could be because of stages of mandibular development, developmental status, growth rates and duration. Limitations of the present study are its inability to reliably determine the gender in both pediatric and geriatric age groups and also in patients with edentulous mouths and osseous disorders affecting mandible.

Conclusion

Mandibular ramus can be a useful tool for gender determination in forensic sciences. The present study found that ramus measurements using digital OPG's were reliable indicators in prediction of gender.

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