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ORIGINAL ARTICLE

Evaluation of Measurement of Gonial Angle and Mental foramen for Prediction of Gender Dimorphism in an Eastern Indian Population Sample - A Radiographic Cross-sectional Study.

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ABSTRACT

Introduction: In gender determination, facial skeletal components play a major role in forensic and anthropological fields. Skull is considered second best, after pelvis, in determination of sex. Mandible is the strongest bone in the body and most dimorphic bone of the skull that often recovered intact.

Aims: The purpose of the present study was to measure, compare and evaluate the mandibular parameters gonial angle and relative position of the mental foramen as sex predictors in an Eastern Indian population.

Material and methods: Panoramic radiographs and lateral cephalograms of the sampled patients were analysed for relative position of mental foramen and gonial angle respectively. This cross-sectional retrospective study was carried out utilizing radiographs of 100 patients (58 females and 42males) between age 18-44 years. A total of 5 measurements were evaluated for sex differences and the results were subjected to statistical analysis.

Results: Our study found that females showed statistically significant higher gonial angle values than males whereas the values of linear measurements of mental foramen were found to be higher in males than females.

Conclusion: The assessment of mandibular morphology through radiographic measurements suggest that gonial angle and mental foramen parameters exhibit significant gender dimorphism and it is a reliable indicator in estimating an individual's gender when comparing to a known population standard.

Keywords: Gender Determination, Gonial Angle, Mental Foramen, Panoramic Radiographs, Lateral Cephalogram.

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INTRODUCTION

Distinguishing males from females by analyzing the morphological characteristics of bone is important in the fields of physical and forensic anthropology. Personal identification in forensic investigation is a vital aspect. In the adult skeleton, gender determination is usually the first step of the identification process as subsequent methods for age and stature estimation are gender dependent.[1] The determination of gender is often limited to meager tissue remnants. In the crime scenes and mass disaters area, the hard tissue being strong and arduous is commonly the typifiying representative from which gender is to be determined. Skull bones and pelvis have been majorly used in gender identification. The use of morphological features of the mandible is a most common approach used by anthropologists and forensic dentists/forensic odontologist in the determination of the sex, whereas among many anatomical landmarks in human skull, the mental foramen is a stable landmark on the mandible.[2,3]

Radiographic and tomographic images have become an essential aid for human identification in forensic dentistry, particularly with the refinement of techniques and the incorporation of information technology resources.[4,5]

Many studies have been conducted in forensic anthropology examining several cephalo-facial characteristics. Dimorphic criteria have been reported relative to the mandibular bone such as gonial angle, the ramus length, minimum ramus breadth, bigonial breadth and bicondylar breadth.[6] The morphology of mental foramen is quite wavering. The mental canal opens superiorly and posteriorly in the mandible, and due to this reason, it is usually visual only 50% the time.[7] Various researchs are conducted on dry adult mandibles for gender determination, but a literature search did not reveal any study with regard to measurements on ramus of the mandible and gonial angle using a panoramic radiographs and lateral cephalograms.[8] In forensic investigations samples from the human mandible possess a great role because of its tenacious nature and persistent strength. Therefore, purpose of the present retrospective study is aimed at obtaining and comparing measurements from superior and inferior border of mental foramen to lower border of mandible and gonial angle measurements on orthopantomographs (OPG) and lateral cephalograms as indicators of gender in eastern India population.

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METHODS

The present study was carried over a period from May 2021 To June 2022. This cross sectional retrospective study was conducted by the Department Of Oral And Maxillofacial Pathology And Microbiology and the patient records were retrieved from Department Of Orthodontics And Dentofacial Orthopaedics at SCB Government Dental College & Hospital, Cuttack, Odisha.

Patient selection

The sample size consists of 100 OPGs and lateral cephalograms each of 100 (58 females and 42 males) between age 18-44 years. Panoramic radiographs (OPG) and lateral cephalograms of the sampled patients were analyzed for relative position of mental foramen and gonial angle respectively. A total of 5 measurements were evaluated for sex differences and the results were subjected to statistical analysis. Single observer readings were computed to avoid any inter observer variations. The mean of right and left side of ramus was calculated for parameter on each OPG and Lateral cephalogram and the final values obtained for males and females were compared. Denatate subjects between the age group of 18 years to 44 years of age were included in the study while OPGs were taken from fully erupted permanent dentition; developmental disturbances of the mandible, magnification errors (vertical and horizontal), jaw pathology, previous jaw surgery and the distortion and presence of supernumerary teeth were excluded.

SAMPLE SIZE

The sample size was calculated using G*Power 3.1.9.7 software.
The input parameters:

Effect size- 0.64 (based on previous research by Abu-Taleb NS et al., 2015.[9])

α probability error- 0.05

Power (1-β error probability)- 0.80

Output parameters:

Critical t- 1.99

Df (degree of freedom)- 78

Sample size- 80

Minimum required sample size was 80. Thus, it was proposed to include 100 participants in the study.

The following parameters were measured on both sides and mean values were taken [Figure 1&2]: S-L **(**superior border of the mental foramen to the lower border of the mandible**)** and I-L **(**inferior border of the mental foramen to the lower border of the mandible). Tangents were drawn to the superior and inferior borders of foramen and perpendiculars were drawn from tangents to lower border of mandible bilaterally.

Fig.1- Orthopantomogram (OPG) illustrates that the tangents were drawn to the superior and inferior borders of foramen and perpendiculars were drawn from tangents to lower border of mandible bilaterally.

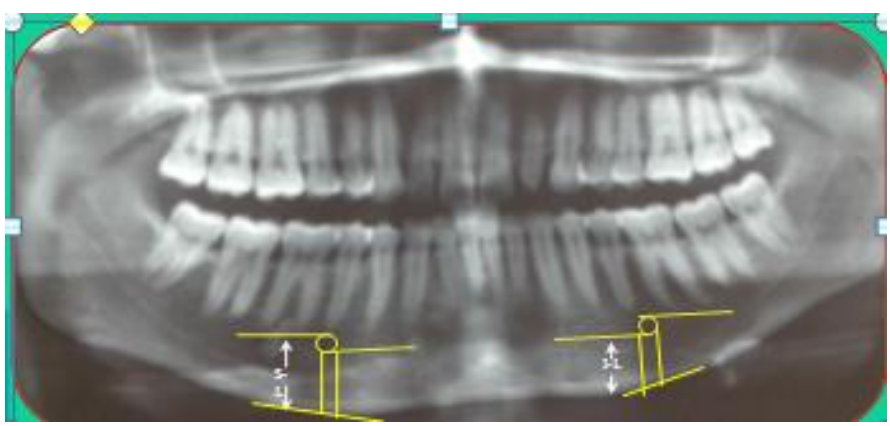


Fig.2- Lateral cephalogram demonstrates the intersection between a traced line tangential tomost inferior point at angle and lower border of mandibular body and other line tangential to posterior border of ramus and condyle.

GONIAL ANGLE: Measured as intersection between a traced line tangential to most inferior point at angle and lower border of mandibular body and other line tangential to posterior border of ramus and condyle.

STATISTICAL ANALYSIS PLAN

Data were entered into the excel sheet. Data were analysed using SPSS (Statistical Package for Social Sciences) 21.0 version, IBM, Chicago. Data were analysed for probability distribution using Kolmogorov-Smirnov test. Descriptive statistics was performed. Inter-group comparison of continuous variables was done using Independent 't' test/Man-whitney U test depending upon the distribution of data. Predictive accuracy was calculated by plotting ROC P value<.05 will be considered statistically significant.

RESULTS

OPG and Lateral Cephalogram were taken from 100 patients (58females and 42 males) between age 18-44 years.

The study included 100 patients with the mean age of 23.4±5.19 years. Male: female ratio was 1.38:1. The description of various study parameters amongst the study population has been provided in [Table 1].

	Mean ± standard deviation	Median (inter-quartile range)	Minimum	Maximum
RSL (Right side)	1.6 ± 0.208	1.6 (1.5-1.8)	1.10	2.10
RIL (Right side)	1.3 ± 0.198	1.3 (1.2-1.5)	0.90	2.10
LSL (Left side)	1.7 ± 0.254	1.7 (1.6-1.9)	1.20	2.70
LIL (Left side)	1.4 ± 0.241	1.4 (1.2-1.5)	0.90	2.30
GA (Gonial Angle)	123.5 ± 6.236	123.5 (119.0-127.0)	108.0	143.0

Table 1. Description of various parameters amongst study participants

Inter-group comparison of various study parameters between males and females showed that the difference in the mean age of male and female participants was statistically non-significant, thus, making the two groups comparable to each other. The value of RSL, RIL, (SL & IL of right side of mental foramen), LSL and LIL (SL & IL of left side of mental foramen) were significantly greater amongst males compared to females. The value of GA was significantly greater amongst females compared to males (p value<.05) [Table 2].

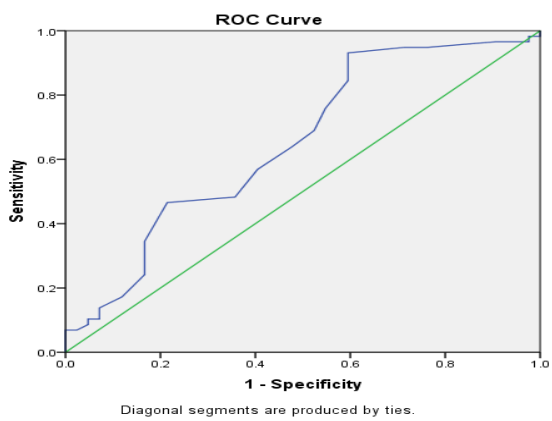
	Female (n=58)		Male (n=42)		P value
	Mean ± standard deviation	Median(inter-quartile range)	Mean ± standard deviation	Median(inter-quartile range)	
Age(in years)$^{\Omega}$	23.4 ± 5.367	22.0 (20.0- 26.0)	23.3 ± 5.009	22.0 (20.0-25.25)	.919
RSL$^{\Omega}$	1.57 ± 0.213	1.5 (1.5-1.7)	1.68 ± 0.187	1.7 (1.5-1.8)	.006*
RIL$^{\Omega}$	1.30 ± 0.206	1.3 (1.2-1.4)	1.41 ± 0.166	1.4 (1.3-1.525)	.001*
LSL$^{\Omega}$	1.68 ± 0.264	1.6 (1.5-1.825)	1.80 ± 0.225	1.8 (1.6-2.0)	.001*
LIL$^{\Omega}$	1.32 ± 0.246	1.25 (1.2-1.425)	1.46 ± 0.210	1.4 (1.3-1.6)	.001*
GA$^{\beta}$	124.81 ± 6.0392	124.0 (120.75-128.25)	121.59 ± 6.089	122.0 (115.75-125.0)	.010*

Table 2. Comparison of different parameters between males and females

*p value<.05 was considered statistically significant. $^{\Omega}$Man-whitney U test. $^{\beta}$ Independent't' test.

The area under the ROC (receiver operating characteristics) curve was .651 indicating that Gonial angle can be used to predict gender. [Figure 3]

FIG.3- Receiver's Operating Characteristic Curve Depicting Predictive Accuracy of Gonial Angle.



RSL, RIL, LSL and LIL were not having normal distribution and thus before analysing AUROC (area under receiver operating characteristics), the data was transformed to normal distribution using reciprocal statistics in SPSS. AUROC curve for RSL, RIL, LSL and LIL were found to be less than .5 which indicated that these parameters cannot be used for prediction of gender [Table 3]

	Gonial angle	RSL	RIL	LSL	LIL
AUROC curve	.651	.342	.286	.327	.051
Cut off	118.5	-	-	-	-
Sensitivity	93.1%	-	-	-	-
Specificity	40.5%	-	-	-	-
Positive predictive value	67.5%	-	-	-	-
Negative predictive value	85.0%	-	-	-	-
Accuracy	71.0%	-	-	-	-

Table 3. AUROC, sensitivity, specificity, positive predictive value, negative predictive value and accuracy of gonial angle in sex determination.

At cut off value of 118.5, the gonial angle was found to have sensitivity, specificity, PPV (positive predictive value), NPV (negative predictive value) and accuracy of 93.1%, 40.5%, 67.5%, 85.0% and 71.0% respectively in sex determination [Table 3]. A value greater than 118.5 indicated towards female gender.

DISCUSSION

Mandible is the most well preserved bone, so it is a very useful tool in forensic studies. Several morphometric parameters of mandible have been evaluated to determine gender dimorphism. Skull exhibits gender dimorphism which primarily depends upon variations of muscle attachment in males at adolescent age, whereas the female skull tends to retain pedomorphic features. The male mandible exhibits increased body height, prognathic mandible and strong lower border along with remarkable muscle markings in comparison to female. The gonial angle formed between the body and ramus in males is less obtuse than in the female.[8,10] The mental foramen has been reported to vary in position in different ethnic groups and gender. Panoramic radiographs are well known to show greater part of maxilla-facial skeleton as a continuous image, thus allowing for a more accurate localization of both mental foramina in both vertical and horizontal dimensions.[9, 11]

In our study, the values of S-L and I-L were significantly high in males as compared with females which are in accordance with studies of Thomas et al, Mahima et al, and Cantonie et al. However, many authors in their studies have found no dimorphism between males and females. The difference may be attributed to the racial and ethnic diversity of population under study.[12, 13 14]
Vodanovic et al in 2006 found that the mean value of I-L does not exhibit sexual dimorphism. The difference may be due to racial diversity of the study population. In our study, this value was also significantly high in males, which also corresponds to the studies of Enlow et al, Amorim et al and Akhilesh et al.[15]

In the present study gonial angle measurements in females are found to be significantly higher than males. Our observation is in accordance with most of the studies.[16,17,18] Particularly, it is observed that an individual with relatively higher masticatory forces has a small gonial angle; men mostly have greater masticatory force than women.[19] This is due to the fact that females have a downward and backward rotation in mandible while males have a forward rotation. The finding is not uniform worldwide and varies among populations, again attributed to ethnicity and racial variations.

CONCLUSION

Orthopantomogram (OPG) is considered as an adjuvant radiographic method to differentiate gender as it provides ground for the measurements of various landmarks from skeletal remains. Analysis of mandibular structures through radiographic evaluation possibly be an effective tool in assessing an individual's identity. Based on the results of the present study, it is possible to conclude that distance from the mental foramen to lower border of mandible and gonial angle exhibits gender dimorphism in Odisha population which would prove to be extremely useful in comparative dental identification in forensic scenarios.

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