

Sex Determination in Kerala Population Using Morphometric Analysis of Orbital and Mandibular Height: An Institutional Based Study

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ABSTRACT

Introduction: Measurement of orbital space and height of the mandible are used as tools for estimation of sex, which can be done by using different radiographic techniques like CT, MRI, frontal and lateral skull view, which gives superior accuracy and reproducibility.

Aims: To determine the sex of the individual using orbital and mandibular height.

Materials and Methods: A cross sectional retrospective study was conducted using a study group consisting of 100 lateral cephalograms both male and female of 18-30 years of age. Lateral cephalograms available in orthodontics department archives were used. In the lateral cephalogram height of orbit was measured by marking the points at supra orbital and infra orbital margin & height of mandible was measured by marking the points at condyion superior (the most superior point on the mandibular condyle) and gonion with the help of GIMPS (GNU Image Manipulation Program) software. The data obtained were analyzed by descriptive statistics, discriminant function analysis using Wilk's Lambda test.

Results: Discriminant function analysis was used to describe the data with appropriate method of presentation. Descriptive statistics showed that mandibular height was statistically significant between males and females. However, the orbital height difference was not statistically significant.

Conclusion: Mandibular height can be used in sex determination, which can be utilized as an adjunct in forensic identification.

Key-words: Sex determination, Mandibular height, Orbital height

Oral and Maxillofacial Pathology Journal (2023): <https://www.ompj.org/archives>

INTRODUCTION

Forensic odontology is a branch of dentistry which deals with identification, examination, evaluation of dental evidence using different techniques and methods.¹ Sex determination of unknown human skeletal remains is one of the parameters used in identification method used in forensic odontology. It can be assessed by using data from morphology of skull, mandible, tooth measurements and DNA analyses from teeth. Certain natural calamities like mass disasters, cyclones, earth quakes, and fire accidents require antemortem radiographs to be compared with postmortem radiographs to identify unknown human bodies and gender. After co-axial bone, skull is the second most gender discriminating part of the human body.² The human skull has many anatomical landmarks like the orbital aperture, nasal septum, sinuses, maxilla, and mandible, which can be used as a tool to identify the gender of an individual. Measurement of orbital space and height of the mandible are used as tools for estimation of sex, which can be done using different radiographic techniques like CT, MRI, frontal and lateral skull view, which gives superior accuracy and reproducibility.³⁻⁵ Various facial indices using cephalometric variables such as orbital index, frontal sinus, ramus height, chin thickness, facial angle, convexity angle, gonial angle, facial height and depth etc had been assessed for sex dimorphism in various populations and ethnic groups.⁶⁻¹¹ The present study was carried out to assess the orbital height,

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How to cite this article: Sabarad P, Shalinipriya N, Prabhu S, Miqdad SM. Sex determination in Kerala population using morphometric analysis of orbital and mandibular height: an institutional based study. Oral Maxillofacial Pathol J 2023;14(1): page no. 33-35

Source of Support: Nil

Conflict of Interest: None

Acknowledgement: Dr. Rohan Mascarenhas -Professor and Head of the Department and Dr. Shahistha Parveen Reader, Department of Orthodontics, Yenepoya Dental College, for their help and support in providing required lateral cephalograms and analysing them.

mandibular height variation for sex determination in Kerala as literature review suggests such parameters has been not checked before in this particular population.

MATERIALS AND METHODS

The study was conducted in the Department of Oral Pathology and Microbiology and in the Department of Orthodontics, Yenepoya Dental College, Mangalore. It is a Cross sectional in vitro study. The study was approved by the institutional ethics committee. It was done by using lateral cephalograms from archives available in department of orthodontics. The sample consist of 100 retrospective diagnosed lateral cephalograms of Kerala population including systemically healthy male and female gender of age group between 18-30 years. Study samples/individuals with any of the developmental anomalies, pathologies, and fractures were excluded from the study. In lateral cephalograms, the measurement of orbital height(right and left) was performed by using the supra orbital margin and infra orbital margin as markers & height of mandible was measured by using the condylion superior (the most superior point on the mandibular condyle) and gonion using GIMPS software² (Figure 1 and 2).

RESULTS

Discriminant function analysis was used to describe the data with appropriate method of presentation. Descriptive statistics showed that mandibular height was showing statistically significant difference between males and females. However, the orbital height difference was not statistically significant (Table 1).



Fig. 1: Orbital height is measured from supra orbital margin to infra orbital margin using GIMPS software

Descriptive statistics shows mean value was more among males than females and standard deviation was more among females than males, having p value p=0.00 for mandibular height parameter. Mean value were showing more value among females than males, and standard deviation was more for males than females, with P value p=0.741 for orbital height parameter. (Table 1)

Discriminant Analysis:

The Discriminant functions $D_m D_m$ and $D_f D_f$ are estimated to discriminate males from females by using Mandibular and Orbital Heights. The two discriminant functions are as follows:

$$D_f = -88.638 + 1.132 \text{ Mandibular Height} + 2.335 \text{ Orbital Height}$$

$$D_m = -97.078 + 1.295 \text{ Mandibular Height} + 2.222 \text{ Orbital Height}$$

In the procedure of classification for a given subject, the Mandibular height and orbital height are substituted in above equation and the Discriminant scores $D_m D_m$ and $D_f D_f$ are calculated and if $D_m > D_f$, the subject is classified as male otherwise female.

The Wilk's Lambda value which is used to check the performance of the estimated discriminant function in classification and value is 0.761, indicating a moderate performance, however it was statistically significant (Table 2)

Mandibular height which has a very high discriminant loading is considered as the very important variable and has the highest contribution in prediction of the sex compared to



Fig. 2: Height of the mandible (CO-GO) is measured from condylar process to angle of the mandible using GIMPS soft

Table 1: Descriptive statistics for orbital height and mandibular height.

		Mean	Std. Deviation	t statistic	P value
Mandibular height (mm)	F	75.160	7.2292	-5.187	0.000
	M	82.564	7.0034		
Orbital height (mm)	F	38.877	3.4992	0.331	0.741
	M	38.638	3.7144		

Table 2: The Wilk's Lambda is used to decide the performance of the estimated discriminant function

Wilks' Lambda	Chi-square	df	Sig.
0.761	26.438	2	0.000

Table 3: Mandibular height shows a very high discriminant loading whereas an orbital height shows least discriminant loading.

Predictor	Discriminant Loadings
Mandibular Height	.936
Orbital Height	-0.06

Table 4: Classification by the estimated discriminant function

		Predicted Group	
		Female	Male
Original group	Female	35	18
	Male	14	33



orbital height (Table 3)

The overall accuracy rate for this study group is 68% [70.2% of males were correctly classified and 66% of the females were correctly classified] (Table 4).

DISCUSSION

Sex determination plays a pivotal role in anthropology and forensic sciences, as it is a first and foremost step in investigation and further analysis is based on it.⁶ Identification of gender by using morphological assessment still remains an unique way of investigation. The human orbit is one of the most complex part of anatomical region in the head. In anthropological studies orbital measurement is one of the morphometric analysis used for determination of sex.² The mandible is the largest, strongest bone in the face. The mandible retains its shape better than other bones as it is a single, strongest bone that is covered by facial musculature, making it easier to remain intact.¹⁰ It is dimorphic, largest, and strongest bone of skull. Presence of a dense layer of compact bone makes it very durable, and hence remains well preserved than many other bones so it plays an important role in forensic odontology and anthropological works.⁵ Therefore, mandible can be used as an indicator for sex determination. Certain natural calamities, like mass disasters, cyclones, earth quakes, and fire accidents, require the use of antemortem radiographs to compare with postmortem radiographs to identify unknown human bodies and gender.² The present retrospective study height of orbit & mandible is measured in lateral cephalogram, to determine sex of an individual. The orbit is measured by marking the points on radiographs from the centre of the supraorbital margin to the centre of the infraorbital margin, and the length of the orbit is marked and measured. Height of the mandible is measured by marking a point from condylion to gonion by using GIMPS software. We considered 100 samples of retrospectively diagnosed healthy individuals of 18-30 years without any developmental anomaly, pathologies, fracture. According to descriptive statistics, mandibular height showed statistically significant difference between males and females, however the orbital height difference was not statistically significant.

Samatha K et al, conducted a study to determine the sex using the mandibular ramus measurements such as maximum ramus breadth, minimum ramus breadth, condylar height, projective height of ramus, and coronoid height which was calculated for the both sexes by using Discriminant function analysis with prediction accuracy rate of 53% and 60% for males and females respectively. Furthermore, Samatha K et al, concluded that high sexual dimorphism was seen with projective height of ramus and least with minimum ramus breadth.⁴ In another study conducted by, Indira AP et al, by using mandibular ramus measurements (in orthopantomograms) with following parameters such as Maximum ramus breadth, Minimum ramus breadth, condylar height, projective height and coronoid height which was calculated by using Discriminant function analysis with the overall prediction accuracy rate is 76%.⁵ In the present study, sexual dimorphism using orbital height and mandibular height using Discriminant analysis showed overall accuracy rate of 68%. This can be attributed to the fact that, many parameters were used and the radiographs used were orthopantomograms, which might be a better imaging technique for such facial indices.

Kanjani V et al, conducted a study to evaluate the orbital aperture dimension by using following parameters such as orbital height, orbital width and interorbital distance in

PA cephalogram for gender identification in north Indian population. In the present study, we had determined orbital height using lateral cephalogram. The overall predictive accuracy rate (84.4%) in Kanjani V et al study is comparable with the present study results. However, In our study, the discriminant loading for orbital Height in determining sex is very less (-0.06), This may be attributed to lateral cephalogram, being used here, thereby determining of sex by using orbital height as a parameter can be better identified by using the PA cephalogram than the lateral cephalogram. This study is first of its kind for orbital height using lateral cephalogram, proving to be not a better mode of assessment compared to PA cephalogram.²

With respect to Mandibular Height, our findings are similar to previous study by Pereira J et al., where the height is significantly high in males compared to females.⁶

CONCLUSION

The present research work infers that both mandibular height and orbital height can be utilized in predicting sex. However mandibular height alone can be a better predictor in lateral cephalogram and orbital height may not be a good parameter in determining sex using lateral cephalogram. It acts as an adjunct when other skeletal components such as pelvic, can be more accurate in sex prediction alone. However, when mandible is the only available component, mandibular height can be utilized in sex prediction.

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