Determination of Gender using Measurements of the Mandible taken from Orthopantomogram and Cephalogram

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Abstract:-Determining of age is essential in forensic and medico legal practices. Most dimorphic bone of the skull is mandible. Therefore, in sex estimation, mandible plays a dominant role. Since the measurements of the mandible vary with the ethnicity, it is important to evaluate the measurements of the mandible which are important in determining gender for a Sri Lankan population. The aim of this study was to determine the gender using measurements of mandible taken from orthopantomogram and cephalogram. This prospective cross sectional study was conducted among 116 SriLankan Sinhala patients (female 93, male 23) who underwent both orthopantomography (OPG) and lateral cephalometric examination at National Dental Teaching Hospital, Colombo 07. Maximum and minimum ramus breadth, condylar height, projective height, ramus height, coronoid height, biogonial width were taken from the OPG image and gonial angle was taken from the lateral cephalometry using left mandible of the patient. According to the statistical analysis, mean values of maximum ramus breadth, minimum ramus breadth, condylar height, projective height, ramus height, coronoid height, biogonial width of males were higher than females. Mean value of gonial angle of males were lower than females. Projective height was the most significant predictor in determining gender (P=0.000). Among the sample, 67.2% predicted the gender accurately using the prediction model found in the present study. 67.7% were predicted as females and 60.9% were predicted as males accurately. In conclusion, the most reliable measurement of the mandible is projective height in determining the gender of a Sinhala population in SriLanka.

Keywords: Gender, Mandible, Orthopantomography, Cephalometry

Introduction:

Age and gender estimation of individuals plays an important role in issues related to immigration, child labour and forensic sciences. Age and gender are the information that is vital to determine the identity in cases where visual recognition is not possible. The role of aging and gender changing in forensic investigations are not limited only to identification. In addition to the identification, age and gender changes can also be utilized in the context of crime investigation, chemical and nuclear bomb explosions, natural disasters, and ethical studies (Bhagwatkar et al., 2016).

To determine the gender, physical and chemical methods are used. As chemical methods DNA test is the accurate method. As physical methods, identification of the skeletal remainders is a very significant step in medico-legal investigations.

Numerous markers on a human skeleton can be used to assessment the sex of the deceased. Sexual dimorphism as seen in the human skeleton can be resolute by using skull, dentition, pelvic and dimorphism. Among

those, skull and pelvic bone are the two most commonly used skeletal markers. Most of the time parts of the pelvis and skull are used for the sex and age determination. Presence of a dense layer of compact bones makes it strong and well unspoiled than many other bones (David et al., 2012).

When the entire adult skeleton is available for analysis, sex can be determined up to 100% accuracy, but in vast disasters or fetal incidents where the loss of the pelvic region, the skull is playing a vital role in sex determination. Skull is the most dimorphic and easily sexed portion of skeleton after pelvis providing accuracy up to 92%. But in a case where intact skull is not found mandible may play a vital role in sex determination as it is the most dimorphic, largest and strongest bone of the skull (David et al., 2012).

Moreover, the morphological changes of the mandible are raised by the occlusal status and age of the subject where longitudinal studies have proposed that remodeling of the mandibular bone occur with age. With 100% accuracy, sex and age are recognized even by the even measurements of mandible (Markande, David and Indira, 2012).

Two main methods can be used to take the measurements of the mandible called, physical method and radiographic method. For the physical method dry mandible which is clearly visualized the anatomical features (Graduate Trainee and Resident, 2017). In radiological method intra oral radiographs, lateral mandible oblique radiographs, orthopantomography (OPG) radiograph, lateral cephalometry and postero-anterior (PA) cephalometry radiographs can be used.

According to the some studies, the mandibular measurements are vary with the ethnicity (Graduate Trainee and Resident, 2017). Therefore, forensic medical professionals in Sri Lanka can't use the measurement values given by the researches in other countries in determining gender using the mandibular measurements. The objectives are to estimate the gender of a known person using the measurements of the mandible for Sri Lankan Sinhala population and to determine the most reliable measurement/s of the mandible can be used to determine the gender (Leversha et al., 2016, Radhakrishnan, Sapna Varma and Ajith, 2017).

Methodology:

This prospective cross sectional study was conducted among 116 Sri Lankan Sinhala patients (female 93, male 23) who underwent both orthopantomography (OPG) and lateral cephalometric examination at National Dental Teaching Hospital, Colombo 07. Panoramic and cephalometry images were collected using via CS 3900 trophy Digital Imaging and Communications in Medicine (DICOM) - 6.4.0.4 software. imageJ windows version software were used to take all the measurements of the mandible. The maximum ramus breadth (A), minimum ramus breadth (B), condylar height (C), height of ramus (D), coronoid height (E), projective height (G) and biogonial

width (H) were taken by orthopantomogram and gonial angle (F) was taken by lateral cephalomerty of the left mandible. Figure 1.1 and 1.2 illustrate the above mentioned measurements.
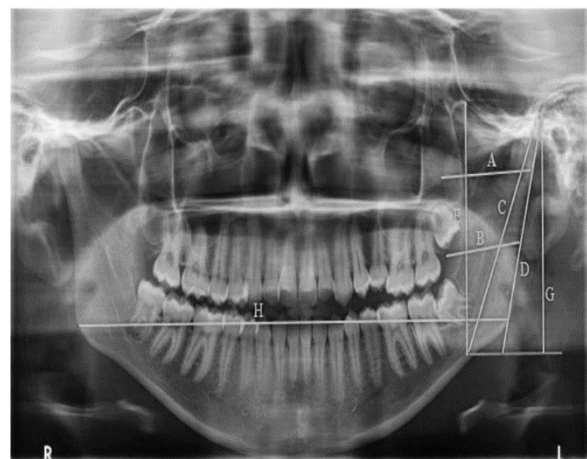

Figure 1 - Measurements taken on OPG radiograph

Figure 2 - Measurements taken on lateral cephalometry radiograph

Result

Descriptive statistics analyze was used to find minimum, maximum, mean, standard deviation (SD) and median values. Kolmogorov-Smirnov normality test was used to find the normality of the distribution significant p value (p> 0.05). According to the results of the KolmogorovSmirnov test, the data set follows a normal distribution.Interclass correlation coefficients were used to determine the reliability of both collectors' rates. Reliability result shows no significant difference among those both collectors', therefore only one data set used to analyze the results.Independent sample t test was performed to compare the difference of means between 2 gender groups. According to the results of Independent sample t test Minimum ramus breadth, Condylar height, Projective height, Coronoid height and Height of ramus significantly differ between males and females (P<0.05). A discriminant function analysis was performed to create a prediction model to predict the gender of a person. Significant mean differences between males and females were found for above five measurements.

According to the wilk's lambda test statistic all 5 variables which were found to be significantly different between two gender groups , were significantly contribute to the proposed prediction model also.

Table 1 - Test of equality of group means

	Wilk's lambda	F	df1	df2	Sig.
Minimum ramus breadth	.960	4.795	1	114	.031
Condylar height	.913	10.878	1	114	.001
Projective height	.888	14.393	1	114	.000
Coronoid height	.890	14.131	1	114	.000
Height of ramus	.932	8.372	1	114	.005

Moreover, table 1.2 demonstrates the relative importance of the variables to the proposed model

Table 2 - Standardized Canonical Discriminant Functions coefficient

	Function
	1
Minimum ramus breadth	.323
Condylar height	-.2.072
Projective height	1.730
Coronoid height	.725
Height of ramus	.393

Although all five measurements play a significance importance to the model, projective height had the highest importance indicated by Canonical discriminant Functions coefficient of 1.730. According to the unstandardized canonical discriminant function coefficients (table 1.3) a discriminant function equation can be derived as below.

D=-7.953+0.063X1-0.256X2+0.211X3+0.089X4+0.053X5

D= Predicted Class Intercept = (-0.793)

X1 = Minimum ramus breadth

X2 = Condylar height

X3 = Projective height X4 = Coronoid height

X5 = Height of ramus

Table 3 - Unstandardized Canonical discriminant Functions coefficient

	function
	1
Minimum ramus breadth	.063
Condylar height	-.256
Projective height	.211
Coronoid height	.089
Height of ramus	.053
(Constant)	-7.953

Discussion:

Result of the study is concerned statistically, except gonial angle measurements, all other seven measurements of the mandible(maximum Ramus breadth: male 47.72mm and female 45.51mm, minimum ramus breadth: male 34.50mm and female 31.88mm, condylar height: male 91.38mm and female 85.16mm, projective height: male 86.47mm and female 79.23mm, coronoid ramus height: male 88.32mm and female 81.18mm, height of ramus: male 73.70mm and female 68.67mm, biogonial width male 214.15mm and female 205.10mm) is higher in males than females. Only gonial angle measurement (female 134.37o and male 132.37o) is higher than males. Most reliable measurement is expressed as projective height through discriminant function analysis. According to the prediction equation, 67.2% overall accuracy can be gained. Males can be predication as 60.9% correctly. Likewise,

correct prediction of females is 67.7%. Projective height is the most significant parameter for the Sri Lankan population. The sensitivity of the proposed model is 67.7 % and the specificity is 60.9%.

As respects the gonial angle, males exposed statistically significant lower mean gonial angle standards than females (132.37o and 134.37o respectively). This was in covenant with many researchers. Hence, the gonial angle values in females were higher than in males. According to the ethnicity, mandibular angle differs among various population (119o) in Indian, Chinese and Peruvian mandibles, (110°) in that of the Neanderthals, (128o) in the European population, (120o) in Xanthoderms and African Negroes and (124o).

This study Saini et al., (2011) revealed important factors on with the study regarding to the mandibular measurements taken from Northern Indian population. It consisted of 92 males and 24 females with 37.4 years mean age. In case of all males, all the metric parameters were higher than females (Coronoid height: male61.68 mm and female 54.89, projective height: male 53.89 and female 47.45, condylar height: male 60.67 and female 54.46, maximum breadth: male 42.81 and f e male 40.34 and minimum breadth: male 31.29 and female 29.65). While it purposed the 80.2% overall accuracy, significant sexual dimorphism could be seen.

Another study Indira et al., (2012) was done in Bangalore population in to this regard. In this study, all linear ramus dimensions were taken from Orthopantomographs were higher in males than females significantly. 50 males and 50 females participated within 20-50 years age group. (Coronoid height: 119.70 mm and 111.15, projective ramus 26 height: 129.05 and 120.82, condylar height: 131.30 and 123.27, maximum breadth: 74.20 and 68.98 and minimum breadth:

51.35 and 46.96 in males and females respectively). 76% of the cases were classified correctly.

Conclusion:

For determination of gender, applicable measurement of the mandible is projective height. The results of this study will contribute in the medico-legal practice in Sri Lanka for determination of gender in Sinhala population.

Reference

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