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Original Article

Weight of Hyoid Bone – A Significant Metrical Index for Sexual Dimorphism

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ABSTRACT

The present study is to assess the significance of weight of fused hyoid bone as a useful metrical index in determination of sex of an individual. The material used in the present study includes 55 fused hyoid bones of known sex of North Indian population, obtained from the cadavers brought to mortuaries for post-mortem. The bone was weighed with the help of electronic weighing scale and the readings were tabulated and statistically calculated. It was noticed that weight of hyoid bone was statistically significant and greater in males than in females. Weight of completely fused hyoid bone showed significant statistical result and can be considered helpful along with other parameters for determination of sex of an unknown hyoid bone.

Keywords: Fused hyoid bone, Weight, Sex determination, Sexual dimorphism

INTRODUCTION

Identification of individual has greater importance in civil and criminal jurisprudence. Determination of age and sex from human skeletal remains is a routine procedure for the forensic anthropologists in India and plays a key role in solving various medico-legal disputes. Various bones or part of the bones have been used to identify the sex of the human. Combined use of both, bony pelvis and skull, for the sex determination, give no more than 90-95% of accuracy [1].

Reliability of sex determination depends on the completeness of the remains and the degree of sexual dimorphism inherent in the population from which the individual originates [2]. The challenge of the determination of sex rises with the incompleteness and friability of the material [3]. The determination of sex is statistically the most important criterion, as it immediately excludes approximately half the population whereas age, stature and race each provide points within a wide range of variables [4].

The hyoid bone is a U-shaped and is suspended from the tips of styloid process of the temporal bones by the stylohyoid ligaments. The hyoid bone lies free, suspended by muscle, and so is very mobile [5]. It comprises a quadrate middle part, the body, and two processes on each side, the greater and lesser horns (cornua). It is readily palpated at the angle where the upper part of the neck meets the floor of the mouth [6]. All human populations show at least some sexual dimorphic features regarding hyoid. These features similar to skull, pelvis and other long bones are population and race specific. In the present study, weight of hyoid of known sex has been taken and tried to analyse based on sexual dimorphism.

METHODOLOGY

The objective of this study was to assess the importance of weight of completely fused hyoid bone as a significant metrical index in sex determination. The study was conducted on 55 fused hyoid bones recovered from medico-legal autopsies in the Department of Forensic Medicine, Pt. B.D. Sharma PGIMS, Rohtak, Haryana. Out of the 55 completely fused hyoid bones studied, thirty-six specimens were obtained from male cadavers and nineteen from female cadavers. The age group ranged from 17 to 82 years. Fused hyoid bones of all those cases where approximate age but exact sex was known were included in this study. All hyoid bones measured in this study were from Northwest Indian population. Hyoid bones from individuals with any congenital anomalies, partially destroyed, fractured, burnt, diseased, deformed or abnormal hyoid bones would be excluded from the study.

After careful dissection of the laryngeal structures during autopsy, the completely ossified hyoid bone was removed from cadavers and were duly numbered after defatting them with acetone. The bones were weighed on an electronic weighing balance.

After midline incision, the neck structures were dissected from the lower border of mandible and then separation of tongue was done and was dissected along with neck structures. The completely fused hyoid bone thus collected was put in a duly numbered jar containing 3/4th plain tap water for maceration without any chemical to avoid any erosion of the bone. These were examined intermittently; and after soft tissue was completely separated the bones were further cleaned with soft brushing the remains of the attached soft tissues. After cleaning, bones were dried at room temperature. Defatting was done by keeping the bones in acetone for few days. Digital weighing machine having air-tight chamber was used to weigh the fused hyoid bone. Weight of bone was obtained in the gram separately with the accuracy of 0.01 gm. Three readings were taken from electronic weighing machine at different times and the average was recorded.

By using computer and statistical aids, SPSS version 18 for windows was used for analysis of results. Descriptive statistics was used to examine the variables. P value of less than 0.05 was considered significant.

OBSERVATIONS AND DISCUSSION

The purpose of the current study is to illustrate that the fused hyoid bone showed significant sexual dimorphism and to explore and assess the degree of sexual dimorphism in weight of fused hyoid bone. The results of this study produced coefficients from a sample of ossified hyoid bones recovered from Northwest Indian males and females in medicolegal autopsy cases. The following observations were made after conducting the unpaired t-test and then discriminant function analysis, sectioning point, identification point, demarking point and limiting point methods were applied to find out the formulas to determine the sex of the individuals from ossified hyoid bone.

Statistical Testing of fused Hyoid Bone

Weight of fused hyoid bone (WCH) variable was statistically highly significant reflecting the sexual differences between male and female fused hyoid bone when weight is used as a parameter. Table 2 showed the value of Wilk's lambda and F-ratio of this variable. In this table, Wilk's lambda calculates how useful a given variable is, as well as the order of variables to enter the function. The F-ratio determines how much variation exists within and between the sexes and the significance level of the variance. t-tests were calculated in order to compare the relative significance of sexual difference between the variables. This table also showed the results of sectioning and discriminating point analysis.

Table 1: Number and Percentage of Cases Used in the Study

	Distribution	
	N	Percent
Male	36	65.45
Female	19	34.55
Total	56	100

Table 2: Comparison Between Male and Female Weight of Complete Hyoid Bone (WCH) Measurement in Fused Hyoid Bone by Univariate and Multivariate Analysis

S.No.	Statistical Tests		WCH
1.	Mean	Male	1.35
		Female	0.988
2.	Standard deviation	Male	0.417
		Female	0.444
3.	Standard error of mean	Male	0.069
		Female	0.102
4.	P-value		0.002
5.	Mean ± 3SD	Male	0.099-2.601
		Female	-0.345-2.319
6.	Wilk's lambda		0.816
7.	F-ratio		11.524
8.	Discriminating point	Value	1.2226
		Male %	56
		Female %	74
		Overall %	62
9.	Sectioning point		-0.436
10.	Fisher's Classification Coefficients	Male	7.410
		Female	5.433
11.	Fisher's Classification Constants	Male	-5.683
		Female	-3.376
12.	Canonical Discriminant Function Coefficients Unstandardized	Coefficients	2.346
		Constant	-2.868
13.	Percent Correctly classified by Discriminant function analysis	Male	72
		Female	79
		Overall	75

p<0.001 (highly significant), p>0.05 (non-significant)

Discriminating point for variable was taken from the average of the mean values for a variable in both sexes. The results from the univariate analysis that were greater than the sectioning point were considered male individuals, and results that were less than the sectioning point were considered female individuals, while the results that were equal to the sectioning point were classiûed as indeterminate. This table showed the coefficients and constant for the used variable in both sexes. The fisher's coefficients are used to calculate discriminant score.

Identification point

The male identification point is the maximal value of a dimension in female bones & for the female bone identification point is the minimum value of a dimension in male bones. The area lying between these points was called overlapping zone.

Demarking points

Demarking points are obtained by calculating the maximum and minimum limits i.e. the range of a

Table 3: Percentage of Completely Fused Hyoids Correctly Classified Using Identification Points (I.P.), Demarking Points (D.P.) and Limiting Points (I.P.)

Variables	Identification points (I.P.)		% Identified with Identification points (I.P.)		Demarking points (D.P.)		% Identified with Demarking points (D.P.)		Limiting Point (L.P.)	% Identified with Limiting Point (L.P.)	
	Male	Female	Male	Female	Male	Female	Male	Female		Male	Female
WCH	2.3	0.62	3	5	2.3	0.099	3	-	1.46	31	84

dimension. Addition of 3 standard deviations to the mean gives the maximum value and subtraction of 3 standard deviations from the mean gives the minimum value. Thus, demarking points were obtained above which no female bone could be found, and this was the upper calculated range of female bone. Any bone having values more than this was bound to be male. Similarly, from the calculated range of male bones, a demarking point was obtained below which no male bone could be found. Thus, any bone having a value less than this was bound to be female.

Limiting point

Although identification and demarking points can identify sex accurately, but only a small proportion of hyoids can be sexed based on these methods as most of the remaining hyoids show the measurements in the overlapping zone. Therefore, a limiting point was chosen in the study, calculated from the average of male and female identification points. Limiting point so calculated was such that the vast number of male hyoids showed value greater than it and the bulk of female hyoid showed values lesser than this limiting point.

Weight of Complete Hyoid Bone (WCH)

Although ample literature is available on sexual dimorphism from weight of other bones, very few literature or case studies have been reported on the sex determination from weight of the completely fused hyoid so far. In the present study, the mean of WCH measurement in articulated bone was found to be 1.347 gm ± 0.417 SD in males and 0.988 gm ± 0.444 SD in females. The difference between means of male and female WCH was found to be statistically significant. Ranjith and Pillai [7] weighed 67 female and 23 female adult hyoid bones obtained from cadavers above the age of 18 years. According to them, the mean weight of the male bone was 1474.40 ± 289.66 mg and that of a female bone was 960±233.27 mg; taking ±1 S.D. into account they calculated that a bone above 1193 mg in weight should belong to a male and the one weighing less than 1185 mg should be that of a female. Based on these criteria they could identify 86.57% male and 96.57% of female bones. Many researchers concurred with the above-mentioned study and found out statistically significant sexual dimorphism in completely fused hyoid bone when weight of hyoid bone is taken as parameter [8,9,10,11]. With the application of mean ±3SD, 4.4% female and 22.4% male bones could be identified. Harjeet and Jit [12] conducted study on northwest Indians applied the formula mean ±1SD to the weights of hyoid bone revealed 79% males and 76% females. When the formulas mean ±3SD (demarking point) was applied, only 29% male and 19% female bones could be sexed correctly. The mean ±3SD range calculated out for the male and female WCH was 0.099-2.601 gm and -0.345-2.319 gm respectively. As far as the Discriminant function analysis is concerned the sectioning point comes out to be -0.407 and based on that 72% male and 79% of females could be correctly differentiated with an overall accuracy of 75% whereas with discriminating point 56% males and 74% of females could be sexed accurately with overall accuracy of 62%.

Table 3 showed another way of sexual differentiation which was brought out by identification, demarking and limiting points methods, evolved on the lines[12]. All these three ways are of less significance for practical purposes as they all showed very less percentage or accuracy regarding correct classification of the sex in hyoid bone.

All these measurements may be useful for classifying accuracy of long bones but not for hyoid bone particularly

CONCLUSION

There was a statistical significant difference between readings observed in weight parameter, which were greater in males than in females and there was a clear cut demarcation between the value of male and female bone. The present study indicates that the sex can be determined with maximum accuracy by taking the univariate and multivariate analysis of the weight parameter of hyoid bone and the accuracy is not satisfactory if only one parameter is taken.

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