Legal Medicine 25 (2017) 6–10

Contents lists available at ScienceDirect

Legal Medicine

journal homepage: www.elsevier.com/locate/legalmed

Sex prediction potential of hyoid metric measurements in Iranian adults

Siamak Soltani, Kamran Aghakhani, Fardin Fallah *

Department of Forensic Medicine and Toxicology, Iran University of Medical Sciences, Tehran, Iran

ARTICLE INFO

Article history:
Received 27 September 2016
Received in revised form 19 December 2016
Accepted 23 December 2016
Available online 24 December 2016

Keywords:
Body Mass Index
Cadaver
Hyoid
Metric measurements
Sex

ABSTRACT

Objectives: Human hyoid is sexually dimorphic and is useful for sexing unknown skeletal remains. We aimed to find sex prediction potential of three linear dimensions of hyoid bones obtained from a series of cadavers with Persian ethnicity.

Methods: This cross-sectional study was carried out in 2015 at Forensic Pathology Organization of Tehran, Iran. We directly measured three linear dimensions of a series of hyoid samples obtained from cadavers during their neck autopsy in a convenience method. These dimensions were width, length and distance between lesser horns of hyoid. Height and weight of cadavers were also documented. Cadavers were of Persian ethnicity and at least 25-year-old. Data were analyzed by SPSS16. Logistic Regression Model was applied to find independent sex predictor(s) of hyoid. Statistically significant level was considered <0.05.

Results: Hyoids of 349 adult cadavers (176 females and 173 males) with mean ± SD age of 39.91 ± 8.13 years were investigated. Male cadavers had significantly higher BMI values (p-value < 0.001). Mean ± SD for width, length and distance between lesser horns of hyoids were 34.45 ± 4.70, 34.61 ± 4.67 and 22.71 ± 2.80 mm, respectively. All measured dimensions had greater mean values in males (all with p-values < 0.001). After adjusting for BMI, length and distance between lesser horns of hyoid were independent predictors of sex with odd's ratio of 4.67 and 1.97, respectively. Combining these two measurements provided sex classification accuracy of 97.4%.

Conclusion: Special metric hyoid indicators can help in accurate sexing of skeletal remnants of adult Iranians. Further studies will find the strongest sex predictors of hyoid bones among Persians.

1. Introduction

Establishing identity of decedents from their skeletal remnants is a challenging task of the professionals in the field of forensic medicine [1–3]. Bones remain intact even years after death and in some cases they are the only clues for identification of incognito dead bodies [4]. Sexing unknown skeletal remains is a priority in recognizing their identity [3,5]. Since early 1900s that sex determination by using hyoid bone had been proposed [6], many studies have documented sex prediction potential of human hyoid [7–9]. To estimate sex from hyoid bones, metric measurements have been used alone [1,7], or in combination with morphologic characteristics [2,8,10–12]. Many regional equations have also been suggested for sex prediction considering various metric dimensions of hyoid bones as their inputs [1,3,12]. Using hyoid morphology for sexing is more subjective and therefore observer-dependent, whereas its metric analysis is more objective and with lower probability of observer's bias [3,9].

Due to racial variations, studies on anatomical features of human hyoid should be regional and population-specific [2,9]. Sexual dimorphism of human hyoid has been studied in various populations in the world but it has not been addressed sufficiently in Iran. In this study we aimed to find sex prediction potential of three simply measurable metric dimensions of hyoid in a series of adult cadavers with Persian ethnicity.

2. Methods

This is a cross-sectional study conducted during September–December 2015 at Forensic Pathology Organization of Tehran, Iran. Study was carried out on hyoid bones that were obtained from cadavers during their neck forensic exploration due to legal indications (usually for the doubtful causes of death). All cases were of Persian ethnicity, at least 25 years old (to be confident of their skeletal maturation) and no more than 48 hours had been passed since their death. Hyoids with fracture or deformity and those belonged to cases with head and neck trauma or strangulation were not included in the study. We measured three dimensions of hyoid bones directly (Fig. 1). These dimensions were linear

* Corresponding author.
E-mail address: fardin.fallah@gmail.com (F. Fallah).

http://dx.doi.org/10.1016/j.legalmed.2016.12.010
1344-6223/

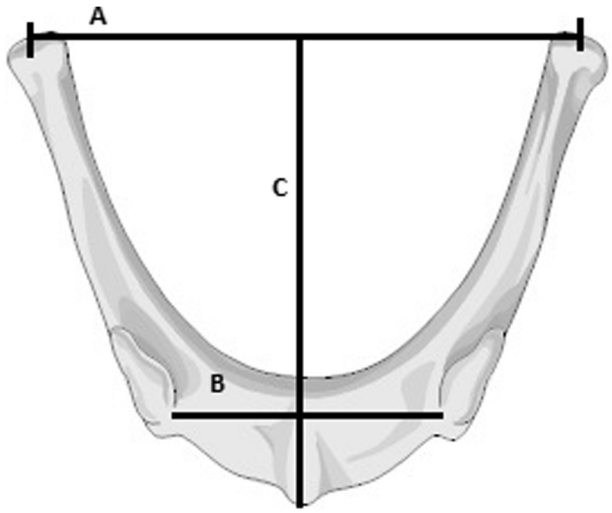

Fig. 1. Hyoid measurements used in this study. Measurement "A" or hyoid width is the distance between midpoints of distal ends of greater horns. Measurement "B" is the distance between lesser horns. Measurement "C" or hyoid length is the distance between midpoints of measurement "A" and anterior edge of hyoid body. These measurements were taken directly on hyoid samples of 349 adult Iranian cadavers (176 females, 173 males) and analyzed for their sex prediction potential. *Source:* smartdraw.com/skeletal-system-diagram/examples/hyoid-bone.

distances between straightforward points that their sex differential potential has been documented in previous studies [1,2,8]. Distance A is the assumptive line that connects middle points of distal ends of greater horns of hyoid; this distance has been mentioned also as hyoid width [1,8]. Distance B is the distance between lesser horns (distance between the medial midpoints of right side and left side facets) [1,2]. Distance C (also mentioned as hyoid length) is the line which connects the midpoint of distance A to the midpoint of anterior edge of hyoid body [1,8]. These distances could be easily measured even by non-experts and are not related to hyoid fusion [1]. We tried to obtain equal number of male and female hyoids during study period in a convenience sampling method. Finally, 349 hyoid bones were obtained from 176 female and 173 male cadavers. Data were collected by two experienced forensic technicians. Age, weight and height of cadavers were also documented. Mean ± Standard Deviation (SD) age of all cadavers was 39.91 ± 8.13 years and ranged from 25 to 54. All three targeted dimensions were measured twice by both technicians with the same digital escalator in millimeters (mm); each one documented his own measurements and in cases of intra- or inter-observer difference, average of documented values was regarded in final analysis. Intra- and inter-observer errors of measured variables were assessed by calculating relative technical error of measurement (rTEM) and coefficient of reliability (R). Equations in the study of Ulijaszek and Kerr were used for calculating these errors [13] and results are presented in Table 1. Data were analyzed by SPSS Version 16. Descriptive statistics are presented in mean ± SD. Independent sample *T*-test, Pearson correlation and Logistic Regression Model were applied for statistical analysis. Statistically significant level was considered <0.05 in this study.

3. Results

Mean ± SD for distances A, B and C in total population were 34.45 ± 4.70, 22.71 ± 2.80 and 34.61 ± 4.67 mm, respectively. Descriptive statistics for age and stature characteristics of cadavers and their hyoid linear dimensions are summarized in Table 2. While ages of male and female cases were homogenous (p-value = 0.15), their stature characteristics were of statistically significant difference (all p-values < 0.001). Correlations between study variables are summarized in Table 3. Considering strong correlation between hyoid dimensions and stature characteristics of

Table 1
Measurement error values for studied dimensions of hyoids.

	Intra-observer errors				Inter-observer errors	
	Observer 1		Observer 2			
Measured dimensions	rTEM[a]	R[b]	rTEM[a]	R[b]	rTEM[a]	R[b]
Distance A	1.98	0.98	2.49	0.97	3.19	0.95
Distance B	1.61	0.98	1.42	0.99	2.31	0.96
Distance C	2.24	0.98	1.84	0.98	3.36	0.94

[a] Relative technical error of measurement.
[b] Coefficient of reliability.

Table 2
Characteristics of cadavers and their hyoid metric dimensions stratified by sex.

	Gender	Mean	SD	Min	Max	P-value
Age at death (years)	Male	39.28	8.12	27	54	0.15
	Female	40.54	7.08	25	50	
Height (cm*)	Male	176.16	1.97	170	185	<0.001
	Female	161.50	3.21	150	170	
Weight (kg**)	Male	79.02	6.34	60	100	<0.001
	Female	63.49	8.82	50	85	
BMI	Male	25.46	1.97	20.76	30.86	<0.001
	Female	24.36	3.41	18.37	35.56	
Distance A (mm***)	Male	38.71	1.92	31	43	<0.001
	Female	30.26	2.18	27	38	
Distance B (mm***)	Male	24.69	2.46	19	32	<0.001
	Female	20.77	1.41	17	25	
Distance C (mm***)	Male	38.97	1.43	35	45	<0.001
	Female	30.33	2.01	27	39	

* cm = centimeters.
** kg = kilograms.
*** mm = millimeters.