



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2015; 1(9): 436-439
www.allresearchjournal.com
Received: 24-06-2015
Accepted: 26-07-2015

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Can human stature be estimated from sternum if sex is not identifiable?

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Abstract

Assessment of stature plays a substantial role while dealing with medico-legal cases. The main intention of the study was aimed at obtaining the regression formula for estimation of stature of an individual when the sex is not known by utilizing the length of manubrium, length of body of sternum and combined length of manubrium and body of sternum. The material for this study was acquired from medico-legal autopsies by the procedure of dissection and maceration of soft tissues of 100 known corpses at Tirunelveli medical college, Tamilnadu, India. The age of the corpses was between 14 years and 75 years.

As an outcome of the present study, the computed regression formula in case of manubrium was $Y=116.6 + 9.1x$ Length of Manubrium(LM) with standard error of ± 7.3 and coefficient correlation 0.38 and in case of body of sternum the regression formula was $Y=117.3+5.1x$ Length of Body of sternum(LB) with standard error of ± 4.4 and coefficient correlation was 0.73 whereas regression formula $Y=93.6+5.1x$ Combined Length of Manubrium and Body of sternum(LMB) with standard error of ± 4.8 and coefficient correlation 0.78 was derived from combined length of manubrium and body of sternum. The Length of Body of sternum (LB) and combined Length of Manubrium and Body of sternum (LMB) seems to be an ultimate source in evaluation of stature. This is by taking into account the higher coefficient correlation of them. Thus, this study confirms that, Length of Body of sternum (LB) and combined Length of Manubrium and Body of sternum (LMB) are trustworthy materials in estimation of stature of an individual where the sex is not identifiable.

Keywords: estimation, manubrium, body of sternum, regression formulae, stature.

1. Introduction

The most vital duty of forensic medicine experts is to find out the identity of a person who might be living or dead. Occurrence of catastrophic events like ship wrecks, air crashes, bomb explosions etc., results in death of enormous number of people. And in the occurrence of such adversities the burden of distinguishing between individual corpses lies entirely into the hands of forensic medicine experts. In addition to such responsibilities, intricacies like end stages of decomposition, disfigurement, shattered bony fragments present together as a greater challenge. The experts also confront difficulties while differentiating between the origins of the bony fragments, and in establishing the most approximate sex, age, and stature. The skill of forensic medicine experts in evaluating the stature of a person from the left over bony pieces is really advantageous. This is because, estimation of stature is the principal approach in ascertaining one's discrete identity. This purpose could be served out by calculation of stature from the resulting bony parts during autopsies. Thus, competence of forensic experts is very essential.

Nutrition, genetics, environment, socio economic status etc are those aspects that decide the stature of a person^[1-4]. The length of each part of the human body has an unflinching correlation with the height of a person. Making use of this piece of evidence the stature can be calculated easily provided that, the entire skeleton is available. When this is not possible and only one or more bones are available, by devising various formulae the stature can be calculated.

The sternum is a superficial bone and is frequently available even in most advanced stages of decomposition^[5]. The other benefit in using the sternum as a study material is that, it can be obtained from the corpses without any destruction of its morphology. By contemplating on

the above facts, sternum was chosen for the study. Thus, the present study is a genuine endeavor taken to compute the stature of an individual using the sternum, considering its beneficial features.

2. Materials and Methods

The sternum which was selected as the material of study, were obtained from 100 known corpses aged between 14years and 75years from Tirunelveli medical college, Tamilnadu, India. Corpses that were compressed, burned or extremely mutilated were excluded and sterna with congenital and acquired deformities as well. During the process of medico-legal autopsies, the costochondral junctions were dissected and the sterno-clavicular joints were detached and finally the soft tissues of the sternum were removed manually and dried [6].

Anatomical method and the mathematical method are the two methods by which stature can be assessed. When the entire skeleton is obtained, the bony parts are set out as per the anatomical location and length is measured. The stature can be found out by this measured length together with appropriate allocation for the soft tissues. When only one bone is accessible than the rule of proportion of length of long bones to the height of a person comes into play. In mathematical method, stature can be evaluated by creating the prediction equation or by developing the multiplication factor for reconstruction of stature [7]. Owing to the requirement of a single bone, the mathematical study was chosen for this study.

Measurements (Fig.1) were taken by using digital vernier caliper [8]. LM was measured from the jugular notch to the lower end of manubrium in par with the technique as suggested (Ashley 1956) [9]. LB was measured from the junction of the manubrium and body of sternum to the junction of body of sternum and xiphoid process (Singh *et al.* 2011) [8]. LMB was measured from the jugular notch to the junction between body of sternum and xiphoid process (Ashley 1956 and Singh *et al.* 2011) [8].

3. Osteometric Parameters Used For Analysis

1. Length of Manubrium (LM) - Fig. 2
2. Length of Body of sternum (LB) - Fig. 3
3. Combined Length of Manubrium and Body of sternum (LMB) - Fig. 4

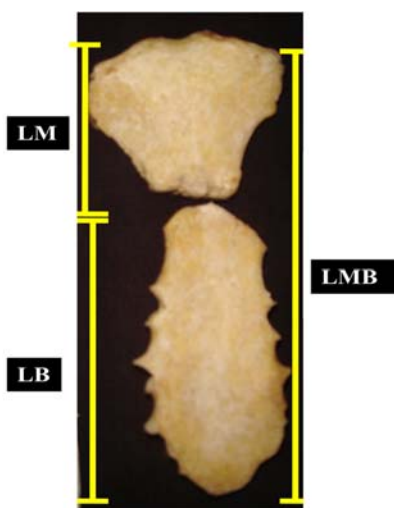


Fig 1: Various measurements of sternum.



Fig 2: Measuring the length of Manubrium



Fig 3: Measuring the length of Body of sternum



Fig 4: Measuring the combined length of Manubrium and Body of Sternum

Data collected were recorded, tabulated and statistically analyzed.

4. Observation

The regression formulae used were as follows:
 For LB: $Y = 117.3 + 5.1 \times \text{Length of body of sternum}$
 For LM: $Y = 116.6 + 9.1 \times \text{Length of Manubrium}$
 For LMB: $Y = 93.6 + 5.1 \times \text{combined length of manubrium and body of sternum}$

In the above formulae the 'Y' is the calculated stature.

Table 1: The correlations between the stature and the sternal measurements in few numbers of cases

Sl. No	Stature in cm	LB (x) in cm	Regression Y=117.3+ 5.1x	S.E	LM (x) in cm	Regression Y=116.6 + 9.1x	S.E	LMB (x) in cm	Regression Y=93.6+ 5.1x	S.E
1.	147	5.7	146	+1	5.0	162	-15	10.7	148	-1
2.	153	6.8	152	+1	5.0	162	-9	11.8	154	-1
3.	148	6.5	150	-2	4.2	155	-7	10.7	148	0
4.	155	7.2	154	+1	4.5	158	-3	11.7	153	+2
5.	157	10.0	168	-1	4.3	156	+11	14.3	167	0
6.	161	8.6	161	0	4.3	156	+5	12.9	159	+2
7.	155	7.2	154	+1	5.0	162	-7	12.2	156	-1
8.	162	9.5	166	+2	4.6	158	+10	14.1	166	+2
9.	164	9.0	163	+1	4.8	160	+4	13.8	164	0
10.	170	9.8	167	+3	4.4	157	+13	14.2	166	+4

The standard error of estimate obtained in this study with the length of body of sternum was ± 4.4. By applying the above error, we can determine the stature of an individual with 68% confidence. If we multiply the standard error of estimate by 2, stature can be estimated with 95% confidence. Determination of stature with 98% confidence can be acquired by multiplying the standard error of estimate by 3. The coefficient of correlation was 0.73.

The appraisal of standard error, we get through in this study by using the parameter length of manubrium is ±7.3. By laying the above error, we can determine the stature of an individual 68% confidence. By multiplying with standard error stature can be estimation 95% confidence. 98% of certainty can be attained by multiplying with 3. The Co-efficient of correlation is restricted with 0.38.

Final parameter to obtain the stature of an individual is by using combined length of manubrium and body of sternum should have a standard error of estimation ±4.8. By applying the above error, we can make out the respective individual with confidence of 68%. If the standard error of estimation is multiplied by 2 yields a confidence of 95%. The précised value can be obtained in a correct manual by multiplying the standard error of estimate by 3. The Co-efficient of correlation is limited with in a bound value of 0.38.

Determination of stature from LB and from LMB seems to be more reliable than from length of manubrium as the range of standard error of estimate are narrow.

5. Discussion

The determination of stature from long bones has been successfully worked upon by a number of researchers [10, 11]. As a result of which, quite a lot of formulations have evolved out. With regard to flat bones the process is not yet over and is still ongoing. Some Authors [12-14] have derived regression formula to estimate the stature of an individual from the length of human sternum.

Menezes RG *et al.* have derived regression formulae Y=117.784 + (3.429 x sternal length) in males with the standard error of estimate 5.64cms and coefficient correlation 0.638 and Y = 111.599 + (3.316 × Length of the sternum) in females with the standard error of estimate 4.11cms and coefficient correlation 0.639 from the length of sternum.

The regression formula achieved as a result of the present study from the length of body of sternum (Y = 117.3 + 5.1 x Length of body of sternum) is relatively more trustworthy than the formula (Y=140.6 + 2.34 x Length of body of sternum with standard error of ±7.0) by T.H. Bijoy singh and A. Momochand (2002) [13] from Imphal, India while the sex could not be determined.

It is clear from the present study that using the LB and LMB for stature evaluation is more perfect than the LM because of their greater coefficient correlation which is strengthened by the various Studies done by Menezes RG *et al.* (2004), Singh J *et al.* and Goksin Nilufer Youguer *et al.* (2014) [14].

6. Conclusion

Regional and biological factors have a greater influence on deciding the identity of an individual. This has been emphasized in the past and present studies. The primary idea derived from the study is that profound importance is to be given for regional wise studies in case of determination of stature. The main result of the present study is that, sternum is an indispensable instrument to determine the stature of an individual which contradicts with the results of certain studies [15]. This study and the regression formulae are most useful when the sex is not determined due to dimorphic variations in the bone sternum.

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