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ORIGINAL ARTICLE

Estimation of Stature from the Length of the Sternum in the Ethnic Meitei Population– A Study in Medicolegal Autopsies

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Abstract:

Identification is necessary for living persons, dead persons, decomposed bodies, and mutilated and burnt bodies. In some cases where long bones are not available; the fresh sternal length can be used for stature estimation. Forty male cases belonging to the ethnic Meitei population within the age group 14-70 years were studied. Linear regression analysis was applied for the different sternal lengths to derive regression equations for the estimation of the stature of the study population. The linear regression obtained for the length of the manubrium, length of the body, combined length of the manubrium and the body and the total sternal lengths were $Y=5.7641X_1+138.53$, $Y=2.277X_2+140.6$, $Y=2.3229X_3+128.81$ and $Y=2.4786X_4+116.05$ respectively. The maximum correlation was observed for the total sternal length (R=0.569) followed by manubrium (R=0.475), the combined length of manubrium and mesosternum (R=0.462) and mesosternum (0.374). The study showed that there was a moderate positive correlation between all the sternal measurements with the cadaveric length.

Keywords: Sternum; Stature; Regression equation; Identification data.

Introduction:

Identification is the determination of the individuality of a person based on certain physical characteristics, i.e., exact fixation of personality. It is necessary for living persons, dead persons, decomposed bodies, mutilated and burnt bodies and skeletons.[1] Stature is an important aspect of an individual's identification. In some cases, such as mass disasters or crimes involving the dismemberment of the victim, the long bones may not be available or incomplete. In such cases, an alternative solution for stature estimation must be sought, and also when a quick estimate is required, fresh sternal length can be used for stature estimation.[2]

There exists a relation between human bones and the stature of an individual, which varies between two sexes as well as amongst different populations which depend on genetics, environmental, nutritional factors, etc. So, population and sex-specific stature estimation equations are needed. However, while estimating age, it must be remembered that the length of a dead body person is about 2.5 cm more than the living stature, possibly due to compression of soft tissues between inter-vertebral discs in a standing position.[3] A few workers observed that the total length of the sternum increases with height, while the manubrium shows some variation, the variation in the length of the manubrium is very less.[4] Hence, the present study was carried out to estimate the stature from the length of the sternum of the ethnic Meitei population.

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Materials and Methods:

The present study was conducted in the mortuary of the department of Forensic Medicine and Toxicology of a tertiary care teaching institute in Imphal.

The approval was taken from the institutional ethical committee of the institute and informed consent was taken from the relatives prior to the study. Forty male cases belonging to the ethnic Meitei population within the age group 14-70 years were included in the study. Fractures of the sternum with obvious deformity, and decomposed, charred, and mutilated bodies were excluded from the study.

The stature of the deceased was first measured with a portable stadiometer and recorded. An 'I'-shaped skin incision was made, and the sternum was removed as a single piece by cutting at the sternoclavicular joints and at the costochondral junctions. After removal, the sternum was cleaned thoroughly by manual stripping of soft tissue as much as possible. It was ensured that the end points of the Vernier calliper were touching the bone, without interference from any soft tissue, by removing as much soft tissue as possible and exposing the bony surface. The sternum was measured by taking midline measurements i.e., length of manubrium (LM-the straight distance from the centre of the suprasternal notch to the centre of the manubrio-mesosternal junction on the anterior surface of the sternum), mesosternum or body (LB-the straight distance measured on the anterior surface from the manubrio-mesosternal junction to the mesosterno-xiphoidal junction), and the combined length of manubrium and mesosternum (LMB-straight distance measured from the centre of suprasternal notch to the mesosterno-xiphoidal junction taken

on the anterior surface of the sternum). The total length of the sternum (TSL-the distance between suprasternal notch and the xiphoid process measured from the posterior surface of the sternum) was also measured by a measuring tape and recorded. The sternum was replaced after the measurements. The findings were recorded, and the data entry was done using windows-based SPSS version 21.0 (Armonk NY: IBM Corp). A p-value of 0.05 or less was considered significant. Linear regression analysis was applied for the different sternal lengths to derive regression equations for the estimation of the stature of the study population.

Results:

Out of 40 subjects studied the majority belonged to the age group of 24-33 years (27.5%) followed by the age group of 34-43 years (25%). The cadaveric length ranged from 152-179 cm (mean±SD of 166.38±6.05 cm) and the total sternal length ranged from 16.2–23.5 cm (mean± SD of 20.30±1.39cm).

Sternal lengths in relation to stature are shown in table 1. A linear regression formula was obtained for different sternal measurements as shown in figure 1 to 4, denoted by Y=aX+b, where 'a' is the regression coefficient of slope or independent variable (sternal lengths), 'X' is the sternal measurement and 'b' is the regression coefficient of intercept/or dependent variable (stature). There was a moderately positive correlation between all the sternal measurements with the cadaveric length.

The standard error of the estimate was calculated for all the sternal measurements as shown in table 2, and was found to be lowest in total sternal length i.e., 5.045 followed by the length of manubrium (5.396), the combined length of manubrium and mesosternum (5.438) and length of the mesosternum (5.688).

Overall analysis showed that the equation derived from TSL has the highest R2 value i.e., 0.3233 followed by the length of manubrium (0.226), the combined length of manubrium and mesosternum (0.2139) and the length of the body (0.14).

Table 1. Sternal lengths in relation to stature.

Sternal length	Range (cm)	Mean (cm)	SD (cm)
Total sternal (TSL)	16.2-23.5	20.30	1.39
Manubrium (LM) length	4-6	4.83	0.50
Mesosternum (LB) length	9.5-13.5	11.32	0.99
Combined length of manubrium and mesosternum (LMB)	14-19	16.17	1.21
Cadaveric length	152-179	166.38	6.05

Table 2. Linear regression models for stature determination.

Sternal length	Regression formulae	R	R2	Adjusted R2	Standard error of estimate (cm)	P value
LM	Y=5.7641X1 +138.53	0.475	0.226	0.206	5.396	0.0019
LB	Y=2.277X2 +140.6	0.374	0.14	0.117	5.688	0.0173
LMB	Y=2.3229X3 +128.81	0.462	0.2139	0.193	5.438	0.0026
TSL	Y=2.4786X4 +116.05	0.569	0.3233	0.306	5.045	0.0001

LM = Manubrial length; LB= Mesosternum, LMB=Combined length of manubrium and mesosternum and TSL= Total sternal length

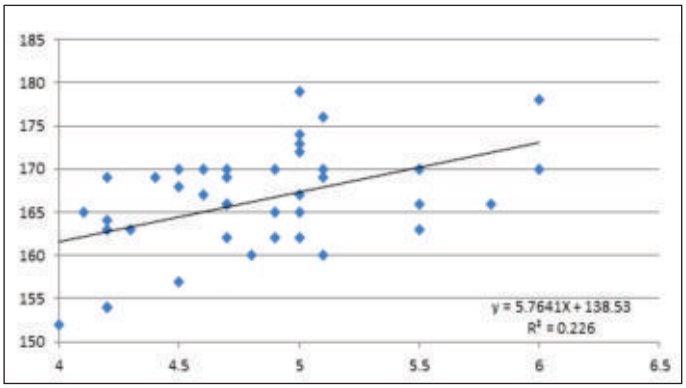

Figure 1. Correlation of the manubrium with cadaveric length.

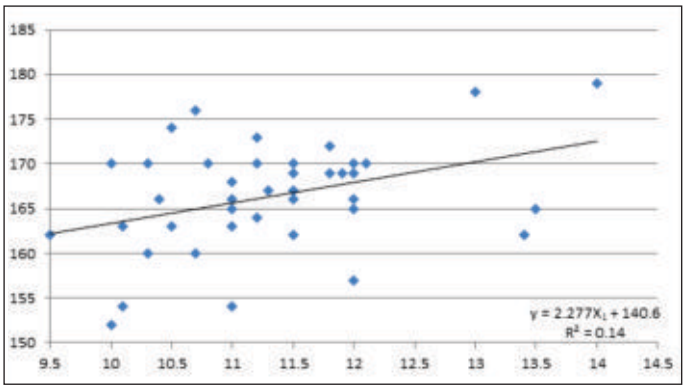

Figure 2. Correlation of the mesosternum with cadaveric length.

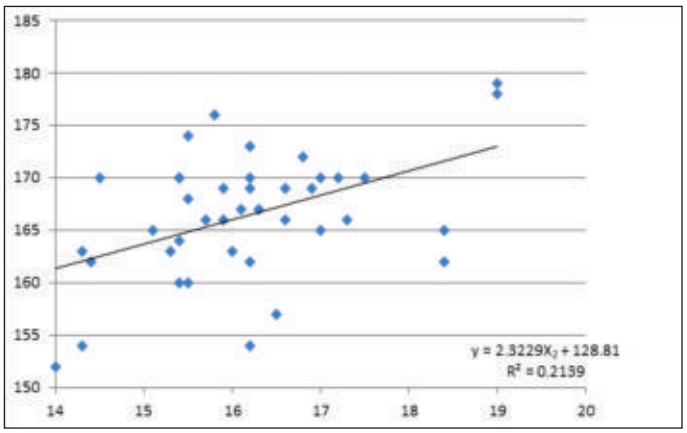

Figure 3. Correlation of the combined length of manubrium and mesosternum with cadaveric length.

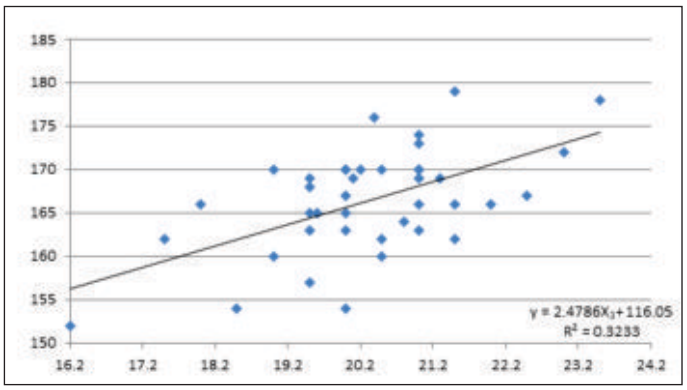

Figure 4. Correlation of the total sternal length with the cadaveric length.

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Thus, the degrees of association of correlation between the total sternal length and stature have the highest accuracy when compared to the equations derived from all the other parameters.

The maximum correlation was observed for the total sternal length (R=0.569) followed by manubrium (R=0.475), the combined length of manubrium and mesosternum (R=0.462) and mesosternum (0.374).

Discussion:

There are biological and regional variations as far as the determination of the individuality of a person is concerned which have been proven in past and present studies.[5] The present study was conducted selectively on specific ethnicity i.e., the ethnic male Meitei population considering the biological and regional variations observed by previous researchers.

Workers like Singh et al.,[3] Menezes et al.,[6] Chandrakant et al.,[7] and Yongue et al.,[8] have developed regression equations by regressing the stature of the individual on the dry macerated sternum. The estimation of stature from the fresh sternal bones was conducted in our study, which is similar to the studies by Tumram et al.[2] and Marinho et al.[9]

Some of the studies by Tumram et al.,[2] Singh et al.,[3] Gupta et al.,[10] and Derade et al.,[11] excluded xiphoid process due to its high variability and included only the manubrium and mesosternum. However, in a study by Beraw et al.,[12] and Marinho[9] fresh sterna were studied including the xiphoid process as it was carried out in our study.

Further, there are very limited studies where the posterior curve length of the sternum including the xiphoid process was taken into consideration for stature estimation except in a study by Baraw et al.[12] Similarly, in our study, this sternal parameter was taken into consideration.

The present study showed that the total sternal length has the highest correlation coefficient (R=0.569), which is in accordance with a study by Menezes et al.,[7] Baraw et al.,[12] and Peiru et al.[13] On comparing all the parameters, total sternal length (TSL) showed the highest degree of correlation with stature (R=0.5696) followed by manubrium (R=0.475), combined length of manubrium and mesosternum (R=0.462) and mesosternum (0.374). However, in a study by Saraf et al.,[14] the combined length of sternum has the maximum correlation with the stature (R=0.894), followed by the length of mesosternum (R=0.853) and manubrium (R=367), which was different from our study findings. Also, in a study by Manorahan et al.,[15] the length of mesosternum and the combined length of manubrium and mesosternum for stature evaluation showed a greater correlation coefficient than the length of the manubrium. These variations between the studies could be because dried sterna were used in their study, whereas in our study fresh sterna were studied.

The standard error of estimate for the total sternum in our study was 5.045 which was comparatively higher than the study by Yongue et al.,[8] and Baraw et al.,[12] and lower than the study by other workers.[2,3,7] In a study by Chandrakanth et al.[7] the standard error of estimate value was found to be quite high and they concluded that the fusion status of the sternum affects the reliability and accuracy of estimation of stature.

Several studies have derived different formulae for both dry and fresh sterna. The formula derived in our study is applicable to the fresh sternum only and cannot be applied to the dry sternum.

The present study emphasizes the importance of the sternum as one of the reliable tools to calculate the stature of a person in addition to or in the absence of long bones.

Limitations and future directions: The study was carried out with a small size in a stipulated time frame. A study with a larger sample size may be taken up to come to a definitive conclusion in the future.

Conclusion:

It is evident from our study that the length of the sternum provides a positive correlation factor for stature. For the ethnic male Meitei population, the sternum may be used for stature estimation when long bones are not available. Further, it may be of immense help for anthropological studies. As the linear regressions derived are limited to a particular ethnic population of this region. Further studies may be carried out on different ethnic populations.

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Conflicts of interest: The authors hereby declare that there is no conflict of interest

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