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Original Communication

Effect of fusion status of sternum in stature estimation – A study from South India

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ABSTRACT

Forensic anthropologists examine and identify skeletal, dismembered and commingled remains in a legal context to establish the biological profile of the deceased. Stature estimation is one of the important parameters in establishing the biological profile. The present study is planned to derive regression models for stature estimation from sternal measurements. Various factors are likely to affect stature estimation in forensic investigations. Since, none of the previous researchers have studied the effect of fusion status on stature estimation from sternum and its segments, the present study attempts to find if the fusion status of the sternum affect its reliability and accuracy in stature estimation. The sample of the present study consisted of 117 sterna that were obtained from autopsied bodies. Five measurements i.e. Length of manubrium (M), length of mesosternum (B), combined length of manusbrium and mesosternum and the (M + B), width at first sternabrae (S1) and width of 3rd sternabrae (S3) were taken on the autopsied sterna. The sterna were classified as fused (both manubriosternal and xiphisternal joints were fused), partly fused (only one of the manubriosternal or xiphisternal joints was fused) and not fused (both manubriosternal and xiphisternal joints were not fused). Regression models were derived using statistical methods. All the sternal measurements show a positive however, a weak correlation with stature. Thus, it can be concluded that the accuracy and reliability of stature estimation from sternum and its segments is quite low in practical situations. Among the sterna classified based on the fusion status, the length measurements of completely fused sterna show significant correlation with the stature. None of the other sternal measurements on the non-fused or partly fused sterna show statistically significant correlation with stature. The present study concludes that the fusion status of the sternum is likely to affect the reliability and accuracy in estimation of stature. The findings of this study however, should be considered 'preliminary' until they are corroborated by similar studies based on larger samples from different populations.

1. Introduction

One of the foremost tasks of a forensic anthropologist is to examine and identify the unknown skeletal, dismembered and commingled remains in a legal context. Emphasis is laid on the need to strengthen the methods of establishing biological profile of the deceased in these cases. Estimation of stature along with other parameters of identification such as sex, age and ancestry are the essential criteria in establishing the biological profile of an individual. This process facilitates in narrowing down the pool of possible victim matches during investigation process.

An accurate estimation of stature is possible if whole skeleton is brought for examination. The process of stature estimation becomes relatively complex in cases where a few/individual bones are brought for examination. It has been shown that the reliability and accuracy of long bones is better than other human bones in stature estimation.[1,2] In the absence of long bones; other bones such as skull,[3–5] scapula,[6] sternum,[7] vertebral column,[8] pelvic bones[9] and small bones of the body[10–12] may be used for stature estimation.

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Sternum also known as the breast bone is a long, narrow, flat plate that is placed in the centre of the front of the chest. Sternum is divided into three parts-the manubrium on the upper side, the body of the sternum in the middle i.e. mesosternum and the xiphoid process in the distal or lower side. As the ossification takes place, the manubrium joins with the mesosternum and the mesosternum articulates with the xiphoid via either a primary or secondary cartilaginous joint.[13] The manubrium fuses with the mesosternum in the old age usually above 50 years, different segments of the sternal body fuse within the ages 14–25 years from below upwards and the fusion of the xiphoid process with the sternal body occurs between the ages 40–45 years.[14] The three parts of the sternum develop from a variable number of centres of ossification and consequently, much of the variation seen in the sternum may be attributed to the number of patterns and ossification centers.[13] In mutilated and dismembered human remains, there are high chances of recovering the intact sternum. In this regard, previous researchers have published studies on the estimation of age,[15–17] sex[18–22] and stature[7,23] from sternum. Besides, there are a few discrete traits of the sternum that can be utilised for identification in forensic examinations.[24]

An individual attains adult stature at around 18 years of age[25] which coincides with the skeletal maturity. Hence, the studies on stature estimation are mostly conducted in adult populations for better reliability and accuracy of the derived models. This may not hold good for the process of stature estimation from sternum where fusion of it segments occur at a later age which is likely to effect the dimensions of the sternum. Moreover, the fusion of sternal segments per se does not follow a definite chronology. The present research was planned considering the fact that limited literature is available on stature estimation from sternal measurements and that none of the previous researchers have reported the effect of fusion status of sternum in stature estimation. The objective of the present study was to study the effect of fusion status on stature estimation and derive regression models for estimation of stature from the measurements of sternum in a modern autopsied sample.

2. Materials and methods

The samples used in the present study included 117 adult sterna (Males = 67, Females = 50) obtained from autopsied bodies at the Department of Forensic Medicine, JSS Medical College, Mysore in South India that has been previously utilised for estimation of age and sex in South Indian population.[17,18] The age and sex distribution of the study sample is shown in Fig. 1. A written informed consent was obtained from the legal heirs prior to the conduction of medico-legal autopsy explaining to them that the sternum will be preserved in the department for further analysis. The stature of the body was measured in centimeters on the autopsy table as length between head and heel. All the cases with evidence of injuries to the head, spine or lower limbs were excluded from the study. The sterna obtained after autopsy were subjected to a thorough maceration[17] to ensure precision in measurements and fusion status. Sterna that were free from any apparent acquired or congenital abnormalities were included in the study. Visual inspection of the joints was done to comment on the fusion status. The sterna were classified as fused (both manubriosternal and xiphisternal joints were fused), partly fused (either of the manubriosternal or xiphisternal joints was fused) and not fused (both manubriosternal and xiphisternal joints were not fused). The following measurements were taken on each sternum using vernier calipers graduated to the nearest 0.01 mm.

Length of manubrium (M): measured from jugular notch to manubriosternal joint.

Length of mesosternum (B): measured from manubriosternal to xiphisternal joint.

Combined length of the manubrium and mesosternum (M + B): measured from jugular notch to xiphisternal joint.

Width at 1st Sternabrae (S1): Breadth of the sterna measured between the notches for the third costal cartilage on both sides.

Width at 3rd Sternabrae (S3): Breadth at the sterna measured between the notches for the fifth costal cartilage on both sides.

Landmarks on the sternum and measurements included in the study are described in Fig. 2.

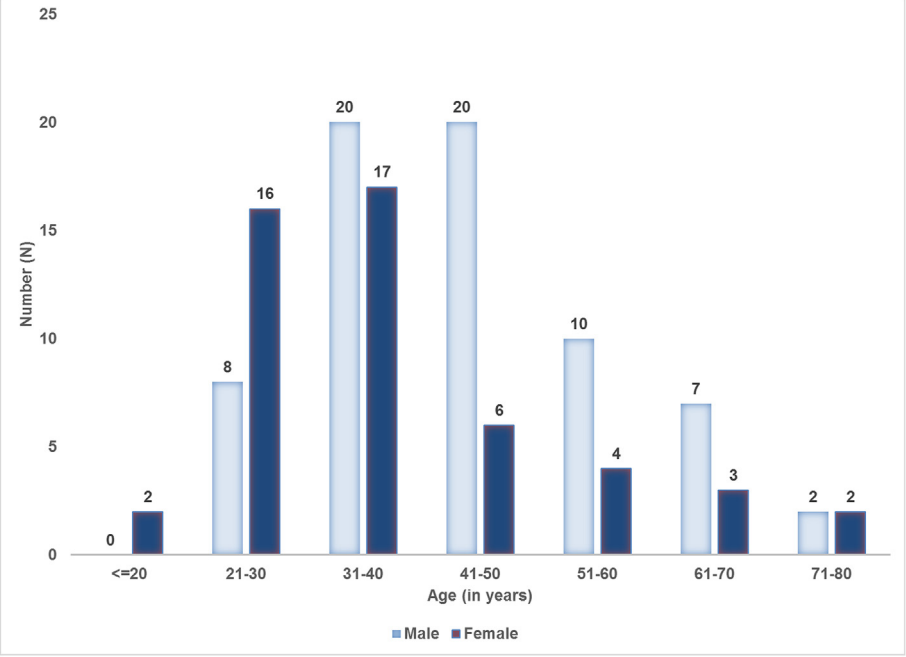

Fig. 1. Age and sex distribution of the study sample (Males = 67, Females = 50).