



Physical Anthropology Section – 2008

H86 A Practical Method for Determining Sex From Human Chest Plate Radiographs

Heather Garvin, MS*, 7471 SE 117th Terrace, Morriston, FL 32668; Luis Lorenzo Cabo-Pérez, MS, Mercyhurst College, Department of Applied Forensic Sciences, 501 East 38th Street, Erie, PA 16546; Kyra Elizabeth Stull, BA, Mercyhurst College, 501 East 38th Street, Erie, PA 16546; and Dennis C. Dirkmaat, PhD, Mercyhurst Archaeological Institute, Mercyhurst College, Glenwood Hills, Erie, PA 16546

Upon completion of this poster presentation, participants will be better informed of the accuracy of past published sex determination methods as applied to human chest plates from a modern forensic sample. Participants will also become conscious of which sexual traits are most reliable from the chest plate region and will be presented with a new practical method for accurate sex determination.

The presentation of this research will impact the forensic community by providing the necessary evaluation and associated statistics of proposed sex determination methods from the human chest plate, which is essential for Daubert compliances. The presentation also presents new practical methods which are accurate and lack complex, extensive procedures, so that they may be applied either radiographically in the medical examiner setting, or osteologically to the skeletal elements of the chest plate, for preliminary or supplemental sex determination.

Highly decomposed or altered human remains often prevent quick assessment of the victim's biological profile at autopsy. When their preservation or integrity do not allow for a diagnosis from soft tissues, the remains require further processing for osteological examination by a forensic anthropologist which adds extra time to the identification process, especially when aggressive maceration methods are avoided. Within this framework, radiographic examination of different anatomical areas can provide a useful tool for obtaining reliable, yet quick assessments of factors such as age, sex or ancestry, and serves to guide the initial stages of a forensic investigation, before processing and comprehensive osteological analysis can be completed.

The present study explores the presence of sexual dimorphism in the anterior thorax region, and its potential for sex diagnosis from anterior chest plate radiographs. Although the skull and pelvis provide the most reliable indicators of sex in human skeletal remains, these areas may be absent or damaged. Additionally, anterior thoracic radiographs are easily taken during autopsy, as the chest plate is routinely removed during autopsy, and presents less orientation problems than other regions. Furthermore, both metric and morphological sex differences in the anterior thoracic region (including observations based on autopsy radiographs) are well documented in the literature. Among them, the degree and pattern of ossification of costal cartilage, morphological changes to the sternal ends of the ribs, and relative size and morphologies of the sternum are described as providing reliable sex estimates.

Although these sexual markers have been noted since the 1980's, they are scarcely used in forensic practice. A lack of proper associated probability estimates essential for *Daubert* compliance, such as percentages of correct classification and posterior probabilities, as well as the scaling problems derived from radiographic recordation, can likely be counted among the top causes of this neglect. The present study addresses these problems by: (1) testing the accuracy, in terms of percentages of correct classification, of existing sex determination methods based on radiographic examination of the sternal area, and of the individual traits employed in these methods, (2) exploring alternative methods to correct for radiographic scale, and (3) estimating the probabilities attached to the newly created alternative methods.

Special attention is paid to costochondral ossification patterns and sternum morphology in this study. With respect to the former, typically only the sternal ribs are available to the forensic anthropologist (and lacking the associated costal cartilage). Given that most of the morphological changes to the sternal rib ends are a direct result of the costal cartilage ossification, a better understanding of sexual differences in cartilage ossification, as observed radiographically, can provide a useful insight into the traits considered in the osteological method.

Sternum morphology is likewise highly dimorphic, and relatively easy to record from radiographs, given the density, placement and orientation of the sternum. If the scaling (distortion) problems can be eliminated, the radiographic observations could be easily extrapolated to defleshed bones.

The study sample consisted of 105 chest plate radiographs of adult males and females, taken at autopsy. The radiographs were digitized and the appropriate metric and non-metric variables (including landmark data) recorded. A sex diagnostic was then obtained for each radiograph through various existing methods, and the corresponding percentages of correct classification estimated. Multivariate predictive equations for sex determination, and the corresponding probability estimates, were obtained through canonical variate analysis, for both sternal linear measurements and partial warps from landmark configurations. The process of rotation, translation and scaling attached to the landmark method serves to effectively remove scale effects, rendering size-free shape variables. Bivariate analysis through linear regression and analysis of covariance (ANCOVA) was applied to the data in order to explore the feasibility of using either ratios or residual analysis to correct for scaling effects, as well as to explore the general allometry of the potential sexual differences detected.

Finally, non-metric analysis of individual stages and trait combinations was applied to assess the potential of costal cartilage ossification as a reliable sex marker. Results suggest that radiographic examination of anterior thoracic radiographs shows a high potential for sex estimation, at least in those individuals showing configurations



Physical Anthropology Section – 2008

close to their group centroids.

Sex Determination, Sternum, Costal Cartilage