H78 Patella Sex Determination by 3D Statistical Shape Models and Nonlinear Classifiers

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After attending this presentation, attendees will learn about a novel 3D statistical method to automatically sex the patella from CT scan data with a high degree of accuracy and repeatability.

This presentation will impact the forensic community and/or humanity by demonstrating how the patella is a compact bone that often survives intact in forensic contexts, yet is greatly underestimated for its role in sex determination.

Sex determination is one of the major challenges for the forensic anthropologist within a medical-legal context and is one of the essential steps in personal identification of an individual from skeletal remains. The most commonly used statistical method in analyzing this sex determination problem is discriminant function analysis. Most bones have been subjected to discriminant function analysis but not much literature has been found on the usefulness of measurements of the patella in the determination of sex using this method. This paper proposes a new sex determination method from patellae using a novel automated feature extraction technique. A dataset of 228 patellae (95 females and 133 males) was collected from the William M. Bass Donated Collection of the Department of Anthropology at the University of Tennessee. High resolution CT scans were conducted using a GE Lightspeed 16 slice computed tomography scanner. After the CT data was segmented, a set of features was automatically extracted, normalized, and ranked. These features include geometric features, moments, principal axes, and principal components. A feature vector of 45 dimensions for each subject was then constructed. A set of statistical and supervised neural network classification methods, were used to classify the sex patellar vectors. Nonlinear classifiers such as neural networks have been used to analyze several medical diagnosis problems. Examples include quantitative liver tissue characterization, bladder outlet obstruction computerized diagnosis and automated chromosome classification. In this paper, different classification methods were compared and a new method for sex determination is proposed which extracts more categories of features, other than the geodesic measurements, and analyzes the classification problem in a nonlinear approach using neural networks. Following the atlas construction and alignment steps outlined above, all the patellae models now lie in the same coordinate frame and have homologous points and faces. In this coordinate frame, six points are found to be the maximum and minimum values for the coordinates x, y, and z respectively. This yields three measures of maximum mediolateral (ML) width, maximum anteroposterior (AP) depth, and superoinferior (SI) height. Additionally, the six points are used to construct a bounding box around the patella, which is used to extract three features describing bounding box width (BBML), bounding box depth (BBAP), and bounding box height (BBSI). Classification success ranged from 83.77% average classification rate with labeling using fuzzy C-Means method (FCM), to 90.3% for linear discriminant function (LDF) analysis. The authors obtained results of 96.02% and 93.51% training and testing classification rates, respectively using feed-forward backpropagation Neural Networks (NN). These promising results of the new features and the use of nonlinear classifiers encourage the usage of this method in forensic anthropology for identifying the sex from incomplete skeletons retaining at least one patella.

Patella, Sex Determination, 3D Statistical Shape

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