H126 Positive Identification Through Comparison of Lateral Patella Radiographs and 3D Scans: A Validation Study

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The goals of this presentation are to: (1) report the findings of research investigating the use of lateral patella radiographs as a means of positive radiographic identification of unknown human remains; and, (2) report the results of quantitative matching of two-dimensional patellae images using Elliptical Fourier Analysis (EFA).

This presentation will impact the forensic science community by demonstrating the accuracy of positive identification utilizing medical radiographs of the lateral patella, as well as demonstrate the feasibility for quantified methods to match 2D images of bone scans with radiographs. Results from these studies will help bring positive identification using medical lateral patella radiographs into compliance with *Daubert* standards.

Two hypotheses were tested: (1) Experienced forensic anthropologists can accurately match lateral patella radiographs; and, (2) a 3D imaged patellae can be accurately matched with lateral patella radiographs using EFA.

The study sample was provided by the Willed Body Program, Michigan State University Department of Radiology.

Radiographs were taken using a General Electric® Amx2 portable X-ray unit. Radiographs were taken according to the standards for radiographic imaging of the patella from the lateral aspect. The distance between the X-ray source and the film was 40 inches, with an exposure of about 60kVp/5mAs. All specimens were radiographed once, then five were radiographed a second time attempting to match the angle of the first image. The first set of images served as simulated antemortem radiographs while the second set served as postmortem radiographs to enable comparisons.

An antemortem pool (n=20) and the five reset radiographs (n=5) comprised the survey radiographs. Images were blocked out with cardstock, leaving only the patella visible. Practicing forensic anthropologists and graduate students in forensic anthropology were asked to match postmortem to antemortem images, or answer "no match." The survey also collected demographic information to analyze the effect of education and experience on accuracy. At the time of abstract submission, 22 completed surveys demonstrate high rates of accuracy (99.5%), sensitivity (98.2%), and specificity (100%).

A Canon® model EOS-40D camera was used to digitize the radiographs on a copy stand with backlighting. Digital images were cropped and equalized in Adobe® Photoshop® CS5. Each patella was then outlined using the Pen tool. The outline was saved as a bitmap (BMP) file for input into SHAPE v1.3.

A NextEngine® scanner digitized each patella's surface in 3D (n=23). A series of 15 2D images were serially captured from the 3D model for comparison to the 2D radiographs. The degree of rotation spanned -15°/+15° around the antero-posterior axis and -10°/+10° around the supero-inferior axis.

The SHAPE v1.3 suite generated Fourier descriptors for all images using 40 harmonics (i.e., 345 2D images generated from the 3D scans and 22 patella radiographs). The sum of the squared differences between the Fourier descriptors for the 3D model and the radiographs was calculated and individuals ranked according to this number. The top-ranked image was accurately matched to the radiographic outline in question in 72% of cases. In an applied situation, creation of a "short list" might be preferred so an expert can then visually determine a match. In this case, note that in 20 of 22 specimens, a correct match was found within the top five of 345 images (1.4%).

Since this sample is relatively homogeneous (mostly elderly White Americans), positive results should be applicable to a more heterogeneous sample; however, increased formation of bony spurs with age may increase heterogeneity. Further studies using EFA should confirm these findings, perhaps including more young individuals.

This project has demonstrated the uniqueness of the human patella in two ways. The survey results indicate that medical radiographs of the lateral patella are valid for use in positive human identification due to individualizing trabecular patterns, bony spurs, and overall shape. In addition, this study adds to the literature on the value of EFA in positive human identification because the lateral outlines of patellae are quantitatively distinguishable, reinforcing that these structures are unique and valuable in forensic casework.

Fourier Analysis, Bone Scan, Patella

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