H44 Radiographic Human Identification Using Bones of the Hand: A Validation Study

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Attendees will discover how to utilize posterior-anterior radiographs of the hand to make a positive identification of unknown human remains and learn the results of a validation study testing this method.

This paper has 3 objectives: (1) to demonstrate how forensic scientists can utilize posterior-anterior hand radiographs for positive human identification, (2) to disseminate the results of a validation study testing this method, and (3) to explain which anatomical criteria proved to be the most useful and least beneficial to the examiners in the identification process.

Positive identification of unknown human remains is a critical part of the medic-legal investigation. Common methods of obtaining a positive identification include DNA, fingerprints, dental radiographs, and other radiographic comparisons such as frontal sinus pattern. A recent Supreme Court ruling from 1993, Daubert v. Merrell Dow Pharmaceuticals, Inc., requires that the standard for scientific evidence in a federal court is the reasoning or methodology underlying the expert's testimony must be scientifically valid. The Daubert test of scientific evidence relies on a preliminary ruling by the judge on whether the scientific theory or technique is scientifically valid based on "widespread acceptance", peer review, publication, testing, rates of error, and the existence of standards. Validation studies, as noted by previous publications and papers at American Academy of Forensic Sciences meetings, therefore, are important for each discipline in the American Academy of Forensic Sciences because scientists need to be able to prove that their scientific testimony is supported by the Daubert test. It should be noted that Daubert is a federal court requirement for evidence, but many states have accepted it for their evidence standards.

In order to investigate the validity of posterior-anterior radiographs of the hand for human identification purposes, a series of radiographs was taken on human cadavers that are part of the Willed Body Program directed by Michigan State University, Department of Radiology, Division of Anatomy. In an effort to approximate antemortem x-rays, radiographs of 50 left hands were taken in the Michigan State University Gross Anatomy Lab using a General Electric Amx2 portable x-ray unit. The radiographs were taken in a manner to replicate the standards employed by radiographic technicians for posterior-anterior hand radiographs of living patients in clinical situations. The distance between the x-ray source and the film cassette was maintained at 40 inches, while the central ray was directed perpendicular to the film at the third metacarpophalangeal joint. The settings on the x-ray machine were set at 50 kVp, while mAs varied from 8-10 mAs for the antemortem radiographs, and 50 kVp and 3 mAs for the skeletal postmortem radiographs. A large, square piece of plexiglass was used to force the hands of the cadavers to remain flat on the radiographic film.

Taking radiographs of 10 of the hands from 40 of the above individuals generated the "postmortem" sample. These hands were removed from the body and processed at the Michigan State University Forensic Anthropology Lab into bony specimens by removing all the soft tissue. The specimens were then re-articulated using a low temperature hot glue gun. Care was taken to orient the bones in an orientation that was similar to the antemortem radiograph. A radiograph was then taken of these reconstructed hands, in essence mimicking a skeletal postmortem radiograph.

The validation component of this study examined the accuracy of making positive identifications between antemortem and postmortem radiographs of the hand. Participant examiners, one forensic anthropologist, four forensic anthropology graduate students, and two forensic pathologists received 50 radiographs from 40 different individuals. They compared 40 antemortem radiographs of fleshed hands from known individuals to 10 postmortem radiographs of bony hands from unknown individuals. No more than one individual represented each one of these 10 postmortem radiographs from the group of the original 40. The participants worked independently, without assistance from others, to match the correct postmortem radiograph to its appropriate antemortem match. The participants were also asked to note on a data sheet which specific anatomical and morphological features were used for identification purposes.

Nine participant examiners were involved in the validation study, with eight completing the study. One individual did not complete the study due to a lack of radiological identification training, thus the individual was not comfortable assigning any positive identifications. Of those who completed the study, results varied. In general, profession, experience level and specific training in radiological identification had a drastic effect on not only the ability to complete, but also perform well in the study. Three forensic anthropologists and three experienced forensic anthropology graduate students had a perfect score in positively identifying the 10 postmortem hand radiographs, which included one radiograph that did not have a corresponding antemortem match. The participants with the most experience and training in radiological identifications had higher accuracies when compared to those with less experience and specific training. Participant examiners noted trabecular patterns of the proximal and middle phalanges, distinguishing radiopaque and radiolucent features, and degenerative changes as the anatomical features that aided their identification. Distal phalanges and carpals were most frequently noted as the skeletal features that were least helpful in the identification process.

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This study demonstrates that the comparative analysis of hand radiographs is an appropriate method for positive identification. When experienced forensic anthropologists completed the exercise, their accuracy was 100%. The study also illustrates that examiners with less experience and training may not be qualified to perform comparative radiographic analyses. Further research is intended to expand the pool of expert examiners in order to provide a sufficient sample for statistical validation.

Human Identification, Hand Radiographs, Validation Study

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