H122 Testing a New Computer-Assisted Forensic Identification Method Developed Through Interdisciplinary Collaboration

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The goal of this presentation is to provide attendees with an example of successful interdisciplinary collaboration to develop a new method of decedent identification for routine use in the medicolegal setting. The attendees will receive a detailed account of method testing and results.

The presentation will impact the forensic science community by describing a practical, time-sensitive identification method for decedents associated with a tentative name on arrival to the medical examiner's/coroner's office. The method is responsive to the National Academy of Sciences. Report recommendations and post-*Daubert* evidence admissibility standards because it is replicable and incorporates a quantified error rate.

Decedent identification obtained by a forensic anthropologist through comparison of postmortem and antemortem radiographs is a relatively routine procedure in the medicolegal setting. The determination of consistency in skeletal features is made by comparison of the radiographs based on the expertise of the anthropologist. Computer-assisted radiograph comparison methods have been explored with some success.[1-3] Computer-assisted methods typically work by first determining a score that quantifies how well the shapes represented in two different radiographs match. There are multiple paradigms for using these raw match scores to determine if a correct match has been found.

A computer-assisted radiograph comparison method has been developed for medicolegal decedent identification through interdisciplinary collaboration between forensic anthropologists, biomedical engineers, and software engineers and designers. The paradigm for this method is calculation of the match score for postmortem and antemortem radiographs of the index individual and also for a postmortem radiograph within an array of similar radiographs from random persons of the same age cohort. Early theoretical efforts, pilot study results, and method development were reported at the 63rd and 64th Annual Scientific Meetings of the American Academy of Forensic Sciences.[4,5]

Preliminary testing of the method produced a 0% error rate for comparison of single lateral cervical vertebrae (5 tests of 55 images=100% correct). The error rate for single lateral lumbar vertebrae was inflated by an index image with substantial out-of-plane artifact (15 tests of 30 images=80% correct). When the out-of-plane image was removed, the error rate fell to 0%. For this study, 36 pairs of anonymized lateral cervical radiographs (n=72 radiographs) were collected from a historical archive. Each pair consisted of radiographs of a specific person taken three years apart. All patients had undergone a cervical fusion procedure between the time-points, but only the vertebrae adjacent to the fusions were used. Match scores were calculated for a cervical vertebra (C3, C4, C5, C6 or C7), using the latest time-point to represent the "postmortem" radiograph. The radiograph taken three years earlier represented the antemortem radiograph. In some cases, match scores were calculated for two vertebrae from one person. Prior to calculating match scores, all images were reoriented and magnification adjusted using the QMA® computer software interface (Medical Metrics, Inc.). Match scores were calculated by QMA® for the correct match and also for matches of the "postmortem" radiograph compared to five radiographs from other persons. Different combinations (100) of Region-Of-Interest (ROI) definition, pre-processing filters, and match score algorithms were tested on this data set, resulting in 54,000 match scores to use in optimizing the algorithms. Data were analyzed using effect sizes and Receiver-Operator-Curve (ROC) analysis.

The study resulted in several key findings. Radiograph pairs could be classified as a correct versus an incorrect match in greater than 95% of matches (5% error rate), using the optimized protocol and algorithms in the larger sample. The fine details of higher resolution radiographs can reduce the percent of correctly matched radiographs since the fine details are harder to reproduce from one time-point to another. Improved results were obtained after reducing the resolution of the radiographs to approximately 0.2mm per pixel. A geometrically simple ROI (rectangular) worked well, thus avoiding the need to define a complex ROI (polygon). The reliability of the match algorithms is reduced if significant osteophytes form between the time-points. Using the maximum match score when more than one vertebra is compared between postmortem and antemortem radiographs improves the reliability of the computer-assisted match, an important finding for future systematic testing of skull and chest films. Refinement of the method is ongoing with further algorithmic optimization testing and inclusion of real postmortem radiographs that may be of different quality than clinical radiographs.

References:

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Identification, Anthropology, QMA®

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