H108 Ongoing Development of the Novel Computer- Assisted Radiograph Identification Method

Sharon M. Derrick, PhD, Harris County Institute of Forensic Sciences, 1885 Old Spanish Trail, Houston, TX 77054; John A. Hipp, PhD, Medical Metrics, Incorporated, 2121 Sage Road, Houston, TX 77056; Jennifer C. Love, PhD, and Jason M. Wiersema, PhD, Harris County Institute of Forensic Science, 1885 Old Spanish Trail, Houston, TX 77054; and N. Shastry Akella, PhD, Chenghao Shi, MS, and Zulun Tan, BS, Medical Metrics, Inc., 2121 Sage Road, Suite 300, Houston, TX 77056*

After attending this presentation, attendees will receive a brief description of the ongoing development of the enhanced version of QMA® and fine-tuning of this quantitative approach to identification basis for the computer-assisted radiograph comparison method and the proposed practical application of the method in medical examiner/coroner offices. Milestones achieved in the development of the method in the previous 12 months will be discussed and plans for an imminent large-scale validation study will be outlined.

The presentation will impact the forensic science community by describing successes in the development and validation progress of a new practical identification method responsive to the National Academy of Science Report recommendations and post-*Daubert* evidence admissibility standards.

A statistically validated, time-sensitive and relatively inexpensive scientific identification method is under development for routine use in the medical examiner/coroner setting. The method is based on an enhanced version of "Quantitative Motion Analysis" software. QMA® has been validated in multiple clinically based peer-reviewed studies of spinal biomechanics and spinal treatments. The software allows for computer-assisted matching of specific skeletal elements, such as vertebral bodies, by tracking them through multiple radiographic images.

Forensic identification of unidentified or tentatively identified remains through comparison of antemortem and postmortem radiographs currently relies on a visual assessment by a forensic anthropologist. The accuracy of the method is dependent on the experience level of the anthropologist and the presence or absence of features traditionally believed to vary significantly among individuals. To objectify this process, QMA® was developed to quantify how well specific anatomic features "match" in a set of radiographs. The ultimate goal of the project is to validate an objective image matching system for forensic radiograph-based identification. The pilot study of this project began with the development of a processing algorithm that provided QMA® with the ability to successfully calculate the required quantification of the match, the "match score."

Several different algorithms have been developed over the course of this project that can be used successfully to quantify a match score. There are also multiple ways to arrive at a composite match by combining match scores for multiple features in one set of radiographs. The final match score reported by the software must be scientifically validated and this requires a systematic method to find the optimal protocol out of the many available options.

The strategy of this study to identify the optimal protocol is to apply the various permutations of the available options to a large collection of radiographs and assess the resulting data based on the sensitivity and specificity for detecting a correct match. As a test, multiple options for preprocessing images and the various successful match score algorithms were applied to a collection of paired radiographs, some of which were correctly matched and others incorrectly matched. A spatial registration process was applied to the images prior to preprocessing to minimize variability caused by the relative position of anatomic features within the radiographs. The preprocessing filters that were tested included histogram equalization, unsharp masking, and shadow enhancement filters. Testing of the match scores included mutual information, image correlation, Dice similarity, and the Jaccard coefficient methods. The resulting data were analyzed to identify the algorithms with the highest sensitivity and specificity for identifying correctly matched images. As expected, the type of preprocessing filter applied and the match score algorithm were significantly associated with the resulting match score (Correlation: sensitivity 71.43, specificity 77.78, p-*value* < 0.001). The sensitivity and specificity tended to be higher using the Dice (sensitivity 85.71, specificity 88.89) and Jaccard (sensitivity 92.86, specificity 88.89) match score algorithms.

The large number of potential preprocessing protocols available and the multiple options for calculating match scores in QMA® require an optimization scheme to identify and validate the optimal protocol for the computer-assisted identification method. The results of this study demonstrate that the optimization process can be completed using sensitivity and specificity data as the primary outcome measures, and that sensitivity and specificity are highly dependent on the combination of preprocessing steps and match score algorithm used. Testing of the optimization process is underway using large sets of example imaging until the sensitivity and specificity data converge to steady values in the optimal protocol for the matching process.

Radiograph Identification, Forensic Anthropology, QMA®

 ** Presenting Author*