H18 Positive Identification Using Chest Radiographs: Standards for Minimum Number of Concordant Points

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After attending this presentation, attendees will gain a better understanding of: (1) a method of decedent identification via comparison of vertebral column characteristics between antemortem and postmortem radiographs; (2) the associated statistical probabilities of a positive identification using this method; and, (3) the variance of those probabilities based on the quality and several other characteristics of the specimens and radiographs.

This presentation will impact the forensic science community by serving as a statistically valid and systematic means for positive identification of decedents when more traditional methods of identification are not available, or when those traditional methods need to be supplemented.

Positive identification is of primary importance for case resolution and bringing closure to the victims' families. Difficulties surrounding the identification process can result from taphonomic processes that result in incomplete recovery of skeletal materials and/or from inadequate antemortem records. Therefore, a variety of identification methods that utilize various anatomical structures is essential for timely and accurate identification. While there are a number of methods used to make positive identifications through radiographic comparison, many lack the scientific rigor necessary to make them admissible in court. The utility of radiographs for positive identification was examined in accordance with the United States Federal Court ruling (*Daubert vs. Merrell Dow Pharmaceuticals*, 509 US.579, 1993) and National Academy of Sciences (NAS) 2009 Report, *Strengthening Forensic Science in the United States: A Path Forward*, which calls for more testable and reliable scientific research. To date, there has been ample research exploring morphological variation in the frontal sinus, chest, and vertebrae for positive identifications; however, much of this research has focused on the investigator assessing morphological similarities or dissimilarities via side-by-side comparisons, which would not satisfy the *Daubert* criteria or NAS report. The utility of radiographs for medicolegal purposes is shown by the uniqueness of certain features of the skeleton in previous research; however, there is a need to quantify their uniqueness. Although vertebral radiographs are commonly used in the identification process, standards do not currently exist regarding a minimum number of concordant points that should be used. The case reports in the forensic literature show that one to four points with no discrepancies have been used to determine identity.

The purpose of this pilot study was to examine the vertebral column in a known sample of 60 antemortem and postmortem chest and abdominal radiographs from the North Carolina Office of the Chief Medical Examiner to: (1) evaluate the uniqueness of traits observed in the vertebrae; and, (2) explore the minimum number of corresponding traits necessary to make a positive identification in order to address the issue of probabilities, a growing concern in the court systems. Thirty comparisons were antemortem and postmortem radiographs from known individuals. To represent the unknown or no-match sample: either an antemortem or postmortem radiograph was compared to a randomly selected individual. The following eight traits were scored for each radiograph: cervical morphology (e.g., pedicle, spinous process shape, etc.), thoracic morphology, lumbar morphology, quality of antemortem X-ray (e.g., good, average, and poor), quality of postmortem radiograph, presence of congenital anomalies, elapsed time between antemortem and postmortem radiographs, and condition of remains (e.g., skeletonized, decomposed, etc.).

To explore patterns and relationships of the data, a robust data mining technique called a classification decision tree was applied. For categorical data, a G^2 or the likelihood-ratio chi-square for the variables is computed and used for multi-level split of the data. The advantages of decision trees are that they are easy to interpret, they are able to handle both categorical and numerical data, and they are robust. Results show that the anatomical elements with the most predictive value were the lumbar vertebrae and indicate that if you have more than five concordant points, you have a 71% probability of correct classification (Fig. 1). If the postmortem X-rays are good or average quality, then the probability increases to 90% and if the antemortem radiographs are average quality, the probability of correctly matching the radiographs increases to 93%. Likewise, if there are less than five points of concordance, there is only a 33% probability of correct classification and if the antemortem radiographs are good or average quality, then the probability increases to 62%. Thus, these results show that a minimum of five points of concordance are needed with good or average quality postmortem radiographs in order to have a 90% probability of correctly classifying or making a positive identification based on the lumbar vertebrae. The cervical and thorathic vertebrae were not found to be unique enough to be used to make a positive identification on their own. However, the use of cervical and thorathic vertebrae in a larger sample is currently being examined.

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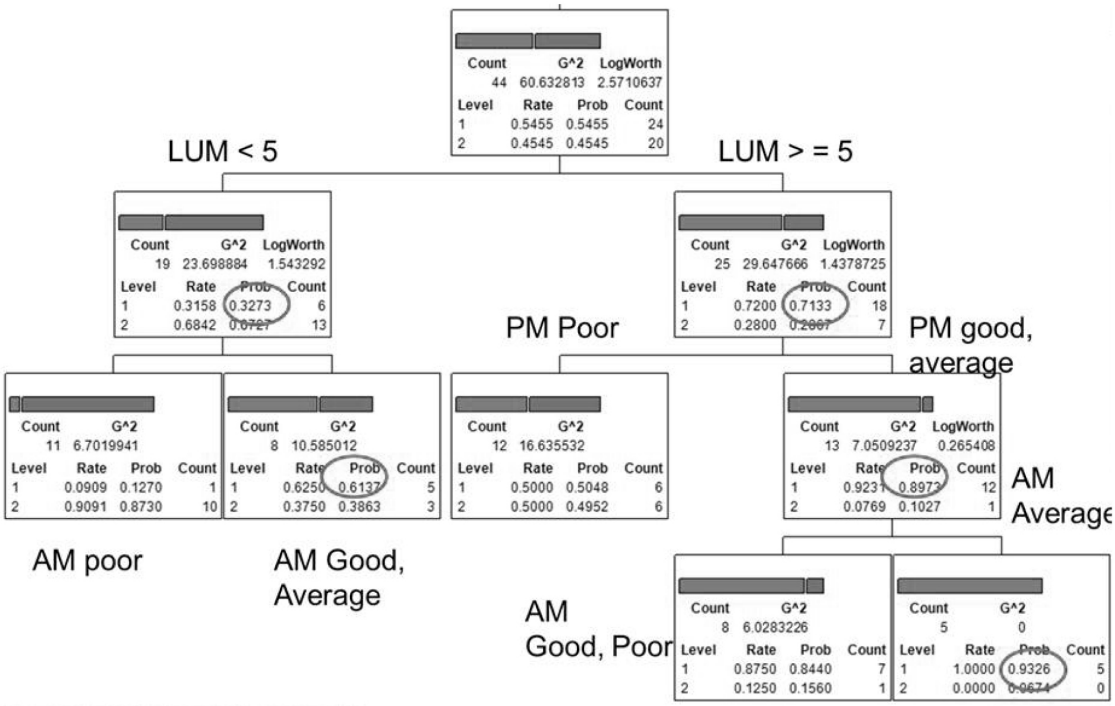

Fig. 1. Results showing the lumbar vertebrae as having the most predictive power and probabilities associated with corresponding traits.

Radiographs, Positive Identification, Number of Traits

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