H104 Testing the Reliability of Frontal Sinuses in Positive Identification Using Elliptic Fourier Analysis

Angi M. Christensen, PhD, 301 Taliwa Drive, Knoxville, TN 37920*

This paper will examine the EFA coefficients of digitized frontal sinus outlines to estimate the probability of a correct identification and discuss the reliability of the technique. Further, the research will discuss when EFA comparison of frontal sinus outlines can provide quantitative substantiation for a forensic identification based on these structures.

This presentation will demonstrate the importance of considering *Daubert* guidelines when conducting research in forensic anthropology, as well as provide the community with a new method for frontal sinus radiograph comparison.

The use of frontal sinus radiographs for confirming the identity of human remains dates to 1925. Traditionally, such identifications involve comparing antemortem and postmortem radiographic records and are usually conducted by a forensic anthropologist, pathologist, or radiologist. The expert makes a visual assessment as to the agreement between the two radiographs (or lack thereof), making a largely subjective judgment as to whether the two belong to the same individual.

Despite the fact that the comparison of frontal sinus radiographs for positive identification has become an increasingly applied and accepted technique, it is exceedingly rare that an expert's opinion goes unchallenged by other experts and/or opposing council. Moreover, recent rulings concerning admissibility of scientific evidence in court require more than credibility, persuasion, and manifest experience of the scientific expert. The current method of frontal sinus radiograph comparison by visual assessment fails to meet evidence admissibility guidelines as set forth in the 1993 case of *Daubert v. Merrell-Dow Pharmaceuticals, Inc*. Specifically, there has been no evaluation of the probability of misidentification using the technique, and there are no standards for confirming or rejecting a putative identification. Even though identifications based upon frontal sinus radiograph comparisons have been routinely accepted by scientists, medical examiners and law enforcement officials, these shortcomings could pose serious problems if forensic scientists were called upon to testify regarding such an identification at trial.

In response to these shortcomings, a study was conducted to assess the reliability of frontal sinuses in forensic comparisons using a geometric morphometric approach called Elliptic Fourier Analysis (EFA). In this study, the shape of a frontal sinus was represented by digitized points along its outline as seen in a standard anterior-posterior radiograph. EFA fits a closed curve to the ordered set of data points, generating a set of coefficients that can be treated as shape descriptors and can be used as variables in discriminatory or other multivariate analyses.

EFA coefficients were generated from 808 digitized outlines of frontal sinuses. Likelihood ratios (the probability of the evidence supposing a hypothesis is true, divided by the probability of the evidence supposing it is false) and posterior probabilities (the probability that the identification is correct assuming that the identification is as likely to be correct as incorrect) were calculated based on these coefficients. The average likelihood ratio in this study was remarkably high (about 1.09E+84 to 1), indicating that the odds of a match given the correct identification are significantly higher than the odds of a match from the population at large. The posterior probability for most cases was 1 or very near 1 indicating that the probability of a correct identification given a match would be nearly 1 in most cases, and about 96% on average.

Thus, for individuals with sufficiently remarkable frontal sinuses, using EFA coefficients of digitized outlines to estimate the probability of a correct identification, and thereby confirm or reject a presumptive identification, is a reliable technique. The technique has also been effectively applied to forensic comparisons. Given these results, EFA comparison of frontal sinus outlines is recommended when it may be necessary to provide quantitative substantiation for a forensic identification based on these structures.

Forensic Anthropology, Frontal Sinuses, *Daubert*

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