A57 Positive Identification Via Frontal Sinus Morphology: A Geographic Information Systems (GIS) Approach

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Learning Overview: After attending this presentation, attendees will understand the application of Geographic Information Systems (GIS) software for establishing positive identifications from antemortem and postmortem frontal sinus radiographs.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing an example of a novel application of GIS software, arcGIS® and ArcMap®, for the purposes of human identification.

Visual comparison of Antemortem (AM) and Postmortem (PM) frontal sinus radiographs has been used to establish positive identifications when other methods, such as fingerprint and dental matching, are not available. However, observer experience continues to influence method performance.[1] In order to address the need for more quantifiable methods in human identification, this research explored the utility of ArcMap® for frontal sinus identification.[2] The main objective of this study was to assess the utility of ArcMap® and its spatial analyst tool, Similarity Search, for identifying a frontal sinus match from radiographs that were collected for a previous study.[2,3] It was hypothesized that Similarity Search would be able to: (1) correctly identify a frontal sinus match based on area and perimeter values; and (2) provide practitioners with a quantifiable and reproducible method for positive identification using cranial radiographs.

Radiographs of 50 male and 50 female donors associated with the University of Tennessee William M. Bass Donated and Forensic Skeletal Collections were digitized using a Diagnostic Pro-Edge Scanner, organized into randomly selected test groups that contained one PM and ten AM radiographs, uploaded into ArcMap® 10.5, and digitized into two-dimensional polygons with area and perimeter values.[2] Similarity Search was instructed to: (1) compare each AM polygon to the PM polygon for that group by area and perimeter values; then (2) rank each AM polygon based on similarity to the PM polygon and calculate a corresponding similarity index value. Hierarchical cluster analysis was used to determine a similarity index value range. Inter- and intra-observer variation was assessed indicating low variation within and among observers and the one-way Analysis of Variance (ANOVA) displayed no significant difference among observers for area or perimeter (p=0.935, p=0.906). Similarity Search correctly identified the true match polygon for 31/50 male groups (62%) and 36/50 (72%) female groups. Based on the cluster analysis, the range of similarity index values for females is 0–11.56, and for males is 0–5.51.

The results of this study demonstrate that Similarity Search can correctly identify a match for males and females with 62% and 72% accuracy, respectively. Results indicate that this is a user-friendly and replicable method with promising initial results despite limited parameters. However, future research that includes additional characteristics beyond area and perimeter will likely improve performance and increase reliability of this method. For example, the use of zonal geometry or the inclusion of a shape analysis algorithm should be explored. Moreover, the inclusion of 3D images (e.g., Computed Tomography (CT) scans) in place of radiographs may resolve issues encountered with ArcMap®, including orientation, scale, and clarity.

Reference(s):

1. Page, Mark, Jane Taylor, and Matt Blenkin. Uniqueness in the Forensic Identification Sciences—Fact or Fiction? *Forensic Science International*. 206, no. 1-3 (2011): 12.
2. 2. ArcGIS Desktop Release 10.5.
3. 3. Christensen, Angi M. *An Empirical Examination of Frontal Sinus Outline Variability Using Elliptic Fourier Analysis: Implications for Identification, Standardization, and Legal Admissibility*. University of Tennessee, Knoxville, 2003.

Frontal Sinus, Geographic Information Systems, Human Identification