



A25 The Effect of Cranium Orientation on Positive Identification Using Frontal Sinus Radiographs

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After attending this presentation, attendees will understand the effect that variations in angle between antemortem and postmortem radiographs have on positive identification using the frontal sinus. This presentation will also outline the appropriate orientation for taking postmortem radiographs of the cranium for comparison to antemortem radiographs.

This presentation will impact the forensic science community by determining the margin of error for skull positioning to ensure positive identification using the frontal sinus, adding to the research previously conducted on courtroom admissibility. Furthermore, this presentation reinforces the standard orientation for postmortem radiographs of the skull as utilized by forensic radiologists and anthropologists.

Although many forensic disciplines have come to accept the qualitative analysis of frontal sinus outlines as an appropriate means of identification, these methods do not meet current evidence admissibility standards. Efforts have been made within recent years to update and improve frontal sinus methods to meet admissibility guidelines by empirically testing their uniqueness and developing more quantitative methods, but there are still many sources of potential error that have yet to be thoroughly examined. A study by Silva et al. began addressing the potential error that variations in angle between antemortem and postmortem radiographs have on the comparison of frontal sinus shapes; however, the quantitative methodology utilized by Christensen, using Elliptic Fourier Analysis (EFA), was not addressed in the Silva et al. study.¹⁻³ This study sought to evaluate how different angulations in cranial orientations during radiography may introduce variation in frontal sinus shape as interpreted from two-dimensional X-ray images and how these variations may affect positive identification results when Christensen's EFA methodology is applied.

This research utilized 16 crania from the Mercyhurst University Donated Skeletal Collection. The crania were radiographed 18 times each at five-degree increments in both the vertical and horizontal planes, resulting in a total sample of 288 radiographs. The frontal sinus outlines from these radiographs were then traced in Photoshop® and analyzed using EFA and principal components analysis. Euclidean distances were calculated from principal component scores within individuals and between individuals to test whether an individual's frontal sinus could be matched regardless of orientation during radiography. A logistic regression model was created to determine the probability of an individual's frontal sinus outlines matching.

Observability of frontal sinuses was affected by as little as five degrees in some individuals. The mean of the Euclidean distances from within individuals was smaller than the mean from between individuals with a statistically significant difference between the means ($p < 0.001$). The logistic regression model indicated that the highest posterior probability was only 80%, even when two of the sinus outlines matched exactly in shape space (Euclidean distance of 0). These results suggest the logistic regression model has a real, but limited, discrimination between matches and non-matches. Posterior probabilities greater than 0.5 were considered as matching; only 66% of the sample was correctly classified as matching or non-matching using the logistic regression equation.

Overall, these results suggest that orientation during radiography can have a significant impact on the accuracy and reliability of frontal sinus comparisons for positive identification. As such, it is important for both clinicians and forensic radiologists and anthropologists to pay close attention to the positioning of the skull during radiographs to ensure minimal variation in orientation. This orientation requires that postmortem radiographs be taken with the orbitomeatal line (from the upper margin of the external auditory meatus to nasion) perpendicular to the X-ray film in order to most accurately match the orientation utilized by clinicians during antemortem radiographs.

Reference(s):

1. Silva R.F., Vaz C.G., Domiciano M.L., Franco A., Carla Ap B., da Costa Meneses do Prado M.M. 2014. Radiographic alterations of the frontal sinus morphology according to variations of the vertical angle in posteroanterior radiographs of the skull. *Acta Scientiarum Health Sciences*. 36(1):113-117.
2. Christensen A.M. 2004. Assessing the variation in individual frontal sinus outlines. *Am J Phys Anthropol*. 127(3):291-295.
3. Christensen A.M. 2005. Testing the reliability of frontal sinuses in positive identification. *J Forensic Sci*. 50(1):18-22.

Positive Identification, Frontal Sinus, Admissibility