



Physical Anthropology Section – 2008

H89 Demographic Expression of the Frontal Sinuses

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This research involves the evaluation of a rarely accessible radiographic juvenile sample. The study drives at further understanding the biological processes involved in the formation of the frontal sinuses, producing a better understanding of those factors which may shape or disrupt development.

This study will impact the medical, anthropological, and legal communities in its evaluation of the growth and development of the frontal sinuses. Also, through the elucidation of its morphological expressions, valuable patterns emerge in relation to age, sex, and ancestry groups.

The high morphological variability of the paranasal sinuses is a well recognized fact within the anthropological literature. This variability combines with a high morphological complexity to produce a structure that is virtually individual-specific. These characteristics, and the relatively frequent availability of ante-mortem radiographs of the area, has led most forensic research on frontal sinuses to focus on their utility for individual identification, mainly aimed at defining the level of precision with which a positive identification can be conducted by comparison of ante- and post-mortem frontal radiographs.

An adaptive value is also frequently attributed to frontal sinuses in the paleontological literature, especially as a potential adaptation to cold environments in some fossil hominid species. Still, a review of the literature reveals a marked scarcity of references focusing on the study of potential inter-populational differences in frontal sinus morphology.

The reason for this neglect is likely related to the same morphological complexity that confers frontal sinuses their value for forensic identification. Their structure may be easily seen as too fickle and idiosyncratic to provide any information about the biological background of the individual. The difficulty to describe mathematically the intricate frontal sinus morphology, and the scaling problems derived from radiographic recording, may as well lead to consider that, even if inter-populational differences were present, their testing and observation would be impeded by the random noise associated to the recording and scaling processes. Consequently, the analysis of inter-group differences in frontal sinuses may appear as too costly to represent an attractive line of research, especially when inter-populational differences may be regarded as a secondary, unimportant issue for positive identification purposes.

These assumptions are not necessarily true. Even when the morphological complexity of frontal sinuses may have prevented a more thorough analysis in the past, sound computing and statistical techniques are nowadays available for accurate recording and scaling of the sinus outline. As a matter of fact, the soundness and applicability of these techniques to the analysis of frontal sinuses are well established, precisely as a consequence of their utility for positive identification studies.

On the other hand, the perception of inter-populational variability as a secondary issue for identification purposes is also fundamentally flawed, as the probabilities associated with individual comparisons are not independent of those related to differential demographic expression, when group differences are present. Therefore, the development and validation of positive identification techniques cannot assume by default the absence of inter-group differences, and difference testing is required.

The present study analyzes the presence of inter-populational differences in a modern radiographic sample collected at the Erie County, Medical Examiners Office, Buffalo, New York, and from forensic casework conducted at Mercyhurst College. The sample comprises juvenile, adolescent, and adult crania of both sexes and with different ancestries. The radiographs were digitized and the outlines of the frontal sinuses traced and recorded. Data transformation and variable reduction were performed through Elliptic Fourier Analysis (EFA), and Principal Component Analysis (PCA). The presence of group differences in sinus morphology and symmetry were analyzed through multivariate ANOVA models, with the principal components as dependent variables and group and sex as grouping factors. Differences in sinus outline complexity were similarly evaluated in terms of fractal dimensions. Discriminant Function Analysis was employed to test the forensic relevance of the observed group differences, in terms of percentages of correct classification. Age differences were assessed through a cross-cut allometric analysis of outline complexity with age.

Results suggest that both individual and group differences in sinus shape may be correlated with sinus size and expansion and, due to their effect size, they are not relevant for positive identification purposes. On this respect, the proposed methodology appears as a promising tool to shed additional light upon the developmental processes shaping the frontal sinus, both between and within different demographic groups, through its application to longitudinal data.

Frontal Sinus, Sex, Ancestry