H52 A New Method for Evaluating Orbit Shape

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After attending this presentation, attendees will be introduced to a novel quantitative method of orbital shape analysis as it relates to discussions of sex and race in human skeletal remains.

This presentation will impact the forensic community and/or humanity by offering an alternative technique of data collection and analysis of human orbital anatomy.

Skeletal determination of race using orbital morphology is typically discussed qualitatively in terms of simple, descriptive labels (e.g., round, square, sloping, etc.). While inherently understandable, such labels are incapable of meaningfully characterizing the continuum of shape variability within and between human populations. Further, these descriptors rely upon individual subjective observation to demarcate between one character state and another. Moreover, even when measurements are taken of the orbital region, they are typically in the form of linear distance measures (height and breath). The resultant orbital index is then partitioned into descriptive ranges of wide, average, or normal (Krogman 1962; Bass 1995). These established qualitative and quantitative methods of data collection may fail to capture all of the available information regarding individual and populational orbit shape.

The present study addresses this issue by applying 3D semi- landmarks to the orbital region. Semi-landmarks are often employed to capture anatomical structures lacking distinct landmarks, such as boundaries and surface curvature. One hundred twenty individuals evenly distributed by race (Black, White) and sex were compiled from the Terry Collection, Smithsonian Institution. Superior and inferior rim curvature for both orbits was captured by collecting a sequence of points along the structure's gross outline (continuous stream data) using a Microscribe® 3DX portable digitizer. The beginning and endpoints of the superior and inferior orbital curve corresponded to accepted landmarks (maxillofrontale and frontomalare anterior). Semi-landmarks were then created within a beta program (Slice 2005), which applies an algorithm that resamples each curve into a user-defined number of evenly-distributed points (10 points per curve; four curves). The semi-landmark data were transformed by generalized Procrustes analysis (GPA), which optimally translates, scales, and rotates the points into a common coordinate system.

Multivariate statistical analyses were then performed on the resulting shape variables. In order to reduce dimensionality a principal component analysis (PCA) was performed on the covariance matrix of the aligned coordinates. A multiple analysis of variation (MANOVA) was then conducted using the PCA scores to test whether sex and race have significant effects on orbit shape.

Both sex ($F=2.63$; df= 42; $Pr>F=<0.0001$) and race ($F=3.19$; df= 42; $Pr>F=<0.0001$) were found to significantly contribute to orbit shape variation. In addition, a significant sex*race interaction ($F=1.65$; df= 42; $Pr>F=<0.0301$) was detected. These results not only confirm previous gross morphological findings of racial variation in orbit shape, but indicate the presence of sexual dimorphism in this structure. Moreover, this method of data collection is not only fairly easy to master, but serves to better preserve the overall architecture of the orbits than traditional morphometric techniques. As such, these results indicate orbit morphology is influenced by both sex and race and the interaction of two.

Orbits, Shape Analysis, Semi-landmarks

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