H44 Age-Related Change in Adult Orbital Shape

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After attending this presentation, attendees will better appreciate the impact of age on adult orbital shape.

This presentation will impact the forensic community by highlighting the importance of considering age when utilizing orbital shape in the identification of unknown remains.

The orbital region conveys a wealth of information about sex, ancestry, and age. This is thanks in large part to its topological complexity, which is a consequence of soft and hard tissue interactions. With age, the smooth appearance of youthful skin is replaced with deepening lines of demarcation (e.g., crows' feet) as the soft tissue around the orbits descends. As interrelated entities, internal hard tissue (i.e., bone) modification in this region may impact the manifestation of external soft tissue change over time. However, alterations in craniofacial bone structure post-adulthood are not as well understood as those witnessed on the soft tissue level. At present, adult orbital shape is known to vary both metrically and non-metrically with sexual dimorphism and ancestry (Krogman 1962; Rhine 1990; Bass 1995), but the impact of the aging process on this region remains a relative mystery (Williams 2008).

The present study addresses this complex issue by applying three- dimensional semi-landmarks to the orbital rims of 664 crania embodying a mix of socially-determined race (Black, White) and biologically-determined sex from the Terry, Hamann-Todd, Maxwell Museum, and W.M. Bass skeletal collections of known individuals. The crania were parsed into three overarching age groups (young adult: 18-39 years; middle-aged adult: 40-59 years; elderly adult: 60+ years). In craniometric analyses, semi-landmarks are often employed in regions lacking distinct landmarks, such as boundaries and surface curvature. Superior and inferior orbital rim curvature was gathered as continuous stream data using a portable digitizer. Semi-landmarks were then extracted utilizing a beta program (Slice 2005), which applies an algorithm that re-samples each curve into a user-defined number of evenly-distributed points (10 points per curve; four curves).

The resultant semi-landmark data were fit into a common coordinate system via a generalized Procrustes analysis (GPA), which filters out the effects of location, scale, and rotation. In order to reduce dimensionality, a principal component analysis (PCA) was performed on the covariance matrix of the GPA-aligned coordinates and the resulting principal component (PC) scores, which accounted for 95% of the total variance, were utilized in subsequent multivariate statistical analyses. A multiple analysis of variance (MANOVA) of the PC scores detected a significant age effect (F=1.98; df= 64; Pr>F=<0.0001), as well as a sex*age (F=1.43; df=64; Pr>F=0.0156) and race*sex*age interaction (F=1.65; df=64; Pr>F =0.0012). The specific age groups contributing to the three-way interaction were evaluated by conducting contrast tests, which compared the age group means for each subpopulation (e.g., White females) within MANOVA. Contrast tests found several significantly different age pairings in the subpopulations (Black males: young versus elderly F=2.59; df=30; Pr>F=<0.0001, White males: young versus middle-aged F=1.94; df= 29; Pr>F=0.0058; young versus elderly F=1.90; df=29; Pr>F=0.0078, White females: young versus middle-aged F=1.63 ; df=27, Pr>F=0.0415, middle-aged versus elderly F=2.10; df=27; Pr>F=0.0038). These age-related orbital differences were visualized in terms of spatial distinctions using vector plots which compared the mean shapes between age pairings that were found to be significantly different. While a specific pattern did not always manifest in these plots, the eye orbits did exhibit such shape changes as supero- inferior expansion, supero-inferior compression, and medio-lateral compression depending on the subpopulation and age groups analyzed.

These results indicate that adult skeletal orbital shape does in fact change with the aging process. Moreover, orbital shape is influenced by the interaction between age, sex, and ancestry. Thus, it is inappropriate within a forensic context to treat the orbital shape differences typically associated with sexual dimorphism and ancestry as static. Instead, age should be factored into sex and ancestry determinations of unknown remains which rely on orbital shape.

Eye Orbits, Semi-Landmarks, Geometric Morphometrics

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