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Sex Estimation from Cochlear Morphology: MRI-Based Analysis and Forensic Applications

Sex estimation is a fundamental task in forensic anthropology, human identification, and clinical research. Traditional methods often rely on skeletal traits such as pelvis and skull morphology; however, these structures may be unavailable or incomplete in forensic cases. Recent advances in imaging technology have revealed that the human cochlea—a spiral-shaped structure in the inner ear—exhibits sexually dimorphic characteristics that can be quantified using magnetic resonance imaging (MRI). This study evaluates the utility of cochlear morphology for sex estimation, analyzing key cochlear parameters including length, width, curvature, and torsion. MRI-based measurements were performed on a sample population of 216 individuals (110 males, 106 females) across a range of ages. Statistical analyses, including multivariate regression and discriminant function analysis, demonstrated significant sex-related differences in cochlear dimensions, with males generally exhibiting larger cochlear length and curvature than females. Pearson correlation coefficients indicated strong reliability between bilateral cochlear measurements ($r > 0.95$, $p < 0.001$). These findings suggest that cochlear morphology is a robust and non-invasive indicator for sex estimation in both living and deceased individuals. The study highlights the potential applications of cochlear-based sex estimation in forensic investigations, anthropological research, and clinical audiology.

Keywords

cochlea, sex estimation, magnetic resonance imaging, sexual dimorphism, forensic anthropology