F16 A Novel Forensic Use of Clinical Odontological Imaging: Geometric Morphometric Analysis of Sexual Dimorphism in the Mandible From Panoramic Scanning X-Ray Images

Emilio Nuzzolese, DDS, PhD, Ambulatorio Nuzzolese, Viale JF Kennedy 77, Bari, 70124, ITALY; Patrick Randolph-Quinney, PhD*, Caroline Wilkinson, PhD, and Katie N. Baines, BSc, Centre for Anatomy & Human Identification, College of Life Sciences, University of Dundee, Dundee, DD1 5EH, UNITED KINGDOM; and Giancarlo Di Vella, PhD, Section of Legal Medicine - University of Bari, P.zza G. Cesare 11, Bari, 70124, ITALY*

After attending this presentation, attendees will have a better understanding of the sex determination during the skull assessment.

This presentation will impact the forensic science community by introducing a novel method of sex determination in the process of human identification investigations.

The human mandible is routinely utilized as part of sex assessment in forensic odontological and anthropological practice. Various studies have pointed to the utility of morphological and metrical traits in the mandible, such as symphyseal shape, gonial angle and eversion, and ramus flexure among others in the assessment of biological sex. The research here presented utilizes geometric morphometric techniques to investigate and quantify shape and size variation in the morphology of the mandibular corpus and ascending ramus, and consequently highlights the potential for forensic human identification. The results of a novel morphometric study are presented using clinical panoramic scanning x-radiography, the goal of which was to develop a methodologically and statistically robust means of investigating biological variation in lower jaw morphology from a commonly acquired clinical data source.

As part of proof-of-concept, clinical digital orthopantogram images (OPG's) were acquired from 50 male and 50 female adult participants from a modern Italian sample population. Ten type I and type II landmarks were applied to the symphyseal region and the condylar and coronoid processes of the resulting 2D images in order to anchor a framework of semi-landmark curves. One-hundred equidistant semi-landmarks were established along the inferior border of the corpus, and the posterior border of the ascending ramus, thus encompassing the sympyseal region, gonial region, and posterior ramus – all of which are isolated anatomical regions which have been demonstrated to exhibit significant expression of sexual dimorphism in previous studies. The resulting landmark and semi-landmark configurations were subjected to Generalized Procrustes Analysis (GPA) with Full Tangent Space Projection. Principal Component Analysis (PCA) was applied in order to assess populational variation. Factor loadings were subject to Canonical Variates Analysis with stepwise and leave-one-out classification in order to assess the effects of sexual dimorphism on mandibular shape. The preliminary results showed individuals to be correctly classified for sex in 89.6% of cases (males were correctly classified in 90.1% of cases, and females in 85.6%).

A partial least squares (2-block PLS) method was further applied, in order to examine patterns of covariation between shape variables and the exploration of patterns of functional modularity. In this case, functional modules are assumed to be units within which there is a high degree of integration from many and/or strong interactions, but which are relatively independent of other such units. The nature of the interactions can be, for instance, developmental, functional, or genetic, depending on the context. Most interestingly the results indicate the greatest level of individual and sex-specific variation is found in the shape-curve and pattern of the inferior corpus, in contrast to that of ramal flexure. However, a moderate degree of modular integration between the corporal and ramal regions suggests that functional ties between the units are correlated in influencing sex-based morphological trait expression. Consequently such units may be studied together or in isolation, and this may allow for the development of identification criteria based on modular unit shape variables which may be applicable for both whole specimens and fragmented remains depending on the forensic situation. Overall, the results are strongly significant and suggest dependently and independently that the shape relationship between the mandibular corpus and the ascending ramus offers significant power for forensic identification purposes.

This investigation was designed to introduce a more standardized method of sex determination in the process of human identification within the field of forensic dental radiology. Orthopantogram images allow an objective and reproducible 2D images reducing observer bias especially when the analysis of the mandible utilizes geometric morphometric techniques. This study confirms that the mandible exhibits significant sexual dimorphism and that skull assessment of unidentified cadavers cannot leave aside the odontological investigation with the benefit of stored radiological images. Nevertheless, further assessment on a wider sample of OPG's should be carried out in order to increase the predictive accuracy of this novel methodology.

Geometric Morphometrics, Sex Assessment, Forensic Odontology

