H28 Three-Dimensional Geometric Morphometric Analysis and Multislice Computed Tomography: Application for Adult Sexual Dimorphism in Human Coxal Bone

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The goal of this presentation is to present an assessment of the sexual dimorphism based on the study of the human adult coxal bone, by three-dimensional (3D) geometric morphometric analysis of clinical multislice computed tomography (MSCT) explorations. This presentation illustrates the potentialities of the MSCT with a particular anthropological tool, the 3D geometric morphometric analysis, and a particular anthropological application, sexual dimorphism.

This presentation will impact the forensic science community by providing an example of anthropological use of the 3D geometric morphometric analysis, based on clinical MSCT.

Background and Introduction: Multislice computed tomography is uncommonly used in anthropology and forensic anthropology. With this in mind, this study demonstrates that the 3D adult coxal shape differences related to sexual dimorphism can be identified and visualized objectively with geometric morphometric analysis based on clinical MSCT explorations.

Materials and Methods: Materials consist of a retrospective study of coxal bones from adult patients undergoing clinical MSCT in the authors' institution. Patients with a known history of bone disease were excluded. A total of 65 MSCT explorations were included, consisting of 30 males and 35 females, with 16 x 1.5 mm collimation. Scans were saved as DICOM files and a 3D post-processing was performed.

The methods included standard anthropometric techniques, 15 osteometric landmarks were chosen on the left innominate. The 3D coordinates of landmarks were identified on the MSCT 3D reconstructions. The three separate bones of the innominate (e. g., the anatomical pubis, the anatomical ilium, and the ischium) were first studied individually. Additionally, a modified ilium shape (consisting in the ilium and the ischial spine), and a modified pubis shape (including the ischiopubic ramus) were studied. Finally, complexes from bone parts were analyzed, including: the ischiopubic complex (consisting of the modified pubis and the ischium), the iliopubic complex (consisting of the ilium and the pubis), the ilio-ischial complex (consisting of the ilium and the ischium), and the complete coxal bone. Males and females were analyzed separately. Percentage errors were calculated for the 15 landmarks to examine the effects of intra- and inter-observer errors. For each analysis the recorded landmarks were scaled, rotated and translated using Generalized Procrustes Analysis. A consensus configuration, or mean shape configuration, was produced for males and females, so that sex differences could be compared. The landmark coordinates were analysed using Principal Components Analysis (PCA) and Canonical Variates Analysis (CVA). Finally, Goodall's F-test and Mahalanobis D^2 matrices were calculated.

Results and Discussion: Clinical MSCT explorations have not been previously used with geometric morphometric analysis to study sexual dimorphism of the adult human coxal bone, using 3D reconstructions. The advantage of geometric morphometric techniques is their ease of use, and their reproducibility. In the present case, intra- and inter-observer variabilities were less than 3%. Goodall's F-test for all structures studied was significant, suggesting that the sexual dimorphism of the specific morphological structures of the skeletal elements, are similar to results achieved in previous studies.

Based on the results of the PCA, CVA, and Malahanobis D^2 distances, the most sexually dimorphic anatomical structures were non- isolated bones: the complete coxal bone, the iliopubic complex, the ilio- ischial complex, and finally the ischiopubic complex. Our results agree with classical sex determination data. The 3D consensus shapes (masculine or feminine) are intrinsically composed of all the differences of lengths or length ratio, which explained the high sexual dimorphism of the innominate. Concerning the ischiopubic complex, our results completely agreed with previous results, demonstrating it is an important marker of sexual dimorphism. However, results were surprising in regards to the iliopubic and ilio-ischial complexes. Data were not found

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concerning the sexual dimorphism of those complexes, but those complexes were highly dimorphic, and particularly more dimorphic than the previous described ischiopubic complex.

The most discriminating isolated bones of the innominate with anatomical and embryological definition were the ilium and the pubis. The modified pubis, including the ischiopubic ramus, had Malahanobis D^2 distances similar to those of the anatomical ilium. This feature had never been described before in the literature. Inclusion of the ischiopubic ramus within the pubis increased its sexual dimorphism. The modified ilium, including the ischial spine, provided supplementary information

concerning the greater sciatic notch, which agreed with the classical anthropological data. Based on the results of the PCA, CVA, and Malahanobis D^2 distances, the isolated ischium presented a weak but significant sexual dimorphism.

Conclusion: The reliability of this method and determined innominate's areas with the greatest shape sexual dimorphism are demonstrated. All the results are on accordance with previous past studies' results but bring also new data for sexual dimorphism. Further studies will be done on supplementary individuals, immature populations. Furthermore, dimorphism analysis of the innominate shape with landmarks type III (semi landmarks) will be an additional way of research.

Forensic Anthropology, Geometric Morphometric, Multislice Computed Tomography

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