H1 Accuracy and Reliability of Craniometric Variables Obtained From 3D-Computed Tomography Images

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After attending this presentation, attendees will gain knowledge of two types of measurement error, namely accuracy and reliability, from craniometric variables obtained with Computed Tomography (CT) images.

This presentation will impact the forensic science community by validating the use of CT images as a data source for anthropologists to use in the development or justification of methods employed to estimate a biological profile.

Cranial measurements are routinely used within forensic anthropology and contribute to the key components of the biological profile, including the estimation of sex and ancestry. The measurements are frequently used in the creation of a new method from a skeletal collection or to positively identify an unknown in both forensic casework and mass disaster situations. In any circumstance, obtaining dry skeletal elements requires a time-consuming process inclusive of extensive preparation and processing. Multiple research studies have suggested the use of 3D-CT scans as a tool to collect cranial measurements from the human body, allowing the anthropologist to bypass the need to remove soft tissue in certain situations. In contrast to conventional radiography, the CT scanner produces an anatomical image from thin slices of the object (i.e., cranium) developed from measurements of absorption due to multiple X-Rays made 360 degrees around the object. Although the fundamental design of the CT machine removes the production of distortion, this has yet to be directly compared in the anthropological literature.

A full-body CT scan was performed prior to autopsy at the State of Maryland Office of the Chief Medical Examiner using GE Light Speed RT-16 scanner as well as 3D volume-rendered image generation in the GE Advanced Workstation (AW-2). Following the autopsy, processing the body was conducted to obtain skeletal measurements on dry elements. After all scans and preparation of the remains were complete, 35 standard cranial measurements (both lefts and rights) were collected from the three source types: the dry skeletal elements; the CT images with soft tissue; and the CT images of the dry skeletal elements without soft tissue.

Measurement error has the potential to drastically affect results and subsequent interpretations and thus should be closely evaluated. Because size of the measurement needs to be taken into account, accuracy of the craniometric variables between the three data sources was compared through percent differences. Inter- and intra-observer error was compared through Technical Error of Measurement (TEM), which is the square root of measurement error variance, and relative TEM (%TEM), which allows for a comparison between variables or sources. Agreement between the measures was also assessed through Bland-Altman plots.

The average percent differences for all source types ranged between 0.6% and 2.0%, indicative of a high accuracy rate. A three-way inter-observer TEM of the cranial measurements obtained on the CT with soft tissue and CT conducted on the dry bone was 2.6mm and 1.78mm, respectively. Three-way intra-observer rates were lower and TEM and %TEM ranged between 0.46 and 0.71 mm and 0.56% and 1.06%, respectively. The intra- and inter-observer rates demonstrate high reliability in landmark location in CT images. Bland-Altman plots illustrate that all measurements are within 2mm from the other two measurements obtained, indicated by all points located within the upper and lower level of agreements.

The results suggest that measurement error associated with craniometric variables obtained on CT images is extremely low and comparable to data collection on dry skeletal elements. More so, the results prove that CT images offer a viable source to obtain metric variables.

Technical Error of Measurement, Percent Differences, Measurement Error

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