A30 Reliability of Craniometric Measurements Using a Variety of Imaging Technologies

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After attending this presentation, attendees will understand that measurements taken from representations of crania are, for the most part, just as reliable as those taken directly on the crania themselves. Attendees will also learn which measurements should be used with caution for each tested data format and how to mitigate these issues when collecting data.

This presentation will impact the forensic science community by supporting the validity of expanding anthropological osteometric databanks to include information derived from indirect sources such as medical scans or laser scans. The ability to reliably collect skeletal information from these indirect sources will greatly enhance the potential for collecting osteometric data on currently underrepresented demographic groups.

With the continuing advancement of biomedical imaging and 3D modeling technologies, anthropologists have begun making use of indirect osteometric data derived from scans of skeletal elements. In response to this trend, a study was undertaken to test the reliability across several different imaging technologies of 26 standard craniometric measurements frequently used in forensic casework.[1] Measurements from five crania of known individuals were collected in duplicate by two anthropologists from Computed Tomography (CT) scans and 3D laser scans of the original crania. The laser scans were also used to create prototype models of the original crania. These prototypes were subsequently laser-scanned and measurements were collected from the prototypes and the laser scans of the prototypes.

Craniometric data were initially evaluated for inter-observer and intra-observer error, with one measurement (Bimaxillary (inferior malar) breadth (ZMB)) showing significant inter-observer error. The nature of this error was identified and a second round of measurement collection was undertaken, this time eliminating any inter-observer error. Measurement sets from each technology were then compared with one another using the previously collected osteometric measurements taken on the crania themselves as the ground truth. Statistical analyses conducted on the craniometric data included repeated measures Analysis of Variance (ANOVA), as well as total technical error of measurement and percent total technical error of measurement.

Results show that the majority of measurements demonstrated no significant differences across data formats. However, a few select measurements were found to be problematic for particular technologies. For example, measurements taken from CT scans in a supero-inferior direction (e.g., Basion-Bregma Height (BBH), Orbital Height (OBH)) were prone to greater deviation from direct measurements of the cranium than other technologies, especially for CT scans taken at greater slice increment and thickness. Also, several measurements defined by Type 1 landmarks, particularly those occurring at complex or unclear suture junctures (e.g., Biasterionic (maximum occipital) Breadth (ASB), ZMB), were found to have high variance across all technologies while measurements based on Type 3 landmarks proved to be highly reproducible. This is contrary to measurements taken directly on crania, where measures defined by Type 1 landmarks are typically the most reliable. This observation is most pragmatically explained by the reduction or complete loss of suture definition in the scan data.

If alternative data sources are to be increasingly utilized for the collection of osteometrics, it is vitally important that efforts are made to ensure scanning parameters are sufficient to capture the level of detail required for accurate measurement collection. If measurements are to be collected from pre-existing scans, then a detailed understanding of how individual measurements may be impacted by the particular data format being utilized is necessary to avoid the introduction of unseen error and the possibility of drawing erroneous conclusions.

Reference:

1. Richard AH, Parks CL, Monson KL. Accuracy of Standard Craniometric Measurements Using Multiple Data *Formats. Forensic Sci. Int.* 2014, http://dx.doi.org/10.1016/j.forsciint.2014.06.015.

Craniometrics, Measurement Error, Medical Imaging