A47 A Pilot Study on Measurement Error on 2D and 3D Images in Forensic Anthropological Applications

Theresa M. De Cree, BA, Mercyhurst University, Erie, PA 16546; Emily Brooks, BA, Erie, PA 16509; Victoria Lamond, BA, Mercyhurst University, Ancaster, ON L9K 1H8, CANADA; Samantha LaFrance, BA*, Mercyhurst University, Erie, PA 16506; Luis L. Cabo, MS, Mercyhurst University, Erie, PA 16546*

Learning Overview: After attending this presentation, attendees will better understand the applicability of radiographs and 3D scans for metric analyses.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a comparative analysis of various mediums of imagery to be analyzed and by demonstrating the possibilities and/or limitations of taking metric measurements on different types of imaging.

The keystone of forensic anthropology is the biological profile, which is estimated from various features of the skeleton and aids in the identification of unknown individuals, consisting of age, sex, ancestry, and stature. The utilized quantitative methods rely heavily on metric data, with FORDISC® 3.1 being the most commonly used application. In light of the COVID-19 pandemic, as well as the general increase in electronic communications between law enforcement and forensic anthropologists, understanding the distortion and error rates associated with metric analyses on 2D models, as opposed to 3D models, becomes increasingly important. 2D and 3D imagery can complicate metric analyses due to image distortion. 2D images ultimately flatten objects in the image, making measurements in a 3D plane, such as diameter, significantly less accurate. Additionally, a poorly taken photo or radiograph can blur the necessary features on skeletal elements, and a poor perspective or composition can obscure measurement landmarks or distort perceived lengths. In the case of 3D scans, human error in scanning or post-processing can create a margin of error that must be accounted for in order to have accurate results.

The goal of this research is to compare a set of measurements taken with these three different media to those taken directly on dry bone in order to assess the gross error rate associated with digital measurement protocols and to quantify the relative contribution of each source of error to these particular media. This can assess the practicality and accuracy of utilizing metric methods via different platforms, quantify the level of accuracy and margin on error when taking measurements in a 2D plane, as well as to assess the best practices for metric methods when researchers do not have access to dry bone samples. This study hypothesized that 3D scanning will provide the most accurate measurements out of the three imaging techniques with statistically lower error rates, and radiographs will be the least accurate due to distortion with statistically higher error rates.

This study compared the error rates associated with repeated measurements of five standard variables from laboratory photographs, standard radiographs, and high-resolution 3D scans as compared to direct measurements on dry bone.[1] A sample of ten complete left humeri were chosen due to their consistency in regard to morphology and lack of overall curvature. Photographs and radiographs were taken anterior-posteriorly and medial-laterally to best recreate all views needed to measure with the highest level of accuracy and precision. The radiographs were taken utilizing the Konica Minolta Regius console CS-2 Version 1.30R00 Digital Imaging System and were analyzed with ImageJ software. 3D scans were taken with the Artec Space Spyder and were analyzed with the associated Artec software. For statistical purposes, the maximum and minimum diameter midshaft measurements, as well as maximum length, were taken on both views of the photographs and the radiographs to account for the flattening of the 2D image and to properly assess error rates. In total, 34 measurements were taken on ten humeri, totaling 340 metric points taken per person for three people.

The preliminary results of this study are consistent with the main hypothesis articulated above: 3D scans represent the best alternative to direct measurements on dry bone, as opposed to photographs or standard radiographs. However, the results of the study also reveal that, when properly oriented and taken correctly, radiographs and photographs can produce approximately accurate measurements, as compared to dry bone, that would not result in significant differences when utilized for morphometric analyses. Inter-observer error was lowest on dry bone and highest in radiographs.

Reference(s):

1. Haas, J. Measurement of Adult Remains. In Standards for Data Collection from Human Skeletal Remains: Proceedings of a Seminar at the Field Museum of Natural History (*Arkansas Archeological Survey Research Report*), edited by Jane E. Buikstra and Douglas H. Ubelaker, 69-84. Fayetteville: Arkansas Archaeological Survey, 1994.

Stature Estimation, Radiographs, 3D Scans