G48 Replica Remains: The Current State of Virtual and Physical Conservation Methods in Forensic Medicine

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After attending this presentation, attendees will have an understanding of the variety of cutting edge technologies available to forensic medicine for the reproduction and conservation of fragile human remains.

This presentation will impact the forensic science community by serving to increase scientific knowledge of new technologies and methods available to the forensic community for the protection of human biological specimens. It will also attempt to advance the state of conservation techniques by proposing alternative methods to the usage of actual human specimens in forensic research.

Many collections of human skeletal remains are exhibiting evidence of wear and tear from years of handling by researchers. Damage to often fragile specimens by repeated analyses from calipers has increased the likelihood of biased data and conclusions. Additionally, evidentiary concerns by law enforcement agencies regarding the documentation and preservation critical physical evidence call for conservation techniques that protect the specimen while providing an anatomically accurate alternative to the actual remains, particularly for use in the courtroom.[1] The goal of this study was to document the process of developing an anatomically accurate virtual and physical reproduction of a human skull that could be used for legal, educational, and research purposes.

In this study, a complete Caucasian male skull with intact dentition was utilized for computed tomography (CT) scanning, three dimensional (3D) computer modeling, 3D laser scanning, rapid prototyping, and casting. Using protocols developed and presented previously by the researchers,[2] the skull was 3D modeled and specific regions of interest were highlighted (ex: individual teeth and selected cranial bones) in order to maintain fine anatomical detail. Visualization and texturing of the final 3D model was completed in a 3D rendering software package. After the completion of the virtual 3D skull, stereolithographic models were exported for rapid prototyping using two different commercially available printers.[3] The actual specimen was 3D surface laser scanned and then shipped to a bone-casting expert for a proprietary reproduction process. After a museum quality replica cast was produced, the virtual and physical models (rapid prototypes and France cast) were compared quantitatively and visually to the actual specimen.

Using a binocular surgical microscope with a micrometer precision measurement reticle, the physical replicas were inspected at all regions of interests for the quantification of anatomical features. The replicas were also examined in the areas in which a high level of anatomical detail is required for biological profile analysis, such as suture lines and dental features. The results of this study suggest that accurate anatomical replicas can be made both virtually and physically to substitute for handling of actual osteological specimens. It was discovered that all of the imaging techniques were all useful tools, and that they were useful in somewhat different ways for different applications.

The benefit of this study is that there is an open discussion of the strengths and weaknesses at each stage of the invasive and noninvasive analyses, which will in turn increase the understanding and scope of forensic conservation. With both virtual and physical replicas, these resources can be used in court as visual aids for juries and also for teaching purposes in osteological labs.[1] The detailed replicas also address the need of existing osteological collections to preserve their materials for long-term display and study. Validated replicas such as those used in this study are providing a reliable alternative to the everyday use of actual osteological specimens.

References:

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2. Decker SJ, Ford, JM, Hoegstrom, EJ, Hilbelink, DR. Virtual Anatomy: Three-dimensional computer modeling and measurement of human cranial anatomy (abstract). In: *Proceedings of the American Academy of Forensic Sciences 60th Annual Meeting*; 2008 Feb 19-23; Washington, D.C.: (14)312.
3. Decker, SJ, Hilbelink DR, et al. Who is this person? A Comparison Study of Current 3□Dimensional Facial Approximation Methods. (abstract) In: *Proceedings of the American Academy of Forensic Sciences 60th Annual Meeting*; 2008 Feb 19-23; Washington, D.C.: (14)338.

Virtual Remains, Rapid Prototyping, Physical Evidence

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