A43 Developing an Empirically Based Ranking Order for Bone Sampling: Examining the Differential DNA Yield Rates Between Human Skeletal Elements — Phase I

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After attending this presentation, attendees will learn the order in which skeletal elements, from a relatively short post mortem interval, are most likely to produce DNA profiles suitable for identification.

This project will impact the forensic science community by replacing intuition with empirical data to establish a comprehensive ranking according to each bone's potential to provide usable genetic material for DNA identification, thus providing investigators with a clear bone sampling strategy. These results are particularly applicable for identification projects following mass fatality events with high fragmentation, which often rely heavily on DNA to identify and reassociate disparate fragments.

DNA may be the only method available for positive identification when access to ante-mortem information is limited; when readily identifiable features, such as fingerprints, have been compromised; or when elements are fragmented as in a plane crash. Large-scale identification efforts focused primarily on osseous material including the World Trade Center disaster and the post-conflict identifications conducted in the former Yugoslavia have led to major advances in understanding genetic material used for individual DNA identifications. It has been noted that bones and teeth yield higher levels of DNA than muscle and are often the only surviving tissue available to establish identification. However, bones differ in their structure, function, and composition leading to possible differences in DNA yield. Existing research into specific bone selection for DNA identification is inadequate.

Current selection of skeletal elements for DNA testing is based on the collective wisdom of forensic practitioners who typically request dense cortical bone such as the femoral shaft. This preference is bolstered by retrospective studies measuring success rates between skeletal elements, focusing on both mitochondrial (Edson et al. 2004, Leney 2006) and nuclear DNA (Milos et al. 2007). These studies found weight bearing long bones to be most successful, however, smaller elements such as patellae or phalanges were often not tested. A more recent examination of DNA success rates by skeletal element found that several smaller elements not typically sampled, such as the patellae and foot phalanges, were more successful than dense cortical bones (Mundorff et al. 2009).

Phase 1 of this project involved DNA testing each skeletal element and tooth type from three recently skeletonized individuals from the donated collection at the University of Tennessee Forensic Anthropology Center. The same bones (n=56), from each of three skeletons were tested (total n=168). To minimize destruction during sampling, a 3/8-inch circular hole was drilled in the bone instead of cutting out a window or wedge. This sampling approach resulted in the collection of ~0.20g of bone powder from both small and large bones. Following extraction and quantification, samples were normalized to 2ng when possible, and amplified with AmpliF*l*STR Identifiler™.

Both the quantity and quality of the DNA from each sample was analyzed to determine which bone types consistently yielded complete DNA profiles, defined as 15 loci and Amelogenin, from all three skeletons. Triplicate data from each bone type was combined to determine the average relative fluorescent unit per locus by element type. The quantification value along with the quality of the resulting profile provides a guide to establishing a comprehensive ranking according to the potential of each element type to yield a complete DNA profile.

Results demonstrate that the quantity and quality of DNA obtained from different skeletal elements is highly variable. Many atypical DNA sample choices, such as cancellous tarsal bones (ankle), the patella (knee-cap) and the distal hand phalanx (finger tip), outperformed more traditionally sampled dense cortical bone such as the femur, tibia, and humerus.

These results supplement traditional DNA sampling protocols by ranking skeletal elements according to their ability to produce high quality DNA profiles. Topping the list are smaller elements that can be removed intact, reducing potential contamination, and can also be removed with a disposable scalpel, reducing the need for a bone saw (and electricity, labor, and expensive equipment), allowing for easier and more efficient sampling in the field.

Phase 2 of this project (in progress) will determine whether these results hold true for skeletonized remains from longer post mortem intervals (0-3 years, 4-10 years, 11-20 years, and 21-50 years) and will document DNA degradation over time.

The opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect those of the Department of Justice.

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