H11 Practical Considerations in Trace Element Analysis of Bone by Portable X-Ray Fluorescence

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The goal of this presentation is to discuss analysis parameters in the use of portable x-ray fluorescence (XRF) in the analysis of trace element levels in human bone.

This presentation will impact the forensic community by providing information on possible error factors in XRF analysis of bone.

Bone chemistry can reveal much about an individual's life history. Certain trace elements can give specific and pertinent information about environmental exposure, diet, and geographical location of residence. X-Ray Fluorescence is a nondestructive method for analysis of trace elements. Portable XRF instruments now available allow trace element analysis of samples in the field or in collections. The use of such instruments requires knowledge of analysis parameters such as x-ray penetration and exit depth. This is especially important if non- homogenized whole bone samples are to be analyzed. In a forensic or burial setting where the bone sample has been exposed to the environment, the elements being studied may be altered due to diagenetic changes. Depending on a variety of factors such as soil and ground water composition, the observed reading may not fully represent the actual bone chemistry composition of the individual. The structure of cortical bone is another important factor because the newly deposited bone layers on the outer surface may have different values of a given element than an older deposited layer deep to the surface, as bone undergoes constant remodeling throughout one's life. Cortical bone is more conducive to use with this portable XRF, as trabecular bone has a number of inconsistencies such as an unsmooth surface, which can inhibit the analytical performance of the procedure.

Two experiments were carried out to understand how analysis depth and removal of surface layers of bone affect analytical results. Analysis depth was determined by examining selected pure elements through varying known thicknesses of cow tibia cortical bone slices. This showed a correlation between the element's x-ray emission energy and the depth of reading by the device. In the second experiment, a small human population from an unknown graveyard found in Youngstown, NY was studied. The burials were discovered and excavated in 1997; very little is known about who these individuals were other than what the osteological analysis has revealed, as few artifacts were recovered from the graves. The surfaces of the bones from this collection were analyzed before and after sanding, to observe if sanding the immediate surface of the analyzed area alters the results. In a burial setting, the way the bones were positioned in the grave can affect the readings taken from one side of the bone to the other. This may result from contact with soil or ground water intrusion in the gravesite. This research has concluded that it is important to take these factors into consideration when performing bone analysis. When determining what areas of the bone to analyze for a particular element under study (a skull fragment versus a long bone fragment) cortical bone thickness and the emission energies of the element of interest should also come into consideration. These results validate the portable XRF device as a powerful and convenient instrument for nondestructive analysis, while highlighting a number of limitations and considerations for its use in obtaining data from bone samples.

Portable XRF, Trace Elements, Bone