H61 Comparison of Portable X-ray Florescence and Inductively Coupled Plasma Mass Spectroscopy in the Measurement of Lead in Human Bone

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After attending this presentation, attendees will be better informed of the use of portable X-Ray Florescence(pXRF) instrumentation in analyzing human bone for lead (Pb) concentration as compared to a traditional labo- ratory-based method of Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) and laser ablation ICP-MS (LA-ICP-MS).

This presentation will have an impact on the forensic science community by demonstrating the utility of portable instrumentation for rapid, non-destructive analysis of inorganic elements in human bone.

Portable XRF is a relatively new technology that has benefits of being non-destructive to specimen samples, easy to operate, and convenient to transport between laboratories or for use in the field. Portable hand-held units are routinely used in geology, scrap metal sorting, and environmental monitoring, most notably for the determination of unsafe levels of lead in soils and paint. XRF analysis in general is capable of giving a rapid reading of the elemental composition of inorganic material with good sensitivity for elements above phosphorus in the periodic table. Lead (Pb, Z = 82), for example, has a detection limit between 10 – 100 ppm. Additionally, the unit used in this study is built with a miniaturized X-ray source for atom excitation instead of a radioactive isotope, eliminating the need for special trans- portation permits as well as reducing the potential occupational exposure hazard of operators.

The goal of this study is to explore the reliability of pXRF results with those of a "gold standard" of inorganic analytical analysis in bone chemistry, ICP-MS. The study will also explore the utility of laser ablation ICP-MS (LA-ICP-MS). Traditional ICP-MS requires destruction of a sample and acid digestion prior to analysis, while LA-ICP-MS requires minimal destruction of <200um ablation spot size with extremely accurate spatial resolution of chemical composition. Both pXRF and ICP-MS provide simul- taneous multiple-element results. This study will report results of lead (Pb) concentrations using both pXRF, ICP-MS, and LA-ICP-MS in bone samples (femoral head and neck) from patients undergoing hip replacement surgery for indications of either osteoarthritis or fracture.

Femoral heads were obtained from Highland Hospital and Strong Memorial Hospital Departments of Surgical Pathology after routine processing and pathologic diagnosis. The specimens of 60 patients were intercepted prior to discard with the approval of the University of Rochester Human Subjects Institutional Review Board. Patient information was de- identified and coded with a study number to preserve patient confidentiality.

The study group was divided evenly with 30 femoral heads with a diagnosis of osteoarthritis and 30 with a diagnosis of fracture. Bone sections were cut using an Isomet precision low-speed saw set at 300 rpm, resulting in a 3mm thick section of coronal plane of mid-femoral head. A section of cortical bone was removed from the femoral neck. Bone samples were dried in a 60 degree C oven for four days to a constant weight.

The portable XRF is automatically prompted for standardization prior to any sample analysis. To further check accuracy of the analyzer, a NIST Standard Reference Material (SRM1486) of bone meal was analyzed.

Portable XRF was performed on a sample of trabecular bone and cortical bone from each individual femoral head and neck. Analysis run times were set at 120 seconds per specimen. Pb concentrations were reported in ppm. ICP-MS analysis was performed on the same samples using clean lab procedures and standard acid digestion protocols. LA-ICP-MS was performed using a 266nm Nd:YAG from CETAC, USA. The NIST (SRM1486 bone meal) standard was analyzed by each technique. Results were reported in ppm. Discussion of the comparison of the pXRF, ICP-MS, and LA-ICP-MS results will be given in the presentation.

Portable XRF analysis of bone is an important tool in the arsenal of portable instrumentation available to anthropologists, archaeologists, odon- tologists, and crime scene investigators. A pilot study of the utility of portable XRF in analyzing cremated bones and teeth showed promising application. Portable XRF has shown to be of great utility in classifying inorganic compo- nents of restorative resins in teeth. This study is the first to report on the use of portable XRF instrumentation in the analysis of intact, relatively fresh human bone samples. The study is also the first to report on the reliability of the results via pXRF as compared to ICP-MS. The ease of use of the pXRF analyzer is attractive for applications of commingled remains, or the rapid analysis of a large number of samples, whether bone, teeth, or other material containing inorganic elements. The capability of the equipment to measure more than one element per analysis may show to be useful in constructing elemental ratios between different fragments of material, to perhaps establish provenance to a single individual. This presentation will only focus on the inorganic element of Pb, with bone serving as the biomarker of environmental exposure.

Portable X-ray Florescence (pXRF), Lead (Pb), Bone

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