H101 X-Ray Diffraction as a Tool for the Analysis of Age-Related Changes in Teeth

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After attending this presentation, attendees will be introduced to a technique for using X-ray diffraction (XRD) to determine the crystallite size of hydroxylapatite, or the crystalline portion, in human teeth and will learn how the crystallite size of hydroxylapatite has the potential to be used to estimate age at death.

This presentation will impact the forensic community by demonstrating the usefulness of XRD and the crystallite size of the hydroxylapatite found in tooth and bone material as a method for age estimation.

Estimation of age is an important component of the biological profile that forensic anthropologists construct in order to attain a positive identification of a deceased individual. This research is a proof of concept study for the use of XRD on a tooth sample to estimate age. Previous research (Meneghini et al. 2003; Hanschin and Stern 1992)[1,2] has concluded that the crystallite size of hydroxylapatite in bone will increase with increased age. This study explores the trends that were seen in crystallite sizes of bone and applies that concept to the hydroxylapatite in teeth. The initial hypothesis for this research states the crystallite size of tooth hydroxylapatite will increase as the age of an individual increases.

The feasibility of the use of teeth in XRD analysis was first tested using a tooth from three separate pigs to determine if there were differences among individuals. Three other pig teeth from a single pig were analyzed to determine if there were differences in tooth type for a single individual. Ten human tooth samples were collected from individuals of known age in order to establish whether the crystallite size of hydroxylapatite changes with increased chronological age. Each sample was ground into a coarse powder using a mortar and pestle and then reduced to a fine powder using a micronizer. Each sample was loaded into a sample holder and run with an X-ray diffractometer.

XRD is a technique that can be used to analyze any crystalline material. When an X-ray beam is produced by the XRD X-ray source, the X-ray hits the sample and diffracted radiation comes from the sample. The characteristics of the diffracted X-rays give a profile for the sample. The resulting diffraction patterns, or sample profiles, from the XRD testing were analyzed using Jade 6 software to determine the full width half maximum (FWHM) for each of the samples. FWHM gives the standard size for the peaks within the sample. The crystallite size was calculated using Scherrer's formula, which takes into account the FWHM and XRD settings to determine the size of the crystals within each sample.

The first set of pig samples proved that it was possible to analyze teeth with XRD. The second set of samples demonstrated that there were crystallite size differences in the tooth types. The human teeth confirmed that there were differences in tooth type and presented evidence that there was a downward correlation between chronological age and crystallite size in teeth. Due to the rejection of the initial hypothesis, an alternative hypothesis was constructed stating that the crystallite size of the hydroxylapatite will decrease in teeth as age increases in an individual. Results of this research suggest the trend toward a decrease in crystallite size as an individual increases in age. The difference with respect to bone may be a result of the unique nature of enamel in teeth. **References:**

1 Meneghini C, Dalconi MC, Nuzzo S, Mobilio S, Wenk RH. Rietveld refinement on X-ray diffraction patterns of bioapatite in human fetal bones. Biophysical Journal 2003;84:2021-9.

2 Handschin RG, Stern WB. Crystallographic lattice refinement of human bone. Calcified Tissue International 1992;51(2):111-20.

X-Ray Diffraction, Age Estimation, Dental Age Estimation

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