H74 Evaluation of Date of Death Through Analysis of Artificial Radiocarbon in Distinct Human Skeletal and Dental Tissues

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After attending this presentation, attendees will understand how radiocarbon analysis of different human tissues within an individual can be used to clarify the approximate date of death

This presentation will impact the forensic community and/or humanity by allowing forensic scientists to determine the date of death of skeletonized human remains with greater precision.

Estimation of the date of death from human remains recovered from forensic contexts represents an important but frequently elusive aspect of anthropological analysis. Such interpretation can be augmented through analysis of artificial radiocarbon, especially in consideration of the type of tissue sampled and the age at death of the individual.

Atmospheric testing of thermonuclear devices between about 1950 and 1963 produced artificially elevated levels of carbon-14 which are reflected in tissues of humans and other terrestrial organisms. Atmospheric levels of carbon-14 increased dramatically between 1950 and 1963 and subsequently declined following cessation of such testing. Interpretation of carbon-14 values in human remains recognizes that different tissues are formed at varying periods in the human lifespan and have distinct rates of turnover. Dental enamel forms during the childhood years and does not remodel. Many areas of cortical and cancellous bone not only have distinct times of formation but also different rates of turnover. Radiocarbon values derived from dental enamel and selected areas of cortical and cancellous bone from the same individual provide opportunities to determine if death occurred before or during the bomb-curve period. If radiocarbon analysis suggests that death occurred after 1950, the values for the different tissues assist correct placement on the curve and thus more precise estimation of the date of death. Most cancellous or trabecular bone, especially that located in areas of red or hematopoietic marrow has more rapid bone turnover than most cortical bone. Thus radiocarbon values of the former would more closely approximate atmospheric levels at the time of death

than those derived from the latter. If bone formation occurred between 1950 and 1963 (the ascending range of the bomb-curve) radiocarbon analysis should reveal greater fraction values for cancellous bone than for cortical bone. If bone formation occurred more recently than 1963 (during the descending age range of the bomb curve) cancellous bone values should be less than those of cortical bone.

Samples were collected from two human female skeletons of known birth and death dates. These samples consisted of permanent teeth, cortical bone from the femoral diaphyses, and cancellous bone from vertebral bodies. One individual was born in 1925 and died in 1995 at the age of 70 years. The other individual was born in 1926 and died in 1959 at the age of 33 years. Radiocarbon analysis was conducted at Lawrence Livermore National Laboratory using standard techniques.

As expected, analysis of the dental tissues revealed carbon-14 fractions below 1.0 suggesting that formation of those tissues predated the bomb-curve. The dental tissues studied in these two individuals formed between the dates of 1925 and 1933.

Three of the four bone samples yielded modern fractions which fell above 1.0 and thus within the bomb-curve. The exception was a cortical bone sample from the 33-year-old. In consideration of the ages at death of the individuals and the shape of the bomb-curve, the radiocarbon analysis suggests more recent formation of the trabecular bone than the cortical bone, as expected, although in the older individual the difference was only about one year. The formation date for the cancellous bone (calculated from radiocarbon analysis) preceded death by about five years in the younger individual. In the older individual, analysis suggested death was preceded about 39 years in the average formation of cortical bone and about 38 years in cancellous bone. This nearly four decade differential between average bone formation and death reflects the slower bone turnover in older adults.

Radiocarbon values derived from dental structures, especially enamel provide information about the dates of formation during the childhood years. Such data can be used to suggest a pre-bomb curve childhood date or help establish the birth date if the dental radiocarbon values fall within the bomb-curve.

Variation of the values derived from bone reflects variation in the timing of both bone formation and remodeling. If these values fall within the bomb-curve they provide the information needed for proper placement on either the earlier ascending or later descending aspect of the curve. Once values are correctly placed on the curve, the date of death can be estimated, in consideration of the age of the individual and other factors.

Although radiocarbon analysis provides unique and valuable information attention must be given to both the age of the individual and the sampling site. Dental enamel provides the ideal source of information to estimate the birth date, particularly if that date falls after 1950. In the absence of soft tissue, cancellous bone from the central skeleton provides radiocarbon values ideal to evaluate the death date and in comparison with

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values from cortical bone and the age at death can help determine if death occurred on the ascending or descending sides of the bomb curve.

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