H86 Date of Birth Estimation of Dead Bodies— A Compilation of C^{14} Reference Levels in Enamel to Assist in Identification Work

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After attending this presentation, attendees will understand how dental enamel formed after 1955 can be dated using the radiocarbon bomb-pulse. They will also learn how aggregated reference radiocarbon data can improve the precision of date-of-birth estimation. Further, the attendees will learn that stable isotopes, aspartic acid racemization analysis, and DNA analysis of teeth can help to identify origin and sex.

This presentation will impact the forensic science community by showing how reported data are important to forensic investigators involved in identification work, since bomb-pulse ^{14}C dating can provide accurate information regarding the date of birth of unknown individuals.

For identification of unknown decedents, dental X-rays and DNA comparisons are the most important methods to determine identity, but each process requires an idea of who the deceased person is. In cases where there are no clues about the identity, then the sex, the date of birth, and age at death are decisive in the identification casework to limit and, hence, facilitate the search for possible matches. During the cold war, above-ground test detonations of nuclear weapons resulted in a substantial increase of ^{14}C in the atmosphere. By measuring such bomb-pulse-generated ^{14}C in modern biological material, a fingerprint of the time for its formation can be obtained. This method has been used in combination with aspartic acid racemization analysis (which gives an estimate of the age at death) to also estimate the year of death. Furthermore, stable isotope levels in teeth have been used to predict the origin of the person.

In this study, ^{14}C, ^{13}C, and ^{18}O concentrations in teeth from people in Mexico, the U.S., and Canada were analyzed. In order to isolate the enamel, the crown was treated with strong NaOH and sonicated. The teeth were then etched with HCl to limit external contamination. The concentration of ^{14}C in the samples was determined by accelerator mass spectrometry. DNA, ^{13}C, and ^{18}O levels in these teeth were analyzed using the Identifiler kit from Applied Biosystems, and isotope ratio mass spectrometry, respectively. Finally, all enamel ^{14}C results in this and previous studies were compiled to produce a tooth ^{14}C reference table.

Results-identified differences in ^{13}C concentrations in teeth over a limited geographical area such as North America are substantial. Teeth from Mexican subjects showed much higher ^{13}C levels than teeth from U.S. and Canadian subjects. The ^{18}O concentrations in tooth roots of U.S. subjects paralleled the levels in drinking water in the areas they were raised. Carbon-14 predicted birth year with an average absolute error of 1.8 ± 1.3 years. By using reference data on enamel ^{14}C levels, estimates of a person's date of birth, and thus age at death, can be provided with greater accuracy than that provided via radiographic analysis of enamel formation. By analysis of ^{14}C in both enamel and root of the same tooth, it could be determined whether the ^{14}C results corresponded to the rising or falling part of the bomb-pulse curve. DNA analysis of the tooth roots indicated the correct sex for all subjects tested.

In order to limit the search for possible matches, the year of birth, the year of death, sex, and geographic origin constitute important variables. Regarding age estimation, anthropological methods often show estimates of +/- 10 years, and such information will not reduce the number of possible matches significantly. In contrast, the bomb-pulse ^{14}C method provides a more accurate age by estimating the year of birth. Interestingly, substantial geographical differences of the stable isotopes ^{13}C and ^{18}O were observed, which can help indicate origin of subjects who are found dead far from their residential area. Both isotopes have also shown to display geographical variation in hair collected from only a few years back, which supports the notion that analysis of these stable isotopes in teeth are likely to be useful during many years to come. Bomb-pulse ^{14}C analysis is a robust method that can provide a very good estimate of year of birth. ^{13}C and ^{18}O analysis may give clues to geographical origin. DNA analysis can, in addition to providing an individual profile, determine the sex. All analyses described above can be performed on a single tooth.

C^{14}, Identification, Teeth

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