G109 Dead Victim Identification: Age Determination by Analysis of Bomb-Pulse Radiocarbon in Tooth Enamel

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After attending this presentation, attendees will understand how biological samples produced in the past 60 years can be dated using the radiocarbon bomb-pulse. Specifically, they will learn how the 14C content of dental enamel can be used to determine year of birth of persons born after 1945.

This presentation will impact the forensic community by providing a technique that improves the accuracy in age determination of dead victims, such as suspected homicides and victims of mass disasters.

Background: Determining the age of an individual is an important step in dead victim identification, particularly in suspected homicide cases and in mass disaster work. Age determination can be performed with high precision up to adolescence by analysis of dentition, but establishing the age of adults has remained difficult. The enamel of individual permanent teeth is formed at distinct, well-characterized time points during childhood. After being laid down, there is no turnover of enamel, so its ^{14}C concentration reflects the level in the biosphere at the time of enamel formation. Atmospheric testing of nuclear weapons doubled the global $^{14}CO_2$ level between 1955 and 1963. After adoption of the Partial Test Ban Treaty in 1963, the level of atmospheric $^{14}CO_2$ started to decrease exponentially with a mean life of about 16 years due to transport into large carbon reservoirs such as the oceans and losses to space. The enhanced level of ^{14}C worked its way up the food chain from CO_2 so that all living things are labeled with the pulse.

Material and Methods: The concentration of ^{14}C in tooth enamel from individual teeth and related it to the known concentration in the atmosphere over time (1950 – present) to establish the time of tooth formation was measured. The dates were then used to estimate the year of birth of the person. To this end, the crown of the tooth was cut away from the root at the level of the cervical line. The crown was then immersed in 10N NaOH, before being placed in a water-bath sonicator. The enamel was then washed with DDH_2O and re-submersed in 10N NaOH during approximately four days to remove all dentin until pre-treated for accelerator mass spectrometry (AMS) analysis.

Results: The technique matched ^{14}C content in enamel to known age very well along the bomb spike curve. The absolute difference between estimated age and true age was 1.1 ± 0.9 years for teeth from Scandinavian subjects, implying a much higher precision than any previous method. Analysis of teeth from deceased subjects from other continents showed similar accuracy, suggesting that the geographical variation of the bomb-pulse radiocarbon does not significantly influence the readings. For teeth formed before 1955, the ^{14}C analysis can only tell that the person was born before the nuclear tests (birth year of person before 1945 - 1952, depending on type of tooth analyzed), but with absolute certainty.

Conclusion: AMS analysis of teeth offers a precise age determination that can be applied in forensic casework, particularly to assist in investigations of unidentified human cadavers. If radiocarbon determination and aspartic acid racemization analysis of teeth are combined, information of both the year of birth and the year of death can be established.

This work was supported by the Human Frontiers Science Program and Wenner-Gren Foundation.

Age Determination, Radiocarbon, Tooth

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