H6 Provenancing Human Remains From Forensic Contexts: Application of Stable Isotope Analysis in Forensic Anthropology

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The goal of this presentation is to highlight the role of stable isotope analysis as an investigative tool for provenancing human remains to aid in narrowing search parameters for missing persons. After attending this presentation, attendees will understand how stable isotope analysis can be used in conjunction with the biological profile, especially in situations where traditional methods have not been successful.

This presentation will impact the forensic science community by illustrating case studies in which stable isotope analysis has aided in the identification process.

Stable isotope analysis of human tissues can provide contextual information on the diet and migration history of individuals. In this study, stable isotope analysis was conducted to determine whether two individuals were likely local or nonlocal to the area where the remains were discovered.

The first case, recovered from a dry creek bottom in the Central Valley of California, consisted of surface-scattered human remains representing a partial skeleton. The biological profile suggests the individual was an adult male. Ancestry could not be estimated due to absence of the cranium. Stable carbon isotope values are -14.3‰ for bone collagen and -10.0‰ for bioapatite, indicating the decedent consumed a diet consisting of relatively equal amounts of C3 and C4 resources. The stable nitrogen isotope value of 11.2‰ is consistent with an omnivorous diet. Both stable carbon and nitrogen isotope values of bone collagen are significantly elevated relative to published data on modern hair keratin of U.S. Americans (δ13C: z = 3.6; δ15N: z = 5.8), suggesting a diet more typical of individuals from Latin America, where corn (a C4 plant) is a common dietary staple.1,2 Furthermore, the stable oxygen isotope value of -6.4‰ is not consistent with local tap water sources, suggesting the decedent was nonlocal to the area where his remains were found. The δ18O value is consistent with tap water sources along the eastern border of the Central Valley, and certain regions of the Southwestern U.S. and Mexico. DNA testing later confirmed the identity of the decedent, a 37-year old Hispanic male, from Tepatitlan de Morelos, Jalisco, Mexico, who had moved to northern California prior to his death. The δ18O value is consistent with this region of Mexico, but is not consistent with his most recent place of residence.

The second case consists of an isolated mandible recovered from the North Coast Range of northern California. Morphological and metric assessments suggest the decedent was an adult male, although classification for ancestry was indeterminate. Stable carbon isotope values are -19.0‰ for bone collagen and -13.4‰ for bioapatite, indicating the decedent primarily consumed C3 food resources with little input from C4 resources. The stable nitrogen isotope value of 11.0‰ suggests an omnivorous diet. Although stable carbon and nitrogen isotope values of bone collagen are also significantly different from published data on modern U.S. Americans (δ13C: z = 2.25; δ15N: z = 5.3), little comparative modern dietary data exist for this area of California.1,2 The stable oxygen isotope value of -7.9‰ is consistent with local tap water sources in the region, suggesting the decedent may be local to the area. These data support a tentative identification of a missing male who resided in the area for his entire life. Future isotopic analysis of a mandibular molar may further refine the geographical parameters.

These case studies reveal examples of valuable contextual information provided by stable isotope analysis that can assist in identification efforts. Stable isotope analysis can be implemented to support a proposed identification, as in case 1, or to narrow the scope of possible missing persons to consider, as in case 2. The benefits demonstrated in these cases support the continued use of stable isotope forensics in conjunction with other biological profile assessments.

References:

1. Valenzuela LO, Chesson LA, Bowen GJ, Cerling TE, Ehleringer JR. Dietary heterogeneity among western industrialized countries reflected in the stable isotope ratios of human hair. PLoS ONE 2012 (7):e34234.
2. Valenzuela LO, Chesson LA, O'Grady SP, Cerling TE, Ehleringer JR. Spatial distributions of carbon, nitrogen and sulfur isotope ratios in human hair across the central United States. Rapid Commun Mass Spectrom 2011;(25):861-68.

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