H57 Extending the Biological Profile Using Stable Carbon and Nitrogen Isotope Analysis: Prospects and Pitfalls

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After attending this presentation, attendees will learn about potential contributions of stable carbon and nitrogen isotope analysis in forensic anthropology. This paper will highlight areas where stable isotope analysis can contribute novel information to the biological profile of unidentified indi- viduals, and will address some practical and theoretical limitations of these applications.

This presentation will impact the forensic community by demonstrating a theoretical basis for applications of stable isotope analysis in forensic anthropology, and its potential for aiding in the positive identification of unknown individuals.

Although stable isotope analysis has been used extensively by anthro- pologists since the 1970s to examine diet and migration patterns in prehistory, it has had very limited use in forensic anthropology. Stable isotope analysis is a commonly used tool by other forensic chemists to trace the origin or composition of soils, drugs, tainted foods, and poached animals. These same principles can be used by forensic anthropologists to provide a more compre- hensive biological profile of unidentified remains, especially when standard methods of identification are unsuccessful. Although the biological profile typically consists of sex, age, ancestry, stature, and antemortem character- istics, stable isotope analysis can provide additional information regarding diet and migration history. Juarez[1] recently provided multi-elemental isotopic data using teeth from native-born Mexicans that may help to identify the birthplace for unidentified remains of border-crossers. Similarly, Regan et al.'s[2] multi-elemental isotopic study showed a high level of discrimination between dental remains of East Asian origin and those of U.S. servicemen and women, which has implications for identifying war-dead from past conflicts.

Isotopes are atoms of the same element that have the same number of protons but a different number of neutrons. Unlike radioisotopes, stable isotopes do not undergo radioactive decay over time, and thus record chemical signatures of biological and geological processes in nature. Isotopes of the same element are chemically similar, but react at different rates in chemical reactions due to differences in atomic mass. This results in the differential incorporation of one isotope over the other, a process known as "fractionation", which accounts for isotopic variation in nature. Stable isotope ratios are measured through mass spectrometry and values are reported relative to an international standard using the delta (δ) notation.

Information on human diets is usually acquired through the study of stable isotopes such as carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$), which are incorporated into body tissues and provide a chemical record of plant and animal foods consumed. Carbon isotopes in nature vary based on the different photosynthetic pathways (C3, C4, CAM) of plants, which are passed up the foodweb to humans. Nitrogen isotopes vary based on diet, habitat, and aridity, and can also record the trophic level of protein resources consumed. $\delta^{13}C$ and $\delta^{15}N$ values from bone record the average isotopic composition of the diet over the past 10-15 years of life. However, $\delta^{13}C$ and $\delta^{15}N$ values from dental tissues provide a permanent record of childhood diet as teeth are forming. Carbon and nitrogen isotopes from hair and keratin provide a more recent dietary record acquired during their period of growth.

Despite recent advances in isotopic applications in forensic anthro- pology, several limitations need to be addressed. The global scale of food exportation, popularity of bottled water, and lack of baseline information on modern populations are all limiting factors. Stable isotope data will continue to be most useful in cases where osteological indicators and contextual infor- mation suggest that an individual is non- native to the area in which they died. This paper will present data from case studies derived from prehis- toric, historic, and modern contexts to highlight potential uses, abuses, and limitations of stable carbon and nitrogen isotope analysis in forensic anthro- pology.

References:

1 Juarez CA. Refining the isotopic fingerprint in modern Mexican populations: using strontium, carbon, nitrogen, and oxygen to determine region of origin for deceased undocumented border crossers. Proceedings for the 59th Annual AAFS Meeting, San Antonio, TX, 19-24 Feb. 2007; (13)340.

2 Regan LA, Falsetti A, Tyrrell A. Isotopic determination of region of origin in modern peoples: applications for identification of U.S. war- dead from the Vietnam conflict II. Proceedings for the 59th Annual AAFS Meeting, San Antonio, TX, 19-24 Feb. 2007; (13):355.

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