A148 Evidence Recorded in Fingernails: Carbon, Oxygen, and Strontium Isotopes Reveal Diet and Travel Histories

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After attending this presentation, attendees will understand the basic principles of how carbon ($\delta^{13}C$), hydrogen ($\delta^{2}H$), oxygen ($\delta^{18}O$), and strontium isotope measurements of fingernails can be used in reconstructing recent diets and geographical movements of individuals.

This presentation will impact the forensic science community by increasing the competence of the law enforcement community on an analytical tool that can be used in travel history reconstructions of unidentified decedents or for homeland security-related matters.

Stable isotope analysis of keratin tissues (hair and fingernails) have been used to reconstruct diet and geographic location across multiple disciplines. The foods that humans consume are reflected in the $\delta^{13}C$ and nitrogen ($\delta^{15}N$) isotope signatures and are indicative of the plant and animal protein contributions of their diet. Beverages that are incorporated from tap water and water in foods contributes to the $\delta^{18}O$ and $\delta^{2}H$ signals that reflect particular geographic locations. Strontium isotope ratios (Sr^{87}/Sr^{86}) are incorporated from environmental sources and reflect geologic structures that waters interact with, food is grown in, or are input from environmental dust. These stable isotope combinations form unique signatures that can allow researchers to understand an individual's diet and geographic movement and can play vital roles in forensic and homeland security matters.

This study focuses on the stable isotope patterns of fingernail clippings from volunteer residents of the Salt Lake City (SLC), UT, region who traveled for varying times to locations outside the United States (Central and South America) before returning home. It was hypothesized that the dietary isotopes ($\delta^{13}C$ and $\delta^{15}N$) would not significantly differ as they moved, because both the United States and South and Central America rely heavily on corn inputs of food sources (animal feed, corn sugars, or syrups in processed foods); however, it was hypothesized that the $\delta^{18}O$, $\delta^{2}H$, and Sr^{87}/Sr^{86} would vary with their travels, as precipitation isotope values ($\delta^{18}O$ and $\delta^{2}H$) and the geologic formations (strontium) significantly differ between their region of travel and SLC.

As hypothesized, the $\delta^{13}C$ and $\delta^{15}N$ values did not change over the course of the study, nor did the diets of the volunteers. $\delta^{18}O$ and $\delta^{2}H$ values displayed patterns that were consistent with their reported travel history. It was discovered that $\delta^{18}O$ and $\delta^{2}H$ values were similar to SLC residents when the volunteers resided in the area and, as they moved to their new locations, there was a departure from these values. The incorporation of the new isotope signature happened rapidly, but it took several months before that portion of fingernail was clipped. These findings were consistent with those of $\delta^{18}O$ and $\delta^{2}H$ incorporation patterns in human scalp hair. In contrast, Sr^{87}/Sr^{86} of the fingernail clippings provided surprising results. It was initially hypothesized that the patterns would be consistent with those of $\delta^{18}O$ and $\delta^{2}H$; however, the Sr^{87}/Sr^{86} were indicative of the volunteers' location when they clipped their fingernails. For instance, one volunteer who went to Ecuador initially displayed $\delta^{18}O$ and $\delta^{2}H$ values that were consistent with SLC, but the Sr^{87}/Sr^{86} values did not match those of SLC residents. This difference was attributed to how the isotopes are incorporated into the keratin protein of the fingernail. $\delta^{18}O$ and $\delta^{2}H$ are incorporated during the protein formation and, once the protein is formed, the isotope signature does not change. Thus, as the fingernail grows from the nail plate forward, the signal does not change. $\delta^{18}O$ and $\delta^{2}H$ of clipped fingernails also represent a time from four to five months earlier, based on average human fingernail growth rates. Findings suggest that Sr^{87}/Sr^{86} are incorporated into the fingernail keratin through environmental or bathing waters and reflect an individual's most recent location.

As one of the first multi-isotope studies on human fingernails, this study reports on new travel-related isotope signals that can be obtained from $\delta^{18}O$, $\delta^{2}H$, and Sr^{87}/Sr^{86} measurements. A major conclusion of this study is that human fingernails (as well as other keratin tissues) can provide information on an individual's diet and travel history. This study has also allowed us a more detailed look at isotope incorporation into fingernails and how these values can vary among individuals.

Stable Isotopes, Human Fingernails, Travel History

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