A62 An Assessment of How "Predictive" Human Geolocation Models Perform When Compared to a "Known" Geolocated Human Enamel Data-Set

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Learning Overview: After attending this presentation, attendees will understand the forensic importance of analyzing oxygen stable isotopes in human enamel ($\delta^{18}O_c$) for the utilization of stable isotope analysis for human geolocation.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by adding to the existing knowledge of the relationship between $\delta^{18}O_c$ values and that of drinking water ($\delta^{18}O_{dw}$) by presenting $\delta^{18}O_c$ values in modern human dental enamel with known provenance.

The geographical life history of an individual can be determined by analyzing stable isotopes in human tissues. The isotopic compositions of tissues are reflective of the environment during tissue formation, with drinking water ($\delta^{18}O_{dw}$) contributing significantly to $\delta^{18}O_c$. The current approach to human provenancing utilizes available tap or drinking water data as the base for placing individuals on a geographical map. This is believed to be possible through the understanding of the relationship between $\delta^{18}O_c$ and $\delta^{18}O_{dw}$. However, limited data is available for known modern $\delta^{18}O_c$, and no known data exist for any Canadian city.

This study investigated the isotopic composition of oxygen stable isotopes in known modern human enamel collected from across Metro Vancouver (MV) and British Columbia, Canada, and tested the relationship between $\delta^{18}O_c$ and $\delta^{18}O$ of tap water ($\delta^{18}O_{tap}$). Isotopic data were compared against known MV tap water values. Results were also compared against the range of $\delta^{18}O_c$ values predicted from $\delta^{18}O_{tap}$ values with linear models reported by other published studies. A total of 41 extracted human molar samples were collected from dental clinics across MV during the years 2015 to 2017. Information on location of residence and any relocations from birth to 25 years was also retrieved from each individual. This was to ensure that known geographical information was acquired from the individuals during the time of tissue formation. Enamel was extracted into powder form (~1mg) by gentle abrasion with a Dremel® diamond-tipped, hand-held drill. Samples were subsequently analyzed on a Delta® Plus XP isotope ratio mass spectrometer with an analytical precision of ± 0.2‰ for $\delta^{18}O$.

Twenty-four of the 41 individuals were of MV origin, two with mixed Canadian origins, and the remaining individuals were from various cities across Canada. The results revealed that $\delta^{18}O_c$ values in tooth enamel from individuals residing in MV during the time of tissue formation showed a range of 3.8‰ with a mean of -8.7‰ ± 0.8 (n=24). Mean $\delta^{18}O_c$ for all Canadian values were -8.7‰ ± 1.1 (n=41) with a range of 5.7‰.

The results from this study indicate there is a positive but weak ($p>0.05$) correlation between $\delta^{18}O$ values in known modern human enamel and $\delta^{18}O$ values in known source tap water. Furthermore, the range of $\delta^{18}O_c$ values observed for a single city of MV is greater than the range for an entire country such as Bulgaria, Japan, or the United Kingdom. The wide range in $\delta^{18}O_c$ values from modern MV residents may be due to the contribution of multiple water sources for MV tap water, which also demonstrates the importance of establishing the isotopic range for individual cities beyond this study. Furthermore, up to 70% of MV individuals were identified as residing outside of MV when utilizing predictive models from other published studies. This finding has significant forensic importance as it demonstrates the weakness of current predictive equations. It is concluded that the theoretical isotopic relationship between human enamel formation and drinking water is valid, and that predictive models need to be built on a solid foundation of known samples.

Stable Isotopes, Enamel, Human Geolocation