H19 Evaluation of Enamel Short Chemical History as a Forensic Tool: A Comparative Study of Six Countries

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The goal of this presentation is to present the method of enamel surface microsampling for acid etching for trace element analysis in the identification of an individual's geographical affiliation.

This presentation will impact the forensic community by introducing a non-destructive and quick sampling tool. It will also contribute to the body of literature concerning enamel surface trace element studies.

The enamel surface of teeth is complex: internally, it is highly chemically active (e.g., remineralization), whereas externally it reacts with the oral, or the burial, medium. Its inorganic chemical elements vary due to factors such as age, sex, oral cavity activities (e.g., food and drink) and environment. In forensic identification, it is important to examine the enamel surface both chemically and morphologically (e.g., microwear) for indicators of an individual's health and place of residence as well as taphonomic conditions which may be identified and reconstructed. There is, however, little research concerning the study of the enamel chemical history of individuals over a short duration.

Extracted tooth samples were collected from the United Kingdom (n=14), the United Arab Emirates (n=11), the Sultanate of Oman (n=11), Iraq (n=10), Yemen (n=15), and Iran (n=15). The sources of teeth were from dental clinics and from Iraq they were derived from the Medicolegal Institute in Baghdad. The Iraq sample included postmortem teeth from forensic cases which had been subjected to explosive and burial conditions. Teeth were washed with tap water and subsequently in distilled water. The enamel surface was sampled, using the acid etching method, by applying a perforated adhesive tape (with 2mm diameter circular hole) and etching that area of the surface with 5 µl of
1.6 N HCL in 70 % glycerol for 35 seconds. The biopsy solution was analyzed for trace elements by the ICP-MS system. Neither the tooth type nor site of sampling were controlled, rather this was dependent upon individual tooth features (e.g., caries, enamel surface cleanliness, smoothness). The elements analyzed included Li, Mg, Al, P, K, Ca, Ti, V, Cr, Mn, Co, Ni, Cu, Zn, As, Se, Sr, Mo, Cd, Sb, Ba, and Pb and overlapped ratios between them. The relative prevalence of these elements was used to assess the variability between the groups. Enamel etching depth was calculated mathematically using the phosphorus concentration. The enamel was examined by stereo microscope and SEM-EDXA system.

Enamel etched depths resulting in high element concentrations were approximately between 5 µm and 35µm. Regression analysis indicated that 11 element concentrations were significantly ($p < 0.05$) related to the etched depth. The relationship was strong with Ca ($R2= 0.9$) but was weak with other elements ($R2= 0.5$ to -0.04), so this was ignored. Some elements distinguished between countries, such as As which has the highest range in the United Kingdom and the lowest in Iran; whereas the Sr range is highest in Yemen and lowest in the United Kingdom clearly reflecting the pollution (e.g., food, air and water) and dietary condition, respectively.

The concentration of the elements Al, Ni, and Se were found to be related significantly ($p<0.05$) to the sex of the individual and the concentration of the elements As, Ti, and Zn were found to be related significantly ($p<0.05$) to the age of the individual, whereas the elements Cr, Mn, Mo, and Pb were found to be related to both sex and age. Additionally, principal components analysis was used to analyze selected elements from the sample (Pb, Sr, Mg, Zn, Cr, As, V, and Ti) after treating them statistically using a compositional statistic method, which takes the log of each element when divided by the Ca concentration.

This method was able to separate the groups.

One of the particles adhering to Iraqi sample 10 was analyzed using EDXA and found to contain mostly metal, including Cr (4.69 %). This may have interfered with the result, as the Iraqi group has the highest range of Cr in a graphical comparison to the other groups. Confounding factors of this method include the sand, caries, calculus, and restorations. The method is useful to record the enamel surface chemical composition and may shed light on the geographical origin of an individual skeleton. Further study is needed to evaluate this method prior to routine usage with forensic casework.

Enamel, Chemistry, Forensic

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