A48 Scanning Electron Microscopes With Energy Dispersive X-Ray Spectroscopy (SEM/EDX) Analysis of Gunshot Residue (GSR) on Pig Bone

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Learning Overview: After attending this presentation, attendees will understand how SEM/EDX may be used to detect and confirm evidence of particulate matter associated with GSR (powder and primer) on pig cranial bone.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a means for trauma on bone considered to be from a firearm to be confirmed through SEM/EDX instead of relying solely on visual assessment.

Anthropologists examine decomposed or skeletonized remains where trauma is interpreted through evaluating patterns of altered bone. Distinguishing between projectile and blunt trauma is complicated by postmortem processes that result in fragmentation or loss of surface features. The presence of projectile fragments in bone or surrounding tissues has long been known to be associated with projectile and gunshot events.[1,2] However, such fragments are not always present, and their absence cannot exclude a gunshot event. The presence of other evidence associated with a firearm discharge may be another indicator that a gunshot event has occurred.

When a firearm is discharged, the primer mix containing lead styphnate, antimony sulfide, and barium nitrate is crushed by a firing pin. The gas that propels the bullet is partly comprised of derivatives of the primer mix, including lead (Pb), barium (Ba), and antimony (Sb), and condenses into droplets that can leave a residue (GSR) on nearby surfaces. Primer residue is utilized in forensic analyses to determine proximity to a firearm, as the residue is commonly deposited on nearby objects, such as the shooter's hands and/or clothing.[3] A finding of GSR primer on bone would justifiably be indicative of a gunshot event within close proximity of the bone.

SEM/EDX have been used to detect GSR on multiple surfaces, including bone.[4,5] SEM/EDX is an analytical method that can determine the elemental composition of single particles. This study prepared samples of *Sus scrofa* for SEM/EDX analysis of gunshot injuries created from three distances (direct contact, 6", and 12"). After wounding, the specimens underwent either outdoor decomposition or warm water maceration. The six heads were sectioned along the mid-sagittal plane, resulting in a total of 12 specimens.

Tescan Vega 3 software was used to control the SEM, while the AZtec software was used to control the EDX. Elemental analysis was performed by the EDX software AZtec. AZtec provides a graph of X-ray values read from the sample, which is then compared to the known X-ray values table, giving the exact element present.

For the 12 specimens, evidence of gunshot powder and primer were discovered, though as distance increases, the number and type of particle detected decreases. For example, both primer and power (Pb, Ba, and Sb) elements were detected from wound tracts from contact samples as well as from surrounding fragments. Specimens that were left to decompose and those that were water macerated provided mixed results. Most samples provided elements that were expected from GSR, but a surprisingly few gave unexpected elements. Some of the unexpected elements, such as iron (Fe) and aluminum (Al), can be found in soil, but others, such as silicon (Si), do not provide any provenance. A limitation of this process is that every sample must be completely dry as the SEM/EDX operates under a vacuum.

Reference(s):

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SEM/EDX, Gunshot Residue, Bone