B30 Gunshot Residue Detection on Wounds in Stagnant Water: Scanning Electron Microscopy With Energy-Dispersive X-Ray Spectroscopy (SEM/EDX) or Inductively Coupled Plasma/Mass Spectrometry (ICP/MS)? A Preliminary Study

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Learning Overview: After attending this presentation, attendees will understand: (1) gunshot residue detection on wounds is challenging in degraded bodies (animal model) in stagnant water with a scanning electron microscopy (SEM) coupled with EDX (energy dispersive X-ray) analysis; and (2) Inductively Coupled Plasma Mass Spectrometry (ICP-MS) might be a solution.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by presenting the use of a highly sensitive technique ICP-MS for gunshot residue detection on wounds in degraded bodies.

Introduction: The study of firearm projectile wounds can be of great importance in forensic practice. While the identification of firearm projectile wounds on putrefactive and degraded bodies might be challenging, the identification of entry wound and exit wounds are more difficult.

Scanning electron microscopy (SEM) coupled with Energy dispersive X-ray (EDX) analysis is the reference technique for gunshot residue (GSR) detection. While some papers have described its use on biological samples, analytical results were only qualitative. Additionally, some technical problems from background noise caused by elements in tissue interfere with element identification using SEM EDX. By contrast, Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is an alternative technique for element detection with high sensitivity that has potential to be considered as a gold standard.

The objective of this preliminary study was to detect GSR using SEM-EDX and ICP-MS on gunshot wound after stagnant water immersion of the anatomical structure and to assess the possibility of entrance and exit differentiation of wounds.

Material and Method: Twenty-two shots were performed on animal model (sheep) by the Laboratoire de la Police Scientifique de Toulouse (technical and scientific police) at distance of 20 centimeters using a .22 long rifle (LR) manual rifle and Remington standard velocity. One thigh was used as reference (D0) and analyzed after shooting while the three others were placed in a barrel filled with stagnant water. Samples from one thigh were collected for analysis after 3, 6, and 14 days of immersion. For the analysis by SEM-EDX, each orifice was split in half with a sterile scalpel so that GSR was directly analyzed on the soft tissues with SEM-EDX and with swab for ICP-MS.

Results: SEM-EDX analysis of entrance wounds, showed particles were numerous compared to exit wounds. However, only Lead (Pb) was detected even at D0. Moreover, Antimony (Sb) peaks were difficult to separate from Calcium peaks. In consequence, the authors were not allowed to attest that particles detected were GSR. Immersion caused an enrichment of particles with Silicon peaks (Si). Pb was still detected but with difficulty because of silt contamination.

ICP-MS analysis showed that Pb and Sb were detected on entrance and exit wounds allowing the conclusion of possible GSR presence. Detection was not affected by water immersion. The difference in quantity of Pb and Sb particles between entrance and exit wounds allowed for distinction with a factor calculated around 14 for Pb and around 5 for Sb. Barium (Ba) quantities were low without any difference between entrance and exit wounds. However, stagnant water contained Ba.

Discussion: Surprisingly, SEM-EDX was not able to detect GSR properly due to washing out effect and was affected by contamination by silt.

In contrast, ICP-MS showed promising results with detection of Lead and Antimony in relatively high concentration in entry wounds with difference between entrance and exit wounds. Contamination by stagnant water silt did not impact Pb and Sb couple detection by ICP-MS. Therefore, ICP-MS is an interesting alternative technique for GSR detection when SEM-EDX failed to detect it.

Gunshot Residue, SEM/EDX, ICP/MS