G83 Differentiation of Bullet Type Based on Analysis of Gunshot Residue Using Inductively Coupled Plasma Mass Spectrometry

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The goal of this presentation is to demonstrate a chemical means to differentiate gunshot residue (GSR) deposited by two different bullet types throughout decomposition. Porcine tissue samples shot with full-jacketed and non-jacketed bullets and analyzed using inductively coupled plasma mass spectrometry (ICP-MS) displayed differences in chemical composition of the resulting GSR, allowing differentiation between the two bullet types. Decomposing porcine tissue samples were also analyzed to identify the most persistent elements to be used for differentiation between the two bullet types at all stages of decomposition.

These research findings will impact the forensic science community by increasing the confidence of gunshot wound identification, aiding pathologists and medical examiners in cause of death determination even in corpses presented in an advanced state of decomposition. Identifying wounds as gunshot wounds also aids law enforcement agencies in their search for the perpetrator, and knowing the bullet type may provide a link between a suspect and a crime.

In decomposing corpses, the presence of GSR can be difficult to visualize due to the decomposition process and larval activity, making chemical means of GSR identification necessary. Solution ICP-MS has been used for the determination of antimony (Sb), barium (Ba), and lead (Pb), elements characteristic of GSR, from cotton swabs spiked with these elements, from shooters' hands, and from shot cotton tissue. Preliminary studies conducted in our laboratory have demonstrated the utility of ICP-MS for the determination of Sb, Ba, and Pb in decomposing GSR-containing porcine tissue samples through all stages of decomposition. However, in order to increase confidence in GSR determination in advanced stages of decomposition, the identification of additional elements, characteristic of the bullet or the interior of the barrel, is necessary. The goals of this research were to differentiate two different bullet types based on element profiles and to investigate the persistence of GSR in decomposing tissue as a function of bullet type.

In order to study the elemental composition of GSR deposited by different bullet types, three pigs were euthanized and control (unshot) samples of skin removed from one. The other two pigs were then shot using a .357 Smith & Wesson Magnum revolver. One pig was shot with ammunition cartridges containing full-jacketed bullets, and the other with non-jacketed bullets. The fresh wounds were excised, and sections of each wound were microwave digested for ICP-MS analysis. Sections of each wound type were also removed for histology analysis, and results confirmed the presence of GSR in both wound types. The digests were initially analyzed in full mass scan mode to identify all elements present at significant levels in the GSR-containing tissue but not present in the control tissue. A selected ion monitoring (SIM) method was then developed to detect only the suite of characteristic elements from both bullet types with greater sensitivity. The significance of variation in element concentrations among full-jacketed bullet wounds, among non- jacketed bullet wounds, and between full-jacketed and non-jacketed bullet wounds were assessed statistically. Differences in element concentrations between the wound tissue (both full-jacketed and non- jacketed) and the control tissue were then assessed statistically. In this way, the two bullet types were differentiated based on differences not only terms of elements present but also based on differences in concentration of common elements.

For this research to have any impact on the forensic science community, the effect of decomposition on GSR persistence was investigated. Three euthanized pigs were obtained and wounded. One was shot with full-jacketed bullets, one was shot with non-jacketed bullets, and one was stabbed to generate open wounds to serve as control (unshot) tissue. Wounds and control tissue samples were collected throughout the decomposition process, and then digested for ICP-MS analysis. Histology was also used to detect GSR throughout decomposition, and results were compared with those from ICP-MS analysis. The tissue digests were analyzed using the SIM method developed previously for ICP-MS analysis of the characteristic suite of elements that differentiate the two bullet types. The most persistent elements throughout decomposition were identified, as they are the most useful for discrimination of bullet type.

Gunshot Residue, ICP-MS, Firearms

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