H53 Gunshot Residue (GSR) on Bone as a Potential Indicator of Gunshot Trauma in the Absence of a Bullet Wound Defect — A Noteworthy Observation

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Attendees will be shown a rib with fracture morphology consistent with blunt trauma that was produced by a bullet. Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray Analysis (EDXA) is used to confirm the presence of gunshot residue (GSR) along the fracture surfaces, and serves to clarify fracture mechanism.

The use of an SEM and EDXA on bone fractures has the potential of impacting the forensic community by providing a means of determining whether a bullet was involved and a mechanism of trauma.

During a recent examination of skeletal case for bone trauma, a fractured rib was found with missing bone fragments. It was conjectured that the fracture resulted from gunshot trauma, but it lacked the characteristic bevel of an entrance or exit wound. An examination of the bone fracture surfaces with a scanning electron microscope was proposed to search for microscopic particles from the bullet (i.e., bullet wipe) as a means of confirming the mechanism of trauma. However, upon examination no metal residue was found. The question then became whether it is possible to fracture a bone with a bullet without leaving microscopic metal particles.

Pork ribs were used as a bone model. Each of four ribs, with approxi- mately one inch of attached muscle, was placed inside a plastic bag and shot once at close range (i.e., 12 inches). The first three were shot with Remington .38 caliber, 158 grain, round nose lead bullets and the fourth with a Winchester .45 caliber, 185 grain, full metal jacket bullet. After each rib had been shot the muscle and as much of the periosteum as possible was physi- cally removed. Each rib was then placed in a paper bag to dry in an incubator at 40º Celsius (approximately 104º Fahrenheit) for five days in preparation for the SEM. After the ribs were dry they were allowed to cool.

The fracture pattern on each of the ribs was examined to verify bullet direction. The intended path was through the plastic bag, through approxi- mately one inch of muscle and then through the rib, passing from external to internal. The bullet defect in the first three ribs produced the expected entrance wound bevel. The bullet missed the fourth rib completely, but the bone was nonetheless fractured by the proximity of bullet. The bone was likely missed due to the obscuring, overlying muscle, coupled with the inac- curacy of the shooter (i.e., first author). Had these bones been recovered from a skeletal case, three of them would have been interpreted as gunshot trauma; however, the rib not directly impacted by the bullet would have likely been interpreted as blunt trauma. The fracture morphology of this rib defines areas of tension and compression indicating an external to internal bending and associate plastic deformation typically associated with slow loading.

Each rib fragment was placed in the Hitachi S-3400 SEM for visual analysis. The specimens were not coated with carbon or gold, as is the usual case. Although the four bones examined did not exhibit macroscopic evidence of bullet wipe, the surfaces near the fractures all exhibited micro- scopic concretions determined by the Oxford INCA Energy 200 Dispersive X-Ray Analyzer as lead, antimony and barium (i.e., GSR). GSR is a common finding on a shooter's hand or on other objects near the gun after firing, but it is surprising to find it on bone covered by muscle tissue and enclosed within a plastic bag. Additionally, GSR was present on both the entrance and exit side of the bone. The mixture of antimony, barium and lead from the primer may accompany the bullet as a vapor and eventually deposits on the bone as it cools.

This simple finding of GSR on both the entrance and exit side of the bone is both surprising and promising. The most obvious application of this observation—if borne out by future research—is its use as an indicator of bullet related trauma in bone fracture cases that may present as blunt trauma. Despite the forceful removal of soft tissue necessary to prepare the bones for this study, the GSR deposits remained intact. Future tests will be needed to determine whether GSR integrity on bone can be maintained through the decomposition process. With increased sample size, differences in amount or perhaps ratio of barium, antimony and lead could serve to indicate bullet direction. Observations, such as soot, stippling and powder residue, are currently used to estimate weapon to victim distance. Perhaps with addi- tional research, GSR on bone could provide another means of determining weapon distance applicable to both autopsy and skeletal cases.

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Gunshot Residue, Gunshot Trauma, Terminal Ballistics

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