H105 Determination of Low Velocity Bullet Trajectory in Long Bones: An Experimental Investigation

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After attending this presentation, colleagues will understand the different methods previously employed to determine direction of fire in the skull, and the importance of experimental study to determine if the method can be translated to postcranial long bones. They will understand the main components of factors that can be employed to determine direction of fire: beveling, entrance and exit wound morphology, and fracture sequencing. They will also see that from experimental investigation, it was determined that the most efficient method for determining direction of fire includes all three factors, as each on its own is insufficient.

This presentation will allow the forensic community to learn of a method for determining direction of fire developed from experimental study as opposed to case study. This will in turn give forensic practitioners another method to reconstruct the events of a crime, differentiate between homicide and suicide and confirm or contradict a witness statement.

Handguns are by far the most common weapon used in violent crimes in the United States (Federal Bureau of Investigations, 2005). Determination of the direction of fire can be used to evaluate witness statements, to differentiate between manners of death (e.g., homicide versus suicide), and to reconstruct events in mass homicides to enable authorities to prosecute guilty parties. Soft tissue markers used by pathologists may not be available if the remains are skeletal.

The publications regarding the estimation of bullet direction in the cranium have been of two main types: determination of entrance and exit wounds by interpretation of defect beveling (Quatrehomme and Iscan, 1998), and analysis of fracture sequence (Sexton, 1979; Dixon, 1984; Smith, et al. 1987). Publications on bullet trajectory in postcranial bones are available (Berryman and Gunther 2000; Langley 2007), but tend to be case studies without controlled factors. Therefore, an experiment was designed to produce gunshot wounds from known directions in the humeri of domestic pigs (*Sus scofa)*. The hypothesis was that the methods used for the cranium would be useful, but may need to be refined due to the very different bone morphology in postcranial long bones.

Twenty humeri from recently deceased articulated pigs were shot with a .357 Magnum full metal jacketed bullet in the midshaft: three from anterior to posterior, three from posterior to anterior, three from medial to lateral, and three from lateral to medial. The remaining eight humeri were shot from directions unknown to the researcher in order to permit a blind study of any method developed from the wounds of known direction. It was found that the humerus of the domestic pig was difficult to shoot when still articulated, and therefore 12 more humeri, clear of flesh but still very wet, were shot at a later date with the same bullet type and from the same distance. After deter- mining that there were no significant differences in the fracture patterns between the fleshed and de-fleshed wet bones of the two shooting periods, the sample contained 22 humeri. Five bones were not used as they were missing a significant number of fragments, were hit tangentially or not hit in the shaft. All five experimental bones that were hit had damage only in the proximal epiphysis; therefore, 12 bones of known direction were present in the final sample.

Beveling was defined as the amount of exfoliation of the bone surface divided by the cortex breadth in order to eliminate any effect this factor may have on beveling. There was significantly more internal beveling of entrance wounds than exits, and more external beveling on exit wounds than entrances. There were, however, two exit wounds that exhibited some amount of internal beveling, supporting earlier conclusions that lack of internal beveling is not a consistent indicator of an exit wound (Quatre- homme and Iscan, 1997, 1998). As expected, the size of the exit defect was significantly larger than the entrance defect. Entrance defects tended to be circular or ovoid in shape, and exit defects tended to have less defined edges and a more rectangular shape. However, none of these patterns were present in the entire sample.

The humeri in this study tended to fracture in a double butterfly pattern, with primary radiating fractures emanating from the superior and inferior aspect of the entrance and exit. When fractures were sequenced, eight of twelve bones had radiating fractures from exit wounds that were halted by those from entrance wounds. In two bones, all fracture lines were ambiguous, and in two bones fractures from the exit halted fractures from the entrance, contradicting the sequencing theory.

It was concluded that each analysis outlined above was not a consistent indicator of directionality on its own, but a method that included all of them (beveling, entrance and exit defect size and shape, and fracture sequencing) would be more effective. In the absence of the blind experimental group, this comprehensive method was taught to five forensic anthropology colleagues with no special background in gunshot trauma. Four colleagues correctly identified all twelve trajectories, and one colleague correctly identified 11 out of 12 trajectories. However, further research in this area is indicated, as a larger sample size would greatly benefit this study.

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