H110 Assessing Directionality of Low Velocity Gunshot Wounds to the Vertebrae: A Preliminary Study

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After attending this presentation, attendees will understand the importance of experimental research to determining the bullet trajectory in the vertebrae as well as main components that can be employed to determine the direction of fire: beveling, fragmentation, and fracturing. Incorporating all three factors is the most efficient method for determining direction of fire.

This presentation will impact the forensic community by introducing a method for determining direction of fire developed from experimental research as opposed to case studies. This will, in turn, give forensic practitioners additional ways to reconstruct the events of a crime, confirm or contradict a witness statement, and differentiate between homicide and suicide.

Firearms, handguns in particular, are common weapons used in violent crime in the United States and around the world. Penetrating trauma is the second leading cause of spinal injuries, and of the two major types of penetrating trauma to the spine (gunshot and stab wounds), the majority are gunshots. This prevalence amplifies the importance of stringent scientific investigations examining bullet trajectory in the vertebrae.

Publications on bullet trajectory in postcranial bones tend to be case studies rather than controlled experiments. Therefore, an experiment was designed to produce gunshot wounds from known directions in the vertebrae of domestic pigs (*Sus scrofa*). The hypothesis was that the determination of bullet trajectory in vertebrae shot with a low velocity weapon is possible using a method modified from that developed for the cranium.

Six vertebral columns from recently deceased pigs were shot with a 9mm full metal jacket bullet, three each a minimum of three times from the anterior and the posterior directions: once in the cervical, once in the thoracic, and once in the lumbar vertebrae. Another two vertebral columns were shot from directions unknown to the researcher in order to permit a blind study of the method developed from the wounds of known directions. A total of 23 gunshots of known direction to various sections of vertebrae made up the known sample.

Zones were assigned to each type of vertebrae (cervical, thoracic, and lumbar) based on the developmental anatomy of the pig vertebrae (Figure 1). In each zone, the researcher recorded the following categories of trauma: undamaged, fracture lines, comminuted, trabeculae exposed, obliterated, and unconnected piece.

Figure 1: a) Zone assigned to the anterior side of the cervical vertebrae,
b) Zones assigned to the posterior side of the cervical vertebrae

The results indicated several general trends: (1) vertebrae shot from posterior-anterior were more fragmented and evinced more fracture lines on the neural arches and spinous processes, (2) the lumbar vertebrae were the least damaged overall, having the least number of adjacent vertebrae affected from each shot, and (3) although more cervical vertebrae were affected by each gunshot wound, the thoracic vertebrae displayed the most damage overall.

It was concluded that a method incorporating all of the factors (beveling, fragmentation, and fracturing) was effective for determining direction of fire. A blind study was conducted consisting of three trials (1) determining direction of fire using only previous knowledge, (2) using examples from the known sample to assist, and (3) using the criteria developed by the researcher along with the examples to determine direction of fire.

The results of the blind study (Table 1) indicated a correlation between experience with gunshot trauma and the percent of cases the participants would successfully determine in Round 3. It also illustrated the complexity of determining trajectory on vertebrae and highlighted the potential benefits of future research

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with a larger sample size and human vertebrae.

Table 1: Summary table of the results from the blind study. Participants with "No Experience" had Master's or Doctoral level course work without any experience with gunshot wound cases. Participants who were "Experienced" had practical experience with gunshot wound cases

Amount of Experience	Participant	Round 1	Round 2	Round 3
No Experience	1	3/6	4/6	3/6
No Experience	2	3/6	4/6	5/6
No Experience	3	2/6	4/6	4/6
No Experience	4	2/6	5/6	1/6
No Experience	5	3/6	4/6	4/6
Experienced	6	3/6	5/6	6/6
Experienced	7	N/A	N/A	5/6

Gunshot, Postcranial, Trajectory

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