A52 Prediction of Bullet Type From Cranial Gunshot Trauma

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Learning Overview: After attending this presentation, attendees will have learned that it is possible to differentiate bullet type (full metal jacket vs. jacketed hollow point) from measurements of cranial entrance wounds.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by discussing the importance of experimental research with gunshot wounds.

Forensic anthropologists have long been interested in cranial gunshot wound interpretation. While being able to understand key extrinsic variables, such as velocity, caliber, distance, type of firearm, and that bullet construction would be useful to a forensic investigation, research has generally fallen short with ways to elucidate such variables from the analysis of bone alone. Retrospective studies that have mined forensic case reports for data have been somewhat useful in terms of establishing patterns, but an experimental approach is superior in its ability to precisely control for extrinsic variables.

Therefore, this project was designed to experimentally test the effect that bullets of the same caliber having two separate constructions (full metal jacket vs. jacketed hollow point) have on cranial gunshot trauma, with the goal being to ascertain whether it would be possible to differentiate between the two different types of bullets from resultant cranial trauma alone. These distinct bullet types are designed to fully penetrate and not fragment (full metal jacket) or penetrate and expand upon contact (jacketed hollow point). Based on the different physical properties of the bullets, it was hypothesized there would be some indication in the cranial trauma that would allow differentiation between the two, with damage from jacketed hollow point bullets being greater.

Forty-five donated adult human heads were obtained from an anatomical tissue supply company, specifically for the purpose of trauma research. A specialized shooting stand was built to support each head at the height of an average adult male, and each head was shot once by the same expert marksperson at a distance of three yards either in the frontal bone or parietal/temporal bone, using a revolver with a $1^{7}/_{8}$" barrel loaded with 0.38 caliber bullets. Bullet type (jacketed hollow point vs. full metal jacket) was distributed randomly yet evenly between individuals. Following the experiment, heads were autopsied and macerated using standard procedures.

Entrance wounds, exit wounds (if present), and resultant fractures were examined both endocranially and ectocranially. Three observers independently scored all 45 crania. Quantitative data were collected on the minimum and maximum diameter of the entrance and exit wounds. Qualitative data included evaluation of bevel characteristics, such as its relative size to the wound and whether bevel margins were smooth or crushed, wound shape (i.e., oval, round, or irregular), presence of circumferential delamination around wound margins, and the degree of any cranial fragmentation.

Given missing values from the qualitative data due to not every cranium having an exit wound and to maximize the sample size number of frontal shots (n=24) and parietal/temporal shots (n=21), only the quantitative data were analyzed here. Logistic regression was used to create a diagnostic test of the quantitative data to include sensitivity (i.e., ability to pick up true positives), specificity (i.e., ability to pick up true negatives), and accuracy; with the jacketed hollow point as the referent bullet. For entrance wounds to the frontal bone, a cut point of 11.0mm minimum diameter had a 90.9% sensitivity, 84.6% specificity, and 87.5% accuracy in determining the bullet type, with the jacketed hollow point entrance more likely to be above 11mm ($p<.001$). For entrance wounds to the parietal/temporal bone, a cut point of 9.5mm minimum diameter had 100% sensitivity, 80% specificity, and a 90.5% accuracy in determining bullet type, with the jacketed hollow point entrance more likely to be above 9.5mm ($p<.0001$).

These results indicate that for .38 caliber bullets, entrance wound diameter at different locations on the cranium is a very strong predictor of bullet construction, with jacketed hollow points creating a larger entrance wound overall. Further research should evaluate if this pattern holds for bullets of other calibers. Finally, these results demonstrate that it is possible to have significant findings with quantitative (and therefore non-subjective) analysis of gunshot wound trauma.

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Gunshot Wounds, Fracture Analysis, Forensic Anthropology