B110 Estimating Muzzle-to-Target Distance From the Physical Characteristics of a Bullet Hole

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Learning Overview: After attending this presentation, attendees will have learned of a new method that relates bullet hole depth and damage characteristics to the muzzle-to-target distance.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a new method of analyzing muzzle-to-target distance that can overcome the limitations of traditional distance analysis tests.

Determining the muzzle-to-target distance of a firearm discharge is an integral part in crime scene reconstruction. When combined with the bullet's trajectory and impact angle, the shooter's location can be approximated, which can support or refute eyewitness accounts and suspect statements. The method most often employed during case work is the Modified Griess test, which analyzes Gunshot Residue (GSR) patterns around bullet holes. This test, however, has a weakness of a three- to five-foot range limit. As a chemical test, the evidence at the crime scene can also be contaminated or obscured. Physical visualization of GSR patterns may require instruments that may not be available at the crime scene. At the same time, bullet holes may be on surfaces that cannot be transported to the lab, such as on walls or doors. This study identified the problem that the Modified Griess test may not always be optimal at a crime scene.

This study sought to develop a new method that overcomes this range limitation as well as offer other unique advantages that the Modified Griess test may not provide. The goal was to observe the physical damage patterns of a bullet hole and relate that to the muzzle-to-target distance. It decided to test this on plywood and Medium Density Fiberboard (MDF), which are common wood substrates found as indoor building materials. Test fires were conducted with a .22 caliber rifle over a range of muzzle-to-target distances on plywood and MDF panels. Afterward, the depth of the corresponding bullet holes was measured, and the physical damage patterns caused by the bullets were analyzed.

The results show that in plywood and MDF substrates, as muzzle-to-target distance increases, bullet hole depth decreases. This trend was steeper in the plywood substrates than MDF, and bullets penetrated deeper into plywood as well. In addition, this study observed that specific damage patterns to the back of the bullet hole can give hints about the shooter's distance and the bullet's velocity. A predictions model was also developed, using a mathematical formula that relates certain variables to bullet hole depth. Using the data from the test fires, the model was able to predict depth given the substrate material, muzzle-to-target distance, and bullet speed. A visual model that relates the depth of the bullet hole to the muzzle-to-target distance was also generated. Muzzle-to-target distance can be extrapolated from this model, as long as the bullet hole depth is measured and the firearm, cartridge, and substrate material information is obtained from the scene.

Not only does this new method cover the limitations of the Modified Griess test, but it works in tandem with other ballistics analysis methods as well. The procedure is easy to learn and perform, and other tests such as impact angle analysis can be performed without interfering with the bullet hole depth, as it is a non-destructive procedure. Test fires can be performed at the same time with tests for GSR patterns. In conclusion, with some fine tuning, this model may become another useful tool that forensic scientists have available to them at the crime scene.

Muzzle-to-Target Distance, Bullet Hole Depth, Wood Substrates