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Interpretation of Unusual Wounds Caused by Firearms

REFERENCE: Stone, I. C. and Petty, C. S., **"Interpretation of Unusual Wounds Caused by Firearms,"** *Journal of Forensic Sciences*, JFSCA, Vol. 36, No. 3, May 1991, pp. 736–740.

ABSTRACT: The interpretation of the range of fire of gunshot wounds requires coordination of information and observations from the autopsy surgeon, scene investigator, and laboratory analyst. Opinions based on incomplete information often lead to misinterpretation of the wound. The effects of interposed targets such as clothing, windows, and body parts are discussed. Case examples are given for interposed targets that cause confusing patterns and even lead to misidentification of the points of entrance and exit of the projectile in the body. The splitting of tissue in areas of bony prominence can be mistaken for evidence of discharge of a firearm at close range.

KEYWORDS: forensic science, wound ballistics, postmortem examinations, gunshot residues

There have been significant advances in the forensic science subdisciplines of gunshot residues and wound characteristics over the past several years. Di Maio [*1*] has summarized most of the practical aspects of firearms and their relationship to gunshot wounds. Fackler et al. [*2,3*] have published their work concerning wound ballistics and the effects of projectiles in and on the body. Stone and his co-workers [*4,5*] have described the examination procedures in the forensic science laboratory for both body specimens and clothing.

The purpose of this paper is to summarize briefly the procedures used in most modern laboratories for detection of gunshot residues (GSR) and then to describe how these findings have been used in difficult cases. Particularly the problems of interposed targets and determination of the points of entrance and exit of projectiles in the body will be considered.

Gunshot Residue Examination in the Laboratory

The examination of clothing includes visual, chemical, and instrumental methods available to most laboratories. These steps and techniques are the following:

1. Visual examination for powder soot and powder.
2. Examination under a binocular microscope and documentation of the findings.
3. Soft X-ray for documentation of powder, missile fragments, bone, and other evidence.
4. Chemical tests for lead (sodium rhodizonate), nitrites (Greiss test), and possibly copper (rubeanic acid).

Received for publication 13 July 1990; accepted for publication 7 Aug. 1990.
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5. Energy-dispersive X-ray analysis for metallic residues such as lead, antimony, barium, and copper.

These methods are applicable not only to clothing but also to tissue excised from wounds. This is useful especially when the wounds may be contact wounds or made at very close range, or when decomposition masks the firearm discharge residues.

Interposed Targets

When we speak of interposed targets, we refer to any object or material through which a projectile or pellet might pass after leaving the muzzle of a weapon and before entering the body. This may be a window, door, tree branch, layers of clothing, or another part of the body, such as a hand or arm. In each of these cases, the stability of the projectile may be affected, causing unusual injuries such as "keyholing," multiple projectiles, or even secondary projectiles (such as glass or bone fragments). It is of utmost importance that autopsy surgeons and other forensic scientists recognize possible interruption of the ballistic path of a projectile.

Rifle or handgun projectiles passing through a window, as in an automobile, can also lead to misinterpretation of wounds. The secondary projectiles of glass can be mistaken for tattooing, although the dicing injuries they produce are significantly different from powder tattooing. Messler and Armstrong [*6*] reported a case involving a rifle used to fire through a window and shade. The pattern of lead residue on the shade, simulating a powder pattern, was caused by partial disintegration of the projectile as it passed through the window.

Dixon [*7*] described the effect that interposed tempered glass had in causing an atypical entrance wound in the head. This same phenomenon has been observed by the authors in several cases in which a lead or partially jacketed bullet passed through an automobile window before striking the victim. Not only could one observe the dicing injuries from the tempered glass, but the pseudo powder pattern was also present.

Shotgun wounds yield the most dramatic variations in the effects of interposed targets. Several years ago, a person evidently discharged a shotgun into his body in a suicidal manner after first firing a test round into the ceiling of the bedroom. The pattern on the ceiling, however, was too dispersed in size for the shotgun (at full choke), the size of the shot, and the distance. A towel was observed in one of the scene photographs but was not collected. The pattern on the ceiling was preserved so that accurate pattern dimensions could be obtained. When using the maximum distance for the size of the room and height of the ceiling, the only way to duplicate the shot pattern was to place a towel over the muzzle and discharge it at about 12 ft (3.7 m). This interposed target caused a dramatic enlargement of the pellet pattern, providing a plausible explanation.

Discussion

Clothing from gunshot cases is received in the Criminal Investigation Laboratory of the Institute of Forensic Sciences, Dallas, Texas, both from the Medical Examiner's Office (which is in the same building) and from the scene or suspects. In 1989, these cases included more than 650 homicides, 200 aggravated assaults, and 360 suicides. Certainly, in most cases it is easy to determine the points of entrance and exit of projectiles in clothing when the results of the autopsy are available to the laboratory examiner. When there is identifiable gunshot residue on the clothing or body, identification of entrance wounds can be made and then test patterns can be obtained to estimate the range of fire.

We find that many of the "experience" factors used by autopsy surgeons and crime laboratory analysts are not based on fact. For instance, powder grains can be deposited

on clothing or in hair at distances of more than 10 ft (3 m), depending on the type of weapon, the ammunition, and the circumstances (for example, a windy outdoor crime scene, as opposed to an indoor one). In experiments at the institute, the authors have observed powder adhering loosely to cloth at distances of as much as 15 to 17 ft (4.6 to 5.2 m) from the muzzle end of a shotgun. Handguns, particularly .357-caliber Magnum or .44-caliber Magnum handguns, can cause deposition of powder at 10 to 12 ft (3 to 3.7 m). We realize that these experiments were performed under ideal conditions and that the powder was adhering so loosely that virtually all of it could be removed by light shaking. However, consideration needs to be given in cases of multiple gunshot discharge wherein blood pervading the clothing can cause adherance of powder from discharge at unexpectedly great distances. This is why the laboratory examiner must have available to him or her all information from the autopsy as well as from the scene investigator. With regard to through-and-through wounds, often more can be learned from examination of the clothing than from the appearance of the wounds, assuming that it is not a close-range discharge that is being investigated. Consistently, we have observed that the inner aspect of the clothing overlying the exit wound will tend to have deposits of bone fragments, missile fragments, tissue, and even powder particles (if it is a contact wound). Examination of the wound track through the body is important to identify the presence of powder and powder soot and the direction of the bullet if it passes through bone. If there is more than one shot to the body, the second discharge may cause sufficient pressure as it passes into the body that it may force tissue and organs out of the defects from the first wound. This can be a source of confusion and misinterpretation if all information is not available to the laboratory analyst and autopsy surgeon.

In a recent police-involved shooting, an emergency room physician wrote on the hospital record that a person had been shot in the back with the projectile exiting the front chest. Upon closer examination it was apparent that the .357-caliber Magnum projectile had struck the hand of the injured person, who was pointing a weapon at the officer, causing a loss of the ballistic stability of the bullet. This, in turn, resulted in an atypical entrance wound in the anterior chest. Surrounding the anterior chest defect were numerous punctate, shallow wounds caused by secondary projectiles (bone and bullet fragments). The main projectile passed through the body and exited the posterior chest, leaving a relatively small exit wound with some splitting. This misinterpretation of firearms wounds by surgeons with inadequate training is a cause for concern for law enforcement and prosecutorial agencies.

The examination of the weapon when available can provide significant information when contact or close-range discharge is an issue. The incidence of blood inside the barrel and on the barrel of the firearm has been reported by Stone [*8*]. There is a relationship between the caliber, the muzzle velocity of the projectile, and the distance which should be taken into consideration when wound interpretation is undertaken. Although the absence of blood in or on the weapon may not address the issue of distance from the body, the presence of blood or blood spatters certainly establishes that the weapon was within a few feet, possibly inches, of the target. As the caliber or muzzle velocity or both increase, there is an increase in the frequency of blood and tissue deposition on the weapon. Shotguns and high-velocity rifles certainly are expected to have a greater frequency of blood, including blood spatters, than smaller caliber handguns.

Another area of wound interpretation that needs clarification is wounds to bony prominences of the body covered by a thin skin layer. Wounds to the forehead, chin, cheek, and other parts of the head can be misleading. Not infrequently, gunshot wounds to these areas result in splitting of the tissue at the periphery of the defect. Misinterpretation of this as a contact wound rather than an atypical entrance wound can be avoided if careful examination is made of the underlying bone and tissue and the wound track. If the wound is from a discharge of a firearm in contact with the head, powder or powder soot or both

are usually visible; an exception occurs with .22-caliber weapons with long barrels. We have observed in suicidal wounds caused by .22-caliber rifles that identifiable residues may not be detected, which is probably a function of the smaller powder loads and longer burning chamber.

In a recent case, the authors reviewed investigative and autopsy data involving a person shot by a police officer. The officer stated that he had responded to shots being fired by discharging his 9-mm-caliber pistol at about 20 ft (6.1 m) from the suspect, striking him in the upper forehead. The wound exhibited no evidence of powder tattooing, powder soot, or any residue in the wound track. The minor splitting around the wound was consistent with what we have just described. Misinterpretation of this wound as being from discharge of a firearm at contact or near-contact range arose from observations using a scanning electron microscope and energy-dispersive X-ray analysis. When the tissue from the entrance wound was examined by one of the authors, no evidence of residues from contact or close-range discharge of a firearm was observed either microscopically or by energy-dispersive X-ray analysis.

The photograph in Fig. 1 illustrates vividly this very point. The case involves discharge of a .357-caliber Magnum handgun with ammunition loaded with ball powder into the forehead. The distance from the muzzle end of the weapon to the forehead was about 12 in. (30 cm). The powder tattooing is evidence against contact of the weapon with the head, inasmuch as only one discharge was involved, yet there is significant splitting of the tissue.

Summary

Interpretation of gunshot wounds needs to be approached with all available information. We have seen too often in reviews of cases that opinions are rendered as to the range of discharge or the points of entry and exit based on incomplete information.

FIG. 1—*Wound from a .357-caliber Magnum handgun discharged from a distance of about 12 in. (30 cm).*

Certainly, failure to consider possible interposed targets and their effects on wounds and also the type of weapon involved would appear to cause the most frequent problems in interpretation. Our experience has been that the most often encountered interposed targets are clothing, doors, windows, and other parts of the body itself, such as an arm or hand. The forensic pathologist needs to have the expertise of the firearms examiner, just as the forensic scientist/criminalist requires information from the interpretation of the wounds on the body and results of the scene investigation. Formation of an opinion concerning gunshot wounds in the absence of any of the above data can lead to improper or incorrect conclusions.

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