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Determination of Direction of Fire from Graze Gunshot Wounds

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ABSTRACT: Careful examination of experimentally produced graze bullet wounds of skin demonstrates that specific wound characteristics may be useful in determining the direction in which the projectile traversed the skin surface. These principles are applied to actual cases with known circumstances.

KEY WORDS: criminalistics, wound ballistics, directionality

The direction in which a discharged projectile traverses the skin can be determined, so it is said anecdotally,² by a careful examination of graze wound configuration. Specifically, the observation was made that the so-called skin tags located along the lateral margins of the graze wound trough point toward the weapon or, expressed another way, in a direction opposite the path of the projectile. Schematically, this principle is demonstrated in Figs. 1 and 2 in views from above the evolving graze wound and from its side.

A search of the scientific literature revealed no articles addressing this subject, although an exact understanding of wound configuration is essential for accurate determination of type of weapon, type of ammunition, range of fire, direction of fire, and such specialized considerations as intermediate targets and shoring. An experimental model was designed to correlate the configuration of graze wounds with the direction of fire.

Materials and Methods

The weapons selected for this study included only handguns, specifically, an F.I.E. 0.22-caliber revolver, Model E15; a Colt 0.38-caliber Special revolver, "Police Positive Special"; and a Remington 0.45-caliber M1911 A1 U.S. Army semiautomatic pistol. The ammu-

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The experiments reported herein were conducted according to the principles described in "Guide for the Care and Use of Laboratory Animals" of the Institute of Laboratory Animal Resources, National Research Council, DHEW Publication No. (NIH) 78-23, revised 1978.

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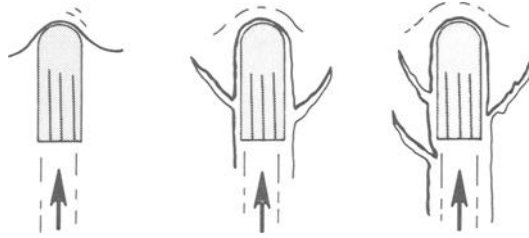


FIG. 1—Schematic view of graze wound in stages, as seen from above the wound. Skin tags point toward the weapon (AFIP Neg. 77-10083-3).

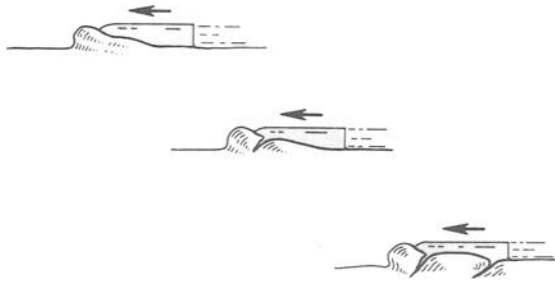


FIG. 2—Schematic view of graze wound from the side (AFIP Neg. 77-10083-2).

dition used in each weapon was, respectively, Remington High Velocity .22 long rifle 40-grain solid point, Western .38 Special 158-grain solid point, and Western .45 automatic 230-grain full metal case.

The animals used to receive the graze wounds were female Yorkshire domestic white swine, each weighing between 34 and 45 kg (75 and 100 lbs). Surgical anesthesia was achieved by intravenous administration of sodium pentobarbital (approximately 30 mg/kg body weight) through an indwelling “butterfly” cannula in a lateral ear vein. The animals were washed and lightly clipped without damage to the skin. After being used in an unrelated ballistics study by another investigator, each animal was killed by means of further intravenous sodium pentobarbital given under the direction of the attending veterinarian.

On the ballistic firing range, eight graze wounds were produced on areas of skin not affected by the previously mentioned study by firing tangentially to the skin with each weapon at an approximate range of 0.3 m (12 in.). So that the influence of tissue fixation (to underlying bone) could be properly assessed, graze wounds were formed on skin of the head as well as on loose skin of the abdomen.

The experimental graze wounds were visually examined, completely excised with underlying subcutaneous tissue, photographed, and studied under a dissecting microscope.

Results

Visual Examination of Graze Wounds

Graze wounds involving both loose abdominal skin and scalp skin that was firmly affixed to bone were successfully produced with all weapons used; furthermore, all wounds demonstrated some degree of skin tag formation along the lateral wound margins.

The graze wounds produced by the .22-caliber revolver revealed skin tags that were

more delicate and smaller than those made with larger caliber weapons. Two such tags are shown in Fig. 3; they point toward the right, a finding consistent with the weapon's being located toward the right. The presence of bullet residue toward the right end of the graze wound trough supports this direction of fire.

A representative graze injury produced by the .38-caliber revolver in loose skin (Fig. 4) demonstrates large tags protruding into the center of the wound as well as smaller ones, giving the margin of the wound a serrated or saw-toothed pattern. The wound shown in Figs. 5 and 6 was also created by a .38-caliber revolver; strictly speaking, this injury is not a graze wound, but rather a superficial perforating wound of the skin. It is clear, however, that the skin tag of the exit wound follows the rule of pointing toward the weapon. Another .38-caliber graze wound (Fig. 7) was formed in skin firmly bound to underlying bone. The resulting skin tags in this injury have the predictable configuration. All of these .38-caliber injuries have bullet residue at the entry site, a finding that may be used to confirm the direction of fire.

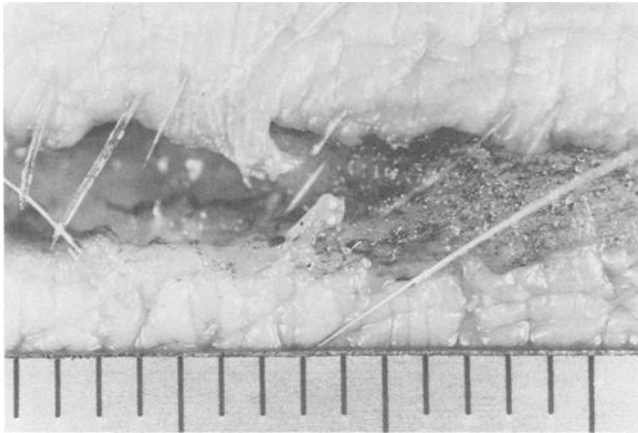


FIG. 3—Graze wound produced in loose tissue of abdomen by .22-caliber F.I.E. revolver with projectile passing from right (photograph as reference) to left (AFIP Neg. 77-6867).

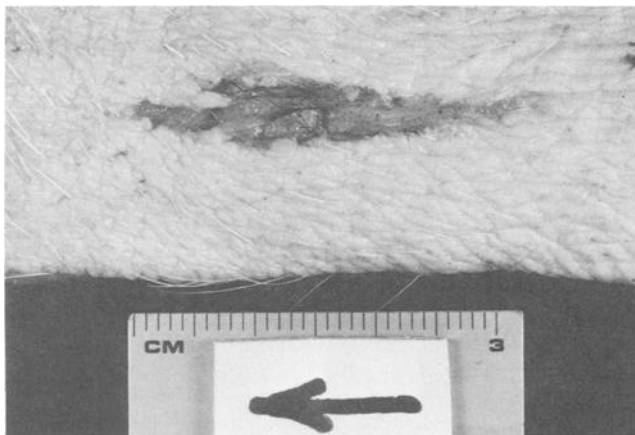


FIG. 4—Graze wound of loose tissue by .38-caliber Colt revolver (AFIP Neg. 77-6863). Arrow indicates direction of missile.

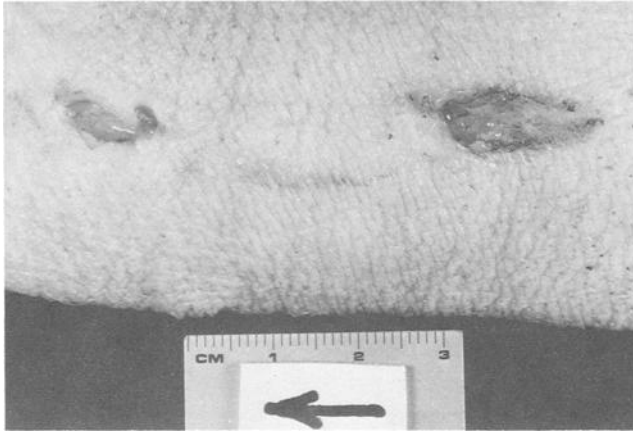


FIG. 5—Superficial “in-out” wound of loose tissue by .38-caliber weapon. Note skin tag of exit wound on the left (AFIP Neg. 77-6864). Arrow indicates direction of missile.

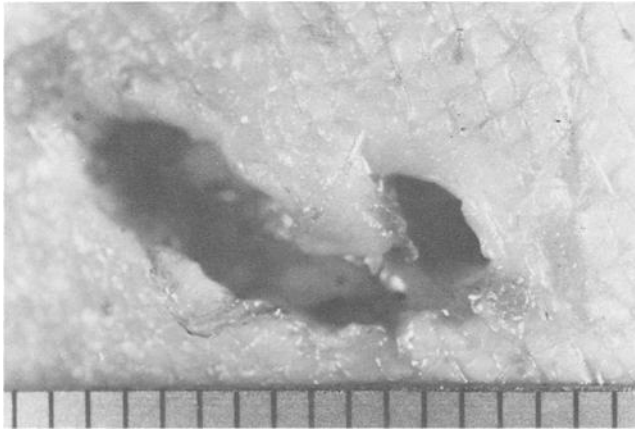


FIG. 6—Exit wound with skin tag (AFIP Neg. 77-6872).

A single graze wound was produced by the .45-caliber semiautomatic in loose abdominal skin (Fig. 8). There are multiple skin tags, again in a saw-toothed pattern, along the margin, but the large tag on the inferior margin on the right best exemplifies the details of wound configuration demonstrated through examination of these wounds with a dissecting microscope.

Examination with a Dissecting Microscope

Each major skin tag along the margins of every experimentally produced wound was studied under an American Optical stereo-optic microscope for details of wound configuration.

On the basis of this examination, a skin tag may be described as an elongated fragment of tissue connected to the margin of a graze wound and projecting into its central portion. Of great significance is the fact that the two borders of each tag are different. The border

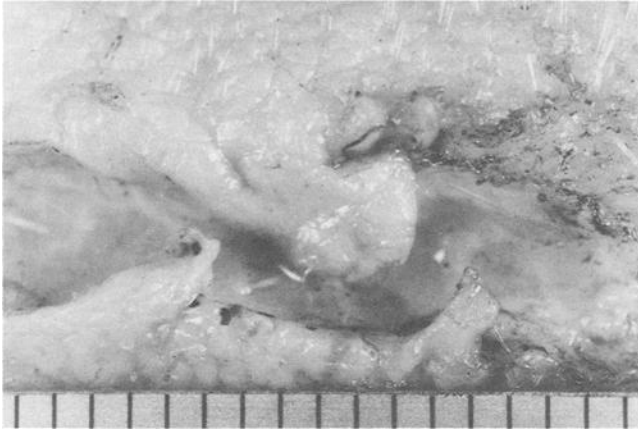


FIG. 7—Skin tags of graze wound on skin firmly affixed to the skull; wound was produced by a .38-caliber weapon. Bullet traversed skin from right to left (AFIP Neg. 77-6873).

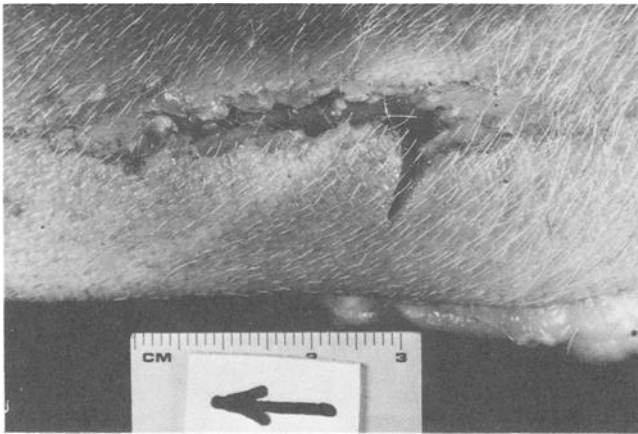


FIG. 8—Graze wound of loose tissue produced by .45-caliber Remington pistol (AFIP Neg. 77-6866). Arrow indicates direction of missile.

nearest the weapon consists of an open-ended tear or laceration with the characteristic irregular margins and tissue-bridging by nerves, vessels, and strands of epidermis. The border away from the weapon, however, has a simple, abraded edge. This characteristic appearance is shown schematically in Fig. 9.

Discussion

The anecdotal statement that the skin tags at the margin of a graze wound point toward the weapon or in a direction opposite to the path of the projectile is too nonspecific and may lead to misinterpretation of wound configuration. The general rule as stated above requires a subjective interpretation by the observer based on a gross examination and a decision as to the direction of the tag; many skin tags defy such a simplistic approach in that the observer can reorient them to point in whatever direction he desires and, therefore, may make a false determination as to direction of fire.

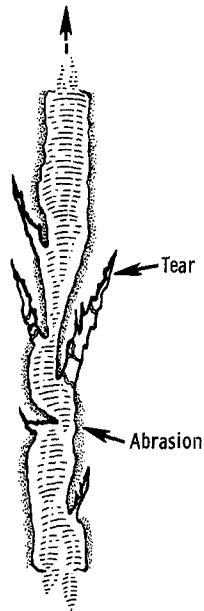


FIG. 9—Schematic diagram of graze wound demonstrating characteristics observed under dissecting microscope (AFIP Neg. 77-10083-1).

The only scientifically dependable way of determining the direction of fire from skin tags along the edge of a graze wound or in an unusual tangential exit wound (Fig. 5) is to examine the tags with a hand lens or a dissecting microscope to determine which border of the tag is lacerated and thus locate the side of the tag toward the weapon.

Application of this principle may be helpful in understanding wound configuration in specific cases. Figure 10 is a photograph of a graze wound caused by a shotgun pellet or pellets striking the top of the head; the pellet was witnessed to have passed from the vic-

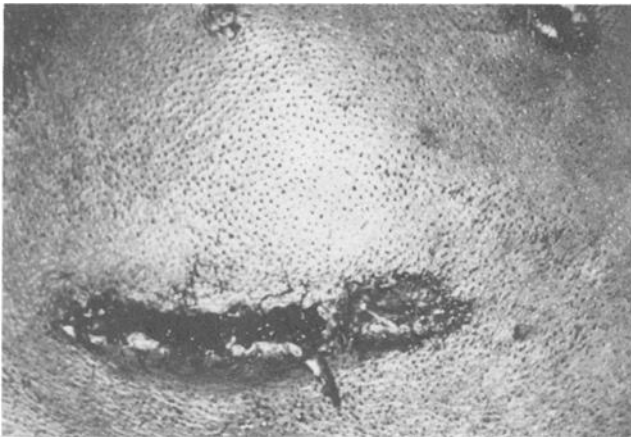


FIG. 10—Homicide wound involving shotgun blast which, by witnessed account, passed from right (with photograph as reference) to left. Graze wound of top of head has large skin tag of posterior margin that points toward the weapon (AFIP Neg. 77-10082-4).

tim's right to his left. The skin tags point toward the weapon, which is on the victim's right; the skin tag on the margin uppermost in the picture appears to have a laceration on its right border, the side toward the weapon by history.

The projectile creating the graze wound depicted in Fig. 11 passed from the decedent's right to his left, creating a number of prominent skin tags; all of these appear lacerated on the left borders (the observer's left), consistent with a bullet traveling from the observer's left to his right.

In addition to bullet residue, powder stippling may mark the entry end of a graze wound trough (Fig. 12); in this case, the projectile moved from lower left to upper right. The skin tags clearly demonstrate lacerated borders on the side toward the weapon.



FIG. 11—Homicide wound produced by handgun of unknown caliber. Bullet passed from decedent's right to his left (used with the permission of Brian D. Blackbourne, M.D., deputy chief medical examiner, District of Columbia).



FIG. 12—Homicide wound produced with handgun. Projectile obviously passed from lower left to upper right as determined by powder stippling and skin tags pointing toward the weapon (used with the permission of James L. Luke, M.D., chief medical examiner, District of Columbia).

Conclusion

The wound configuration of graze gunshot wounds as well as of superficial tangential perforating wounds can be a helpful indicator of direction of fire. Skin tags along the margins of a graze wound and occasionally in a tangential exit wound may be examined with a hand lens or a dissecting microscope to determine the lacerated border of the tag; the lacerated border is located on the side of the skin tag closest to the weapon. Bullet residue patterns or powder stippling, or both, may be used in some cases to confirm the direction of fire. These observations appear to be independent of weapon caliber or degree of tissue fixation to underlying bone.

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