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The Characteristics of Head Wounds Inflicted by ''Humane Killer'' (Captive-Bolt Gun)—A 15-Year Study*

ABSTRACT: The "humane killer" or captive-bolt gun, is the tool/weapon widely used in meat industry and private farmer households for slaughtering animal stock. Out of 17,250 autopsies performed at the Institute of Forensic Medicine in Novi Sad during the 15-year period (1991–2005), 29 cases of suicides and two homicides were committed by captive-bolt pistols. Wounds inflicted by captive-bolt guns have specific morphological features, distinctive from wounds made by other kinds of hand firearms. Selected features of the captive-bolt wounds (punched round entrance and a double pattern of smoke soiling) depend on distance and angle of instrument at the time of firing. Autopsy findings were compared with an experimental model consisting of 20 domestic pigs. Obtained results confirmed that the appearance of the entrance hole and soot deposits, along with differences in shape, location, extent, and density of soot blackening, could be useful in identification of weapon, direction of discharge, shooting distance, and angle of the muzzle to the frontal and sagittal planes of the head at the moment of fire.

KEYWORDS: forensic science, forensic pathology, cranio-cerebral trauma, gunshot, captive-bolt gun, ''humane killer''

Captive-bolt guns are used as weapons for humane slaughtering of animals in the meat industry and should be placed against the animal's forehead to induce immediate unconsciousness before slaughtering livestock (1,2). This kind of weapon is also widely used on household farms in Vojvodina, the northern region of Serbia, because a firearms license is not required.

A captive-bolt gun (Fig. 1) consists of a simple cylindrical metal tube (barrel) with a heavy flange muzzle. A metal bolt placed in its center, *c.* 15–17 cm long and 1 cm wide (No. 3, Fig.1), is launched upon discharge of a blank powder gun cartridge. The tips of the bolts are concave (conically grooved) with very sharp edges, and its front looks like a sharp-edged circular punching tool. The tip of the bolt is very rarely convex and rounded. After discharge, the bolt is pulled back into the barrel by a withdrawal spring. The muzzle is wide and slightly convex, with a central round opening of about 1 cm, from which the bolt is propelled beyond the muzzle. Symmetrically beside the central hole, there are two lateral round openings of diverging smoke conduits, 0.3 cm in diameter, with a distance of 2.2 cm between them (No. 5, Fig. 1). They are used as outlets for the explosion gases, as the bolt occludes the central hole of the muzzle.

Violent deaths inflicted by captive-bolt guns are rarely reported in medical legal practice, and are predominantly suicidal, while accidents and homicides are unusual events (3–6). Due to the different appearance of the entrance wounds observed at autopsy, we decided to conduct an experimental study on specificities of entrance wounds inflicted by this specific weapon and to compare our findings with the autopsy reports.

Methods

The method used in this study was based on a comparison of both autopsy findings and the results of the experimental model. The experiment was established on the analysis of captive-bolt wounds of 20 domestic pigs, inflicted in a routine procedure in the city slaughterhouse. The study included four groups of five animals, where the muzzle was placed tightly against the forehead under different angles in relation to the frontal and sagittal plane of the head.

In the first group (A) the captive-bolt gun was placed perpendicularly to the animal's forehead, where the imaginary line drawn through the small gas outlets perpendicular to the sagittal plane. In other groups the shot was fired at an acute angle, *c.* 45° to the frontal plane, where the imaginary line between gas openings were

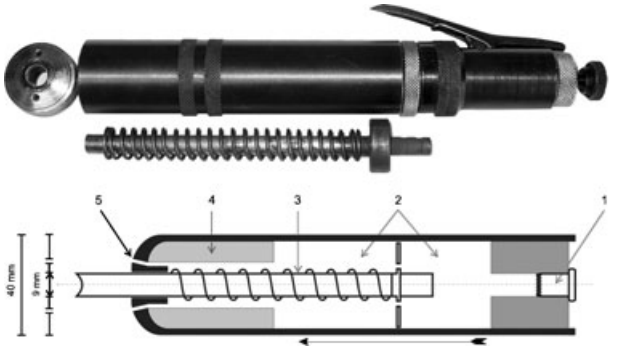

FIG. 1—*Scheme of a captive-bolt gun (1, Blanc cartridge; 2, chamber; 3, metal bolt with a withdrawal spring; 4, boundary; 5, diverging smoke conduits).*

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at 90° (group B), 45° (group C), and 0° (group D) angles to the sagittal plane. Strong 9-mm Luger blank cartridge ammunition with red tip was used.

Related autopsy cases were analyzed. Out of 17,250 autopsies carried out at the Institute of Forensic Medicine in Novi Sad, during the 15-year period (1991–2005), only 29 cases of suicides committed by captive-bolt pistols and two homicides (out of these two, one was a combination of homicide and suicide) were found. Of the 29 suicides, the vast majority was committed by the pistol placed on the forehead or at a close range. In the reported homicide cases, the muzzle of the instrument was held against the frontal and occipital head surfaces, respectively.

Results

In experimental group A (where the gun was placed perpendicularly against the forehead of the animal) wounds consisted of a central round defect of the skin and underlying soft tissue and the entry wound resembled the entrance into a tunnel. The edges of the wound entrance were flat and smooth with no contusions. As no retraction of the surrounding tissue occured, the size of the entrance hole was almost identical or slightly less than the diameter of the bolt. The usual contusion ring around the central hole was not present. In the close proximity of the skin defects there were two symmetrically arranged eccentric oval zones of blackening (Fig. 2). If the injury was inflicted in the hairy part of head, the powder soot was deposited in the hair, making changes on the skin more discreet (Fig. 3). In such cases hair acts as a filter, which allows only particles of high mass to pass through.

On the outer plate of the skull bone the entrance was round, sharp-edged and the same diameter as the bolt, with no powder soot deposits around it. Linear bone fractures were rarely seen (Fig. 4). The inner plate was more damaged, so that the channel in the bone had the shape of the funnel with its wider end oriented towards the cranial fosse (crater-shaped).

In groups B, C, and D (where the gun was placed at different acute angles), 10 cases displayed an entrance hole similar to the cases from group A. In the cases of other five animals, skin at the level of the entrance hole on one pole was cut semi-circularly, while skin on the opposite end was still attached, partly closing the central defect, after being retracted, and contused (Fig. 5).

If the muzzle was placed in the manner that the imaginary line drawn through the smoke outlets was at a right angle to the sagittal plane (group B), the powder discharge produce two elongated eccentrically blackened areas symmetrical to the wound. As the soot deposits zone radiated outward and became wider, it gradually decreased in intensity, resembling an opened or semi-opened handfan (Fig 5). If the angle of firing decreased, the soot zones were wider and paler toward the periphery.

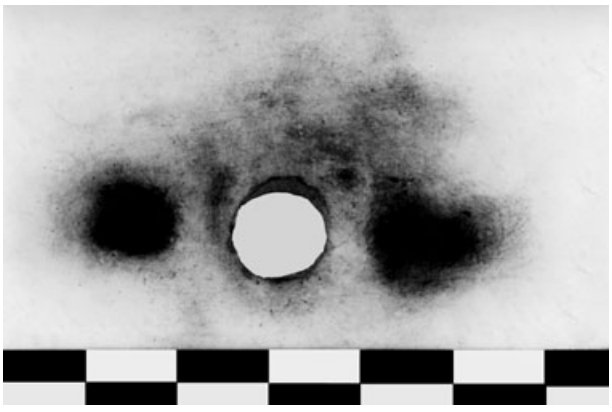

FIG. 2—*Wound characteristics—the pistol was perpendicularly placed to the forehead.*

FIG. 3—*Wound characteristics at the hairy part of the head—the pistol was perpendicularly placed to the head.*

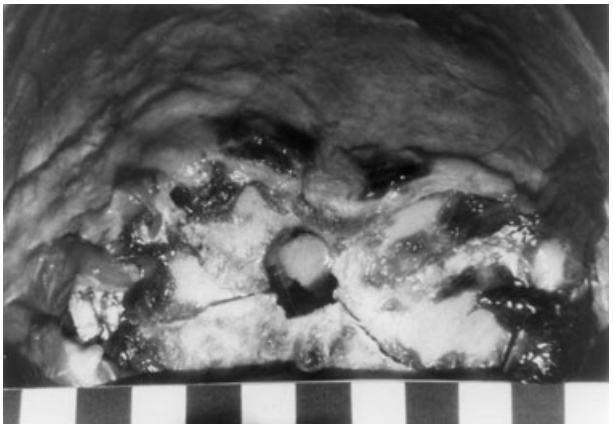

FIG. 4—*Damage to the outer surface and linear fracture of the occipital bone.*

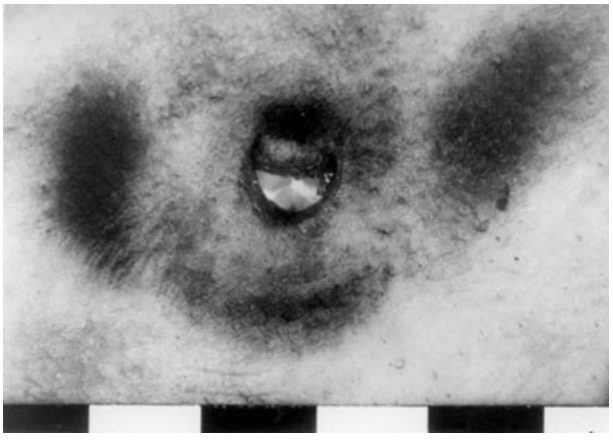

FIG. 5—*Wound characteristics—the pistol was at an oblique angle placed to the forehead.*

If the shot was fired at position where the imaginary line connecting the gas openings was at a 45° angle to the sagittal plane (group C), the smoke-soiling pattern was arranged in two asymmetric zones of blackening by the entrance hole in the form of an exclamation mark. On the side of the wound closer to the contact point of the muzzle circumference and skin, there was a more pronounced oval zone of blacking soot pattern, due to the fact that the gap between muzzle and skin was small. On the opposite side of the wound, this gap became consecutively larger producing an elliptic gray soot zone gradually decreasing in density toward the periphery. In cases where the imaginary line drawn through the smoke escape openings are parallel to the sagittal line (group D), smoke deposits are similar to those formed in the previous case, with the exception of its sagittal alignment.

"Powder tattooing" of the skin was not seen in any of the analyzed groups. In groups B, C, and D, damages of the skull bones on the outer plate and the inner plate had identical characteristics as in the previous group. Contact wounds observed in experimental group A were identical with the reported features from more than three quarters of the autopsy cases (12 cases).

In cases where the bolt struck the skin under an oblique angle, the entrance defect was predominantly circular, with an unilateral beveling of the corium. In two cases, attached parts of the cut-retracted skin were found. The appearance of smoke deposits corresponded with the angle at which the captive-bolt gun was held, as in the experimental model.

In both groups (experimental model and autopsies), findings in the brains were almost identical. The intracranial brain injuries looked like a wide wound channel a few centimeter long, with a slightly larger width at the entrance. The channel was filled with destroyed brain tissue and clotted blood, and sometimes on the very bottom pieces of punched-out skin and bone, as well as strands of hair were found. No injuries were reported on the far parts of the brain.

Discussion

Due to the specific structure of the captive-bolt body and the way it discharges, this type of gun causes different wound characteristics in comparison to the wounds inflicted by classic handguns (2,7). The most prominent difference is the round skin entrance with sharp edge, resembling a punched hole. The second one is smoke-soiling pattern, which is arranged in two different zones of soot deposits corresponding with two openings of diverting smoke conduits. Soot deposits observed in the vicinity of the wound openings in the autopsy cases corresponded with those reported in the experimental groups, which might be a great help in estimating the shooting angle (Figs. 6 and 7). Furthermore, features of the captive-bolt wounds depend on distance and position of the tool at the time of firing.

Perpendicularly Contact Wounds

When the captive-bolt gun was placed perpendicularly onto the surface of the head, there was no muzzle imprint and no star-shaped entry wounds, typical for standard handguns contact wounds over bone (2). The bolt of the captive-bolt gun enters the skull, and prevents the high-pressure explosive gas from penetrating the area between the skin and the skull, which causes ballooning out and stellate splitting of the skin. The high-pressure gas within the barrel escapes through the lateral smoke outlets on the muzzle (Fig. 6*a*). The destructive strike effect of the bolt to the skin, which in classic handguns originates from free bullet's

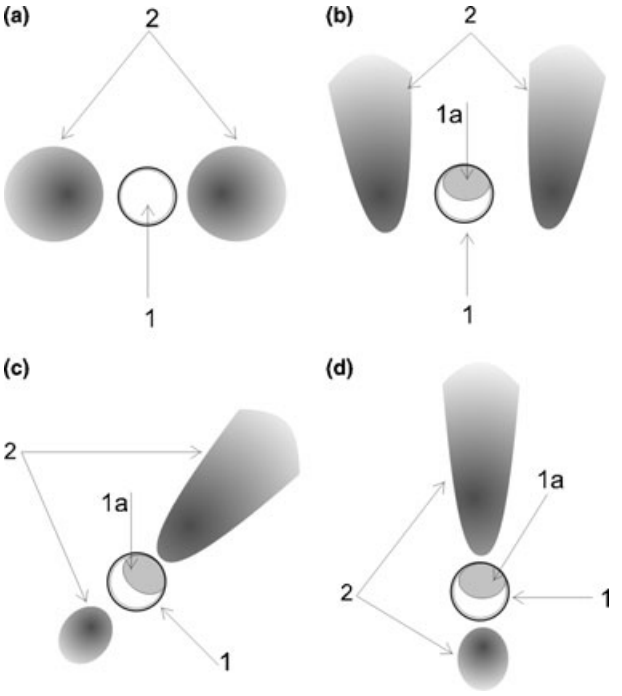

FIG. 6—*Scheme of wound characteristics—(a) the pistol is at a right angle; (b, c, d) the pistol is at an oblique angle (1, entrance hole; 1a, "open window" appearance; 2, smoke-soiling pattern).*

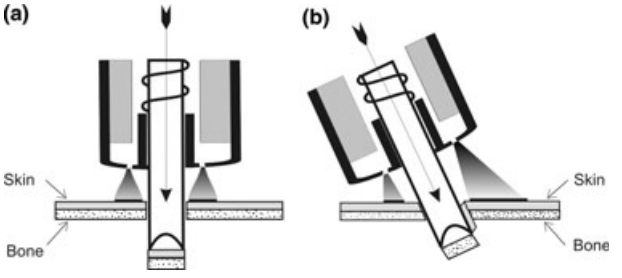

FIG. 7—*A scheme of the punching effect of the excavated distal bolt end producing a smoke deposits—(a) the pistol is at a right angle; (b) the pistol is at an acute angle.*

kinetic energy and rotation around its longitudinal axis, is different in this type of weapon. The sharp edge of the concave tip cuts through the skin and the underlying bone (Fig. 7*a*), producing round holes in a manner that is similar to punching holes in a leather belt, where the edge of the contact wounds have characteristic features of section wounds.

Contrary to the classic contact gunshot wounds, in all cases of captive-bolt wounds, even in hard-contact discharge, smoke deposits were observed near the entrance hole, which is in concordance with already published data (8–10). Due to the fact that the front of the muzzle is convex when its central part is against the skin, and escaping holes are at near-contact distance in the close proximity of the skin. In autopsy cases where zones of blackening were larger and less intensive, the wounds were inflicted from near-contact firing. Sometimes a faint circular or semi-circular smoldering occurs around the edges of central defect. It could be caused by gas, escaping alongside the bolt (Figs. 2 and 5). This is typical for guns used for a longer period of time, as well as instances where stronger gunpowder cartridges were used.

Compared with standard gunshot contact wounds, brain structure was less damaged, due to the fact that there was no powerful intracranial gas pressure. The wound canal had the shape of a less clear-cut funnel caused by the bolt tip and secondary bone projectiles. The punched-out skin and bone were pushed into the wound channel (11,12). Despite low impact velocity (<50 m/sec), brain lesions around the wound channel were similar to gunshot wounds caused by low-velocity projectiles (<300 m/sec) (13,14). This situation could be explained by kinetic energy transfer from the bolt and bone fragments to the soft tissue (12–15). In contrast to extensive local tissue damage, there were no morphologic signs of indirect lesions away from the impact point, such as skull fractures, cortical contusions, or intra-cerebral hemorrhages.

Angled-Contact Wounds

If the gun is placed at an oblique angle, the entrance hole has additional features. In such cases, complete circumference of the muzzle is not in contact with the skin, so that the entire round edge of the bolt does not touch the skin at the same time (Fig. 7*b*). The bolt tip cuts the skin at the point of a muzzle contact, causing unilateral sickle-shaped beveling of the corium. As the cut part of the underlying bone has been pushed into the wound channel by the bolt, the skin on the opposite side sometimes remains uncut, due to the fact that the edge of the bolt does not press the bone with sufficient force. The wound inflicted in this way has the entrance hole of the specific shape: on one end skin is cut semi-circularly, while on the opposite one the semi-circularly cut part of the skin is attached, retracted, partly closing the central defect like a flap (Figs. 5 and 6*b–d*) or "opened window" (8). In certain cases, there is an asymmetrical contusion of the skin, which is caused by the friction of the bolt due to an oblique position of the gun in contact shots.

In the cases of acute angled-contact, more of the gunpowder residue escapes from the gap where physical touch is not complete, producing the dark-gray blackening on the site of contact, but as the soot deposits zone radiate outward and became wider, it gradually decreases in intensity to the lighter gray tones (Fig. 6). Nevertheless, we did not observe the "powder tattooing" of the skin, which would be a mark *sine qua non* of intermediate-range discharge (2) in any case, despite the fact that the opposite smoke outlet in this position is at intermediate-range distance. The proposed explanatory mechanism could be the position of the plate at the beginning of the bolt (No. 3 in Fig 1), which is in the front of the blank cartridge, preventing escape of powder grains from the barrel.

Conclusion

Wounds inflicted by captive-bolt guns have specific features, distinctive from wounds made by other firearms. The appearance of the entrance hole and soot deposits, as well as differences in their appearance and location, may be used to identify the weapon, as well as direction and angle of fire to the frontal and sagittal plane of the head, even the inclination degree.

Autopsy cases with injuries inflicted by captive-bolt guns described in this report were predominantly suicidal in nature, and the muzzle was placed perpendicularly tightly against the forehead. Captive-bolt pistols are not suitable for committing homicide, due to the fact that the bolt of the humane killer gun is too short, making it impossible to shoot from a distance.

In all gun-wound cases where the entrance hole has sharp edges, without a ring-shaped contusion, with no exit and/or radiographic or autopsy evidence of an internal bullet, one should suspect use of a captive-bolt instrument.

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