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Effects of Decomposition on Gunshot Wound Characteristics: Under Moderate Temperatures with Insect Activity

ABSTRACT: Previous studies document characteristics of gunshot wounds shortly after they were inflicted. This study was conducted to determine if the early stages of decomposition obscure or alter the physical surface characteristics of gunshot wounds, thereby affecting the quantity and quality of information retrievable from such evidence. The study was conducted in August and September, 2005 in Nova Scotia, Canada in forested and exposed environments. Recently killed pigs were used as research models and were shot six times each at three different ranges (contact, 2.5 cm, and 1.5 m). Under these test conditions, the gunshot wounds maintained the characteristics unique to each gunshot range and changes that occurred during decomposition were not critical to the interpretation of the evidence. It was concluded that changes due to decomposition under the conditions tested would not affect the collection and interpretation of gunshot wound evidence until the skin was degraded in the late active or advanced decay stage of decomposition.

KEYWORDS: forensic science, gunshot wounds, firearms, decomposition, insect activity, gunshot distance

Physical characteristics of gunshot wounds are used by death investigators to determine information such as the type of weapon, the distance, and the angle of the gunshot with respect to the body. There are a number of events that may happen after death such as damage by insects and animals, heat effects, and decomposition changes that may alter or obscure gunshot wound evidence (1). The typical characteristics of gunshot wounds have been described from bodies discovered relatively soon after the wound has been inflicted (1,2). There is little documentation describing the effects of decomposition of a body on gunshot wound characteristics (3). How long does evidence of a gunshot wound persist when a body is exposed to different environmental conditions? Are there any changes in the gunshot wound characteristics with the onset of decomposition that could affect interpretation of the evidence?

An entrance gunshot wound leaves distinct characteristics on the surface of the skin. Contact wounds display margins that are often described as seared, charred, and imbedded with soot. Unburned powder may be seen in and around the wound. Contact wounds are often distinguishable by a muzzle impression. Gas discharged into the wound forces the skin to distend and slam against the end of the firearm from which the bullet emerges often resulting in an impression on the skin in the form of soot or an abrasion. A zone of abrasion devoid of soot can be found just outside the margin of the wound. This is a result of the skin rubbing against the barrel of the firearm (2,4,5).

The most distinguishable characteristic of an intermediate range gunshot wound is a pattern known as "powder tattooing." This pattern results from the impact of unburned or partially burned gun-

powder grains onto and into the skin and is produced at distances greater than contact. Generally, handguns produce these patterns up to distances of 1 m; however, this distance varies depending on the type of ammunition and characteristics of the particular firearm.

Distant wounds have fewer characteristics, generally consisting of a hole surrounded by a rim of abrasion, and there may be the presence of bullet wipe residue. Bullet wipe is seen as a darkened ring around the margins of the hole as a result of firearms discharge residues, such as lead, being wiped from the surface of the bullet onto the skin (2,6).

Decomposition is a progressive process from start to finish and can be divided into five stages: fresh; bloat; active decay; advanced decay; and dry/remains (7). Throughout these stages, the body undergoes a number of changes that may alter or obscure gunshot wound evidence on the skin. The length of time a body spends in each of these stages can be affected by a number of factors including carrion insect abundance, temperature, rainfall, and exposure conditions (8–10).

The purpose of this research was to assess the effects of early stages of decomposition on the physical surface tissue characteristics of gunshot wounds when a body is exposed to the elements. It was hypothesized that early stages of decomposition would affect the physical characteristics of gunshot wounds and the amount or quality of evidence retrievable from such wounds. Pigs were the optimal human model for the research because the skin, as well as the decomposition activities, is very similar between pigs and humans (7). The research was conducted in exposed and forested environments during late summer in Dartmouth, Nova Scotia, Canada.

Materials and Methods

Site Selection and Preparation

The study site consisted of an open field and forested area on Nova Scotia Power property in Dartmouth, Nova Scotia, Canada.

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The open field consisted of grass, low shrubs, and rocky ground while the forested area consisted of deciduous trees with a damp leaf-covered ground.

Two groups of six pigs (*Sus domesticus*), approximately 20 kg each, were obtained from Maple Lane Farms in Nova Scotia, Canada, immediately after death. The pigs were killed by a single shot in the head with a 0.22 caliber rifle. Pigs were shaved on one side of the torso to remove coarse hair and that area was washed to remove dirt. Each pig was shot six times with a semi-automatic handgun (Glock model 19, caliber 9 × 19, Glock GmbH, Deutsch Wagram, Austria): twice at contact; twice at an intermediate range (2.5 cm); and twice at a distant range (1.75 m) (Fig. 1). The ammunition used was Winchester brand, caliber 9 mm Luger, 115 grain, full-metal jacket bullets. All of the wounds studied were inflicted within 6 h of death.

On August 30, 2005, three pigs were placed in an exposed environment and three were placed in a forested environment. Pigs were placed approximately 15 m apart. Each pig was completely enclosed in chicken wire to prevent scavenger damage and the cages were anchored in the ground with rebar to prevent scavengers from moving the carcasses. The ambient air temperature was recorded hourly. This entire process was duplicated on September 15, 2005. The sites for the replicate groups were separated by approximately 2 km (3).

Data Collection and Analysis

Pigs were examined every 24 h; digital photographs and measurements of hole diameters of individual wounds were recorded daily as well as characteristics of the overall pattern, shape, and appearance. Wounds were observed and information was collected until the carcass was completely decomposed. Initially, wounds inflicted postmortem were examined and the characteristics observed were compared to documented information on wounds inflicted perimortem (1,2). The characteristics of each wound type were recorded and any changes that occurred were documented as each pig decomposed. Wounds inflicted at all ranges, on all pigs, were compared to each other (3).

Results

Decomposition

Decomposition was driven primarily by insects and the progressive stages outlined by Anderson and VanLaerhoven (7) were observed. The duration of the stages in this research varied from the time given by Anderson and VanLaerhoven (7), but the overall descriptions and sequence of the stages were the same (Fig. 2a–d). Carcasses in both the exposed and forested environments went

through the same stages of decomposition but pigs in the exposed environment decomposed about 5 days faster than those in the forested environment (Fig. 3, compare Fig. 2b,c). Gunshot wound characteristics were evident in both environments even with extensive maggot activity on the carcass (Fig. 2b). These characteristics were visible in both environments until the skin completely dried up in the advanced decay stage (Fig. 2d).

Contact Shots

Characteristics observed initially (day 0) on the contact wounds were typical for that type of wound compared to the literature on perimortem gunshot wounds (1,2). All of the contact shots displayed a muzzle impression during the fresh stage (Fig. 1). Some of the impressions were clearer and more distinct than others because the amount of pressure used with the contact varied slightly between shots. The muzzle impression was initially black due to soot deposition (Fig. 1). As decomposition progressed, the soot washed away and the muzzle impression remained visible as an abrasion on the skin (Fig. 4a). The distinctive muzzle impression was still visible in the active decay stage of decomposition (Fig. 4b), and remained visible until the wounds were covered completely by maggots.

In this study, a zone of abrasion outside the wound margin was initially characterized as being devoid of soot or other material (Fig. 4c). As the bloat stage developed, this zone of abrasion became more prominent and developed discoloration due to drying. As the bloat stage progressed, this zone of abrasion blended in with the rest of the muzzle impression (Fig. 4a).

Data were collected from the pigs once, late in the dry remains stage, when there were only dried skin and bones left. Although there were holes still visible in the dried skin, the characteristics were not clear enough to conclude the wounds were consistent with a gunshot (Fig. 2d).

Intermediate Shots

The intermediate range shots (2.5 cm) inflicted on the specimens in this study showed the typical gunshot wound characteristics described in the literature (2,4). Soot was visible on the first day of exposure (Fig. 1) and for the first 1–3 days of the bloat stage, unless it had been washed away after a period of rainfall. As the bloat stage progressed, the edges of the wounds dried and darkened with the dry zone restricted to the edge of the wound. Initially, unburned and partially burned powder was visible but it could not be determined whether it was on the surface or embedded in the skin. During the bloat stage, powder tattooing was confirmed by a yellow to red discoloration of the skin and individual powder particles were observed embedded in the skin (Fig. 5a).

Late in the active decay stage, characterized by widespread maggot colonization of the body, the extensive decomposition had little effect on wound characteristics with the distinct tattooing still present and visible (Fig. 5b).

Distant Shots

Bullet wipe was present around the wound immediately after the pigs were shot from a distance of 1.75 m (Fig. 1). As drying occurred, the edges became darker and bullet wipe was no longer visible. An abrasion ring was evident on day 1 (Fig. 6a). Abrasion around the wound became clearer, as a ring of discoloration around the wound, as decomposition progressed through the bloat stage.

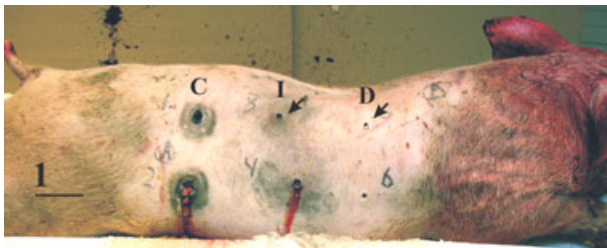


FIG. 1—Gunshot wounds inflicted with a pistol at contact (C), intermediate (I, 2.5 cm) and distant (D, 1.75 m) ranges. Arrows indicate bullet holes. Scale bar = 2.5 cm.

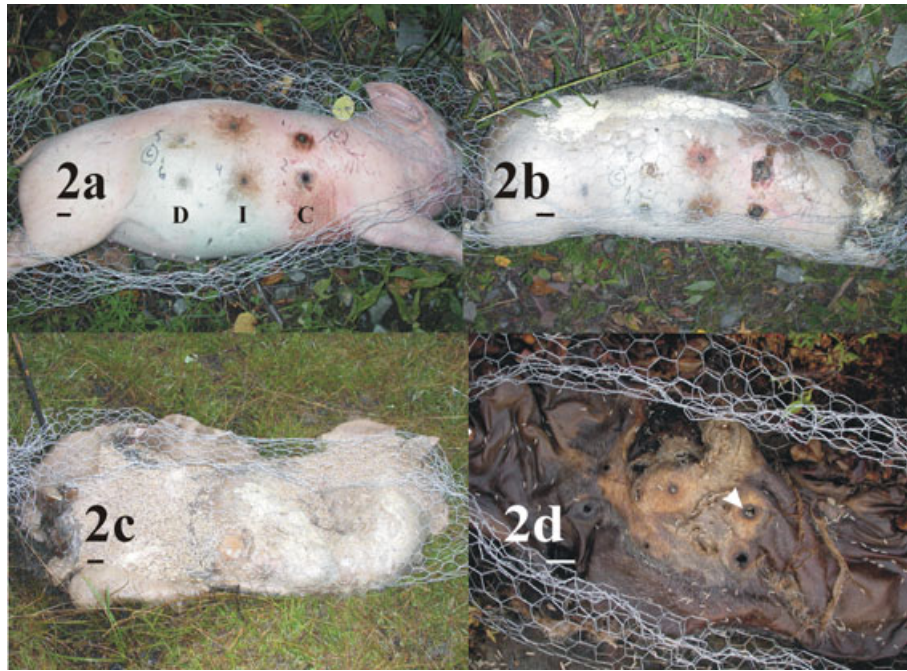


FIG. 2—Decomposition effects on gunshot wounds in a forested and exposed habitat. (a) After 4 days' exposure in a forested habitat. (b) After 8 days' exposure in a forested habitat. (c) After 8 days in an exposed field habitat. (d) After 10 days in an exposed field habitat. Arrow shows one of the wounds. Scale bars = 2.5 cm.

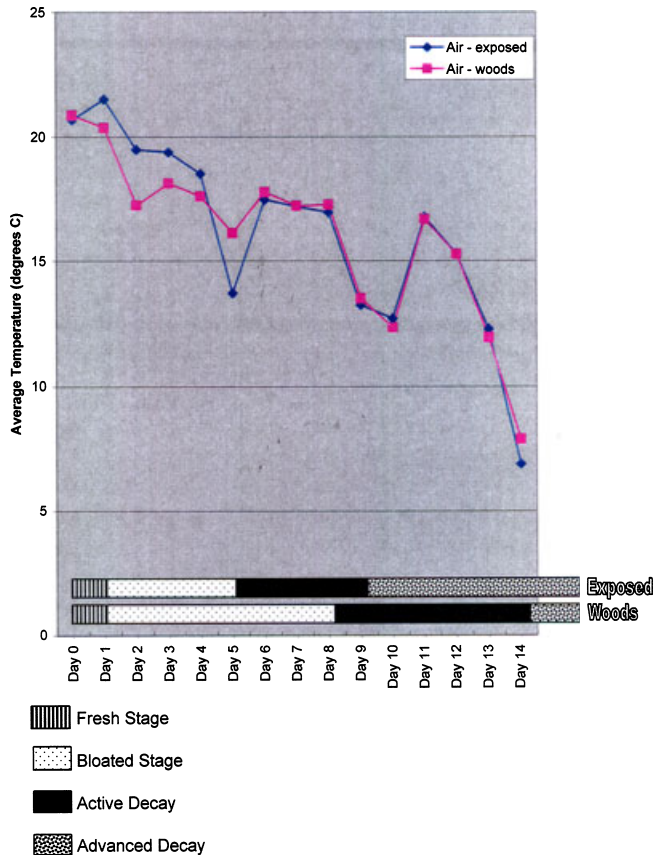


FIG. 3—Exposed and wooded condition—ambient air temperature and length of time for stages of decomposition.

By the active decay stage, decomposition obscured the gunshot wound characteristics and only the bullet hole was visible (Fig. 6b).

Bullet Hole Diameter

As the pigs decomposed the bullet hole diameter increased slightly. The average measurement of the hole diameter for contact shots increased from 7.5 mm to 9.9 mm, intermediate wounds increased from 4.8 mm to 6.6 mm, and distant wounds increased from 4.4 mm to 7.2 mm.

Discussion

Decomposition activities did not affect the surface gunshot wound characteristics to an extent that might lead to misinterpretation of the evidence. The wounds maintained their unique characteristics which were distinguishable until the active decay stage of decomposition (Figs. 4b, 5b, and 6b). Changes to bullet hole diameter were minimal. The increases in bullet hole diameter observed in this study should not affect an experienced examiner's ability to recognize it as a gunshot wound. The changes in wound characteristics observed were related to the stage of decomposition. Changes in characteristics described occurred during the bloat stage and early in the active decay stage (Fig. 3). According to Pollak and Reiter (11), holes made by maggot feeding activity can superficially resemble gunshot wounds. In this study, insect activity did not produce any pseudo-gunshot wounds, even though there was extensive maggot activity. It is possible that the gunshot holes provided entrance points to the body so maggots did not make additional entrance holes.

Changes that occurred to the contact shots were not critical to the identification of this type of gunshot wound. Muzzle impression patterns lost some definition as decomposition progressed, but the pattern associated with the wounds was typical for a contact shot (Fig. 4b). Wounds made from the other ranges did not develop a pattern or discoloration around the wound that would mimic a muzzle impression.

The most distinguishable characteristic of an intermediate range gunshot, powder tattooing, was evident until the skin was degraded.

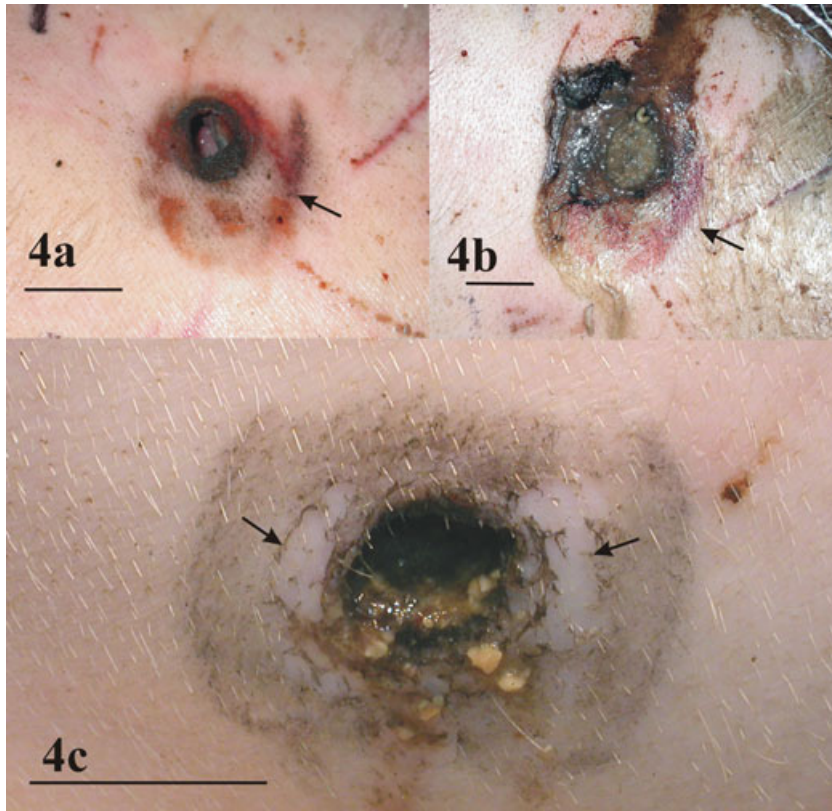


FIG. 4—Decomposition effects on contact gunshot wounds after exposure in a forested habitat. (a) After 2 days' exposure. (b) After 8 days' exposure. Arrows indicate muzzle impression. (c) Fresh contact wound (day 0) showing abraded area, indicated by arrows. Scale bars = 1 cm.

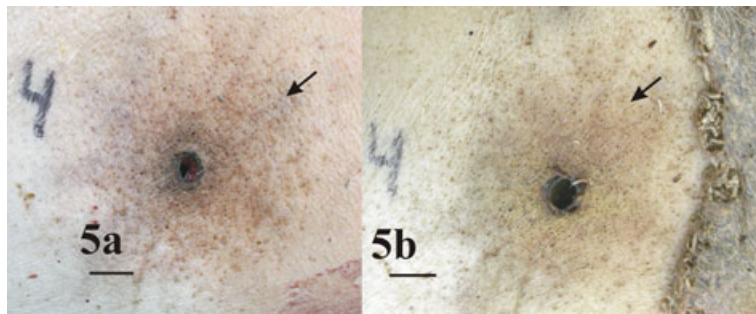


FIG. 5—Decomposition effects on intermediate range gunshot wounds in a forested habitat. (a) After 1 day exposure, arrow indicates powder tattooing. (b) After 10 days' exposure, arrow indicates powder tattooing. Maggots can be seen feeding on skin and underlying tissues to the right of the wound. Scale bars = 1 cm.

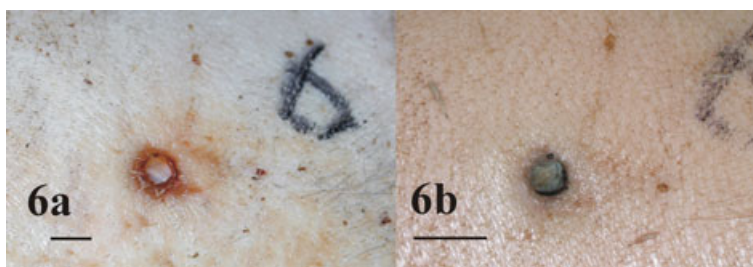


FIG. 6—Decomposition effects on distant range wounds in a forested habitat. (a) Wound characteristics after 1 day exposure. (b) Wound after 8 days' exposure. Scale bar = 1 cm.

Close examination of the pattern showed the presence of individual powder particles embedded in the skin (Fig. 5*b*). The area surrounding wounds made at the other ranges did not show this characteristic or any similar characteristics as decomposition progressed.

Distant shots can be difficult to confirm at any point in time through external examination alone because there are fewer distinctive characteristics (2). Characteristics of a distance wound were clear early in the bloat stage but as decomposition progressed, the characteristics of the wounds lost definition making them more difficult to identify (Fig. 6*b*). Late in the active decay stage there were insufficient characteristics on the body to confirm, through surface examination alone, that the wound was caused by a gunshot.

The changes that occurred to the three ranges of wounds were seen in all pigs in both the exposed and the forested environment. Although the pigs took longer to pass through the stages of decomposition in the forested environment, changes in the gunshot wounds occurred during the same stage in both environments. Most changes occurred during the bloat stage, regardless if this stage lasted for five days or eight days. Therefore, it was the stage of decomposition, not time alone, that affected the characteristics of gunshot wounds. It is therefore important to consider the stage of decomposition of a body when examining gunshot wounds because similar wounds on different cadavers observed on the same time line could look different if they are in different stages of decomposition (Fig. 2*b,c*).

An in-depth forensic examination requires more than an external examination of the wounds. This study focuses on one of the key examinations required to confirm the presence of a gunshot wound and the range from which the wound was inflicted. In this study, the early stages of decomposition did not obliterate the surface evidence of gunshot wounds. The overall characteristics persisted as decomposition progressed and the three ranges of gunshot wounds (contact, intermediate, and distant) were distinguishable until the skin degraded at some point between the active and the advanced decay stage of decomposition.

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