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Effects of Decomposition on Gunshot Wound Characteristics: Under Cold Temperatures with No Insect Activity

ABSTRACT: Information on gunshot wound characteristics has been well documented; however, there is little documented information on the effects of decomposition or environmental conditions on gunshot wound characteristics. This study was conducted in order to determine if decomposition would obscure or alter the physical surface characteristics of gunshot wounds when exposed to a low temperature environment. The study was conducted from November 2005 to January 2006 in Nova Scotia, Canada in forested and exposed environments, with air temperatures between −10°C and +10°C. Pigs were used as human models and were shot six times each at three different ranges (contact, 2.5 cm, and 1.5 m). Gunshot wound characteristics persisted until the wounds were covered with ice and snow, after which changes were observed. The changes were recognized as being unique to the different ranges of gunshots and it was concluded that changes due to decomposition under the conditions tested would not affect the collection and interpretation of gunshot wound evidence.

KEYWORDS: forensic science, gunshot wounds, firearms, decomposition, freezing, gunshot distance

Gunshot wounds display unique physical characteristics that are valuable in forensic examinations. Events that happen after death, such as decomposition, may alter or obscure gunshot wound evidence (1). Physical conditions such as freezing, thawing, and other extreme environmental conditions could also affect gunshot wound characteristics. Literature describes gunshot wound characteristics on bodies found shortly after the wound has been inflicted; however, there is little documented evidence on what happens to gunshot wound characteristics after the body starts to decompose, or under different environmental conditions (1–3).

Gunshots can leave unique characteristics on the surface of the skin. In a contact wound, the end of the firearm from which the bullet emerges (the muzzle) is pressed against the surface of the skin. Gunshot wounds caused in this manner result in margins that are often described as seared, charred, and imbedded with soot. Unburned gunpowder may be observed in and around the wound. Gas discharged into the wound forces the skin to expand and slam against the muzzle. This often results in an impression of the muzzle on the skin in the form of an abrasion or soot. When the skin stretches outward more than it can withstand, it tears, resulting in a stellate appearance to the wound. This is common with contact shots where a thin layer of skin and subcutaneous tissue overlies bone (2,4,5).

The impact of unburned or partially burned gunpowder grains onto and into the skin results in a pattern commonly known as "powder tattooing." This pattern is a distinct characteristic of an intermediate range wound and is produced at distances greater than contact. These patterns are commonly produced with handguns up to a distance of 1 m; however, this distance varies depending on characteristics of the firearm and the type of ammunition. Distant wounds have fewer defining characteristics, generally consisting of a hole surrounded by a ring of abrasion. The abrasion ring is caused by the bullet rubbing against the skin as it passes through it. There may be the presence of bullet wipe which is seen as a darkened ring around the margins of the hole. This is the result of firearm discharge residues, such as lead, being wiped from the surface of the bullet onto the skin (2,6).

Abell et al. (7) and Payne (8) showed that the presence of insects greatly affects the decomposition process and increases the rate of decomposition. The absence of insects results in decomposition that is primarily microbial with minimal tissue degradation (7).

The purpose of this research was to assess the effects of decomposition on gunshot wound characteristics (physical surface tissue characteristics) when a body is placed in an exposed environment and when placed in a shaded environment with low temperatures (−10°C to +10°C) such that insects would not contribute substantially to the physical changes as the body decomposed. It was hypothesized that when insects are absent and temperatures are low, decomposition will not affect the surface characteristics of gunshot wounds to the extent that they could be misinterpreted.

Materials and Methods

Site Selection and Preparation

The study site consisted of an open field and an adjacent forested area on Nova Scotia Power property in Dartmouth, Nova Scotia, Canada. The open field consisted of grass, low shrubs and rocky ground and the forested area consisted of deciduous trees with a damp leaf-covered ground. Although the trees and shrubs lost their leaves, there remained a difference between the sites in terms of ground coverage and shade. 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

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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). The ammunition used was Winchester brand, caliber 9 mm Luger, 115 grain, full metal jacket. On November 7, 2005, three pigs were placed in the open field and three were placed in the forested area. This entire process was duplicated on November 8, 2005 (3).

Pigs were placed approximately 15 m apart and the sites for the replicate groups were separated by approximately 2 km. Pigs were wrapped completely with chicken wire to prevent scavenger damage and were anchored in the ground with rebar to prevent scavengers from pulling the carcass away (3).

Data Collection and Analysis

Pigs were examined at 48 h intervals and evidence was documented through digital photographs, field notes, and measurements of the diameter of the bullet holes. Wounds were observed and information was collected until the pigs remained consistently frozen. Initially, wounds inflicted postmortem were examined and characteristics observed were compared to documented information on wounds inflicted perimortem (1,2). The characteristics of each wound were recorded at each site visit (3).

Results

Decomposition

There were two recognizable stages of decomposition, fresh stage and bloat stage; however, it was not the typical bloat stage as described by Anderson and VanLaerhoven (9). The torso developed discoloration due to decomposition but it did not distend. Overall, pigs looked the same as they did when they were shot on day 0. Pigs maintained this appearance and remained intact until observations were complete 56 days later (Fig. 1*a,b*). There were no differences observed in decomposition between pigs in the woods and pigs in the exposed environments over the 56 days.

Contact Shots

Initially, all of the contact shots displayed wound margins that were stained with soot. A zone of abrasion around the wound was present on all contact wounds and after 1–3 days' exposure became more prominent with drying (Fig. 2*a*). A muzzle impression was visible in soot when the pigs were initially shot and was visible as a distinct abrasion by day 1 or day 2 (Fig. 2*a*). The characteristics observed with the contact shots maintained their appearance until the pigs were covered in snow (Fig. 2*b*). Once ice and snow covered the pigs, the effect of cold temperature was apparent; the underlying wounds became desiccated. Desiccation was restricted to the areas of damaged epidermis which were the abraded areas in the shape of the muzzle (Fig. 2*c*).

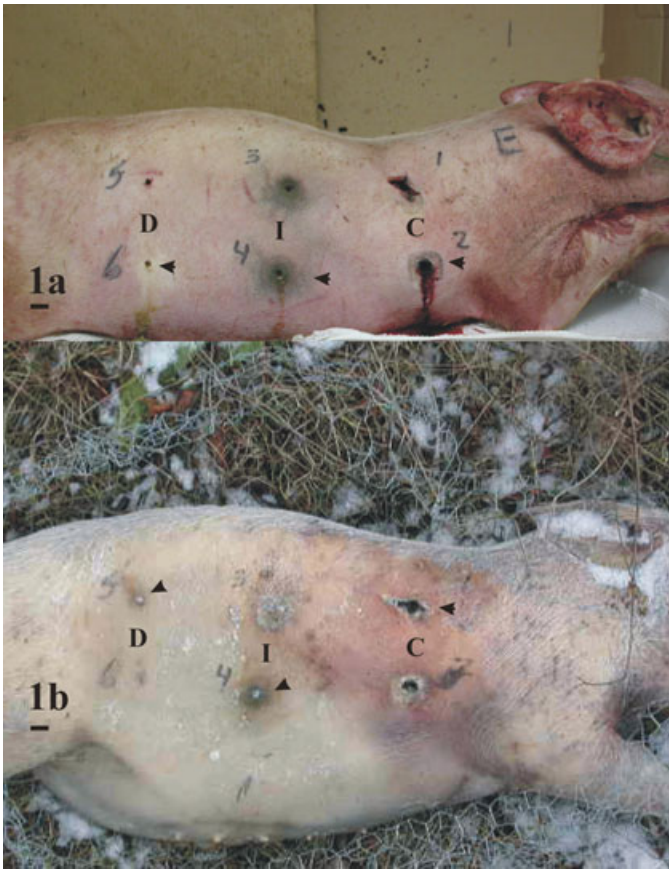

FIG. 1—*Gunshot wounds inflicted with a pistol at contact (C), intermediate (I, 2.5 cm) and distant (D, 1.75 m) ranges. Arrows indicate bullet holes. Scale bar = 1 cm. (a) Day 0, wounds were initially inflicted. (b) After 56 days' exposure to the environment.*

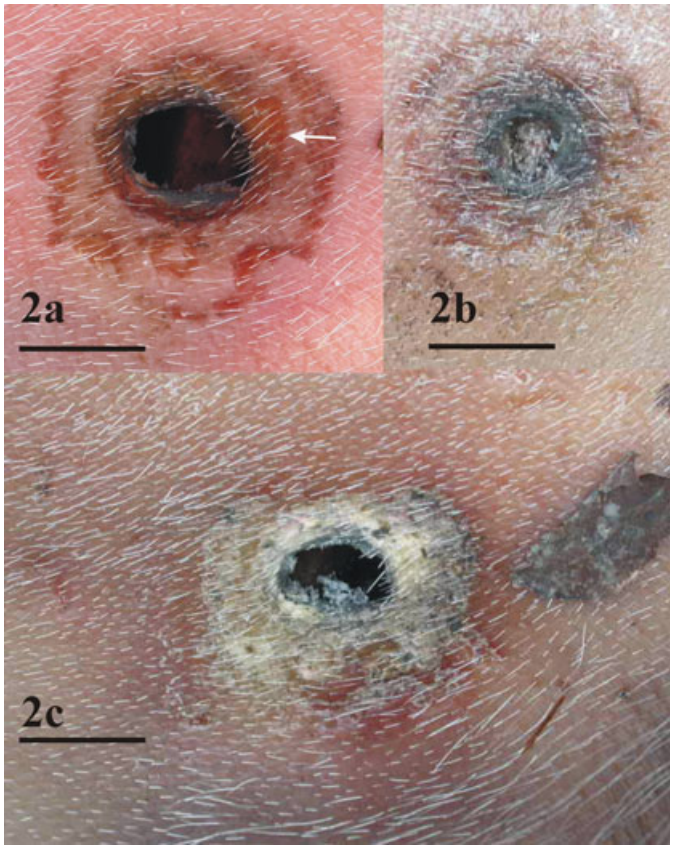

FIG. 2—*(a) Contact wound after 4 days' exposure. Arrow shows zone of abrasion. Scale bar = 1 cm. (b) Contact wound after 56 days' exposure that was not covered with ice and snow. Note preservation of muzzle impression. Scale bar = 1 cm. (c) Contact wound after 56 days' that was covered with ice and snow. Note desiccation is restricted to site of muzzle impression. Scale bar = 1 cm.*

There were six holes that displayed stellate tearing and this phenomenon was observed on day 0 (Fig. 3*a*). The characteristic kept this form until the final day of observation (Fig. 3*b*). Unburned gunpowder was observed at the edge of four of the wounds. It appeared as yellowish green clumps found along the bottom edge of the hole (Fig. 3*a*). Powder was apparent until wounds were desiccated.

Intermediate Shots

Unburned and partially burned gunpowder was visible initially and remained evident until the final day of observation. Powder tattooing was not obvious on day 0 and there was a lot of soot initially associated with the wound. After day 2, powder tattooing was confirmed by red discoloration. The pattern was generally dense with discoloration from individual particles at the edge of the pattern (Fig. 4*a*). Powder tattooing remained visible until the final day of observation (Fig. 4*b*). Once ice and snow covered the pigs, the effect of cold temperature was apparent; the underlying wounds became desiccated. Desiccation was restricted to the areas of damaged epidermis which were the areas of the powder tattooing patterns (Fig. 4*c*).

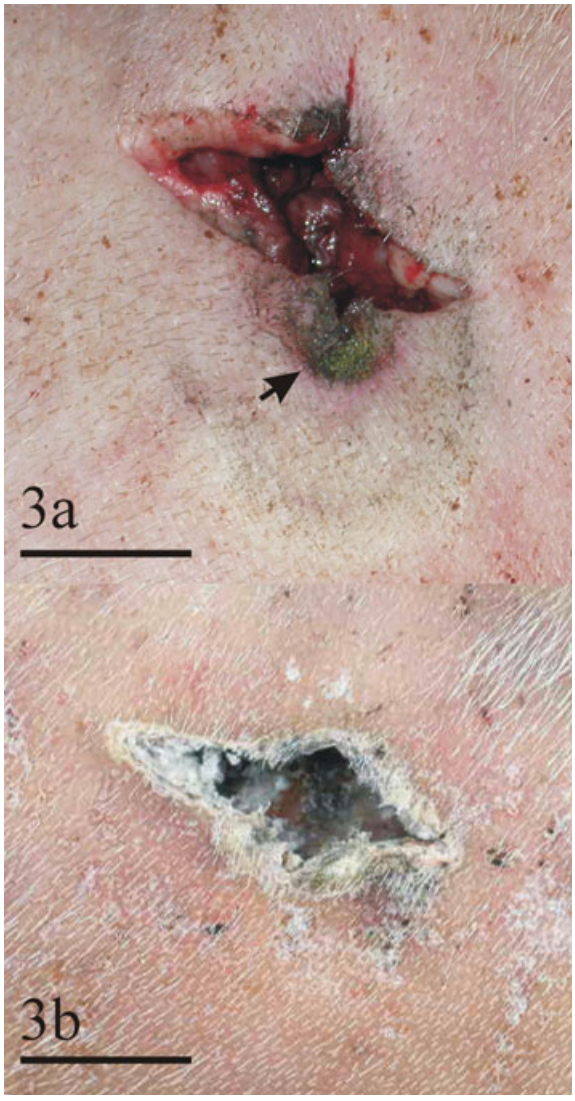

FIG. 3—*(a) Fresh contact wound (day 0) displaying stellate tearing. Arrow shows unburned gunpowder. Scale bar = 1 cm. (b) Contact wound after 56 days of exposure that was covered with ice and snow. Scale bar = 1 cm.*

Distant Shots

Bullet wipe was present on all shots on day 0 (Fig. 5*a*) and was no longer visible after days 2–4. A dried abrasion ring was prominent on all of the wounds on day 1 or 2 and remained visible throughout the period of observation on half of the wounds (Fig. 5*b*). The abrasion rings on the other half of the wounds

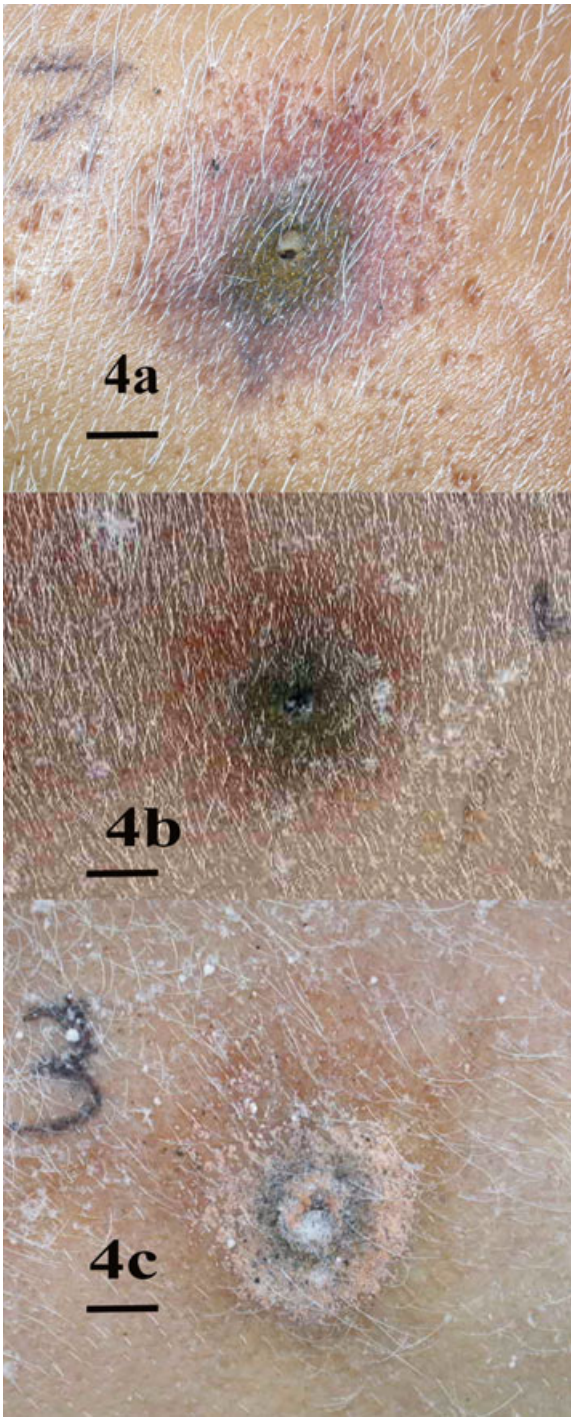

FIG. 4—*(a) Intermediate wound after 4 days' exposure to the environment. Scale bar = 1 cm. (b) Intermediate wound after 56 days of exposure that did not become covered with ice and snow. Scale bar = 1 cm. (c) Intermediate wound after 56 days of exposure that was covered with ice and snow. Note desiccation is restricted to area of powder tattooing. Scale bar = 1 cm.*

FIG. 5—*(a) Fresh distant wound (day 0). Arrow shows bullet wipe. Scale bar = 1 cm. (b) Distant wound after 56 days of exposure that did not become covered with ice and snow. Scale bar = 1 cm. (c) Distant wound after 56 days of exposure that was covered with ice and snow. Scale bar = 1 cm.*

became desiccated or were obscured by ice or snow by the final day of observation (Fig. 5*c*).

Bullet Hole Diameter

As time progressed throughout the study, the bullet hole diameter changed slightly. The average measurement of the hole diameter for contact shots increased from 9.2 to 11.1 mm, intermediates wounds decreased from 4.6 to 4.4 mm, and distant wounds decreased from 4.4 to 3.9 mm.

Discussion

Payne (8) states it is difficult to divide decomposition of a carcass into well-defined stages when insects are absent or when temperatures are low. The results of this study support Payne's observation; the pigs entered the earliest phase of the bloat stage, evidenced by the green discoloration in the torso. Apart from this, there was little change in the overall appearance of the pigs over the 56-day observation period. The characteristics of the gunshot wounds did not change over the 56 days to the extent that would lead to misinterpretation of the evidence (Fig. 1*a,b*). Once the wounds were covered with ice and snow, the effect of desiccation was evident on the wounds. The desiccation was restricted to the damaged epidermis around the gunshot wounds; therefore, what remained were a desiccated muzzle impression in contact shots and a desiccated gunpowder pattern in intermediate shots.

In conclusion, when insects were absent and temperatures were low, gunshot wounds maintained their characteristics. Once the bodies became covered with ice and snow, the wounds did not assume the typical appearance of gunshot wounds; interpretation at this point would be difficult if one were not familiar with the effects ice and snow may have on gunshot wound characteristics.

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