



Lethal trajectory: a case of fatal injury from an accidentally projected metal fragment[☆]

Giacomo Madeo[☆] , Roxenny Massiel Bruno Bonilla, Paola Kildani, Mario Gabbrielli

University of Siena, Italy

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ABSTRACT

Introduction: Mechanical energy trauma is a major cause of death, especially in high-risk occupational settings such as agriculture and industry. These injuries result from the sudden transfer of mechanical energy to the body via impacts, compressions, or projected objects. This report presents an accidental fatality in a rural area involving an excavator with a brush-cutting attachment.

Material e methods: A male was found supine along a country road near an agricultural field. Inside the field stood an excavator with its boom extended toward a hedge, equipped with a brush cutter. The windshield was shattered, with glass fragments inside the cab and around the vehicle. A cylindrical metal fragment (15 cm long, 0,5 cm diameter) was found on the driver's seat.

Results: External examination showed an inwardly beveled wound on the right hemithorax and another in the lumbar area. Autopsy revealed a wound path from the chest injury, directed downward, left to right, and front to back, with soft tissue lacerations, rib fractures, pleural penetration, diaphragmatic and right liver lobe injury, and an outwardly beveled wound in the lumbar region. Death occurred from massive hemorrhage and respiratory failure as the victim reached the roadside. The projectile was a piece of metal mesh forcefully ejected by the brush cutter after impact with a wire fence. The injury pattern was consistent with high-energy trauma.

Discussion: This case highlights the importance of thorough scene investigation in violent deaths, as autopsy alone would not have revealed the projectile origin or the event dynamics.

1. Introduction

The study of injuries resulting from external trauma has always played a central role in forensic medicine, given their frequent occurrence — such as in traffic accidents and occupational injuries. As Puccini [1] already noted, in traumatology the causal factor is identified with the principle of force. The injuring potential of a body depends on its kinetic energy (so-called “living force”), which is in turn determined by its mass and velocity: it is directly proportional to the weight and increases geometrically with velocity. In other words, a body with twice the mass of another, moving at the same speed, has double the kinetic energy; while if two bodies have the same mass but one moves at double the speed, the latter has four times the kinetic energy.

Traumatic injuries can be schematically classified into the following categories:

- **Blunt force injuries:** compressions and skin abrasions, bruises and hematomas, excoriations, lacerations and contused-lacerated wounds, visceral injuries, bone fractures;
- **Sharp force injuries,** inflicted with proper or improvised weapons: stab wounds, incised wounds, stab-incised wounds, chop wounds, abrasions, impalements, mutilations;
- **Gunshot wounds:** from single or multiple projectiles, blast injuries;
- **Major trauma:** falls from height, run-overs, explosions, crush injuries;
- **Violent mechanical asphyxias:** smothering, throttling, strangulation, hanging, drowning, internal submersion, blockage of airways, thoracic compression, confinement.

It must also be noted that injuring objects may be typical — specifically designed for that purpose — or atypical, i.e. intended for other uses but capable of producing similar effects, such as incised wounds caused by glass fragments.

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^{*} Corresponding author.

E-mail address: madeo5@student.unisi.it (G. Madeo).

Forensic traumatology thus aims at identifying the nature and extent of the injury, the type of injuring agent and its mechanism of action, as well as the circumstances of the traumatic event, with particular focus on differentiating between homicidal, suicidal, accidental, self-inflicted, or work-related injuries. Furthermore, it evaluates the legal implications of the traumatic event.

In occupational settings — particularly in industrial, agricultural, and construction contexts — the risk of injuries caused by mechanical energy is particularly high due to the use of heavy machinery, high-powered equipment, and complex operational devices. Understanding the mechanisms of injury, together with the correct application of safety and prevention measures, is therefore essential for the protection of workers' health and physical integrity.

The purpose of the present contribution is to report a case of trauma caused by mechanical energy in an agricultural setting, in which the use of a hedge-cutting arm produced a projectile-like fragment acting similarly to a firearm bullet. The medico-legal scene inspection was crucial for reconstructing the event and identifying the injuring agent, subsequently confirmed by the autopsy examination.

2. Materials

The fatality occurred in open countryside. The scene inspection was carried out at 18:30, two hours after the discovery of the body, with the aid of artificial lighting. The body lay supine on the roadside at the edge of a field accessed through a wide ungated entrance. Inside the field, about 70 m away, there was a Caterpillar tracked excavator, oriented towards a hedge behind which stood a metal fence with anti-intrusion spikes. The excavator was equipped with a hedge-cutting arm with lateral chains. The arm was touching the hedge, approximately 1,5 m above the ground, positioned parallel to the driver's cab. The front windshield of the excavator was shattered, missing its lower left portion corresponding to the driver's seat; numerous glass fragments of various sizes were scattered both inside and around the machine (Photos 1–3).

On the seat, multiple glass fragments of varying size and a cylindrical metallic fragment, grey-black in color, irregular in shape, 0,5 cm in diameter and 15 cm in length, were observed. On the lower third of the left side of the seatback, corresponding to the driver's position, there was a punctiform discontinuity (Photo 3).

3. Results

External examination revealed the body in supine position, partially covered with a white sheet and a thermal blanket, later removed. The decedent wore only boxer shorts, socks, and shoes, as the work clothes had been removed by rescuers and placed near the body.

On the face and neck, numerous excoriations and small discontinuities were noted, caused by the impact of windshield glass fragments. On the anterior chest, in the upper right pectoral region, there was a contused-lacerated wound with bruised margins and burn features. The wound was linear, transversely oriented, measuring 8 cm in length, with maximal diastasis of 2,5 cm; it extended into the underlying soft tissues with hemorrhage and exposure of deeper layers (Photo 4). On dorsal inspection, the back appeared diffusely smeared with soil and blood. On the lower third of the right side of the back, there was a 0,5 cm "C"-shaped wound, concavity facing downward, with blood extravasation (Photo 5).

At the scene, ambient temperature was 4°C at 19:07. Rectal temperature was 30,5°C at 19:00. Weather was clear with moderate wind. Rigor mortis was present in the jaw and beginning in the upper and lower limbs. Hypostasis was poorly represented, pinkish-red in color, located posteriorly on the trunk and limbs in non-compressed areas, and disappeared completely on pressure.

The decedent's work clothing was bloodstained. On the sweatshirt, in the anterior right area, there was an oval discontinuity with gaping, introflected margins, burn marks, and a surrounding reddish halo. On the posterior side of the sweatshirt, in the right flank area, a second circular defect of 0,5 cm with everted margins was noted. On the undershirt, a similar oval wound with introflected margins was visible on the anterior right area, while posteriorly, in the right flank, there was a drop-shaped defect with its apex downward, everted margins, and 0,5 cm in diameter. All fabric lacerations were triangulated.

Autopsy revealed the wound tract extending obliquely through the right chest wall, with fractures of the 5th and 6th ribs, intercostal muscle laceration, and massive right hemothorax (~1650 ml of blood in the pleural cavity). The diaphragm showed a 1 cm circular perforation. The tract continued caudally into the liver, with a 6 cm laceration on the superior surface and an 8 cm laceration on the inferior surface of the right lobe. The trajectory was consistent with the high-energy penetration of a rigid, irregular foreign body.



Photo 1. Brush-cutter arm touching the hedge, with a wire mesh fence located behind it.



Photo 2. The front windshield was shattered and missing its lower-left portion.



Photo 3. Metal fragment and glass fragments on the seat. On the upper left part of the backrest, a small hole in the fabric.

Histology revealed diffuse signs of blood stasis and edema. The brain showed perivascular and perineuronal optically empty spaces, consistent with cerebral edema, and vascular congestion. The lungs showed areas of atelectasis, alveolar edema, inflammatory foci, increased connective tissue, acute emphysema with rupture of alveolar septa, and vesicular-bullous cavities. The heart showed diffuse myocardial sclerosis with fibrous replacement, cicatricial areas from prior ischemic events, and vascular thickening, associated with congestion. The liver showed fibrous septa subdividing the parenchyma and hepatocytes with vacuolization. The kidney displayed vascular congestion, fibrous replacement, and some hyalinized glomeruli. The spleen maintained preserved architecture but with reduced erythrocytic content.

Death resulted from thoracic and abdominal osteo-visceral injuries caused by the impact of a small, hard projectile animated by significant kinetic energy, striking the victim in the right anterior chest with a trajectory — relative to the erect body — downward, left-to-right, and front-to-back. The projectile penetrated the right pleural cavity, causing pneumothorax and massive hemothorax, traversed the diaphragm, passed into the abdominal cavity, lacerated the right lobe of the liver, and exited through the posterior abdominal wall in the right lumbar region. It is hypothesized that the victim, seated in the excavator, bent forward at the moment the projectile detached, failing to avoid it. The injuries produced pneumothorax and hemothorax from soft tissue bleeding, as well as intra-abdominal hemorrhage, initially allowing the



Photo 4. A discontinuity of the tissues was observed in the upper right pectoral region (entry wound).



Photo 5. A discontinuity of the tissues was observed on the right lumbar region (exit wound); note the margin were everted.

man to seek help but leading to progressive deterioration and death within approximately twenty minutes. The metallic fragment found on the seat is fully compatible with the fatal projectile.

4. Discussion

Analysis of this case highlights the crucial role of the medico-legal scene inspection, which allowed reconstruction of the event dynamics and, most importantly, identification of the injuring agent: a metallic fragment functioning as an atypical projectile. External examination confirmed the entrance and exit wounds, while autopsy enabled reconstruction of the wound tract, showing rib fractures, diaphragmatic perforation, and hepatic lacerations, consistent with high-energy penetration and exit through the lumbar region.

The key factor triggering the injuring potential of the metallic fragment — later recovered from the seat — was the velocity imparted by the hedge-cutting mechanism. Contact with the metal fence spike caused detachment of the fragment, which became incandescent and was projected at high speed.

5. Conclusions

The two investigative stages — the scene inspection and the autopsy — provided, in a complementary manner, the essential elements for understanding the injury dynamics: on one side, the environmental reconstruction and position of the evidence; on the other, the identification of the specific injuries and their production mechanism.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

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