



Homicide, suicide, or accident? Complex differential diagnosis. A case series

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ABSTRACT

Distinguishing between homicides, suicides, and accidental deaths remains a challenging task. The examination of actual cases, which involve a multitude of variables, significantly contributes to our understanding of these matters. In this context, we present three distinct cases that required the involvement of various specialists to conduct a thorough analysis of the manner of death. In the first case, the integration of on-site inspection, autopsy, radiological, and kinematic data enabled the identification of a homicidal death. In the second case, the combination of circumstantial evidence, autopsy findings, toxicological analysis, and meteorological data revealed an atypical accidental death resulting from an attempted suicide. In the third case, radiological findings, supplemented with criteria from forensic science, indicated an accidental manner of death. In all reported cases, a multidisciplinary approach played a pivotal role in the differential diagnosis of the manner of death.

1. Introduction

Distinguishing between homicide, suicide and accident remains challenging, but case studies offer valuable insights [1]. Numerous authors have underscored the significance of adopting a comprehensive investigative approach, incorporating various methods and analyses. Indeed, a multidisciplinary approach often proves crucial in establishing an accurate diagnosis of the manner of death, especially in complex cases [2–5].

The study of real forensic cases, with many variables involved, contributes significantly to the understanding of these issues. In real-life scenarios, forensic pathologists observe and interpret a wide range of data, including autopsy findings, radiological scans, toxicology analysis, and circumstantial evidence [6]. This experiential knowledge is progressively developed and refined by the findings of individual cases, leading to a more comprehensive understanding. This understanding is further enriched by interacting and collaborating with experts in various fields [7].

In this context, we present three cases that demanded the involvement of several specialists to conduct a comprehensive analysis, encompassing circumstantial, autopsy, toxicological, kinematic, and radiological data.

2. Cases presentation

2.1. Case 1

A 60-year-old man struck a 24-year-old young man with his car. Two hours later, the man went to the police to report an unintentional accident. The young man, who remained at the scene of the collision, received assistance from the emergency services. Unfortunately, shortly after being taken to the hospital, he succumbed to his injuries.

During the on-site inspection, investigators noticed black marks on the adjacent wall where the young man's body was found (Fig. 1). Examination of the vehicle revealed damage to the bodywork, bloodstains, and fragments of down filling material in the front right-hand area (Fig. 2).

The post-mortem computed tomography (CT) scan revealed multiple fractures, including those of the right parieto-temporal bone, skull base, right humerus, thoracic and lumbar vertebrae, sacrum, and right ilium (Fig. 3). Multiple tears in the down jacket and trousers were observed during the examination of the victim's clothing. An external examination showed soft pink hypostasis and multiple abrasions on the right fronto-zygomatic and gluteal regions, as well as on the knees and ankles bilaterally. Contusions of the lungs, spleen, and kidneys were found the autopsy. The cause of death was attributed to hemorrhagic shock, and

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Fig. 1. Tyre marks on the wall detected during the site inspection.



Fig. 2. Damage to the bodywork of the front right side, with detail on the down filling and blood stains.

the location of the fractures correlated with injuries consistent with lateral crush trauma.

During the investigation, it was revealed that the victim had filed a legal claim against the driver just two days prior to the accident. Additionally, surveillance footage captured the car's movement a few meters before the point of impact.

Kinematic analysis indicated that the vehicle was traveling at a high speed, resulting in a high-energy collision with the victim. It was highly likely that the young man was crushed between the right front portion of

the car and the adjacent wall. This conclusion was supported by the pelvic fractures, which were indicative of crushing trauma, the tyre marks on the wall, and the presence of down and bloodstains on the damaged car.

The integration of autopsy, radiological, circumstantial, and kinematic data led to the conclusion that the manner of death was homicide.

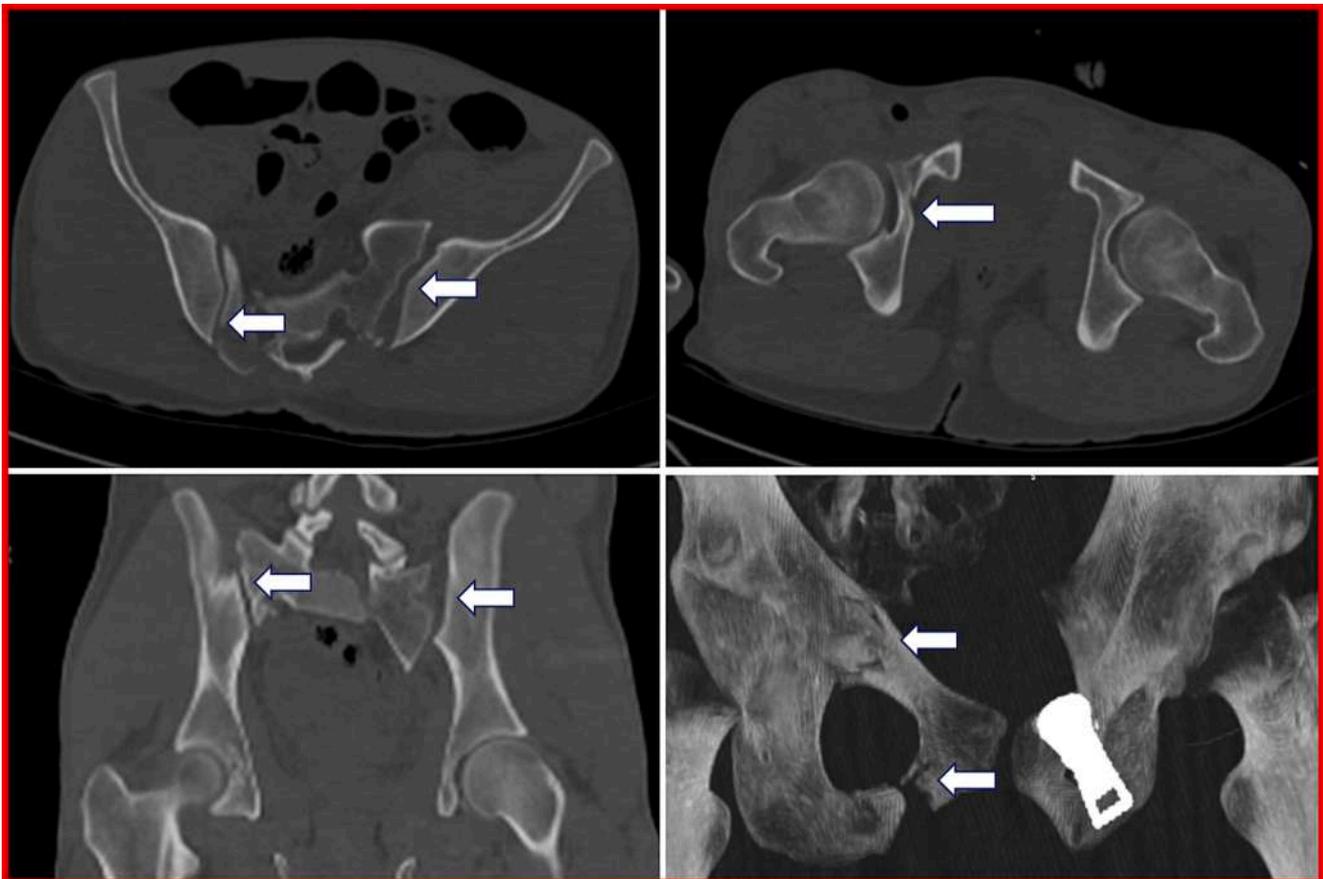


Fig. 3. Multiple pelvic fractures on postmortem CT scan.

2.2. Case 2

In May 2016, a 45-year-old man was found dead in the driver's seat of his locked car with closed windows. An on-site investigation uncovered a bloodstained switchblade knife, an unsealed insulin pen, a blister pack of benzodiazepines, and a suicide note in close proximity to the body.

The autopsy showed multiple stab wounds at the wrists (Fig. 4). The radial and ulnar artery were intact. Thus, the cause of death due to hemorrhagic shock was ruled out. Toxicological tests were positive for therapeutic concentrations of benzodiazepines (alprazolam). The man did not have diabetes, and the insulin pens recovered were sealed and unused (see Fig. 5). Consequently, acute drug intoxication was ruled out as the cause of death.

A witness reported that he had seen the victim in the car from the day before, sitting in the same position in which he was found dead. Weather and climate data, encompassing temperature, humidity, and solar radiation, from the preceding days were analyzed. Considering the sealed windows, the car's dark color, and the prevailing weather conditions it was estimated that the temperature within the vehicle had reached approximately 40 °C with a humidity level of 55 %. Based on this information, the perceived temperature inside the car was approximately 58 °C [8]. Prolonged exposure to such conditions is known to be increase to heat stroke, which could have led to the fatal outcome.

Therefore, it was postulated that the man intentionally attempted suicide by cutting his wrists and taking benzodiazepines, but the cause of death was determined to be accidental heat stroke resulting from the extreme temperatures reached inside the car.

2.3. Case 3

A 55-year-old man was found lying on the floor of his workplace within an industrial plant. He appeared confused and had noticeable facial bloodstains. A significant bloodstain was observed on the floor near to a shelving (Fig. 6). The man was transported to the hospital, where a CT scan revealed a subarachnoid hemorrhage, along with multiple fractures of the right fronto-temporal bone (Fig. 7) and radius. The man died due to infectious complications during his three-month hospitalization after undergoing neurosurgical intervention.

The autopsy confirmed the fractures as reported in radiology and showed the brain lesions. No additional traumatic injury was observed. The cause of death was septic shock resulting from a bacterial infection contracted during hospitalization for the head trauma.

No circumstantial data suggested that aggression had occurred. However, in the absence of witnesses or video evidence, the manner of death was assessed also using the forensic criterion commonly referred to as the "hat brim line". In this case, all skull fractures were found within the boundaries of the brim line, supporting the assumption of an accidental fall (Fig. 8).

3. Discussion

The reported cases demonstrate that assessing the manner of death is a complex process and it is crucial the integration of all available information during the investigation.

The first case involved a pedestrian impact, where the victim sustained injuries typically associated with the lower body's impact against the front of the vehicle. These injuries included abrasions and fractures to the pelvis and limbs. Determining the manner of death in pedestrian collision cases is challenging when only autopsy and radiological data



Fig. 4. Wrists stab wounds.

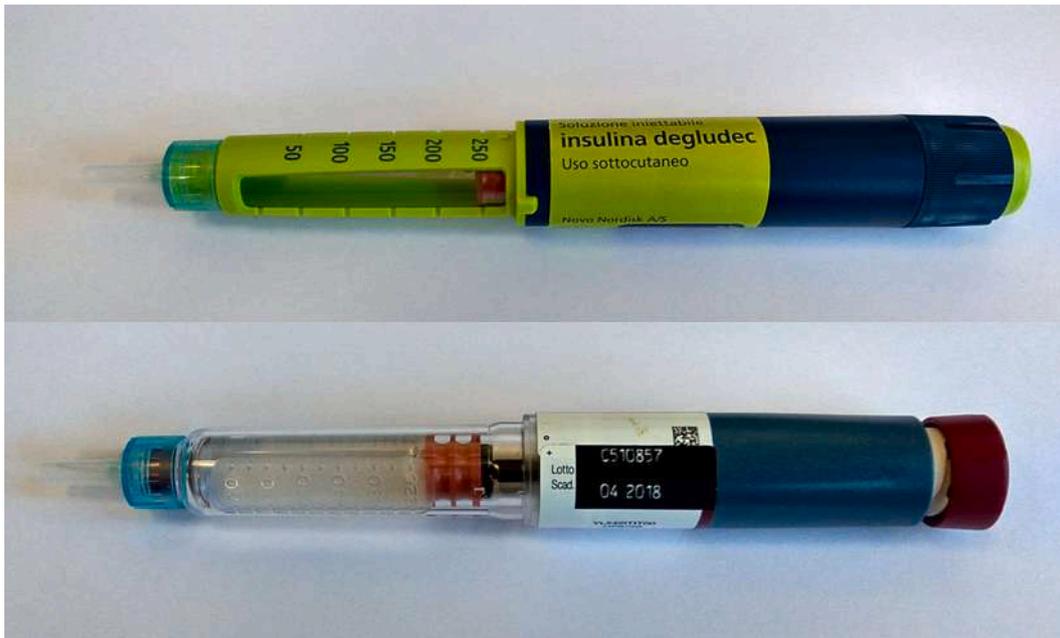


Fig. 5. Sealed insulin pens found on the passenger seat.



Fig. 6. Blood stain contiguous to the body.

are available. Homicide becomes a consideration if there was a prior argument or dispute between the victim and the driver. The absence of skid marks or brake marks on the road surface may also suggest that the driver intended to hit the victim [9]. Moreover, during the investigation, it is essential to assess the presence of public or surveillance cameras that might have recorded the incident and to check for dashboard devices or black boxes in the vehicle [10,11]. In the reported case, the analysis of down filling material and blood stains on the car body provided indications of the point of impact. Additionally, the presence of tire marks on the wall and bilateral pelvic fractures suggested crushing trauma between the car and a wall. Kinematic analysis confirmed that the vehicle was traveling at a high speed at the time of impact, with no evidence of braking. These findings implied that the collision involved significant kinetic energy and no evasive maneuvers. Finally, witness statements confirmed that the driver and victim knew each other and had been involved in an argument, increasing the likelihood of a homicidal cause of death [12].

The second case is unique due to the presence of many factors typically associated with suicide deaths, despite the absence of any established traumatic or toxicological cause of death during the autopsy. The most compelling evidence was the presence of stab wounds on the wrist, a common feature of suicide attempts [13,14]. However, it's crucial to note that these injuries did not damage any significant vascular structures and thus could not have been the cause of death. Furthermore, the victim had tested positive for benzodiazepines at a non-lethal level, making it unlikely that benzodiazepines were the cause of death. The presence of an insulin pen also suggested suicidal intent, even though, in this case, the pen was sealed and unused. This indicates that the individual had acquired suitable means to achieve a hypoglycemic death [15]. A suicide note was also found in the car, indicating suicidal intent. The analysis of the vehicle characteristics and weather data indicated that the likely cause of death was an accidental heatstroke. The post-mortem diagnosis of heatstroke remains a diagnosis of

exclusion when there is no circumstantial or medical evidence of elevated body temperature or signs of multi-organ failure. When the ambient temperature at the time of death is elevated, it supports the presumption of heatstroke as the cause of death in cases where the antemortem temperature cannot be determined [16–19]. In the reported case, the most plausible hypothesis was death due to heatstroke, as the victim had been inside the car for a day with temperatures reaching 58 °C. The true reason behind the incident, whether it was a genuine suicide attempt or a demonstrative act, remains a subject of debate and is likely to remain an unresolved issue.

In the third case, where death occurred three months after the head injury, it was essential to base the assessment of the manner of death on radiological images taken at the hospital immediately after the accident. Previous studies have emphasized the significance of forensic radiology in complex cases, as imaging can offer valuable insights to supplement autopsy findings [20,21]. Radiological data were interpreted according to forensic practice, employing the hat brim rule. This rule defines an area delineated by the outermost circumference of the cranial vault, with its upper boundary passing through the glabella. According to the hat brim line rule, head injuries resulting from accidental falls are typically situated within this boundary, whereas injuries caused by blows, as observed in homicide cases, tend to occur above the hat brim line [22,23]. Moreover, multiple instances of ecchymoses and abrasions are frequently observed in cases involving blunt force trauma. These injuries are typically absent in accidental falls, where a specific point of impact can be identified [24,25]. However, the hat brim line rule doesn't offer a definitive differential diagnosis between accidental and homicidal deaths, relying on statistical and probabilistic data. The determination of the manner of death is always based on the comprehensive evaluation of all available evidence. The reported case was primarily classified as an accidental death due to the lack of circumstantial evidence indicating an act of aggression. The location of the fractures within the brim line and the absence of additional facial

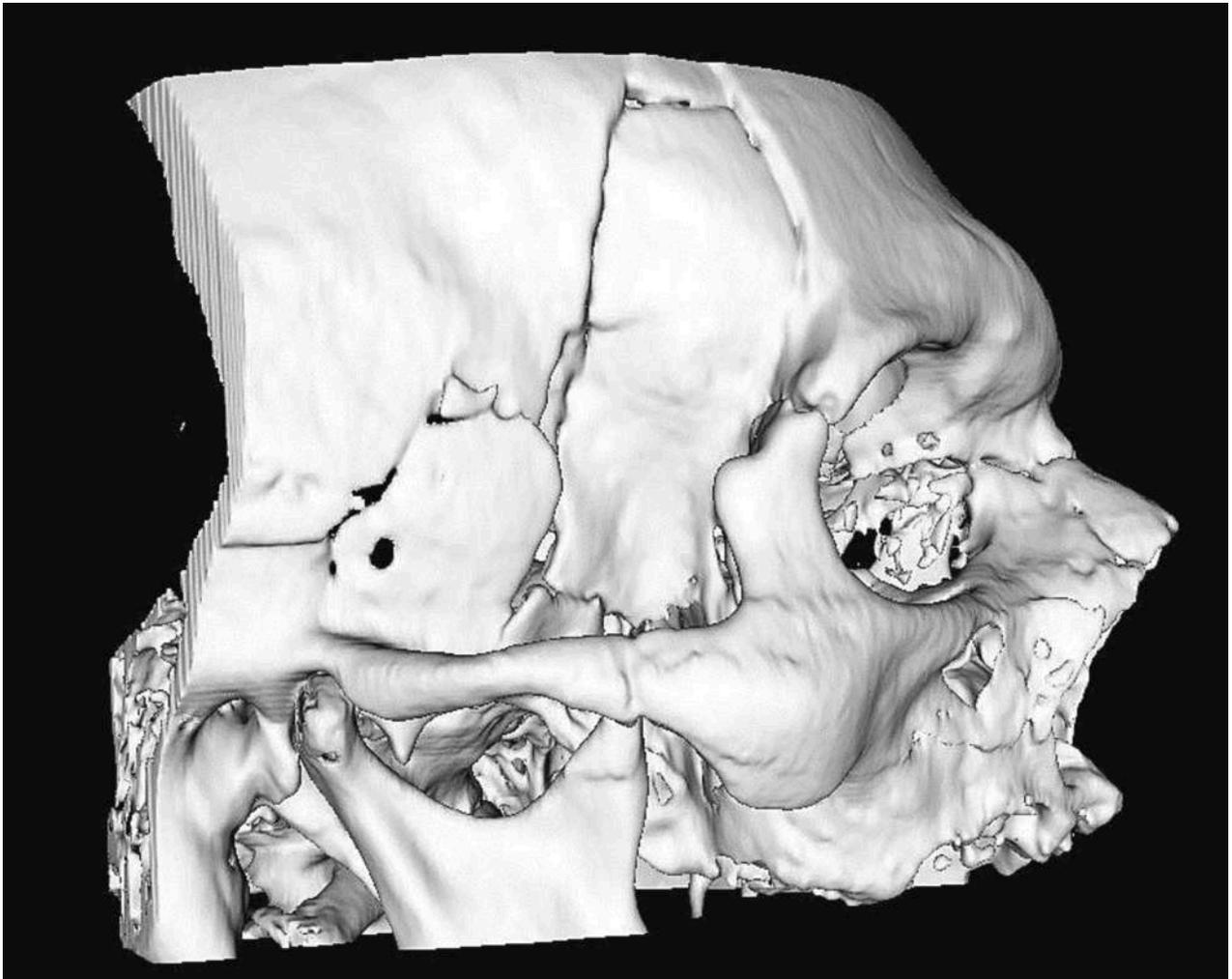


Fig. 7. Temporal fractures on postmortem CT scan.

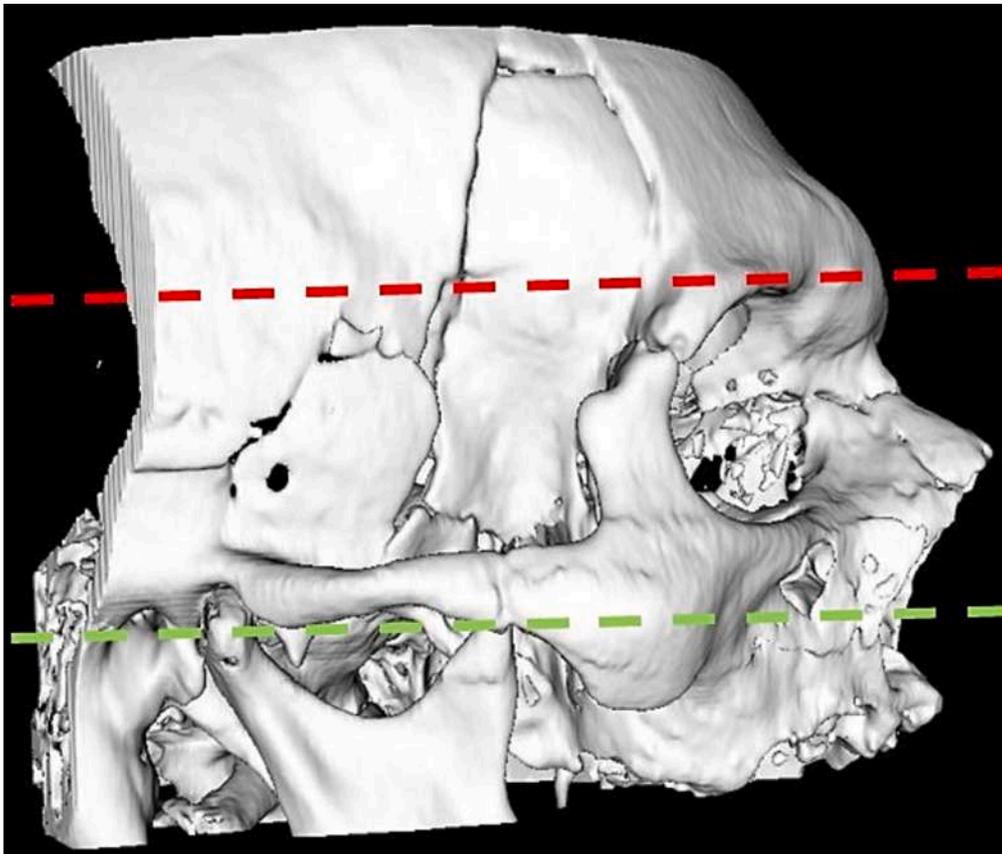


Fig. 8. Hat brim line applied to case 3.

injuries further supported the presumption of an accidental death. The wrist fracture could be explained by an attempt to mitigate the impact upon hitting the ground.

4. Conclusions

The assessment of the manner of death is a significant challenge and its interpretive complexity may still be underestimated. The results of the presented case series emphasize the necessity for a case-specific and multidisciplinary approach in forensic practice. This approach should incorporate the insights of the forensic pathologist along with information derived from specialist reports and investigative findings.

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.

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