

CASE REPORT

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# Alcohol and fatal penetration of the cranium by an airgun pellet—a case study from Poland

Sebastian Glowinski<sup>1,2\*</sup> , Sławomir Majdanik<sup>3</sup> and Barbara Potocka-Banaś<sup>3</sup>

## Abstract

**Background** Airguns with the energy of ejected pellets below 17 J are not considered weapons in Poland, can be purchased without permission, and do not require registration. The mere possession of this kind of airgun does not entail any legal consequences, unless it is used for an unauthorized purpose. Sports and recreational shooting do not have to take place within shooting ranges. However, the improper use of this type of weapon can lead to serious injuries and death. In addition, the impact of high blood alcohol content on pain perception can lead to a lack of awareness of the gunshot.

**Case presentation** A 36-year-old woman died a few hours after a head injury inflicted by a 5.50-mm caliber pellet fired from an air gun. The first pellet penetrated perpendicularly through the left temporal bone to the brain. The gunshot tract of this head wound was 6 cm long and ran horizontally and perpendicularly to the surface of the squamous part of the temporal bone. The tract ran through the skin of the skull, the left temporal muscle, and the squamous part of the temporal bone (where the bone was only 1.5 mm thick). The pellet then penetrated the cerebral dura mater, cerebral pia mater on the borderline of the left temporal and frontal lobes, and left lateral wall of the sphenoidal sinus. The victim did not complain of pain due to a high level of alcohol intoxication (0.35 blood alcohol content). The pellet from the second shot (on the foot) penetrated the right foot and was inflicted by the victim.

**Conclusion** The victim died not earlier than 3 h after being shot as a result of intracranial injuries that caused hemorrhage. The outcomes of this study indicated that high alcohol content resulted in reduced awareness of the victim and no apparent symptoms of developing intracranial injuries.

## Highlights

- People should not underestimate the injury caused by an air weapon
- A small external wound is often misleading
- Highly intoxicated with alcohol may alter the perception of pain
- A victim may not be aware of the damage to brain structures and die after a while

**Keywords** Air rifle pellet, Cranial lesions, Death, Intoxication

\*Correspondence:

Sebastian Glowinski  
sebastian.glowinski@tu.koszalin.pl

<sup>1</sup> Institute of Physical Culture and Health, State Higher School of Vocational Education in Koszalin, Lesna 1, 75-582 Koszalin, Poland

<sup>2</sup> Institute of Health Sciences, Slupsk Pomeranian University, Westerplatte 64, 76200 Slupsk, Poland

<sup>3</sup> Department of Forensic Medicine, Pomeranian Medical University, Powstanców Wielkopolskich 72, 70111 Szczecin, Poland



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## Background

According to the Weapons and Ammunition Act of May 21, 1999 (Journal of Laws No. 53/1999, item 549, as amended), airguns with the energy of ejected pellets below 17 J are not considered weapons in Poland (Ustawa o broni i amunicji 1999). Airguns can be purchased without permission and do not require registration. The mere possession of airguns with an energy below 17 J does not entail any legal consequences unless it is used for an unauthorized purpose. Sports and recreational shooting do not have to take place on shooting ranges. They may occur outside shooting ranges, but special care must be taken (Smędra-Kaźmirska et al. 2010). In most cases, airguns are used to shoot metallic projectiles called pellets. These are considered low velocities and are generally regarded as safe (Mishra and Satwinder 2014). Pneumatic weapons use compressed air to propel projectiles. These can be classified by the type of projectile they propel, propulsion mechanism, and caliber (Fig. 1).

The standard calibers for airguns in Poland are 4.5 mm (0.177 in) and 5.5 mm (0.22 in). Depending on the pellet material, they can be made of steel, lead, copper, or plastic. Lead is the most frequently used material in Poland for pellets. The pellet weight was dependent on the pellet brand. Different nose shapes are used for pellets. These are axisymmetric projectiles of three basic types: wad-cutter, sharp-pointed, and spherical. The round-nose pellet in a variable range of Mach numbers showed the best aerodynamic and dynamic behaviors in comparison with other pellets. From aerodynamic and dynamic viewpoints, sharp-pointed pellets would have been preferred if all the shaped pellets had the same weight (Rafeie and Teymourdash 2016). Moreover, a more aerodynamically shaped projectile exhibits a slower decline in velocity and kinetic energy owing to air resistance (Khan 2017). Ladomatos came to the opposite conclusion in his research (Ladomatos 2019). According to the presented results, the geometry of the front face has a weak influence on the drag acting on the pellet base. Flat, sharp-pointed, and cavity-head pellets had higher overall drag coefficients than a spherical pellet. Because of their

extremely lightweight, pellets lose velocity rapidly and become harmless at less than 100 m (DiMaio 1999).

Research on airgun injuries has been conducted for several years (Mallozzi 2008). Milroy et al. described the characteristics of a series of people accidentally or deliberately killed by air-powered weapons (Milroy et al. 1998). Various studies have indicated that injuries are predominant in school-aged patients and male adolescents. This is because the use and manufacture of this type of weapon are aimed at this population (Naude and Bongard 1996; Chhetri and Shapiro 2004). Bakovic described a case of suicide in a young female who used an air rifle (Bakovic et al. 2014).

Abad et al. reported that the critical velocity required for the penetration of human skin by an airgun pellet is approximately 38–70 m/s (Abad et al. 2009). The skin thickness and subcutaneous tissue affect the degree of penetration. DiMaio et al. established that skin penetration of the human lower extremities occurs at 101 m/s for a 4.57 mm, (0.18 in.) 0.54 g pellet, and 75 m/s for a 1.07 g, 5.59 mm (0.22 in.) pellet (DiMaio et al. 1982). Skurczyński demonstrated that air rifles can produce enough power to cause projectiles to penetrate the skull, depending on the distance between the weapon and penetrated tissue (Skurczyński 1965). The pellets typically enter transnasally, transocularly, or transtemporally. In these regions, the bone is the thinnest (Ford et al. 1990). Keten presented the problem of fatal internal organ injuries from close-range air gunshots (Keten et al. 2016). A 6-year-old boy was injured by an air gun. The pellet entered the chest cavity and injured the lung and aorta, causing the death of the boy as a result of bleeding.

People may put themselves or others at risk of air gun injury by inappropriately consuming alcohol in situations where firearms are present. Thus, alcohol consumption is seen as a contributing factor to the occurrence of firearm injuries. Research on this subject has been conducted for many years. For example, Branäs reported that over one-quarter of these decedents in the USA (homicides and suicides) had consumed alcohol heavily before their death (Branäs et al. 2016). The consumption of alcohol in



**Fig. 1** a KANDAR B3-3 airgun. b Diabolo pellet and metal box with 5.5-mm pellets

large doses (BAC - blood alcohol content, 0.25–0.45%) leads to a condition called Stupor-Coma. These stages can be dangerous and even fatal if a person is critically injured. A person in the coma stage is at risk of death. Alcohol has been found to alleviate physical pain, but requires doses consistent with binge drinking to do so. Thompson et al. suggested that a BAC of 0.08% produces a small increase in the pain threshold, a reduction in pain intensity, and a moderate to large reduction in pain intensity ratings (Thompson et al. 2017). Thus, alcohol is an effective analgesic that delivers a clinically relevant reduction in pain intensity ratings. Horn-Hofman et al. indicated that alcohol does, in fact, have pain-dampening effects (Horn-Hofmann et al. 2015).

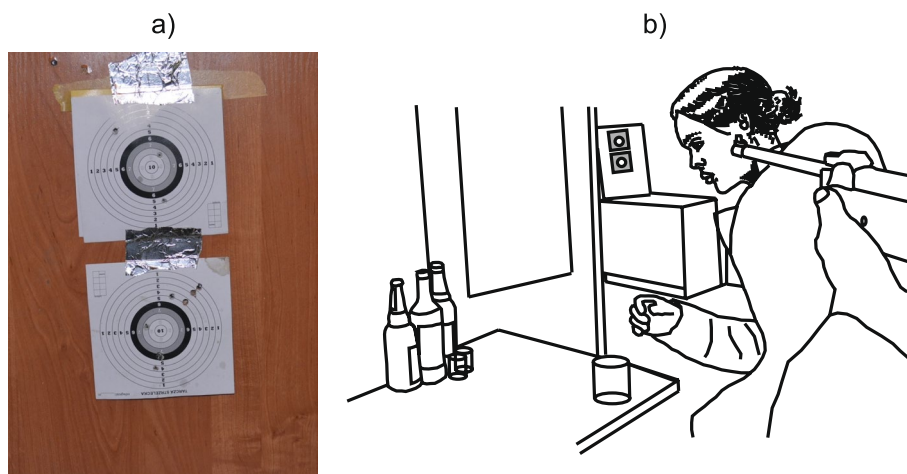
### Case presentation

In the early hours of the morning, in a flat town in Poland, an ambulance crew member called for intervention and reported the death of a 36-year-old woman. The body, already showing early signs of death (*livores mortis*), was kept in a room. On the left temple of the deceased, an injury initially described as epidermal abrasion was found, which raised concerns of the medical staff and was the reason why police officers were called to the site. During the emergency procedure, the woman's glucose level, 7.8 mmol/L, was measured. The owner explained that the victim was a friend and asked him to stay overnight the previous evening. After drinking alcohol (beer and vodka) together, they went to bed before midnight, each in a different room. He found the body of his deceased friend the next day, when he was ready for work. The victim then sat on the floor, with her abdomen resting on a soft bed. In his opinion, she was already

dead by then, but nevertheless, he put her on the floor and tried to help.

A detailed visual inspection of the body location was conducted. On top of the cupboard, there was a wooden board leaning against the wall, with targets inside it. The targets had holes in them. Numerous signs of damage caused by airgun pellets were identified on the furniture and on the walls of the flat. During the preliminary external examination of the corpse, small wounds were found in the left temporal area and right foot. The injuries had tracts, classified as gunshot wounds.

The owner of the flat was interrogated as a suspect in connection with the suspicion that the woman had died by unlawful killing. He explained that the previous night, he and the woman had been drinking alcohol and shooting from a distance with an airgun at targets in the corridor (Fig. 2a). Sitting on a couch in one of the rooms, they took turns shooting at two targets glued to a board set in the hallway on a cupboard. The woman was probably already drunk to such an extent that she was unable to load the air gun with the pellet. As the man fired a shot, the woman, sitting on his right, leaned over to reach for a glass of vodka or beer on the coffee table in front of the couch. Her head was on the shooting line of the airgun held by the man, approximately 20–50 cm from the barrel. As the suspect was shooting, at that very moment the woman was accidentally shot in the temporal part of her left head. The perpetrator assumed that the shot ricocheted from the head. Only slight bleeding abrasion of the epidermis was visible on the temple, while the victim did not complain of any significant ailments. They then continued to consume alcohol and shoot at the targets in the hallway. At one point, the man went to another room from where he heard a shot. At that time, the woman



**Fig. 2** Site of the incident and a reconstruction scheme: **a** targets used for aiming the airgun and **b** scheme of the incident and accidental shooting in the temporal region of the head in the victim reaching for a glass on the coffee table

shot herself from the airgun onto her right foot. Upon returning to the room, the man noticed a wound on the victim's foot, so he hid the airgun and went to sleep in another room. In the morning, while the man was preparing for work, he noticed that the woman was dead.

In this case, a shooting incident reconstruction was performed, during which the suspect presented circumstances in which he was supposed to have accidentally shot the victim on his flat. In particular, the exact positions of the airgun, the victim's head, and the targets placed in the hallway at the time of the accidental shooting were indicated (Fig. 2b).

During the course of the investigation, an examination of the secured air gun was performed, and a forensic autopsy was performed on the deceased's body. A gunshot wound on the head was found, starting with an entrance wound ( $\varnothing$  5 mm) in the left temporal-epidural region (Fig. 3a). The wound had a tract that ran through the skin of the skull, left temporal muscle, and squamous part of the temporal bone. The wound tract ran through the dura mater and pia mater on the borderline of the left temporal and frontal lobes (where a massive diffuse subarachnoid hematoma was also found) and the left lateral wall of the sphenoidal sinus (with the hematoma in its lumen and secondary massive blood aspiration to the lower airways) (Fig. 3b). In this case, the pellet entered transtemporally, where the bone was the thinnest (1.5 mm on autopsy). The gunshot tract of the head wound was 6 cm long in total. Although no exit wounds were found on the scalp, no pellets were found inside the cranial cavity. However, an autopsy revealed that after turning the victim's corpse sideways,

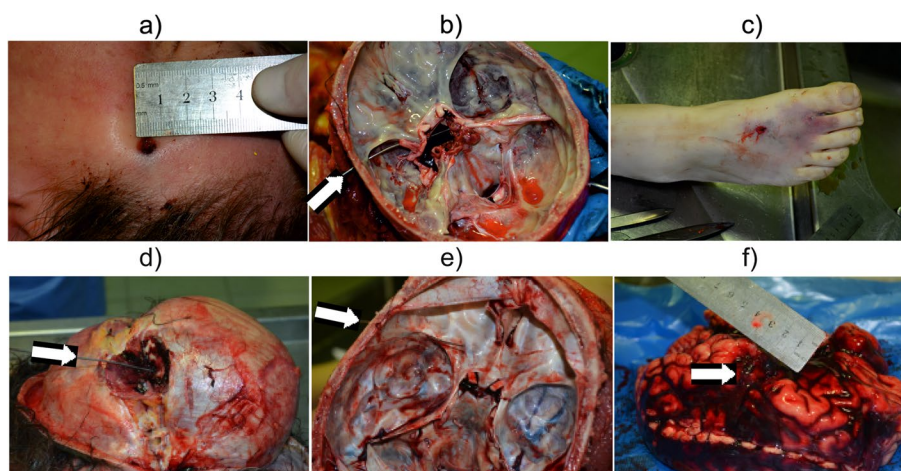
the pellet, together with the blood, flowed out of her body through the nasal canals (cranial cavity  $\rightarrow$  sinus cavity  $\rightarrow$  nasal cavity). Diabolo pellets retrieved from the skull and foot are presented in Fig. 4.

The entrance wound on the right foot was  $6 \times 3$  mm and was surrounded by a 1-mm wide margin of abraded epidermis, with a rounded posterior end and a pointed anterior end (Fig. 3c). It was located within a diffuse dark-red bruise measuring  $80 \times 70$  mm. The gunshot tract was 60 mm long and ran under the skin above the dorsal side of the 2nd metatarsal bone towards the base of the second toe.

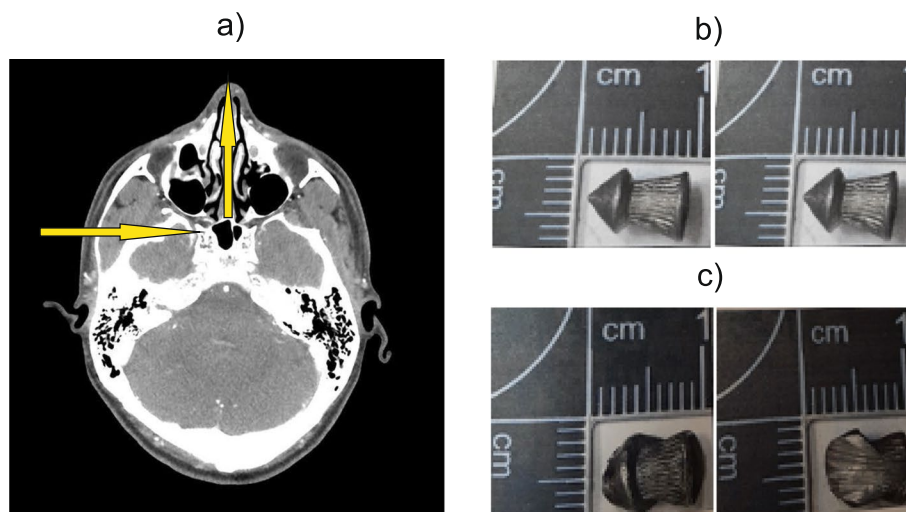
During the autopsy, the blood and urine samples were collected from the corpse for toxicological tests. The tests showed the presence of 0.34% ethyl alcohol in the blood and 0.46% in the urine.

In the conclusions of the post-mortem report, a gunshot wound to the head with intracranial injuries and aspiration of the blood to the lower airways with subsequent asphyxiation was considered to be the direct cause of the woman's death. The autopsy results did not contradict the suspect's version of the possibility of accidental head injury with a pneumatic weapon in the victim. In addition, the victim was heavily intoxicated with alcohol which may have caused her to underestimate the effects of her head injury, and her reduced level of consciousness, which was already altered by previous alcohol consumption, masked the symptoms of developing intracranial injuries.

After a preliminary investigation, the suspect was accused of manslaughter by the public prosecutor.



**Fig. 3** Entrance wound and trajectory **a** left cranial entrance wound, **b** trajectory of airgun pellet in the skull, **c** right foot entrance wound, **d** left temporal muscle hematoma with the entrance wound, **e** basal of the cranium (the arrow indicates wound entering cranial cavity), **f** massive diffuse subarachnoid hematoma (the arrow indicates arachnoid laceration on the borderline of left temporal and frontal lobes)



**Fig. 4** Diabolo pellet **a** schematic representation of “route” using an example CT scan (cranial cavity → sinus cavity → nasal cavity). **b** Pellet retrieved from the patient (two side views); **c** pellet from the skull and from the foot

## Conclusions

Injuries to the skull, face, and neck caused by pneumatic weapon projectiles are most commonly reported, and some of these cases have fatal outcomes (Holland et al. 2004; Bratton et al. 1997). Much has been published on the fact that the head is the most common part of the body penetrated (Bowen and Magauran 1973; James 1962; Shaw and Galbraith 1977). Nonfatal injuries include brain damage and permanent impairment. This is because the human skull is vulnerable to penetration by airgun pellets.

Our case study highlights that skull penetration by air gun pellets can occur and lead to death. The depth of penetration and damage depends on the characteristics of the tissues on the trajectory of the projectile. The present case is interesting because the pellet went through the lateral wall of the sphenoidal sinus and leaked via the nasal canal with the blood, once the dead body was turned on the side. Moreover, the victim died not earlier than 3 h after being shot as a result of intracranial injuries that caused the hemorrhage. Aspiration of the blood into the lower airways resulted in the suffocation of the victim. High alcohol content resulted in reduced awareness of the victim and no apparent symptoms of developing intracranial injuries. If helped properly immediately after the shooting, the victim would have had a chance of survival.

Injuries inflicted by airguns are frequently underestimated, and airguns should not be played with, especially by people who are under the influence of alcohol. The public, as well as governments and legislatures, should be advised that air guns are not toys but dangerous weapons that may cause serious injuries and even death. This case report advocates for more rigorous regulations regarding air guns and safety standards, especially in Poland.

## Abbreviations

BAC Blood alcohol content

## Acknowledgements

We are most thankful to the District Court Szczecin-Prawobrzeże and the West in Szczecin, 7th VII Police Local Criminal Division (Poland), that has approved the publication of this case report.

## Authors' contributions

Conceptualization, S.G.; formal analysis, S.G.; methodology, S.G. and S.M.; project administration, S.G.; supervision, S.G.; validation, S.G.; data curation, S.M. and B.P.-B.; software, S.G.; visualization, S.G.; writing—original draft, S.G. and S.M.; writing—review and editing, S.G. and B.P.-B. The authors have read and approved the final manuscript.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Availability of data and materials

25 November 2020.

## Declarations

### Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

### Consent for publication

The authors affirm that identifying details (name, date of birth, identity numbers, and other information) of the participant that were studied are not published in written descriptions, photographs, and genetics. The District Court Szczecin-Prawobrzeże and the West in Szczecin, 7th VII Police Local Criminal Division (Poland), has approved the publication of this case report.

### Competing interests

The authors declare that they have no competing interests.

Received: 13 April 2022 Accepted: 2 February 2023  
Published online: 16 February 2023

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