J Forensic Sci, May 2009, Vol. 54, No. 3
doi: 10.1111/j.1556-4029.2009.01024.x
Available online at: www.blackwell-synergy.com

CASE REPORT

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A Fatal Shot with a Signal Flare—A Crime Reconstruction*

ABSTRACT: A reconstruction of an incident of a fatal wounding of a football fan with a parachute flare was performed. Physical and chemical examinations of the victim's trousers and parts of a flare removed from the wound in his leg were performed by means of an optical microscope and a scanning electron microscope coupled with an energy dispersive X-ray spectrometer. Signs of burning were seen on the front upper part of the trousers, including a 35–40 mm circular hole with melted and charred edges. Postblast residue present on the surface of the trousers contained strontium, magnesium, potassium, and chlorine. Also the case files—the medical reports and the witnesses' testimonies—were thoroughly studied. It has been found that the evidence collected in the case supported the version of the victim being shot by another person from a distance.

KEYWORDS: forensic science, criminalistics, crime reconstruction, signal flare, postblast residue, scanning electron microscopy coupled with energy dispersive X-ray spectrometry

Within a contemporary legal system, expert witnesses are defined as persons who through education or experience have developed skill or knowledge in a particular subject (any science, art, trade, or occupation) so that they may form an opinion that will assist the administration of justice. The report created by the expert witness and the subsequent oral testimony is rendered to fill gaps resulting from the tribunal's inability to draw upon its own technical experience to reach conclusions. Thus, it should be independent and based on sound scientific practice, including interpretation of the facts acceptable by the majority of the scientific community. One of the most common criticisms raised against the expert is his or her competency. A competent expert witness has to be a specialist in the pertinent field, as the court expects to be able to relay on the evidence offered that must be properly researched, balanced, and not misleading (1). However, a lack of competency is not the only source of differences in opinions of various experts in the same case. Missing or neglected information may significantly influence the final interpretation of the evidence by the decision-maker.

Rapid development of science in general required that the majority of forensic sciences have branched into sub-disciplines, e.g., within the field of criminalistics a specialization of ''physical and chemical examination of the evidence for forensic purposes'' was created. It embraces examinations of microtraces of various materials, such as glass, paint, plastics, and metals, identification of gunshot, explosion, and arson residues as well as unknown substances. For further increase of competency, even narrower subdivisions occur, such as explosive examinations, gunshot examinations, etc. However, the particular range of duties of an expert is set out in various cases. Frequently, besides fulfilling particular tasks according to their specialization, experts are asked by the administration of justice to perform a case reconstruction, and so an evaluation of which of the existing versions of an incident is more probable. An example of an incident reconstruction in addition to ''physical and chemical examinations'' of probes in a rare case of a fatal wounding with a rocket parachute flare is presented in the current work.

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*Presented at the 1st FINEX Conference of the ENFSI Working Group on Explosives, April 14–16 2004, Noordwijkerhout, The Netherlands.

Received 2 April 2008; and in revised form 16 July 2008; accepted 21 Aug. 2008.

Case Description

A fight between two adverse groups of football fans occurred on the street of one of a Polish city. During this fight three rocket parachute flares were released horizontally at one group of fans. One of the flares hit a man in the front upper part of his left leg. Witnesses noted sparks and flames, red in color, emanating from the man's trousers and saw him pull out a pipe-shaped object from his thigh—the body of the flare. The man suffered major trauma to his upper leg and was in a severe state of shock. He died a week later as a result of his injuries. The prosecutor collected testimonies from a great number of witnesses chosen from both of the adverse groups of football fans as well as from the local inhabitants. Moreover, detailed medical reports of the actions taken by the rescue team and the surgeons of the angiosurgical department and later postmortem examination performed by forensic pathologists were included in the case files.

The victim's trousers, being damaged as a result of the incident, and parts of a signal flare that were removed from the wound in his leg by medical doctors during the first operation, together with the medical reports and the witnesses' testimonies, were sent for examinations to an explosives expert. After performing investigations he concluded that the young man most probably had a signal flare in his trousers that accidentally discharged. As this statement remained in opposition to the medical reports and the testimonies of the majority of the eye-witnesses, the entire evidence collected was sent to the Institute of Forensic Research, Krakow for counter-expertise to establish the most probable version of the incident.

Physical and Chemical Examinations of the Victim's Trousers and the Parts of the Flare Found Inside his Wound

The subjects of the physical and chemical examinations that were to be performed in the Institute of Forensic Research, Krakow were trousers of the victim as well as the parts of a rocket

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FIG. 1—*The view of the front upper part of the victim's trousers with the untouched trouser belt and pockets.*

parachute flare that were found inside the wound in his leg. Initially, a visual examination of the probes was performed using a stereoscopic microscope SMZ 2T (Nikon, Tokyo, Japan). A large blotting, brown in color, of fabric and lining in the upper and medial part, both in the front and back of the trousers was observed. Gray-brown and gray-white particles were seen on both the inner and the outer surfaces of the trouser leg (Fig. 1).

An effort was made to align fragments of the fabric of the trousers and the lining around the place of the greatest damage and possibly to assemble into one piece. As a result of this a circular hole of the

FIG. 2—*The view of the upper part of the victim's trousers focused on the circular entrance hole in the groin area.*

FIG. 3—*Parts of a rocket parachute flare found at the dead end of wound channel in the victim's leg.*

diameter of about 35–40 mm was revealed (Fig. 2). The fabric on the edges of the hole was melted, charred, folded, and pressed, so that there appeared alternately fragments changed, being of darker color, and unchanged, in the original state. On the external side of the fabric there were present radial pressings and smears of soot converging in the center of the hole. The internal side of the fabric was not stained; only pressings were observed. Thus, the hole was identified as the entrance of an object of a circular cross-section and a high temperature, striking the trousers with a high kinetic energy in a perpendicular direction to the trouser leg. No damage could have been identified to the trouser belt and the pockets or any of their contents.

The elemental analysis of the residues that were found on the trousers was carried out using a scanning electron microscope JSM-5800 (Jeol Ltd., Tokyo, Japan) and an energy dispersive X-ray spectrometer Link ISIS 300 (Oxford Instruments Ltd., High Wycombe, UK) (SEM-EDX). The gray-brown and gray-white residues that were adhered to the surfaces of the trousers contained strontium, magnesium, potassium, and chlorine. A number of small particles exhibited spherical morphology that is often associated with materials that have been involved in explosives events. The presence of strontium can be related to the combustion of red flare as strontium salts are added to pyrotechnic mixtures to obtain a red flash (2–7).

Moreover, there was performed an optical examination of the parts of the flare that were found inside the victim's wound, including a parachute made of a white cotton fabric with metal chains and a metal disc of 21 mm in diameter and 5 mm in thickness (Fig. 3). It has been established by means of SEM-EDX method that both the chain and the disk were made of steel and the disk was additionally plated with zinc. As the external parts of the flares used in the studied accident were not collected, it was not possible to establish the producer and so the source of flares. It is also very probable that having not collected any of the tubes left in the street after the flares were discharged, a potential link between the flare and the person who had discharged it was lost.

A Study of the Case Files

Witnesses' Testimonies

A group of football fans, to which belonged the victim, was attacked by another, more numerous group of fans, among other things by means of three rocket parachute flares fired in their direction. They were released almost simultaneously, each one by a

different person. The distance between the foreheads of these groups was rated by the witnesses at about 50 m. The values ranged from 15–100 m and the one most frequently given was 50 m. The time of the whole incident was rated at about 10 sec.

The attacked fans turned back and scattered. Nobody saw the moment of shooting of one of them—a 17-year-old man—but many were attracted by its results: shouting of the wounded boy, sparks and flames of red color emanating from the upper part of his trousers. One of the witnesses noticed that the injured person had thrust into the thigh a pipe-like object, which he himself drew out. Another witness saw an object protruding from the thigh of about 10 cm and lying close by yet another object of the length of about 15 cm and the diameter of 2–2.5 cm.

It is worthwhile mentioning that witnesses selected from the attacking group denied possessing and using any flares and suggested that the victim had a flare in his trousers. This, however, remained in opposition not only to the testimonies of the attacked group but also to those given by a number of local inhabitants, who observed the incident from windows of their flats. Some of the witnesses reported also the presence of the metal tubes that remained on the street for a few days after the incident.

Medical Records

A medical examination of the victim revealed a rugged wound with charred edges situated in the medial part of his left thigh, 5–10 cm below the groin area, with a channel boring through the back group of thigh muscles, near the femur. A hemorrhage of the left femoral artery, burns of grade III of the lower extremities, scrotum and penis as well as burns of grade II of the right hand, and signs of subsequent hemorrhagic and traumatic shock were observed. The reported burns of grade II of the right hand of the patient are in agreement with the fact noticed by one of the witnesses that the victim drew out a pipe-like object from his leg with his hands.

The course of the wound channel was perpendicular to the axis of the thigh suggesting the horizontal damaging action against the man remaining in the upright position. From the dead end of the wound channel there were removed elements of a signal flare, including a metal disc and a rolled-up parachute with an attached metallic chain. After the surgical procedure a massive bleeding from the injury occurred that was associated with a rupture of the femoral vein. Thus, the patient was send to the angiosurgical department of a specialized hospital, where the objective examinations showed three traumatic wounds of the left thigh in its medial, posterior, and lateral surfaces with traumatic vein wounds and the signs of the burn of muscles of grade IV. The succeeding operation was undertaken to suture the femoral vein. In the next 24 h, a partial excision of the neurotic tissues of both the left and the right thigh was surgically performed; however, it resulted in the arterial hemorrhage from the left femoral artery again. In spite of intensive treatment, the state of the patient deteriorated and the ischaemia in the left thigh occurred. Thus, in the seventh day after the accident, the left leg was amputated to the level of the thigh and in the eighth day, sudden circulatory arrest occurred and the patient died.

The autopsy, carried out later, exhibited the following: a surgically dressed wound of the left thigh with damages to the surrounding soft tissues and great vessels; the femoral artery bridge; the femoral vein suture; the left lower extremity amputated; the femoral bone blackened; inflammatory defects in the integument of the right hand and the blackened pubic hair of hypogastrium and the right thigh. Moreover, bilateral lung and pleura inflammations as well as signs of septic damages of the internal organs were observed.

The results of the injury and burns caused by a signal flare shot as well as the subsequent effects on the human body were very interesting themselves and reported in detail from the medical point of view by forensic pathologists Kobek et al. (8). The case was found to be singular in Poland, however, according to the experience of forensic explosive examiners in Europe, similar cases of a misuse of rocket flares and flare guns, especially by football fans, happened occasionally in other countries.

Discussion

Signal flares—an invention patented by an American Martha Coston in 1871—were ever since typically used as a distress signal and for other communicating purposes at sea, on the railways, roads, and between aircraft and people on the ground (9; http://www.uscg.mil/hq/cg5/cg5214/docs/DomesticPyroGuide.pdf; http://en.wikipedia.org/wiki/Flare_(pyrotechnic); http://www.entship.ca; http://www.nauticexpo.com). According to safety of life at sea rules, both signal and enlightening flares belong to boat and nautical equipment (http://www.uscg.mil/hq/cg5/cg5214/docs/DomesticPyroGuide.pdf). The rocket parachute flares can be either fired from a flare gun or ignited by hand. These manually operated are in the form of a tube about 28 cm in length and about 2.5 cm in diameter (http://www.entship.ca; http://www.nauticexpo.com).

The construction scheme of a hand-operated parachute flare is presented in Fig. 4. The external casing plays the role of a launcher of the flare cartridge. The outlet of the casing is secured with an elastic cap. On the opposite side there is a lock nut. In order to use the flare, the nut should be opened and the string pulled, causing the explosive reaction of the primer, this in turn devising the combustion of the black powder, and so, setting off a jet engine of the cartridge of the flare. The cartridge being the body of the flare,

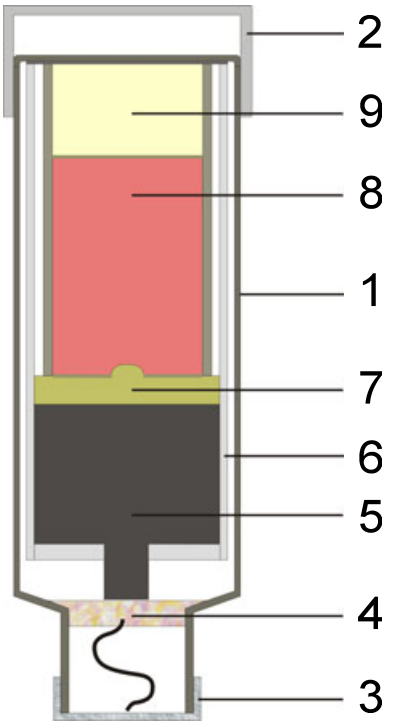

FIG. 4—*A scheme of the construction of a rocket parachute flare: 1—the external casting, 2—the outlet cup, 3—the lock out, 4—the primer, 5—the black powder propellant, 6—the cartridge case, 7—the nitrocellulose propellant, 8—the pyrotechnic candle, 9—the parachute.*

besides the jet engine consists of a small charge of nitrocellulose gun powder, the flame mixture called a pyrotechnic candle or a "star," the parachute, and a cardboard dummy. The cartridge leaves the launcher with a speed of above 100 m/sec. The burning time of the black powder charge in this kind of flares is 2–3 sec. In this period of time, the cartridge fired upward into the air reaches an altitude of about 300 meters. In the next stage, the charge of a nitrocellulose powder combusts that incites flashing of the "star" and causes deploying of a small parachute to slow down its descent (7; http://www.nauticexpo.com). The "star" flashes with an intensity of at least 30,000 candela for at least 40 sec (http://www.uscg.mil/hq/cg5/cg5214/docs/DomesticPyroGuide.pdf; http://en.wikipedia.org/wiki/Flare_(pyrotechnic; http://www.entship.ca; http://www.nauticexpo.com). Some kinds of flares may contain a metal disk to stabilize the parachute in the air.

Taking into account the above-described typical behavior of a manually operated rocket parachute flare and the case information available, it has been concluded that most probably the signal flare had hit the victim during the stage when it had had enough kinetic energy to penetrate the muscles in his leg. The flare had undergone full propulsion prior to hitting the victim and hit him during the black powder deflagration stage of its lifespan. Acting as a projectile, the flare caused the observed mechanical and thermal damages in the trousers as well as the severe wounding and burning of the young man's leg. It is very probable that the stage of ignition of the "star" occurred after the flare had hit the victim, resulting in the red flames that had been visible to witnesses. This conclusion was supported by the fact that the parachute being found at the dead end of the wound channel was rolled up, as stated in the testimony of the operating surgeon.

It is very unlikely that the flare accidentally ignited in the victim's trouser pocket or behind the belt, as there was no damage associated with the trouser belt and the pockets, or their contents. The performed examinations of the flare parts found in the channel of the victim's wound did not provide information on the producer and, as a consequence of that, on the distributor and a possible user of the flare. Neglecting collection of the flare casings at the crime scene caused not only a reliable identification of the source of the flare to be lost but also a possible link to the persons who released the flares.

While studying the case it has been found that signal flares and other pyrotechnic devices are not subjects of data collections such as takes place in the case of firearms or explosive devices and so no reference was available. Therefore, an interpretation of the examinations of the presented case significantly relied on the personal experience of the forensic examiner with other types of flares as well as an exchange of information with experts in the field of explosive examinations.

Conclusion

While evaluating the forensic findings in the presented case the following evidence and facts were taken into account:

1. The direction of the flare shot wound of the victim and the presence of the flare parts, including a rolled-up parachute at the dead end of the wound channel.
2. The information on the course of the incident: the distance of the fighting groups of people rated at about 50 m.
3. The sequence of the explosive reaction chain in a parachute flare.
4. The presence of a circular, 35–40 mm hole in the front upper part of trousers of the victim.
5. The presence of a particulate material consisting of strontium, chlorine, magnesium, and sulfur, i.e., elements typical for red flare residue.

The probability of obtaining the above-mentioned information and evidence, under the condition that the parachute flare was released at a distance from the victim, was assessed to be much higher than the probability of obtaining the same information and evidence, under the condition that the flare was initiated in the victim's trousers. It should be underlined, however, that the assessment might change, if any of the above information were different or not known to the expert.

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