CASE REPORT

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Rare Electrocution Due to Powerline Contact in a Hot-Air Balloon: Comparison with Fatalities from Blunt Trauma

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ABSTRACT: Powerline contact by hot-air balloons is one of the most frequent concurrences in balloon accidents resulting in injury or death. Injuries and deaths are usually a result of blunt trauma from falls. In this report, we describe the aircraft, the circumstances of the accidents and the autopsy data in two powerline contact accidents involving three deaths, one from electrocution and two, from blunt trauma sustained in falls. Appropriate pilot behavior is briefly discussed.

KEYWORDS: pathology and biology, electrocution, hot-air balloon accidents, blunt trauma

From 1976 through 1983, 231 balloon accidents were reported in the United States, of which 88 (38.1%) involved powerlines [*1*]. Most injuries and deaths are a result of blunt trauma from falls rather than electrocution [*2*]. There were 16 accidents involving fatalities, resulting in 33 deaths. Nine powerline accidents resulted in 22 deaths, while seven nonpowerline accidents resulted in 11 deaths. In a more recent report, 293 balloon accidents were reported, of which 110 (37.5%) involved powerlines [*3*]. Seven of those accidents resulted in 14 deaths (four powerline accidents resulted in eight deaths, while three nonpowerline accidents resulted in six deaths). Of the three nonpowerline accidents resulting in deaths, two resulted in five deaths due to fire on board from failed fuel

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fittings. In the third, the pilot died in the air from a heart attack. Of 15 instances during this period where powerlines were involved as a result of the pilot deflating or attempting to deflate before contacting the wires, there were no fatalities and seven injuries.

Electrocution is rarely the cause of death in balloon accidents involving powerlines. In both National Transportation Safety Board reports noted above [*1,3*], no deaths were the result of electrocution; all those associated with powerlines were the result of falls. In one unpublished case, however, a pilot flew into powerlines, the pyrometer cord (an electrical connection from a temperature sensing instrument in the gondola to a thermocouple at the top of the envelope) contacted the pilot's hand and he was electrocuted when his feet touched the ground.[6]

Injuries sustained by falls due to powerline contact can vary from trivial to fatal [*4*].[7] In most cases occupants are not injured (many of these are not even reported to authorities); when balloon/powerline contact is made, those injuries that are sustained are usually not serious.[7] For example, a pilot who jumped from a balloon from an estimated 7.5 m (25 feet) after contacting electrical lines broke his jaw and nose but sustained no permanent injury.[7] Prior to his exit, his passengers jumped from the gondola from about 1.5 m (5 feet) and sustained no injuries. On the other hand, a pilot who contacted a power line while landing, fell about 7.5 m (25 feet) with and while still inside the gondola after all cables connecting the gondola to the envelope were severed by electrical arcing and sustained major internal injuries. His passenger sustained a broken wrist.[7] In an exceptional incident, a passenger who jumped from about 6 m (20 feet) from a balloon just before it contacted a powerline, sustained permanent spinal injuries.[7]

Case 1

A 2380 m^3 (84 000 ft^3) hot-air balloon with an experienced (more than 100 h in balloons and 6000 h in fixed wing/rotorcraft) pilot and three passengers came into contact with a powerline while landing next to a dirt road running parallel to a state highway. The pilot had flown over the highway and the powerlines at least 30 m (100 ft) above ground level in a northerly direction, and was descending to land. Suddenly, the balloon direction shifted to westerly, and even with the application of both propane burners, the gondola contacted the powerlines (two 7200 volt single-phase wires strung on wooden poles about 24 m (80 ft) apart). The ground (neutral) bottom wire came into contact with a 74-year-old female passenger on the left buttock while the upper "hot" wire contacted a metal cable attaching the envelope to the gondola. The metal cable was also in contact with the propane tank which was touching the passenger in the area of the left hip and left lower thorax. The woman sustained an electrical shock and immediately lost consciousness. She fell backwards out of the gondola 9 to 11 m (30 to 35 feet) to the ground (Fig. 1).

A physician examined the woman less than 1 min after the fall. She was nonresponsive, had no carotid pulse and had dilated, fixed pupils. Cardiopulmonary resuscitation was attempted for about 10 to 15 minutes, without success. At autopsy, the woman had extensive electrical burns of the abdomen, left hip and buttock, back and left leg. Deep charred lacerations were noted within the burn of the left thigh area (Fig. 2). She had multiple fractures of the ribs, sternum and pelvis. There was also a lacerated descending aorta with small hemothoraces and hemoperitoneum. The fractures and internal injuries were considered to be postmortem following death by electrocution. Postmortem toxicology revealed a low alcohol concentration.

[6]George Hahn, President, Albuquerque International Balloon Fiesta, personal communication, 1991.

[7]Personal observations, senior author.

FIG. 1—*Scene of Case 1: the decedent is on the ground in the lower foreground, center* (arrow), *with the two surviving passengers looking on.*

FIG. 2—*High voltage electrical burns of left hip and thigh with lacerations of skin and subcutaneous charring, 74-year-old balloon passenger electrocuted when "hot" and neutral powerlines made contact with the gondola, Case 1.*

Case 2

A relatively inexperienced (allegedly a balloon pilot for 6 months with less than 50 h flying time) balloon pilot ascended in a 2210 m^3 (78 000 ft^3) hot air balloon and, after two intermediate stops to change passengers, was flying in a northerly direction with one passenger. He began to descend for landing, but was told by his crew that he was over a sensitive area where landing was not recommended [5], and so he flew on. He radioed to the crew that he saw powerlines ahead and would overfly them and land beyond. Instead, the balloon's gondola struck two powerlines (24 000 volt three-phase) 21 m (70 ft) above the ground. A loud snap was heard and a fire in the gondola was noted almost immediately, probably from ruptured fuel lines (Fig. 3). The passenger exited the gondola, sliding part way down the ground handling line, which had been unwound and thrown over the basket edge immediately after the powerline contact. He had also gripped at least two of the wires carrying current (Fig. 4) for a short time as he descended. However, while descending, he lost his grip and fell about 8.5 to 9 m (28 to 30 ft) to the ground. The pilot, also exited the basket, and held on to the ground/handling line for a short time before losing his grip, free-falling approximately 20 m (65 ft) to the ground. An emergency physician arrived at the scene within approximately 2½ minutes, and found both individuals in shock, with thready pulses and flail chests. Well-equipped emergency personnel arrived within minutes. The pilot was pronounced dead at the scene; the passenger was airlifted to a major trauma center and was pronounced dead about 2 h post-trauma.

Autopsy of the 45-year-old pilot revealed blunt trauma to head, neck, thorax, abdomen and upper and lower extremities. There were second and third degree fire burns of the face, neck and both wrists. Multiple skull fractures with subdural hemorrhage and cerebral contusions, fractured ribs and pelvis, hemothorax and hemoaspiration were noted on internal examination.

Autopsy of the 32-year-old passenger revealed blunt trauma of the head, trunk and extremities, with fractured ribs, pelvis and arms. He also had visceral and soft tissue contusions of the lungs, neck, brain and testes. First degree fire burns were noted on the right arm, right side of the abdomen and right ear.

No alcohol was found upon toxicologic examination in either person.

Discussion

Most fatalities in accidents involving hot-air balloon contact with powerlines result from blunt force injuries when the balloon occupants fall or jump to the ground. Electrocution seldom occurs because the occupants rarely come into direct contact with the electrical wires and only a portion of the balloon itself is conductive of electricity.

In this article, we present a rare electrocution fatality that occurred when a balloon passenger made direct contact with an electrical wire. The pilot saw the powerlines a few seconds before contact was made, but the fatally injured passenger did not because she was facing away from the balloon path. When the gondola came into contact with the lines, it was coincidental that the passenger was leaning against the gondola rim and fuel tank when she and the gondola struck the wire (Fig. 5).

It is reasonable to believe that she died immediately as the result of electrocution. The electrical burns on the body were located such that high voltage electrical current most likely passed through her chest causing ventricular fibrillation. Although she fell from the basket sustaining multiple fractures and internal injuries, those injuries were sustained after she was already fatally injured.

Most hot-air balloon powerline accidents occur as the result of pilot error. When flying near powerlines, a pilot must maintain a wide margin of lateral distance so that immediate

FIG. 3—Top: *gondola in wires and on fire (Case 2) (occupants had exited the gondola before this photograph was taken);* bottom: *about two minutes later, just as envelope detaches from gondola, which is still in the wires.*

adjustment can be made for any change in wind velocity or direction. Pilots should fly over powerlines in a level or ascending condition, not descending, unless the circumstances are such that quick landing is urgent. If confronted with the possibility of powerline contact, pilots are instructed to deflate immediately, because it is safer to be on—or close to—the ground if powerline contact is made, rather than high enough so that a

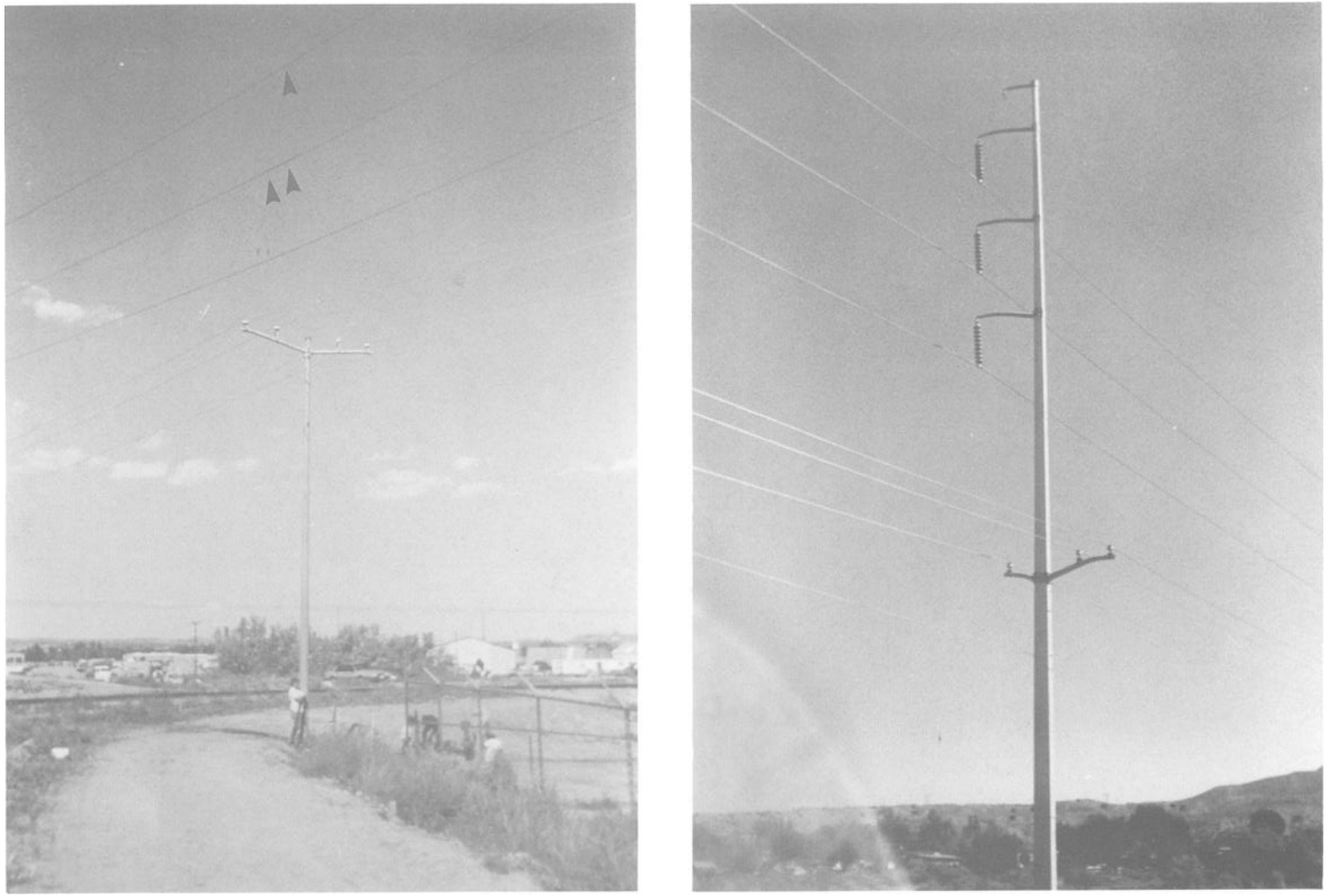

FIG. 4—Left: *note the shorter pole with four wires attached to insulators and the four upper wires with burn marks (arrowheads) (Case 2);* right: *the taller pole with all eight wires attached (this pole is about 150 feet to the east of the left Fig. 4).*

FIG. 5—Top: *the leather rim of the gondola from Case 1 with scuff marks made by powerline (arrowhead)—the decedent was standing with her hip and buttock against this rim;* bottom: *arrow points toward the tank that was touching the hip of the decedent (photograph taken from the opposite side as Fig. 3, top).*

fall would cause serious injury. For example, in a series of 39 balloon powerline accidents studied for pilots' actions before contact, differences in pilots' decisions were significant. In the group of cases where the pilot tried to fly over the lines but struck the lines instead, 26% involved fatalities and 47%, serious injury. In the group where the pilot deflated

or attempted to deflate prior to striking the lines, there were no fatalities and 30%, serious injury [6].

If a powerline strike is imminent, all individuals in the gondola should crouch down inside the basket, all fire should be extinguished and all tank valves closed. If there is time, pressure should be released in all propane hoses. These precautions allow no exposed parts to be available for wire contact and no source of flame ignition. Helmets should be worn in cases where any force is expected in the landing.

Finally, cables made of nonconductive Kevlar^{R} are available for the gondola to envelope attachment [7]. Electrical conductance undoubtedly played a part in both accidents, and nonconductive cables could have made a difference.

Although in the first case the decedent and the other two passengers had been drinking alcohol before or during the flight, the pilot had not. In Case 2, neither pilot nor passenger had consumed alcohol. There is no evidence to suggest that alcohol plays a significant part in reported balloon accidents.

Forensic pathologists examining fatal victims of hot-air balloon powerline accidents should keep in mind that death may occur from electrocution during flight, thermal burns or natural causes, as well as from injuries from falls. Even though electrocution is uncommon when a hot air balloon strikes a powerline, the potential exists. Electrical burns may be difficult to identify if there are major blunt force injuries associated with a fall or if there are thermal burns from a gondola fire.

As in all violent deaths, every effort should be made to correlate the cause of death with the circumstances of the accident. In hot-air balloon accidents, this may require a review of the pilot's actions prior to the accident, an understanding of hot-air balloon equipment, function and capabilities, a knowledge of environmental conditions, and a review of statements of witnesses and survivors. This important information can then be evaluated in correlation with autopsy findings, toxicologic data and medical history in order to answer the inevitable questions surrounding these tragedies.

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