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FATAL GYROPLANE CRASH WITH POST-CRASH FIRE: FIRST REPORTED CASE IN SLOVAKIA

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Abstract: Gyroplanes are lightweight, rotor-driven sport aircraft generally regarded as stable and safe when operated under appropriate conditions. However, accidents involving gyroplanes, particularly those resulting in post-impact fires, can present significant challenges for forensic investigation. This case report describes a rare fatal gyroplane crash in Slovakia in which the aircraft was destroyed by fire, and the only human remains recovered consisted of a severely charred body part. The extent of thermal destruction precluded visual identification and conventional autopsy analysis. Toxicological screening revealed no substances of forensic interest, and a carboxyhemoglobin concentration of 5.3% suggested the decedent did not inhale combustion gases, indicating death occurred prior to the onset of fire. The most probable cause of death was determined to be trauma-induced hemorrhagic shock sustained in the crash. This case highlights the importance of multidisciplinary forensic approaches, combining scene investigation and aviation records, in reconstructing fatal aviation events and identifying victims when remains are severely degraded by fire.

Keywords: gyroplane, aviation accident, post-crash fire, ultralight aircraft, autopsy.

INTRODUCTION

Over the past several decades, sport aviation has gained popularity among private pilots and aviation enthusiasts for its accessibility, cost-effectiveness, and the freedom it offers in flight planning and maneuverability. One of the distinctive aircraft used in this category is the gyroplane – also known as an autogyro or gyrocopter. Although often mistaken for helicopters due to their rotor systems, gyroplanes operate using fundamentally different flight mechanics. They generate lift through an unpowered, free-spinning rotor while propulsion is provided by an engine-driven propeller, typically mounted at the rear of the fuselage (1, 2).

Gyroplanes are lightweight, low-speed aircraft designed to cruise at altitudes below controlled airspace, with maximum allowable speeds reaching up to 185 km/h (3). Their configuration usually includes an open or semi-enclosed cockpit, a four-point harness for occupant restraint, and protection provided by windshields and helmets. Despite their relatively simple construction, gyroplanes are widely considered stable and safe when operated under appropriate conditions (1, 4).

This case report presents a rare instance of a fatal gyroplane crash in Slovakia, in which the aircraft was entirely consumed by fire. The only human remains recovered consisted of a severely charred torso, making both identification and postmortem examination particularly challenging. This report outlines the forensic investigation, including scene documentation, autopsy findings, laboratory analyses, and the multidisciplinary approach taken to establish the identity of the deceased and determine the cause of death.

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CASE REPORT

On May 19, 2023, the remains of a white-red gyroplane Nisus Aero Nisus OM-M199 (Fig. 1) were discovered in a forested area near the municipality of Námestovo, Slovakia. The aircraft had reportedly crashed sometime between the evening of May 18 and the afternoon of May 19, and was destroyed by a post-impact fire. The body of the pilot was recovered from the wreckage in the form of a severely charred human torso of initially unknown sex and identity. Investigators at the scene determined that the aircraft had likely collided with treetops prior to ground impact and ignition. The body was in the cockpit area and appeared to have been directly exposed to the core of the fire (Fig. 2).

Figure 1. Nisus Aero Nisus OM-M199 gyroplane at the AERO 2023 airshow, EDNY airport, Friedrichshafen Germany, photographed by Ingo Warnecke (Airport-Data.com).

The remains were transferred for forensic examination, including a full-body X-ray. The body was unclothed, with all garments incinerated except for small fragments of charred black fabric on the right lower limb. The remains consisted of four main anatomical components: a torso with head, neck, left thorax, and left upper limb; the right lower limb including the femur and foot; the left knee with adjacent femur and tibia; and additional heavily charred bone and tissue fragments (Fig. 3). The skin and subcutaneous tissues

Figure 2. a - Gyroplane wreckage completely destroyed by post-crash fire; b - Destroyed tree-top that caused the gyroplane crash (arrow); c - Body part of the decedent trapped in the wreckage; d - Bones with white coloration indicating exposure to extreme temperature.

were extensively carbonized, with fourth-degree burns observed throughout. The skull was intact but calcined and the brain showed severe thermal damage with no signs of hemorrhage. Eyeballs were destroyed. Internal organs were mostly absent or unrecognizably damaged by fire, though shrunken lungs, a heart fragment, liver section, and a kidney were partially identifiable. All bone fragments and soft tissues were consistent with a single individual. Notably, based on their macroscopic appearance, some bones displayed a white, calcined coloration, indicating exposure to extreme heat, likely ranging from 800 to 900°C (5).

Examination of the cranial bones revealed features consistent with male sex, including robust jaw structure, pronounced external occipital protuberance, prominent mastoid processes, and male-pattern orbital morphology. Dental inspection showed advanced wear and multiple prosthetic restorations, including bridgework and large fillings. Teeth were fragile and charred, but valuable for forensic comparison and DNA analysis. No anatomical anomalies or surgical implants were observed.

Tissue and bone samples were collected for DNA profiling. A small blood sample, obtained from muscle tissue on the left side of the thorax, was preserved and subjected to toxicological screening. No alcohol or narcotics were detected, and no medications affecting the central nervous system were present. Postmortem blood analysis performed using a validated photometric method revealed a COHb level of 5.3%, which falls within the physiological range (6). This finding strongly suggests that the decedent did not inhale significant combustion products and was already deceased at the time of the post-impact fire.

Due to the extent of thermal damage, direct identification of trauma patterns was not possible. However, based on the scene investigation, the body's position within the wreckage, and the lack of evidence for foul play, the most probable cause of death was determined to be trauma-induced hemorrhagic shock

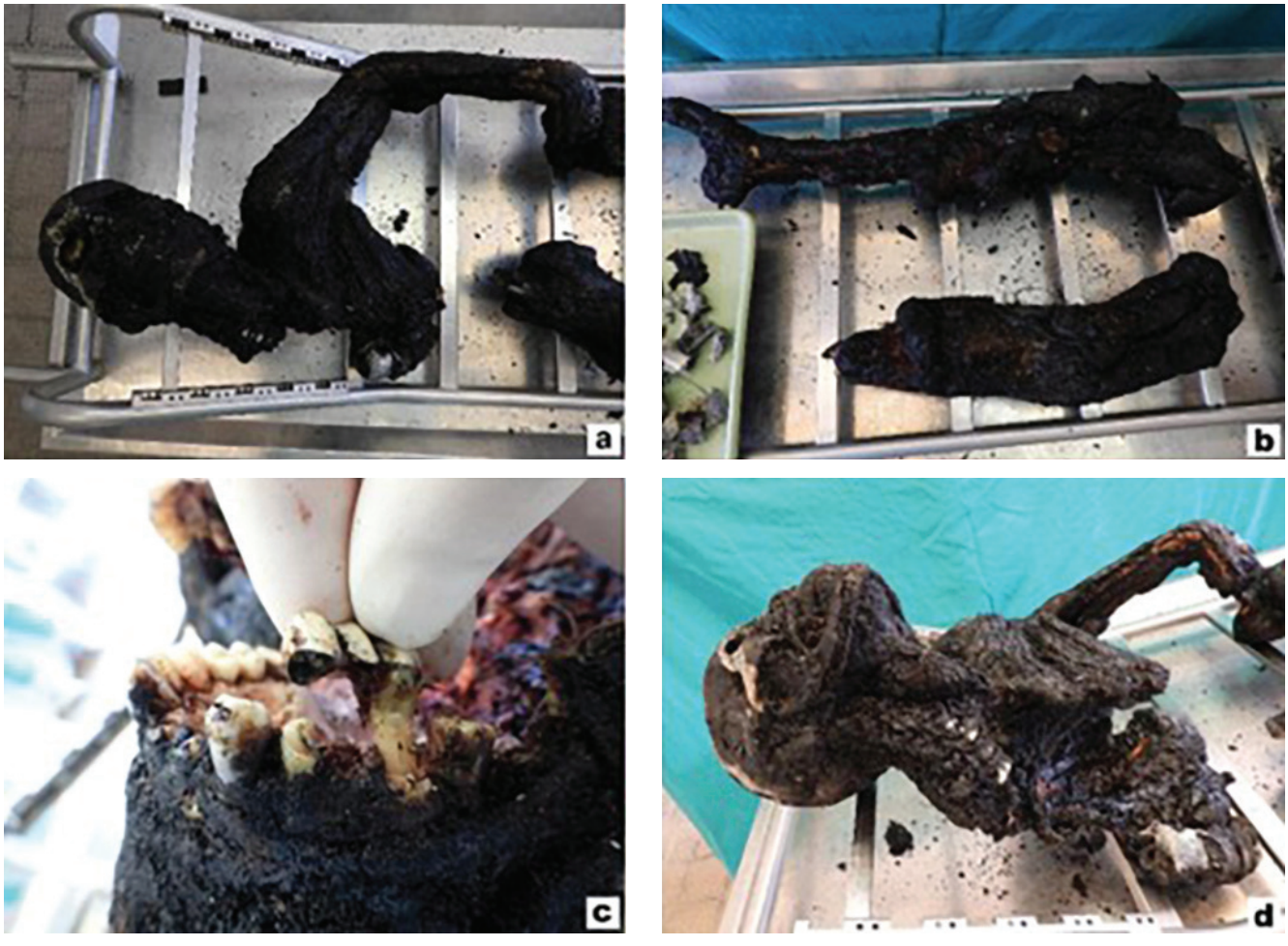

Figure 3. a - Torso with head, neck, left thorax, and left upper limb; b - Right lower limb including the femur and foot and the left knee with adjacent femur and tibia; c - Fragile teeth with advanced wear and multiple prosthetic restorations, bridgework and fillings; d - Second look on decedent head with visible robust jaw structure and prominent mastoid process.

sustained in the crash. Although no pathological findings were identifiable due to the destruction of soft tissues, the possibility of a disease-related cause of death cannot be entirely excluded. Thermal changes were consistent with postmortem exposure to high heat.

DISCUSSION

This case highlights the unique challenges forensic pathologists face in aviation disasters, particularly those involving light sport aircraft such as gyroplanes. Gyroplanes occupy a niche within general aviation and, while generally considered to have a favorable safety profile (7), the accidents that do occur can be especially severe. Although gyroplanes are typically regarded as relatively safe when compared to other ultralight and sport aviation aircraft, data suggest that approximately 40% of gyroplane accidents are fatal (8,9). This underscores the significant risks involved, particularly in the context of mechanical failure, pilot error, or adverse weather conditions. Unlike larger aircraft, gyroplanes lack protective structural elements, which increases the likelihood of occupants sustaining severe trauma upon impact. Moreover, while post-crash fires are less frequent due to limited fuel capacity, they can occur and are capable of entirely consuming the aircraft, as demonstrated in the present case.

Despite the growing use of gyroplanes in sport aviation, comprehensive scientific literature on gyroplane accidents remains limited. Most existing studies have focused on general aspects such as crash dynamics, accident epidemiology, or flight safety data (7,9-11), while detailed forensic analyses, particularly those involving autopsy findings, are seldom reported. Only a small number of published cases have addressed the pathological features of fatal gyroplane accidents, and even fewer have included thorough postmortem examinations or scene-to-autopsy correlations. Reports by Hellerich & Pollak (1995), Ast *et al*. (2001), Madea *et al*. (2015) and Doberentz *et al*. (2020) contribute rare insights into the forensic challenges posed by such incidents (3, 8, 12, 13).

Notably, gyroplane crashes complicated by post-impact fires are exceptionally rare in the literature. In such events, complete incineration of the airframe and occupant can significantly hinder forensic analysis. High-temperature fires frequently destroy crucial physical evidence, obscure injury patterns, and cause severe thermal alteration or reduction of human remains, complicating the determination of both cause and manner of death. These conditions also limit the use of conventional identification techniques, such as visual recognition, fingerprinting, or dental comparison.

Based on the available information, it is unclear whether the Nisus Aero OM-M199 gyroplane was equipped with a ballistic parachute rescue system. This uncertainty is relevant because such systems, while designed to enhance safety during in-flight emergencies, have been associated with explosions and post-impact fires following ground collisions of motor gliders (personal experience of the co-author of this paper, Miloš Sokol). In the current case, the final report of the air accident concluded that the gyroplane impacted the ground, resulting in the rupture of the fuel tank and the subsequent ignition of fuel, which led to a massive post-crash fire.

From a forensic pathology standpoint, the injury pattern observed in this case was consistent with those reported in other fatal light aircraft incidents. A review of 27 fatal light aircraft and glider accidents found that the most common lethal injuries were extensive multi-organ trauma (including rupture of the lungs, heart, liver, and aorta) and skeletal fractures (affecting the skull, ribs, spine, and long bones) (14). Polytrauma is typically the primary cause of death in high-speed aviation crashes (8). Doberentz *et al*. (2020) described a tandem gyroplane crash involving two 49-year-old male occupants, both of whom died from deceleration-related polytraumatic injuries. In that case, the pilot sustained a ring fracture at the base of the skull – an injury often resulting from hyperflexion of the neck and sometimes exacerbated by helmet use or impact (3). In our case, severe fractures of the thoracic spine served as an equivalent marker of fatal head-neck trauma.

This case may be compared with other reported incidents in the forensic literature. Tsokos (2013), in a report on an ultralight aircraft crash, emphasized the importance of correlating scene findings with autopsy results for legal documentation and to exclude non-accidental causes of death (15). Similarly, Wiegmann & Taneja (2003), in a large-scale review of 559 aviation-related autopsies, found that blunt force trauma was the primary cause of death in 86% of cases. The most reported skeletal injuries involved fractures of the ribs, skull, facial bones, tibia and pelvis, underscoring the predominance of high-energy impact injuries in aviation fatalities (16). While the present case involved a single decedent and a light sport aircraft, the forensic patterns align with these broader findings, reaffirming the critical role of trauma analysis in the investigation of aviation-related deaths.

Although the identity of the decedent was initially unknown due to the extent of thermal destruction, DNA analysis performed on bone, along with forensic examination, confirmed the presumed identity of a 59-year-old Hungarian citizen, believed to have been the sole pilot of the aircraft. In addition to the biological profile, supporting information was obtained from airport departure records, which confirmed that the individual had taken off alone in the gyroplane. No comparative dental records were available, but all available evidence including scene investigation, anthropological findings and aviation departure logs, consistently supported the identification, with no contradictory indicators observed.

In conclusion, this case underscores the significant forensic challenges presented by fatal gyroplane accidents involving post-impact fire. The complete incineration of the aircraft and the extensive thermal damage to the human remains complicated both the determination of the cause of death and the identification process. Despite these limitations, the integration of scene investigation, anthropological assessment, and molecular techniques, enabled the successful reconstruction of the events and confirmation of identity. The pattern of injuries was consistent with high-energy blunt force trauma typically seen in aviation crashes, and toxicological findings indicated that the decedent did not survive long enough to inhale combustion gases. The absence of evidence indicating third-party involvement or pre-existing medical conditions supported the conclusion that the crash and subsequent death were probably accidental in nature. Given the rarity of published forensic pathology reports on gyroplane fatalities, particularly those complicated by fire, this case contributes valuable data to the limited literature. It also highlights the importance of multidisciplinary collaboration in the investigation of aviation-related deaths, especially when conventional identification and diagnostic methods are compromised by extreme postmortem changes.

Conflict of interest

The authors declare that they have no conflict of interest.

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