

Lilienthal's Fatal Glider Crash in 1896: Evidence Regarding the Cause of Death

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Otto Lilienthal's pioneering work on gliders helped form the basis for development of powered aircraft. His death following a glider crash in 1896 was officially ascribed to fracture of the cervical spine. However, the clinical details assembled here make it more likely that he died from head trauma with resulting complications, possibly including intracranial hematoma.

Keywords: Otto Lilienthal, glider design, aviation accidents, intracranial hematoma.

OTTO LILIENTHAL'S reputation as a pioneer of human flight is primarily based on his successful design and demonstration of gliders in Germany during the 1890s. He introduced many of the aerodynamic concepts, based on scientific research, still employed in wing construction today. His flight experiments were well known to the Wright brothers as they were designing the aircraft that would make the first powered flight in 1903 (5,8). From 1891–1896, Lilienthal built more than 20 different gliders, including early versions of motor-glider, and made several hundred flights in the Rhinow Hills west of Berlin (1,7). These test flights covered distances from 25 to 250 m (80 to 800 ft) and the directional control of his gliders gradually improved until he was able to achieve controlled 180° turns (4).

A visiting American physicist, Robert W. Wood, watched Lilienthal flying a week before the crash. His photograph (Fig. 1) shows that Lilienthal flew his glider while wearing street clothing without a helmet or anything else we would recognize today as protective devices. During flight, his forearms were inserted into sleeves on the frame with his elbows flexed, supporting his upper body within the wing structure while his lower body hung vertically below. The glider was controlled by the movement of Lilienthal's lower body shifting the glider's center of gravity and thus altering pitch and bank. He landed on his feet, running, and in an emergency could quickly separate from the glider by releasing his arms and dropping away from the frame. We report here on our investigation regarding the fatal crash that occurred at Gollenberg Hill near Stoelln at about noon on August 9, 1896.

The only eyewitness account of the accident was provided by Lilienthal's glider mechanic, Paul Beylich. Lilienthal launched himself as usual in his "Normal Glider,"

but trouble arose when he attempted to steer through a heat eddy. Beylich reported that, while the glider was falling nose-first from an altitude of about 15 m, Lilienthal tried to re-establish lift by swinging his body back to correct the attitude of the glider. That maneuver failed and he hit the ground still in the glider (6,7,9).

Lilienthal was pulled alive from the wreckage and volunteers helped Beylich transport the severely injured flyer by horse-drawn carriage from Gollenberg to the guesthouse of August Herms in nearby Stoelln (1). A physician, Dr. Niendorf, saw Lilienthal there about 2 p.m. At that time, Lilienthal was paralyzed from the waist down but was talking, could move his hands and arms normally, and was not in great pain. No external injuries were noted except some abrasions whose locations were not recorded (6).

Niendorf attended Lilienthal later that evening as he was transported in a cargo train about 50 miles to the Lehrter train station in Berlin. During transport, Lilienthal lost consciousness and developed breathing difficulties. The next morning, he was moved, this time in a horse-drawn ambulance, to the clinic of Ernst von Bergemann (1836–1907), the leading German neurosurgeon of the day; that clinic is today the Charité Hospital on Ziegelstrasse. Lilienthal died there at about 5:30 p.m. on August 10, about 36 h after the crash (6). The cause of death was recorded in the clinic's registry as "fracture of the spine" (1,3). X-ray examinations were not routine at the time and it is not known whether an autopsy was performed (1,2).

During his visit a week earlier, Wood saw a serious incident in flight that was probably similar to that fatal accident. Wood reported: "[T]he apparatus tipped sideways as if a sudden gust had got under the left wing. For a moment I could see the top of the aeroplane, and then with a powerful throw of his legs [Lilienthal] brought the machine once more on an even keel, and sailed away

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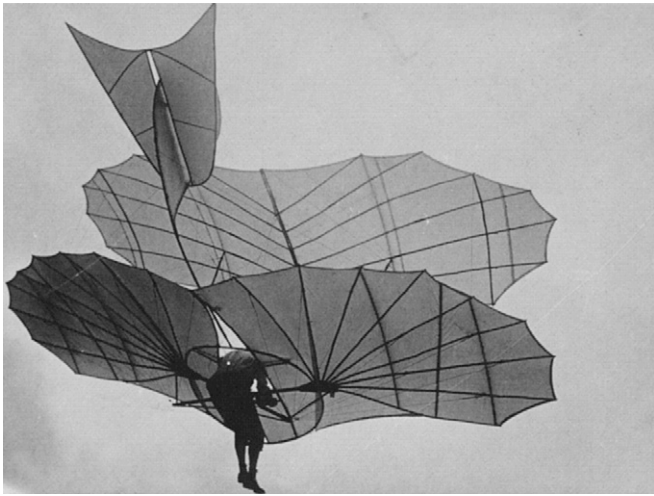


Fig. 1. Otto Lilienthal with his double decker at the Fliegeberg, Berlin, October 19, 1895. Photograph by Dr. Richard Neuhaus. Courtesy of the Otto Lilienthal Museum, Anklam, Mecklenburg-Vorpommern, Germany. Picture No. OLM F0941LF.

below me across the fields at the bottom, kicking at the tops of the haystacks as he passed over them. When within a foot of the ground he threw his legs forward, and notwithstanding its great velocity the machine stopped instantly, its front turning up allowing the wind to strike under the wings, and he dropped lightly to the earth. I ran after him and found him quite breathless from excitement and the exertion. He said: 'Did you see that? I thought for a moment it was all up with me. I tipped so, then so, and I threw out my legs thus and righted it. I have learned something new; I learn something new each time' (10).

Following the crash, the remains of the glider were taken to Lilienthal's factory on Koepenicker Strasse in Berlin. Photographs taken there give clear evidence of the force of the impact (7). However, only the right wing of the glider was damaged, and it seems likely that the impact was absorbed in part by the structure of the wing. With the flyer's arms still fixed in the sleeves, this type of impact would have thrown his torso sideways into the frame of the glider, which may have injured the thoracic spine (T8–T10), leading to the waist-down paralysis that should not in itself have been fatal. Oral history and some written documents also mention a fracture of the cervical spine (C3), but that remains doubtful (1,6,9) and Lilienthal greeted Niendorf at the bedside by shaking his hand and no breathing abnormalities were noted at that time. It therefore seems unlikely that an unstable cervical spine injury was the cause of death. It

seems to us that Lilienthal probably suffered a concussion and the later symptoms were produced by intracranial bleeding or gradual swelling of the brain, which would explain the delayed loss of consciousness and late onset of breathing difficulties. How could such a concussion occur during the crash without leaving external evidence of head trauma?

If Lilienthal were hanging from his forearms with his elbows flexed and the glider hit the ground moving forward with the right wing down, his lower body would have been bent backward as it struck the ground and his head would then hit the frame of the glider off the centerline. A seemingly minor blow to the temporal region, where the skull is relatively thin, can cause a fracture there accompanied by injury to the meningeal artery, causing development of an intracranial hematoma without external signs of damage. The symptomatology described in this case is classic for such an injury. We, therefore, suggest that Lilienthal's death was not related to the spinal fracture that caused paralysis of his legs, but was rather the result of a growing intracranial hematoma, a phenomenon not well understood at the time.

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