

case report

Cardiac rhythm recorded by implanted loop recorder during lightning strike

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Lightning strikes cause severe injuries and fatalities. Injuries vary from self-limiting skin manifestations to cardiac arrest and death. Because the event is sudden and unpredictable, assessment of the direct effects of the lightning on the human heart is usually impossible. In this case, a 16-year old boy who had an implanted loop recorder subcutaneous cardiac monitor was hit by lightning during a picnic and survived. A cardiac rhythm strip was recorded live during the strike.

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Although uncommon, lightning and floods are the leading weather-induced causes of death worldwide.^{1,2} The reason for death after lightning strike is speculated as being secondary to cardiac arrest,³ but this has never been proved or recorded before. Injuries vary from self-limiting skin manifestations to cardiac arrest and death.³ For obvious reasons it is difficult to assess the direct effect of the lightning on the human heart, because the event is sudden and unpredictable. In our case, a 16-year old male was hit by lightning strike, and by chance, the heart rhythm was recorded live during the strike, by an implanted loop recorder.

CASE

At the age of 13 years, a previously healthy boy presented with recurrent syncopal attacks of 5-6 attacks/week lasting 3-5 minutes, mostly happening in an upright posture. The attacks were typically preceded by dizziness and blackouts, but no palpation was noted and the attacks never happened during exercise or while sleeping. He was referred to a pediatric cardioelectrophysiology clinic for investigation. Physical examination was unremarkable as was the family, developmental and past history. All investigations including multiple ECGs and Holter monitors were normal. The tilt table test was positive for hypotension, and a diagnosis of neurocardiogenic syncope (vasodilatory type) was entertained.

The patient was advised to increase water and salt intake and at one point was prescribed atenolol (Tenormin) and then midodrine to control his symptoms.

At the age of 16 years, because he was still symptomatic with recurrent syncope, an implantable loop recorder (Reveal, Medtronic, USA) was implanted subcutaneously to rule out any arrhythmic causes of symptoms. Fortunately, there were no arrhythmias detected during dizzy episodes which proved the diagnosis of a severe form of neurocardiogenic syncope. With time and treatment, no more syncopal attacks were detected for the next two years. Symptoms improved gradually with time and subsided completely at the age of 18 years. Just before a routine appointment for removal of the device, he went with his friends on a picnic in Jizan city in Saudi Arabia where they were hit by lightning. Two of his friends died immediately. He lost consciousness for a few seconds and then recovered completely. Meanwhile, a live cardiac rhythm strip was recorded by the device (**Figure 1**).² The ECG showed the effect of the lightning strike initially as a large spike, followed immediately by ventricular fibrillation for few seconds that changed to ventricular tachycardia and fortunately to sinus rhythm. When he presented to the hospital, ECG, echocardiography and cardiac enzymes were all normal. He did well for the next 2 years, and the device was explanted safely.

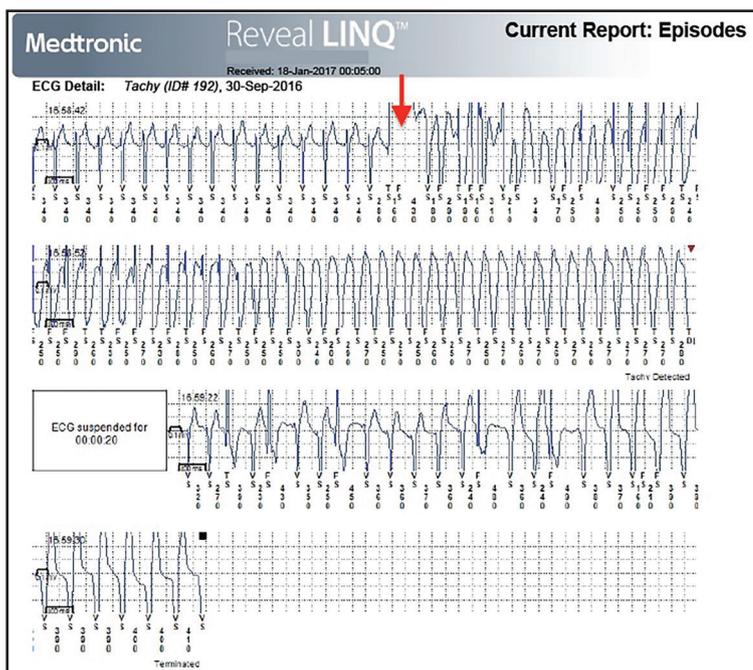


Figure 1. Record from the implantable loop recorder during the lightning strike, showing sinus tachycardia initially, followed by a large spike at the time of the lightning strike, followed by ventricular fibrillation for few seconds, followed by a rapid monomorphic ventricular tachycardia at a rate of 250 msec (240 beats/minute), then a slow ventricular tachycardia, before spontaneous resolution to sinus rhythm (red arrow indicates moment of lightning strike).

DISCUSSION

From 1940-2015, a total of 9311 lightning fatalities were reported in the United States, an average of 53

per year.^{1,2} Hundreds more are injured annually. In 2016, there were 38 fatalities in the United States.⁴ Injury patterns are unpredictable and range from mild symptomatology to death.^{5,6} However, lightning-induced cardiac arrest may be more survivable than other causes while still leaving substantial neurologic deficits in survivors. Almost two-thirds of the deaths from 2006-2013 occurred during outdoor leisure activities.⁷ For obvious reasons, it is difficult to assess the direct effect of the lightning on the human heart because it occurs suddenly without being recorded. In one study, 19 victims who survived five separate lightning strikes were studied over a 2-month period.⁸ Each patient was evaluated by serial ECG, CK-MB determinations and echocardiography showed ST segment, T wave abnormalities, ventricular dysfunction, pericardial effusion and pericarditis. Our case report showed clearly that the mechanism of arrhythmia that occurs after a lightning strike is ventricular fibrillation. Ventricular fibrillation (the most dangerous human arrhythmia) happens if the strike occurs at a vulnerable time on the cardiac electrical cycle and ECG (R on T phenomenon), which induces this fatal arrhythmia. We believe the same happened to his unlucky friends who died at the event, mostly because the ventricular fibrillation persisted for a longer time, leading to cardiac arrest and finally, to death.

This case offers an opportunity to understand the immediate effect of lightning and electrical shock in general on heart electrical activity. Teaching the public about the appropriate precautions to avoid lightning is important to avoid catastrophic consequences.

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