CASE REPORT

Atrial fibrillation in a commercial diver

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**Background**
The torpedo ray is a fish with powerful electric organs, which can serve either as predatory tool or defensive weapon. The name comes from the Latin ‘torpere’, to be stiffened or paralysed, referring to the effect on someone who handles or steps on a living electric ray.

**Aim**
To present an unusual case of atrial fibrillation due to electric shocks by the torpedo ray (electric ray).

**Results**
A 42-year-old male commercial diver presented with atrial fibrillation after receiving repeated electric shocks from a torpedo ray while on routine diving operations. Such occurrences are extremely rare and we could find no documented case in the medical literature.

**Conclusions**
Electric current can damage the body by disrupting electric rhythms, inducing muscular spasms and burns. In this case, we report atrial fibrillation in a diver exposed to repeated electric shocks from a torpedo ray.

**Key words**
Atrial fibrillation; electric shock; torpedo ray.

**Introduction**
Ventricular fibrillation and sudden death are well-known physiological consequences of high-voltage electrical injury. Various authors have reported ischemic changes, direct myocardial injury and myocardial infarction as well [1]. Atrial fibrillation, though, is reported as an uncommon complication [2].

Electric rays (order Torpediniformes) are fish (Figure 1) capable of producing an electric discharge, varying from as little as 8 V to up to 220 V depending on the species, which is used to stun or kill prey [3]. Electric current damages the body by heat generation, muscle contraction or by interfering with the nervous and cardiac systems.

**Case report**
A 47-year-old commercial diver presented to the cardiologist with irregular heart rhythm (HR). He had been inspecting a pipeline on the seabed at 165 feet depth the previous night, when he received four electric shocks from a torpedo ray fish. By the fourth time, his response to verbal commands became incomprehensible and his breathing heavier. This was confirmed later on by the review of video footage. The helmet video showed the diver shouting ‘electrical’ and ‘fish’ as he made attempts to reach his line with evident physical distress. The sound confirmed four separate electrical discharges from the torpedo ray that knocked the diver unconscious. He became limp and was rescued by a diver in 8 min. There was evidence of drooling from the mouth when the Kirby–Morgan helmet was removed. The receiving treating physician on the diving boat reported him to be confused and extremely restless. Glasgow Coma Scale was 12/15. He was taken into the decompression chamber and therapeutic decompression treatment was started by the diving supervisor in view of the rapid ascent. The vessel started a 6-h journey to the shore. He stabilized 15 min later with a Glasgow Coma Scale of 15/15. His vitals were recorded: blood pressure (BP), 110/70 and HR 64. Vital signs and higher mental functions were monitored over the next few hours by a standard decompression illness protocol. His orientation improved and he recognized his co-diver after half an hour. There were no localizing neurological signs on examination. His upper lip was swollen due to a blunt injury from impact of the helmet. When the dive boat reached the shore, he was referred to the hyperbaric specialist. On re-evaluation, his pulse was reported as irregular and he was referred to a cardiologist. The rhythm was confirmed as slow atrial fibrillation (87 per min) with a BP of 140/80. Systemic examination including central nervous system was unremarkable. He was admitted to cardiac intensive care for monitoring and evaluation. Investigations revealed an elevated white cell count (11 000 mm$^{-3}$), while other parameters such as electrolytes, cardiac enzymes, troponin levels, thyroid profile...
and liver function tests were normal. An echocardiogram did not reveal any structural defects and ultrasound of the abdomen was normal. The lung fields were clear on chest x-ray. The HR did not respond to electric cardioversion but reverted to sinus rhythm later with amiodarone infusion. It took 36 h before he reverted to sinus rhythm. He stayed in the hospital for 6 days and was subsequently discharged and advised rest for 4 weeks. At the time of discharge, he had a controlled sinus rhythm of 46 per minute and BP was 134/80 on amiodarone, warfarin, aspirin and salbutamol. A week later amiodarone and warfarin were also discontinued.

There was no evidence that the diver had a pre-existing medical condition. His last physical was unremarkable with a normal electrocardiogram. He gave a family history of hypertension and confirmed working as a diver for the last 23 years with no significant medical history. He was a non-smoker, took occasional alcohol when off duty and was not on any drugs at the time of the event. On this occasion, he had been diving from this location for 1 week without any complaints. While diving, he used surface-supplied enriched air with a mixture of oxygen and nitrogen.

He was reviewed by the cardiologist and certified fit to resume underwater duties. He was advised to take perindopril and aspirin. His subsequent periodic reviews were normal.

Discussion

Our diver suffered four electric shocks from a torpedo ray and was subsequently found to be in atrial fibrillation. There was no evidence of narcosis, subsea electrical cables or electric shock from diving equipment. It is possible that our diver experienced atrial fibrillation as a result of an encounter with hazardous marine life even though there were no external signs of injury from the ray.

Acute atrial fibrillation may have a number of causes, including drug use, surgery, electrocution, myocardial infarction, pericarditis, myocarditis, pulmonary diseases, hyperthyroidism and other metabolic disorders [4]. The incidence of atrial fibrillation increases with advancing age, with an annual incidence per 1000 person-years of ~3.1 cases in men and 1.9 cases in women aged 55–64, rising to 38.0 and 31.4 cases in men and women aged 85–94 [5]. Whatever the cause, it confers a 5-fold increase in the incidence of stroke [6]. Furthermore, an ischemic stroke in the presence of atrial fibrillation is twice as likely to be fatal than strokes occurring in sinus rhythm [7]. In the absence of structural cardiac disease, the likely cause of atrial fibrillation is atrial tachycardia originating at the insertion of the pulmonary veins into the left atrium which degenerates into atrial fibrillation [8]. In our case, investigations did not pick up any significant systemic disease. With a history of electric shock under water, it is reasonable to assume that the cause of his atrial fibrillation was the electric current he received.

An electric shock can occur upon contact of a human or animal body with any source of voltage high enough to cause sufficient current flow through the muscles or nerves. High-tension shocks (>1000 V) from lightning strikes and overhead power cables cause severe internal burns and may cause cardiac arrest usually due to asystole [9]. Low-tension shocks (<300 V at 50 Hz) can cause ventricular fibrillation [10]. The shock delivered by these electric fish is low voltage and therefore likely to be the cause of this diver’s arrhythmia. Why does not every low-voltage electric shock cause arrhythmia? Apart from personal susceptibility, wet skin conditions reduce the resistance to electric current. An electrical shock on wet skin has potential to cause more serious damage to tissues [9,11]. It is therefore impossible to state that one voltage is ‘dangerous’ and another is ‘safe’. Additionally, our diver was shocked four times and this potentiated the electrical effects. Atrial fibrillation is independently associated with a 50–90% increase in the risk of death, which persists after adjustment for coexisting cardiovascular conditions [12]. Our patient was fortunate to revert to sinus rhythm before developing any long-term complications. The diver successfully returned to work after 4 weeks absence.

Conflicts of interest

None declared.

References

2. Wehrmacher WH. Atrial fibrillation due to accidental electric shock. JAMA 1957;165:349.

Figure 1. Torpedo sinuspersici.


