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MYOCARDITIS AND DIVING

In the last column I talked about the most common cause of death in divers; having a heart attack while diving. These heart attacks are usually the result of coronary artery disease in which the arteries in the heart degenerate and eventually become blocked. Occasionally someone dies suddenly and there are no signs of CAD on autopsy. In young healthy people there is usually some other structural abnormality in the heart, but not always.

I work as an expert witness/consultant in a lot of cases of diving deaths and as a result I have read a large number of autopsies on divers. Most pathologists have little or no training or experience in doing an autopsy on a diver. In the standard autopsy procedure the chest is opened first and the heart removed. The lungs and brain are examined later. As a result, seeing a few gas bubbles in the heart, brain and lungs is common (air moved into the open blood vessels) and it is then impossible to determine if the person suffered arterial gas embolism. In a diving autopsy, the chest should be opened underwater and the brain should be examined before the heart is removed. Most autopsies on divers I have read are relatively poorly done.

During many autopsies, examination of the heart is limited to weighing it, measuring it, cutting it open, and looking at it. This is a good way to identify CAD and other structural problems. If nothing is found and the person died suddenly, it is usually assumed that they died from an arrhythmia (cause unknown). If they died in the water, it is often assumed that they 'drowned'.

In 1983 a 21 year old fit healthy male was playing soccer in front of the clinic where I was working. He suddenly collapsed and could not be revived. The autopsy showed nothing so it was assumed that he died from an arrhythmia. In 2008 a 38 year old male, obese (5'8" or 172 cm and 212 pounds or 96 kg) diver did a routine CCR dive on a wreck at 240 fsw (73 msw) depth. The next day he jumped into the water to do a similar dive. He swam ½ way along side the boat towards the downline and suddenly sank. His body was found 8 hours later on the bottom. His computer showed a direct descent to the bottom and then no movement. Only minor equipment problems were found on exam (nothing that should have been fatal).

On autopsy there were no signs of CAD (surprising given his age and obesity) or other cardiac abnormalities. The pathologist noted microscopic myocyte necrosis (very small areas of dead heart cells) with infiltration of white blood cells into the tissue of the heart. They listed the cause of death as 'myocarditis'. No mention of arterial gas embolism, oxygen toxicity, hypoxia, hypercarbia, or even drowning was made. I would have written it off as the all too common poorly done autopsy on a diver except that it was the best written autopsy I have ever read, so I did a literature search on myocarditis. What I learned surprised me!

Myocarditis simply means inflammation of heart cells. The most common causes are infections, toxic effects or autoimmune effects (the immune system mistakenly attacks the person's own heart). This can result in serious damage to the heart, heart failure, and the requirement for a heart transplant or death.

Myocarditis can present as cardiovascular collapse one to two days after infection of the heart by a virus (rare) or more typically symptoms present about two weeks after the heart is infected, while the virus is being cleared from the heart. In some cases a chronic process can occur.

I have known about myocarditis since I was a medical student in the 1970s. I thought it was rare, and usually serious. I was shocked to discover that not only is it relatively common, the real incidence is completely unknown! It is now believed that the majority of cases are asymptomatic and in many other cases the symptoms are so mild that the diagnosis is never made (the person just feels a bit 'off' and assumes that they have the 'flu').

One autopsy series in a major US city showed myocarditis in 1 to 1.5% of all cases of sudden and unexpected death, usually viral or medication caused. Internationally, a parasitic infection called Chagas disease (18 million people infected) results in 50,000 deaths annually from myocarditis.

Studies have shown that in sudden cardiac death (SCD) in young people in North America, up to 20% are due to myocarditis. It also causes up to 7% of SCD in competitive athletes, 20% of SCD in military recruits, and up to 33% of cases of idiopathic ventricular tachycardia.

It is unknown how sick most people with myocarditis are because most cases are never diagnosed! In sick patients who manage to eliminate the virus, less than 4% die. If they do not eliminate the virus about 25% die. In diagnosed cases, the average age is 42.

Many cases of myocarditis have no symptoms. When symptoms are present, the most common are fatigue, mild shortness of breath, sore joints, shortness of breath on exertion, irregular heart beat, and in 20% of cases… fever. Up to 35% of people have chest pain but it tends to be sharp and stabbing (not like a heart attack) and may be due to inflammation of the sack around the heart (pericarditis). If one of the very small areas of necrosis is in an electrically sensitive area of the heart, the person can suddenly develop a fatal arrhythmia. If the infecting virus is parvovirus B19, the myocarditis might present like a lateral wall heart attack. Up to 50% of people who are diagnosed with

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myocarditis have a history of a viral like illness about 2 weeks before the symptoms of myocarditis.

In North America, and presumably in Europe and Australia, myocarditis is usually due to a viral infection of the heart. A very wide range of viruses can cause myocarditis. HIV virus is unique in that it reduces the ability of the heart muscle to contract without inflammation. Myocarditis is present is more than 50% of people with HIV infections. Worldwide the most common bacterial cause of myocarditis is diphtheria. Other bacteria that cause myocarditis are strep, staph, bartonella, brucella, letospira, salmonella, and lyme disease.

The most common cause of myocarditis in South America is the parasite trypanosomiasis (Chagas). Trichinosis (from pork) can also cause myocarditis. Many drugs (clozapine, penicillin, ampicillin, hydrochlorothiazide, methyldopa, sulfonamide) and medications (lithium, doxorubicin, cocaine, catecholamines, acetaminophen, zidovudine) can cause myocarditis. Common toxic causes include lead, arsenic, carbon monoxide and Chinese sumac. Wasp and scorpion stings, spider bites (black widow) and radiation therapy can cause myocarditis, as can connective tissue disorders like SLE (lupus), RA (rheumatoid) and PSS (scleroderma).

Myocarditis is difficult to diagnose. Cardiac enzymes are only elevated in 35% of cases (the areas of necrosis are often very small) and the white count is only up 25% of the time. There are a wide variety of EKG abnormalities. MRI is quite useful and MRI targeted biopsy is diagnostic. However, no one is going to do this in a person with mild symptoms!

Most people with myocarditis require no treatment or simple supportive care. Sicker patients require cardiac monitoring, oxygen, and fluid management. Some require pacing. Stimulants like sympathomimetic drugs seem to increase the heart damage and risk of dying. After the person recovers, they should avoid ALL strenuous activity, including diving for at least six months (risk of recurrence). In people who present with heart failure, 50% recover, 25% stabilize and do well, while 25% progress and do poorly.

In the western world the most common cause is a viral infection and the use of vaccination against measles, mumps, rubella (MMR), polio and influenza has greatly reduced these causes of myocarditis. Meat inspection has almost eliminated trichinellosis and the resultant myocarditis. Many other viruses can cause myocarditis and in animals, vaccination against these viruses has been shown to prevent myocarditis.

This is all very interesting but exactly what does it have to do with diving? Animal studies have clearly shown that exercise and swimming increases replication of the virus in the heart, increases the heart weight (not a good thing), and increases the risk of dying. One autopsy series of 22 children who had drowned, with no symptoms of being ill or other cause, showed that 5/22 (23%) had myocarditis! In all cases the heart was grossly normal at autopsy and the diagnosis was made microscopically. As was mentioned in the last column, swimming and simply being in the water increases the risk of having a fatal arrhythmia.

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diving medicine

Having myocarditis also increases the risk of a fatal arrhythmia. The combined effect may be more than additive.

So, what is the bottom line? Myocarditis is common, usually caused by a viral infection of the heart, and often has minimal symptoms. Most people recover fully without problem. Anyone with diagnosed myocarditis or even suspected myocarditis should be restricted from all activities, including diving, for at least 6 months after they appear to have made a complete recovery. If you are feeling 'off' or like you have the 'flu', you should avoid strenuous activity, including swimming and diving.

In all cases of sudden cardiac death and all cases of 'drowning' (basically anyone who dies while in the water), a very careful microscopic examination of the heart tissue should be done at autopsy looking for myocarditis. It is highly probably that myocarditis is a much more common cause of death in divers (and others) than has been recognized historically.

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