Editorial

Persistent (patent) foramen ovale (PFO): implications for safe diving

Diving medicine is a peculiar specialty. There are physicians and scientists from a wide variety of disciplines with an interest in diving and who all practice 'diving medicine': the study of the complex whole-body physiological changes and interactions upon immersion and emersion. To understand these, the science of physics and molecular gas and fluid movements comes into play. The ultimate goal of practicing diving medicine is to preserve the diver's health, both during and after the dive. Good medicine starts with prevention. For most divers, underwater excursions are not a professional necessity but a hobby; avoidance of risk is generally a much better option than risk mitigation or cure. However, prevention of diving illnesses seems to be even more difficult than treating those illnesses.

The papers contained in this issue of DHM are a nice mix of various aspects of PFO that divers are interested in, all of them written by specialist doctors who are avid divers themselves. However, diving medicine should also take advantage of research from the "non-diving" medicine community, and PFO is a prime example. Cardiology and neurology have studied PFO for as long, or even longer than divers have been the subjects of PFO research, and with much greater numbers and resources. Unexplained stroke has been associated with PFO, as has severe migraine with aura. As the association seems to be strong, investigating the effect of PFO closure was a logical step. Devices have been developed and perfected, allowing now for a relatively low-risk procedure to 'solve the PFO problem'. However, as with many things in science, the results have not been spectacular as hoped for: patients still get recurrences of stroke, still have migraine attacks. The risk-benefit ratio of PFO closure for these non-diving diseases is still debated.[1,2]

For diving, we now face a similar problem. Let there be no doubt that PFO is a pathway through which venous gas emboli (VGE) can arterialize, given sufficiently favourable circumstances (such as: a large quantity of VGE, size of the PFO, straining or provocation manoeuvres inducing increased right atrial pressure, delayed tissue desaturation so that seeding arterial gas emboli (AGE) grow instead of shrink, and there may be other, as yet unknown factors). [3–6] There is no doubt that closing a PFO, either surgically or using a catheter-delivered device, can reduce the number of VGE becoming AGE.[7] There is also no doubt that the procedure itself carries some health risks which are, at 1% or higher risk of serious complications, an order of magnitude greater than the risk for decompression illness (DCI) in recreational diving.[8,9]

Scientists seek the 'truth', but the truth about how much of a risk PFO represents for divers is not likely to be discovered nor universally accepted. First of all, the exact prevalence of PFO in divers is not known. As it has been pointed out in the recent literature, a contrast echocardiography (be it transthoracic or trans-oesophageal) or Doppler examination is only reliable if performed according to a strict protocol, taking into account the very many pitfalls yielding false negative results.[10] The optimal procedure for injection of contrast medium was described several years ago, but has not received enough attention.[11,12] Indeed, it is our and others' experience that many divers presenting with PFO-related DCI symptoms initially are declared "PFO-negative" by eminent, experienced cardiologists!

Failing a prospective study, the risks of diving with a right-to-left vascular shunt can only be expressed as an 'odds ratio', which is a less accurate measure than is 'relative risk'. The DAN Europe Carotid Doppler Study,[13] started in 2001, is nearing completion and will provide more insight into the actual risks of DCI for recreational divers.

The degree of DCI risk reduction from closing a PFO is thus not only dependent on successful closure but also (mostly?) on how the diver manages his/her dive and decompression in order to reduce the incidence of VGE. It has been convincingly shown that conservative dive profiles reduce DCI incidence even in divers with large PFOs,[14,15] just as PFO closure does not protect completely from DCI if the dive profiles are aggressive.[7,16] Prospective studies should not only focus on the reduction of DCI incidence after closure, but should take into account the costs and side effects of the procedure, as has been done in the cardiology and neurology studies.

Imagine lung transplants becoming a routine operation, costly but with a high success rate; imagine also a long-term smoker suffering from a mild form of obstructive lung disease and exercise-limiting dyspnoea. Which of two options would you recommend: having a lung transplant and continue smoking as before, or quit smoking and observe a progressive improvement of pulmonary and cardiac pathology? As opposed to patients with thrombotic disease and migraine, divers can choose to reduce DCI risk. In fact, all it takes is acceptance that some types of diving carry too high a health risk – whether it is because of a PFO or another 'natural' factor.[17] It would be unethical to promote PFO closure in divers solely on the basis of its efficacy of shunt reduction. Unfortunately, at least one device manufacturer has already done so in the past, citing various publications to specifically target recreational divers. Some technical diving organizations even have recommended preventive PFO closure in order to undertaking high-risk dive training.

As scientists, we must not allow ourselves to be drawn into intuitive diver fears and beliefs. Nor should we let ourselves be blinded by the ease and seemingly low risk of the

procedure. With proper and objective information provided by their diving medicine specialist, divers could make an informed decision, rather than focus on the simplistic idea that they need 'to get it fixed' in order to continue diving. A significant relationship between PFO and cerebral damage, in the absence of high-risk diving or DCI, has yet to be confirmed.[18-20] Studying PFO-related DCI provides us with unique opportunities to learn more about the effect of gas bubbles in various tissues, including the central vascular bed and neurological tissue. It may also serve to educate divers that safe diving is something that needs to be learned, not something that can be implanted.

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Front page: sequential images (duration 2.5 sec) of a contrast-transthoracic echocardiography demonstrating patency of the foramen ovale; courtesy Germonpré P, Obeid G, Centre for Hyperbaric Oxygen Therapy and Cardiology Department, Military Hospital, Brussels.