



DIVING MEDICINE ONLINE

Comprehensive updated online information about diving and undersea medicine for the non-medical diver, the non-diving medical professional and an excellent reference source for the diving medical specialist.

Patent Foramen Ovale

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PFO (Patent foramen ovale) is a persistent opening in the wall of the heart which did not close completely after birth (opening required before birth for transfer of oxygenated blood via the umbilical cord). This opening can cause a shunt of blood from right to left, but more often there is a movement of blood from the left side of the heart (high pressure) to the right side of the heart (low pressure).

People with shunts are less likely to develop fainting or low blood pressure with diving than are obstructive valve lesions (such as mitral valve stenosis or aortic stenosis), but are more likely to develop fluid accumulation in the lungs from heart failure and severe shortness of breath from the effects of combined exercise and water immersion.

Ordinarily, the left to right shunt will cause no problem; the right to left shunt, if large enough, will cause low arterial O₂ tension (hypoxia) and severely limited exercise capacity. In divers there is the risk of paradoxical embolism of gas bubbles (passage of bubbles into the arterial circulation) which occur in just about all divers in the venous circulation during decompression.

Blood can flow in both directions with Intra-atrial shunts at various phases of the cardiac cycle and some experts feel that a large atrial septal defect (PFO) is a contra-indication to diving. In addition, a Valsalva maneuver, used by most divers to equalize their ears during descents and ascents, can increase venous atrial pressure to the point that it forces blood containing bubbles across the PFO into the arterial circulation. Thus the usual filtering process of the lungs is bypassed.

Dr. Fred Bove, a Temple University cardiologist, did a search of the literature for patent foramen ovale in relation to diving and diving risks. His conclusion of a meta analysis of 1400 injured divers in about 2.5 million divers (DAN, 1991) in whom the risk of DCS is about 0.05% in the diving population, was that the risk ratio for decompression sickness is increased by a factor of about three for individuals with PFO, and is reduced by a factor of about 2 in individuals who do not have a PFO. It would appear that the risk is low and the significance of the small differences is questionable.

Echocardiography is the tool of choice in making the diagnosis of PFO. However, it's probably not a good idea to do an echocardiogram on all divers because of the cost/benefit ratio. If you personally are concerned or are having some of the symptoms of decompression illness that are undeserved, then a bubble contrast echocardiogram should be done. Bubble contrast

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echocardiography appears to be the most sensitive method for detecting a shunt while color flow doppler appeared to be a poor means of detecting the shunt in a transthoracic echo.

There have been recent reports of an association between cerebral emboli, [migraines with aura and right to left shunts](#) (PFO).

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