

The cost of the X-ray exposure does not warrant the benefits to be gained from X-raying all sports divers.

Dr Ian Unsworth

I accept that totally. I am not an avid advocate of bone X-rays for sports divers either. However, we do know that dives within the tables may produce some degree of venous gas emboli. If we accept that these may be the essential aetiology of bone change, then perhaps we ought to change our view, and say that sports divers may be susceptible to dysbaric osteonecrosis. The problem is that sports divers are not investigated for this. Perhaps we should be taking samples of sports divers and have a look at that bone.

Dr Fred Bove

I agree that we ought to do some study. The best way to know what you are doing is to get intelligent information and use it intelligently. It would be nice to have bone scans. We have learned in exercise physiology that when somebody has pain somewhere, the bone may look perfectly normal on X-ray, but when one does a scan, there is a stress fracture. The hyperaemia of the stress fracture may show up on scan, but an early fracture will not show up on X-ray. If the problem is under perfusion of a section of bone because of bubbles, then the chances are that we would find that on a scan and obviously not find it on an X-ray during the acute period. Denis Walder in England has done some work which shows that some divers who are bent have abnormal scans when studied soon after their exposure. It would be nice somewhere to generate some funds to do X-rays in some sports divers and to do bone scans in some sports divers, perhaps only in the ones that get bent, to find out what happens.

MEDICAL EVALUATION OF THE SPORTS DIVER

AA Bove

GENERAL REQUIREMENTS

The physician who evaluates candidates for sport diving should be familiar with diving physiology, the subsea environment in which the diver works, and the physiological responses of the body to cold, exercise and pressure. With this background, a diving candidate can be properly assessed and the correct decision made even in cases where a diving candidate may have a chronic disease. One way to determine how a diver will respond to diving with some chronic illness, is to consider how the illness will be affected by exercise, pressure, cold and emotional stress.

I have addressed exercise previously. A candidate with chronic illness should be able to meet the requirements of

exercise that I outlined. If these requirements are not met, then either the candidate should not be approved, or should be considered a special problem requiring added support during diving. An example of the latter is a physically handicapped person (an amputee or a paraplegic, but not from DCS) who might dive with other handicapped divers in highly supervised programmes. Exercise capacity need not be guaranteed in all diver candidates. The individual between 16 and 35 years old who is physically fit, and by history has good exercise tolerance, usually poses no problem. Persons in this age group who are poorly conditioned, and most candidates over 40 years old, should have an exercise evaluation prior to diving. In addition, persons with chronic illness or history of chronic heart or lung disease can be exercise tested when there is doubt about their exercise capacity.

The effects of pressure which must be considered are chiefly those due to Boyle's Law (a good review of these pressure-volume relations in diving is worthwhile). Inability to equalize middle ear pressure, a chronically perforated ear drum, history of spontaneous pneumothorax and evidence of lung blebs on X-ray are all contraindications to diving. There is at present some controversy about diving after thoracic surgery. The great number of coronary bypass operations in the US have generated a group of divers who have had chest surgery. My personal experience with four or five of these patients is positive. They had no problem from the chest surgery per se. Their major problem is exercise capacity, and this can be adequately tested.

Another important and controversial area is allergic asthma. Patients with clinical evidence of airway obstruction at rest or with exposure to cold, or during exercise should be disqualified because of the high risk of pulmonary barotrauma. Patients requiring drugs for asthma control likewise should not dive. A history of asthma long past, with four or five symptom free years, no wheezing and no drug therapy, is probably not a contraindication to diving. However, one must examine carefully to be sure that no airway obstruction exists. Pulmonary function studies will help document the state of airway resistance. However their greatest use will be when you need objective data to support a disqualification. It is less common to need pulmonary function studies to document normality.

Although cold stress is not commonly considered in qualifications, there are several problems which need to be considered. Cold induced asthma was mentioned above. Breathing cold gas from a scuba bottle can have the same effect as breathing cold atmospheric air. If cold air induces asthma on land, it is likely to cause problems while diving. People with Raynaud's disease, ie. cold induced digital cyanosis, should not dive if the problem is uncontrolled since gangrenous fingers and toes may develop from the cold water exposure. Cold also induces a change in the circulation which adds a load to the heart. Persons with mild hypertension may have an excessive rise in blood

pressure in a cold water environment. Also note that drugs which block the autonomic system will reduce the body's ability to adapt to cold, and excess heat loss leading to hypothermia, may result.

Behavioural factors include chronic illness which may limit the diver's capacity to perform needed skills. Examples are severe arthritis, paralysis or amputation of an extremity (see above for exceptions).

Illness which renders the diver prone to sudden unconsciousness such as drug dependent epilepsy and insulin dependent diabetes mellitus. Occasionally severe migraine attacks will incapacitate a diver. Serious cardiac arrhythmias which result in reduced cerebral perfusion should also be included.

Finally the physician should assess the candidate's emotional make-up. At present only the grossest of abnormalities would prohibit diving, nevertheless, the physician should make some judgement about the emotional stability of the candidate. Abuse of drugs or dependency on drugs or alcohol should disqualify a candidate.

SPECIAL CONSIDERATIONS

The following pot pourri comes from personal experience and interest, is not inclusive, but can serve as examples of how to apply the fundamental physiological information to specific cases.

Hypertension

Persons on large doses of anti-hypertensive drugs have reduced exercise tolerance, poor thermal balance and occasionally orthostatic hypotension. All of these must be considered. Patients on diuretics alone, small doses of beta blockers, etc., with good exercise tolerance and good blood pressure control can dive. Each case must be decided individually.

Coronary Artery Disease

Exercise induced ischaemia or arrhythmias at 10 - 12 mets or less is a contraindication to diving. The 35 year old man with a single vessel bypass whose heart is completely revascularised and has good exercise tolerance can dive. The evaluation is complex. I suggest you befriend a cardiologist, get him or her into diving and then maintain a continuous dialogue about this question, which is becoming more frequent each year.

Congenital Heart Disease

Patients with cyanotic heart disease have poor exercise tolerance and usually will not appear as candidates. Patients with asymptomatic atrial or ventricular septal defects should not dive because of the risk of paradoxical embolism

reaching the brain from the venous circulation. We showed several years ago that these shunts change direction briefly during diastole and bubbles can pass from right to left even though the measured shunt is from left to right.

Lesions which obstruct blood flow in the central circulation reduce exercise tolerance, and contraindicate diving. These include aortic stenosis, coarctation of the aorta, severe pulmonary stenosis, hypertrophic subaortic stenosis, and mitral stenosis.

Pacemakers

New pacemakers are being used which sense the atrial rate and stimulate the atria and ventricles in sequence. These are not yet in common use, thus most pacemakers are fixed rate types, and do not produce adequate augmentation of cardiac output during exercise. A personal poll of manufacturers reveals that most pacemakers are tested to 130 feet equivalent pressure, and should function properly. Note that no clinical tests have been performed under pressure. However, the major concern is over exercise capacity, and newer pacemakers may overcome this problem.

Artificial Heart Valves

These pose several problems. First, the state of cardiac performance may be chronically reduced even with valve replacement and exercise tolerance will be low. Second, most valves do not function well with high cardiac outputs, so again during heavy exercise the patient may develop severe limitations. Third, most patients are on chronic anti-coagulation and run the risk of bleeding heavily from the minor trauma usually experienced while diving. The newer tissue valves may ultimately overcome these difficulties, but there is no data at present on which to base a diving approval in valve replaced patients.

Endocrine disorders

Most well controlled endocrine disorders do not contraindicate diving. Diabetes mellitus that is insulin dependant is the one obvious exception, as hypoglycaemia can progress to unconsciousness without warning.

Pregnancy

An Undersea Medical Society panel met on this topic several years ago and decided to recommend that a pregnant woman refrain from diving until delivery. This recommendation was based on some evidence that foetal and maternal tissues clear inert gas at different rates and one could not guarantee a bubble free foetus following a dive that was safe for the mother. We also felt that the higher oxygen partial pressure could be detrimental to foetal development. We assumed that the pregnant diver wished to deliver a healthy child, and felt that the sport would best be postponed in the interest of a healthy child.