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Medical aspects of diving

Healthwatch

by Tarun Sahni, MBBS, MD, DMM

The Emirates with its warm waters, clean beaches, and fascinating undersea world serve as a source of inspiration for tourists and local residents to take up ***scuba diving*** and explore the secrets of the sea. A number of clubs all over the UAE and in neigbouring Oman offer diving courses, provide equipment and other support for both the novice diver and the advanced recreational divers. Off the coast many ***commercial divers*** are actively working under hazardous conditions in the open ocean, on oil platforms and in other undersea work. There is difference in the practice of these two types of diving and therefore also in their medical implications.

Whenever humans endeavour to explore the secrets of nature, whether it involves space travel, mountaineering, high altitude exposure of ***diving,*** they have to adapt to the hazards of that environment. It is the fascination of the unexplored areas and the thrills of interacting with unknown risks that serve as an attraction to these adventure, sport or recreational activities. It is important for every individual intending to explore nature's secrets to familiarise himself with the medical and physiological impact of that environment on the human body. It will help him to adapt better and so enjoy to the maximum the beauty he is discovering.

Diving medicine is different from conventional forms of medicine since we are looking at healthy people who are not the usual "patients" unless the impact of the environment causes untoward effects. This form of medicine is thus complimentary to environmental medicine, occupational medicine or sports medicine.

This article is targeted at recreational divers or those who intend to take up diving. It is hoped that this will lead to promoting healthier diving practice and awareness, and lead to many more years of enjoyable, scuba diving. This will augment the information being disseminated by your dive instructors who are themselves adept in handing many facets of diving medicine and emergencies.

The shallow water diver uses air and includes the sports divers, harbour divers, calm divers, scientific and police divers. They can dive to a maximum of 50 metres though most sports diving is restricted to 30 metres since after that depth the effect of nitrogen narcosis can begin to be appreciated (explained later).

We proceed with a hypothetical diver who wants to take up diving and discuss the medical aspects in brief relating to each aspect as he goes diving.

PREPARING TO DIVE

Medical/health status: When you decide to take up diving, you must give a thought to your present state of physical and mental health. You should not be grossly overweight or badly out of shape. Your dive club will give you a questionnaire to fill up, which you must do truthfully. You may have a medical ailment for which you need to take some medication, you may however still be fit for diving. The advantage in recreational diving is that it is possible to tailor the type of dive to be compatible with the diver's medical limitations if any.

If you suffer from asthma, epilepsy, high blood pressure, diabetes, heart disease, have had a recent surgery, are prone to allergies, are on oral contraceptive or anxiolytics you must consult a doctor. You must also intimate your blood group and known allergies to any drugs to your doctor and dive instructors.

A common cold or a dry cough can be significant when you go diving since they can predispose to barotraumas. Intake of alcohol or drugs prior to diving is not advisable since it impairs judgement and predisposes to decompression illnesses. Dentures should be removed before diving.

The lady diver needs some special considerations especially if she is in the middle of her periods, is pregnant or on contraceptive pills.

Diving location: Divers usually familiarise themselves with the area they are diving in. The temperature of water helps to decide a suitable diving suit. Prior awareness of the marine animals in that area helps to take suitable precautions and the first aid measures. The weather forecast may predict rough seas and poor visibility and you may plan the dive on another day. Diving at even slightly higher altitude may mean that dive compressors may not give accurate readings. Also it is advisable to finish your last dive, well before you are planning to take a flight else you may suffer from decompression sickness in the flight. It is also advisable to be familiar with available local medical aid, closest diving doctor and the closest decompression chamber with contact phone numbers.

Equipment: Selection of equipment is best done under the guidance of your instructor. Remember the equipment is going to serve as an extension of your body and should be reliable and comfortable. The face mask and mouthpiece should be particularly comfortable to ease in *clearing your ears* and prevent "faccial squeeze". Masks with optical correction are preferred to the use of contact lenses which may get lost during diving. The lips should seal around the mouthpiece and prevent entry of water into the mouth. It is advisable to have equipment with an Octopus, an additional breathing mouthpiece to be shared with your buddy in emergencies.

IMMERSION PHASE OF THE DIVE

Once you have prepared to dive, the next step is the immersion phase of the dive, wherein the diver is in the water but has as yet not begun the descent. This is the time to check your buoyancy, the tightness of your face mask and the smooth operation of your demand valves.

Physiological changes: Immersion creates a condition of weightlessness, like that experienced by astronauts. This reduces the amount of blood normally pooled in the legs, and also there is constriction of blood vessels in the skin as a response to the cold water. This causes an increase of blood in the central circulation and an increase in cardiac output and leads to increased output of urine. This causes a relative decreased plasma volume on return to surface, which the diver much replace by drinking lots of fluids particularly if there is a suspicion of decompression illnesses.

Buoyancy: This determines the effort a diver must employ to dive into the water. If he has positive buoyancy he will tend to float and descent will be difficult. If he is negative buoyant, he will tend to sink faster and will have difficulty when surfacing. A diver can increase his buoyancy by using weight belts, by using a wet suit or using a buoyancy compensator. Weight belts should have a quick release buckle for rapid ascent to surface in case of an emergency. Remember that as you consume gas from your scuba cylinders, the weight reduces and will lead to an increase in buoyancy.

Water currents: Strong water currents or water swell may cause the diver to be carried away rapidly from the diving site. The diver should be prepared for this both while preparing for descent and when returning to surface, when the already tired diver may find it an arduous task to swim against the current to the boat. Caution also needs to be taken to avoid being swept into the propeller.

To be continued next week

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Medical aspects of diving — II

(Part 1 of this 2-part article discussed the medical aspects when preparing to dive and during the immersion phase of the dive. This article discusses the remaining aspects.)

by Tarun Sahni, MBBS, MD, DMM

Descent phase

PHYSICS: For every 10 metres the diver descends the pressure rises by one ATA (that is the pressure exerted by the atmosphere at sea level). It is important to appreciate that the increase of pressure for every unit increase of depth is greater in shallower depths. Therefore also the impact of pressure volume changes on the body is maximum at shallower depths.

In accordance with Boyle's law for gases (pressure is inversely proportional to volume) this will cause a reduction in volume in the air containing spaces such as the lungs, sinuses and middle ear cavity. To counteract the effect of this reduction the diver breathes air at a higher pressure from with an air source. The scuba diver carries a compressed air cylinder on his back which supplies him air through a "demand valve" with an inbuilt "depth compensator" so that the pressure of air breathed is exactly equal to his surrounding water pressure.

The effect of this increase of pressure on air spaces is most commonly appreciated in the middle ear cavity. The diver has to make a conscious effort to equalise pressure across both sides of the eardrum. Inability to do this can result in pain in the ear and aural barotrauma, which usually resolves and the diver can return to diving within a week or two.

Activity at depth

Breathing gases at higher pressures: Since the diver is now breathing air at a pressure equal to the diving depth the partial pressure of the gases which make up air (nitrogen, oxygen, and carbon dioxide) are also proportionally increased. In accordance with gas laws these gases dissolve in the body tissues. The amount of gas dissolved in a particular tissue is dependent on the depth, the duration of the dive, the tissue characteristics and the mixture of diving gas breathed.

The air breathed at depth is denser (thicker) and this causes an increased work of breathing and the diver may feel he has to take extra efforts to fill his lung.

The raptures of the deep (Nitrogen narcosis): Nitrogen exerts a narcotic effect on the body at depths below 30 metres by dissolving in tissue and slowing down neural transmission. This effect is similar to the effect of alcohol and presents with euphoria, overconfidence, poor mental judgment and aggravation of panic. The effect increases with depth and makes air diving unsafe on air at depths below 50 metres. A remarkable effect of nitrogen narcosis is that it immediately wears off when the diver reduces his depth.

Oxygen & carbon dioxide: At depth there is also a possibility of hypoxia if the air in the cylinder is finished, of which the first warning may be an increased resistance to breathing. Oxygen toxicity, CO2 toxicity and effects of gas contaminants, if the air in the cylinder is incorrectly filled up, may also be felt at depth.

Vision is altered and objects appear closer than they actually are. even in the cleanest ocean waters, only about 20% of the incident light reaches a depth of 10 metres and only one per cent reaches 85 metres. The variation of absorption of light of different wavelengths is responsible for the blue green hues seen at depth. Because of the greater absorption of red colour it appears dull green. Some illumination is thus needed even in shallow depths to see true colours.

Hearing and the vestibular apparatus (responsible for balancing) are also altered while at pressure. Hearing is reduced by about 30 to 70dB but the transmission of sound is faster in water and the intensity of the sound is greater due to the water being a solid medium.

Ascent phase of the dive

By this time the diver is tired and keen to return to surface and the comfort of the dive boat. However this phase of diving requires the diver to take maximum care to avoid dysbarism (injury due to the effects of changing pressure), namely pulmonary barotrauma & decompression illnesses.

Pulmonary Barotrauma (burst lung) can occur due to the effect of the expanding gases on the lung tissue during ascent. As mentioned earlier, in accordance with the Boyles law there is now a reduction of pressure as the diver ascends and the volume of gases increases proportionally. The diver must remember to never hold his breath in ascent, he must breathe normally to let these expanding gases escape from the lungs and prevent damage.

Decompression sickness (DCS): The gases which are dissolved in the body tissues while working at depth are released slowly during ascent. Too rapid release of these tissue gases can result in formation of bubbles which can block blood vessels and cause pressure effects in any tissue and thus lead to the symptoms of DCS or commonly known as Bends. This can present as a skin rash, joint pain or the more serious effects on the brain, spinal cord, lungs, vestibular apparatus etc.

To prevent DCS divers are familiar with decompression tables which guide them to ascend at a particular rate and to stop at specific depths called "decompression stops" to permit release of gases at a slow rate and thus avoid damage to tissues. Modern decompression metres combine data from the depth and duration of the dive to calculate safe decompression schedules on the basis of data stored in it. Some advise that above 30 years of age, the diver should reduce bottom time by 10 per cent for each decade.

DCS is an emergency and the advice of the closest diving physician should be sought, and arrangements made for taking the diver to the closest diving chamber. As a first aid measure, the diver should be given 100% oxygen to breathe. Disaster can occur if the initial symptoms are ignored and divers are advised to seek medical advice at the earliest/remotest suspicion of DCS.

Post-dive considerations

Many diving related ailments manifest hours after the dive and it is advisable to remain in close proximity of a diving treatment facility especially if there has been some untoward activity during the dive.

Flying after diving: The nitrogen present in the tissues continues to be released even after returning to surface and continues for about 12 hours. In case one ascends in an unpressurised aircraft the reduction of pressure on the ascent of the aircraft will behave like another decompression and may lead to greater release of gases and thus lead to symptoms of DCS.

Diving accidents:

Like all adventure sports, diving is a potentially hazardous sport. Most diving accidents are preventable with use of common sense and proper training. The time and effort spent in preparing for the dive is valuable to enjoy a trouble-free dive. Accidents typically occur in the inexperienced novice diver and the overconfident advanced diver. All divers are well advised to adhere to buddy system while diving and the use of buddy lines to communicate amongst divers is strongly recommended.

Diving at shallower depths may be as hazardous as diving at deeper depths. In a Japanese series it was found that two-third of accidents occurred at depths less than 10 metres and more at the start of and the end of the dive. Loss of buoyancy control and consumption of drugs including alcohol are common causes of accidents. Among the other common causes is panic which is best avoided by safe practices. High standards of physical fitness, freedom from medical diseases, training in accident prevention and management, an appreciation of the limits of equipment and a healthy respect for a potentially hazardous environment will prevent accidents.

Sports diving is an interesting and challenging sport and the pleasure derived in exploring the secrets of the deep are parallel to none. For the uninitiated I strongly recommend this sport especially if you enjoy aquatic activities.