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Decompression Sickness in Divers

Diving Medicine

Ichiro NASHIMOTO

Mankind has a long history of diving. It is said that Chinese dove for pearl oysters about 4,000 years ago. Diving is rigorous matter for terrestrial mankind. As the underwater environment has no air for breathing, high water pressure, low water temperature, and difficulties in communications with others. These conditions are hostile and life threatening to divers, and based on this background, diving medicine needs to develop to find safe diving methods and proper treatment of diving's ill-effects. Just as space medicine, diving medicine forms an important part of environmental medicine. Some of the leading topics and research problems of diving medicine follow.

1. Respiratory problems of diving

Divers are subject to drowning, oxygen depletion and carbon dioxide accumulation when in water. The simplest way to prevent drowning is to hold one's breath under the water. Skin diving or breath-hold diving has been widely used to gather seaweed or catch shellfish from ancient times to the present. The Ama of Japan is a typical professional breath-hold divers.

Humans can hold their breath for at least tens of seconds. The breaking point of breath-hold is related to PAO_2, $PACO_2$, and lung movement. Bradicardia will appear during breath-hold diving.

For longer and deeper diving, it is necessary to use an underwater breathing apparatus (UBA), either a self-contained UBA (SCUBA) or surface-supplied UBS. Even if a diver can breathe air in the water, there are the added problems of increased resistance of breathing and/or pressure breathing.

2. Comparative physiology of diving animals

Sperm whales regularly dive for an hour or more, and have repeatedly been found entangled in submarine cables at depth exceeding 1,000 m (Scholander, 1964). Scholander found that sperm whales have large oxygen stores, a great capacity for buffering carbon dioxide and other metabolic acids, tolerance of low oxygen and high CO_2 tension, bradicardia, peripheral vasoconstriction, differential distribution of the circulation, reduced energy metabolism, a bellow function and an avoidance mechanism of bends. His excellent work has greatly contributed basic information to the physiology of asphyxia defence.

3. Effects of high pressure on human

Humans live normally at about 1 atmospheric pressure (1 ATA or 101 KP). Under water, humans experience a hydraulic pressure of 1 atm/10 m. In pneumatic caisson or compressed air tunnel, workers are exposed to high pressure atmospheres. The various effects of high pressure on human are shown in Table 1.

Table 1. Effects of High pressure on Man

Physical Action	Pathophysiological Effects	III-effects
Compresson		
Direct (mechanical) Effects		
a) Even compression		
b) Uneven compression	Deformation of tissues	Squeeze
Indirect Effects		
a) Increased density of air	Increased airway resistance	Ventilation insufficiency of lung
b) Incleased partial pressure		
a. Oxygen	Toxic action of oxygen	Oxygen toxicity (oxygen poisoning)
b. Nitrogen	Narcotic action	
c. Carbon dioxide	Hypercapnia	Carbon dioxide poisoning
Decompression		
Direct Effects		
a) Even decompression		
b) Uneven decompression	Lung expansion	Lung rupture, Air embolism
Indirect Effects		
Reduced solubility of gas	Bubble formation in tissues	DCS, Aseptic bone necrosis

4. Thermal problems of diving

Since the thermal conductivity and heat capacity of water are larger than those of air, control of body temperature is severely affected by water temperature during a dive. Diving in cold water will easily induce hypothermia. To prevent it, wet or dry suit has been used.

5. Decompression sickness (DCS)

Improper decompression from a raised environmental pressure will results in the formation of bubbles in body tissues which may induce circulatory disturbances and/or deformation of tissues, and some secondary pathophysiological changes. If the damage is severe, the signs and symptoms of DCS will appear. and death is a possibility.

DCS can be prevented by the appropriate use of validated decompression tables, oxygen breathing during decompression and after surfacing and suitable health care. Early recompression therapy is effective against DCS.

6. Others

The effects of diving on woman have been studied with special reference to the susceptibility of a pregnant woman to DCS as well as the influence of rapid decompression on a fetus.

Drugs are widely used for medical treatment and can be found in almost every home. Since the pharmacological effects of drug may change under a hyperbaric state, the careful use of drugs is needed for persons who are exposed to high pressure atmospheres.

Finally, as a researcher engaged in the investigation of diving and hyperbaric medicine since 1954, I am greatly concerned by the recent inactivity will cause the decline of diving medicine in Japan. Thus, I sincerely hope that young researchers will seriously and sincerely take up the study of diving medicine.

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