

## Case Report

# Decompression Sickness (DCS) and Diving Illnesses Mimicking DCS : A Case Series

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### Abstract

**Introduction :** Diving is an operational commitment of navy. Diving operations are conducted with / without the presence of a Marine Medical Specialist. Incidence of Decompression amongst naval divers is low compared to recreational SCUBA diving. Decompression Sickness (DCS) and Pulmonary Overinflation Syndrome (POIS), subsets of diving-related injury related to scuba diving. If adequate decompression time is omitted, the trapped bubbles may lead to DCS. POIS is due to an overly rapid ascent to the surface resulting in the rupture of alveoli and subsequent extravasation of air bubbles into tissue planes. On rare occasions, the bubbles may traverse the cerebral circulation (CAGE), causing a potentially fatal condition. Overall, the incidence of adverse effects can be diminished with safe diving practices.

**Decompression Sickness (DCS) :** DCS is a condition in which metabolically inert gas gas bubbles that form while diving do not have adequate time to be resorbed or "off-gassed." It never happens with pure oxygen diving and never occur while at bottom. As per grading, Type I - minor DCS, generally known as bends and Type II - severe DCS.

**Treatment :** Treatment for DCS is followed as per guidelines promulgated in INBR 2806. Mainstay of treatment remains with Oxygen Table 61 & 62 of INBR 2806 which is same as RNBR 2806 as table 5 & 6 of US navy Diving Manual.

**Incidences :** Incidences of DCS are reported at Diving training centre and saturation diving vessels and incidences of diving related injuries like Mask injury, hypoxia, CAGE are documented are reported at Escape Training School.

**Conclusion :** Incidence of DCS in Navy Divers is rather very low due to proper follow of procedures, stringent training and fitness of divers.

**Key Words :** INBR 2806, Treatment Table 61

### Introduction

Diving is an operational commitment of navy. Diving operations are conducted with / without the presence of a Marine Medical Specialist. INBR 2806, a guideline for Indian Navy regarding detailed conduct of operation is being followed during any diving activity [1]. Incidence of Decompression amongst naval divers is low compared to recreational SCUBA

diving. Decompression Sickness (DCS) and Pulmonary Overinflation Syndrome (POIS), subsets of diving-related injury related to scuba diving. The incidence of diving-related DCS ranges from 1 to 35 events per 10,000 dives, depending on region of the world and specific class of diving. This results in bubble entrapment in specific regions of the body, most commonly in joints such as the shoulder. If adequate decompression time is omitted, the trapped

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bubbles may lead to DCS. POIS is due to an overly rapid ascent to the surface resulting in the rupture of alveoli and subsequent extravasation of air bubbles into tissue planes. On rare occasions, the bubbles may traverse the cerebral circulation (CAGE), causing a potentially fatal condition. A slow and controlled ascent, plus proper control of buoyancy can reduce the dangerous consequences of pulmonary barotrauma. Overall, the incidence of adverse effects can be diminished with safe practices.

### Diving Operations

Diving operations conducted in the Indian Navy are of the following nature :

- (a) For routine check of Ship's hull
- (b) Practice diving - To remain fit for the diving, the divers undergo routine diving at swimming pool, during night (Night Diving), open sea diving and Chamber dives etc.

(c) Diving for special purposes : Diving operations are carried out for search and rescue purpose, underwater cutting, amphibious operation, Mine Countermeasure (MCM) & EOD.

(d) Clandestine diving : Diving operations are carried out using pure oxygen delivery closed circuit sets. These sets are used to avoid any detection of bubbles on the surface.

(e) Saturation Diving : In this mode of diving, a diver stays at depth for days. He completes his assigned job and comes back to the diving bell for rest. After the end of the assigned job completion, he is decompressed once for all. This mode saves time which would have been required at every occasion of decompression after a short period of the dive.

### Decompression Sickness (DCS) :

DCS is Inherent to diving. It is caused by metabolically inert gases and due to fast ascent rate. DCS never occurs with pure oxygen diving, neither occurs while at depth. As per grading it is of two types :

Type I - not serious type or minor DCS. Commonly known as 'Bends'

Type II - Serious type or severe DCS effecting Central Nervous System (CNS), inner ear, cardiovascular system, GI system.

Oxygen treatment table for DCS is shown below as Fig 1 & Fig 2.

**Table 61 Oxygen Neocompression Table**

Gauge (meters)	Depth	Stoppages Ascent (min)	Elapsed time	Rate of ascent (meters/min)
18		20 (O <sub>2</sub> )	0000-0020	-
18		5 Air	0020-0025	-
18		20 (O <sub>2</sub> )	0025-0045	-
18-9		30 (O <sub>2</sub> )	0045-0115	3m in 10 min
9		5 Air	0115-0120	-
9		20 (O <sub>2</sub> )	0120-0140	-
9		5 Air	0140-0145	-
9-0		30 (O <sub>2</sub> )	0145-0215	3m in 10 min
Surface			0215	

*Fig 1*

**Table 62 Therapeutic Neocompression Table**

Gauge (metres)	Depth	Stoppages Ascent (min)	Elapsed time	Rate of ascent (metres/min)
18		20 (O <sub>2</sub> )	0000-0020	-
18		5 Air	0020-0025	-
18		20 (O <sub>2</sub> )	0025-0045	-
18		5 Air	0045-0050	-
18		20 (O <sub>2</sub> )	0050-0110	-
18		5 Air	0110-0115	-
18-9		30 (O <sub>2</sub> )	0115-0145	3m in 10 min
9		15 Air	0145-0200	-
9		60 (O <sub>2</sub> )	0200-0300	-
9		15 Air	0300-0315	-
9		60 (O <sub>2</sub> )	0315-0415	-
9-0		30 (O <sub>2</sub> )	0415-0445	3m in 10 min
Surface			0445	

*Fig 2*

Few interesting cases are discussed below :

**Case 1 :** A qualified diver on promotion related diving course had performed diving at shallow water first at 10 MSW depth with compressed air, second time again upto 4 MSW after a gap of 40 min and third time dived as buddy upto 18 MSW with compressed air. He had to do lot of running around as it was his last day and he had to get his outgoing formalities and catch a train. During the train journey he developed wiggling pain on his at shoulder.

He did not report sick as he thought it as pain shoulder due to stress & strain. He took some symptomatic measure. As the pain did not subside till next day, he reported to the unit MO, a Specialist

in Marine Medicine. He was diagnosed as a case of type I DCS (bends) and was put on recompression therapy using Table 61 of INBR. He responded while at depth and treatment completed with Table 61. There was no recurrence of pain. (Fig 3)

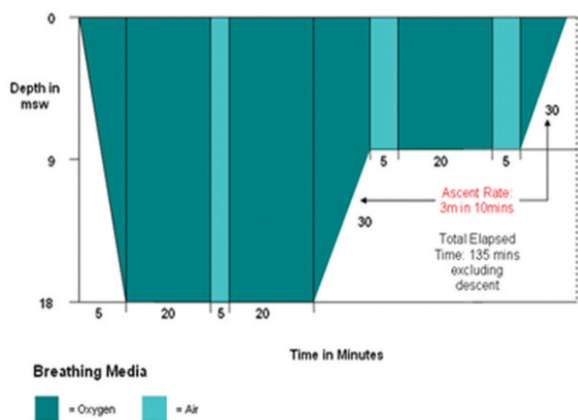


Fig 3 : Therapeutic Recompression Table 61 for the case

**Case 2 :** A young submarine trainee sailor while undergoing Escape Training from 30 M water tower had sudden loss of consciousness soon after reaching surface. Immediate first Aid was administered with 100% O<sub>2</sub> by mask and he regained consciousness after 10 min. He gave history of breath hold for few seconds while ascending from bottom. Clinically his vitals parameters were within normal limits except high normal respiratory rate. However his oxygen saturation was maintained with high flow oxygen through face mask. Quick neurological examination revealed right sided hemiplegia. Bilateral lung fields were clear on auscultations. He was diagnosed as a case of Cerebral Arterial Gas Embolism (CAGE) and administered recompression therapy using extended Oxygen Treatment Table 62 at the accident site. (Fig 4) He showed improvement in power of limbs. He was admitted to hospital for complete evaluation and further management.

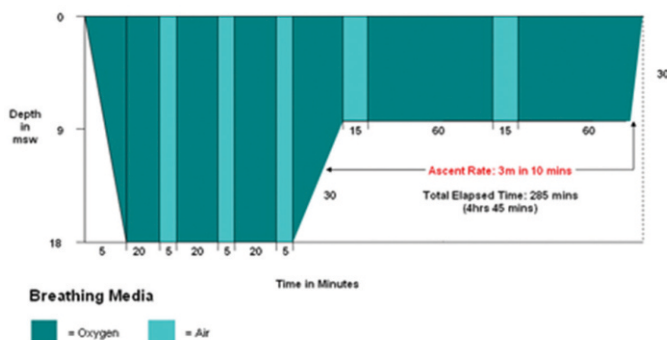


Fig 4 : Therapeutic Recompression Table 62 used in the case

Subsequently he developed focal seizure of right upper limb for which successive recompression therapy was offered using Table 62 daily for next 34 days along with active physiotherapy. Patient had full recovery after 34 days. Subsequent evaluation in hospital revealed fibrotic strand in lung parenchyma with necrotic hilar lymph nodes. He was managed as sputum negative PTB with 6 months of ATT. The individual was made unfit for S/M but still in Navy in good health.

**Case 3 :** 48 yrs. old Ex Naval Diver presented with sudden onset weakness of right side of body noticed just before surfacing after an underwater task at 30 MSW. He surfaced along with buddy diver with controlled ascent. He was also noticed to have speech difficulty while communicating along with deviation of angle of mouth to left. There was history of heaviness of head however there was no history of nausea, vomiting, loss of consciousness, seizure, Joint pain/itching, respiratory difficulty, sensory & autonomic deficit.

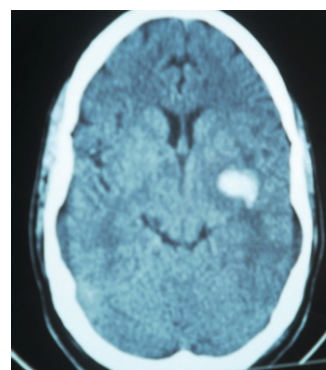


Fig 5 : NCCT Brain revealed acute parenchyma haemorrhage in-M2 branch of Lt MCA

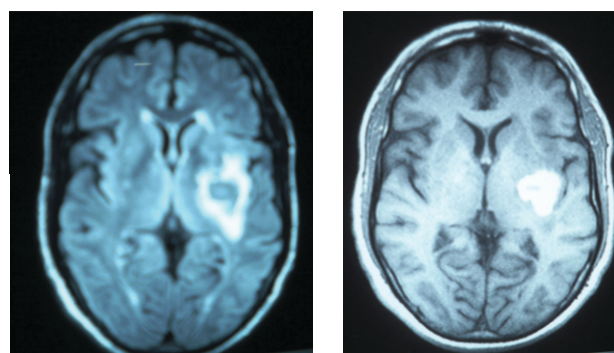


Fig 6 : MRI Brain revealed acute intraparenchymal haemorrhage involving (L) subcortical white matter, internal capsule, and thalamus with lentiform nucleus

He was provisionally diagnosed as a case of neurological decompression sickness (DCS) and recompressed in a hyperbaric chamber using oxygen

table 62 at the accident site. In view of no relief of symptoms, he was transferred to hyperbaric centre at tertiary care hospital of navy for further management.

Clinical examination revealed Pulse 76/min, B/P-240/142 mm Hg. Neurological examination revealed normal HMF, motor aphasia, UMN Right 7th Nerve palsy. Right sided hemiparesis. Other systemic examinations were WNL. In view of above findings and history not corroborating with DCS, differential diagnosis of acute stroke was made. Urgent NCCT brain was done which revealed acute parenchyma haemorrhage in-M2 branch of Lt MCA (Fig 5).

Subsequently MRI Brain revealed acute intra parenchymal haemorrhage involving (L) subcortical white matter, internal capsule, and thalamus with lentiform nucleus. (Figure 6)

He was managed as a case of haemorrhagic stroke likely aetiology of accelerated hypertension. He had uneventful recovery and discharged with residual motor weakness. He was made unfit for future dive.

### Discussion

The cases discussed above are unique on their out-merit. The first case shows that DCS can take place even with shallow water dive maintaining the decompression schedule. Here dives were repetitive and followed by exertion. He had full recovery after therapeutic recompression with oxygen table 61. Repeated air dives increase the nitrogen load in blood thus increase the chance of formation of nitrogen bubbles while decompression.[ 4]

In second case the individual had suffered from CAGE secondary to pulmonary barotrauma due to existing pulmonary pathology precipitated by transient breath hold while on ascent. This case shows the danger of pre-existing lung pathology and holding breath during ascent. There is always an increased chance of pulmonary barotraumas in above situation leading to life threatening outcome.[ 4,5]

Third case, the diver had suffered acute haemorrhagic stroke due to accelerated hypertension probably precipitated due to stressful diving condition. Most importantly this type of presentation during diving activity pose diagnostic dilemma and mimic severe DCS and misguide the diving physician.

### Recent Trends in DCS Management

Apart from therapeutic recompression, adjunctive therapy using different drugs especially

administered. Statin medications alter numerous biochemical, and biophysical processes, which may influence bubble formation. Statins preserve endothelial integrity, reduce ischemia/reperfusion injury, and depress the interdependent inflammatory and coagulation cascades via pleiotropic properties involving up-regulation of endothelial nitric oxide synthase (eNOS) and NO[ 6].

In China, oral administration of Ethanol is being used for treatment in the dose of 50-70 ml of pure ethanol in 100 ml of 5% Dextrose, to be taken orally within 10 minutes of DCS.[7] It is claimed that this treatment may be given as first aid on site in absence of a hyperbaric chamber.

### Conclusions

Diving is an operational commitment of Navy. DCS is the occupational hazard arising from the practice of diving. The incidence of DCS is lower in scientific dive (0.324/10,000 person-dives) compared to 0.9-35.3/10,000 in recreational, instructional/guided, commercial and/or military diving. However, if proper protocol of compression, decompression, physical fitness is maintained DCS may be avoided to large extent. The incidence of DCS is very low in the Navy set up due to following Factors:

- (a) Stringent Physical Training for Divers.
- (b) Physical fitness
- (c) Regular & Thorough Medical check-up.
- (d) Following the diving practice as per laid down procedures.

DCS may occur even after following all safety rules. Not all incidents occurring during diving activity need to be due to DCS. Presence of other co morbidity also to be kept in mind.

### How to cite the article

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### Source of support

Nil

### Conflicts of interest

All authors have none to Declare.

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