DIVE COMPUTERS AND FLYING AFTER A DIVE TO 39 M FOR 10 MINUTES

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An interesting report by Balldin[1] describes an experiment in which 10 healthy, male divers or military helicopter pilots simulated a rectangular profile dive to a maximum depth 39 m for a bottom time of 10 minutes in a hyper/hypobaric chamber. The ascent rate was 18 m/minute and no decompression stops were performed, in accordance with the US Navy Tables. After an interval of 3 hours at 1 ATA, the pressure in the chamber was reduced to simulate an altitude of 3,000 m which is similar to the maximum cabin pressure that occurs in some commercial airliners. A Doppler ultrasonic bubble detector was used to monitor the divers in the pre-cordial position. Bubbles were detected in 30% of the divers, however no cases of decompression sickness (DCS) were diagnosed.

Many dive computers indicate the surface interval required before flying in a commercial aircraft after a dive or series of dives. These surface intervals vary greatly between computers, depending on the decompression model on which the computer is based and the parameters and criteria used within the model. Curious to discover what surface intervals various dive computers would require before flying after a dive to 39 m for 10 minutes bottom time, I collected a variety of units and tested them in a pressure chamber.

The chamber was pressurised to 4.9 ATA over one minute, maintained at 4.9 ATA for 9 minutes and then gradually released over 4 minutes to simulate an average ascent rate of approximately 10 m/minute, as specified by most of the computers. The only computer that indicated the need for a decompression stop was the "Micro Brain Pro Plus" which required a stop of 45 seconds at 3 m. Table 1 shows the results.

Table 1

INTERVALS BEFORE FLYING FOR VARIOUS DIVE COMPUTERS

Dive computer	Interval
Aladin Pro (US Divers Monitor 2)	36 min
Datamax Sport	3 hr 25 min
Micro Brain Pro Plus	0 hr
Skinnydipper	5 hr
Suunto SME-ML (R1)	2 hr

The results caused me some concern. Three of the five computers indicated surface intervals considerably shorter than the 3 hours after which Balldin found substantial gas phase formation.

One would hope that the slower ascent rate recommended by the computers would reduce the degree of gas phase formation below the level that occurred in Balldin's subjects, but, to my knowledge, this has still not been proven. In any case, despite the very useful ascent rate indicators incorporated in most dive computers, many divers still, at times, find it difficult to maintain such a slow ascent rate, especially if no ascent line is available. If ascent is too rapid, substantial bubbling may occur, and this will very likely slow down gas elimination. The current computers do not adequately account for any delayed off-gassing due to a rapid ascent and will give exactly the same surface intervals before flying (as well as identical repetitive dive times) as when the ascent rate has been adhered to. In a similar experiment to the above, an ascent rate of 18 m/minute gave almost identical results on the dive computers despite their recommended ascent rates having been greatly exceeded. The only difference was that the "Micro Brain Pro Plus" required a decompression stop of 70 seconds at 3 m. It still indicated that it was safe to fly immediately after the dive.

We can never really be sure exactly when it becomes "safe to fly" after a dive as it will depend on the degree of gas phase formation and for how long it persists. There is a gradual reduction in risk with time. Many authorities now recommend that a diver waits at least 24 hours before flying after any air dive, but a substantial number of divers have suffered from DCS after having waited far longer than 24 hours before flying. Flying as long as 5 days after extensive diving has resulted in symptoms.

Most dive computers are continuing to improve as the manufacturers realise their shortcomings and modify their programs accordingly. However, it appears that they still have some way to go. By the end of 1988, 121 cases of bends in divers using computers had been reported to the US Diver Alert Network (DAN,) 77 of these occurring in 1988 alone.[2] In the USA, computer-related DCS increased from 14% of the total DCS cases in 1987, to 36.6% in 1988.[3] Divers should not blindly follow their computers but should add substantial safety margins to the times allowed by their units.[4] This advice seems very relevant to flying after diving.

Interestingly enough, despite the worrying short intervals often given by the "Aladin Pro" and "Micro Brain Pro Plus" for flying after diving, these two dive computers are generally more conservative than the other brands for most diving situations and are, in my opinion, the best dive computers currently available.

REFERENCES

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SCUBA TRAINING FOR THE OUT-OF-AIR SITUATION

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By far the most contentious subject to raise with those who instruct scuba divers is whether practice in making an out-of-air ascent should be prohibited, permitted if performed under very strictly controlled conditions, or be made an integral part of the training course. This paper discusses dispassionately some of the background to the controversy and records the manner in which the main instructor organisations in Australia have chosen to resolve the conflict between the risk factors of the alternative possible courses of action. Tables 2 to9 are constructed from information in the Divedata Databank (Project Stickybeak) files. These files are accessible to any interested person or organisation.

Historical Background

Until pumps had been developed capable of supplying air in sufficient volume to maintain a man underwater the only way to dive was in the breath-hold mode, although some records state that Greek divers in ancient times may sometimes have used air lowered to them in cauldrons by people in boats.[1] The problem of supplying air to keep the water from rising too high with within diving bells as they descended was solved by sending air down in weighted barrels on a line, a method described by Halley[2] which remained in use till a sufficiently effective air pump was developed and users changed to this method of replenishing the bell air. He later designed a hookah system which was supplied by the pressured air within the bell. The mortality and morbidity among the workers is unknown but it is probable that accidents occurred when the workers were faced with a necessity to reach the surface or drown, with some suffering air embolism. In those rough, tough days their deaths would be accepted as due to drowning as the very existence of such a condition as air embolism had yet to be recognised.

As soon as it was realised that a man could be supplied with a continuous flow of air while wearing a helmet, which was in essence a mini-bell, the commercial possibilities were recognised. Now workers were free to move on the sea bed, no longer limited to the area immediately below the bell. The occupation of commercial diver came into existence, hardy, brave labourers who seemingly had a philosophical (or resigned) attitude to the dangers of the work they performed. The early suits were of a helmet and jerkin type, so filled with water if the wearer bent too far forwards, a design soon replaced by the standard suit (except among pearl and sponge divers). The open suits could be discarded by the wearer should necessity or panic make him desire an emergency surfacing.[3] It was such untrained divers who first made "free ascents", luck deciding the outcome of the ascents, although the reason why the fatalities occurred was not discovered until the US Navy introduced practice out-of-air ascents for submariners and some died.

The first recorded instance of a "for real" free ascent from a submarine was that of Corporal Bauer and his two crew from 18 msw depth in 1851. William Bauer must have been an exceptional man because while trapped in the damaged "Sea-Diver" listening to anchors trying to engage themselves in the submarine's structure, intending then to pull it to the surface but more likely to break one of its portholes, and watching water seep through the damaged joints on the hull plates, he managed to think clearly. In this he was helped by the remarkable composure of his crew. His knowledge of physics enabled him to recognise that the hatch was kept firmly closed because the water pressure was greater outside than in the submarine but that he could equalise the pressures by opening the sea-cocks to allow water to enter. That he persuaded his crew that this course of action was safe says much for his personality. All three ascended successfully despite each first taking a last deep breath before opening the hatch. The success of their response to the life or death situation was without benefit of prior training or, as far as is known, planning for such an emergency.[4]

That their survival was not a unique event can be given credence by the findings of the British Submarine Escape Mission, set up by the Admiralty to investigate known cases of escape from actually sunk submarines of all nations.[5] This noted that most of the successful escapes were made without the use of the equipment designed for use in such circumstances "but rather by free ascent or buoyant-assisted free ascent (buoyant ascent)... a result of the malfunctioning (equipment) and/or poorly-trained crews". There is relevance in this comment to the subject of the training of scuba divers and especially to attempts to perform a buddy-breathing ascent unless both divers are well trained and have sufficient air available.