Observed bubble dynamics in oxygen or heliox breathing and altitude decompression sickness

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ALTITUDE decompression sickness (DCS) is a common risk in aviation and has been extensively studied over the past two decades (2, 3, 9). Attempts have been made to find a correlation between ultrasonic bubble detection and symptoms of altitude DCS (1, 8). Models extrapolating the risk of DCS from diving to altitude have not always been successful (4). Altitude DCS can occur in flying after diving, during accidental loss of cabin pressure, flying to extreme altitude, and repeated helicopter flights in intensive military operations. Denitrogenation by breathing oxygen either as a prebreathe or during decompression has been proposed as a means of reducing the risk of DCS (7, 10, 12). Exploring the effect of different treatments on the fate of altitude-induced bubbles may add to our understanding of altitude DCS and enable us to derive decompression procedures.

In a study in the Journal of Applied Physiology, Hyldegaard and Madsen (6) use their long-serving model for the observation of bubble kinetics in the tissue of the rat to explore the effect of decompression to the commonly used cabin pressure of 71 kPa. Air bubbles previously injected into adipose tissue were observed during decompression. The study supports the notion that bubbles can grow to a greater extent at low pressure and raises the question of how to reduce the risk of DCS. The authors found that compared with hypobaric air breathing, a switch to oxygen breathing had a dual effect: an initial increase in bubble volume, after which the bubble diminished and disappeared. A switch to heliox also led to bubble disappearance but prevented the large increase in volume at the outset. The time to disappearance of half of the bubbles in heliox (50:50) ~60 min from the gas switch, may be shorter (although not significantly) than it was for oxygen breathing, ~67 min. The last bubble disappeared in heliox (50:50) ~128 min after the gas switch, whereas during oxygen breathing 30% of the bubbles remained for longer than 170 min. Both of these measures point to the superiority of heliox. Thus for adipose tissue, heliox (50:50) may be preferable to breathe heliox (50:50). This experimental model can be used further to explore accidental loss of cabin pressure. After decompression to extremely low pressure, both aqueous and adipose tissues would immediately be flushed with either oxygen or heliox. Immediate switching of the gas mixture is required because after half an hour at low pressure (the period of time used in the present study), most of the supersaturated dissolved gas in the aqueous tissue and half of the supersaturated gas in the adipose tissue of the rat would have been eliminated. It may well be that studies on this topic will lead to replacement of the emergency oxygen supply in aircraft by heliox. Finally, decompression models that calculate the critical gas volume for DCS risk, such as that of Flook (5), can incorporate the findings of the present and future studies to predict the risk of DCS with different gas mixtures at altitude.

An interesting observation is the initial bubble growth during oxygen breathing. This may have implications for aviation accidents involving the sudden loss of cabin pressure. Breathing oxygen to overcome the hypoxia will result in the growth of any decompression bubbles that have been formed and increase the risk of DCS. In such an event, it would be preferable to breathe heliox (50:50). This experimental model can be used further to explore accidental loss of cabin pressure. After decompression to extremely low pressure, both aqueous and adipose tissues would immediately be flushed with either oxygen or heliox. Immediate switching of the gas mixture is required because after half an hour at low pressure (the period of time used in the present study), most of the supersaturated dissolved gas in the aqueous tissue and half of the supersaturated gas in the adipose tissue of the rat would have been eliminated. It may well be that studies on this topic will lead to replacement of the emergency oxygen supply in aircraft by heliox. Finally, decompression models that calculate the critical gas volume for DCS risk, such as that of Flook (5), can incorporate the findings of the present and future studies to predict the risk of DCS with different gas mixtures at altitude.

This is an interesting study by Hyldegaard and Madsen (6) that prompts further investigations on aqueous tissue and with greater pressure reduction, conditions that may lead to the evolution of decompression bubbles.

REFERENCES

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