LETTER TO THE EDITOR

An alternative mechanism underlying the protection against decompression illness by helium preconditioning

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TO THE EDITOR: In their recent paper, Zhang et al. (3) concluded that helium preconditioning protected rats against decompression illness (DCI). After three 5-min sessions of helium breathing (79% He, 21% O_2) at atmospheric pressure, interspersed with 5-min periods of air inhalation, experimental rats were exposed to 709 kPa for 60 min and decompressed. Helium prebreathing increased the percentage of rats that did not suffer DCI from 28% in the control group to 56% in the experimental group, also reducing the death rate from 32 to 24%. In addition, a helium prebreathe increased the score on the grip test, and reduced the percentage of surviving rats with abnormal somatosensory evoked potentials.

The authors admitted difficulty in identifying the protective mechanism, due to helium being an inert gas. The only explanation they could suggest was the entry of helium into cavities within proteins, thus affecting their conformation and activity. In that case, one would have expected the helium molecule to remain within the protein throughout the hyperbaric exposure.

Decompression bubbles can expand and develop only from preexisting gas micronuclei. It is known that nanobubbles form spontaneously when a smooth hydrophobic surface is submerged in water containing dissolved gas. We have shown that these nanobubbles are the gas micronuclei underlying decompression bubbles and DCI (1). Active hydrophobic spots (AHS) on the luminal aspect of blood vessels are composed of lung surfactant and produce bubbles on decompression.

A study using atomic force microscopy to investigate the influence of various gases on surface nanobubbles found that at 25°C, the diameter of surface nanobubbles was 123, 163, and 478 nm and the radius of curvature 203, 535, and 853 nm for He, N_2 and O_2, respectively (2). Surface nanobubbles composed of helium are smaller than those of nitrogen and oxygen, as too is the radius of their curvature. Density, temperature relationship, and the total volume of nanobubbles also vary with the dissolved gas (2).

We demonstrated that the initiation of AHS (the formation of the first bubble) is the function that governs the appearance of bubbles. This is a slow process compared with simple diffusional expansion, peaking 45 min after decompression (1). Therefore the mechanism underlying the protection afforded by a helium prebreathe may in fact be the differences between the shape, density, and total volume of nanobubbles composed of helium and either O_2 or N_2. The exchange of gases between the dense gas layer from which nanobubbles bud off and the medium is currently unknown. If the entry rate of helium into the dense gas layer is faster than the speed at which it leaves, helium nanobubbles may be present on decompression and affect the outcome by reducing bubble formation.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the author.

AUTHOR CONTRIBUTIONS

R.A. drafted manuscript, edited and revised, and approved final version of manuscript.

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