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BRIEF COMMUNICATION

Effects of Hyperbaric Simulation of Scuba Diving Pressure on Plasma β-Endorphin

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Scuba divers   Plasma β-endorphin   Hyperbaric pressure

MANY studies have reported an increase in the plasma concentrations of β-endorphin immunoreactivity (β-EIR) in humans after various forms of strenuous exercise, including running, cycling, skiing and weightlifting [for reviews, see (2,14)]. It is possible that this increase in β-EIR is caused by physical stress, because several other types of other physical stresses, such as surgery (13), parturition (3) and electroconvulsive therapy (7), are known to elevate plasma levels of β-EIR in humans. A feeling of well-being or euphoria which often accompanies or follows strenuous exercise [e.g., (12)] has been suggested by some authors to be due to an opiate-like effect of the increase in β-EIR release (8,10), but a correlation of changes in mood with exercise-induced elevations in plasma β-EIR (16) has not been a consistent finding (5,6).

Feelings of well-being and elevations of β-EIR in plasma have also been reported under conditions of minimal physical movement in scuba divers who were submerged under water in a state of neutral buoyancy for 20 min (1,15). These changes were obviously unrelated to exercise and were not due to venipuncture for blood sampling or to the use of scuba breathing equipment (1). Recently, it was reported that tactile pressure, in the form of a massage, increased plasma β-EIR levels (9). In the present study, the possible role of the increased pressure of submersion of plasma β-EIR levels was assessed with the use of a hyperbaric chamber to mimic the pressures of different diving depths. The results indicate that the elevated plasma β-EIR from submersion is likely not due to increased pressure.

METHOD

The subjects in this study were eight male scuba divers ranging in age from 30–53 years (41 ± 3.6 years). They had 1–12 years of diving experience (4.4 ± 1.9 years), ranging from 10–1300 dives (232 ± 155). Five of the subjects had only 1–2 years of diving experience.

This study was performed at the hyperbaric chamber facility of Duke University (Durham, NC). During this study, four blood samples were taken by venipuncture from each subject, the first two from the right arm and the second two from the left arm. The first sample was taken while the subjects were seated in the chamber, about 10–15 min prior to increasing the pressure to simulate a dive to a depth of 2 ft. (0.6 m). This pressure was maintained for 20 min, and the second blood sample was taken

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TABLE 1

EFFECTS OF 2- AND 50-FT DIVING PRESSURE SIMULATIONS IN A HYPERBARIC CHAMBER ON β-EIR IN PLASMA FROM SCUBA DIVERS

Blood Sample Testing Period	β-EIR (pg/ml)
1. Pre-2-ft depth simulation	40.3 ± 6.6
2. Post-2-ft depth simulation for 20 min	37.8 ± 6.2
3. Pre-50-ft depth simulation	30.2 ± 4.9
4. Post-50-ft depth simulation for 20 min	27.0 ± 6.9

within the first 3.5 min following restoration to normal pressure. Subjects were then allowed to leave the chamber for 1 hour, after which they reentered the chamber. A third blood sample was taken while the subjects were seated in the chamber, about 10 min prior to increasing the pressure to simulate a dive to a depth of 50 ft. (15.2 m). This pressure was maintained for 20 min, and the fourth sample was taken within the first 3 min following restoration to normal pressure.

For the determination of plasma β-EIR, blood samples were collected in heparinized syringes. Plasma was obtained by centrifugation at 1,500 × g for 10 min at 4°C. Each sample was then frozen on dry ice and stored at −70°C, until analyzed. β-Endorphin was extracted from thawed plasma samples with octadecylsilyl-silica cartridges (Sep Pak® C18 cartridges; Waters Associates, Milford, MA), and eluted with 4 ml of 75% acetonitrile containing 0.1% trifluoroacetic acid. The resulting cartridge extracts were concentrated to dryness in a centrifugal vacuum concentrator, and β-EIR was quantified by radioimmunoassay, as described previously (1).

RESULTS

The effects of simulating the increased pressures of 2-ft and 50-ft dives in a hyperbaric chamber on the levels of β-EIR in plasma are summarized in Table 1. Analysis of variance indicated no significant differences among the divers in the four blood samples taken during the experiment, $F(3,28) = 1.02$. There was a tendency for the mean plasma β-EIR to decrease over time, but this was not statistically significant. Thus the significant increase in plasma β-EIR observed after submersion in water (1,15) could not be mimicked by exposure to increased pressure in a hyperbaric chamber. In addition, none of the subjects reported feelings of well-being or euphoria after exposure to increased pressure in the hyperbaric chamber.

DISCUSSION

In previous studies, it was reported that submersion of male scuba divers in a state of neutral buoyancy for 20 min at a depth of 10 feet (3 m) resulted in significant increases in plasma β-EIR (1,15). Furthermore, there appeared to be an inverse correlation between the increase in β-EIR with submersion and diving experience, such that the more experienced divers showed less of an increase in β-EIR, although all subjects reported feelings of well-being, relaxation or euphoria after the period of submersion (15). In contrast to the increase in plasma β-EIR observed with submersion, exposure to pressure in a hyperbaric chamber had a tendency to decrease plasma β-EIR during two 20-min periods of exposure to increased pressures. Although the decreases during each 20-min period were not statistically significant, it is of interest that during the duration of the entire experiment (about 2 h), plasma β-EIR decreased 32% from a mean of 40 to 27 pg/ml. A 42% mean decrease in plasma β-EIR (from 51 to 30 pg/ml) was recently reported in men during continuous water immersion up to the neck for 2 h (4). Thus it is possible that the first exposure to low pressure in the hyperbaric chamber initiated a sequence of physiological changes resulting in a decrease of β-EIR which did not reach a nadir until some time beyond the 20-min exposure period. The mechanism of such an initiation is not known, but Coruzzi and co-workers (4) postulated that the decrease in β-EIR observed in their study may be due to an increase in the release of dopamine. Alternatively, one could speculate that hyperbaric pressure might decrease the release of β-endorphin from the pituitary, as a result of decreasing the firing rate of hypothalamic neurons (11).

The present study indicates that exposure to pressure in a hyperbaric chamber causes neither an increase in plasma β-EIR nor an increased feeling of well-being. Consequently, it is concluded that the increases in these two parameters with submersion under water do not appear to be due to increased pressure. On the other hand, it cannot be stated with certainty that a direct relationship exists between elevated β-EIR in plasma and feelings of well-being. Further studies with opioid antagonist administration would be required for determining whether endogenous opioids might be involved in submersion-induced feelings of well-being.

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