Holding breath for several minutes elevates marker for brain damage

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Divers who held their breath for several minutes had elevated levels of a protein that can signal brain damage, according to a new study from the *Journal of Applied Physiology*. However, the appearance of the protein, S100B, was transient and leaves open the question of whether lengthy apnea (breath-holding) can damage the brain over the long term.

"The results indicate that prolonged, voluntary apnea affects the integrity of the central nervous system, and may have cumulative effects," the Swedish researchers said. The release of S100B into the blood suggests that holding one's breath for a long time disrupts the blood-brain barrier, they said.

The concern is that repetitive exposures to severe hypoxia (lowered oxygen supply), such as that experienced by individuals training and competing in static apnea diving events, could cause neurological damage over time. The researchers recommended further research on free divers that would begin early in their careers and follow them for years to monitor their neurological function.

The study is "Increased serum levels of the brain damage marker S100B after apnea in trained breath-hold divers: a study including respiratory and cardiovascular observations." The researchers are Johan P.A. Andersson, Mats H. Linér and Henrik Jönsson, of Lund University in Sweden. The American Physiological Society published the study.

Free diving is a tradition

There is a tradition of breath-hold diving in Japan and some other parts of the world that goes back hundreds of years, although the occupation has been dying out. These divers harvest seaweed, shellfish and other growth from the sea bottom, diving dozens of times per day. Some divers routinely dive to depths of 90 feet on a single breath while others dive in the 15-30 foot range.

More recently, breath-hold diving has become a competitive sport. Competitive events include how long divers can remain underwater, how far they can swim underwater and how deep they can dive. Participants must undergo intense training to increase their lung capacity while learning crucial safety measures.

Breath-hold diving often leads to hypoxia, elevated blood pressure, slowed heartbeat and other physiological changes. However, whether the sport causes any long-term damage to the brain has remained a point of contention. Studies have produced conflicting results.

The authors of this study see cause for concern, noting that in six international competitions between 1998 and 2004, 10% of the contestants in the static apnea events were disqualified after they lost either motor control or consciousness. In this event, participants float face down on the water for as long as possible without coming up for air. The world record for the event is 11 minutes 35 seconds. Divers at international competitions routinely hold their breath 4-7 minutes.

"Whether such hypoxic episodes are associated with a risk for brain damage in these athletes remains to be established," the researchers said. "Studying the changes in established biochemical markers of brain damage after such performances offers the possibility to address this question."

Breath hold experiment

Nine competitive breath-hold divers (eight men and one woman) took part in this study, along with six individuals who had limited experience with breath-hold diving. The nine competitive divers formed the experimental group, while the non-divers acted as the controls.

The researchers told the participants to lie on their backs on a cot and hold their breath for as long as possible. The conditions were dry, but mimicked a static apnea dive in which the divers float face down holding their breath. The divers used whatever preparatory techniques they customarily use in competition, such as hyperventilating, insufflation (filling the lungs with as much air as possible) and breath-holding warm-ups.

The researchers took arterial blood samples from a catheter inserted into the artery that runs through the wrist. They took samples before the breath hold, at the end of the breath hold and at fixed intervals for the two hours following the end of the breath hold. The researchers also measured arterial blood gases. They did the same measurements on the individuals in the control group, but the controls rested on their backs for the entire experiment, without performing the breath hold or the warm-ups.

Among the findings of this experiment:

- The average breath-hold time was 5 minutes 35 seconds. The longest was 6 minutes 43 seconds and the shortest was 4 minutes 41 seconds.
- The marker for brain damage, S100B, rose in seven of the nine divers.

- The controls showed no change in S100B
- On average, S100B rose 37% within 10 minutes after the apnea ended.
- S100B levels returned to normal within two hours for all the participants.
- The divers showed signs of asphyxia, that is, blood oxygen levels fell, while carbon dioxide levels rose.

The S100B levels, while elevated, were well below levels associated with brain injury. In brain-injured patients, the presence of S100B in the blood can increase by several hundred percent.

In addition, the elevation of S100B was more transient in the divers, compared to people who suffered brain injury. The divers had a quick return to normal, while S100B levels peak in 24 hours in brain-injured patients.

The transient nature of the increase in S100B among the divers probably indicates the blood-brain barrier has been compromised, allowing the protein to escape from the fluid in the brain into the circulation. The blood-brain barrier controls what passes between the brain and the circulation. S100B would normally remain in the brain.

Other sports have also been associated with a similar transient increase in S100B, the researchers noted, including boxing, headings in soccer, running and long-distance swimming. One study also reported that individuals suffering sleep apnea had elevated levels of S100B in the morning, although another study indicated there had been no change in S100B overnight.

More information: jap.physiology.org/cgi/search? … 9&volume=&firstpage=

Source: American Physiological Society (news : web)