Shielding body protects brain from 'shell shocking' blast injuries

April 28 2011

Stronger and tougher body armor to shield the chest, abdomen and back may be just what soldiers fighting in the Afghanistan and Iraq wars need to better protect their brains from mild injuries tied to so-called "shell shock," results of a Johns Hopkins study in mice suggest. Such mild trauma, resulting from the initial shock of exploding mines, grenades and improvised explosive devices (IEDs) now accounts for more than 80 percent of all brain injuries among U.S. troops. Some 160,000 American veteran men and women are estimated to have sustained this kind of trauma.

"Protecting the body is absolutely essential to protecting the brain," says senior study investigator and Johns Hopkins neuropathologist Vassilis Koliatsos, M.D. "Blast-related injuries, including what we call blast-induced neurotrauma, are the signature medical events of current wars, and improvements to body armor in addition to helmet- wearing are likely going to be needed if we want to minimize their threat to our soldiers' health," says Koliatsos, a professor at the Johns Hopkins University School of Medicine.

In a report to be published in the May edition of the *Journal of Neuropathology and Experimental Neurology*, Koliatsos and his team used a metal shock tube specially designed at Hopkins' Applied Physics Laboratory to isolate the effects of an explosion's primary blast wave on mice.

Researchers found that a plastic glass covering around the torso of shocked mice fully protected them from any axonal nerve cell damage in critical parts of the brain responsible for body movement, including the cerebellum and the corticospinal tract, which links nerves in the brain to those in the spinal cord. Body armor also shielded mice from over 80 percent of the axonal damage observed in the brain's visual pathways when compared to mice wearing no body armor.

The study also found that wearing similarly secured plastic glass helmets conferred no greater protection from neurological damage from the initial, overpressure wave than in mice shocked without protective headgear.

Koliatsos emphasizes that these results do not undermine the need to wear a helmet to shield their head from flying shrapnel and other bomb debris and protect them from secondary blast waves, some of which are strong enough to throw bodies more than 100 feet.
The study is believed to be the first to show widespread axonal damage in the brain from mild blast explosions and was designed specifically to investigate the ill effects on the body of the primary blast, of extremely fast-moving, high-pressure air, researchers say.

Indeed, the axonal damage observed from mild blast injuries was similar to that seen in many motor vehicle accidents, Koliatsos says, with blast damage possibly due to impulse stress on the brain coming from inside the body, whereas a typical car crash involves impulses coming from outside the body. In mild traumatic brain injury, fluid pressure from the initial explosion could be rippling through a soldier's chest and lungs to the brain, by way of the major blood vessels of the neck and the cerebrospinal fluid, he says. Another possible explanation is that blasts trigger inflammatory responses, which attack the brain.

"Axons can be quite elastic, and they can expand, slowly, but we suspect that if they stretch too quickly, they will suffer damage or even break," Koliatsos says.

Among the study's other findings were that unprotected mice took twice as long as mice who had worn a body shield to socialize with mice newly introduced to their surroundings. Unprotected mice also fell off a mock log-rolling test a minute earlier than shielded mice, who stood up just as long as unshocked mice who heard the blast from outside the tube.

In unshielded mice, researchers found that the lungs were the chest organ most likely to be marred by a blast wave, but the absence of any respiratory injury did not mean the brain was safeguarded, with brain injuries evident in both lung-damaged and lung-undamaged mice.

"Our results should put military physicians in the field on notice that they need to really closely monitor veterans for mild traumatic brain injuries even in the absence of any lung injury," says Koliatsos. "Regardless of what you call it -- shell shock, mild traumatic brain injury, or mild traumatic brain injury combined with post-traumatic stress disorder – it may hide a serious neurological condition." Koliatsos and colleagues will analyze brain tissue samples from recently deceased veterans who suffered mild traumatic brain injury to see if there are any permanent signs of axonal damage.

Study co-investigator Ibolja Cernak, M.D., Ph.D., medical director of the biomedicine business area in the Department of National Security Technology of the Applied Physics Laboratory, led development of the shock tube used in the study.

Researchers used a known experimental model, called the Pathology Scoring System for Blast Injuries to help set the strength of the helium blast needed to induce a mild traumatic brain injury. Blast pressure was set at roughly 10 pound-force per square inch.

More information: journals.lww.com/jneuropath/pa … ttoc.aspx#1865725017

Provided by Johns Hopkins Medical Institutions