Skull resconstruction immediately following traumatic brain injury worsens brain damage

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Immediate skull reconstruction following trauma that penetrates or creates an indentation in the skull can aggravate brain damage inflicted by the initial injury, a study by a University of South Florida research team reports. Using a rat model for moderate and severe traumatic brain injury, the researchers also showed that a delay of just two days in the surgical repair of skull defects resulted in significantly less brain swelling and damage.

The study was published March 16, 2012 in the online journal PloS ONE. While further investigation is needed, the findings have implications for the acute treatment of traumatic brain injury (TBI), considered the signature wound of soldiers who have served in Iraq and Afghanistan, said the study's principal investigator Cesar Borlongan, PhD, professor and vice chair of research at the USF Health Department of Neurosurgery and Brain Repair

"A double-edged sword," is how Borlongan describes the inflammation and subsequent swelling of brain tissue that occurs immediately following TBI.

When the brain is initially penetrated -- by a bullet, shrapnel, other debris, or even the force of blast waves, for instance -- inflammation helps recruit the body's own good (glial) cells to the damaged site to limit localized injury. For a short time, the inflammation-induced edema, or

swelling of the brain, is beneficial to help relieve pressure within the skull. However, chronic inflammation precipitates increases in intracranial pressure that perpetuate a vicious cycle leading to secondary cell injury and death.

Cranioplasty is an operation to repair malformations of the skull caused by TBI; the procedure may involve replacing a missing piece of the skull protecting the underlying brain and/or improving the appearance of the skull's surface. Current clinical practice emphasizes performing cranioplasty quickly upon initial hospital admission to help reduce the likelihood of infection or other complications that may arise when the brain is exposed.

"Our preclinical study indicates that reconstructing the skull too early in the brain's natural healing process may interfere with critical therapeutic benefits of brain swelling post-TBI," Dr. Borlongan said. "It's better to wait at least two days."

The USF researchers studied rats with moderate and severe TBI. Post-TBI, the animals were randomly assigned to skull bone flap replacement with or without bone wax (a sterile mixture to help control bleeding from bone surfaces); no skull reconstruction; or delayed skull reconstruction with bone wax alone, which was performed two days following TBI.

The brains of all the animals were analyzed in the laboratory five days after surgery. While immediate reconstruction provided aesthetic repair of the skull fracture, this early surgical procedure, with bone wax alone or with bone wax and skull bone flap, significantly increased cortical brain tissue damage in both moderate and severe animal models.

Overall, whether the rat model was moderate or severe TBI, delayed reconstruction limited the worsening of brain tissue damage compared to

immediate reconstruction. In fact, for moderate TBI, the extent of damage observed in the brains of rats that received delayed reconstruction was on a par with that in the animals getting no reconstruction. In those with severe traumatic brain injury, the tissue damage was significantly larger. The authors suggest this may mean a two-day delay, while more beneficial than immediate reconstruction, was not sufficient to counteract the intracranial pressure generated by severe TBI.

The researchers concluded that the timing of cranioplasty warrants further evaluation in both laboratory and clinical settings.

"Our results suggest that delaying cranioplasty until the TBI-induced cerebral swelling has subsided may reduce unwanted exacerbation of cortical damage associated with skull reconstruction," Borlongan said. "We need to carefully weigh the risk of infection that comes from leaving the brain somewhat exposed with the benefit of enhancing the brain's own repair of its cells."

"Finding a safe and effective cranioplasty regimen will require determining the optimal period of time when we let the brain repair itself and balancing that with when to best introduce a regimen of surgical skull repair and other potential therapies," said co-author Harry van Loveren, MD, the David W. Cahill endowed professor and chair of the USF Health Department of Neurosurgery and Brain Repair.

More information: "Immediate, but Not Delayed, Microsurgical Skull Reconstruction Exacerbates Damage in Experimental Traumatic Brain Injury Model;" Loren E. Glover, Naoki Tajiri, Tsz Lau, Yuji Kaneko, Harry van Loveren, Cesario V. Borlongan; PloS ONE 7(3), e33646, March 16, 2012.

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