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In rats, diffuse brain damage can occur with no signs of 'concussion'

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A standard experimental model of concussion in rats causes substantial brain damage—but no behavioral changes comparable to those seen in patients with concussion, reports a study in the April issue of *Neurosurgery*, official journal of the Congress of Neurological Surgeons.

The results highlight the "disconnect" between preclinical and clinical studies of concussion, according to the report by Dr. Charles L. Rosen of West Virginia University, Morgantown, and colleagues. The study also adds to concerns over the possible long-term effects of repeated, "subconcussive" brain trauma—causing no concussion symptoms—in humans.

Despite Diffuse Brain Damage, No Signs of 'Concussion' in Rats

Concussions are thought to be a form of "mild traumatic brain injury." However, there is no definitive diagnostic test to determine when a concussion has occurred. Instead, concussion is diagnosed on the basis of symptoms such as headache, nausea, dizziness, and confusion.

In contrast, animal studies of concussion have focused on directly observed injury to brain tissues, with little attention to the possible behavioral and functional consequences of the brain trauma. Thus there is a "clear disconnect" between experimental and clinical studies of concussion, according to Dr. Rosen and colleagues.

To address this discrepancy, they used a standard technique, called the "impact-acceleration model," to induce brain injury in rats. As reported by previous studies, this technique caused "diffuse axonal injury" to the brain, with visible evidence of damage on the cellular level.

The researchers also compared injured and uninjured animals on a wide range of functional and behavioral tests. The tests were chosen to reflect symptoms and functions similar to those used to diagnose concussion in humans—for example, locomotor activity, coordination/balance, cognitive function, and anxiety- and depression-like behaviors.

But despite a rather extensive pattern of brain injury, the rats had no significant abnormalities on any of the tests. That was so on the day after brain injury as well as up to one week afterward. "The lack of functional deficits is in sharp contrast to neuropathological findings indicating neural degeneration, astrocyte reactivity, and microglial activation." Dr. Rosen and colleagues write.

Findings Support Concerns about 'Subconcussive Injury'

The new study comes at a time when new researchers are finding evidence of long-term neurodegenerative changes in the brains of people who have never been diagnosed with a concussion. One key study in high school football players found changes in neurological function and health in athletes who never had concussion symptoms, but had sustained "repetitive subconcussive blows."

Traditionally, concussion has been regarded as a temporary problem that resolves with no long-term effects. But that view has changed in recent years, with studies in athletes and others showing chronic traumatic encephalopathy linked to repetitive head injury—both the concussive

and subconcussive types.

The new experiments support the concept that significant brain damage may be present in individuals who have completely normal results on symptom-based assessments currently used to diagnose concussions. Dr. Rosen and coauthors write, "It appears that even subconcussive injury, or injury below the current clinical threshold for detection using standard measures, may have lasting neurological effects."

The researchers emphasize that their short-term study in rats provides no direct evidence of long-term changes caused by "mild" traumatic brain injury in humans. They discuss the need for further research to clarify the effects of traumatic brain injury over time, and to develop new models for understanding the long-term impact of repeated head trauma.

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