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Traumatic brain injury

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WHAT WAS THE STUDY ABOUT? In the article "A Prospective Diffusion Tensor Imaging Study in Mild Traumatic Brain Injury" (*Neurology*® 2010;74:643–650), Andrew Mayer and colleagues studied the effects of mild brain injury using a special kind of magnetic resonance image (MRI). The new MRI sequence is called diffusion tensor imaging (DTI). DTI is useful because it assesses the white matter of the brain in a very specific way. In a sense, the white matter of the brain is where the "wiring" of the brain is located. Like a computer, the brain is made up of many parts, each with a specific role. Although each part is important, how the parts are wired together is essential to the complete function. Dr. Mayer wanted to look at the "wiring" of the brain, after head injury, to understand better how this part of the brain is affected by an injury.

Although a standard MRI is often used when a person has a brain injury, this type of MRI is not very good at showing smaller kinds of changes that occur after a mild brain trauma. Dr. Mayer and his group thought that even though a "standard" MRI cannot "see" the injury, the "wires" of the brain are injured in mild traumatic brain injury (mTBI). For this reason, the authors felt that DTI might be a more sensitive marker of brain injury. If the wiring is important to the complete brain function, then an injury to the white matter would lead to problems with how the computer works. This would cause difficulties with complex brain functions like attention, decision-making, and memory.

In his study, Dr. Mayer directly compared people who had mild brain trauma to those without a known brain injury. In order to be thorough, he evaluated people with mTBI at 2 time points: both near the time of their injury and several months afterward. He looked at "usual" testing like a standard MRI and a pencil-and-paper kind of test called neuropsychological testing. He added the DTI information and then compared how the 2 groups did on each of these tests.

WHO WERE THE PARTICIPANTS? Working in New Mexico at the state's level 1 trauma center, Mayer and colleagues identified people with mTBI from the university's emergency department. They carefully reviewed the medical records to identify the cases of mTBI, as defined by the American Congress of Rehabilitation Medicine. The individuals who had an injury were matched with people without mTBI. To ensure that the groups were as similar as possible, they selected "controls" who were the same age, gender, and educational level as the people in the mTBI group. To ensure that there would be no other reason for possible abnormalities on DTI, they excluded people with a history of neurologic disease or psychiatric disturbance. They also excluded anyone who had any head injury within the last year. Finally, they wanted to be certain to exclude people with a learning disorder, attention-deficit hyperactivity disorder, or a history of substance or alcohol abuse.

Each person had an extensive evaluation within 3 weeks of injury. The average time after the injury was 12 days. Each person had detailed tests of their brain, to look carefully at both cognitive function and brain structure. To understand whether there were any problems with the brain "wiring," the team looked carefully at several regions of white matter. Specifically, they looked at the genu, splenium, and body of corpus callosum: all 3 are major "wiring" tracts that link the 2 sides of the brain. In addition, they looked at the superior longitudinal fasciculus, the corona radiata, the superior corona radiata, the uncinate fasciculus, and the internal capsule for both hemispheres. These are all white matter tracts that are important to brain function.

The team looked at the DTI in 2 ways. First, they compared the DTIs of the people with brain injury to those who had not had brain trauma. Second, they looked at any differences between the 2 sides of the brain in *each* individual.

WHAT WERE THE RESULTS? The study group consisted of 22 people with mTBI. There were 21 matched controls. When the tests of cognitive function (neuropsychological testing) were compared, it was found that people with mTBI said that they were having more problems with emotions and thinking. In addition, the people who had brain injury more frequently reported problems with their bodies as well.

When the radiologist reviewed the "usual" MRIs for both groups, he found that all were normal. However, DTI measures, when adjusted for baseline intellectual function, were higher in the mTBI group than in the people who had no prior brain injury. Dr. Mayer and his colleagues took this one step further. They wanted to be certain that the control group in the study was representative of the general population. They compared the DTI results of the control group to a larger sample of people with no brain injury and found that the 21 controls in their study were identical to a larger group of people that had been previously studied.

At the time of publication, a significant proportion of participants, 59% (10 of 17) of people with mTBI and 94% (15 of 16) of controls, had already had the 3- to 5-month follow-up testing. When Dr. Mayer re-tested the healthy matched control group, he found that their DTI testing did not change over time. This was in comparison to the mTBI group. The mTBI group had improved memory scores and lessened problems with thinking when compared to their matched controls. This seemed to match with the information obtained from DTI: over time, the DTI became more normal (i.e., values closer to those of the healthy controls).

The authors acknowledge that much research has yet to be done. Most of the information has so far been on studies in animals. Since an animal's response to brain trauma may be different from a person's response, scientists are always concerned about the accuracy of animal data. Dr. Mayer's study suggests that there may be a better way of assessing the brain after a mild traumatic injury.

WHY IS THE STUDY IMPORTANT? Many medical tests are available to assess the brain after an injury has occurred. Many of these tests are insensitive in their ability to detect subtle brain abnormalities. Dr. Mayer's research suggests that newer brain imaging, such as the changes in DTI measures, may provide a more accurate and objective classification of patients with mTBI. Better assessment of the degree of injury could have clear implications for both treatment and prognosis. For instance, how does cognitive rehabilitation help people with mTBI? Does rehabilitation help to restore normal brain function faster? Could this be measured with DTI? It is clear that we are still in the early phases of understanding how humans recover from TBI. With research like this, we may understand better the critical steps to recovery and be able to provide treatments which help people to recover faster and more completely.

PATIENT PAGE

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About traumatic brain injury

WHAT IS TRAUMATIC BRAIN INJURY? Traumatic brain injury (TBI) occurs most often after a sudden jolt or blow to the head. Grading scales are used to gauge the severity of injury. For instance, most people agree that "mild" TBI does not cause loss of consciousness; however, it may cause a brief period of time when the patient is not thinking perfectly clearly. "Severe" brain injury causes prolonged loss of consciousness or coma. Recent medical literature shows that even mild TBI is associated with neurologic problems, and much research is now devoted to understanding what happens during TBI, how this leads to neurologic problems, and what can be done to prevent or minimize problems due to TBI.

It is estimated that 1.4 million people see a doctor for TBI each year in the United States.[1] Of these, it is estimated that 235,000 are admitted to the hospital for evaluation and treatment, and 50,000 die. Another way of looking at this is that of the estimated 1.4 million people who go to the emergency room, about 1.1 million are treated and later released. Of course, it is unknown how many people have a mild TBI and never seek medical attention. It is estimated that TBI costs the United States (in medical costs, lost work, etc.) about 60 billion dollars a year!

The most common causes of TBI are falls, accounting for 28%. Motor vehicle accidents are number 2, causing 20% of TBI; 19% are due to a collision with a stationary object; and 11% are due to assaults.

TBI can cause many neurologic problems. The most common are headaches and neck pain, which can persist for days or even weeks after the injury has occurred. Problems with memory and concentration, decreased speed of thinking, and a "delay" in responding to what other people say are also common. Other complaints include tiredness, dizziness, nausea, vomiting, ringing in the ears, and a loss of either taste or smell. A person who has had a head injury and has persistent neurologic complaints should see a doctor or go to the emergency department!

NEUROIMAGING AND TRAUMATIC BRAIN INJURY A computed tomogram (CT) is often the first test that is done when a person with TBI goes to the doctor (either in the office or in an emergency department). In the emergency department, the reason for a CT, which is usually easily obtainable, is to look for a serious problem that may need immediate intervention. For instance, if a person who had TBI were found to have had bleeding in the brain, that person might need emergency brain surgery.

Magnetic resonance imaging (MRI) often provides more detailed pictures of the brain. In most people who have had TBI, an MRI is ordered to better evaluate neurologic problems when the CT shows no clear abnormality. In other cases, the CT may show something, but may be "vague," and so an MRI is ordered to better define the problem.

In most cases, MRI is superior to CT.[2] In 2008, Lee et al.[3] published a study of 36 people with mild TBI, which they defined as loss of consciousness lasting less than 30 minutes. In this study, CT identified a problem in 50% while MRI showed an abnormality in 75%, demonstrating that MRI is "better" than CT in showing brain injury after a head trauma.

When a brain injury occurs, swelling (also called edema) often results. The swelling is due to fluid, which is mostly water. MRI is excellent at detecting this water. Two newer kinds of MRI, diffusion weighted imaging (DWI) and diffusion tensor imaging (DTI), are very good at detecting up the "extra" water. Since trauma leads to edema in the brain, these MRI techniques have been increasingly studied to discover whether there are better ways to look at brain trauma. By understanding brain trauma better, scientists may be able to identify treatments that will stop the problem. These kinds of therapies could then prevent neurologic problems *before* they have a chance to happen.

TRAUMATIC BRAIN INJURY AND MOOD One of the problems that follows TBI is a change in mood, such as depression or anxiety.[4] How the two are linked is only now being understood. For instance, if a person has a TBI, and then long-term disability, is it the TBI or the psychological stress from the disability that leads to changes in mood? Or perhaps the injury to the brain is *directly* responsible for the change in mood.

A number of studies have tried to address these questions. Many of these studies, for obvious reasons, have been done in soldiers who were wounded in battle. These studies have shown that TBI causes depression. Furthermore, studies have shown that TBI worsens depression if it was already there. In 2008, a study of soldiers injured in Iraq was published. The authors defined mild TBI as brief loss of consciousness, being dazed or confused, or having amnesia for the injury. In soldiers who lost consciousness, there was a much higher risk of developing depression.

Several studies have shown that anxiety is also a problem after TBI. The information about anxiety is less clear than for depression. However, when people who had an injury to an arm or leg were compared to those who had a head injury, anxiety was much more common after the head injury. Whereas 14% of people reported anxiety after injury to a limb, almost half (47.4%) reported anxiety after head trauma.

CONCLUSIONS What is the link between head injury, neurologic problems, and mood? This is an excellent question, and one that scientists are only beginning to understand. The brain is complex and is able to perform many tasks at once. The brain is constantly taking in information (vision, hearing, sensation, etc.) and is continually assessing our environment. It responds to this information through reflexes (like moving away from danger) and emotions. Injury to the brain can cause either temporary or permanent injury to this delicate system. TBI causes brain dysfunction. This can come out as weakness or numbness, but can also produce an abnormal emotional response. As research develops, scientists and doctors will better understand how brain injury causes both neurologic and emotional problems. Better understanding may lead to better treatments, perhaps one that could prevent the problem from developing.

FOR MORE INFORMATION

The Brain Matters
http://www.thebrainmatters.org
Brain Injury Association of America, Inc.
http://www.biausa.org
Brain Trauma Foundation
http://www.braintrauma.org

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