Traumatic Brain Injuries

Wayne O'Donal, CST

Surgical technology students are introduced to one of the most basic tenets of the operating room early in the first weeks of their training: every person in the room is a highly trained and valuable member of the surgical team. That team includes non-sterile members such as the anesthesia provider and the circulating nurse. It also includes sterile members such as the surgeon, the surgical assistant and the surgical technologist. "Perioperative patient care is delivered by a team; numerous categories of personnel assist in various direct and indirect patient care activities."[1]

It is important that all OR team members know their jobs well, but they also must learn to interact and work together to best utilize their skills for a successful, infection-free outcome. The student must also realize that every member of the surgical team is different and distinct from any other member.

Although all members have been trained, all of them have their own personalities and histories. Sometimes individuals join the OR team with learning difficulties such as dyslexia or with a handicap such as colorblindness. Some may have personality disorders such as attention deficit or obsessive/compulsive disorders.

There are also Certified Surgical Technologists who also are survivors of traumatic brain injury (TBI). Every year, more than 1.7 million adults and children in the United States sustain a traumatic brain injury.[1] Currently, more than 3.1 million Americans live, work, learn

LEARNING OBJECTIVES

- Review the anatomy that is affected by traumatic brain injuries
- Explain what diffuse axonal injury is and what causes it
- Recall the symptoms and complications that TBI patients may deal with following their injury
- Read about what it's like to be a TBI survivor
- Learn how TBI impacts patients potentially for their entire life

This image shows DAI hyperintensity in opposite hemisphere.
Photo courtesy of Wayne O'Donal

This image shows areas of DAI also clustered on contralateral side, directly across from impact contusion. DAI is also suspected in the left corpus callosum. Photo courtesy of Wayne O'Donal

and play while also dealing with the effects of TBI.[2] Some 12% of all hospital admissions may be TBI-related, resulting in that nearly 225 out of every 100,000 people could be affected by some type of TBI in their lifetime.[2]

This article will take an in-depth look at TBIs and give the reader useful information about common symptoms and behavioral actions of those with head injuries.

WHAT IS TBI?

A TBI is not simply brain damage. A useful, legal definition is found within the Individuals With Disabilities Education Act of 1990 (as amended). In that law, traumatic brain injury is defined as:

> "An acquired injury to the brain caused by an external physical force resulting in total or partial functional disability or psychosocial impairment, or both, that adversely affects a child's educational performance. The term applies to open or closed head injuries resulting in impairments in one or more areas, such as cognition; language; memory; attention; reasoning; abstract thinking; judgment; problem-solving; sensory, perceptual and motor abilities; psycho-social behavior; physical functions; information processing; and speech. The term does not apply to brain injuries that are congenital or degenerative, or are caused by birth trauma."[2]

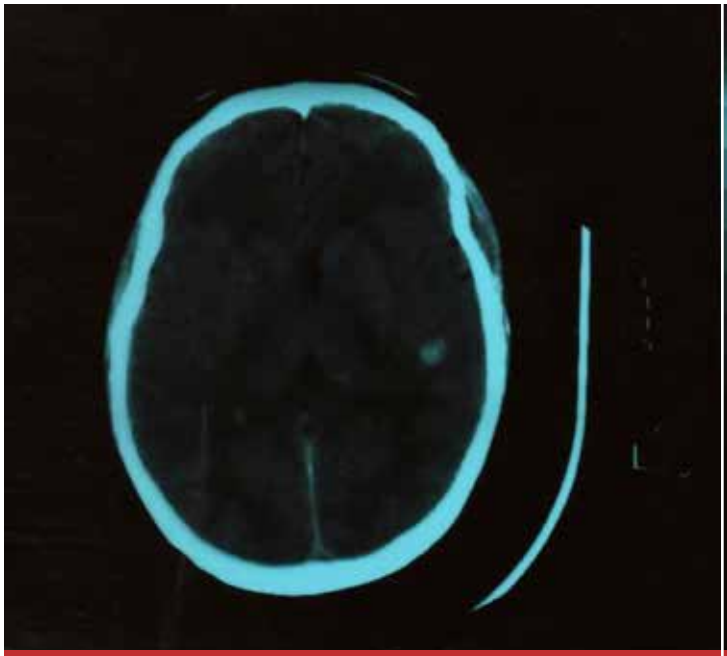
For the purpose of this article, frontotemporal closed head injuries will be discussed.

BRAIN MEMBRANE REVIEW

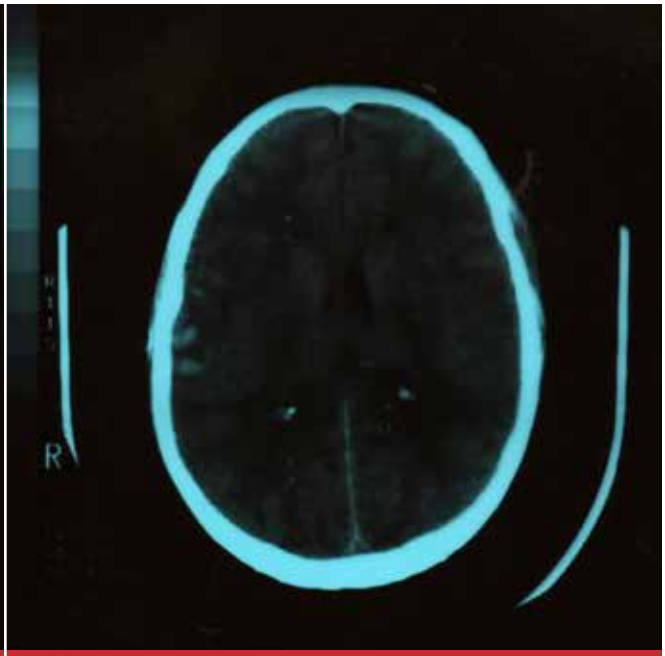
The human brain lies within the cranium, or skull, and is surrounded by three distinct membranes that serve to nourish and protect the brain. From outer to inner layer they appear as: dura mater, the dura mater, the arachnoid mater and the and the pia mater.

The dura mater is the tough, thick exterior layer, and serves to protect the brain and keep the brain tissues in place. Its thin, outer layer serves as the cranium's periosteal membrane, similar to any other bone. The dura's tough, inner layer serves as the structural support for the capillaries, which eventually descend into and nourish the brain. The dura mater also adheres to and follows the convolutions of the inner surface of the skull.

The arachnoid layer is thinner and more delicate than the dura mater. It is also composed of an outer and inner layer. The outer layer is a fibrous layer, which is in intimate



This image shows areas of distinct DAI hyperintensity on ipsilateral side as well as left Splenium of Corpus Callosum. Photo courtesy of Wayne O'Donal



This image shows contralateral cluster of hyperintensity as well as less distinct areas within cortex adjacent to contusion and in Splenium of Corpus Callosum. Photo courtesy of Wayne O'Donal

contact with the dura mater, even forming protrusions, or arachnoid villi through it, allowing the excess cerebrospinal fluid (CSF) to pass through and become absorbed into the bloodstream. The arachnoid's inner layer is more intimate with the brain's surface and the innermost membrane layer. This layer closely follows the surface of the brain. Spider-web-like filaments called trabeculae extend through the CSF-filled subarachnoid space and connect with the innermost layer. Blood vessels cross through this space and CSF flows within it to surround the exterior of the brain.

The innermost, vascular, epithelial layer is termed the pia mater. It intimately forms the epithelial lining of the brain, following most of the sulci. Capillaries penetrate through the pia mater to nourish the brain. All three of the meninges are partly composed of fibrous, flattened interlocking cells that may aid in keeping the CSF from leaking out into other areas.

BRAIN TRAUMA

Often, a traumatic event causes bleeding within these membranes. Uncontrolled bleeding causes blood to pool and leak into adjacent meningeal spaces, and increased intracranial pressure results. A closed head injury is potentially more damaging than one with a skull fracture since brain cells eventually begin to die from increased intracranial pressure. With subdural and subarachnoid hemorrhaging, the forces the skull has received are enough to shear and separate the three meningeal layers and disrupt the normal flow of CSF and cranial blood supply. These spaces then begin to fill with blood, which finds its way around the nearest cortical sulci. Continued hemorrhaging may create a hematoma, pushing brain tissue away from the skull and building up more pressure. When this is the case, a neurosurgeon will schedule an emergency craniotomy for shunt placement through the patient's forehead, intending to drain CSF from the brain's ventricular space to avoid this build up.

DIFFUSE AXONAL INJURY

Major difficulties experienced after receiving a closed head injury are not caused only from the pressures. Blunt forces also cause the soft, jelly-like brain to slosh around and bump against the irregular bony surface structures along the base of the skull and behind the face. The brain is basically an organ that is physically separated from all surrounding structures except the brainstem, with which it is continuous. Axons arise from specific cells in the outer cortex of the brain, descend and converge into the white matter, cross at the corpus callosum, travel through the brainstem and extend down the length of the spinal cord. Therefore, any forced movement is essentially a restricted, rotational movement which exerts alternating tension and

Living with Trauma

I am a TBI survivor. My TBI occurred in January of 1995 when I was a timber framer and home builder. My injury occurred on the late afternoon of January 31, 1995, when an extension ladder I was using suddenly telescoped downward, sending me instantly down to the frozen ground nearly 24 feet below. Witnesses said I tried to stand and speak, but faltered in the attempt and lapsed into unconsciousness. I arrived at the local emergency room in a coma about 40 minutes later. When my wife arrived, the attending ER physician gave her a long list of traumatic ailments including: fractured left wrist, possible broken rib with a bruised and bleeding left lung, multiple fractures of the orbital bones of the left face, fractured left pelvis and multiple contusions of the brain with sub-dural and sub-arachnoid hemorrhaging. He explained to her that I had suffered a severe brain injury and measured 7 on the Glasgow Coma Scale. He then added his list of prognoses: fractured wrist will heal with a splint, bleeding in the lung has already slowed, rib should heal fine with conservative treatment, fractured orbit of the left eye will probably need plastic surgery and bleeding of the brain has already begun to slow down. He ended, however, with "the real concern is the multiple contusions of the brain, and the swelling. The first 72 hours are critical, so he will be transferred to Maine Medical Center as soon as he is readied." The last thing he related was that head injuries are very unpredictable, and I could wake up tomorrow and be fine, or I could die.

My wife could process this information except for one thing: she had no knowledge of what a Glasgow Coma Scale (GCS) was, nor whether I would improve by decreasing to 1 or increasing to 14. Years later, we learned that the Glasgow Coma Scale, developed in 1974 at the University of Glasgow, Scotland, is a tool used by first-responders to identify and categorize head trauma patients based on their responses to three different physical and verbal stimuli.[5] The lower the number is assigned, the more severe the trauma is. By the time I arrived at Maine Medical Center later that evening, I had improved to a 9 on the GCS. The nursing notes from the ambulance ride explained that I was an agitated patient that needed a constant supply of sedatives to keep me calm.

I spent a total of nine days at MMC: six days in the Special Care Unit – reviving from the coma and extubated on day 6. I made steady progress and was in the neuro ward for three more days before being sent across the street to a nearby inpatient neuro rehab hospital. My first specific, post-trauma memory was formed a day or so later, as in-laws and close relatives visited me in the facility's family room. When asked, I thought it was 1991, four years earlier than it really was. I also did not know why I was in the hospital, or how bad my physical and mental problems were. Throughout the next three weeks, I formed more and longer memories of my co-patients, therapists, orderlies and family members. Twenty years later, I still remember some of the names of my therapists, and some of the activities we did.

I had been diagnosed with both subdural and subarachnoid hemorrhaging. One of the first things the neurosurgeon at MMC did was to schedule an emergency craniotomy for shunt placement through my forehead, intending to drain CSF from my brain's ventricular space to avoid this problem. Fortunately, my arms reached toward the placement of a new Foley catheter, which showed meaningful movement, and therefore demonstrated an improved GCS score. With that development, the surgeon halted the operation, and I was never scheduled for another regarding my brain injury. During my later recovery in the rehab hospital and beyond, there was a constant reminder of "the surgery that didn't happen" as it took months for the shaved portion of hair on my forehead to grow back.

A NEW LIFE

It is not easy to restart a life after severe head trauma. That statement seems obvious, but it is not so obvious to the one to whom the trauma occurred. I arrived back at my own home about one month after the TBI occurred, but far from normal. A day or so later, I

assured my timber framing boss that he shouldn't worry, and I'd be back to work in a couple of weeks. Like all TBI survivors, I had no idea how impaired I truly was. While as an inpatient at a neuro rehab facility, I could not walk normally because of imbalance and a pelvic fracture. I was easily confused because I had developed diplopia and I could not remember my wife's name due to post-traumatic amnesia. My son thought I didn't look his dad because I had aphasia and a shaved forehead. Due to an inability to pay attention, I was unable to form new memories, which left me severely disrupted. With time and therapy, all these problems eased, however, others were hidden for months until I went back to school. About two years after my closed-head TBI, I entered my year-long surgical technology program.

Like all TBI survivors, I had no idea how impaired I truly was. While as an inpatient at a neuro rehab facility, I could not walk normally because of imbalance and a pelvic fracture. I was easily confused because I had developed diplopia and I could not remember my wife's name due to post-traumatic amnesia. My son thought I didn't look his dad because I had aphasia and a shaved forehead.

As the TBI survivor no longer has a properly functioning brain, he or she must develop ways to assist their damaged brain to function as well as possible. Both inpatient and outpatient rehabilitation efforts are designed to combat a range of specific cognitive and physical deficits that are caused by or exacerbated by a TBI. When relearning how to return to social life, my therapists described me as a higher functioning TBI survivor. That label insured that I would be groomed to use tools such as a memory book or a day planner and be encouraged to look for transitions to help me think of new options.

Recent TBI survivors have a restricted world view and are very self-centered: it is an adaptation for survival, if you will. They must gear their daily efforts to focus only on a few basic items each day, and then expand their skills with experience. Learning to think beyond themselves and acknowledge others is a challenging task. Early in recovery, I simply could not follow a conversation unless I was directly facing the speaker in a one-on-one situation. If there was anyone else around us that spoke, they were ignored. Later, I could follow conversations, logical sentences, even phone conferences nearly as well as before due to my brain's ability to make new connections.

However, I have found that I do not learn new information as quickly or efficiently as before. While in surgical technology school, I needed to be especially deliberate and literal – nearly obsessive/compulsive – with my notes and practices. For me to learn how to scrub a new procedure, I had to start by organizing my Mayo stand in the same basic way I learned, and then rearrange it from there. For example: During knee arthroscopies, I would set up as though I was on the patient's left – my comfort zone – and only then could I make adjustments to change to the patient's right.

As no two brain injuries are exactly alike, not all TBI survivors will experience all symptoms, nor will they always be displayed at the same intensity. Cognitive fatigue often is one of the worst problems that any survivor faces, and it does not always appear the same way each time. Throughout my years of recovery, I have found that mental and physical fatigue have sometimes wreaked havoc with my performance. While in the surgical technology program, physical and cognitive fatigue was so great that I would consistently read single paragraphs several times over before I understood it. I was smart enough for the program, but every single wore me out. I even began to sleep at my parent's home (which was close to the school) three to four times a week just to save the one-hour drive each way. Achieving a passing grade in the program was much more difficult than working toward a bachelor's degree 20 years prior. However, when graduation day arrived, I passed with strong grades and had two offers

of employment lined up. I also passed my CST examination and became a full-time CST.

SCRUBBING WITH TBI

I often have been my own worst enemy during my tenure as a scrub tech. My first position after training was at a small, 40-bed at a hospital in Maine. There were RNs that also scrubbed, but there was only one other fulltime CST in the OR. She was a well-respected 20-year veteran. I was hired as the second scrub, allowing more of the nurses to circulate and recover patients. Afraid of what reactions there might be, I specifically asked the clinical director at my interview that she not let anyone know of my TBI, although she was fully cognizant of it. As it turns out, she was extremely good at keeping secrets. However, it did not take long for personality traits, disorders and disabilities to be realized by the rest of the team. I was completely on my own, and I intended to prove to the world, to my neuropsychologist, to my wife and to myself that I had the ability, the motivation and the drive to succeed in my chosen field of work.

> At some time or another, I have experienced many of the symptoms and complications listed in this article. Disinhibition has been particularly hard to overcome, and bothers me perhaps more than any other.

Due to the high numbers of surgical cases we performed each week, it was not long before serious mental fatigue began to make itself known. The OR was so busy that three times in the first five months I worked all day, nearly all night and all the next day. After a night of emergent surgeries, the instrument kits often were stacked three-deep all along the dirty-room counter. It was my job to put them all back together and prepare them for morning processing. Following one long night near the end of my sixth month, I was assembling trays in a nearly somnambulistic state. I found a banded single instrument in a tray, so I took it out. A minute or two later I found it back in, so I took it out again and again. Later that morning it took one of the circulating/scrubbing RNs well over an hour to straighten out my "creativity." Nobody was happy about that incident. It seems odd to me that I can remember that night so clearly now, 20 years later, but was too exhausted at that time to remember putting an instrument into the wrong tray time after time after time. I am certain that laparoscopic sheath was discovered back in the tray that early morning.

This first scrubbing job exacerbated my sleep deprivation so much that I began to experience another form of physical and mental fatigue that I had not yet experienced. One day in the OR I was scheduled to scrub on a knee arthroscopy with debridement and partial meniscectomy. It was to be my introduction to knee arthroscopy. After learning to drape and set up the case, the surgeon began to ask for instruments from what we called the Concept Tray (various biters and graspers in a box with the company name embossed on the top). I was unfamiliar with these strange instruments, never having seen them before, and had no idea what the surgeon was asking for. My mentor – the 20-year veteran scrub tech – reluctantly pointed to the correct instrument every time. She eventually exclaimed "What is the matter with you? I showed you these things just last week! How can you forget all this stuff in one week?" I denied at the time ever having seen the Concept Tray before, but a review of my case notebook later that day revealed that this exact case had occurred seven days prior. Same case, same room, same mentor, same surgeon, same scrub tech.

This was a disturbingly new manifestation of cognitive fatigue, one that left absolutely no hint of an entire surgical experience in my brain. It was as though I had been in a deep sleep through the entire introductory case the week before, a sleep that left no part of the case in my semantic memory. I was shocked and frightened when I saw those notes, in my own handwriting, in my own notebook – the first time I had experienced such a complete and utter failure to remember an event. The same thing happened a week later, this time with a colon resection. Then, as I saw a pattern forming, for the first time I began to fear that I would fail as a scrub tech.

Despite these and other difficulties, my three-month review cited hard work, desire, willingness to learn, ability to work with others and improvement

in skills that resulted in a favorable appraisal. A little more than three months later, I felt that things were finally coming together. However, it was short lived as I was terminated shortly after.

What could I learn from this failure that I took away for future jobs? I learned that keeping a TBI secret from the rest of the team was the wrong decision. If the CST, RNs, surgeons, and even the OR supervisor had known that I had previously experienced a severe head-injury and yet trained to scrub successfully in a tough surgical technology program, perhaps I could have caused less frustration and received a bit more understanding and patience.

STARTING OVER, AGAIN

Following this failed attempt at scrubbing in a full-time in a hospital setting, I took my wife's advice and applied to various part-time positions in the area around our home in Maine. One that seemed to be simple enough to do was a position in the central supply department in a hospital about an hour away. I applied for the position, which was for a very limited number of hours each week. For a brief introductory period, I worked with the CSD director of several years of experience, and then was on my own. I settled into the routine quite easily. Weeks later I learned that New England Organ Bank was looking for applicants to take a weekend course in tissue (but not organ) recoveries. Tissue recovery techs are subcontracted by NEOB to procure in a sterile manner certain whole bones, hearts for their valves, patella tendons with attached patella, long sciatic vein segments and abdominal aorta segments, all for reprocessing into implantable permanent tissues or bone filler material. I attended one of the most exciting and well taught workshops that I ever experienced, received some dissection experience and became a NEOB recovery technician primarily covering the state of Maine. At that time, Maine provided as many tissue donors to NEOB as Vermont, New Hampshire and Massachusetts combined, so more recovery techs were needed. I obtained a pager, provided a call schedule to NEOB, bought liability insurance and sat back to receive calls.

I was called, on average, about once per week. Occasionally, the cases came close together, but other times calls were very rare with some coming during the daytime and some being all-nighters. I learned to pack a small supply of medication, a toothbrush and undergarments, for I never knew when I would arrive home again. After a while though, I did begin to experience cognitive and physical fatigue. I performed recovery duties for a little more than two years, eventually becoming team leader. Although I was not making much of an income doing this work, I was gaining valuable knowledge about scrubbing, about teamwork and about record keeping. As I continued recovering human tissues, I was learning to deal with cognitive and physical fatigue, and I finally accepted that I would most likely have to deal with these issues for the rest of my life. I continued to recover tissues for NEOB until the summer of 2000 when I was offered a position as a full-time CST in a local hospital's OR.

The Memorial Hospital, in North Conway, New Hampshire, was seeking to add a CST to its operating room staff in the spring of 2000. After discussing this with my wife, we decided that I should apply. The two part-time situations I held at the time were restricted to just a few repetitive cases, which I was now very familiar with, and had enabled me to regain my confidence and improved my self-image. I was offered the position, but there was an interesting catch which almost caused me to refuse. I had applied for a .5 FTE position, but was offered a full-time position. I was completely honest about my TBI with the clinical coordinator of the OR when I applied. In fact, I had spoken to her four years earlier when I was originally let go from my first situation. She remarked that I seemed more self-assured and confident this time around, revealing no insecurities about my abilities.

She offered me a position that, similar in some ways to my first attempt, was also different in other, more important ways. This hospital already had three fulltime CSTs on its staff, with a fourth at part time. Also, I would be filling a dual role. Half of the time I would be scrubbing on cases and the remainder would be spent in CSR/CSD. Having been involved successfully in a CSR/CSD for the previous four years showed me that this position would be feasible. Being on call with the other three scrub techs on a rotating schedule was the questionable part. When the clinical supervisor assured me that all-night call work was nearly unheard of there, I accepted her offer.

At some time or another, I have experienced many of the symptoms and complications listed in this article. Disinhibition has been particularly hard to overcome, and bothers me perhaps more than any other. One form of disinhibition shows itself in a sudden rage seemingly at the least provocation. It most often happens thus when I am frustrated by my inability to remember specific things – especially actions within a sequence of steps. This places me in the position of being easily overcome by anything that causes other frus-

trations, such as when case carts are jammed up in the cart washer room and I need to access one quickly. Or it may be that I have tried to grasp an instrument from the assembly table in CSD, and it slips from my hurried grasp for the third time in a row. I scared my coworkers a few times early in my tenure there, but everyone is a bit more relaxed now knowing that it is temporary.

Another difficulty I have unsuccessfully avoided is forgetting simple steps in sequences. I cannot count the number of times I offered the surgeon his surgical gown even before offering the drying towel. And I know that every surgeon prefers to make a small incision before introducing the laparoscopic trocar, but she is offered the trocar first perhaps 60% of the time. Imagine the level of frustration you would experience if you were the one constantly making these rookie mistakes no matter how many hundreds of times you have scrubbed on these cases.

Physically, I am as strong as I ever was, but I'm a bit less balanced and more easily tired. Damage to some my cranial nerves has played havoc with some of my bodily systems, resulting in urinary urgency whenever I stand up, an inability to adjust to temperature fluctuations and inability to smell most common odors.

In some areas of the OR, I am the go-to tech. I am the one who always knows where a missing instrument could possibly be found. I have taken on the responsibility of checking all incoming and outgoing loaner tray inventories. The loaner company sales reps know that I can be trusted to know that their instruments are well cared for. I am the tech who sends out broken instruments for repair and gets the scissors sharpened. The OR coordinator can rely on me to know how to access any specific laparoscope by its serial number and to be able to clean and sterilize any instrument from any of the ancillary departments. I have also developed a consistent ability to diagnose and troubleshoot almost any problem with endoscope reprocessors and sterilization systems. In other words, I have developed my own niche of success within the OR department. I am most fortunate that I have discovered a very supportive team of coworkers.

As I look back on the past 14 years as a surgical technologist, I can smile at what the years have shown. No, they have not all been easy, not all happy, not exceptionally successful, but each year has produced growth and improvement and the experience of discovering my new self for myself and by myself and the other OR team members who have become more than just supportive coworkers – they are friends.

I have written this article to help other CSTs, RNs, MDs and any other OR team members to reach a new level of understanding for all TBI survivors, whether or not they work in an OR. Some of us are victims of acts of war. Some of us are victims of motor vehicle accidents, work accidents or competitive sports. We are out there in the world, and we are here in the OR. We are doing the best job we can do, alongside all the other individual team members.

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compression forces upon all the axonal pathways within the brain. Since the brain's corpus callosum contains all the axons which unite the left and right hemispheres, it experiences a major part of the twisting forces that are generated within the brain. A single axon is an extension of a single neuron, so itself is not equipped to absorb strong twisting forces. The cell bodies of the neurons are located throughout the grey matter cortex of the brain's temporal, frontal, parietal and occipital lobes. As neurons experience twisting and shearing forces, their axons are occasionally severed, causing irreparable harm and eventual death of the cell. Diffuse axonal injury, or DAI,[5] is a common result of TBI, and can be seen

in CT images a few hours post injury as edemous, hypointense (lighter-colored) areas of damaged axonal pathways and in some gray/white matter cortical interfaces. Weeks after the TBI event, the brain's ventricles may appear larger, as they expand into newly emptied spaces.[6]

DAI is known to be a very common result of many blunt-force head traumas. School sports activities and playground accidents often can cause DAI, such as concussions received in football or rugby tackles, boxing, and gymnastics and ice-skating falls. The changes in behavior and learning capacity

TBI: A CT of the head years after a traumatic brain injury showing an empty space marked by the arrow were the damage occurred.

Photo credit: James Heilman, MD

Traumatic Brain Symptoms

Traumatic brain injuries can have many physical and psychological effects. Some signs or symptoms appear immediately following the traumatic event, while others may appear days, weeks or months later.[8]

Mild Traumatic Brain Injury Symptoms

- Loss of consciousness for a few seconds to a few minutes
- No loss of consciousness, but a state of being dazed, confused or disoriented
- Headache
- Nausea or vomiting
- Fatigue or drowsiness
- Difficulty sleeping
- Sleeping more than usual
- Dizziness or loss of balance
- Sensory problems, such as blurred vision, ringing in the ears, a bad taste in the mouth or changes in the ability to smell
- Sensitivity to light or sound
- Cognitive or mental symptoms
- Memory or concentration problems
- Mood changes or mood swings
- Feeling depressed or anxious

Moderate to Severe Traumatic Brain Injuries Symptoms

- Loss of consciousness from several minutes to hours
- Persistent headache or headache that worsens
- Repeated vomiting or nausea
- Convulsions or seizures
- Dilation of one or both pupils of the eyes
- Clear fluids draining from the nose or ears
- Inability to awaken from sleep
- Weakness or numbness in fingers and toes
- Loss of coordination
- Profound confusion
- Agitation, combativeness or other unusual behavior
- Slurred speech
- Coma and other disorders of consciousness

Complications

There are wide-ranging complications that can occur following a TBI. Like symptoms, complications can appear immediately after or take weeks to months to show up. Moderate to severe injuries can result in prolonged or permanent states of consciousness such as:

- Coma
- Vegetative state
- Minimally conscious state
- Locked-in syndrome
- Brain death

Other physical complications that may occur to TBI patients include:

- Seizures
- Fluid buildup
- Infections
- Blood vessel damage
- Nerve damage

Many TBI patients also experience a change in overall cognitive processing and functions.

Cognitive abilities that may be affected include:

- Memory
- Learning
- Reasoning
- Speed of mental processing
- Judgment
- Concentration
- Problem-solving
- Multitasking
- Organization
- Decision-making
- Completing tasks

Other problems that commonly occur following a TBI are language and communication and social problems. TBI patients may have difficulty with:

- Following conversations
- Organizing thoughts and ideas
- Speaking or writing
- Understanding speech or writing
- Reading cues or deciphering nonverbal signals
- Changes in tone or attitudes
- Using muscles to form words
- Self-control
- Awareness
- Risky behavior
- Accurately seeing their self-image
- In social situations
- Verbal or physical outbursts

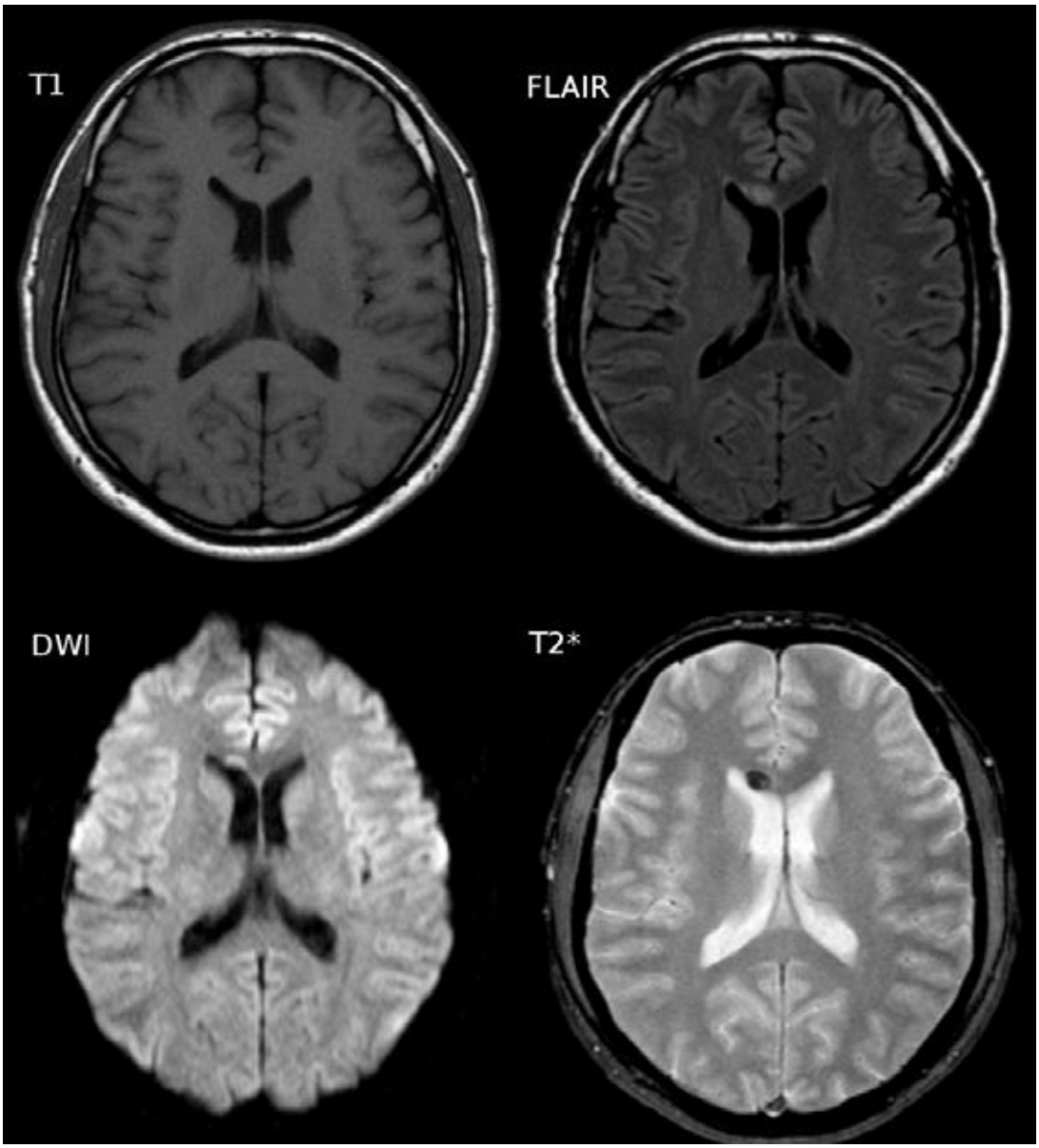
Emotional changes in TBI patients can include:

- Depression
- Anxiety
- Mood swings
- Irritability
- Lack of empathy
- Anger
- Insomnia
- Changes in self-esteem

Sensory problems commonly occur in TBI patients, and can greatly affect their quality of life as some of the symptoms never fade or go away. These problems can include:

- Ringing in the ears
- Difficulty recognizing objects
- Impaired hand-eye coordination
- Spots in their vision
- Bitter taste or difficulty smelling
- Tingling skin
- Trouble with balance

TBI patients are also at a greater risk for diseases that gradually remove brain functions including Alzheimer's, Parkinson's and dementia.



DAI: Diffuse axonal injury after a motorcycle accident. MRI after 3 days: On T1-weighted images, the injury is barely visible. On the FLAIR, DWI and T2, the weighted images a small bleed is visible.

Photo credit: Hellerhoff

which accompanies DAI, however, is all over the spectrum, depending upon the location, magnitude and repetition of the force. Diffuse axonal injury is at least as detrimental in its effects as the original blunt force hemorrhage. Some of the more modern types of MR imaging (FLAIR, DWI, SWI and GRE)[7] often can show more DAI than the non-contrast CT images usually obtained at the initial trauma center. Emerging MR techniques may one day show mild TBIs to produce DAI. And although shearing and hemorrhaging are the result in the death of important brain cells due to the loss of established connections, in most cases, however, the brain has the ability to recover to a certain level. Many times the brain can make new connections with remaining axons and with early and proper medication and challenging stimuli, brain function can be somewhat restored.

ABOUT THE AUTHOR

Wayne A O'Donal, CST, graduated from Gordon College in Wenham, Massachusetts, in 1978. He became a timber framer and builder, eventually becoming a building contractor. While recovering from an accident and seeking a change in employment, he discovered the world of surgical technology. He became certified in April of 1998, and has been learning to scrub with a TBI ever since, work-

ing in small hospitals in Maine and New Hampshire. Wayne lives with June, his wife of 36 years, in a timber-framed home he built himself in Denmark, Maine. His 21-year-old daughter Perry recently married an Air Force Munitions Specialist and resides in Germany, while his 26-year-old son Timothy works as a shift leader at a local restaurant. Wayne's hobbies include working on almost any project involving wood, hiking the slopes of nearby Pleasant Mountain and helping his wife research and write her historical novel series based in nearby Fryeburg, Maine. He recently built his first, authentic 2-fathom Birch-bark canoe, and is planning his second one and hoping to make this interest part of his retirement plan.

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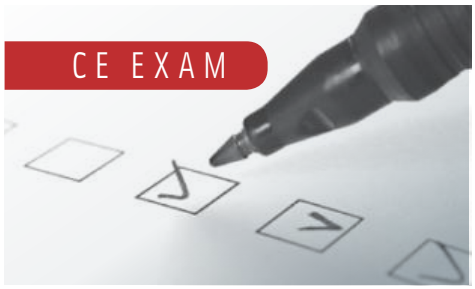

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Traumatic Brain Injuries

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1. How many patients each year sustain a traumatic brain injury?
a. 3.1 million
b. 100,000
c. 1.7 million
d. 1.2 million

2. The dura mater is the_____ membrane layer.
a. Inner
b. Third
c. Small
d. Outer

3. The arachnoid's outer layer is _____ in texture.
a. Epithelial
b. Fibrous
c. Vascular
d. Structural

4. Which part of the brain contains the axons that unite the left and right hemispheres?
a. Corpus callosum
b. Outer cortex
c. Spinal cord
d. Temporal lobe

5. The Glasgow Coma Scale was developed in ___ in Scotland.
a. 1970
b. 1974
c. 1977
d. 1980

6. Mild traumatic brain injury symptoms do not include:
a. Loss of balance
b. Coma
c. Memory problems
d. Difficulty sleeping

7. Physical complications that may occur to TBI patients include:
a. Nerve damage
b. Seizures
c. Locked-in syndrome
d. All of the above

8. When TBI patients are relearning how to communicate, they may have difficulty _____.
a. Making decisions
b. Following conversations
c. Completing tasks
d. Organizing

9. Cognitive abilities that may be affected in TBI patients include:
a. Judgment
b. Nerve damage
c. Problem-solving
d. Both a and c

10. Sensory problems that commonly occur in TBI patients can include:
a. Tingling skin
b. Bitter taste
c. Both a and b
d. Neither a and b

TRAUMATIC BRAIN INJURIES #407 November 2017 2.5 CE CREDITS $15

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