HEAD INJURY WITH HELMET USE

*by Greg "Doc" Trojan*Introduction

While motorcycling has been targeted as a "public burden" and garners most of the public attention concerning head injury, it is actually a minor cause of head injury in the United States. Motor vehicle accidents, falls, assaults, pedestrian and bicycle accidents are all responsible for larger percentages of head injuries incurred in the U.S. While some ten million head injuries occur each year, head injury accounts for only two percent of all deaths in the U.S. The great debate over helmet laws has drawn attention away from the major causes of head injury and drawn it to motorcycling.

Helmet usage itself does not preclude the occurrence of the coup-contrecoup type brain injury that is suffered in most head injuries. This paper presents an overview of the anatomy of the brain and mechanisms of head injury in non-technical terms to provide an understanding of this problem. As motorcycling comes under closer scrutiny this information will be needed to answer to those who would place unreasonable restriction on motorcycling.

Brain Injury In the U.S.

Within this country, it is estimated that ten million head injuries occur each year. Of these, 90% are minor. There are approximately 500,000 brain injuries each year. They result in 70,000 deaths, over 60% of whom die before reaching a hospital. There are 70,000 disabling injuries and 10,000 severe spinal cord injuries each year. The head injury rate for men is three times higher than for women and peaks in the 15-24 year old age group.

In five selected studies on head injury, the major cause of brain injury was transportation related. The second leading cause was falls, with assault/gun shot wounds third. In these studies, transportation related accidents account for approximately 50% of the total.

In terms of head injury, motorcyclists in two studies (Olmsted County, MN and North Central, VA) represented only 8% of the transportation related head injuries, or less than 4% of the estimated total number of head injuries. Motor vehicle accidents accounted for 78% and pedestrian and bicyclists 14% of transportation related head injury in both studies.

The Fatal Accident Reporting System (FARS) in 1986 reported 1650 fatally injured riders wearing helmets; 2082 were not using helmets and 788 were helmet use undetermined.

The preliminary FARS 1986 states that helmet usage is essentially the same for fatally injured and all riders.

Two studies of motorcycle accidents showed head injury rates of 22% for all accident-involved riders and near 30% head injury rate for fatalities, for both helmeted and non-helmeted riders.

Anatomy of the Brain

The brain is the most amazing organ of the human body. To understand brain injuries, one must have a fair working knowledge of the brain's anatomy and how it reacts in an acceleration/deacceleration accident.

The brain weighs on average three pounds and is so vascular that while it represents 1.2% of the body's weight, it receives 10% of the blood flow from the heart. Blood reaches the brain through the two internal carotid arteries and two vertebral arteries running along the spine. There is an interconnecting of these arteries on the underside of the brain. This area is called the circle of willis. If one artery should become blocked, the others provide blood flow to that part of the brain.

The brain is very sensitive to a lack of blood flow, as brain cells cannot store oxygen or sugar. An interruption in blood flow of as little as four minutes can start to damage the brain, and ten minutes causes irreparable damage and death. The outside of the skull is also very vascular; this large blood flow and perspiration help to maintain the temperature of the heat sensitive brain.

The brain is enclosed within the skull which is composed of twenty-two bones, with eight bones making up the cranium which encloses the brain. The inside of the skull is smooth except for the base which at the level of the eye is very rough with a number of ridges. Within the cranium adhering to the bone is a tough tissue covering called the dura that envelopes the brain.

In the subdural space is the cerebro spinal fluid. This fluid performs a number of functions, the main one being to protect the brain from impact concussion. The brain “floats” in the cerebro spinal fluid, lessening the weight on the base, and is supported at the base by the spinal cord. The brain, buoyant in the cerebro spinal fluid, can move within the cranium to a very limited degree. The space between the temporal bone and the brain is only one millimeter.

Covering the brain is the arachnoid membrane, a subarachnoid space and the pia matter. The brain is divided into three parts: the cerebrum, the cerebellum and the brain stem. The latter is in turn made up of the mid-brain, pons and medulla oblongata.

The brain is composed of a soft tissue similar to pudding in its consistency. The cerebral cortex is made up of gray matter and covers the outer expanses of the cerebrum in a layer from 1 to 4.5 millimeters thick, containing some 14 billion nerve cells. It is in the cerebral cortex that the higher thought processes take place, though activity and consciousness depends on the cortex’s interaction with the rest of the brain. The rest of the area under the cortex is made up of white matter.

The brain stem consists of the delineation, mid-brain, pons and medulla. This area provides the connection between the brain and the rest of the body. The brain stem gives rise to the cranial nerves and control of such vital functions as respiration, blood pressure and sleep and wake cycles. The autonomic nervous system originates in the brain stem and controls digestion, heart rate and the glands of the body, all at a sub conscious level.

The nerve cells that make up the brain consist of a cell body, processes called dendrites, and the axon which branches off of the cell body. The axon is a single nerve fiber that leaves the nerve cell body and can be up to several millimeters long. The axons of the cells in the central nervous system are covered and held in place by a myelin covering. This covering is made up of the outer layers of schwann or gleia cells. One gleia cell may support a number of nearby neurons. The communication between cells of the brain travel by chemical / electric signals along the axon which branches out ending at the synapses between adjoining nerve cells.

At the gap between cells an information transfer occurs by a chemical process. The cell body and dendrites receive this information at the synapses and then transfer it to the next cell. In this way the pathways between billions of nerve cells are completed within the brain. The nerve pathways to the body cross over from one side to the other at different points along the brain stem and spinal cord. Thus, one side of the brain controls the opposite side of the body.

Mechanism Of Head Injury

Those suffering severe head injury have a 50% to 65% fatality rate before the patient reaches a hospital. There are two mechanisms of injury to the brain: contact and acceleration-deceleration. Each causes different types of injuries.

Contact injury is the result of an object striking the head causing a local injury. When an object strikes the head, the use of a hard hat or helmet dissipates the energy of impact by spreading it over a large area. It is important to note that the head and brain are not in motion.

Acceleration-deceleration injury occurs when the head is placed in motion or stopped suddenly. This paper concentrates on these injuries as they are the type frequently seen with motorcycle accidents. When a person riding a motorcycle is involved in a collision they are most often thrown from the motorcycle. If the rider’s helmet impacts with an object the helmet and then the rider’s head stop in their forward motion. The brain, having its own mass, continues in motion until it strikes the inside of the skull. It then rebounds striking the opposite side of the skull. This phenomena is called coup-contrecoup (pro-nounced coo - contracoo) and is used to describe any injury where the brain moves and impactis with the inside of the skull. This type of injury can result in anything from mild concussion to fatal diffuse axonal injury.

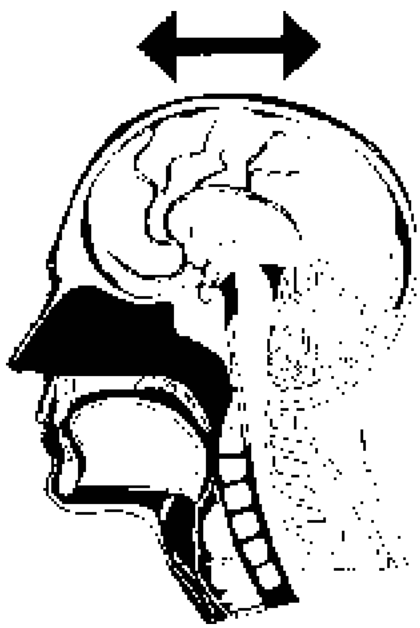
Impact of great force is needed to cause a fracture of the vault of the skull. Skull fractures are often associated with subdural hematomas due to tearing of the meningeal arteries at the time of injury. Fractures of the base of the skull (basal skull) are common, this being the weaker part of the skull.

Tearing of the dura is a side effect of basal fractures, and may allow infections to reach the brain. A common complication of skull fractures is intracranial bleeding, either extradural (outside the dura) or subdural (inside the dura).

The transfer of impact energy through helmet retention systems, causing brain stem tearing and basal skull fractures, has been noted as the mechanism of injury in a number of studies. (A blow to the chin bar of a full face helmet transfers the impact energy to the retention system. The force is then transferred through the mandibular condials to the base of the skull, its weakest point.) Frontal impact causing hyperextension of the neck is also likely in causing cervical dislocation and placing traction on the brain stem, resulting in tearing of the pontomedullary junction. The pons is relatively thick compared to the medulla. It is at the thin point of the junction that the tearing occurs.

D.A. Simpson, et al noted that of thirteen helmeted motorcyclists, nine had principal impacts to the chin bar or face causing tears of the pontomedullary junction. Four who suffered either vertex or lateral impacts had corresponding brain stem tears. The mechanism is postulated to be similar to that of frontal impacts.

Coup-Contrecoup



The brain floats within the skull in cerebro spinal fluid. When the body is in motion and stops suddenly, the brain continues to move within the skull. The brain strikes the skull and rebounds, striking the other side (coup-contrecoup). While a helmet provides impact protection, it cannot stop the brain from moving inside the skull. This happens at speeds as slow as ten to thirteen miles per hour.

Types Of Injuries

The majority of brain injuries are closed injuries, that is, there is no open wound to the brain. Closed injury can be classified into two types, focal and diffuse.

Focal injury is the type most often seen with assaults or a blow to the head. Damage is localized to one part of the brain.

Diffuse brain injury is wide spread throughout the brain and is attributed mainly to acceleration-deceleration. Diffuse brain injury accounts for the majority of head injury in the U.S. Acceleration-deceleration can produce both focal and diffuse types of injury.

Concussion and contusion are forms of coup-contrecoup injuries. Concussion is a temporary interruption of the function of the brain, which in its more severe form causes a loss of consciousness. Contusions are focal damage usually occurring in the frontal and temporal lobes of the brain.

Subdural hematoma is a bleeding into the space between the dura and the brain. This injury is due to the tearing of the bridging veins when the brain moves due to sudden deceleration, as in a fall. This is the most common type of intracranial bleeding. Left untreated this injury can be fatal.

The area of bleeding continues to grow, displacing the brain and increasing the intracranial pressure causing further damage to the neurons. Through the use of CAT scans the outcome of patients has improved and shown to be very good if treated within the first two hours after injury. Recovery drops off dramatically if the injury is not cared for within the first four hours.

Diffuse Axonal Injury (DAI) is a result of the coup-contrecoup movement of the brain. The results of this injury can range from mild concussion to death. DAI is the most common type of brain injury, seen in one-half of severely injured patients.

Diffuse axonal injury occurs at the moment of impact, resulting in increased intracranial and intracerebral pressure along with shear, tensile and compression forces. The shearing force causes tearing or damage to the inside of the neural axons throughout the brain. The damage to the axons disrupts the connections between neurons and the brain's ability to transfer information.

The patient suffering a severe DAI may remain in a coma for a long period of time. DAI is responsible for the greatest number of severely disabled people and those surviving in a vegetative state.

Skull fracture: While a fracture of the skull takes a great deal of force it does not guarantee damage to the brain itself. There may be a fracture without brain injury occurring. Lateral fracture of the skull is the more common type. This fracture runs along the side of the skull top to bottom and can extend to the base.

Basal skull fractures are not uncommon, presenting the danger of infection reaching the brain due to the associated dural tears. Brawley and Kelly noted 24% of 1250 head injuried motorcyclists had basal skull fractures.

Secondary Damage After Brain Injury: Brain swelling is common in patients who suffer head injury. The swelling can be severe enough to displace the brain and cause harnessing of the brain stem. The brain swells either from an increase of cerebral blood flow or because of a rise in the water contained in the brain tissue. The increased pressure is treated with a barbiturate induced coma until the pressure decreases.

Damage to the brain due to the lack of oxygen soon after an injury occurs is common. This furthers any damage that has already occurred. The lack of oxygen to the brain can be caused by a drop in blood pressure or blockage of the airway in an unconscious patient.

While many times the brain injury sustained cannot itself be treated, the secondary damage can be prevented by immediate medical care to prevent blockage of the airway, lack of oxygen to the brain and shock. This can be accomplished by anyone trained in basic first aid.

Conclusions and Recommendations

The perception by the general public that motorcyclists account for "most" of the head injuries is without merit and has no basis in fact. Motorcycle related accidents represent a very small portion of all head injury in the U.S. The perception is probably based in part on the constant turmoil over the mandating of safety equipment that receives so much attention in the media.

While a helmet can dissipate impact forces, the use of a helmet does not preclude the occurrence of coup-contrecoup type injury, nor does it provide protection to the rest of the body's vital organs. Impact speeds as little as twelve to fifteen miles per hour can cause acceleration-deceleration injuries to the brain. Although much more study needs to be done in this area, no studies of motorcycle fatalities in states requiring universal helmet usage have been undertaken.

Hyperextension of the spine and diffuse axonal injury comprise some of the head injury being suffered by helmeted riders. Studies of motorcycle accidents have not looked at the causes of fatal injury with helmet usage. The large number of fatally injured helmeted riders points to the need for a rethinking of the approach to motorcycle safety.

The debate over mandating of safety equipment has wasted the very valuable and limited resources of the motorcycling community. It has divided a group that has the same goal, that of saving motorcyclists' lives. It is time to move on to a new approach.

A multifaceted program to improve motorcycle safety is obviously the most effective means of reducing accidents and injuries. The use of rider education programs for the beginning and experienced rider is a first step. This must be coupled with other safety education programs aimed at motorcycle awareness, protective gear and licensing. These programs need to be part of an ongoing continuing education for motorists and motorcyclists alike. The only way to ensure that the brain and other vital organs are not damaged is to prevent the accident from occurring.

DOC TROJAN

I started riding around the age of fifteen, and kept my first street bike at a friend's house because my mother didn't allow motorcycles at her house. I became involved in the MRO movement in 1979 with the first bill to reinstate Ohio's helmet law, which had been modified on July 17, 1977. ABATE of NE Ohio took on the task of defeating the first of many reinstatement bills.

The legislative field has always been my main interest and as ABATE grew I took on the day to day task of watchdogging the legislature. ABATE of NE Ohio turned over to ABATE / CMRO and I took on the Legislative Coordinator's spot for more than a few years. I have been to DC some 25 times since 1989 to lobby our Congressional delegation. In 1993 and 94 I was elected State Director.

My main hobby throughout this time frame was being a firefighter / paramedic, which I did for 20 years and have now retired. I have attended all but the first Meeting of the Minds. I also work with NCOM and with our AIM attorney here in Ohio.