North Memorial
Trauma Update
North Memorial Medical Center is a *Level I Trauma Center*

Volume 9 | April 2010

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North Memorial Trauma Update is pleased to have Dr. Robert Roach, Metropolitan Neurosurgery, as our guest author. He will be discussing traumatic brain injuries.

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Traumatic Brain Injury

Traumatic brain injury (TBI) is a commonly seen entity in the community Emergency Department (ED). In the United States it is estimated there are approximately 1.5 million TBIs per year. This is nearly 4000 per day, or 3 per minute. Nearly 50,000 people die per year from TBI.

Of those with TBIs, 80 percent are mild. In fact it is estimated that many patients with mild TBIs do not present for medical evaluation at all, going unreported. Thus the true number may not be known. Nearly 20 percent of brain injuries are moderate to severe, often having significant long term effects for the patients and families involved.

Mode of injury is somewhat age and gender related. In younger males, motor vehicle crashes are the most common cause of TBI. Falls remain the most common cause of TBI in older patients, frequently females. Assaults, penetrating injuries, and sports injuries make up most of the remainder. Males are twice as likely to suffer TBIs as women.

INITIAL ASSESSMENT IN TRAUMATIC BRAIN INJURY

Thorough assessment of the patient is important in determining the nature and extent of any neurological injury. Features in the past medical history such as seizure activity, loss of consciousness, focal or generalized neurologic deficits, improvement or worsening of deficits are relevant in the initial assessment of the patient sustaining a neurological injury. More general information as to the nature of the event, presence of other confounding injuries, hemodynamic instability, orthopedic injuries, drug use, and so on are important to know as well.

Prompt neurological evaluation is important to establish a baseline against which subsequent examiners may compare and use to aid in determining the nature and type of imaging necessary. The commonly used Glasgow Coma Scale (GCS) is easily applied and provides a reasonably comprehensive assessment of the pertinent signs in a patient who is uncooperative or whose level of consciousness is compromised. If time and the patient's condition allow, more detailed neurological exam, including level of consciousness, speech function, cranial nerves, detailed motor and sensory exams, reflexes and cerebellar testing is helpful for later comparison.

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The GCS assesses the patient's motor, verbal, and eye opening responses.

EYE OPENING

Spontaneous	4
To verbal command	3
To pain	2
None	1

BEST MOTOR RESPONSE

Following commands	6
Localizes pain	5
Withdrawal	4
Decorticate	3
Decerebrate	2
None	1

VERBAL RESPONSE

Oriented	5
Confused	4
Inappropriate	3
Incomprehensible	2
None	1

A GCS of 3-8 is a severe TBI, 9-12 is a moderate TBI, and 13-15 is a mild TBI.

Computed tomography (CT) is the imaging modality used most commonly in assessment of the neurologically injured patient. CT scanners are nearly ubiquitous, and available at all hours of the day or night in most ED settings. They rapidly provide important diagnostic information regarding the nature and extent of brain injuries. MRI imaging has little to offer in the acute trauma setting and skull films are of historical interest only. CT angiography is increasingly available and may provide useful information regarding potential vascular injuries in the trauma patient.

Indications for head CT:

- History of loss of consciousness, or amnesia
- Suspected penetrating injury
- Cerebrospinal fluid (CSF) or blood from the nose or ear
- Scalp laceration to bone
- Violent mechanism of injury
- Persistent headache or emesis
- Pediatric - fall from significant height or onto hard surface, suspected non-accidental trauma
- Impaired consciousness or focal neurologic signs

Disposition of the patient with a TBI may be difficult and one should err on the side of caution. Those with **mild brain injuries** require close observation, whether at home in a reliable setting or as an inpatient. Patients in this group with the radiographic or clinical findings listed below may be admitted for inpatient observation in a community hospital.

Clinical indications for admission to a community hospital:

- Skull fracture or suture diastasis
- Persistent neurologic signs
- Difficulty with assessment (drugs, alcohol, seizure)
- Absence of responsible adult for observation at home
- Concurrent medical instability/concerns (cardiovascular, anticoagulation)
- Impaired level of consciousness

Patients with **moderate** (GCS 9-12), or **severe** (GCS 3-8) **TBI** are more likely to have significant mass lesions seen on CT, requiring prompt medical or surgical treatment. These findings include subarachnoid hemorrhage, cerebral contusions, epidural hematomas, and subdural hematomas . Other diagnostic considerations include skull fractures, associated spinal injuries, seizure, and so on. Recognition of any of the following lesions on CT requires prompt transfer to Level 1 trauma hospital where Neurosurgical coverage is available.

- **Skull Fractures (Linear, depressed - open or closed, basilar)**
  Linear are most common, and result from direct impact to the cranium. Depressed skull fractures may lacerate the dura, resulting in CSF leak, or mechanical injuries to the brain. Basilar skull fractures result from direct trauma to the mastoid, occipital, or supraorbital regions and carry associated risk of CSF leak. Antibiotic prophylaxis with CSF leak is unnecessary.

- **Subarachnoid hemorrhage**
  Trauma is the most common cause of subarachnoid hemorrhage (SAH). This finding is seen in at least 40% of patients with TBIs. The distribution is different than that for SAH related to aneurysms, being more often seen over the cerebral hemispheres, in the interhemispheric fissure, or along the tentorium, and less often in the cisterns at the base of the brain or in the Sylvian fissures.

- **Cerebral contusions (intracerebral hematomas)**
  These generally occur in the frontal or temporal lobes, and result from tearing of subpial vessels, with localized hemorrhage. On repeat scanning 12-24 hours later approximately 30-50% increase in size. (Figure 1)

- **Epidural Hematomas**
  These generally result from tearing of dural or skull vessels caused by deformation of the skull or fracture. They may occur in all ages, but are usually seen in those younger than age 50. Despite their wide recognition they are actually relatively uncommon, being seen in only about 5-15% of fatal head injuries. Their frequency is somewhat age related; in adults epidural hematoma is less common than subdural or intracerebral hematoma, while in the pediatric population epidural hematoma is the most frequent intracranial hematoma. Most are seen over the cerebral

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Figure 1

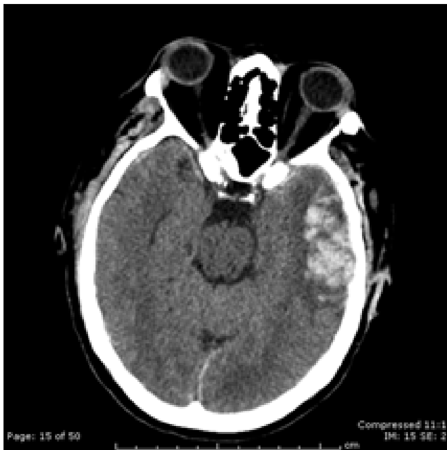


Figure 2

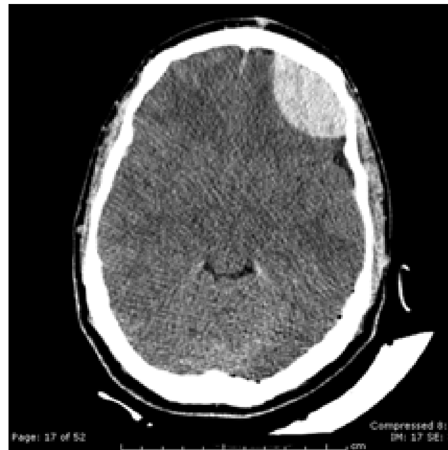
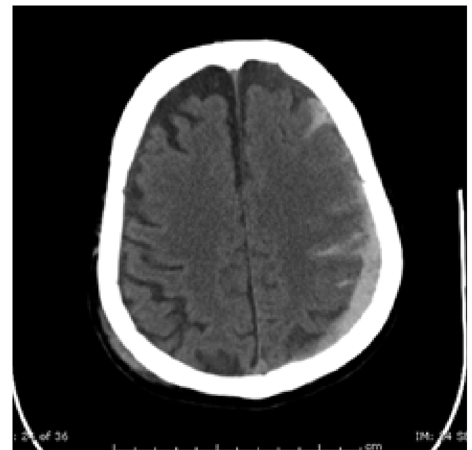


Figure 3



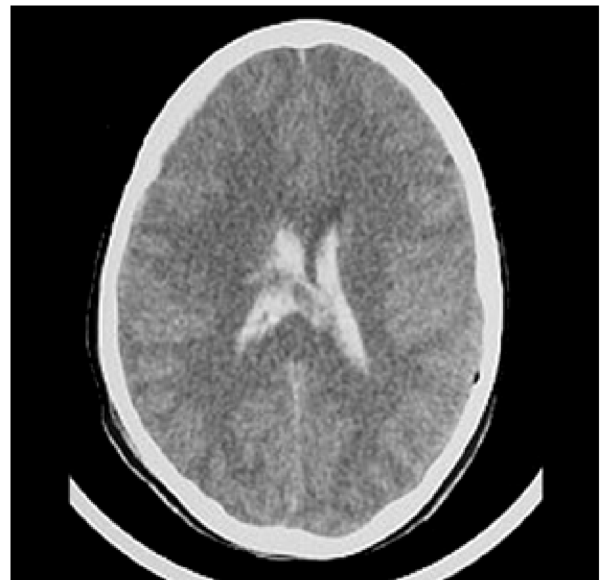
convexities, in association with the middle meningeal artery. Hemorrhage under arterial pressure strips the dura from the inner table of the skull, forming the characteristic hematoma in the epidural location. On CT they may have either a bright appearance consistent with clotted blood, or a lucent "swirl" of unclotted blood within the more typical hematoma. (Figure 2)

The classic clinical course of a "lucid interval" following a period of unconsciousness from the initial blow, followed by a period of unconsciousness as the hematoma exerts increasing mass effect is uncommon, occurring in only about 20% of cases. The prognosis with these lesions is much better than with other intracranial hematomas.

- Subdural Hematoma
  - **Chronic Subdural Hematoma**
    These generally occur in the elderly, are often well tolerated, and many times require surgical treatment. They usually present in a delayed manner, at least 14 days after an injury. They have a characteristic CT appearance, with low attenuation, frequently are multiloculated, and follow the contour of the inner table of the skull. Given the patient population in which they are generally seen they may become alarmingly large, with substantial midline shift, and little apparent symptomatology.
  - **Acute Subdural Hematoma**
    These may be of venous or arterial origin, though most commonly are associated with tearing of a bridging vein between the cortex and the dura. These represent 50-60% of acute post-traumatic intracranial hematomas. The average age is generally older than that seen for patients with epidural hematomas. They are more commonly seen after injuries involving abrupt movement of the head, such as a fall or assault, rather than motor vehicle collisions. They are also commonly associated with other parenchymal injuries of the brain. As such then, their prognosis is less favorable. (Figure 3)

- Intraventricular Hemorrhage
  Actual clot in the ventricles, as distinguished from subarachnoid hemorrhage which may occur in the ventricles, is a poor prognostic sign. This is usually seen in the most severe of TBIs, occurring in as many as 25% of patients with severe head injury. It's presence signifies the great force imparted to the head, and is thought to occur from bleeding from venous structures within the ventricular system. (Figure 4)

Figure 4



- Diffuse Brain injuries
  These are the most commonly seen brain injuries, and range along a continuum from concussion to persistent coma. Physiologically the injuries are extensive, and at a level not well seen with CT.
  - **Concussion**
    Strictly speaking this is defined as a period of loss of consciousness, usually brief, in the absence of radiographic findings. There may be transient

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focal neurologic findings such as anisocoria, motor loss (unilateral, bilateral), or sensory changes (paresthesias of the extremities), which resolve over time.

Initial CT imaging of the brain is negative, and later MRI imaging is as well. In cases of objective motor weakness, or subjective sensory changes MRI imaging of the cervical spine is often useful, to rule out an acute cervical injury such as a contusion of the spinal cord, disc herniation or hematoma causing cord compression.

- **Diffuse Axonal Injury**
  Usually associated with small hemorrhages in the white matter, diffuse axonal or shear injuries are associated with rotational forces or lateral acceleration. The hemorrhages are seen in the areas of maximal acceleration force on the brain and result from rupture of small cerebral vessels. They are characteristically seen in the corpus callosum, walls of the third ventricle, internal capsule, basal ganglia, dorsolateral brain stem, and superior cerebellar peduncles. The extent and location of the axonal injury are important determinants of functional recovery, and patients with extensive involvement may be severely disabled for life.

Patients with the above findings should be transferred promptly to a facility with Neurosurgical services.

Clinical indications for transfer to a Level 1 trauma hospital:

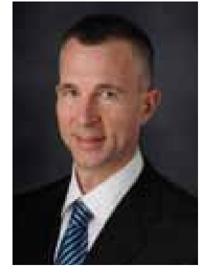
- Coma persisting after resuscitation
- Deteriorating level of consciousness, or progressive neurological signs
- Skull fracture and any of the following: impaired level of consciousness, seizure, neurological symptoms and signs
- Open injury, depressed skull fracture, skull base fracture, CSF leak, penetrating injury
- Multi-trauma
- Normal CT but any unsatisfactory clinical neurological progress

Radiographic Indications for prompt Neurosurgical Evaluation

- Abnormal CT - mass lesion, midline shift, intracranial air, hemorrhage, hydrocephalus

Once the decision is made for transfer to a facility with Neurosurgical care several things are important to keep in mind. The basic considerations in any trauma resuscitation apply - hemodynamic stability, airway control, and so on.

If a CT has not been done, but signs of elevated Intracranial Pressure(ICP) are present (obtundation, anisocoria, localizing neurologic signs) treatment of this presumed condition is reasonable. This includes gentle hyperventilation to pCO2 of 32-34 mm Hg, as well as administration of Mannitol (1gm/kg, infused as a bolus as rapidly as possible) or Hypertonic Saline can be used as available at your facility. If there are CT findings suggesting elevated ICP, treatment with hyperventilation and Mannitol are indicated as well.



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References:

- *Winn, RH, Youmans Neurolgical Surgery 5th edition, 2003, W.S. Saunders*
- *Batjer, HH, Loftus, CM, Textbook of Neurological Surgery, 2nd edition, 2002, Lippincott, Williams, Wilkins*

QUESTIONS:

1. The most commonly used imaging modality in patients with traumatic brain injuries is:

a. MRI
b. CT Angiography
c. Computed tomography (CT)
d. Skull x-rays

2. Most patients with traumatic brain injuries suffer severe injuries.

a. True
b. False

3. Antibiotic prophylaxis is necessary in patients with otorrhea.

a. True
b. False

4. Which of the following is not an indication for transfer to a Neurosurgical Unit?

a. Patients with deteriorating or progression of neurological signs
b.. Patients with open depressed skull fractures
c. Patients with skull fractures and normal neurological examination
d. Patients with a normal CT but an abnormal neurological examination
e. Patients with a coma that persists after successful resuscitation and re-warming

5. Which of the following is not an important consideration in transferring patients for Neurosurgical care?

a. Maintaining an adequate airway
b. Assuring adequate ventilation
c. Maintaining an adequate blood pressure
d. Treating increased intracranial pressure
e. Obtaining a head CT

Answers: 1c, 2b, 3b, 4c, 5e

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ATLS (Advanced Trauma Life Support)

June 3 & 4, October 14 & 15, December 2 & 3

This program was developed by the *American College of Surgeons Committee on Trauma* and is designed to assist physicians in providing the first hour of emergency care to trauma patients. Training combines didactic lectures and practical skills stations, allowing time to perfect skills in the initial assessment; and management and stabilization phases of trauma patients.

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2010 Trauma Nursing Education

Trauma 101

April 19

This program was designed to cover the basics of the multi-system care of the trauma patient through discussion and case presentations.

Trauma 201

October 25

This program builds on the basics presented in Trauma 101. Discussions and case presentations cover the critical care needs of the injured patient. Trauma 101 is strongly recommended as a prerequisite to this class.

For registration and/or questions, please call (763) 520-5940 or email, ce@northmemorial.com

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