Head injury

Head injury is a frequent cause of emergency department attendance, accounting for approximately 3.4% of all presentations, with an incidence of around 450 cases per 100 000 population per year

PATHOPHYSIOLOGY

Brain metabolism

The brain relies on blood borne glucose for 90% of its energy requirements.

Cerebral blood flow and auto-regulation

Normal cerebral blood flow is approximately 55 ml /100 g/ min and is usually maintained at a constant level via mechanisms termed cerebral auto-regulation.

Intracranial pressure and brain herniation

The brain is confined by a rigid container, the skull. The addition of a mass lesion can initially be compensated for by the displacement of cerebrospinal fluid (CSF) and venous blood out of the intracranial cavity. During this period the intracranial pressure (ICP) will remain at normal levels. As further expansion of the mass lesion occurs, quite small increases in volume result in relatively large increases in ICP, brain herniation and rapid clinical deterioration.

Primary versus secondary brain injury

Primary brain injury occurs at the time of impact and includes injuries such as brainstem and hemispheric contusions , diffuse axonal injury and cortical lacerations. Secondary brain injury occurs at some time after the moment of impact and is often preventable. The principle causes of secondary brain injury are hypoxia, hypotension, raised ICP, reduced cerebral perfusion pressure and pyrexia. Prevention of secondary brain injury results in improved neurological outcome after head injury and may make the difference between independent survival and dependent survival/death.

Causes of secondary brain injury

■ Hypoxia: PO2 < 8 kPa

■ Hypotension: systolic blood pressure (SBP) < 90 mmHg

■ Raised intracranial pressure (ICP): ICP > 20 mmHg

■ Low cerebral perfusion pressure (CPP): CPP < 65 mmHg

■ Pyrexia

■ Seizures

■ Metabolic disturbance

CLASSIFICATION OF HEAD INJURY

1) Glasgow Coma Score (Severity of head injury)

Severity of head injury is classified according to the Glasgow Coma Score (GCS), as the GCS – and in particular the motor score – is the best predictor of neurological outcome:

• Minor head injury: GCS 15 with no loss of consciousness (LOC);

• Mild head injury: GCS 14 or 15 with LOC;

• Moderate head injury: GCS 9–13;

• Severe head injury: GCS 3–8.

2) Blunt vs. penetrating

Head injury may be classified as blunt or penetrating. Penetrating head injuries are further divided into low-velocity injuries such as those caused by stabbing and high-velocity injuries such as gunshot injuries.

3) Morphological (type of injury)

A head injury may be classified according to the type of injury that has occurred. ***Skull fractures*** may be divided into vault or base of skull fractures. Vault fractures may be open or closed, linear or comminuted, depressed or non-depressed. Base of skull fractures may or may not be associated with CSF rhinorrhoea and otorrhoea or cranial nerve palsy.

Intracranial haematomas may be extradural, subdural, subarachnoid or intracerebral. Areas of mixed-density intracerebral haematoma in head injury are termed contusions.

CLINICAL FEATURES

History

A history should begin with the ***mechanism of injury***. A dangerous mechanism of injury such as a fall from a height or a high-speed motor vehicle accident should make you suspicious of multisystem injury, including spinal injury. A head injury with LOC when there is no clear accidental mechanism of injury should prompt you to think of non-accidental causes of collapse, such as syncope or aneurysmal subarachnoid haemorrhage, or medical conditions, such as hypoglycaemia.

Try to establish the neurological status of the patient at the time of the injury and soon afterwards. Is there a history of LOC or amnesia? Amnesia may be antegrade (for events after the injury) or retrograde (for events preceding the injury). Was the patient responding, moving and talking appropriately after the accident? Was there evidence of seizure activity? In the severely head-injured patient, what was the GCS at the scene, prior to intubation or on arrival at hospital? Have there been any abnormalities of pupillary responses? Is there a history of possible hypoxia or cardiovascular instability?

As with all trauma patients, any available history regarding pre-existing medical conditions, medication and drug allergies will be useful. In particular, the use of medications such as anticoagulants or anti-platelet drugs will be relevant to a patient with an intracranial haematoma. Is there a history of alcohol or illicit محظور drug use? Is the patient on insulin?

Examination

Primary survey

Examination should begin with resuscitation and a primary survey. The cervical spine should be immobilized with three-point fixation. ‘D’ in the ABCDE approach to a primary survey stands for disability and should include ***assessment of pupillary size and reactivity, GCS and the presence of focal neurological signs.*** A full head, neck and peripheral nerve examination is performed as part of the secondary survey.

Neurological examination should be repeated frequently and recorded, as changes in neurological status imply alterations in ICP and changes in the GCS (especially deterioration) are much more important indicators of the need for treatment than any absolute level. The GCS is composed of eye (E), verbal (V) and motor (M) responses. The best possible score is 15/15 and the

worst possible score is 3/15. ***For each category, the score given is the best score obtained during the examination***. For example, if a patient localises to pain on one side and extends to pain on the other then the motor score is 5/6. If the patient is not eye opening or obeying commands in response to verbal stimuli, then a painful stimulus must be applied. This stimulus should ideally be applied in the region of trigeminal nerve innervation, such as the supraorbital ridge, but it is commonly accepted practice to use a sternal rub or trapezius squeeze. A patient who is eye opening to painful stimuli, saying occasional words and flexing to pain has a GCS of 9/15 (E2, V3, M4). Always record the three components of the score.

If a patient is intubated then the verbal score is 'T'. For example, a patient who opens eyes to speech (E3), is intubated (VT) and localises to pain (M5) has a GCS of 7T/15. The pupillary light response should be recorded. The pupillary size is recorded in millimetres and the light response as present, sluggish or absent. Anisocoria or an asymmetrical sluggish response may suggest partial third nerve dysfunction on the side with the larger or sluggish pupil, implying uncal herniation as a result of a mass on the ipsilateral side. As the third nerve becomes increasingly compromised the ipsilateral pupil will become fixed and dilated. It may be difficult or impossible to expose the cornea because of periorbital bruising.

Direct ocular trauma may cause a traumatic mydriasis that can be confused with a third nerve palsy. Traumatic mydriasis is suspected if there is evidence of ocular trauma and if the pupillary dilatation has been present since the time of injury.

Secondary survey in a head-injured patient also includes a detailed examination of the head, face and neck. First, look and feel the scalp. There may be evidence of external head injury such as subgaleal haematoma or scalp laceration, which may be a cause of significant external blood loss. Palpation of a scalp laceration may reveal an underlying skull fracture with or without a CSF leak. Look for clinical evidence of skull base fracture: bilateral periorbital bruising (**raccoon eyes**), bruising over the mastoid (**Battle's sign**), CSF rhinorrhea or otorrhea, or haemotympanum. Bleeding from an ear may result from local trauma or from a skull base fracture with a perforated tympanum.

A skull base fracture may be associated with a facial or vestibulocochlear cranial nerve injury. Examine the eyes. Look for evidence of injury to the conjunctiva or cornea. Re-examine the pupils. Using an ophthalmoscope, look for retinal detachment. Examine eye movements: gaze paresis suggests midbrain or brainstem dysfunction. Assess the facial skeleton for evidence of orbital ridge, zygomatic or maxillary fractures.

A peripheral nerve examination should record limb tone, evidence of motor weakness or sensory loss, and reflexes. In those patients with an associated spine injury it is important to document neurological deficits, particularly if the patient is likely to be moved to the operating theatre or to intensive care where such an assessment will not be possible for some time afterwards.

The neurological examination must be recorded and repeated in a patient admitted with head injury. A change in neurological status that is picked up early will result in timely investigation and treatment of emergent problems and will help prevent secondary brain injury.

Taking a history in head injury

■ Mechanism of injury

■ Loss of consciousness or amnesia

■ Level of consciousness at scene and on transfer

■ Evidence of seizures

■ Probable hypoxia or hypotension

■ Pre-existing medical conditions

■ Medications (especially anticoagulants)

■ Illicit drugs and alcohol

Glasgow Coma Score (GCS)

Eyes open

Spontaneously	4
To verbal command	3
To painful stimulus	2
Do not open	1

Verbal

Normal oriented conversation	5
Confused	4
Inappropriate/words only	3
Incomprehensive sounds only	2
No sounds	1

Intubated	T

Motor

Obeys commands	6
Localises to pain	5
Withdrawal/flexion	4
Abnormal flexion (decorticate)	3
Extension (decerebrate)	2
No motor response	1

Examination in head injury

- Glasgow Coma Score
- Pupil size and response
- Lateralising signs
- Signs of base of skull fracture
  - Bilateral periorbital oedaema (raccoon eyes)
  - Battle's sign (bruising over mastoid)
  - Cerebrospinal fluid rhinorrhoea or otorrhoea
  - Haemotympanum or bleeding from ear
- Full neurological examination: tone, power, sensation, reflexes

MANAGEMENT OF MILD HEAD INJURY (GCS 14–15)

The majority of patients presenting to hospital with a mild head injury are discharged from the emergency department after history, examination and a period of observation.

The following criteria must be met before discharge:

- The patient must have a GCS of 15/15 with no focal neurological deficit;
- The patient must be accompanied by a responsible adult and should not be under the influence of alcohol or other drugs;
- Verbal and written head injury advice must be given to the patient and their accompanying adult.

Written head injury advice describes to patients the symptoms that should prompt them to obtain further medical advice, which usually involves a return to the emergency department.

These include:-

- Persistent or worsening headache despite analgesia,
- Persistent vomiting,
- Drowsiness,
- Visual disturbance such as double or blurred vision, and
- Development of weakness or numbness in the limbs.

Some patients with mild head injury are at significant risk of intracranial haematoma and require a computerised tomography (CT) scan. Selecting which patients should have a CT scan is not always easy. On the one hand, scanning all patients with minor head injury would be expensive, time-consuming and would unnecessarily expose thousands of patients to ionising radiation. On the other hand, a missed intracranial haematoma is a potentially life-threatening medical error. The National Institute for Health and Clinical Excellence (NICE) has published some guidelines for when to carry out a CT scan in a patient with mild head injury.

NICE guidelines for computerized tomography (CT) in head injury

■ Glasgow Coma Score (GCS) < 13 at any point

■ GCS 13 or 14 at 2 hours

■ Focal neurological deficit

■ Suspected open, depressed or basal skull fracture

■ Seizure

■ Vomiting > one episode

Urgent CT head scan if none of the above but:

■ Age > 65

■ Coagulopathy (e.g. on warfarin)

■ Dangerous mechanism of injury (CT within 8 hours)

■ Antegrade amnesia > 30 min (CT within 8 hours)

MANAGEMENT OF MODERATE TO SEVERE HEAD INJURY

Management of a patient with a moderate to severe head injury begins with resuscitation and a primary survey. The principle aim of treatment is the prevention of secondary brain injury and ***this is best achieved by the avoidance of hypoxia and hypotension.*** It follows that investigations such as a CT scan of the head are of secondary importance to restoring normal oxygenation and blood pressure, even if that means going to the operating theatre to prevent ongoing abdominal or pelvic blood loss. The cervical spine must be immobilized until such time as an appropriate radiological investigation can be performed.

Having completed the primary survey and established the presence of a moderate to severe head injury, the next appropriate step is a CT scan of the head. This investigation is aimed at identifying an intracranial haematoma, the evacuation of which will reduce intracerebral pressure and reduce the likelihood of secondary brain injury. The CT scan will also provide information about scalp soft tissue injury, skull fracture, including base of skull fracture, and lesions not requiring immediate surgery, such as small intracerebral contusions. In the case of an intubated patient, it is useful at this point to request, in addition to a CT scan of the head, a CT scan of the entire cervical spine. Early consultation with the local neurosurgical service is advised. Simple measures to reduce ICP include positioning the patient with the head up 20–30 [reverse Trendelenburg (head up) when the spine has not been injured] and making sure that the cervical immobilisation collar is not so tight

as to restrict venous return from the head. In patients with pupillary dilatation suggesting acutely raised ICP, the administration of 0.5 mg/ kg of 20% mannitol will temporarily reduce ICP during interhospital transfer or on the way to theatre. Excessive use of this osmotic diuretic can lead to hypovolaemia and hypotension.

To be continued…….

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