Craniocerebral Traumas

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Traumatic brain injury

• **Primary**: penetrating injuries through the cranial bone can cause direct brain damage locally, or at the opposite (contralateral) side (contrecoup)

• **Secondary**: brain edema, extradural hematoma, subdural hematoma (brain compression)
Consequences of cranial traumas

- Brain edema
- Skull fractures
- Extradural (epidural) hematomas
- Subdural hematomas
- Intracerebral hematomas
- Subarachnoid hemorrhage
Clinical presentation of brain damage

- **Cerebral concussion**: transient loss of consciousness following a blow to the head, quick recovery, amnesia
- **Cerebral contusion**: morphological damage to cerebral tissue from focal bleeding or edema, slower recovery, may be incomplete with neurological deficit
- **Cerebral compression**: bleeding into the skull spaces (epidural, subdural, subarachnoid, intracerebral, intraventricular)
Signs and symptoms of head traumas

- Galea lesions: bruising or laceration of the skin, scalp wounds, galeal hematomas
- Meningeal irritation: neck stiffness, Kernig’s sign
- Increasing intracranial pressure: headaches, nausea, vomiting, optic disc edema
- Impaired conscious level: amnesia, drowsy, reacts to movement, reacts to painful stimulus, no reaction
- Glasgow Coma Scale (GCS)
- Pupil differences, ocular movement disorders
Raised intracranial pressure

- Normal ICP < 10 mmHg
- Mild ICP increase 10-20 mmHg
- Moderate > 20 mmHg
- Severe > 40 mmHg
- «Monro-Kellie» doctrine:
  - rigid skull bone
  - CSF, blood, brain are incompressible, an increase in one constituent results in an increase in the intracranial pressure
Raised ICP: brain edema

Mechanism:
- vasogenic: impairment of blood-brain barrier, fluid escapes to the extracellular space
- cytotoxic: damage of cell metabolism, intracellular Na⁺ increases, fluid accumulates within cells

Signs and symptoms:
- meningeal irritation, headaches, nausea, vomiting, papilledema, impaired conscious level

Treatment:
- diuretics (Furanthral)
- hyperosmotic infusions (Mannitol)
- hyperventilation (drop in PCO₂ >> vasoconstriction >> reduction in cerebral blood volume)
- CSF drainage (ventricular puncture and CSF withdrawal)
- barbiturate therapy (reduces neuronal activity and depresses cerebral metabolism)
- steroids (cell membranes are stabilised >> decrease in perifocal peritumoral edema, no benefit in traumatic brain swelling)
Raised ICP: cerebral blood flow (CBF)

• Systemic blood flow = blood pressure / vascular resistance

• CBF = cerebral perfusion pressure / cerebral vascular resistance

• Cerebral perfusion pressure = systemic blood pressure – ICP
Raised ICP: symptoms and signs

- Headaches
- Nausea, vomiting
- Optic disc swelling (papilledema)
- Pupil difference (tentorial herniation, irritation and compression of the III. nerve): pupils initially small (excitement), later dilated and fixed to light (palsy)
- Gaze disturbances (upward gaze is initially lost)
- Deterioration of conscious level (tentorial or tonsillar herniation >> compression of ascending reticular activating system in the brainstem and midbrain)
- Respiratory and circulatory irregularities, arrest
- Cushing-reflex: initial increase in blood pressure and a fall in pulse rate (bradycardia) associated with expanding intracranial mass
Conscious level assessment

• Historically used vague terms:
  - stupor, semicoma, deep coma

• Glasgow coma scale (GCS; 1974):
  - eye opening
  - verbal response
  - motor response
Conscious level assessment: Glasgow coma scale (GCS)

Eye opening: spontaneous 4
to voice 3
to pain 2
none 1

Verbal response: orientated 5
confused 4
inappropriate words 3
incomprehensible sounds 2
none 1
Glasgow Coma Scale (GCS)

**Motor response:**
- obeys command: 6
- localizes pain: 5
- withdraw (pain): 4
- flexion (pain): 3
- extension (pain): 2
- none: 1
Glasgow Coma Scale (GCS)

- **Score**
  - 5: 14-15 – alert, oriented
  - 4: 11-13 - drowsy
  - 3: 8-10 - stupor
  - 2: 5-7 – semicoma (reacts to pain)
  - 1: 3-4 – deep coma (no reaction to pain)
ICP monitoring

- Mandatory at GCS 8 or less

- Types of ICP monitoring:
  - epidural
  - intraparenchymal
  - intraventricular (CSF drainage as well)
Management of raised ICP

- **Conservative (non invasive):**
  - Diuretics (Mannitol)
  - hyperventilation
  - barbiturate coma

- **Operative (invasive):**
  - ventricular puncture (CSF drainage, ICP monitoring)
  - evacuation of subdural, epidural or intracerebral hematomas (space-occupying lesions)
  - malignant i. c. hypertension (>40 Hgmm):
    decompressive craniectomy
Skull fractures

- **Closed fractures**: the scalp (skin and galea) intact
- **Open fractures**: penetration of skin and galea, open scalp wound (risk of infection)
- **Linear fractures**: no dislocation between fractured bony edges (usually single)
- **Depressed fractures**: dislocated bone fragments into the cranial space (single or multiple)
Skull fractures: diagnostic approach

- Examination of scalp wound (palpable bone fragments or foreign body)

- Skull X-ray: AP and lateral

- CT scan: bone window
Skull fractures: management

- **Scalp wound**: toilette, removal of foreign material, suture
- **Linear fractures**: conservative management
- **Depressed fractures**: operative treatment, elevation of dislocated bone fragments, fixation (suture, wire)
- **Skull base fractures**: usually conservative treatment (antibiotics, prevention of infection); permanent liquorrhoea needs CSF drainage (lumbar puncture), exploration, reconstructive operation
Skull fractures: complications

Early complications:
- extradural, subdural, intracerebral hematomas
- infection (meningitis, cerebral abscess)
- neurological deficit (palsy, speech arrest)
- conscious level deterioration

Late (permanent) complications:
- amnesia
- personality changes
- liquorhoea
- epilepsy
- neurological deficit, disabilities
Cerebral concussion: management

- Skull X-ray, CT scan
- Observation
- Pain killers (headaches)
- Diuretics
Cerebral contusion: management

- skull X-ray, CT scans (repeated controls)
- reduction of cerebral edema
- observation, GCS chart
- GCS 8 or less: ICP monitoring
  - epidural
  - intraparenchymal
  - intraventricular
Extradural (epidural) hematoma

Pathophysiological mechanism:
- head injury, fracture of the temporal bone, rupture of the middle meningeal artery, arterial bleeding, rapidly growing hematoma, brain compression

Symptoms:
- headache, nausea, vomiting

Signs:
- meningeal irritation, focal neurological signs (localization), rapid deterioration of conscious level

Diagnostic approach:
- skull X-ray: cranial fracture, bone displacement
- CT scan (bone window as well): fracture, lentil-shape hematoma, midline shift (position of the falx)

Management:
- urgent operation (craniotomy, evacuation of the hematoma, coagulation of the bleeding artery)
Subdural hematoma

Pathophysiological mechanism:
- venous bleeding (head trauma, stretching and rupture of bridging veins, gradual subdural accumulation of blood)

Forms:
- acut: severe skull injury, young adults, contusion and laceration of brain surface
- chronic: mild head trauma, occur predominantly in infancy and in the elderly, cerebral atrophy, alcoholism, coagulation disorder

Presentation:
- slow, gradual evolution
- focal neurological signs (especially limb weakness)
- deterioration in conscious level, often with fluctuating course
- dementia

Diagnostic approach:
- CT scan: subdural collection, midline shift (acut: hyperdens, chronic: isodense with capsule)

Management:
- no midline shift: observation
- space occupying hematoma (midline shift):
  1. burr holes + drainage (acut liquid hematomas without a capsule)
  2. craniotomy and resection of the membrane + drainage (chronic collection with capsule)
Intracerebral hematoma

Pathophysiological mechanism:
- hypertensive vasculopathy, (atherosclerotic wall changes, rupture of small perforating arteries)

Presentation:
- focal neurological signes (limb weakness, speech problems)
- impairment of conscious level

Diagnostic approach:
- CT scan: i.c. high density lesions

Management:
- i.c. hematoma without a mass effect: conservative treatment (reduce perifocal edema, diuretics, ensure patent airway and adequate blood oxygenation)
- space-occupying hematoma: craniotomy + evacuation of hematoma
- stereotactic puncture + drainage (liquid hematomas)
- intraventricular hematoma: drainage + hematoma lysis (Urokinase)