Management of head trauma

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Definitions

- Concussion:
- Contusion:
- Contrecoup injury:
- Diffuse axonal injury:

Concussion

- *Alteration of consciousness as a result of non-penetrating traumatic injury to the brain with no gross or microscopic parenchymal abnormalities*
- *Brain injury: impact damage, and secondary injury*

Second impact syndrome

- Primarily in athletes who sustain a second head injury apperantly while symptomatic from an earlier injury; mortality 50-100%

Glasgow coma scale

- E4M6V5 to E1M1V1
- Best eye opening: spontaneous, to speech, to pain , none
- Best verbal: oriented, confused, inappropriate, incomprehensible, none
- Best motor: obeys, localize pain, withdraw to pain, flexion, extensor, none

Grading head injuries

- Minimal : GCS: 15, no loss of cons, no amnesia
- Mild: GCS 14 or 15 plus brief LOC <5 minutes or impaired alertness or memory
- Moderate ; GCS:9-13 or LOC>-5min or focal neurological deficit
- Severe : GCS: 5-8
- Critical: GCS: 3-4

Delayed deterioration

1. 75% will exhibit ICH
   A. Present on initial evaluation,
   B:develop in delayed fashion 1. Delayed EDH,2 delayed SDH,3 delayed traumatic contusions
2. Post traumatic diffuse cerebral edema.
3. Hydrocephalus
4. Tension pneumocephalus
5. Seizure
6. Metabolic abnormalities: hyponatremia, hypoxic, hepatic encephalopathy, hypoglycemia, adrenal insufficiency, drug or alcohol withdrawal
7. Vascular events: dural sinus thrombosis, carotid or VA dissection, SAH due to ruptured aneurysm spontneous or post trauma, CCF, cerebral embolism
8. Meningitis
9. Hypotension (shock)

Post traumatic brain swelling

1. Increased cerebral blood volume: loss of cerebral vascular auto-regulation
2. Ture cerebral edema: vasogenic or cytotoxic cerebral edema. Within hours of head trauma

Transfer of the trauma patients

Items should be evaluated in trauma patients for transfer

1. Hypoxia or hypoventilation
2. Hypotension or hypertension
3. Anemia
4. Seizure
5. Infection or hyperthermia
6. Spinal stability

Management in the E/R

Physical examination in trauma

1. General physical condition

2. Neurologic examination:

General physical conditions(I)

1. Visual inspection of cranium

- A. evidence of basal skull fracture
- 1. Raccoon’s eye
- 2. Battle’s sign
- 3. CSF rhinorrhea , otorrhea
- 4. Hempotypanum,
- B. Check for facial fractures
- 1. Lefort fracture
- 2. Orbital rim fracture

General physical conditions(II)

- C. Periorbital edema, proptosis
- 2. Cranio-cervical auscultation:
- A. Auscultate over carotid arteries
- B. Auscultate over globe of eye
- 3. Physical signs of trauma to spine
- 4. Evidence of seizures

Neurologic exam(I)

- 1.Cranial nerve exam
- A: Optic nerve function
- B: Pupil: size in ambient light and reflex
- C. VII
- D. Funduscopic examination
- 2. Level of consciousness / mental status

Neurologic exam(II)

- *A. Glascow coma scale*
- *B: Orientation*
- *3. Motor exam*
- *4. Sensory exam*
- *5. Reflexes*

Radiographic evaluation

- CT scan in trauma;
- 1. Blood; extraaxial, intraaxial,
- 2. Hydrocephalus
- 3. Cerebral swelling
- 4. Evidence of cerebral anoxia
- 5. Skull fracture
- 6. Ischemic infarction
- 7. Pneumocephalus
- 8. Shift of midline

Indications for initial CT

- 1. Presence of any moderate or high risk criteria : GCS<=14, unresponsiveness, focal deficits, amnesia for injury, altered mental status,deteriorating neuro status, signs of basal or calvarial skull fractures
- 2. Assessment prior to GA,

Follow-up CT

- Routine
- 1. For pts with severe head injuries. A. For stable pts, between days 3-5 and again days 10-14 B. several hours after (time zero) CT to rule out delayed EDH, SDH, or traumatic contusions
- 2. For pts with mild to moderate head injuries: A. with an abnormal initial CT, CT repeated prior to discharge B. Stable pts with mild head injury and normal initial CT : do not require follow-up CT
- Urgent
- follow-up CT: neurological deterioration (loss of 2 or more points on GCS, development of hemiparesis or new pupillary asymmetry) persistent vomiting, worsening H/A, seizures or unexplained rise in ICP.

- **Spine films**
- **Skull films**
- **MRI scans in trauma**
- **Arteriogram in trauma**

E/R management specifics(I)

- Admitting orders for minor or moderate head injury
- Admitting orders for minor head injury(GCS>=14)
- Admitting orders for moderate head injury(GCS9-13)
- Early use of paralytics, and sedation

E/R management specifics(II)

- **Intubation and hyperventilation**
- **Indications for intubation in trauma**
- **1.Depressed level of consciousness(GCS<=7)**
- **2. Need for hyperventilation**
- **3. Severe maxillofacial trauma**
- **4. Need for pharmacologic paralysis**
- **Cautions regarding intubation:**

E/R management specifics(III)

- Mannitol in E/R
- 1. Evidence of intracranial hypertension
- 2. Evidence of mass effect
- 3. Sudden deterioration prior to CT
- 4. After CT, if going to O.R.
- 5. After CT if a lesion associated with IICP
- 6. Assess salvageability

E/R management specifics(IV)

- Contradications:
- 1. Hypotension or hypovolemia
- 2. Relative: mannitol may slightly impede normal coagulation
- Prophylactic AED: does not prevent late development of post traumatic seizures(2 weeks of prophylaxis is adequate)

E/R management specifics (V)
patient with associated severe systemic injuries

- *Prehospital hypotension and/or hypoxia indicated poor prognosis, DPL. DIC.*
- *Fat embolism syndrome: after long bone fracture, appear 12-72 hours; acute respiratory failure, global neurological dysfunction, petechial rashes, pyrexia, retinal fat emboli.10 % mortality*
- *Indirect optic nerve injury*

Exploratory burr hole

- ***Infrequently used:***
- ***Indications :clinical criteria: 1. Sudden drop of GCS. 2. One pupil fixed and dilated 3. Paralysis or decerebration develops; other criteria***
- ***Management : controversial***
- ***Technique: position, choice of side, approach, outcome***

Intracranial Pressure

- General information about ICP
- 1. Cerebral perfusion pressure: MAP-ICP, autoregulation, CBF will impair if CPP<=40
- 2. Intracranial pressure: A. modified Monro- Kellie (blood , CSF, brain , other components) , inelastic and completely closed container C. Pressure is distributed evenly throughout the intracranial cavity

- ***Normal (5-15 mmhg)***
- ***Intracranial HTN: 1. Edema, 2. Hyperremia, 3. Traumatic induced masses, 4. Hydrocephalus, 5. Hypoventilation, 6. Systemic hypertension, 7. Venous sinus thrombosis 8. Increased muscle tone and valsalva maneuver, as a result of agitation or posturing , 9. Sustained posttraumatic seizures***

Second rise of ICP: 3-10 days following injury

- *1. Delayed EDH*
- *2. Delayed traumatic ICH*
- *3 . Cerebral vasospasm*
- *4. Severe ARDS with hypoventilation*
- *5. Delayed edema formation (more common in pediatrics*
- *6. Hyponatremia*

- *Cushing triad; hypertension, bradycardia, respiratory irregularity*
- *CT scan and elevated ICP*

ICP monitoring(I)

- *Indications:*
- *1. Patients with severe head injury GCS<=8*
- *2. Multiple systems injured with altered level of consciousness*
- *3. Subsequent to removal of intracranial mass*
- *Contraindications:*

ICP monitoring(II)

- *1. Awake patients*
- *2. Coagulopathy*
- *DC ICP monitoring when ICP normal for 2-3 days*
- *Complications: 1. Infection, 2. Hemorrhage, 3. Malfunction or obstruction. 4. malposition*

ICP monitoring(III)

- *Type of monitors*
- *1. IVC(standards)*
- *2. Intraparenchymal*
- *3. Less accurate*
- *Subarachnoid, subdural, epidural, ets.*

ICP monitoring(IV)

- *IVC: (intraventricular catheter), insertion technique(entry site, trajectory , insertion length), set-up*
- *Types of ICP waveforms: normal waveforms, pathologic waveforms(Lundberg A, plateau wave; Lundberg B wave, pressure pulses; Lundberg C waves.*

ICP monitoring(V)

Normal functioning of the IVC systems: Check every 2-4 hours, 1. Check for presence of good waveforms, 2. Open system to drain and lower drip chamber to check for patency, 3. For system open to drainage A. volume should increase with time, maximal 450-700ml qd, B. drip chamber should empty into drainage bag regularly 4. In cases where there is question whether the monitoring is actually reflecting ICP ...

ICP monitoring(VI)

- *IVC problems:*
- *1. Air filter on drip chamber get wet*
- *2. Air filter on collection bag get wet*
- *3. Improper connections*
- *4. Changing the position of the head of bed*
- *5. When open to drain, pressure reading is not meaningful*
- *6. Drip chamber fall to floor.*

ICP monitoring(VII)

- IVC trouble shooting:
- 1. IVC no longer works:
- A. Manifestation of problem: 1. Dampening or loss of normal waveform 2. No fluids drain into drip chamber B. Possible causes: occlusion of catheter proximal to transducer, IVC pull out of ventricle, C. Test:
- 2. IVC waves dampened

ICP monitoring(VIII)

- *A. possible causes: 1. Occlusion of catheter proximal to transducer 2. IVC pull out 3. Air in system*
- *Adjuncts to ICP monitoring: Xenon CT, PET etc*
- *Jugular venous monitoring: SjVO2,* brain tissue oxygen tension monitoring, cerebral microdialysis etc.

ICP treatment measures(I)

- *ICP management protocol*
- *Goal of therapy*
- *1. Keep ICP <20-25MMhg*
- *2. Keep CPP >70mmhg*
- *Surgical treatment: any subdural or epidural larger than 1 cm maximal diameter, hemorrhagic contusions*

ICP treatment measures(II)

- General care: two major goals: 1), avoid hypoxia. 2). Avoid hypotension
- Specific treatment measures
- 1. Antacids and or H2 blockers
- 2. Aggressive control of fever
- 3. Arterial line for BP and frequent ABGs
- 4. CVP and or PA line if high dose of mannitol is needed

ICP treatment measures(III)

- *5. IV fluids*
- *A. Choice of fluids1. Isotonic, 2. avoid hypotonics*
- *B. Fluid volume*
- *1.Adequate to prevent hypotension,*
- *2. Normalization of intravascular volume etc*

ICP treatment measures(IV)

- C. Pressors are preferable to IV fluids in head injury
- Measures to lower ICP:
- 1. Positioning
- 2. Light sedation
- 3. Avoid hypotension
- 4. Control HTN
- 5,. Prevent hyperglycemia
- 6. Intubate patients with GCS<= 8
- 7. Avoid hypertension

ICP treatment measures(V)

- *Measures to use for documented IC-HTN*
- *1. Heavy sedation and/or paralysis*
- *2. CSF drainage*
- *3. Osmotic therapy : A. mannitol,B. euvolemic to slightly hypervolemic, hypertonic saline etc*
- *4. Hyperventilation to PCO2=30-35mmhg*
- *5. Steroid: not recommended*

ICP treatment measures(VI)

- *Second tier therapy for persistent IC-HTN: Head CT to rule out surgical condition. EEG to rule out status epilepticus*
- *1. High dose barbiturate therapy, if ICP >20-25mmhg*
- *2. Hyperventilate to PCO2 25-30mmhg, monitoring with SjVO2*
- *3. Hypothermia*

ICP treatment measures(VII)

- *4. Decompressive craniectomy*
- *5. Hypertensive therapy*
- *Adjunctive measures*
- *1. Lidocaine*
- *2. High frequency ventilation*

High-dose barbiturate therapy(I)

- Theoretical benefits: 1.Vasoconstriction in normal area, 2. Decreased metabolic demand for O2 with accompanying reduction of CBF. 3. Free radicals scavenging, 4. Reduced in intracellular calcium 5. Lysosomal stabilization
- Indications: use of barbiturate should be reserved for situations where the ICP cannot be controlled by the previously outlined measures

High-dose barbiturate therapy(II)

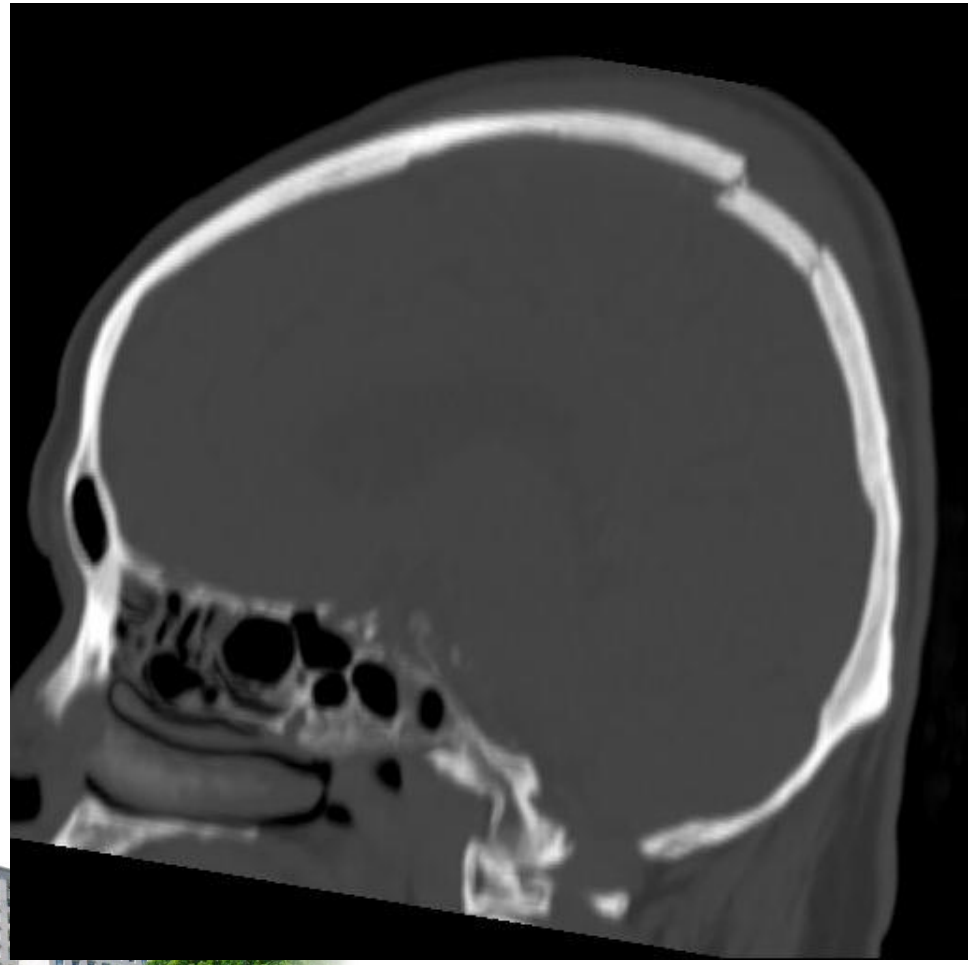
- *Choice of agents: pentobarbital, thiopental, propofol, etc*
- *Pentobarbital: fast onset; 15min, short duration of action3-4hrs, half life, 15-48 hrs*
- *Protocol for pentobarbital: loading dose: 10mg/kg, for 30 min, reloading 5mg/kg qhr x 3 doses; maintenance : 1mg/kg/hr*

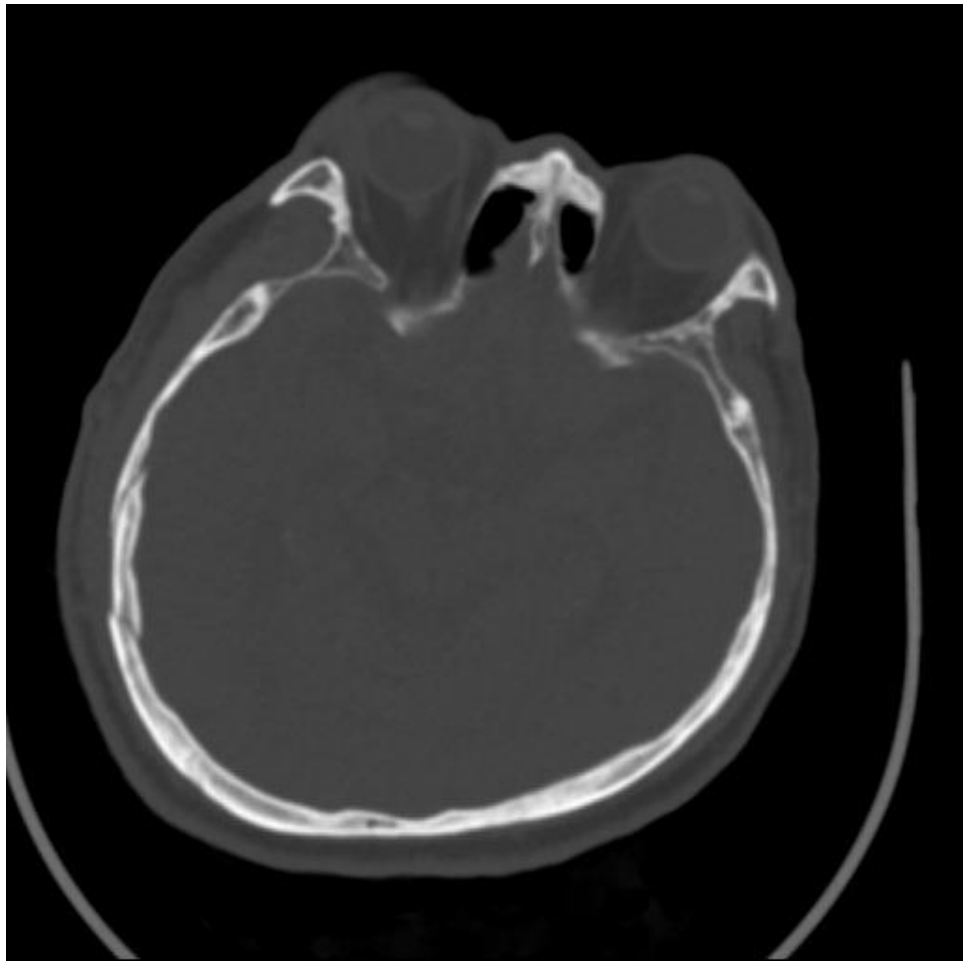
High-dose barbiturate therapy(III)

- *Thiopental coma:*
- *load with 5mg/kg over 10 minutes, continuous infusion 5mg/kg/hr for 24 hrs, rebolus with 2.5 mg/kg as needed, titrate according to ICP or EEG*
- *Propofol for ICP management: not well studied*

Skull fractures(I)

- *Depressed skull fracture*
- *Criteria to elevate depressed skull fractures: 1. >8-10mm depression(or >thickness of skull) 2. Deficit related to underlying brain 3. CSF leakage 4. Open depressed fracture*
- *Technical considerations: ...*





Skull fractures(II)

- Basal skull fractures:
- Diagnosis: radiographic diagnosis: CT is poor for diagnosis, plain skull and clinical criteria are more sensitive; clinical diagnosis: 1. CSF otorrhea, or rhinorrhea 2. Hemotympanum,3. Post auricular ecchymosis(battle sign), 4. Periorbital ecchymosis (racoon eye) 5. Cranial nerve injury
- Treatment:

Skull fractures(III)

- 1. Traumatic aneurysm
- 2. Post traumatic CCF
- 3. CSF fistula
- 4. Meningitis
- 5. Cosmetic deformity
- 6. Post traumatic facial palsy

Skull fractures(IV)

- *Temporal bone fractures: often mixed. longitudinal and transverse type.*
- *1. Longitudinal fractures: more common 70-90%*
- *2. Transverse: perpendicular to EAC, often pass through cochlea, and may place stretch on geniculate ganglion, resulting VII, VIII nerve deficits*

Skull fractures(V)

- Post traumatic facial nerve palsy;
- management:
- 1. Regardless of time of onset;
- A. Steroid
- B. Consultation with ENT
- 2. Immediate onset of facial palsy, facial EMG, take 72 hrs to become abnormal , surgical decompression
- 3. Delayed onset of facial palsy : follow serial ENOG, surgical decompression

Skull fractures(VII)

- *Craniofacial fractures*
- *1. Frontal sinus fracture*
- *2. LeFort fractures, I (transverse), II(pyramidal) , III (craniofacial dislocation).*
- *3. Pneumocephalus*
- *4. Tension pneumocephalus*

Skull fractures(VIII)

- *Skull fractures in pediatrics:*
- *1. Post traumatic leptomeningeal cysts(growing skull fractures)*
- *2. PING-PONG ball fractures*

Epidural Hematoma(I)

- Incidence; 1 % of head trauma admissions, 1/2 of subdurals, male to female : 4:1, usually in young adults, rare before age 2 and after age 60
- Presentation:
- 1. Brief post trauma loss of consciousness
- 2. Lucid interval for several hours
- 3. Obtundation , contralateral hemiparesis and ipsilateral pupillary dilatation.

Epidural Hematoma(II)

- 4. Others: h/A, vomiting, seizure, hemihyperreflexia, unilateral Babinski sign, elevated ICP, In Pediastrics: EDH must be suspected if there is a 10 % drop in Hct after admission.
- Source of bleeding: arterial in 85 % , remaining, vein, and dural sinuses.
- CT scan in EDH: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Epidural Hematoma(III)

- Classic CT appearance occurs in 84 % cases, high density convex(lenticular) shape adjacent to skull, in 115 the side against the skull is convex, and that along the brain is straight , and in 5 % it is crescent in shape.
- Mortality with EDH: overall 20-55 % higher in elderly,
- Treatment:

Epidural Hematoma(IV)

- *Treatment: Medical Only for small lesion , in most cases it is surgical condition*
- *Management: admit, observe, steroid for days , follow up CT in one week if stable , prompt surg if signs of local mass effect or herniation etc,*
- *Surgery:*
- *Indication of surgery; 1. Symptomatic, 2. Greater than one cm in thickest measurement, 3. EDH in pediatrics is risker than adults.*

Epidural Hematoma(V)

- *Delayed epidural hematoma: definition; an EDH that is not present on the initial CT scan , but is found in subsequent CT scan (9-10%)*
- *Risk factors:1. lowering ICP either medically or and surgically 2. Rapid correcting shock 3. Coagulopathy.*
- *Key to diagnosis: high index of suspicion*

Epidural Hematoma(VI)

- *Posterior fossa epidural hematoma: 5% of EDH, more common in first two decades of life, 84 % have occipital fracture, cerebellar sign is surprising lacking or subtle , surgical evacuation is recommend for symptomatic lesion , overall mortality: 26%*

Subdural Hematoma(I)

- Acute subdural hematoma: the impact damage is much higher in acute subdural than in epidural hematoma, much lethal
- Common causes of traumatic ASDH:
- 1. Accumulation around parenchymal laceration
- 2. Surface or bridging vessel torn

Subdural Hematoma(II)

- CT scan in ASDH: crescentic shape of increased attenuation to inner table, edema is often present, membrane formation begins about 4 days after injury, isodense after 2 weeks,
- Treatment: rapid surgical evacuation should considered for symptomatic subdurals that are greater than one cm in thickest measurement , large craniotomy


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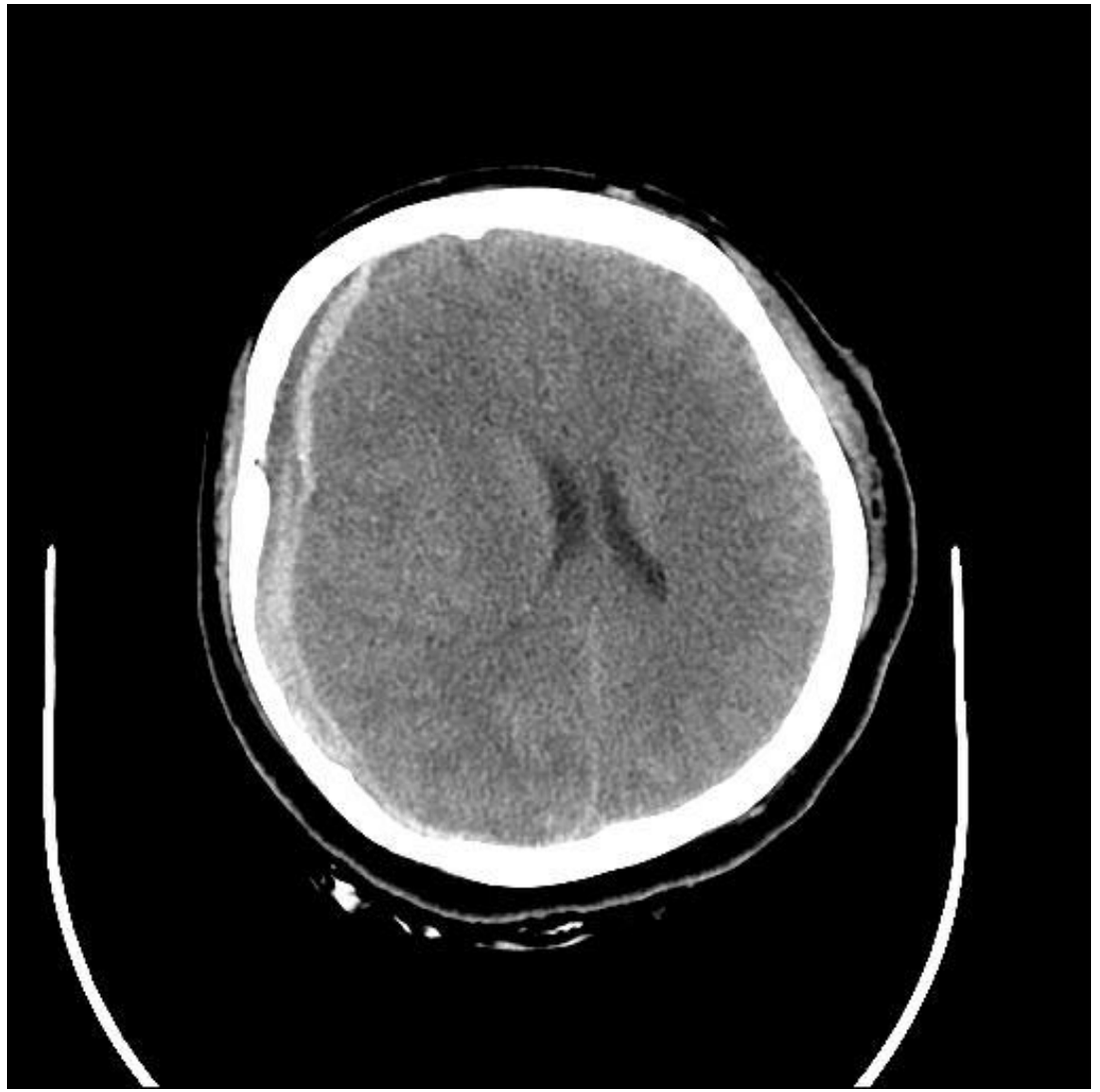


Subdural Hematoma(III)

- Morbidity and mortality with ASDH:
- Mortality; 50-90% higher in aged and coagulopathy
- 1.Patients operated within 4 hours had 30% mortality, compared to 90 % operated after 4 hours
- 2. Functional survival 65 % with surgery within 4 hours
- 3. Other factors etc...

Subdural Hematoma (IV)

- *Infantile acute subdural hematoma:*
- *Rarely purely blood, 75% are bilateral, skull fractures is rare,*
- *Treatment: guided by clinical condition and size of hematoma, percutaneous tap, chronic persistent; SP shunt, craniotomy,*
- *Outcome: 8 % morbidity, and mortality , much better than ASDH.*

Subdural Hematoma(V)

- ***Chronic subdural hematoma: generally in elderly , head injury in less 50 % , risk factors: alcohol abuse, CSF shunts, coagulopathy, , bilateral in 20-25 %, classically: motor oil fluid, presentation: from headache , confusion language difficulty, or TIA like symptoms, to varying degree of coma, hemiplegia, or seizures, Dx: unexpected prior to image.***

Subdural Hematoma(VI)

- *Treatment:*
- *1. Seizure prophylaxis*
- *2. Coagulopathies should be reversed*
- *3. Surgical evacuation of hematoma indicated for A. symptomatic lesion, B. subdurals with maximal thickness greater than 1 cm, post op care.*

Subdural Hematoma(VII)

- *Outcome: clinical improvement when subdural pressure is reduced to close to zero,*
- *Complications: seizure(most common), ICH, reaccumulation, more in the elderly and debilitated.*

Subdural Hematoma(VIII)

- *Spontaneous subdural hematoma*
- *Traumatic subdural hygroma*
- *Extraaxial fluid collections in children*

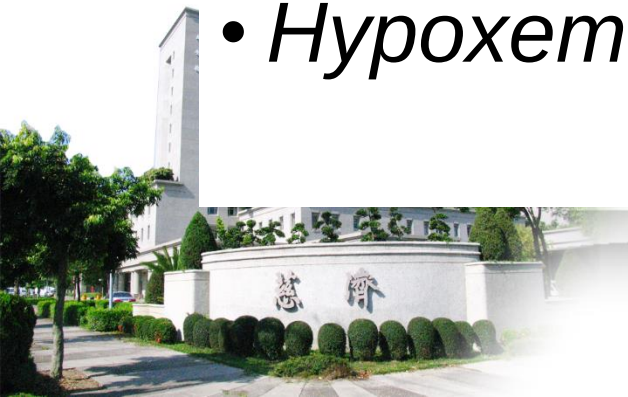
Post traumatic hydrocephalus

Nutrition in the head-injured patient

- *1. By the 7th day after head injury , replace the following A. non-paralyzed patients 140% of predicted basal energy expenditure.*
- *2. Provide >15 % of calories of protein*
- *3. Nutritional replacement should begin within 72 hrs of head injury in order to achieve #1 by day 7*
- *4. Enteral or parenteral. IV hyperalimentation*

Outcome from head trauma

- *Increasing Age*
- *Persistent IICP*
- *Impaired or absent pupillary light response or eye movement*
- *Hypotension*
- *Hypercarbia*
- *Hypoxemia, or anemia*



Gunshot wounds to the head

Non-missile penetrating trauma

High altitude cerebral edema

Cephalhematoma

Child Abuse

Post Concussive Syndrome

Reference

- Handbook of neurosurgery
- Neurosurgery WILKINS etc..