

# Head Trauma

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# Head Trauma – Lecture Objectives

- Be able to:

- Review pathophysiology of head injuries
- Recognize signs and symptoms of head injury
- Conduct a complete but rapid neurologic exam
- Classify the severity of head injury
- Properly treat head injuries
- Recognize types of head injury requiring neurosurgical or trauma center referral

# Head Trauma - Epidemiology

## ➤ Head injury causes:

- 25 to 50% of all trauma deaths in U.S.
- 60% of all vehicle crash deaths
- 2 million injuries / 400.000 hospitalizations per year
- Death rates of 24 to 36 per 100.000 per year
- Cumulative mortality from head injuries admitted to trauma center – 15 to 40%
- Delayed or prolonged effects (even from minor trauma):
  - Headache, memory loss
  - Behavioral / learning / psychologic dysfunction

# Head Trauma – Types of Injuries

- Scalp lacerations / abrasions / contusions
- Skull fractures
- Brain injuries
  - Diffuse
    - Concussion
    - Diffuse axonal injury
    - Cerebral edema
  - Focal
    - Intracranial hemorrhages (subarachnoid, subdural, epidural, parenchymal)
    - Brain lacerations



# Causes of Death from Head Trauma

- External exsanguination
  - Uncommon but can occur from major scalp lacerations
- Respiratory / cardiac depression from brainstem compression
- Reduced brain perfusion due to increased intracranial pressure (from mass effect or diffuse cerebral edema)

# Brain Vascular Perfusion

- Perfusion pressure of blood supplying the brain represents the difference between the arterial / capillary pressure and the intracranial pressure (ICP)
- As ICP increases, perfusion pressure decreases (unless arterial blood pressure also increases; this increase is limited though by development of cerebral edema)
- Therefore, measures to decrease ICP tend to increase brain perfusion

# Head Trauma

## History Items to Determine

- History needs to be fully elicited only AFTER the ABCs have been addressed
- Time of injury; type or source of injury
- Head fixed or mobile at time of injury
- Any secondary blows to head
- Loss of consciousness
- Nausea
- Neurologic symptoms
- Alcohol or drug intake
- Environmental factors (such as hypothermia)
- Prior head injuries or neurologic problems
- Current medications and allergies

# Head Trauma

## Level of Consciousness

- Assessing the level of consciousness is the most important first step in the exam
- Any decrease in the level of consciousness implies possible presence of brain injury
- Other (perhaps concurrent or additional) causes of decreased level of consciousness:
  - Hypoxia, alcohol, drugs, hypoglycemia, cerebrovascular accident, hypothermia or hyperthermia, carbon monoxide

# Head Trauma

## Interpretation of Vital Signs

- If signs of shock (low BP and high pulse) – usually is due to another site of injury (uncommonly shock can be due to scalp laceration blood loss alone)
- If low pulse and increased BP, possibly represents Cushing reflex indicating increased ICP
- Sudden tachycardia and hypotension can be a preterminal sign of impending brainstem herniation.

# Head Trauma

## Interpretation of Vital Signs (con't.)

- Bradypnea can be early sign of increased ICP
- Cheyne-Stokes respirations or Central Neurogenic Hyperventilation pattern imply brainstem injury
- Usually these respiratory rate alterations should not be seen since the patient should be intubated and hyperventilated early.



# Head Trauma

## Initial Physical Exam

- Level of consciousness should be addressed as part of the primary survey
- Most of the rest of the head exam should be part of the secondary survey
- Scalp exam:
  - Feel (with glove hand) for tenderness, swelling, step-offs in skull, crepitus
  - Don't move head to look at back of scalp until C-spine injury is fully ruled out (may carefully logroll patient to check occipital scalp, if neck immobilization is maintained with collar and assistant holding head in-line)

# Head Trauma

## Scalp Lacerations

- Very actively bleeding scalp lacerations may need to be quickly sutured or stapled to effect hemostasis; otherwise a direct pressure bandage should be applied
- Only rarely would clamping of bleeding scalp vessels be needed
- Generally shaving around scalp lacerations is not needed if adequate cleansing can be done



# Head Trauma

## Physical Exam

### ➤ Ears

- Should look in both canals and carefully suction under direct vision any blood in canal to determine if it is from canal or inner ear source
- Check for Battle's sign (ecchymosis over mastoid)
- Nose, throat, face – assess as detailed in the Facial Trauma section of the ETC course
- Check drainage from ears or nose on filter paper for “ring sign” indicating CSF leak

# Head Trauma

## Physical Exam (con't.)

### ➤ Eyes – assess for:

- Pupil size and reactivity
- Extraocular movements (EOMs)
- Visual acuity if patient awake
- Conjunctiva / cornea for injury
- Fundoscopy – seldom important but sometimes can see retinal hemorrhages or intraocular injury (usually see papilledema from increased ICP only after extended time)

# Head Trauma

## Components of the “mini-neurologic Exam”

- Level of consciousness
- Pupil reactivity
- Limb motor ability
- Utilize these to assign a Glasgow Coma Scale (GCS) number score

# Head Trauma

## Glasgow Coma Scale (GCS) Points

- Eye opening (E score)

Spontaneous – 4

To speech – 3

To pain – 2

None (closed) – 1

- Best motor response (M score)

Obeys commands – 6

Moves toward stimulus – 5

Withdraws to pain – 4

Flexion response to pain\*\* – 3

Extensor response to pain\* – 2

None – 1

- Best Verbal Response (V score)

Oriented – 5

Confused – 4

Inappropriate (garbled) – 3

Incomprehensible (grunts) – 2

None – 1

Sum of the E,M,V scores then is the GCS score #

\*\* (decorticate posturing)

\*(decerebrate posturing)

# Use of GCS to Categorize Head Trauma Severity

- Severe – GCS  $\leq 8$
  - Moderate – GCS 9 to 12
  - Minor – GCS 13 to 15
- 

# Head Trauma

## Definition of Coma

- No eye opening
- Does not follow commands
- No verbalization
- GCS score  $< 8$   
(some with GCS = 8 are in coma)

# Limitations to GCS scoring

- Orbital injury – eye may be unable to be opened due to lid edema
- Limb injury – patient may not move limb due to fracture or other injury of limb
- Children who are nonverbal
- Note any of these factors that would tend to falsely lower the GCS

# Heat Trauma Physical Exam Signs Suggesting Intracranial Mass Lesion

- Coma and unilateral dilated, fixed pupil
- Lateralized extremity weakness
- Posturing (especially if asymmetric)
  - Decorticate – arms flexed at elbows
  - Decerebrate – arms extended at elbows, legs stiffly extended at knees.



# Head Trauma

## Signs of Severe Head Injury

- Unequal pupils
- Lateralizing motor response or weakness
- Open injury with CSF leak or exposed brain tissue
- Depressed or open skull fracture
- Deterioration in neurologic status
- Coma

# Emergency Management of Major Head Trauma

- For any patient with coma or other signs of severe head injury, the key emergency management is endotracheal intubation (using rapid sequence induction is best if patient condition and time permit) and hyperventilation, and rapid fluid treatment for shock
- Hyperventilation reduces the  $p\text{CO}_2$  which causes cerebral vasoconstriction thereby reducing ICP (best “target”  $p\text{CO}_2$  is 26 to 28 mmHg)

# Head Trauma

## Patient Reassessment

- Frequent reassessment of the head trauma patient is extremely important to detect deteriorations or changes
- Signs of dangerous neurologic deterioration:
  - GCS drop of 2 or more points
  - Increased severity of headache
  - Increased size of one pupil
  - Unilateral weakness

# Major Head Trauma

## Emergency Management Sequence

- ABCs / primary survey
- Endotracheally intubate and hyperventilate
- Immobilize C-spine
- Resuscitate if in shock
- Stop scalp bleeding (direct pressure dressing)
- Assess for other causes of altered mental status
- Complete the secondary survey and neurologic exam
- Decide if radiographs or CT needed
- Decide if emergent neurosurgery or transfer to trauma center needed
- Treat for increased ICP / cerebral edema
- Secondary treatments

# Head Trauma – Quick Assessments for Other Causes of Altered Mental Status

- Hypoxia
  - Treat all patients with high flow oxygen initially
  - Check pulse oximetry of arterial blood gas
  - Check carboxyhemoglobin level if possible fume / smoke inhalation
- Hypoglycemia
  - Check fingerstick glucose; treat with IV 50% dextrose if <70 mg/dL
- Hyperthermia or hypothermia
  - Rapid temperature control measures as needed
- Alcohol ± drug intoxication
  - Check levels but don't assume altered mental status is due only to alcohol or drugs – must rule out head injury first as the cause

# Head Trauma – Treatment for Increased ICP / Cerebral Edema

- Hyperventilation to  $p\text{CO}_2$  of 24 to 30 mmHg
- Fluid restriction (if not in shock and no ongoing fluid losses)
- Mannitol 1 g/Kg IV  $\pm$  furosemide 1 mg/Kg IV
- Consider use of barbiturates (phenobarbital 10 to 20 mg/Kg IV loading or pentobarbital 3 to 6 mg/Kg IV)
- Steroids not indicated unless spinal cord injury also present
- Consider placing intracranial pressure monitor bolt



# Head Trauma

## “Secondary” Treatments

- Antibiotics
  - Anti-staphylococcal (first generation cephalosporin) if penetrating skull injury, major contamination, or CSF leak
- Tetanus toxoid ( $\pm$  tetanus immune globulin) if last immunization > 5 years ago
- Diazepam (0.2 to 0.3 mg/Kg IV) or lorazepam (0.1 to 0.2 mg/Kg IV) followed by diphenylhydantoin (18 mg/Kg IV at rate < 50 mg/Kg/min.) for seizures
- Consider pain medications once all diagnostic studies complete and if no contraindications

# Head Trauma

## Scalp Lacerations

- Usually can repair in one layer
- Need to repair galea as separate layer (with absorbable suture) if also lacerated
- Usually do not require antibiotics
- Suture removal in 7 days

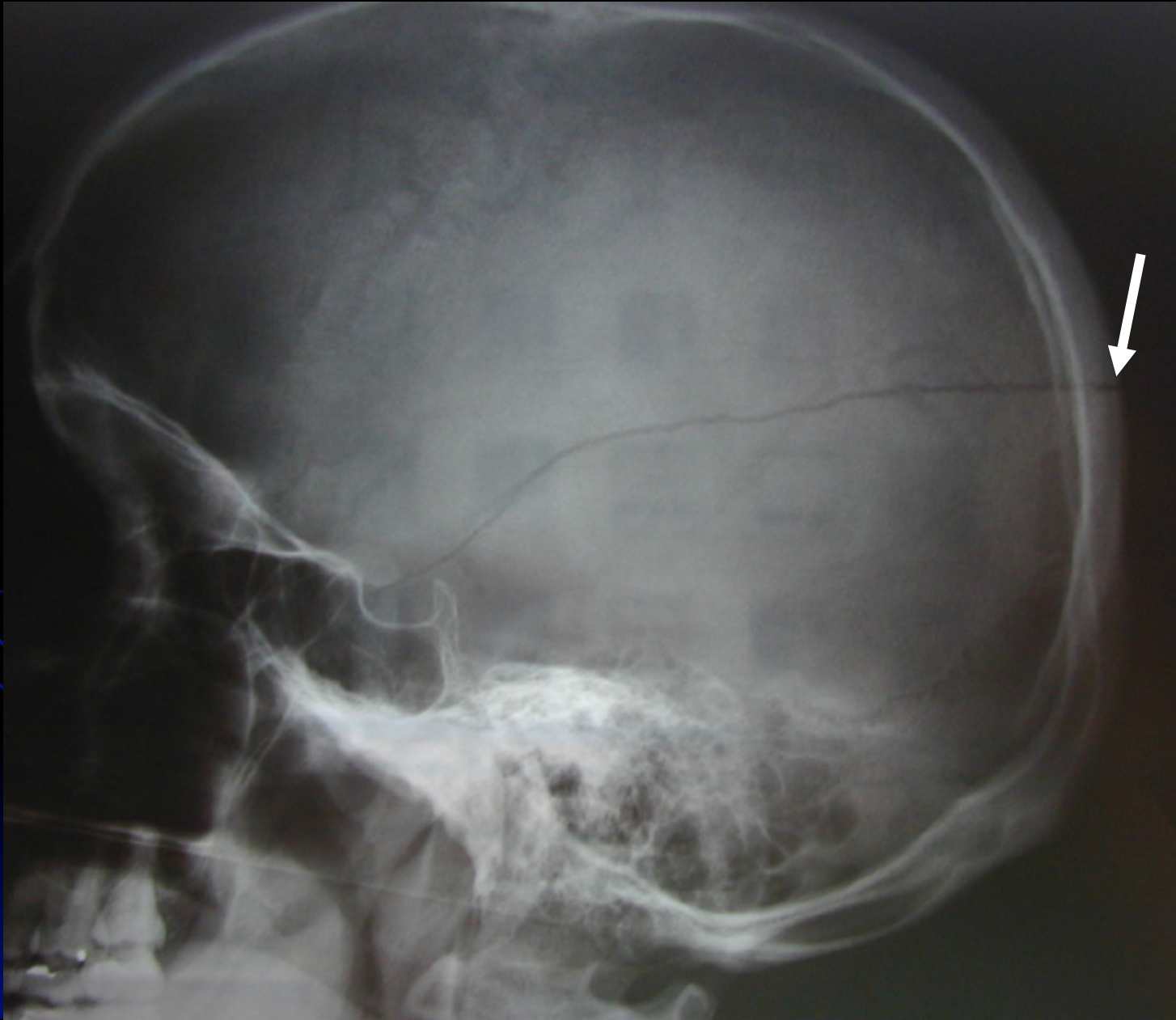


# Head Trauma

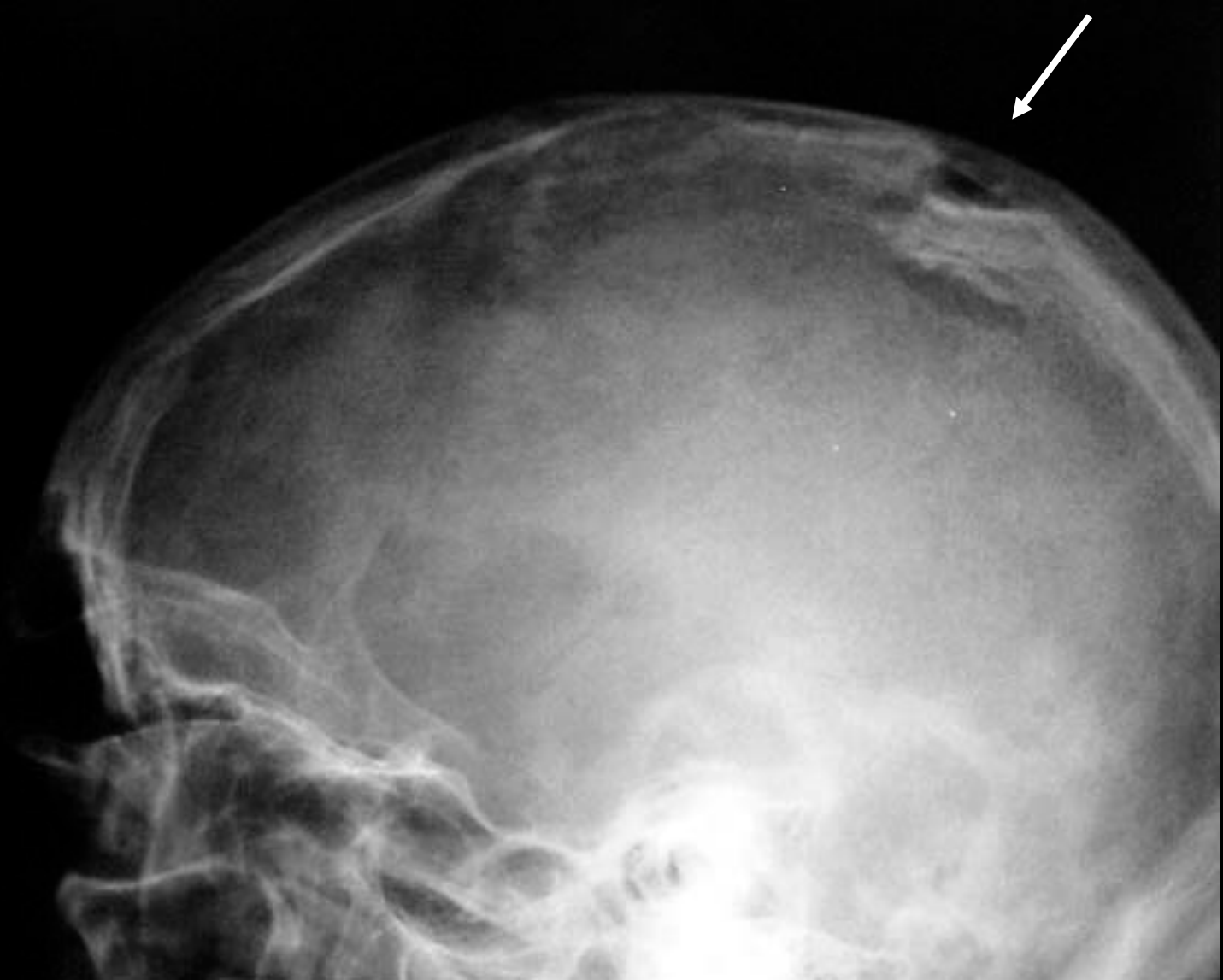
## Skull Fractures

- Most do not require specific treatment (underlying brain injury may need separate treatment)
- Need surgery if:
  - Open fracture (save any bone fragments identified)
  - Depressed  $> 3$  to 5 mm
- Skull X-rays only indicated if head CT NOT otherwise needed and patient has:
  - Suspected depressed or open skull fracture by physical exam
  - Large scalp hematoma thru which skull cannot be felt well enough to rule out depressed fracture (some surgeons think CT indicated if fracture line crosses middle meningeal artery groove in order to rule out epidural hematoma)

## Fraktură parietală



## Fraktură craniană cu înfundare



# Head Trauma

## Basilar Skull Fractures

- Cannot be seen well on skull radiographs
- CT indicated to assess for intracranial injury
- Signs:
  - Periorbital ecchymoses (“raccoon eyes”)
  - Battle’s sign (echymosis over mastoid)
  - CSF leak from nose or ear
  - Hemotympanum
  - Sometimes deafness from auditory nerve injury
- Usually do not require specific treatment (sometimes delayed dural repair for CSF leak needed)



# Semnul Battle



## Ochi de raton





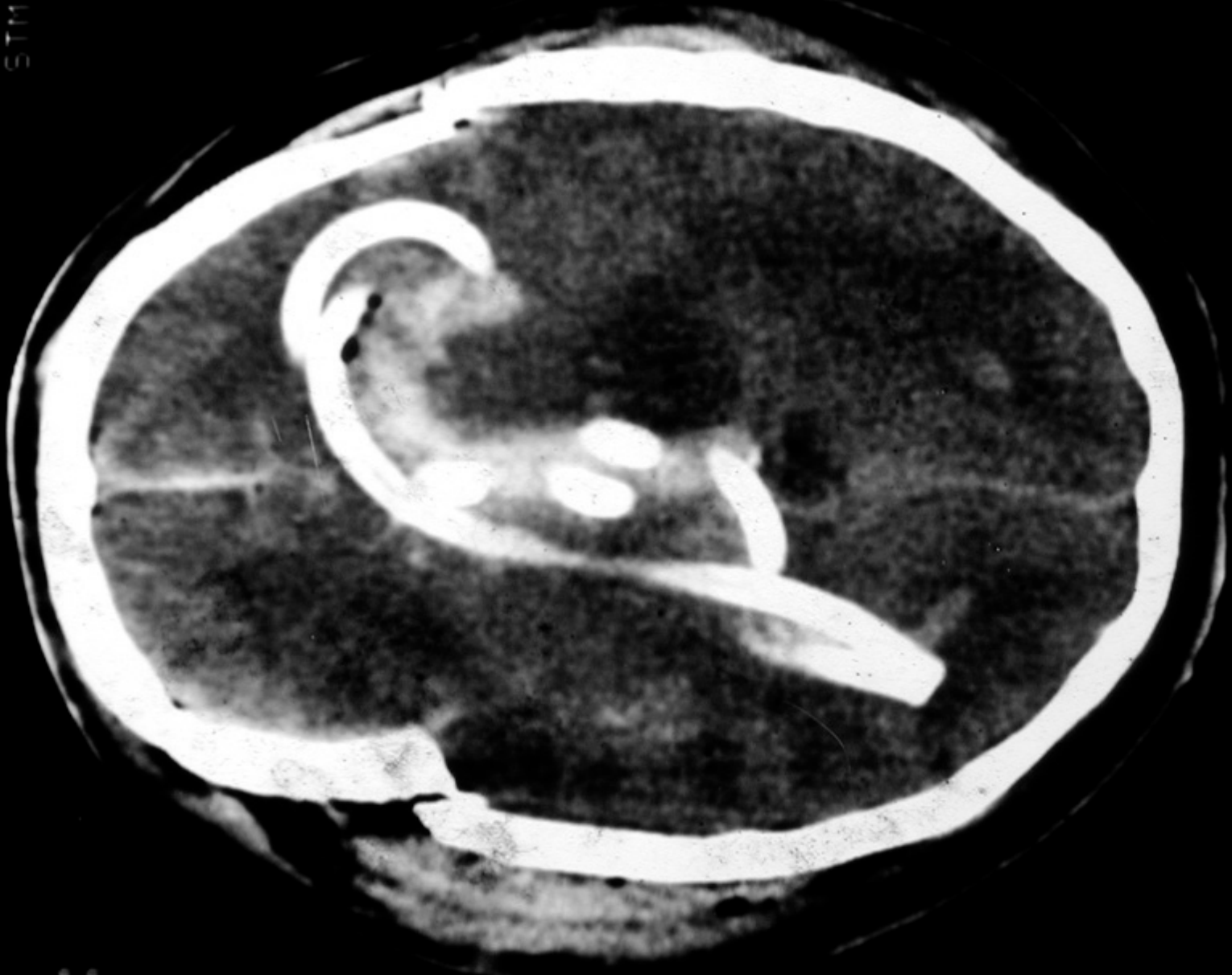
# Hematoame periorbitale

- “Ochi de panda” – sugestivi pentru fractura de bază de craniu
- Sondă de aspirație gastrică introdusă pe cale nazală – manevră interzisă



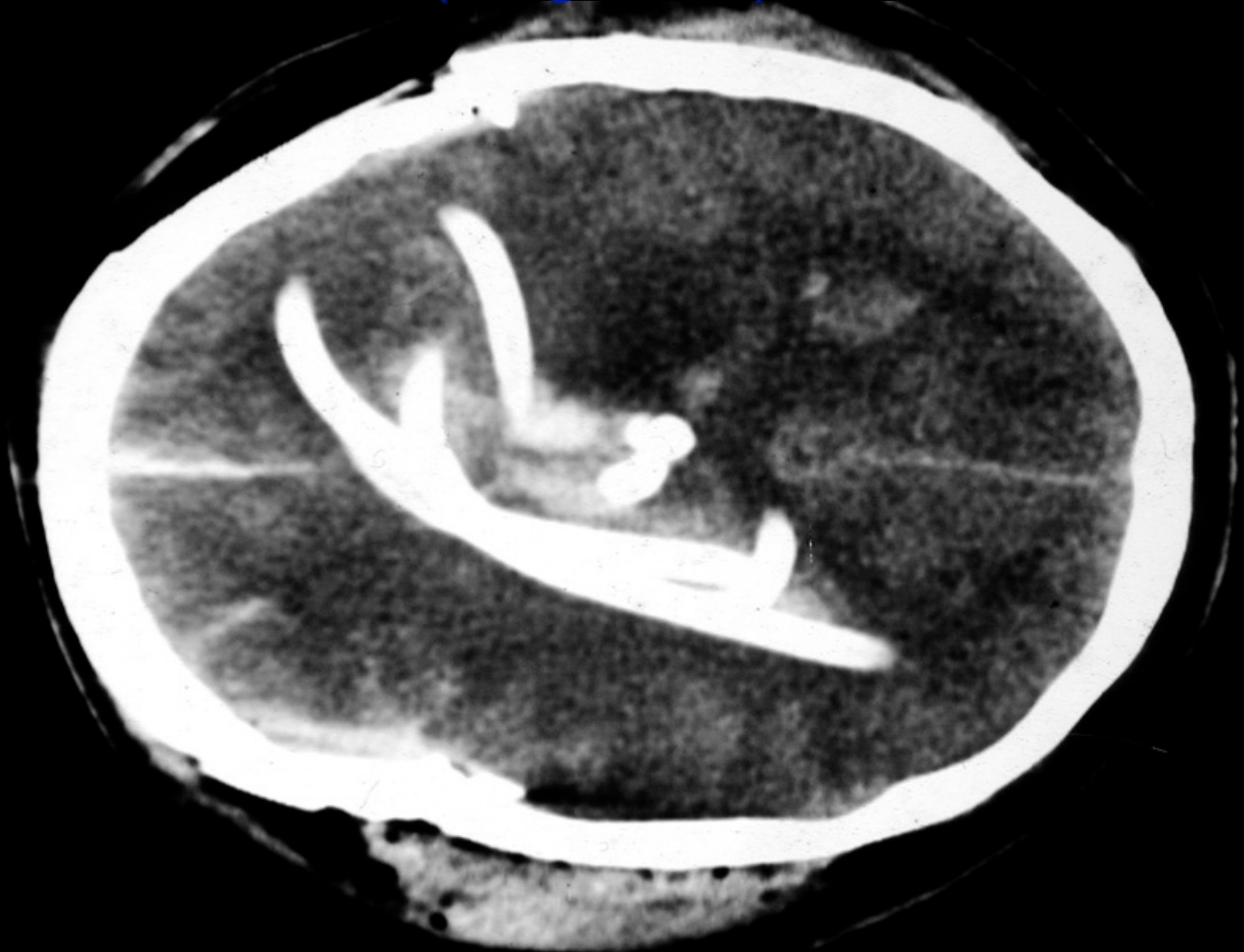
# Sondă nazogastrică în parenchimul cerebral (imagine CT)

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STM





# Sondă nazogastrică în parenchimul cerebral (imagine CT)



# Head Trauma

## Concussion

- Symptoms (not all need occur in same patient)
  - Brief loss of consciousness (< 5 minutes)
  - Headache
  - Dizziness
  - Nausea / vomiting
  - Normal neurologic exam
- May need to be admitted if severe dizziness or persistent vomiting
- Usually do not need CT but just need observation in hospital for 2 to 24 hours

# Head Trauma

## Use of Computed Tomography (CT)

- CT indicated for head trauma patients with:
  - Altered mental status
  - Lateralizing signs
  - Progressive headache
  - Persistent vomiting
  - Any neurologic deterioration
  - Open brain injuries
  - Signs of basilar skull fracture

# Head Trauma

## Diffuse Axonal Injury (DAI)

- Represents diffuse damage (usually from shearing effect) to neurons throughout the brain
- Manifested by deep coma
- High mortality and poor prognosis
- No specific treatment beyond that for increased ICP

# Head Trauma

## Intracranial Hematomas

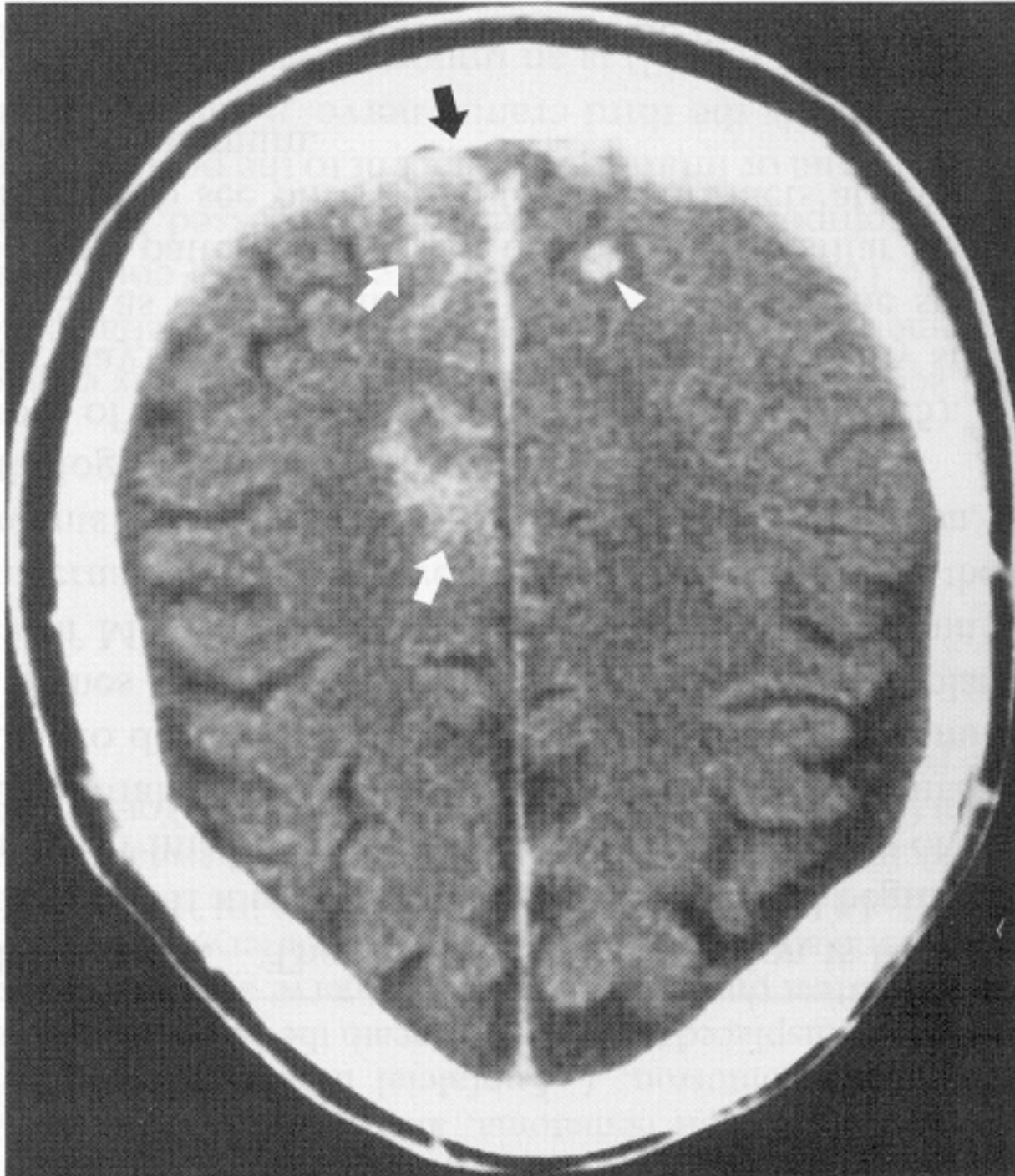
- If identified on CT, always require neurosurgical consult
- Some may not require surgery however
- May also be associated with diffuse brain injury or diffuse cerebral edema

# Head Trauma

## Subarachnoid Hemorrhage

- Evident on CT by blood in subarachnoid space, usually diffusely over brain
- If major intraventricular bleed, then has poor prognosis
- If limited extent, may not require specific treatment and can have good prognosis

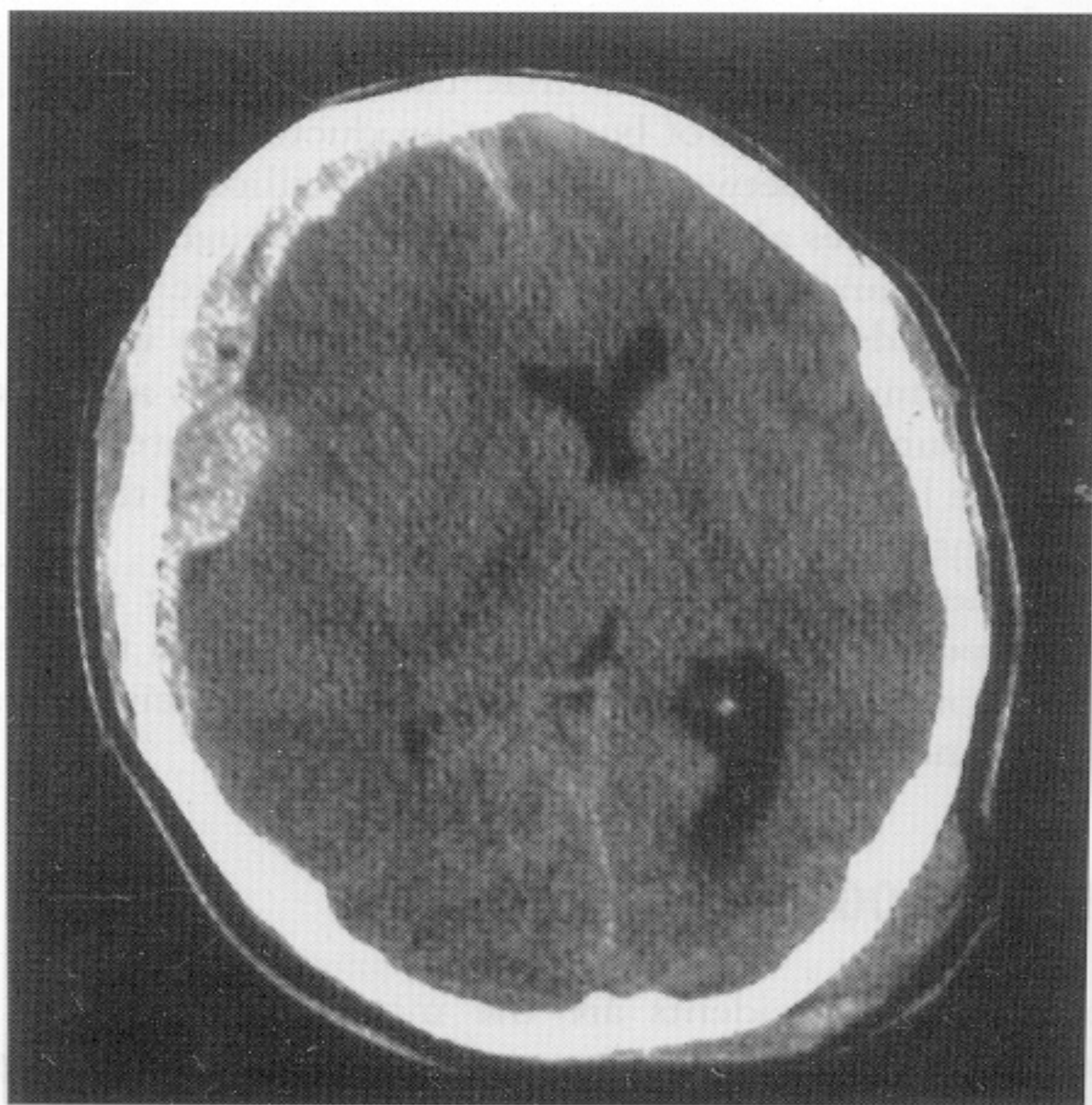




# Head Trauma

## Subdural Hemorrhage

- High mortality (40 to 60%) due to underlying brain injury
- Represents bleeding from torn dural bridging veins  $\pm$  brain surface arteries  $\pm$  brain tissue laceration
- Treat by craniotomy and drainage (unless very small and bilateral)





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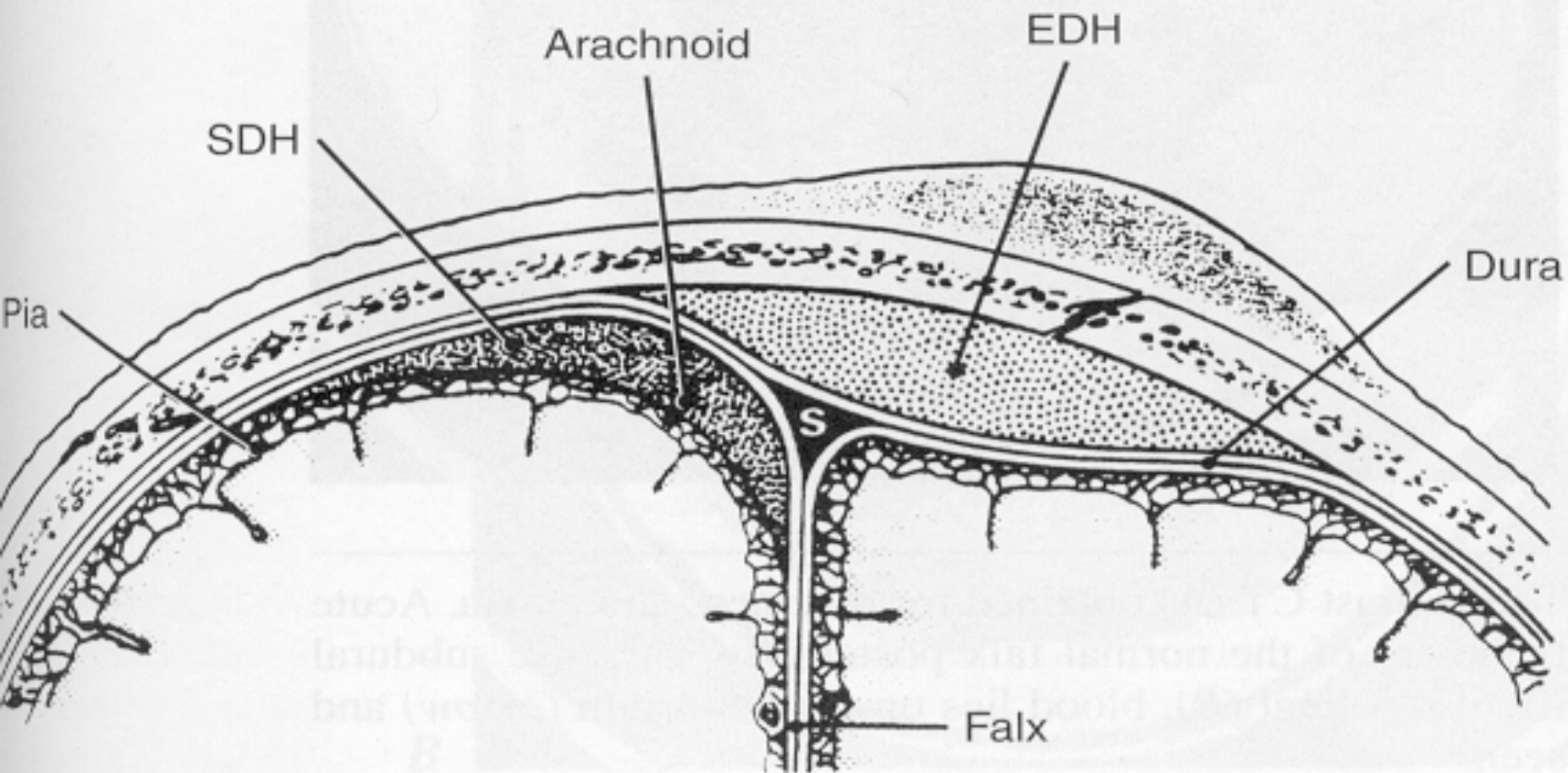
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# Head Trauma

## Epidural Hemorrhage

- Uncommon – only 0.5 to 5 % of head injuries requiring hospitalization
- Often caused by middle meningeal artery laceration
- Classic presentation (in 1/3 of cases):
  - Loss of consciousness at impact followed by lucid interval of a few minutes to hours, then progressive decline in level of consciousness
- Emergent craniotomy indicated if identified – causative artery usually needs ligation (and hematoma drained)
- Mortality 10 to 50 % (better prognosis than subdurals because usually less underlying brain injury)







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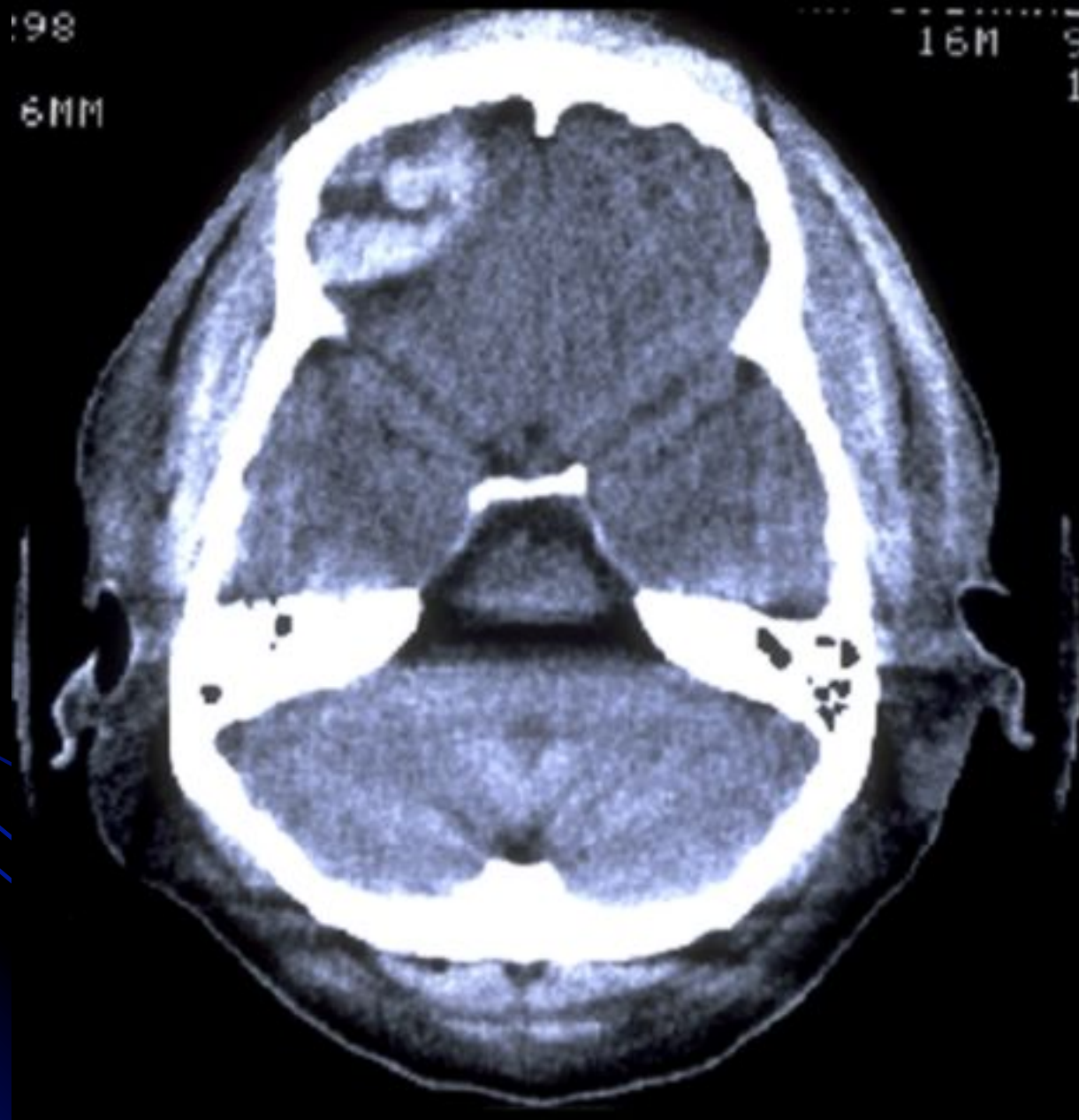
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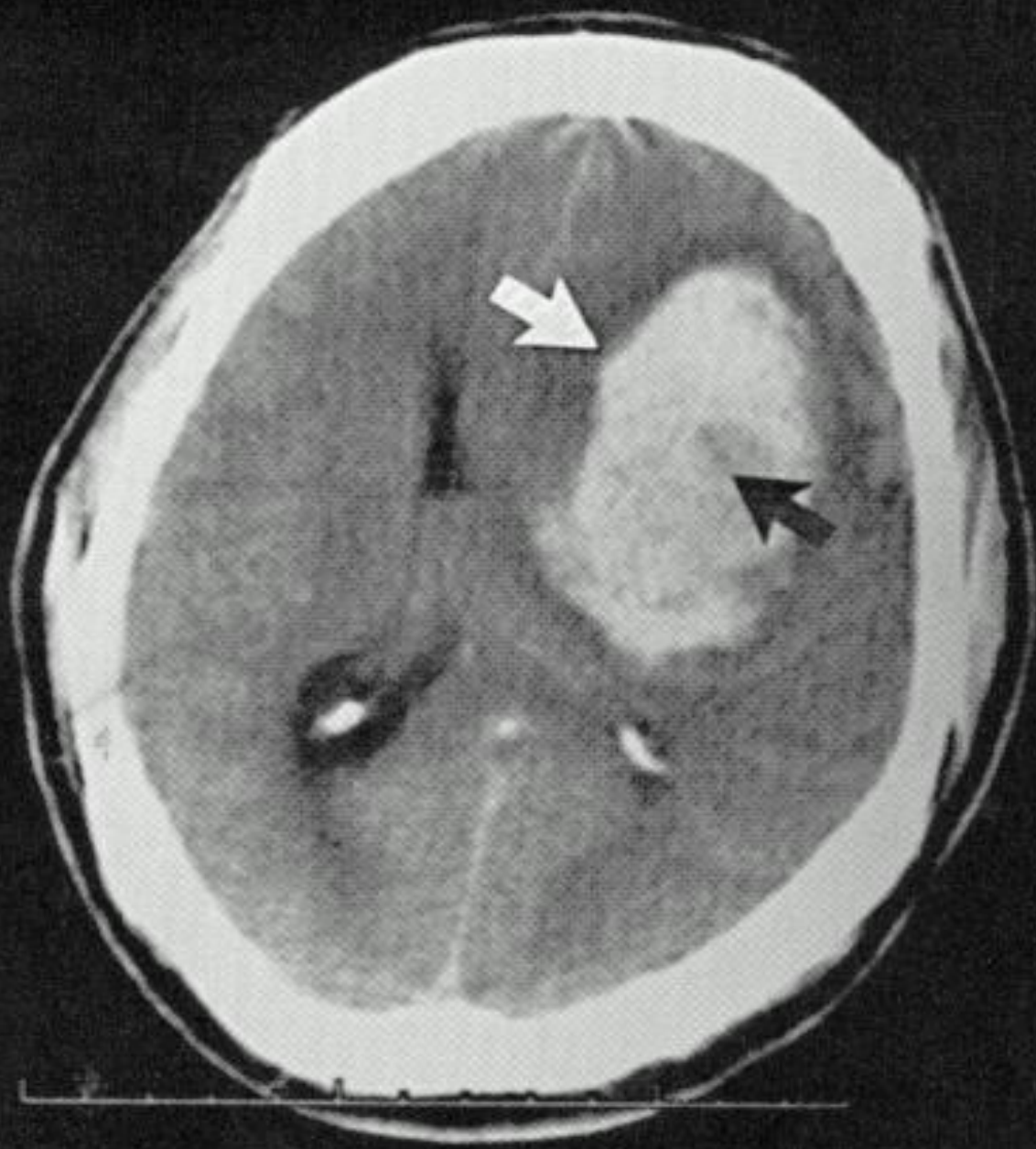


# Head Trauma

## Intraparenchymal Brain Hemorrhage

- Intracerebral is most common
- Small ones may not need surgery
- Brainstem ones may be inoperable
- Surgery indicated if large, progressive, or associated with significant cerebral edema
- Increased risk of seizures





# Head Trauma

## Subdural Hygroma

- Caused by tear in pia / arachnoid and one-way leakage of CSF (cerebrospinal fluid) into subdural space
- Symptoms and treatment same as for subdural hematoma (although prognosis much better since usually much less underlying brain injury)



# Head Trauma

## Other Diagnostic Techniques

- **Magnetic Resonance Imaging (MRI)**
  - Not usually useful acutely
  - Does not visualize bony injury or fresh blood as well as CT
  - Contraindicated if patient has implanted metal (clips, staples, etc.)
- **Cranial ultrasound**
  - Can be used to determine midline shift
  - Does not visualize hematomas well
- **Radioisotope brain scanning**
  - Useful only to document lack of brain perfusion to declare brain death (to allow organ donation)
- **Angiography** – may be needed if suspected carotid artery injury
- **EEG** – not useful acutely

# Head Trauma

## Penetrating Brain Injury

- Patients with obvious fatal penetrating brain injuries may still warrant resuscitation to become organ donors
- CT indicated even for tangential gunshot wounds to rule out blast effect to brain
- Post-traumatic seizures can occur in up to 50% of cases, so usually seizure prophylaxis (with diphenylhydantoin or phenobarbital) is indicated
- All should receive antibiotics

Plagă înjunghiată temporală dreaptă – cuțitul trece prin spatele orbitei oprindu-se în naso-faringe



Plagă înjunghiată temporală dreaptă – cuțitul trece prin spatele orbitei oprindu-se în naso-faringe





Plagă înjunghiată temporală dreaptă – cuțitul trece prin  
spatele orbitei oprindu-se în naso-faringe





Plagă înjunghiată temporală dreaptă – cuțitul trece prin  
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Plagă înjunghiată temporală dreaptă – cuțitul trece prin  
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Plagă înjunghiată temporală stângă



## Plagă înjunghiată temporală stângă



## Plagă înjunghiată temporală stângă





## Plagă împușcată fronto-parietală stângă





Plagă împușcată fronto-parietală stângă  
Orificiu de intrare - detaliu



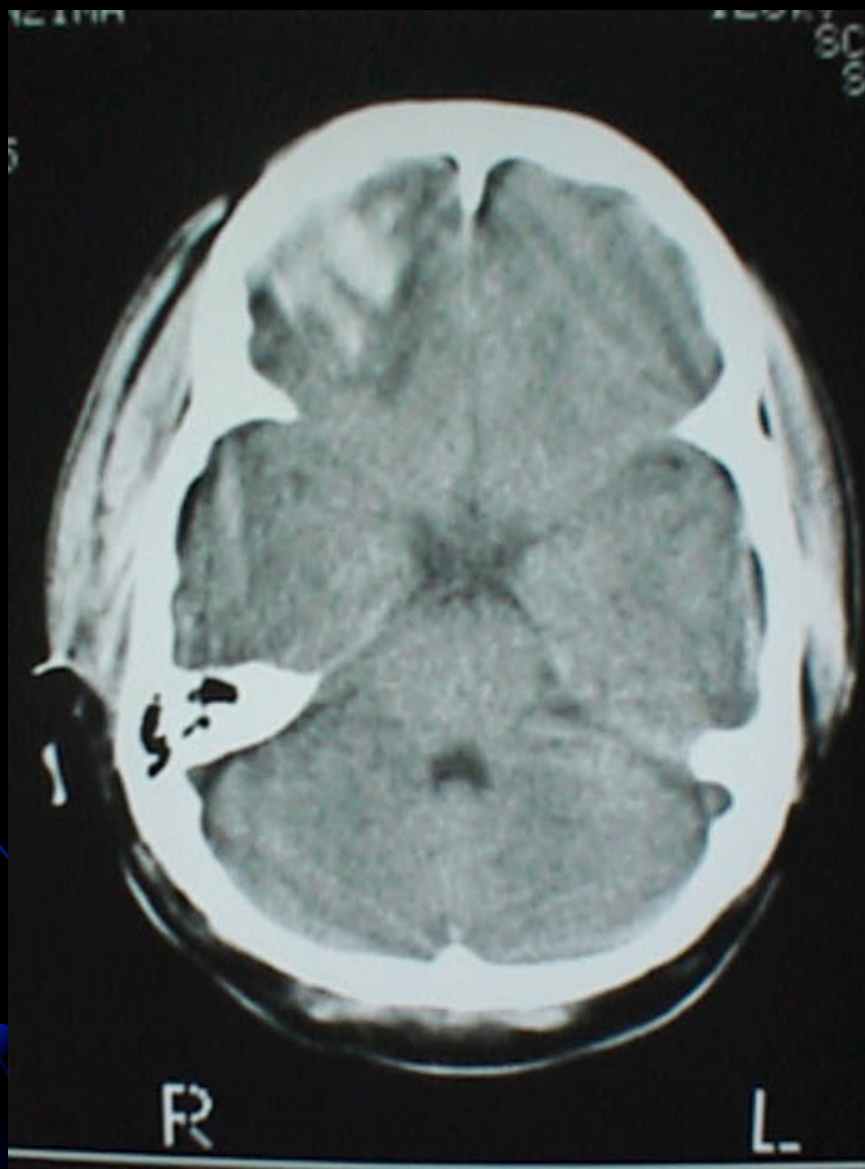
Plagă împușcată. Fractură fronto-parietală stângă.  
Multiple fragmente de proiectil



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Multiple fragmente de proiectil

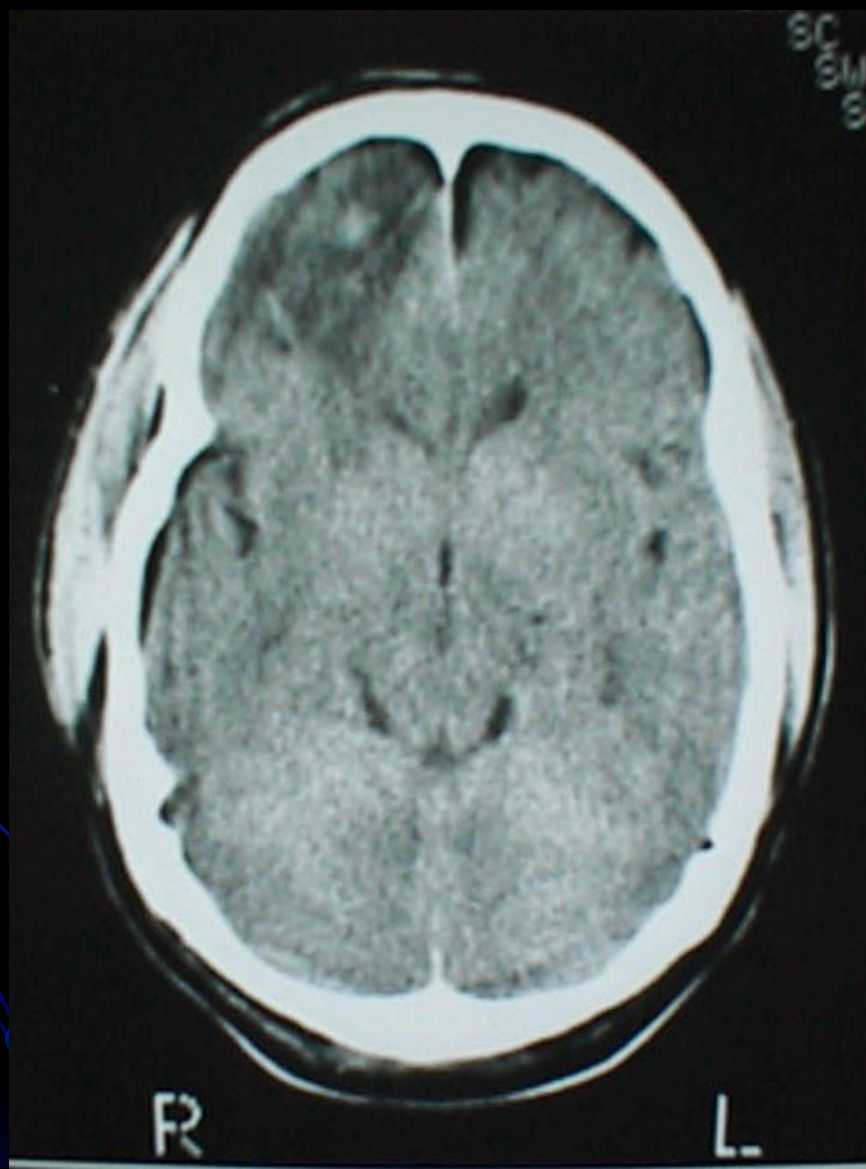


Traumatism cranio-cerebral prin împușcare – hemoragie frontală bilaterală, contuzie parietală și hemoragie subarahnoidiană



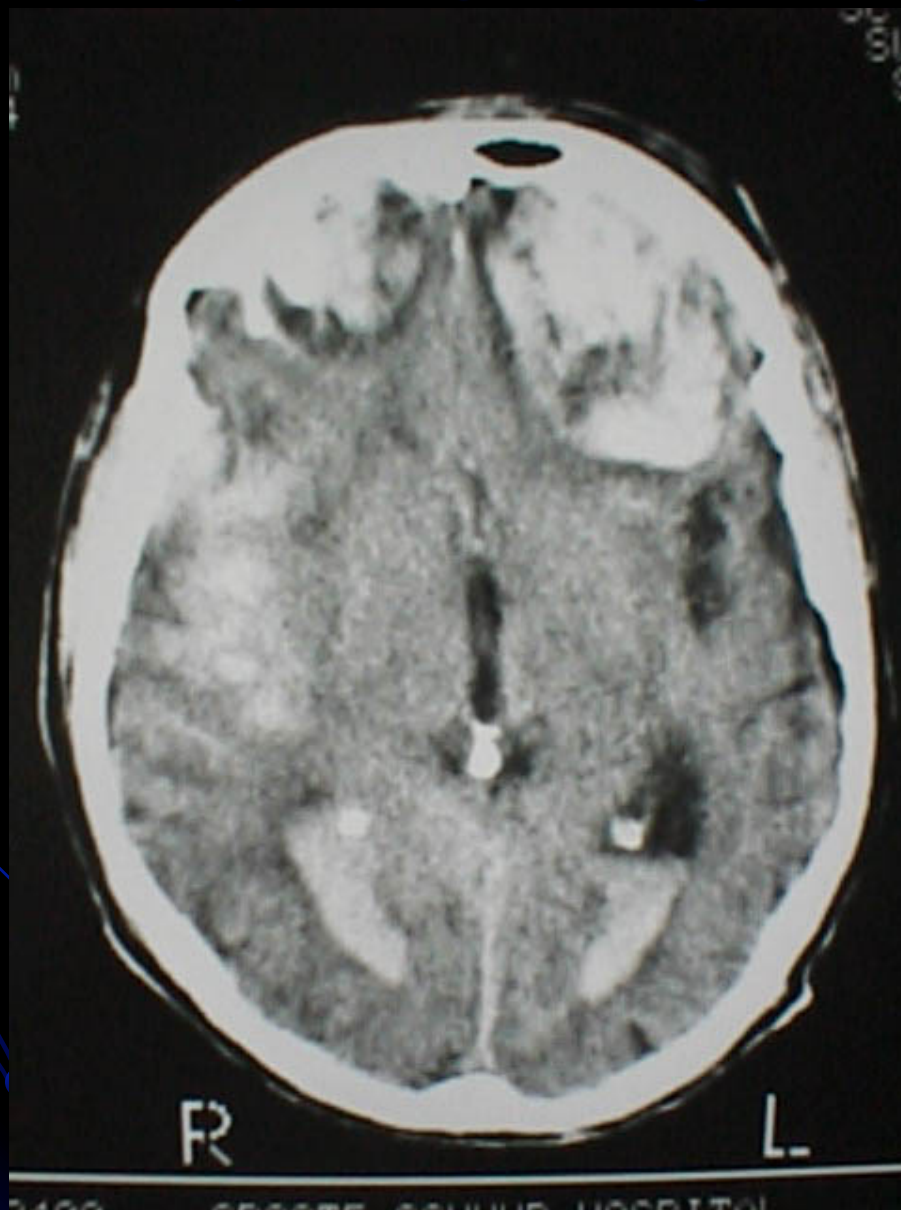


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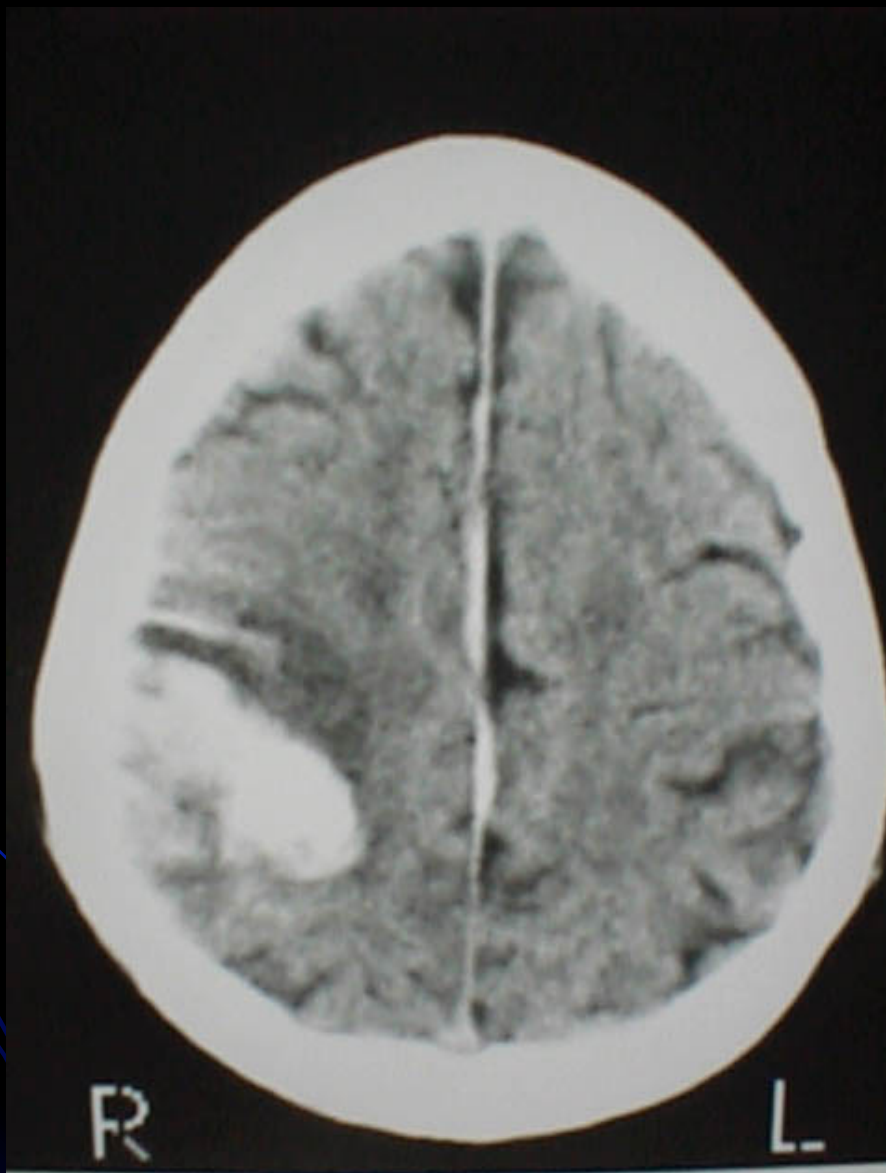




Traumatism cranio-cerebral prin împușcare – hemoragie frontală bilaterală, contuzie parietală și hemoragie subarahnoidiană



Traumatism cranio-cerebral prin împușcare – hemoragie frontală bilaterală, contuzie parietală și hemoragie subarahnoidiană



Plagă împușcată cu alicie – jumătatea stângă a feței -  
leziuni ale globului ocular stâng



Plagă împușcată cu alică – jumătatea stângă a feței -  
leziuni ale globului ocular stâng



# Traumatism cranio-cerebral prin împușcare cu alică

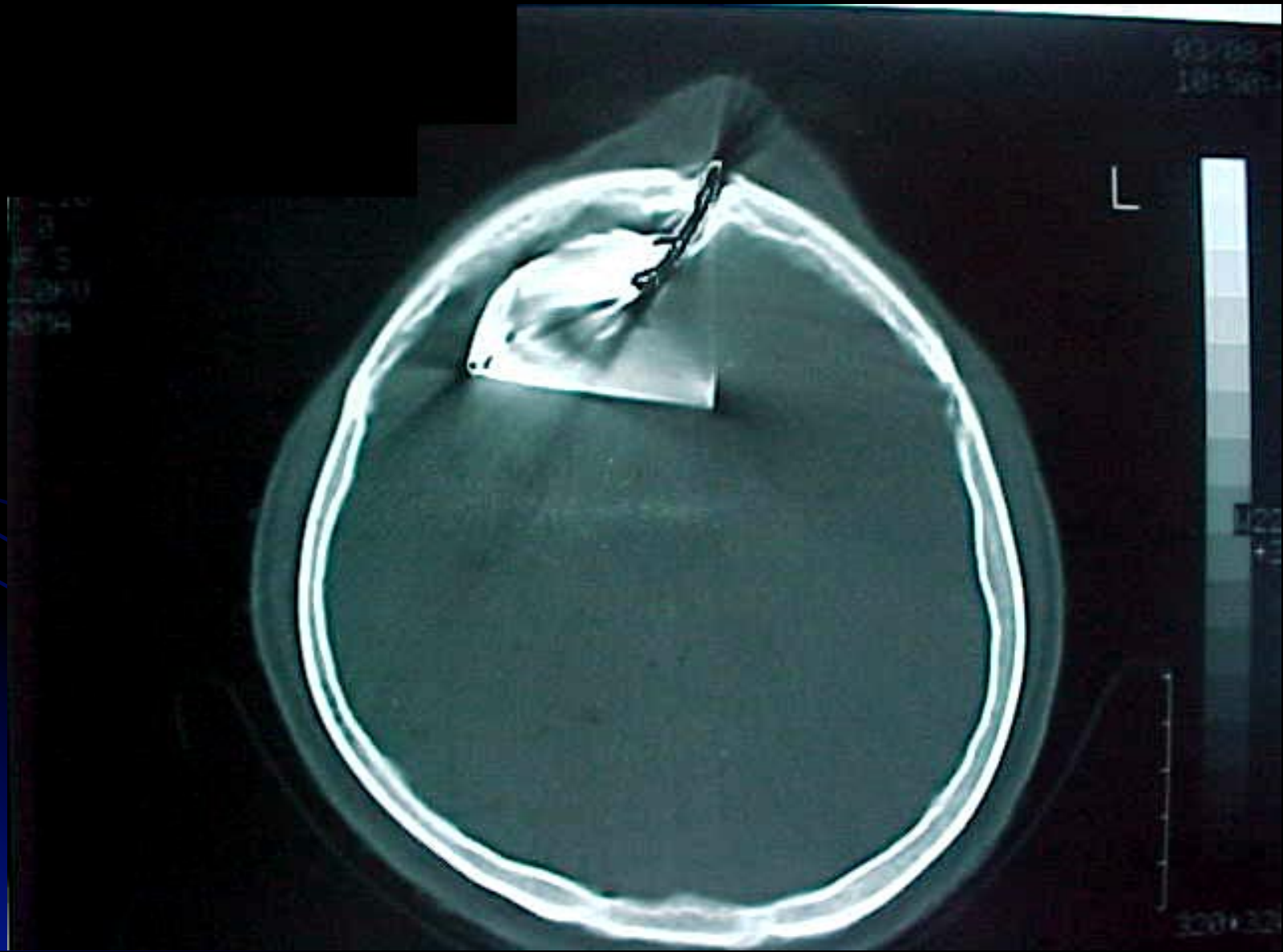




## Traumatism cranio-cerebral – șrapnel frontal



## Traumatism cranio-cerebral – șrapnel frontal



# Head Trauma

## Patient Management Decision Scheme

- Severe head injury:
  - Resuscitate, get CT, consult neurosurgeon, prepare for emergent neurosurgery
- Moderate head injury (GCS 9 to 12):
  - Resuscitate, get CT, admit to hospital for observation
- Minor head injury
  - Decide if CT needed, observe at least 2 hours, consider overnight admission, next day follow up
- Open or depressed skull fracture – resuscitate, get skull films, decide if CT needed, consult neurosurgeon, prepare for surgery

# Head Trauma

## Interhospital Transfer Considerations

- If patient has severe head injury and hospital does not have neurosurgical capability, then patient should be transferred to care of a neurosurgeon at another hospital
- Discuss transfer with this neurosurgeon and obtain his agreement to receive the patient
- CT or other studies should not delay transfer if patient already meets clinical criteria for transfer
- Decide with the referral surgeon if mannitol, furosemide, anti-seizure meds will be given prior to transfer
- Send all medical records, lab results, CT scan films, X-ray films with patient
- Make sure personnel accompanying patient to other hospital are capable of managing complications enroute



# Head Trauma Summary

- First: manage ABCs, Primary Survey
- Treat shock (if present) aggressively with IV fluids
- Assess level of consciousness
- Complete secondary survey
- Assign Glasgow Coma Score
- Decide if skull films or CT needed
- Classify type and severity of injury
- Decide if neurosurgery consult or transfer to trauma center, or admission for observation needed
- Arrange early followup for discharged patients