PBL

SHEET NO.

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Neurosurgery

Introduction

From ancient times through the present day, numerous civilizations have performed multiple procedures to open the skull including trepanation, craniotomy, and craniectomy.

Additionally , the tools that were used back then to perform these procedures are similar to the tools that we use nowadays.

General concepts

The head can be divided into the following layers :

1. Scalp.
2. Skull.
3. Meninges.
4. Brain.

The SCALP consists of five layers :

S : Skin
C : Connective tissue
A : Aponeurosis (Galea aponeurotica)
L : Loose areolar tissue
P : Pericranium (Periosteum)

- ✓ The periosteum on the outer surface of the cranial bones becomes continuous with the periosteum on the inner surface of the skull bones at the sutures.
- ✓ Loose areolar tissue : the subaponeurotic space is the potential space beneath the epicranial aponeurosis and is filled with loose areolar tissue.

Trepanation , Craniotomy , Craniectomy

Trepanation :

- **Drilling a hole** into the skull to expose dura and brain and treat related problems like **drainage of a subdural hematoma** .
- **Same as *Burr hole***.
- Burr hole means a hole done using a drill.
- Burr hole surgery is the main treatment for **subdural hematomas** that develop a few days or weeks after a minor head injury (chronic subdural hematomas) in which the blood is fluid in consistency (non-coagulated).
- The procedure occurs by making a hole in the skull and then draining the blood that is described to be similar to motor oil (this operation is similar to renewing motor oil that occurs in car garages).

Craniotomy :

- Removing a bone flap from the skull in order to perform surgery on dura or brain **and fixing it back**.

Craniectomy :

- Removing a bone flap away from the skull and **not putting it back** again in order to decompress the brain (relieve pressure on the underlying brain) .
- Craniectomy is the preferred procedure in cases of severe cerebral (brain) swelling due to severe traumas that cause high intracranial pressure. A large window is opened in order to relieve the pressure on the brain and the skin is directly put back on the brain. When the pressure is relieved, the bone fragment can be put back into place during a future surgery.
- Note : the bony fragment should be preserved by placing it in a specialized refrigerator (if the surgeon is intending to put it back).

Cranioplasty :

- Putting back something else other than the bone flap.
- Examples : titanium mesh or bone cement.
- This approach is used when a severe trauma causes a comminuted fracture (when the bone is shattered or fractured into three or more pieces) or when the bony fragment is bacterially contaminated.

Consequences of brain injury

Brain injuries can result in several consequences including :

- Swelling in the area of trauma accompanied by redness.
- Loss of consciousness.
- Headache.
- Vomiting.
- CSF leaking.
- Convulsions (seizures).
- Most importantly , **concussion.**

Concussion : temporary loss of consciousness caused by a blow on the head without any radiological evidence.

Convulsion : happens due to cortical irritation caused by a space occupying lesion including tumors or hematomas due to ruptured cerebral vessels.

Hematomas

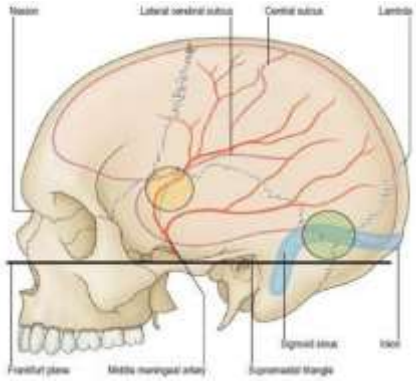
Upon brain injuries , blood can accumulate in different locations including :

- **Subgaleal (subaponeurotic) hematoma** : accumulation of blood between the epicranial aponeurosis of the scalp and the periosteum.
- **Extradural (epidural) hematoma** : accumulation of blood between the skull and the dura matter.
- **Subdural hematoma** : accumulation of blood between the dura matter and the arachnoid matter.
- **Subarachnoid hematoma** : accumulation of blood between the arachnoid matter and the pia matter.
- **Intraparenchymal bleeding** : bleeding within the brain parenchyma.

Notes :

- Each type of hematoma presents with different clinical features and has a different treatment approach.
- Brain injuries accompanied by skull fractures (penetrating trauma) carry a better prognosis than closed (blunt) head injuries.

Extradural (epidural) hematoma



➢ Pathophysiology

- Well-localized bleeding above the dura.
- **Always acute.**
- Arterial in origin (arterial bleeding caused by tearing of an artery) → rapid accumulation of blood under high arterial pressure.
- Usually occurs due to trauma over the pterion which is an area where the skull bones meet (frontal , parietal , temporal and sphenoid bones).
- The pterion is weakest part of the skull and trauma at this site can be fatal.
- The anterior branch of the **middle meningeal artery** is the most common source of epidural bleeding.
- The middle meningeal artery is a branch of the maxillary artery (branch of the external carotid artery).

➢ Appearance on CT scan

- **Biconvex lens shape**.
- The periosteal layer of the dura mater is continuous with the sutural ligaments at suture sites → little area available for expansion of the bleed → hematoma takes the shape of a biconvex lens .

➢ Treatment

- **Craniotomy** and evacuation of blood clot as it cannot be sucked out through a burr hole.
- Recent (fresh) acute bleeding acquires the nature of jelly (clotted) , so it can't be drained using a Burr hole.
- Rapid intervention is required to prevent serious complication including brain herniation.

Subdural hematoma

➢ Pathophysiology

- Poorly-localized bleeding under the dura matter (venous blood is located between the dura and arachnoid).
- Mostly venous in origin (venous bleeding due to rupture of the **bridging veins** which connect the brain to the dura) → slow buildup of blood under low venous pressure → blood accumulates slowly (days to weeks after trauma)
- Either acute or chronic.
- A subdural hemorrhage is caused by a violent shaking of the head (e.g. child abuse or car accident) and commonly occurs in alcoholics and elderly.
- The blood vessels involved are the superior cerebral veins ("bridging veins").
- **A CT scan shows a thin, crescent shaped density that hugs the contours of the brain.**
- No blood in the CSF after lumbar puncture.

Acute subdural hematoma

- ✓ Acute subdural hematomas are less than 72 hours old
- ✓ Sometimes , the bleeding is very severe especially in elderly patients who take anti-coagulants , causing rapid expansion and significant pressure on the brain and requiring rapid intervention → *Acute subdural bleeding*.
- ✓ The color of the bleeding on the CT scan is white like the color of the bone (**hyperdense**) and the hematoma is **lunar in shape**.
- ✓ In acute venous subdural bleeding , the blood acquires the nature of jelly (clotted) and **craniotomy is the treatment of choice (similar to epidural hematoma).**

Typical acute SDH on CT scan:
Lunar shaped
Bleeding is Hyperdense:
(white like bone)
Venous bleeding

Note :

- There is a distinct type of subdural hematoma called **Subacute subdural hematoma** (in the period of 3-21 days from the head injury) in which the density of the hematoma is similar to the density of the brain , hence , the hematoma is extremely hard to be identified on the CT scan.
- In this case , an **MRI** is extremely helpful.

Chronic subdural hematoma

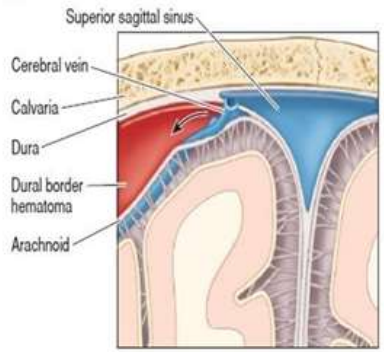
Typical chronic SDH on CT scan:
Lunar shaped
Bleeding is hypodense like CSF
Venous bleeding

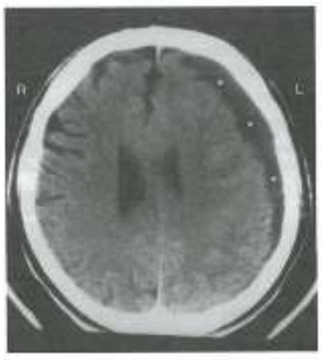
- ✓ Chronic subdural hematomas develop over weeks.
- ✓ When one of the bridging veins ruptures and starts to bleed slowly, the blood starts to dissolve with time (jelly nature of the blood is lost) → *Chronic subdural bleeding*.
- ✓ Chronic subdural hematoma appears on the CT scan with **hypodense** color like the CSF and takes a **lunar shape**.
- ✓ Since the blood in chronic venous bleeding loses its jelly nature (the blood is fluid in consistency) , **it can be drained using trepanation or Burr hole**.

Notes :

- With rapid intervention , epidural hematomas carry a better prognosis than subdural hematomas.
- Subdural hematomas tend to recur and are usually caused by minor traumas.

	Epidural (acute)	Acute subdural	Chronic subdural
Location	Between the skull and dura matter	Between dura and arachnoid matter	Between dura and arachnoid matter
Cause	Arterial	Venous	Venous
Rupture	Middle meningeal artery	Bridging vein	Bridging vein
Shape	Biconvex lens	Lunar	Lunar
Color		Hyperdense	Hypodense
Treatment	Craniotomy	Craniotomy	Trepanation





B. Subdural Hematoma*

Lucid interval

- Lucid interval is a temporary improvement in a patient's condition after a traumatic brain injury, after which the condition deteriorates.
- It occurs after the patient is knocked out by the initial concussive force of the trauma, then lapses into unconsciousness again after recovery when bleeding causes the hematoma to expand past the point at which the body can no longer compensate.
- A lucid interval is especially indicative of an epidural hematoma.
- An estimated 20 to 50% of patients with epidural hematoma experience such a lucid interval.
- It can last minutes or hours.
- To stop the hemorrhage, the torn artery or vein must be ligated or plugged. The burr hole through the skull wall should be placed about 1 to 1.5 in. (2.5 to 4 cm) above the midpoint of the zygomatic arch.

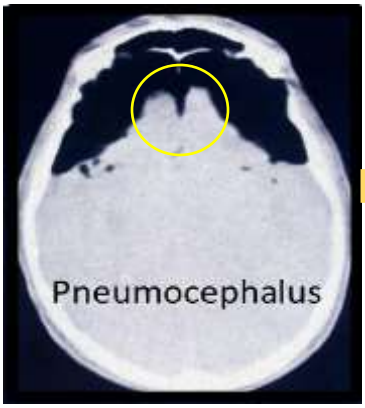
Base of skull fractures

- Base of skull fracture is really important because sometimes we miss it (we don’t see it on a CT scan) , and we won’t notice it until symptoms start to appear.
- Why it is important to identify base of skull fractures?

- Because of possible serious complications like CSF rhinorrhea or otorrhea and then meningitis.
- **Explanation** : base of skull fractures are dangerous because they might cause abrasions in the meninges (dural tearing) and therefore leakage of the cerebrospinal fluid (CSF) through the nose or the ear , this means that there is communication between the brain , meninges , and the external environment which might cause meningitis.

- What signs of base of skull fracture do we know?

- **Racoon eyes** : periorbital discoloration or hematoma that is symmetrical in shape, it indicates base of skull fracture even if we cannot see it on a CT scan
- **Battle sign** : hematoma behind the ear (bruising over the mastoid process).
- **Pneumocephalus** : subdural air in CT scan.



- CT scan of a patient with tension **pneumocephalus** typically showing air that compresses the frontal lobes of the brain.
- This results in a tented appearance of the brain in the skull known as the **Mount Fuji sign**

- Base of skull fracture can be indicated by :

➔ Fluid (CSF) or blood leaking from the patient's ear (otorrhea).
➔ Fluid (CSF) leaking from the patient's nose (rhinorrhea)

These two complications can stop on their own , but in case they don't, this requires a surgical intervention.

Regarding rhinorrhea , in case we can't see fluid running from the nose , we ask the patient if he feels a salty taste in his throat.

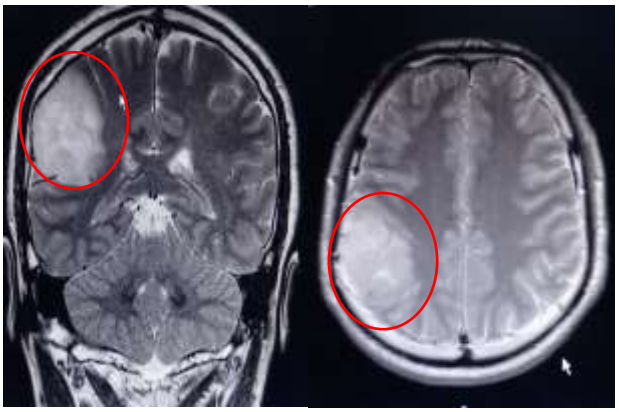
Brain Contusion

- Intra-parenchymal localized bleeding.
- If it exceeds 3 cm then it is an intracerebral hematoma.
- Most contusions occur in the **frontal , temporal and occipital poles.**
- When an object impacts the head, brain injury may occur from collision of the brain with the skull at the site of impact—a *coup injury*—or opposite the site of impact on the other side of the brain—a *contrecoup injury.*

- In certain cases the patient must be admitted to the hospital and monitored because the bleeding can expand in the first 48 hours.
- Diffuse expansion of the bleeding might require performing a surgery (craniectomy) to relieve the pressure on the brain , and even removing a part of the brain.

Special cases

1) **Case (1)** : this is a brain MRI



- We can see a lesion in Right parietal Lobe
- Homogenous but doesn't have well defined borders
- Typical of **low-grade primary brain tumor**
- Best management : Stereotactic biopsy or navigation guided biopsy

➔ If low grade : observe

➔ If high grade : radiation

2) **Case (2)** : How do you describe this brain lesion?

- Shape : Well circumscribed, rounded
- Contents : Cystic (CSF intensity fluid)
- Location : Rt occipital
- No enhancement with contrast (i.e. no vascularization).
- This is a typical **Brain Hydatid cyst**.

Test yourself

Q1) Removing a bone flap from the skull to operate on the brain is called :

a. Craniotomy
b. Cortectomy
c. Decompression
d. Skullectomy

Q2) All of the following are characteristic signs of base of skull fractures except :

a. Racoon eyes
b. Concussion
c. Rhinorrhea
d. Otorrhea
e. Ecchymosis behind the auricle

Q3) Which of the following Is true regarding subdural and epidural hematomas?

a. Epidural hematomas are poorly localized
b. Epidural hematomas are usually crescent shaped
c. Subdural hematomas are mostly venous
d. Epidural hematomas are located between dura and arachnoid matter

Q4) All of the following are true about epidural hemorrhage except :

a. It increases intracranial pressure
b. It Involves arterial bleeding
c. It mostly involves venous bleeding
d. Is well localized , its expansion stops at the skull sutures

Q5) All of the following are true except :

a. Acute subdural hematoma appears hypodense on CT scan
b. Epidural hemorrhage involves arterial bleeding
c. Subdural hemorrhage involves venous bleeding
d. Treatment of epidural hematoma is by craniotomy

Q1	Q2	Q3	Q4	Q5
A	B	C	C	A