

Meningitis

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Red: Doctors' and important notes.

Green: Team notes.

CNS Infections:

Portals of entry of infection into the CNS:

1. Hematogenous spread (**most common**). The most common source is **infective endocarditis**.
2. Direct implantation (traumatic or in congenital CNS malformation)
3. Local extension (occurs secondary to an established infection in a nearby organ (air sinus mostly, an infected tooth or middle ear))
4. Through the peripheral *nervous system into the CNS* (certain viruses, such as rabies and herpes zoster)

Herpes zoster is not the same disease as herpes simplex

Examples on CNS infections:

1. Meningitis:

It is an inflammatory process of the leptomeninges and CSF within the **subarachnoid space**.

Leptomeninges: The two innermost layers of tissues that cover the brain and spinal cord. The two layers are called the arachnoid mater and pia mater

→ Meningoencephalitis?

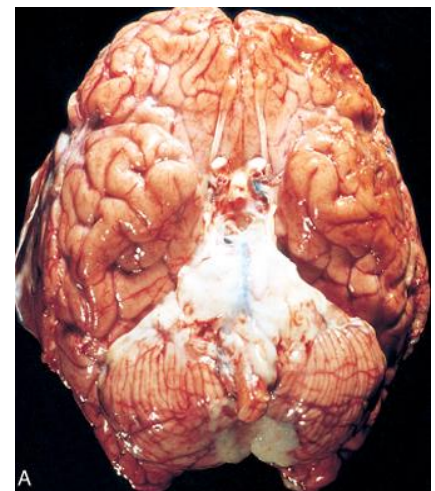
It is an inflammation of the brain and spinal cord and their meninges

- Pyogenic meningitis = bacterial:

It is a medical emergency

The causative microorganisms are:

- **Neonates** : *Escherichia coli* and group B streptococci
- **Infants:** *Streptococcus pneumoniae*



Slide shows pyogenic meningitis, where pus is covering the brain stem and cerebellum.

- **Adolescents and young adults:** ,*Neisseria meningitidis* (Meningococcal meningitis) and *Haemophilus influenzae* (becoming less due to immunization)
- **Elderly:** *listeria monocytogenes* and *Streptococcus pneumoniae*

CSF Findings in spinal tap (lumber puncture):

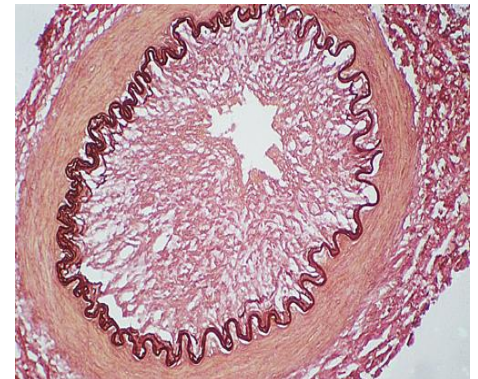
- **cloudy** or frankly **purulent** CSF
- as many as 90,000 **neutrophils** /mm
- **raised** protein level
- **markedly reduced** glucose content
- bacteria may be seen on a Gram stained smear or can be cultured, sometimes a few hours before the neutrophils appear

Clinical Features:

- Systemic **non-specific signs** of infection
- Meningeal irritation signs and neurologic impairment:
 - Headache, **photophobia**, irritability (especially in kids, this can show as them not wanting to eat, talk, or sleep), clouding of consciousness and **neck stiffness**.
- Untreated, pyogenic meningitis can be fatal
- Effective antimicrobial agents markedly reduce mortality associated with meningitis

Complications:

- Phlebitis (Inflammation of the walls of a vein) may → cause venous occlusion → hemorrhagic infarction of the underlying brain.
- Leptomeningeal fibrosis → hydrocephalus
- Septicemia → hemorrhagic infarction of the adrenal glands and cutaneous petechiae (known as **Waterhouse-Friderichsen syndrome**, particularly common with meningococcal and pneumococcal meningitis)
- Focal cerebritis (**encephalitis**) & seizures
- Cerebral abscess
- Cognitive deficit
- Deafness



Thrombus occluding an artery

- Aseptic Meningitis (Viral Meningitis):

Aseptic meningitis is a misnomer (A wrong or inaccurate use of a name or term)

Clinically:

- it is a term for an illness comprising meningeal irritation, fever, and alterations of consciousness of relatively **acute onset** without recognizable organisms
- The clinical course is less fulminant (**severe and sudden**) than in pyogenic meningitis, is usually self-limiting, and most often is treated symptomatically

Pathogens: in approximately 70% of cases, a pathogen can eventually be identified, and most commonly is an **enterovirus**.

The CSF analysis shows:

Pleiocytosis: an abnormal increase in the number of cells (as lymphocytes) in the cerebrospinal fluid

- **Cells:** an increased number of **lymphocytes** (pleiocytosis),
- **Protein:** the elevation is only moderate
- **Glucose:** is nearly always normal.

Macroscopically: there are no distinctive characteristics except for brain swelling, seen in only some instances

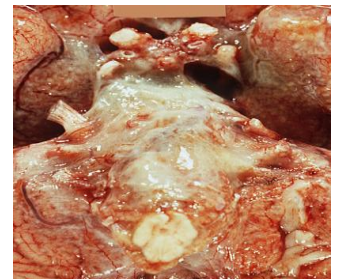
Microscopically:

There is either no recognizable abnormality or a mild to moderate infiltration of the leptomeninges with lymphocytes

2. Tuberculosis:

Always remember that TB is a chronic infection

Location: the subarachnoid space contains a fibrinous exudate, most often at the **base** of the brain

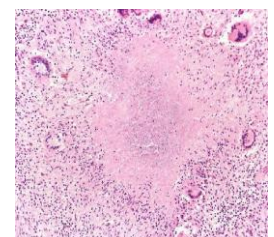


Tuberculoma is well-circumscribed intraparenchymal mass:

- Rupture of tuberculoma into subarachnoid space results in tuberculous meningitis
- A tuberculoma may be up to several centimeters in diameter, causing significant mass effect
- Always occurs after hematogenous dissemination of organism from primary pulmonary infection

Microscopically:

There is usually a central core of caseous necrosis surrounded by a typical tuberculous granulomatous reaction. (**Necrotizing granuloma**- area of inflammation in which tissue has died-)



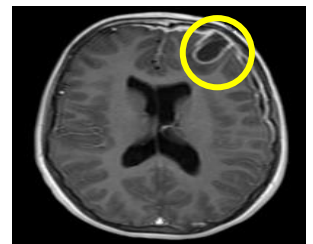
CSF in TB:

- There is only a moderate increase in cellularity of the CSF (pleiocytosis) made up of mononuclear cells (**lymphocytes**), or a mixture of polymorphonuclear (**neutrophils in acute cases**) and mononuclear cells
- **The protein:** level is elevated, often markedly
- **The glucose:** typically is moderately reduced or normal

3. Epidural and Subdural Infections:

The epidural and subdural spaces: can be involved with bacterial or fungal infections, usually as a consequence of direct local spread.

- Epidural abscess, commonly associated with **osteomyelitis** (Inflammation of bone or bone marrow), arises from an adjacent focus of infection, such as sinusitis or a surgical procedure.



N.B: Epidural abscess are not considered CNS infections. Patients with epidural abscess are predisposed to meningitis and other diseases but still don't have an infection in the CNS.

- When the process occurs in the spinal epidural space, it may cause spinal cord compression and constitute a neurosurgical emergency
- Infections of the skull or **air sinuses** may also spread to the subdural space, producing **subdural empyema**.
The underlying arachnoid and subarachnoid spaces are usually unaffected, but a large subdural empyema may produce a mass effect.
- In addition, thrombophlebitis may develop in the bridging veins that cross the subdural space, resulting in venous occlusion and infarction of the brain

Subdural empyema (i.e.: Abscess) is an intracranial focal collection of purulent material located between the dura mater and the arachnoid mater

Symptoms include: those referable to the source of the infection. Most patients are febrile (fever), with headache and neck stiffness, and if untreated may develop focal neurologic signs, lethargy, and coma.

Treatment: surgical drainage → resolution (termination) of the empyema occurs from the dural side; if resolution is complete, a thickened dura may be the only residual finding. With prompt treatment, complete recovery is usual

4. Brain abscess:

Most common organisms: Streptococci and staphylococci in non-immunosuppressed populations.

Predisposing conditions:

- Acute bacterial (infective) endocarditis (usually give multiple microabscesses)
- Cyanotic congenital heart disease in which there is a right-to-left shunt (paradoxical) e.g: atrial septic defect
- Loss of pulmonary filtration of organisms (e.g, bronchiectasis)

Location: most common on cerebral hemispheres

Morphologically:

- Liquefactive necrosis
- The surrounding brain is edematous , congested & contains reactive astrocytes (gliosis) & perivascular inflammatory cells
- **Clinical presentation:** progressive focal neurologic deficits in addition to the general signs of raised intracranial pressure such as: behavior changes, decreased consciousness, headache, lethargy, weakness, numbness, eye movement problems, and double vision, Seizures, Vomiting

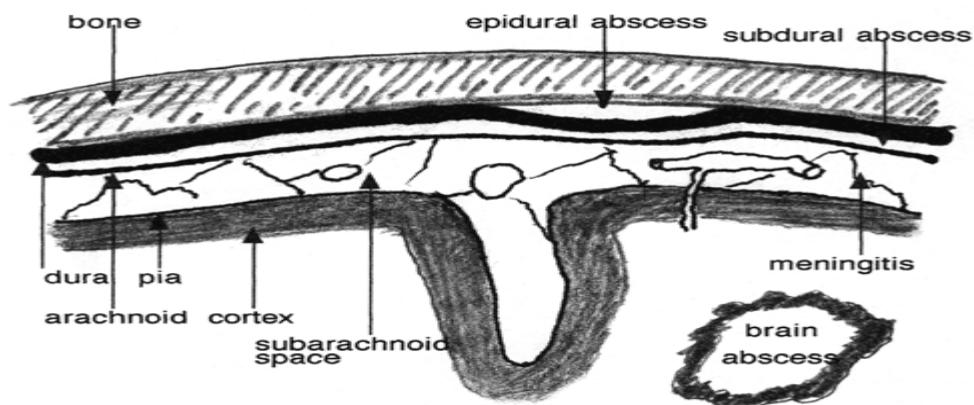
Liquefactive necrosis happens when inflammatory cells and the enzymes of leukocytes digest ("liquefy") the tissue. It happens in some focal and bacterial infections, but for unknown reasons, also happens in hypoxic death of the cells of the CNS.

The CSF findings:

- Contain only scanty (little) cells.
- Protein: ↑ (due to immune system reaction, where most of these are immunoglobins)
- Glucose: Normal level.

Complications of Brain abscess:

- Increase in intracranial pressure leading to herniation
- Rupture of abscess into subarachnoid space or ventricle



Subdural empyema (enhancing) and brain abscess in a patient with sinusitis.

Homework:

Create a table of CSF findings in Meningitis, aseptic meningitis, TB meningitis, Brain abscess and multiple sclerosis!

	Pyogenic meningitis	Aseptic meningitis	TB	Brain abscess	Multiple sclerosis
cells	neutrophils	Lymphocytes	Lymphocytes with some neutrophils	Scanty cells	pleocytosis
protein	Markedly elevated	Normal or slight elevation	Markedly elevated	elevated	Elevated especially γ -globulin (oligoclonal band)
glucose	Markedly reduced	normal	Normal or slightly reduced	normal	