Intracranial infections

- Congenital
- Encephalitis
- Meningitis, empyema
- Cerebritis, abscess, ependymitis
- Granulomatous infection
- Fungal and parasitic infections
- HIV intracranial manifestations
Enhancement [ The injected contrast material goes inside the lesion ] →

- ↑ density in CT
- ↑ signal in MRI

- Meningeal enhancement = meningitis
- Marginal enhancement = abscess
Congenital and neonatal Infections

The classic TORCH infections include:

- Toxoplasmosis
- Rubella
- Cytomegalovirus (CMV)
- Herpes simplex virus (HSV) type 2

Transmission through three major routes

- Hematogenous transplacental (toxoplasmosis, most viruses except HSV type 2)
- Ascending cervical infection (most bacteria)
- During delivery through birth canal (HSV type 2)
The pattern of calcification is not entirely specific.

- CMV calcifications are usually central periventricular
- Toxoplasmosis calcifications are more widespread with slight predilection for basal ganglia
congenital brain infection
TOXOPLASMA
PROTOZON

- CAT
  - CONGENITAL
  - DURING PREGNANCY
  - IMMUNITY
- CATTLE
  - BY FOOD
- HUMAN
  - CHEST
- AQUIRED
Toxoplasmosis

- Toxoplasma gondii 1-5% mortality
- Acute infection during pregnancy → fetus
  - first trimester 17% abortion
  - 2nd trimester 25% fetal death
  - 3rd trimester 65% sub clinical infection
- CNS manifestations: hydrocephalus, microcephaly and calcifications
- Treatment by antibiotics
Toxoplasmosis
Congenital toxoplasmosis
CYTOMEGALOVIRUS
One of the Herpes viruses

- Infects every person at sometime of his life
- Infected pregnant woman [acute or activated] → fetus
- Infection occurs by blood
- Infection during or after birth rarely affects the CNS
  - During 1st trimester: Neuronal migration disorders
  - During 2nd trimester: Hydrancephaly, microcephaly, porencephaly, and calcifications
- Clinically: convulsions, mental retardation, hearing and visual affection
F 2Y

Cytomegalovirus
Cytomegalovirus
Intracranial calcifications not seen on MRI
Encephalitis

Immune suppression ➔ brain infection by viruses

AIDS
CANCER
ORGAN TRANSPLANT

VIRUSES

Meningitis
Acute encephalitis
Acute demyelinating encephalomyelitis
Subacute and chronic encephalitis
Encephalopathy
Encephalitis

Acute non focal [ diffuse] inflammatory disease of brain

- Usually caused by **viruses**

- **CT and MRI**  
  - Multiple hypodense areas [CT]
  - Low signal in T1 and high signal in T2 [MRI]
  - Contrast injection  
    gyral pattern of enhancement
Viruses can cause various CNS manifestations (often overlap)

A. Meningitis
B. Encephalitis
C. Leukoencephalitis (predominantly involving white matter)
   - Subacute sclerosing panencephalitis (SSPE)
   - Progressive multifocal leukencephalitis (PML)
D. Vasculitis and infarcts
HIV encephalitis
Encephalitis versus infarction
Encephalitis

Some viruses may have a more specific imaging appearance

Herpes Simplex 1:750,000

Type I Childhood or Adult encephalitis

Type II Neonatal encephalitis

- Herpes simplex virus – type1 is the cause of 95% all HE

[The most common fatal encephalitis in the childhood and adults]

- Brain biopsy is not usually needed since imaging is diagnostic

- Mortality rate 50% - 70%
HERPES SIMPLEX

TYPE I, 95%

- NON SEXUALLY TRASMITTED
  - Hematogenous spread
- Childhood or adult encephalitis

TYPE II, 5%

- SEXUALLY TRASMITTED
  - Through birth canal
- 30% CNS INFECTION
- 80% DIE
- 20% SEVERE DAMAGE
Most congenital HSV is transmitted at birth from contact with infected genital secretions. Usually of type II. CNS infection in neonatal cases is suspected via viral diffusion through the blood brain barrier, leading to diffuse brain damage, death or severe neurological sequelae such as seizures, microcephaly, ventriculomegaly, multicystic encephalomalacia.
Herpes encephalitis

Herpes Simplex $1:750,000$

- **CT** Hypodense lesion with mild mass effect in the temporal lobe. Gyral enhancement after contrast injection

- **MRI** More sensitive, temporal lobe lesions, petechial hemorrhage

- **Late sequelae**
  Encephalomalacia, brain atrophy, calcification
Herpes encephalitis [signal abnormality  temporal lobes]
Herpes encephalitis
Herpes encephalitis
Post-encephalitic Sequels

No contrast  Contrast
Acute Demyelinating EncephaloMyelitis [ADEM]

- Demyelinating lesions throughout the white matter
- Posterior fossa involvement is common in children
- Multiple lesions with no mass effect
- 25% will have permanent defect with 10% mortality
- DD Multiple sclerosis [MS]
  - Antecedent viral illness or vaccination
  - Monophasic disease
- Clinically early [headache, drowsiness, fever]
  - later [neurological deficits, seizures, death]
M 7.5 Y

ACUTE DEMELINATING ENCEPHALOMYELITIS
ACUTE DEMELINATING ENCEPHALOMYELITIS

M 10 Y
Meningitis

Meningitis is the most common from CNS infection

- Pyogenic meningitis
- Viral meningitis
- Granulomatous meningitis (TB)
Meningitis

Complications of meningitis include:

- Hydrocephalus
- Sinus thrombosis
- Subdural / epidural empyema
- Parenchymal infection, infarction
- Ventriculitis / ependymitis

Sterile Subdural effusions are common in infantile meningitis
Para sagittal subdural empyema

meningitis with epidural abscess
Para sagittal subdural empyema
Ependymitis, 2 cases
SSS thrombosis secondary to meningitis
Meningitis due to mastoiditis

Subdural hygroma
Meningitis with subdural effusion
Extension along the perivascular spaces
Cerebritis

Is the earliest stage of purulent infection
Extends intra-cranially by blood, directly from sinuses, trauma

Early cerebritis (3 to 5 days): ill-defined nonenhancing focus.

Late cerebritis (4 to 14 days): patchy enhancement and edema
Cerebritis, abscess

- **Early capsule** [about 2 weeks] thin enhancing rim
- **Late capsule** [weeks or months] thick enhancing rim
Cerebritis, abscess

Resolution of imaging findings lags behind clinical improvement

Complications of pyogenic abscess include:

- Formation of satellite or “daughter” abscesses
- Ventriculitis, ependymitis
- Purulent leptomeningitis
Contrast enhanced CT

MRI axial T2

Typical brain abscess

Contrast enhanced MRI
Ventriculitis

- **Ventriculitis/ependymitis** is more likely to occur from **surgical procedures** than from ruptured brain abscess or meningitis
- Uncommon, but serious
- Choroid plexitis [enlargement and enhancement]
Ventriculitis
Ventriculitis
Granulomatous Diseases

There is an increasing prevalence of TB in developed countries due to HIV, IV drug abuse, immune compromised states, homelessness, crowded conditions in confined populations (e.g. prisons and nursing homes), and immigration from endemic areas.

CNS TB can cause

- Meningitis
- Encephalitis
- Tuberculoma or abscess
Tuberculous meningitis with hydrocephalus
Multiple tuberculomata
Multiple tuberculomata, 2 cases

Subdural empyema
Multiple tuberculomata
TB abscesses + subdural collection
Tuberculous meningitis with hydrocephalus
And multiple parenchymal tuberculomas
CT scan without and with contrast  
MRI axial T1 and T2 WIs
Fungal and parasitic infections of the CNS are generally uncommon and often require impairment of host immune system.

CNS manifestation of fungal infection:
- Meningitis
- Encephalitis
- Granuloma or abscess

Fungal CNS infections include:
- Aspergillosis
- Candidiasis
- Cryptococcosis
- Mucormycosis
Contrast enhanced MRI

Meningitis
Cysticercosis

- The most common CNS parasitic infection
- *Taenia solium*
- Ingestion of contaminated water or food → parasite in the body. Embryo lodges in the brain tissue or meninges
cyst around the scolex [vesicular stage]
- intense inflammatory reaction → formation of capsule [colloidal stage]
- Larva dies → calcification
Cysticercosis

- Two types
  - Cysticercus cellulosae [cyst with scolex inside]
  - Cysticercus racemose [grape like cysts, no scolex]
- Intraventricular Cysticercosis 7-20%
  - 4th ventricle is the most common
  - Single or multiple
  - Free or subependymal

Cysticercus cellulosae and Cysticercus racemose are two types of cysticercosis. Intraventricular Cysticercosis affects the 4th ventricle, which is the most common site. It can be single or multiple, and it can be free or subependymal.
MRI axial T1

MRI axial FLAIR

Cysticercosis
Cysticercosis  scolex
Cysticercosis
Subarachnoid Cysticercosis
Cysticercosis, calcified stage  periventricular calcifications
Neuro cysticercosis [ 3 imaging features ]

- Peri ventricular calcification
- Cysts with scolex inside
- Subarachniod cysts
Hydatid cyst
2% of intracranial SOLs

**CT**
- Unilocular cyst
- CSF density
- No edema, no enhancement
- ± calcification

**MRI**
- Low signal T1 and high signal T2
Hydatid cyst
CNS Manifestations of HIV Infection

INFECTIONS

HIV
Toxoplasmosis
Cryptococcus
Cytomegalovirus
Papovavirus

[Progressive multifocal leukoencephalopathy PML]

neoplasms
1ry and 2ry Lymphoma

Meningitis
Lymphoma
CNS Manifestations of HIV Infection

- Non pyogenic abscesses are more likely to occur in immune compromised patients and include toxoplasma, mycobacterium, fungi, nocardia, actinomycosis.
HIV encephalitis
Toxoplasma encephalitis in a patient with AIDS
Toxoplasma abscess
Cytomegalovirus
Multiple tuberculomata (AIDS patient)
White matter abnormalities in a 29-year-old AIDS patients
PML

- Reactivated Papovirus acquired during childhood
- Destroys oligodendrocytes → failure to maintain myelination
- 4% of AIDS patients develop PML
- Weakness, aphasia, ataxia, hemiparesis
- No dementia [present in HIV encephalitis]
- Poor prognosis death within 3-18 months
- White matter lesions located superficially then deep
- No edema, no mass effect, no enhancement
PML (AIDS patient)
Brain atrophic changes developed in 9 months in a 20 years old AIDS patient.
Characteristic Imaging Findings

- Diffuse meningeal enhancement → Meningitis
- Marginal enhancement → Abscess (intracerebral or extra axial)
- Periventricular calcifications → Toxoplasmosis, CMV, Cysticercosis
- Intraaxial cyst with no enhancement → Hydatid
- Bilateral temporal non enhancing lesion → Herpes encephalitis
- Enhancement of the ventricular walls → Ependymitis
- Multiple non enhancing extra-axial cysts → Cysticercosis
Non contrast CT head scan

A] Hydatid cyst
B] Cystic astrocytoma
C] Arachnoid cyst
D] Cystic hygroma

Mention the site of lesion?!
Considering diffuse astrocytommas:

- The most common of all astrocytommas [x]
- Usually present in elderly patients [x]
- Usually seen in the posterior fossa [x]
- MRI is more sensitive than CT in detection of tumor size [T]
- Show heterogeneous post contrast enhancement [x]
Pre- and postcontrast T1 weighted MR images

A] Intracerebral hematoma
B] Infiltrating glioma
C] Viral encephalitis
D] Glioblastoma multiforme

Mention the site of lesion?!
THANK YOU

سبحانك اللهم و بحمدك نشهد ان لا اله الا انت نستغفرك و نتوبر اليك