Imaging in a confused patient: Infections and Inflammation

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Inflammation as a cause of confusion

**Infectious**
- meningitis
- encephalitis
- vasculitis
- abscess

**Non-infectious**
- meningitis
- encephalitis
- vasculitis
- tumor
- demyelination
- trauma
- toxic
- metabolic
Confusion

**History:** Symptoms, pace, review of systems, coincident non-neurologic disease, medication changes, drug exposures

**Physical exam:** Level of consciousness, localizing signs

**Secondary phenomena:** hydrocephalus, mass effect, herniation
“Confusion plus” syndromes

1. Viral encephalitis: + fever, seizures
2. Limbic encephalitis: + seizures, behavior change
3. Wernicke: + ataxia, oculomotor paresis
4. ADEM: + fever, preceding illness
5. CJD: + progressive, seizures, myoclonus
6. NPH: + ataxia, incontinence
7. PML: + immunosuppression
8. PRES: + hypertension, exposure to chemo
9. Non-convulsive status epilepticus: + seizures
10. Serotonin syndrome, NMS: + med exposures
11. Acute hepatic encephalopathy: + elevated ammonia
12. Pontine (and extrapontine) myelinolysis: + hypo-Na
Confusion

What is the relationship of confusion to consciousness and arousal?

Danaila L and Pascu ML, 2013
Confusion

Conscious: state of awareness of self and environment, and responsiveness to external stimulation and inner need.

Levels of consciousness or arousal: awake, drowsy, stuporous, obtunded, comatose

Unconscious: state of unawareness of self and environment, coupled with diminished responsiveness to environmental stimuli.
Neuroanatomy, alteration of arousal
A 53 year-old woman who fell down stairs
A 53 year-old woman who fell down stairs
Coma, trauma to ARAS
Coma, injury to ARAS thalamic projections

Basilar thrombosis

CNS lymphoma
Coma, ischemia to ARAS cortical projections
Meningeal inflammation
Meningitis, compartments

(pachymeninges)
Skull | Dura | Outer arachnoid ~ CSF ~ inner arachnoid | Pia | Brain

epidural    subdural    subarachnoid    intraparenchymal    intraventricular

(leptomeninges)

scalp
skull
cortex
pia

superior sagittal sinus
arachnoid granulations
subarachnoid space
subdural "space"

vein
dura
arachnoid
Pachymeningitis (dura)
Pachymeningitis (dural myeloid sarcoma)
Leptomeningitis (pia, carcinomatous)
Meningitis (carcinomatous)

Klein JP, Handb Clin Neurol 2016;136:923
Leptomeningitis in sarcoidosis
Leptomeningitis in tuberculosis

Axial graphic shows the early capsule formation of an abscess with central liquified necrosis and inflammatory debris. Collagen and reticulin form the well-defined abscess wall. Note the surrounding edema.

Klein JP, in Youmans and Winn Neurological Surgery, 2016
Leptomeningitis and vasculitis

Lymphocytic meningitis due to HSV-2

Ischemic infarctions and hemorrhages

Leptomeningeal enhancement

J Neurovirology 2014;20:419
Meningitis (dura & pia) in infection
Cerebral inflammation
Encephalitis, limbic (VGKC with thymoma)
Encephalitis, EEE virus
HIV encephalitis
HSV-1 encephalitis

Adams and Victor’s “Principles of Neurology”, 10th Ed, 2014
HSV-3 (VZV) encephalitis, vasculitis

NEJM 2000;342:635
HHV-5 (CMV) ventriculo-encephalitis

*opportunistic*, associated with ventriculo-encephalitis, also, meningitis, transverse myelitis, and radiculomyelitis
HHV-6 encephalitis

*opportunistic, medial temporal lobe tropism*
JC virus encephalitis

Am J Hematol 2016;91:1057
Creutzfeldt-Jakob disease, sporadic
Creutzfeldt-Jakob disease, sporadic
Hypoxemic encephalopathy
Hypoxemic-ischemic encephalopathy
Delayed post-hypoxic leukoencephalopathy

4 weeks post-inhalation

3 weeks later

10 months later
Heroin inhalation toxicity
Axial graphic shows early cerebritis, the initial phase of abscess formation, in the frontal lobe. There is a focal unencapsulated mass of petechial hemorrhage, inflammatory cells, and edema.
Cerebritis  ➔ Abscess

**Early cerebritis:** Patchy enhancement
masses of PMNs, hyperemia

**Late cerebritis:** Intense, irregular rim enhancement
coalescence of masses, necrosis

**Early capsule:** Well-defined, thin-wall, enhancing rim
collagenous capsule, liquefied core

**Late capsule:** Cavity collapses, capsule thickens
thick wall of collagen and fibroblasts

Ddx: glioblastoma, metastases, demyelination,
hematoma, subacute infarction.
Cerebral abscess

T1-post

DWI

ADC
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Tuberculoma

J Clin Neurosci 2013;20:1599
Neurocysticercosis
Tumefactive demyelination

Klein JP, in Youmans and Winn Neurological Surgery, 2016
ADEM
Summary

Confusion may result from inflammation of the brain and meninges.

Infectious and non-infectious inflammation can cause meningitis, encephalitis, vasculitis.
Summary

The history and physical exam are key.

Identify the clinical syndrome, then correlate to imaging.

Assess all compartments.

Anticipate secondary effects of primary disease process.