Abscess, Empyema

Last updated: April 17, 2019

INTRACEREBRAL ABSCESS

- encapsulated or free pus in brain substance.
  - accounts for 2% of intracranial mass lesions.
  - male/female ratio ≈ 2:1.
  - median age at presentation 30-45 years; 25% cases occur in children < 15 years!

ETIOPATHOPHYSIOLOGY

- rare disease in immunocompetent individuals.

PREDISPOSING CONDITIONS

1) immunosuppression: AIDS, organ (esp. bone marrow) transplant recipients, chronic corticosteroid therapy, neutropenia, lymphoma / leukemia.
   - HIV is associated with brain abscess caused by Toxoplasma gondii, Mycobacterium tuberculosis.
   - fungi are responsible for up to 90% of cerebral abscesses among recipients of solid-organ transplants.
2) **congenital heart disease** (with right-to-left shunt), **pulmonary A-V fistulas** - infected venous blood bypasses pulmonary filter (gains access to cerebral arterial system).
3) **IV drug abuse**.

SOURCES

1) **infectious focus** elsewhere:
   a) *direct osteomyelitic spread* or *retrograde septic thrombophlebitis* from **CONTIGUOUS CRANIAL SITE** (40-50%): *otitis media* (pediatric or older adult populations), *sinusitis* (young adults), mastoiditis, odontogenic infections, facial / scalp infections, meningitis (rare*).
      *brain abscess in child < 2 years suggests associated bacillary meningitis
   b) *hematogenous spread* from **REMOTE INFECTION SITE** (30%): *pulmonary infection* !!! (bronchiectasis, lung abscess), endocarditis, osteomyelitis, IV injection with unsterile syringe / drug.
2) **penetrating** cranial **trauma** (esp. gunshot and retained bone fragments).
3) **neurosurgical procedures** (6-7 per 10,000 clean neurosurgical procedures).

ETIOLOGIC AGENTS

(reflect *primary infective process* and *immune state of host*).
30-60% abscesses are mixed infections!

1) **streptococci** (esp. *Streptococcus intermedius* group – *S. anginosus*, *S. constellatus*, *S. milleri*) are identified in 50-70% brain abscesses.
2) **anaerobic bacteria** (predominantly *Bacteroides* species) are common in ***chronic otitis media*** or ***pulmonary disease***.
3) *Staphylococcus aureus* and Gr- rods are common after ***cranial penetration*** from surgery or trauma.
   N.B. pneumococci, meningococci, Haemophilus influenzae (major causes of bacterial meningitis) are rarely recovered from brain abscess!
4) fungi are common in ***immunosuppressed***:
   Aspergillus fumigatus – after organ transplantation, granulocytopenia.
   Candida – in chronic corticosteroid therapy, granulocytopenia, after bone marrow transplantation, IV drug abusers.
   Zygomycetes (mucormycosis) – granulocytopenia, IV drug abusers.
5) parasites are common in ***immunosuppressed***.

- intact brain parenchyma is relatively resistant to infection - in order for brain abscesses to form, there must be *pre-existing compromised area* (*ischemia, necrosis, hypoxia*) in brain tissue.

PATHOLOGIC STAGES

Abscess formation evolves through FOUR STAGES (regardless of infecting organism):

INFLAMMATION → NECROSIS → SUPPURATION → CAPSULE

1) ***EARLY CEREBRITIS*** (days 1 to 3) - perivascular infiltration of PMNs, plasma cells, and mononuclears; marked surrounding cerebral edema.
2) ***LATE CEREBRITIS*** (days 4 to 9) - well-formed necrotic center reaches its maximum size and is surrounded by inflammatory infiltrate of macrophages and fibroblasts; rapid new vessel formation around developing abscess; thin capsule (fibroblasts and reticular fibers) gradually develops; area is surrounded by cerebral edema.
3) ***EARLY CAPSULE FORMATION*** (days 10 to 13) - necrotic center decreases in size; inflammatory infiltrate contains increasing number of fibroblasts and macrophages; mature collagen evolves from reticulin precursors, forming capsule that is better developed on cortical than ventricular side of lesion.
4) ***LATE CAPSULE FORMATION*** (day 14 and later) - well-formed shrinking necrotic center surrounded by dense collagenous capsule.

- depending on *etiologic organism* and *immunologic status*, there may be delayed / incomplete encapsulation, or abscess may enlarge more quickly.
- encapsulation is more complete (more mesenchymal cells forming taugher capsule) on cortical side (than on ventricular side) - *propensity of abscesses to extend and rupture into ventricular system*.
- encapsulation is less extensive in hematogenous abscesses.

LOCATION

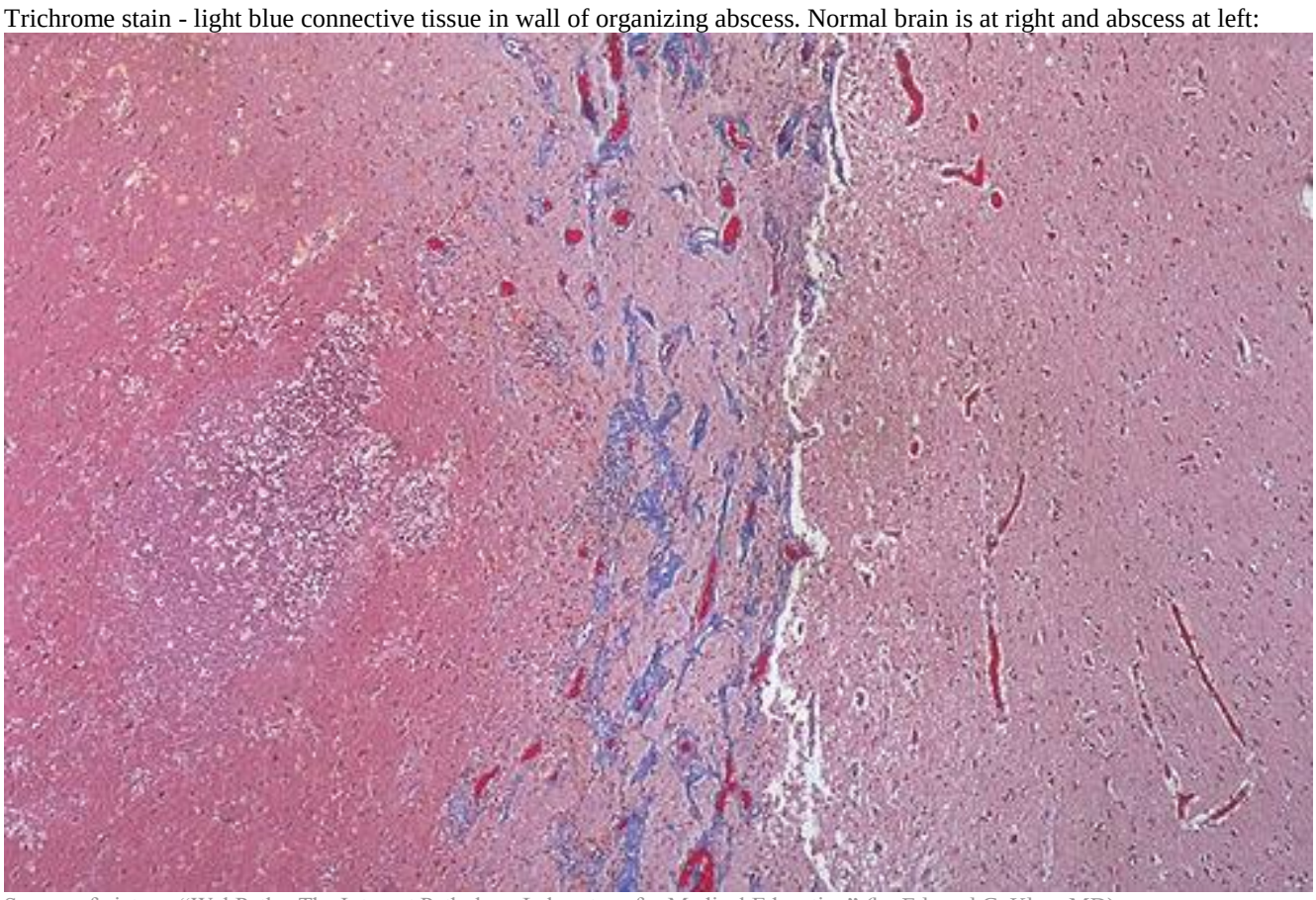
frontal = temporal = parietal > cerebellar > occipital > brainstem, intrasellar, basal ganglia, thalamus

Otogenic abscesses – temporal lobe (adults), cerebellum (children).
Sinogenic abscesses – frontal areas.
Hematogenous spread – following characteristics:

1) multiple* brain abscesses (although solitary lesions may also occur)
2) distribution of middle cerebral artery - parietal lobe predominates (highest blood flow).
3) initial location at *gray matter-white matter junction*.

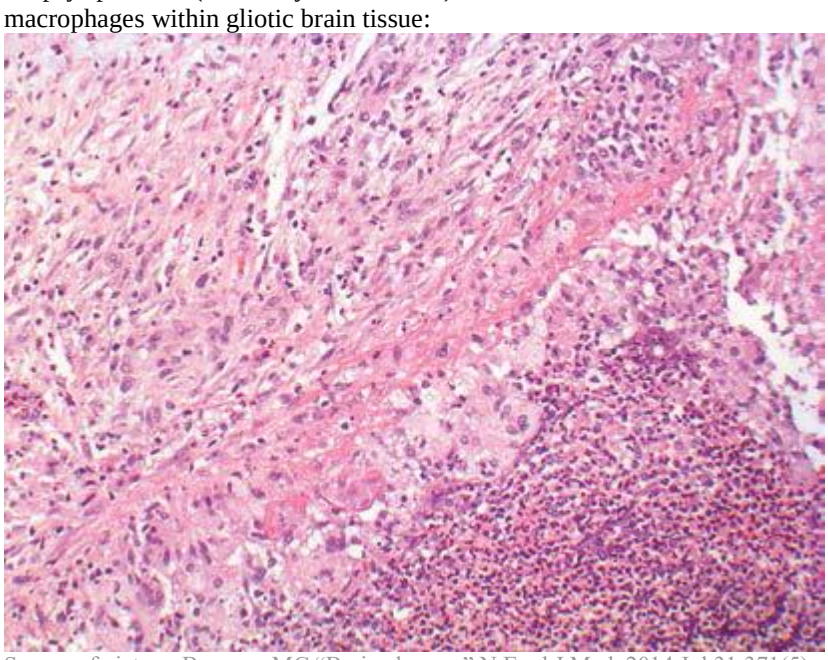
*another cause of multiple abscesses – **immunosuppression**.

Trichrome stain - light blue connective tissue in wall of organizing abscess. Normal brain is at right and abscess at left:



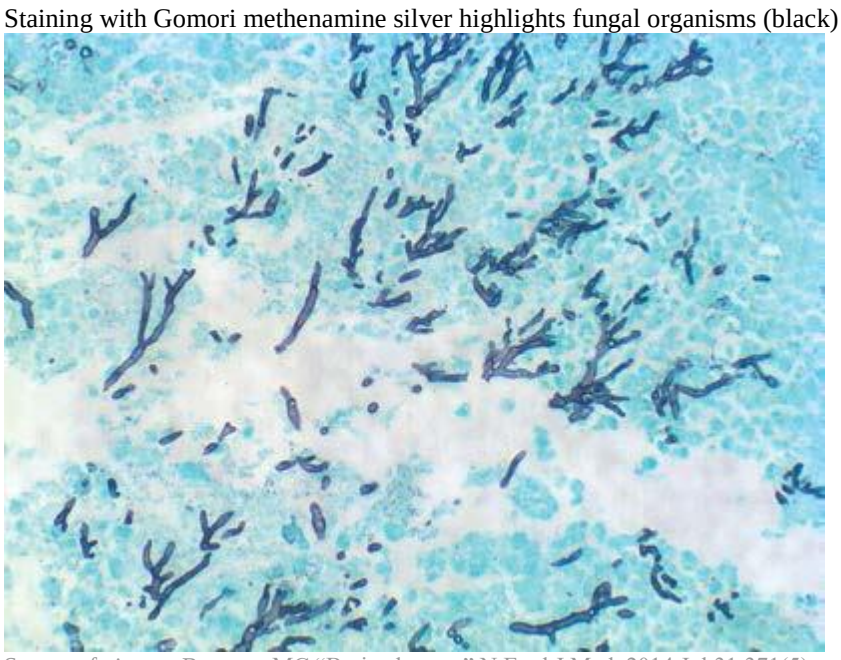
Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>

Biopsy specimen (hematoxylin and eosin) - abscess with collections of neutrophils (prominent in lower right corner) and macrophages within gliotic brain tissue:



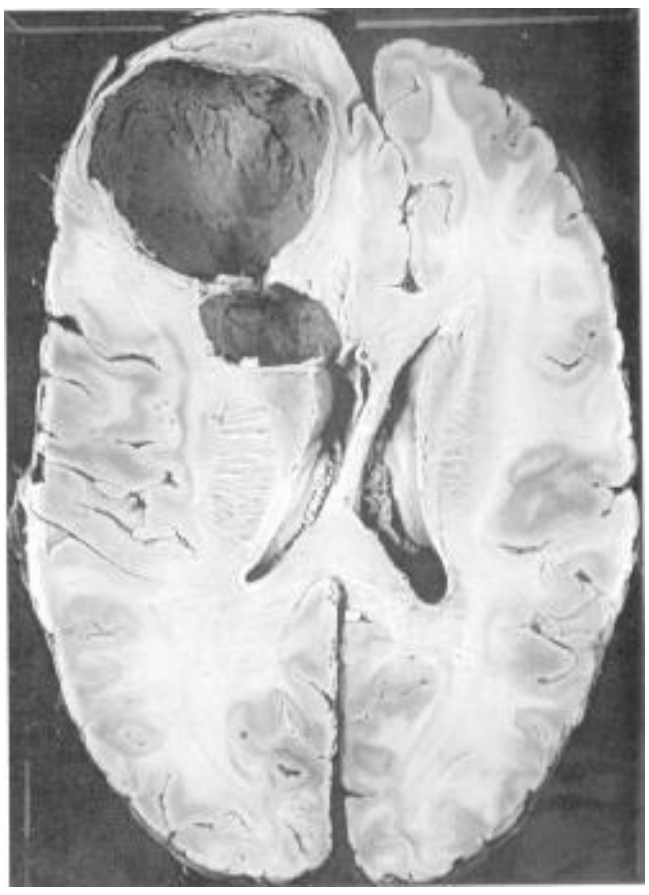
Source of picture: Brouwer MC "Brain abscess." N Engl J Med. 2014 Jul 31;371(5).

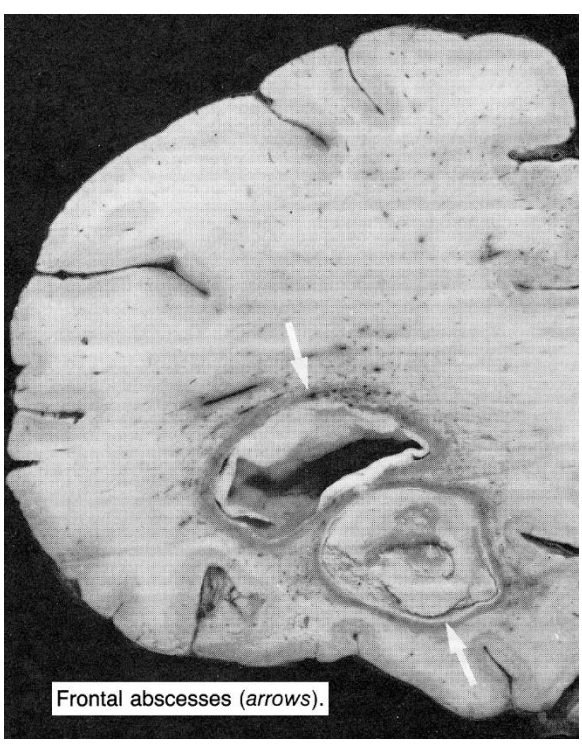
Staining with Gomori methenamine silver highlights fungal organisms (black):

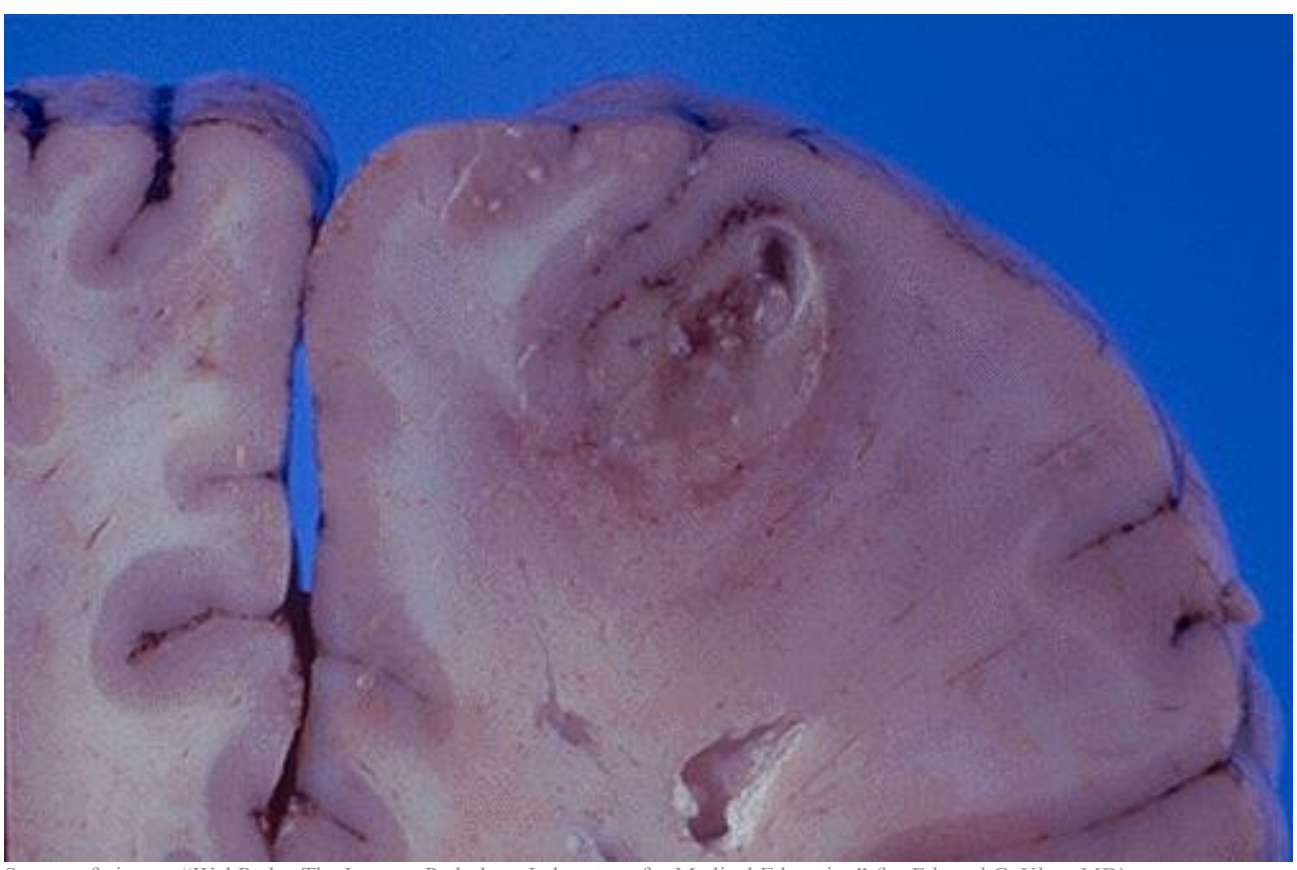


Source of picture: Brouwer MC "Brain abscess." N Engl J Med. 2014 Jul 31;371(5).

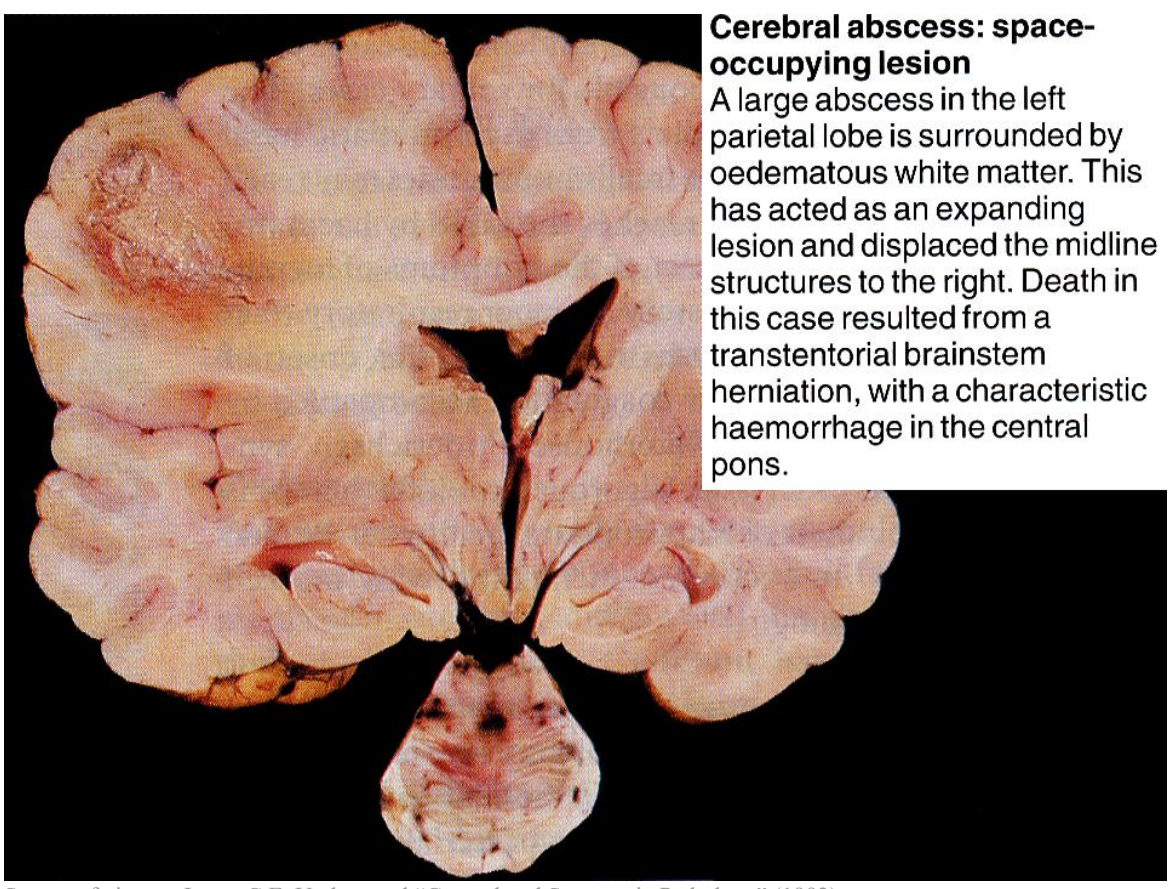
"Daughter" abscess, posterior to main abscess, had ruptured into lateral ventricle as terminal event in this case:







Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>



Source of picture: James C.E. Underwood "General and Systematic Pathology" (1992); Churchill Livingstone; ISBN-13: 978-0443037122 >>

CLINICAL FEATURES

- rapidly expanding infectious mass lesion (most patients have ***subacute course*** with symptoms progressing during ≥ 2 weeks; may be indistinguishable from meningitis or encephalitis):

1) ICP↑ - prominent hemicranial or generalized headache (most common symptom! - 70-90% patients), alterations in consciousness, vomiting, papilledema (rare finding in meningitis!).
2) focal neurological deficit (75% patients!) - seizures (focal or generalized) are particularly prominent!

3) infection – *fever* < 50% (i.e. may be minimal or absent!!!); nuchal rigidity is present in 25-50% patients.

Abrupt neurologic deterioration:

a) *abscess rupture* into ventricular system → **ventriculitis & hydrocephalus**, **shock & death**.
b) *abscess rupture* into subarachnoid space → **meningitis** (sudden rise of CSF pressure, cell count↑ up to 50,000/mm^3, decrease in sugar content).
c) *brain herniation*
d) *spontaneous hemorrhage*

DIAGNOSIS

Lumbar puncture is contraindicated - risk of herniation!

CSF - **aseptic meningeal reaction** (pressure↑, 0-1000 PMNs, protein slightly↑, normal sugar)

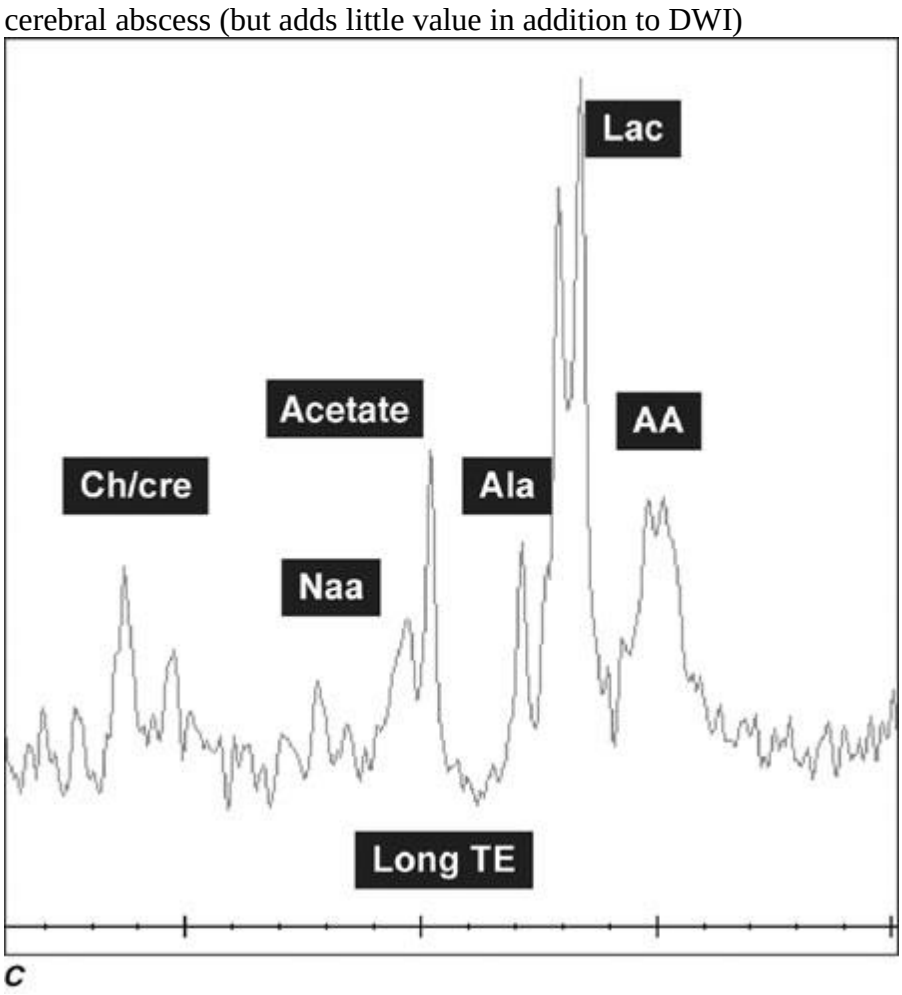
1. Contrast-enhanced **CT / MRI** - *low-density lesion* with sharply demarcated, dense, uniform* *ring of contrast enhancement* surrounded by hypodense region of *edema*.
*markedly irregular wall suggests tumor!

MRI is study of choice for initial detection and subsequent monitoring.
DWI has specificity 96% for differentiation from brain tumors.

Abscess, stroke, and lymphoma (high cellularity) have ***diffusion restriction*** (bright on DWI, dark on ADC), whereas gliomas and metastases do not restrict diffusion!
Same as epidermoid cyst (bright DWI) vs. arachnoid cyst (normal DWI)

Cerebritis stage (MRI is superior to CT): area of hypointensity (hyperintensity on T2) with indistinct margins and patchy contrast enhancement in periphery.

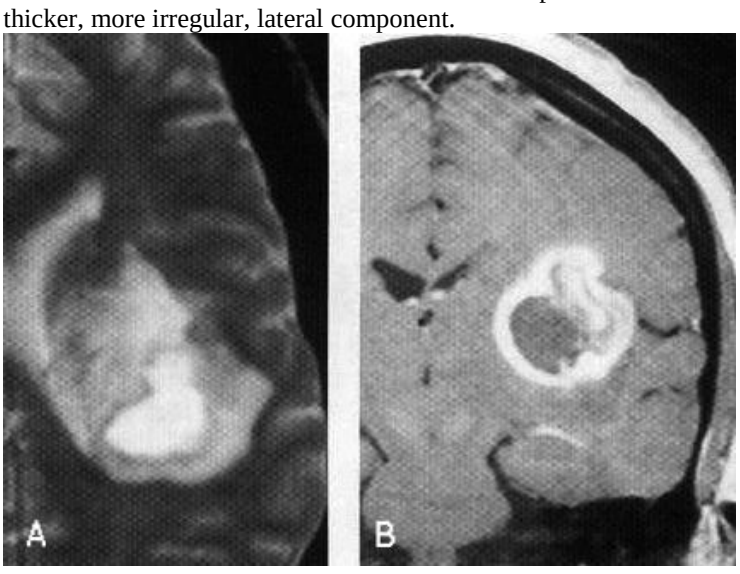
- *enhancing ring may appear at late cerebritis stage before true capsule has been formed*! H: DELAYED SCAN (obtained 30 min. after IV contrast) - *contrast diffusion into low-density center of abscess* (vs. stage of formed true capsule - no inward diffusion of contrast).
- **MRS** – ↑*acetate, lactate, amino acids, alanine* (and ↓NAA) - highly suggestive of cerebral abscess (but adds little value in addition to DWI)



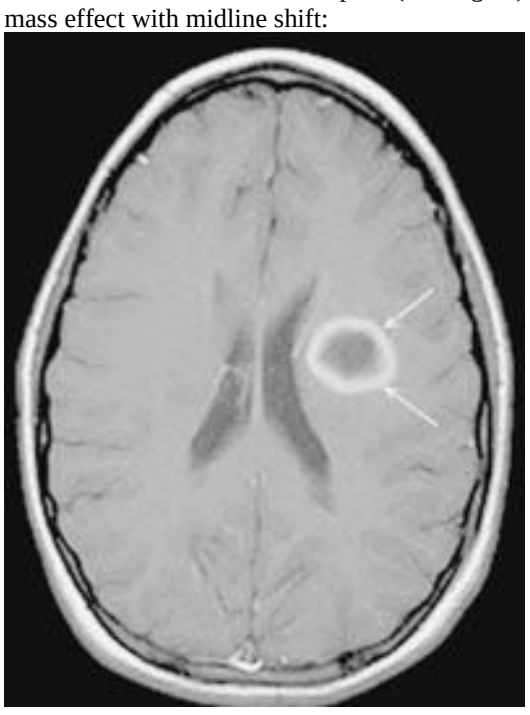
Encapsulated stage: *low T1 intensity* (*T2 hyperintense*) lesion with *diffusion restriction* surrounded by *edema*.

- *glucocorticoid use* may alter appearance - only 40-60% reveal ring enhancement.

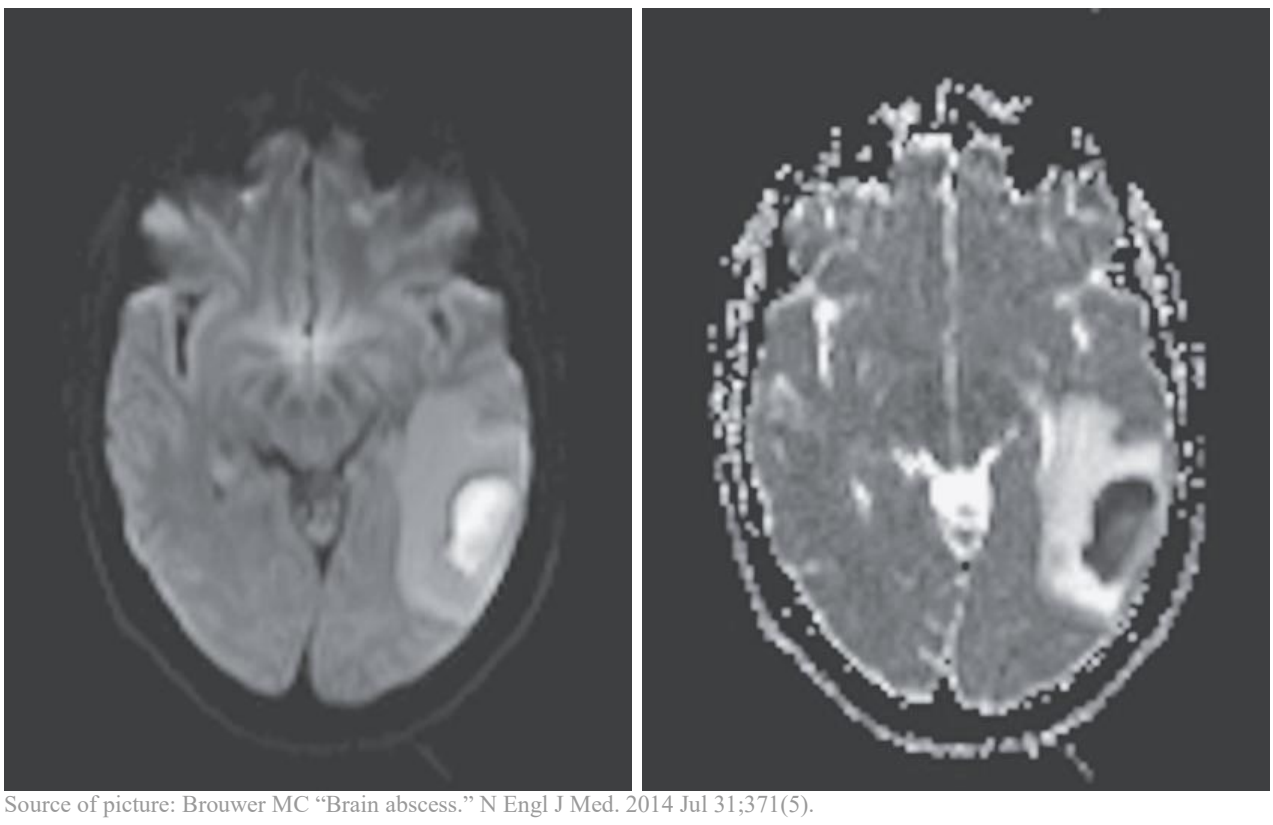
Fungal abscess in 48-year-old diabetic:
A) axial T2-MRI: central hyperintense abscess cavity with surrounding vasogenic edema.
B) coronal post-gadolinium T1-MRI: large multiloculated abscess cavity with enhancement of capsule and abscess wall. Note mild mass effect + relative thinness of medial wall compared with thicker, more irregular, lateral component.



T1-MRI with gadolinium: necrotic mass with peripheral enhancement and surrounding edema. Ependymal enhancement in lateral and third ventricles (ventricular rupture, ventricullitis), enhancement of subarachnoid space (meningitis), mass effect with midline shift:

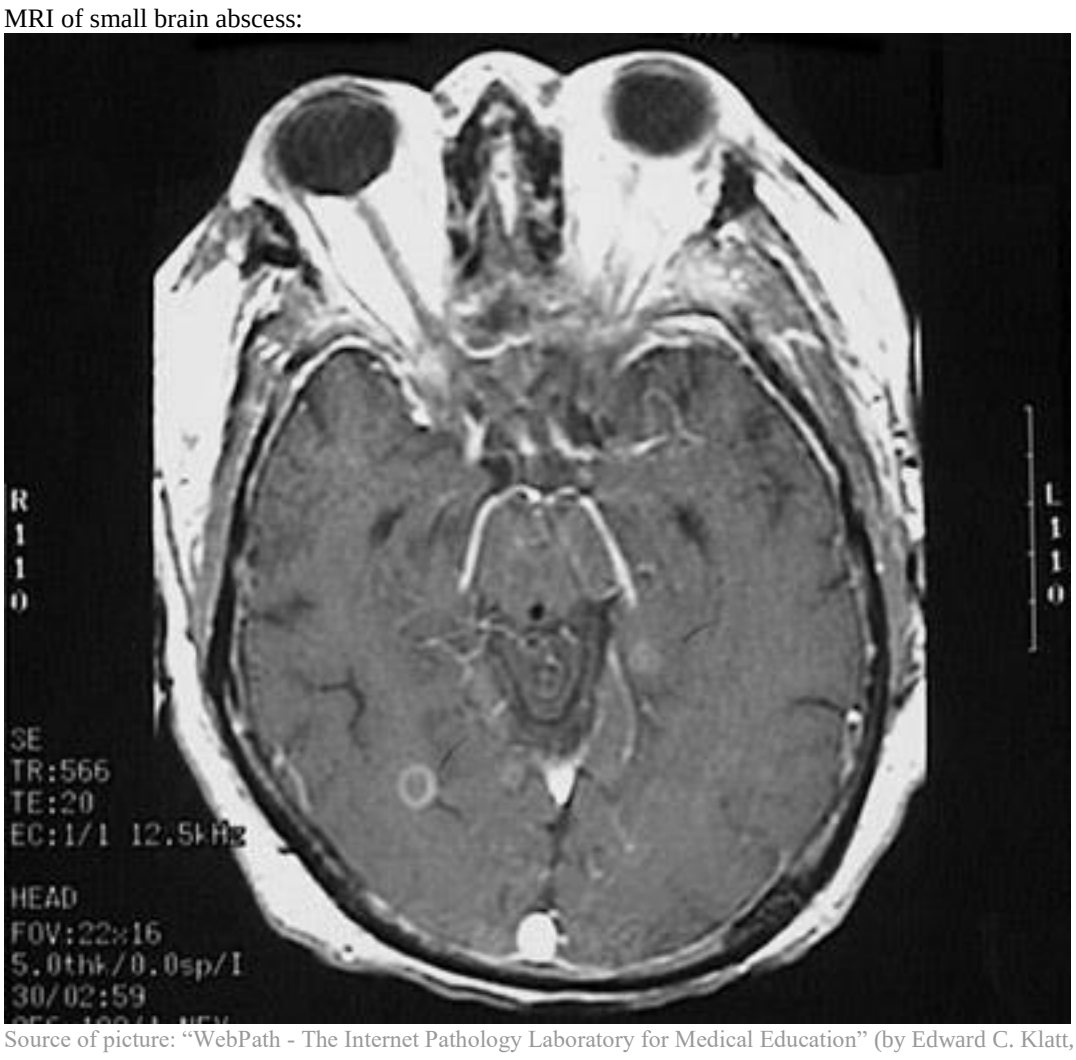


Diffusion restriction:



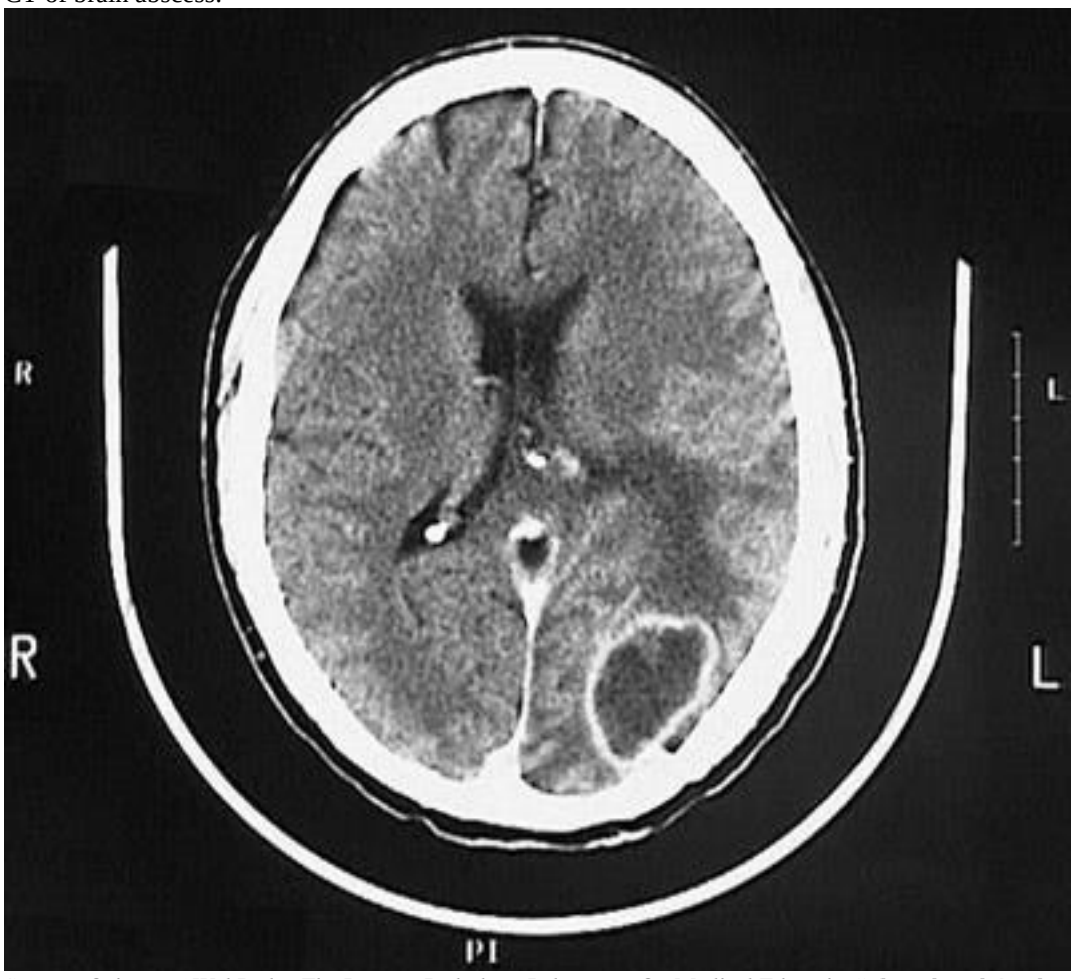
Source of picture: Brouwer MC "Brain abscess." N Engl J Med. 2014 Jul 31;371(5).

MRI of small brain abscess:



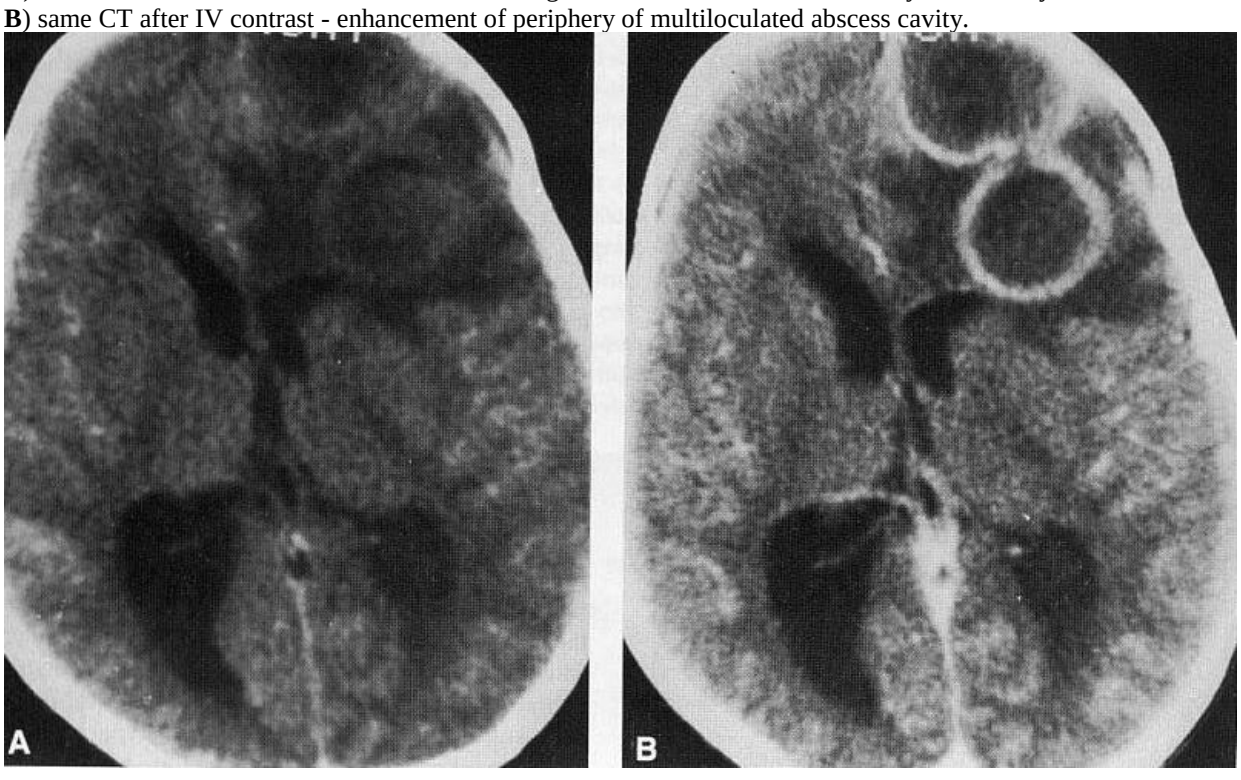
Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>

CT of brain abscess:

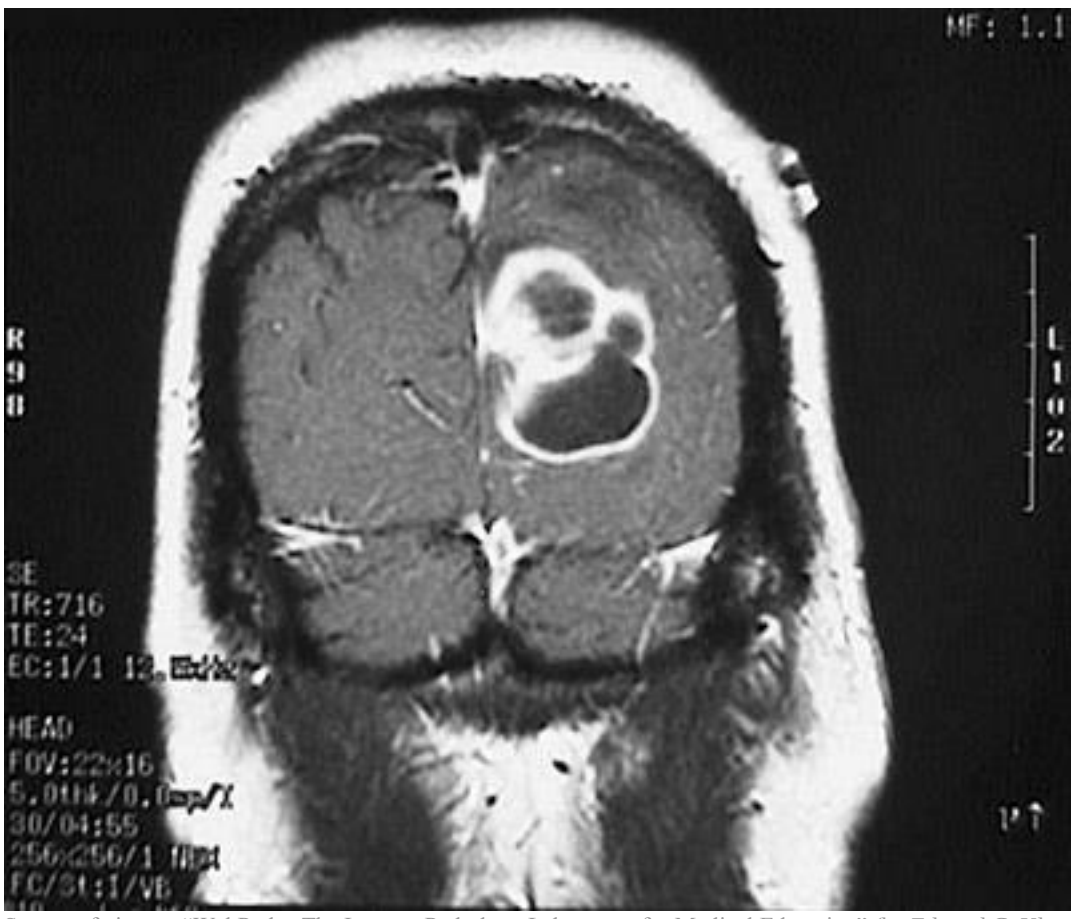


Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>

Abscess in right-to-left cardiac shunt:
A) CT - marked mass effect in left frontal lobe; ringlike isodense areas surrounded by low-density edema.
B) same CT after IV contrast - enhancement of periphery of multiloculated abscess cavity.

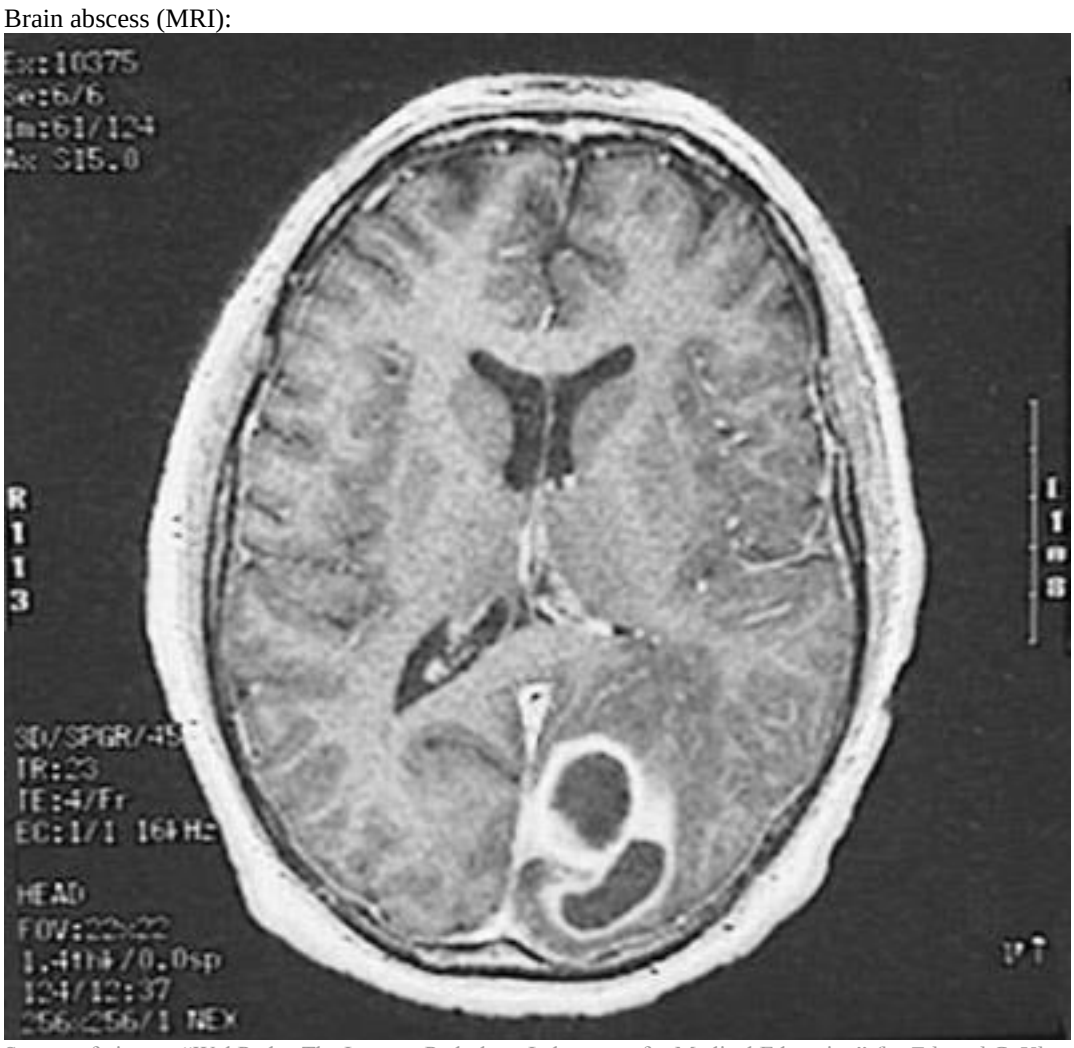


Brain abscess (MRI):



Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>

Brain abscess (MRI):



Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>

2. **EEG** - focal slowing.

3. Etiological organism identification:
   a) procedure of choice - **CT- / MRI-guided stereotactic abscess aspiration** (abscess is often sterile by time of operation).
   b) **blood cultures** (positive in ≈ 10% cases*).
   c) serum should be sent for ***antitoxoplasma IgG*** (in patients with AIDS).

   *when hematogenous dissemination from remote site of infection is likely etiology

- ***pulmonary infection*** is found in ≈ 10% cases (**chest X-ray** is mandatory for all patients!).

4. **Blood** – leukocytosis, ESR↑.
   N.B. in significant number (≈ 40%) of patients, laboratory criteria for infection are lacking!

Distinguishing brain *abscess* from brain *tumor*:
1) **C-reactive protein (CRP)↑**
2) **indium-111-labeled leukocyte scintigraphy** (detects areas of active inflammation); false-positive results - leukocytic infiltration into brain tumor (esp. with severe necrosis).

TREATMENT

1. Decreasing mass effect – **corticosteroids** (only for profound cerebral edema with impending herniation!; may decrease penetration of antibiotics! - discontinue when edema and mass effect improve).

2. Antimicrobial therapy: dosages → see p. Inf1 >>
   - antibiotics for 6-8 weeks (at least 1-2 weeks should be intravenous**)**
   - empirical therapy for AIDS patient – after results of neuroimaging (focal mass lesion without impending herniation) and toxoplasma serology:
     A) > 1 enhancing lesion *OR* positive toxoplasma serology = presumptive diagnosis of *TOXOPLASMA ENCEPHALITIS* → start **PYRIMETHAMINE** (+ **leucovorin**) plus:
        a) **SULFADIAZINE** – first choice
        b) **CLINDAMYCIN** – second choice
        c) **ATOVAQUONE**
        d) **AZITHROMYCIN**

     B) 1 enhancing lesion *AND* negative toxoplasma serology → brain biopsy.
        N.B. rarity of toxoplasmosis in children may warrant brain biopsy without any preceding studies.

   - severely ill / immunocompromised / transplant patients - **MEROPENEM** is first-line choice.

   - empirical therapy for immunocompetent patients (must cover streptococci & anaerobes):
     A) **PENICILLIN G** 4 MMU q4h + **CEFTRIAXONE** 2 g q12h + **METRONIDAZOLE** 500 mg q8h
     B) **PENICILLIN G*** + **METRONIDAZOLE****

        *covers streptococci and anaerobes
        **covers *Bacteroides fragilis*

C) **METRONIDAZOLE** + 3rd-generation **cephalosporin** (**CEFOTAXIME**, **CEFTRIAXONE**, **CEFTAZIDIME**)* ± **VANCOMYCIN** OR **NAFCILLIN****

*cover *Enterobacteriaceae* (e.g. otitic origin)
**cover *Staphylococcus aureus* (e.g. after cranial trauma, neurosurgery, endocarditis)

Empiric treatment of children: CEFTRIAXONE/CEFOTAXIME + METRONIDAZOLE

D) one of **penicillins** + **CHLORAMPHENICOL**

- neurosurgical patient: **VANCOMYCIN** + **CEFEPIME** + **METRONIDAZOLE**
- *FUNGAL* abscesses - **AMPHOTERICIN B**, **VORICONAZOLE**.
- *NOCARDIA* abscesses - **TRIMETHOPRIM–SULFAMETHOXAZOLE** or **SULFADIAZINE**.

Response to antibiotics is best monitored by serial CT / MRI
- abscess healing is indicated by decrease in its size.
- failure to demonstrate abscess shrinkage in 4 weeks constitutes antibiotic failure → surgery.
- antibiotics must be continued until abscess cavity resolves completely (usually 6-8 weeks).

N.B. ring enhancement may persist for up to 9 months after cure.

3. Draining pus + taking material for culture (unless contraindicated because of suspected organism type or patient's clinical condition)

Even lesions with thick, well-developed ring enhancement on CT may disappear with medical management!

a) stereotactic **abscess aspiration** - procedure of choice; requirement - abscess > 1 cm showing central cavity* - lower morbidity

*aspiration *during cerebritis stage* has unacceptable risk of hemorrhage (esp. in children).

- leaving continuous drainage catheter is not recommended.
- if organism is known, indications for just decompression:
  1) abscess **close to ventricles** (risk of catastrophic rupture → ventriculitits → hydrocephalus)
  2) significant **mass effect** (mostly if abscess > 2.5 cm)

b) **complete abscess extirpation** - rapid decompression; may cause damage to brain parenchyma (→ risk of seizures); indications:
  1) **gas** within abscess cavity
  2) **fungi** , **tbc**, **branching bacteria**(esp. *Actinomyces*, *Nocardia* species)
  3) single **large** (> 3 cm) **& readily accessible** abscess
  4) abscess in **posterior fossa** (potential of brain stem compression)
  5) retained **foreign bodies** (incl. bone fragments)

PROGNOSIS

CT diagnosis has been responsible for modern marked reduction in morbidity / mortality

Mortality 5-20% (if untreated ≈ 100%).
Sequelae:
1) seizure disorder (80-90% patients!) - prophylactic **PHENYTOIN** should be given for at least 1 year to all patients!
2) focal motor or sensory deficits
3) behavior and learning problems
4) recurrence of abscesses

SPECIAL SITUATIONS

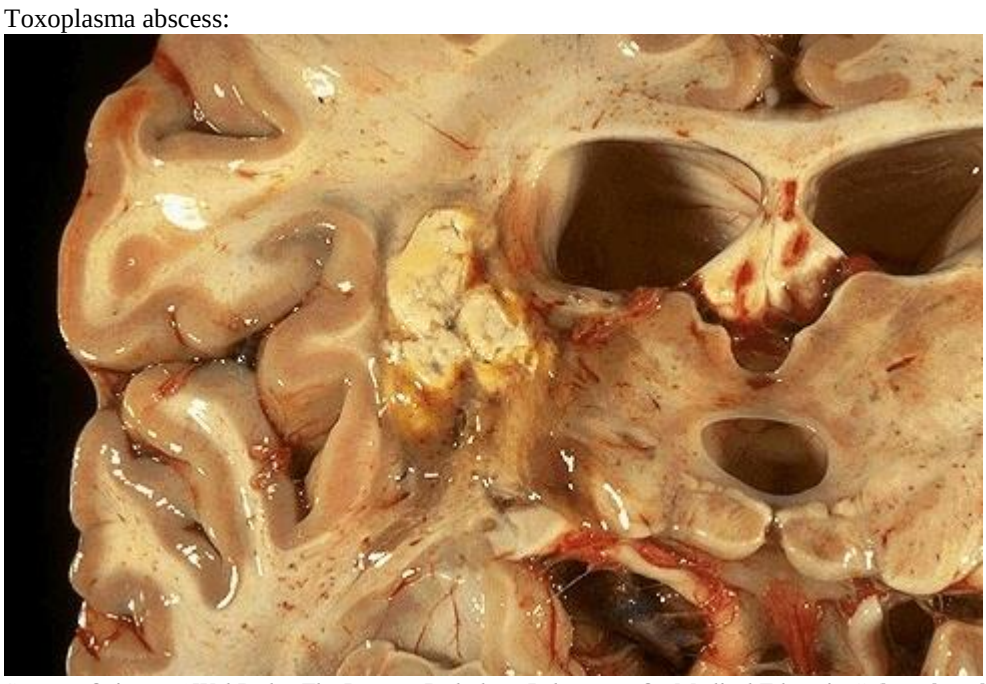
TOXOPLASMA GONDII

- cause of majority of focal infectious CNS lesions in AIDS patients.

Most difficult differential diagnosis is from ***lymphoma***!

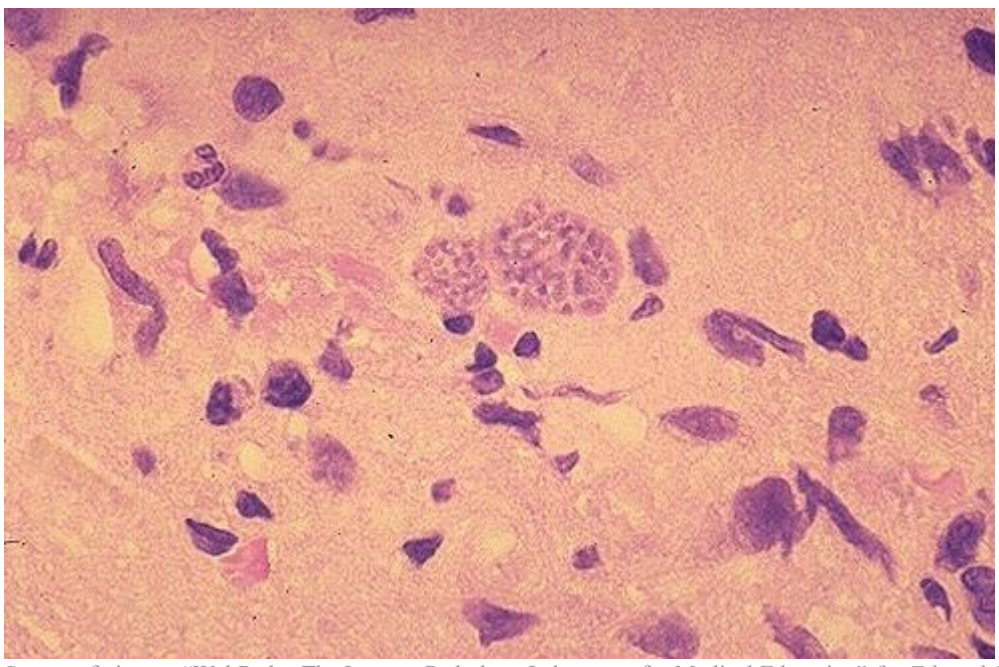
- persists in CNS and eye (immunologically privileged sites) → meningoencephalitis & chorioretinitis.
- lesions typically located in:
  1) cerebral cortex near gray-white junction
  2) thalamus and basal ganglia
  3) less often - cerebellum and brain stem; rarely - spinal cord.

Toxoplasma abscess:



Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>

Brain biopsy - Toxoplasma gondii cysts in microglial nodule with variety of inflammatory cell types (patient with AIDS):



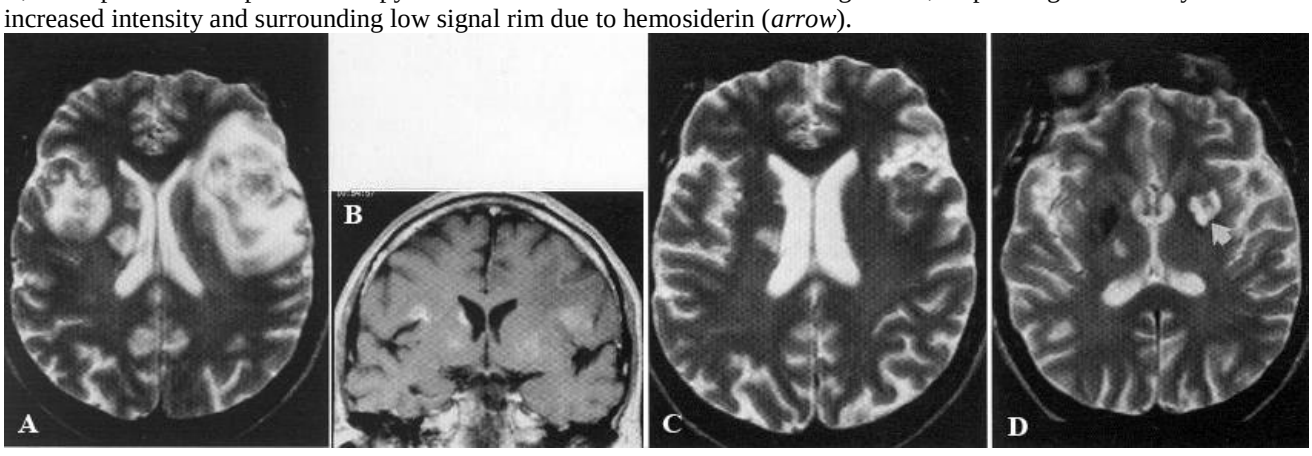
Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>

Clinically – acute ÷ chronic meningoencephalitis with **FOCAL FEATURES** (multiabscesses).

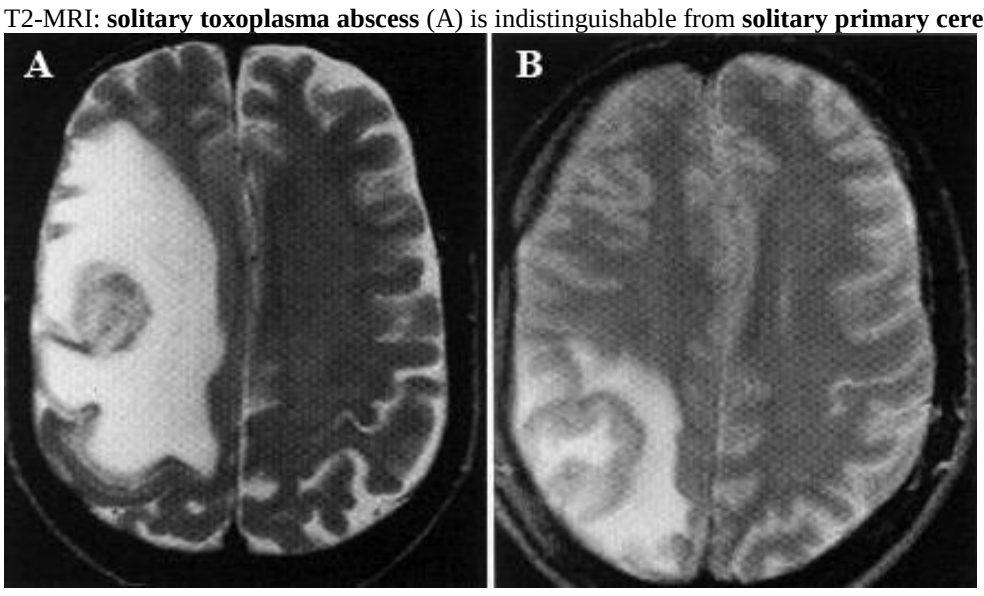
Diagnosis:

1) positive serology - **antitoxoplasma IgG** in serum (only indicates exposure, but not active infection).
2) **contrast neuroimaging** (MRI is superior to CT) - like pyogenic abscesses or lymphoma: *multiple lesions enhance in ringed or diffuse pattern*; relatively small (1–4 cm); surrounded by edema.
   - **thallium SPECT** (± CSF **PCR** for EBV) - distinguishing ***toxoplasmosis*** from ***primary CNS lymphoma*** (focal increased uptake is seen in lymphoma) - similar CT/MRI appearance.
   - cerebral *calcifications* are not found in postnatally acquired infections!
3) **CSF** - protein↑, mononuclear pleocytosis (< 100 /mm^3), glucose normal or ↓.
   - presence of CSF antibodies may be sensitive indicator of CNS infection.
   - *PCR* - disappointing (96–100% specificity, but only 50% sensitivity).
   - Toxoplasma can be demonstrated in CSF sediment (with Wright or Giemsa stain or organism can be cultivated).
4) DEFINITIVE DIAGNOSIS:
   a) 1-2 week **trial of antitoxoplasma therapy** (objective response must be seen on imaging; small lesions may disappear completely in matter of weeks).
   b) **brain biopsy** - organism detection (both free tachyzoites and encysted bradyzoites may be found at periphery of necrotic foci).

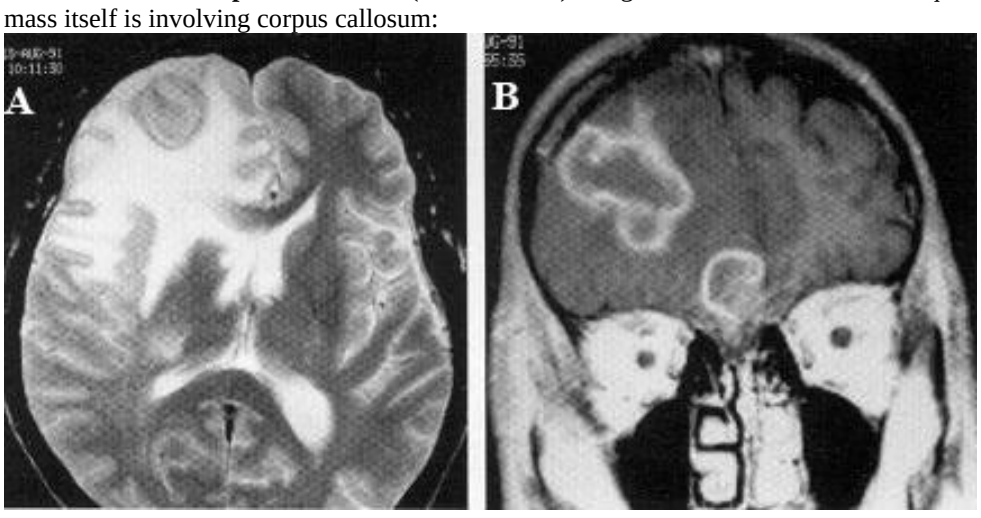
Typical toxoplasma abscesses and response to treatment (T2- A,C,D; T1- B).
A. Multiple masses of varying sizes with propensity to involve basal ganglia and grey–white matter junction; perilesional edema.
B. High signal on T1-MRI due to hemorrhage.
C,D. Response to toxoplasma therapy - reduced size of lesions and surrounding edema; responding lesions may show increased intensity and surrounding low signal rim due to hemosiderin (*arrow*).



T2-MRI: **solitary toxoplasma abscess** (A) is indistinguishable from **solitary primary cerebral lymphoma** (B):



Enhancement in **toxoplasma abscess** (T2- A; T1- B): irregular rim enhancement is frequent; perilesional edema but not mass itself is involving corpus callosum:



Treatment – for at least 6 weeks. *see above >>*

- for mass effect – **corticosteroids** (discontinue as soon as possible).

Prognosis

- relapses occur in 50% AIDS patients and 15-25% non-AIDS patients.
- large lesions (reduce in size and have less surrounding edema) may continue to enhance for > 2 years.

primary & secondary prophylaxis in HIV-infected patients → see p. 269 >>

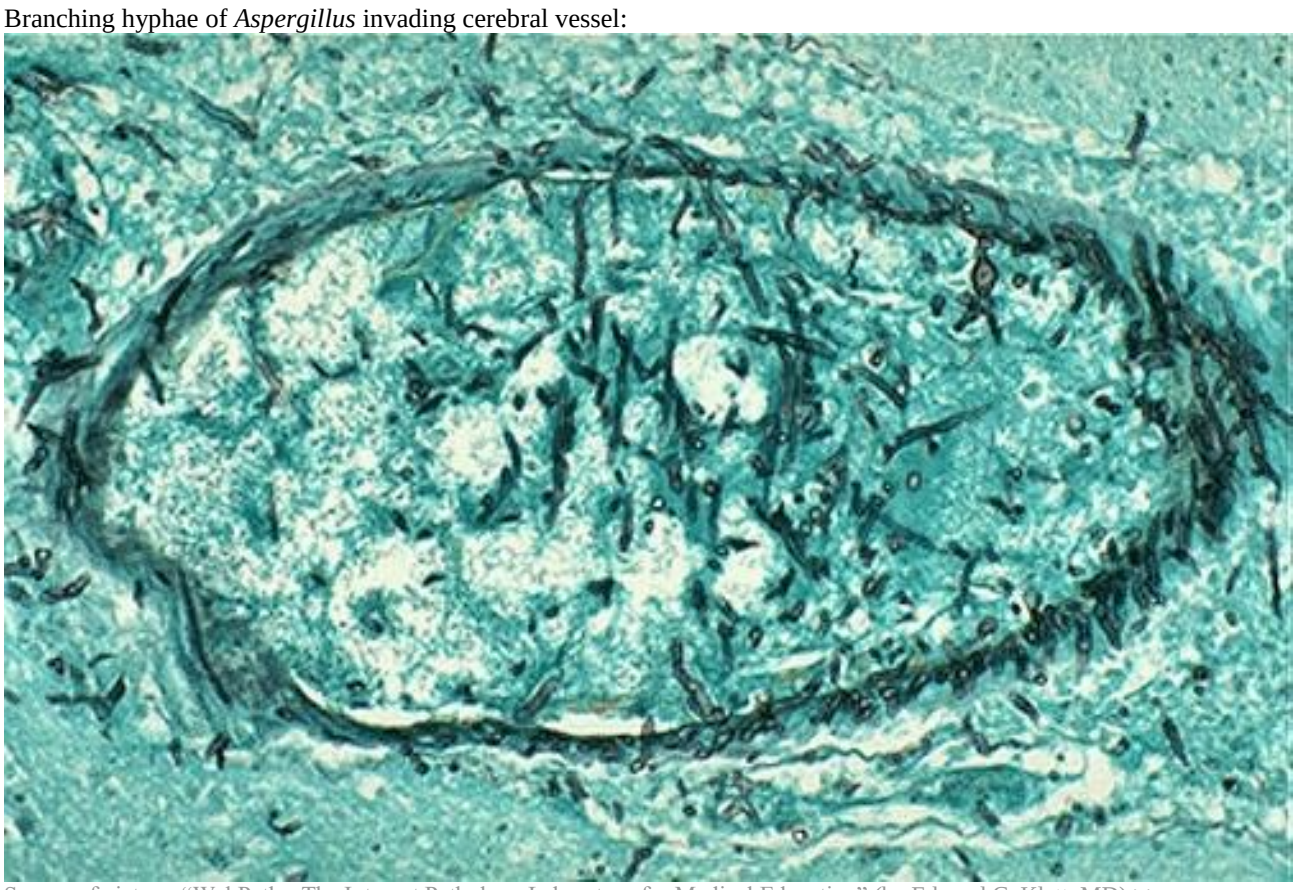
ASPERGILLOSIS

- immunosuppressed* patient with unremitting fever.

*Aspergillus causes 50% brain abscesses after bone marrow transplantation

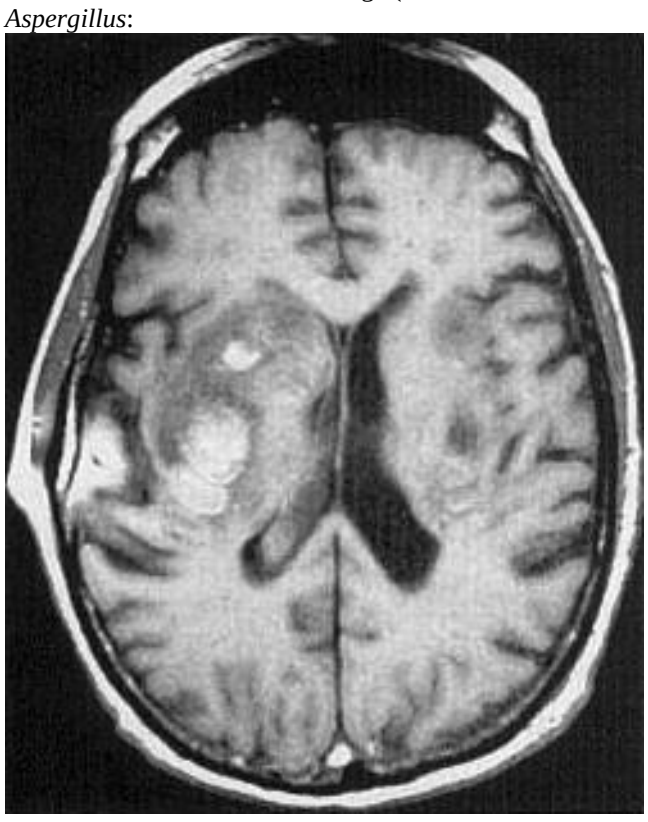
- ANGIOINVASIVE: multiple thrombotic infarctions / SAHs from ruptured mycotic aneurysms → ***multiple brain abscesses*** (in major vascular territories).
- radiologically similar to pyogenic abscesses.

Branching hyphae of *Aspergillus* invading cerebral vessel:



Source of picture: "WebPath - The Internet Pathology Laboratory for Medical Education" (by Edward C. Klatt, MD) >>

Bilateral infarction and hemorrhage (in territories of lenticulostriate perforating arteries) caused by angioinvasive *Aspergillus*:



- **chest X-ray** - pulmonary infiltrates; **bronchoscopy** may identify infecting organism in some cases.
- rapid diagnosis – *Aspergillus* **antigen test** in blood.
- treatment - liposomal **AMPHOTERICIN B** (0.8-1.0 mg/kg/d) + **FLUCYTOSINE** (25 mg/kg q6h).

New drugs for invasive aspergillosis:

VORICONAZOLE (loading 6 mg/kg IV q12h for two doses → maintenance 4 mg/kg IV q12h).

CASPOFUNGIN (70 mg IV over 60 min single loading dose on day 1 → 50 mg/d IV).

CANDIDA

- see p. Inf1 >>

INTRAMEDULLARY SPINAL CORD ABSCESS

Only < 100 cases have been reported since 1830:

- males > females.
- PEAK INCIDENCE in 1st and 3rd decades of life.
- particular high risk factor – IV drug abuse.
- most common etiology: *Staphylococcus* and *Streptococcus* species, followed by Gr- organisms.

- **solitary abscesses** most likely appear in thoracic cord.
  - abscesses may occur in areas of infarction (explaining septic spread to lower half of thoracic cord).
- **holocord abscesses** have been reported in 5 patients.
- *spinal cord abscesses do not destroy fiber tracts* (abscess displaces fiber tracts and spreads along axonal pathways!).

CLINICAL FEATURES

Acute cases - similar to EPIDURAL ABSCESSES (but percussion tenderness is not noted) - extremely ill patients presenting with:

1) **symptoms of infection** - acute onset of back pain, fever, chills, malaise.
2) **neurological symptoms** – weakness ÷ paraplegia, paresthesia, bladder and bowel incontinence.
   - since inflammatory process involves surrounding vasculature, spine cord infarction may lead to irreversible paraplegia.

Chronic cases - mimic INTRAMEDULLARY TUMOR - gradually progressing **neurological symptoms** predominate over those of systemic infection.

DIAGNOSIS

Neuroimaging method of choice - **gadolinium-enhanced MRI**:

1) *mass* (homogenous spinal cord enlargement on T1-MRI but high signal intensity on T2-MRI);

2) abscess *margin enhances brightly* with gadolinium.

CSF (can be within normal ranges!) - protein↑, pleocytosis.

Identification of infecting organism - **cultures from abscess aspirate** (aerobic and anaerobic bacteria, fungi, and tuberculosis) during laminectomy.

Myelography - only widening of spinal cord.

TREATMENT

1. **Antibiotics** – empirically broad-spectrum antipenicillinase penicillin; minimum 4 weeks following surgery.
2. **Steroids** (**DEXAMETHASONE** 4-10 mg q6h during entire course of treatment) – to reduce spinal cord swelling.
3. Surgical drainage of abscess cavity - LAMINECTOMY one level above and below abscess edges:
   - open dura.
   - identify area of spinal cord involvement (swelling, hemorrhage, distended veins).
   - ***abscess aspiration*** for culture & stain (Gram, India ink).
   - **myelotomy** over length of abscess.
   - ***irrigate*** (wound and abscess cavity) with antibiotic solution.
   - ***closure*** in anatomical layers.
   - **drain** is optional.

PROGNOSIS

- MORTALITY 10-20%.
- significant percentage of patients have *abscess recurrence* - **repeat MRIs** are essential in long-term follow-up care (enhancement of cavity will likely continue for several weeks).

SUBDURAL EMPYEMA (CRANIAL AND SPINAL)

- pus collection ***in space between dura mater and arachnoid***.

INTRACRANIAL >> SPINAL (only 50 cases reported in literature)

- 13-20% of localized intracranial infections.
- most common in children & young adults (70% patients are in 2-3rd decade of life).
- males > females (3:1).

ETIOPATHOPHYSIOLOGY

- primary causes – **sinusitis** (esp. frontal) 50-80%, otitis media 10-20%, superficial infections of scalp and skull, craniotomy, meningitis (very rarely!*), suppuration of subdural hematoma.
  *vs. *in infants* subdural empyema represents infected subdural effusion (complicating bacterial meningitis).
  - *in spine*: hematogenous spread from distant site (most commonly), trauma, spine surgery, dermal sinus.
- pathophysiology:
  a) **direct spread** via erosion of bone adjacent to dura mater.
  b) **septic thrombophlebitis** of mucosal veins (e.g. of sinuses) → retrograde extension with drainage of bacteria into regional dural veins → superior sagittal sinus → subdural space.
- brain beneath pus is molded in manner similar to that seen in subdural hematoma.

PROGRESSION
- subdural space has no barriers (hence, empyema not abscess!) - empyema *evolution is remarkably rapid* (along falx and over convexities).
- subdural empyema may breach arachnoid (arachnoid is not very strong barrier) → meningitis.
- septic thrombophlebitis extends from dural sinuses to cortical veins → cortical venous infarction of gray and white matter drained by thrombosed vessels → brain abscess (25% patients!).
- with successful treatment, thickened dura may be only residual finding.

CLINICAL FEATURES

- patient is acutely ill (entire clinical picture may evolve in as little as few hours or as long as 10 days):
  1) **frontal sinusitis** - periorbital edema and erythema, local pain and tenderness, etc.
  2) **fever**, **chills**
  3) severe **headache** (often localized initially to side of infection), **nuchal rigidity** (70-80%).
  4) MASS EFFECT - progressive **disturbance of consciousness**, increase in infant head size with bulging fontanel.
  5) FOCAL NEUROLOGICAL DEFICITS (80-90% patients; caused by cortical vein thrombophlebitis): **seizures** (30-60% patients), **hemiparesis**, aphasia.

Spinal subdural empyema - fever with rapidly progressive spinal cord compression.
- **backache** is not as characteristic as in spinal epidural abscess.
- tenderness along spine is often absent (vs. spinal epidural abscess).

DIAGNOSIS

- marked peripheral leukocytosis.
- **MRI** (procedure of choice) – *hypodense crescent* adjacent to inner border of skull or adjoining falx with mildly (markedly on T2-MRI) *increased signal intensity* compared with CSF;
  N.B. empyema is denser than CSF; vs. *benign subdural effusion* - isointense (on MRI T1- and T2) with CSF!
  - contrast enhancement of empyema margin (fine, intense line).
  - underlying parenchymal edema.
  - mass effect.
  - empyema extent is limited by attachments of dura (way to distinguish epidural from subdural suppurative process).
- **cerebral arteriography*** (formerly was used routinely) should be employed on emergent basis when MRI is unavailable and subdural empyema is strongly suspected despite normal CT - *subdural avascular mass*.
  ***myelography** for spinal empyema.
- **subdural tap** may be diagnostic *in infants*.
- **lumbar puncture** should be avoided; CSF is as in cerebral abscess (aseptic meningeal reaction):
  - clear and colorless;
  - neutrophilic pleocytosis may be absent;

– protein 75-150 mg/dl; sugar content is normal.
– bacteria are not found (CSF is sterile!)

TREATMENT

- surgical emergency!
- **anticonvulsants** should be administered prophylactically.

1. Intravenous antibiotic therapy (same as that for brain abscess) – against organisms typically isolated from chronic sinusitis / otitis:
   aerobic streptococci (30-50%)
   anaerobic and microaerophilic streptococci (15-25%)
   staphylococci (12-25%; majority of cases of spinal subdural empyema)
   aerobic Gr- bacilli (3-10%)

   Empiric therapy: dosages → see p. Inf1 >>
   1) **PENICILLIN G** OR **3rd-generation cephalosporin** (**CEFTRIAXONE** or **CEFOTAXIME**)
   2) **METRONIDAZOLE**
   3) **NAFCILLIN** OR **VANCOMYCIN**
   - IV for at least 3 weeks after surgical drainage → PO to complete 6-week course.

2. Management of increased ICP; use of **steroids** (tapered rapidly after surgery) is common but remains controversial.

3. Immediate surgical drainage:
   A. **CRANIAL** – via **craniotomy** (esp. for posterior fossa subdural empyemas) or **multiple burr holes**.
      - ***drains*** are left in subdural space for several days.
      - postoperatively, repeat CT / MRI scans – ***reoperation*** (drainage of loculated pockets) is typically necessary.
   B. **SPINAL** – **laminectomy** → dural incision → drainage.

   - although extensive antibiotic irrigation of subdural space at time of surgery (**BACITRACIN** + **VANCOMYCIN** or **GENTAMICIN**) is common, there are no data on benefits of this practice.

PROGNOSIS

- mortality 10-40% (almost fatal if untreated).
- in 8-46% patients **chronic epilepsy** results; disabling hemiparesis or aphasia (5-25% survivors).

CRANIAL EPIDURAL ABSCESS

- suppurative infection in **epidural space** (between dura and bone).

Epidural abscesses: SPINAL >> CRANIAL (9:1)

- etiology & pathogenesis ≈ subdural empyema.
  – almost always associated with *overlying infection in cranial bones* (e.g. penetration from chronic sinusitis or mastoiditis; most common cause is craniotomy complicated by wound infection).
  – hematogenous spread to epidural space from remote site of infection is extremely rare (vs. extremely common cause of spinal epidural abscess!).
- rare in young children; median - 6th decade.
- MORBIDITY & MORTALITY are low.

- remains well localized due to tight adherence of dura to overlying calvarium; but abscess often crosses dura along emissary veins → subdural empyema, meningitis, etc.
- abscesses rarely dissect beyond base of skull.

CLINICAL FEATURES

- slowly growing mass (*does not produce sudden major neurologic deficits* unless complicated by deep extension*) - insidious clinical presentation:

*subdural empyema, meningitis, intraparenchymal abscess

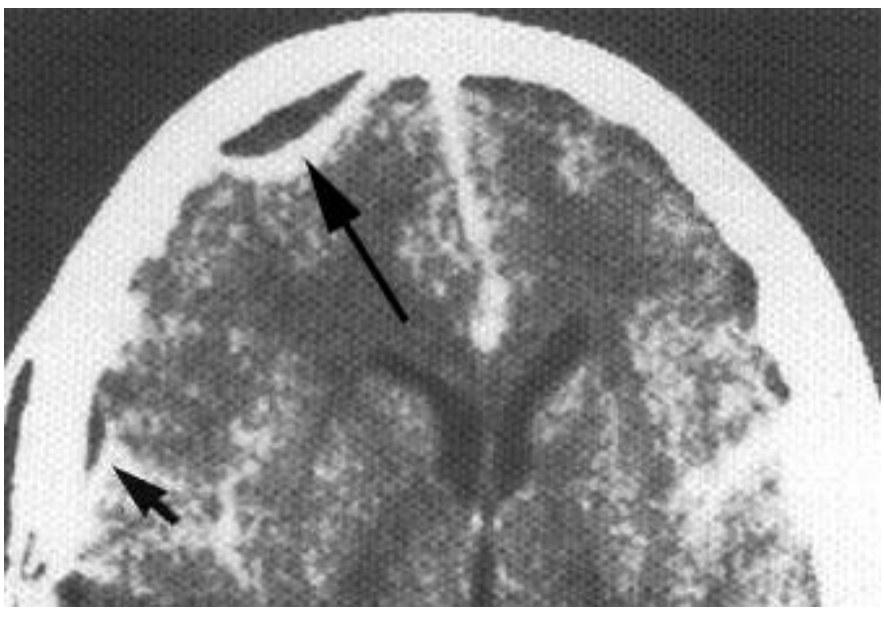
1) unrelenting hemicranial **headache** or persistent **fever** (patient may otherwise be asymptomatic!!!).
2) without treatment, INTRACRANIAL HYPERTENSION and FOCAL NEUROLOGIC SIGNS ultimately develop (when infection extends into subdural space).

DIAGNOSIS

MRI - superficial, circumscribed ***lenticular-shaped lesion*** of diminished density*, with ***inner rim of contrast enhancement***** (thicker and more irregular than with subdural empyema).

*but higher signal intensity (on T1- and T2) than CSF
**inflamed dura

- MRI is free from bony artifacts adjacent to inner table of skull.
- MRI readily differentiates abscesses from sterile effusions or chronic extraaxial hematomas.



Lumbar puncture is certainly to be discouraged until after imaging has established that significant mass effect is not present.

- modest aseptic CSF reaction.

Hyponatremia is found in 30% cases.

TREATMENT

Antibiotic therapy → see *SUBDURAL EMPYEMA >>*

Surgical drainage - depending on extent of lesion and involvement of overlying bone:

a) **burr holes**
b) **craniotomy**
c) **craniectomy (debridement of infected bone)**

- ***dural grafting*** may be necessary (if dura has been breached by infection).
- communications between sinus cavities and epidural space may require later surgical closure.

SPINAL EPIDURAL ABSCESS

- any infectious phlegmon involving epidural space, even without demonstrable contained pus (true abscess).

Spinal epidural space:

TRUE space – *posteriorly*; AP width greatest where spinal cord is smallest (T4-8 and L3-S2).

- midthoracic region (T4-8) – largest amount of epidural fatty tissue – most common location for spinal epidural abscess!

POTENTIAL space – *anteriorly* (because dura is adherent to posterior surface of vertebral bodies).

- anterior abscesses usually occur at cervical levels.

Can occur at all ages (60% patients are 20-50 years of age).

ETIOPATHOPHYSIOLOGY

a) most common (2/3) ETIOLOGY (vs. cranial epidural abscess) - **HEMATOGENOUS SPREAD** from remote site.
   - **immunosuppression** (most commonly AIDS or diabetes mellitus) is predisposing condition in 50% cases.
   - **small hematoma** (mild blunt trauma) provides *locus minoris resistentiae* - may allow for hematogenous seeding of infection.
   - hematogenous spread to vertebral body / disc (*osteomyelitis / discitis*) may also occur → subsequent extension into spinal epidural space.

b) **DIRECT EXTENSION** (1/3) from **vertebral osteomyelitis** is esp. common in IV drug abusers.
   - other sources of direct extension - decubitus ulcers, infected abdominal wounds, psoas abscesses, perinephric and retropharyngeal abscesses, iatrogenic complication of lumbar puncture.
   - ***tuberculous*** epidural abscess is usually associated with vertebral osteomyelitis.

Spinal epidural abscess extends ≈ *3 spinal segments* (may extend for as long as 13 segments).

Spinal cord lesion:

- **gross appearance** of spinal cord is usually normal.
- direct compression of neural tissue & inflammatory thrombosis in intraspinal vessels → infarction → MYELOMALACIA.
- **microscopically** - scattered areas of softening, vacuolization of cord, areas of necrosis (disappearance of cells, loss of myelin, axonal swelling).

CLINICAL FEATURES

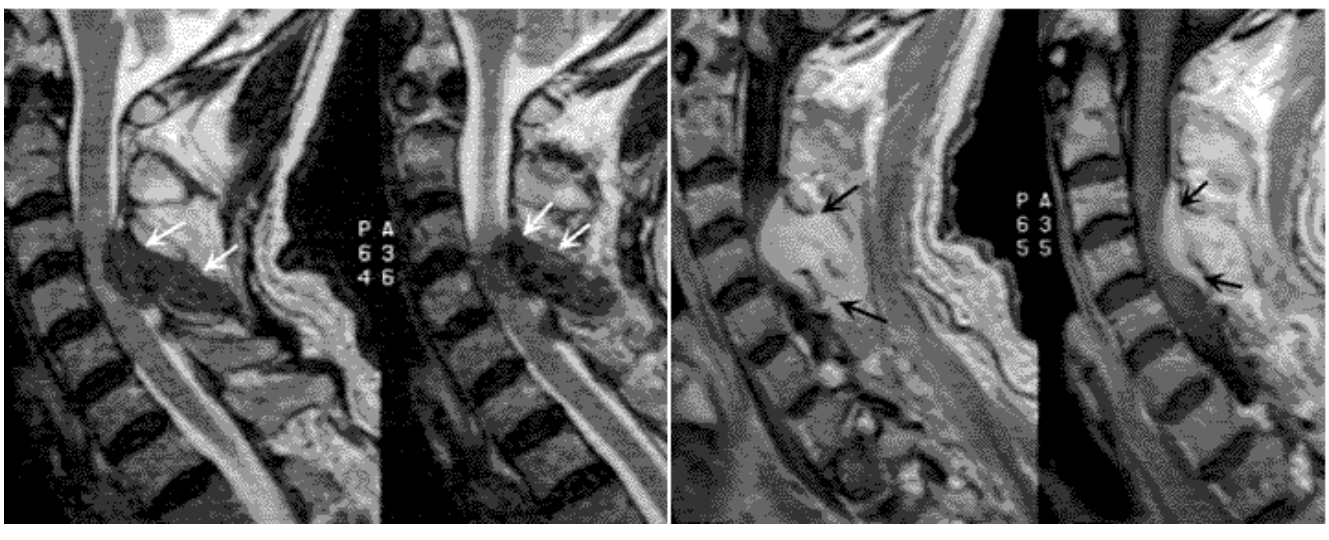
1. **Fever**.
2. **Back pain & tenderness** (on percussion & movement) at affected spinal level.
   - erythema and swelling in area of back pain.
   - stiff neck and headache are common.
3. Progressive compression of spinal cord (appears within hours ÷ weeks of initial symptoms):

   radicular pain
   ↓
   paresis & **loss of sensation** below lesion level + bowel & bladder dysfunction
   ↓
   complete paraplegia & loss of all sensory modalities below level of lesion (i.e. transection syndrome)

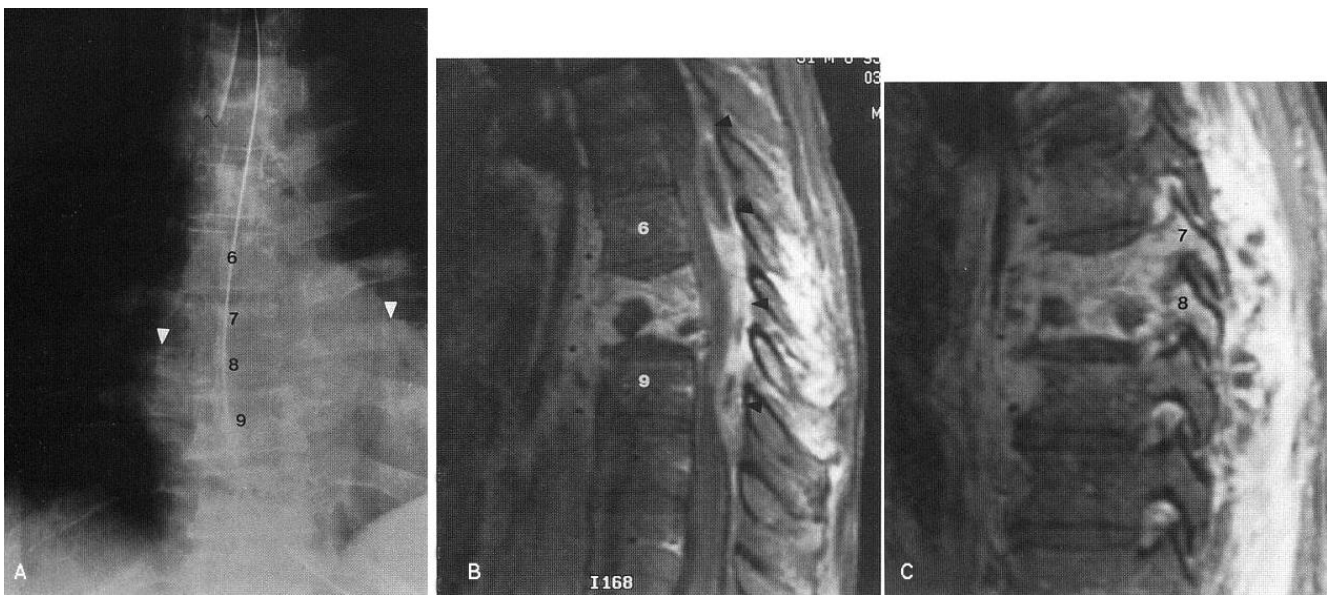
DIAGNOSIS

MRI (procedure of choice) – abscess is isointense to CSF (hyperintense on T2).

- contrast enhancement of lesion occurs.



Staphylococcus aureus **spondylitis with epidural abscess** in IV drug abuser:
A: AP radiograph - large, paravertebral soft-tissue mass and "extra" rib pair (*arrowheads)* resulting from discitis and marked bony destruction of adjacent T7 and T8 vertebrae (appearance mimics single normal vertebra).
B: Midsagittal postgadolinium T1-MRI - diffuse vertebral enhancement and obliteration of intervening disc space except for two residual intervertebral fluid collections (again mimicking single diffusely involved vertebral body); large posterior epidural phlegmon and abscess (*arrowheads*) as well as large anterior vertebral soft-tissue mass.
C: Parasagittal MRI - involvement of two adjacent posterior elements (confirming that process represents pronounced discitis/osteomyelitis of two levels).



Lumbar puncture (demonstrates subarachnoid block) should not be performed:

1) risk for infection spread to subarachnoid space.
2) risk for herniation from decompression below area of obstruction

- if meningitis is suspected - high cervical tap is often safest approach.

Normal plain **CT** alone does not exclude diagnosis (if MRI is unavailable → use CT myelography).

Myelography (not necessary if abscess is diagnosed by MRI/CT) - *extradural block* (complete in 80% patients)

- performed by ***cervical puncture***.
- needle is advanced slowly and *suction applied with syringe as epidural space is approached* - if abscess has extended to level of puncture, pus is withdrawn → terminate procedure (use pus for culture).

X-rays show osteomyelitic findings in 1/3 cases.

TREATMENT

Immediate surgery: **laminectomy** - decompression - drainage of epidural space.

- *granulation tissue* is commonly found in association with epidural abscesses and may require excision during course of decompression.

Antibiotics: 4-6 weeks IV → 2-3 months oral.

- empiric antibiotics should cover:
  1) *S. aureus* (etiological agent in majority of cases!!!) – NAFCILLIN.
  2) *M. tuberculosis* (ISONIAZID, RIFAMPIN, ETHAMBUTOL, PYRAZINAMIDE + STREPTOMYCIN or RIFABUTIN or CLOFAZIMINE).
  3) most authorities would provide additional Gr- coverage (3rd-generation cephalosporin, quinolone, or aminoglycoside).

PROGNOSIS

- relates inversely to **amount of neurologic dysfunction at time of diagnosis**:
  only pain → recovery without deficit.
  some weakness → 50% will achieve complete resolution.
  paralysis < 36 hours' duration → < 50% will show some return of motor function.
- in *tuberculous epidural abscess* motor recovery has been reported even after paralysis lasting for weeks.

BIBLIOGRAPHY for ch. "Infections of Nervous System" → follow this LINK >>