TB OR NOT TB?

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Harvard Medical School, MSIII

Gillian Lieberman, MD
Patient X is an otherwise healthy 36 year old male, originally from Tanzania, who presented to his PCP with:

- 3 months of daily HA

More recently:

- Nausea/Vomiting
- Blurry Vision
PATIENT PRESENTATION

On further questioning, he tells you:

• Lost 20-30 pounds over the last 3 months
• Drenching night sweats for the past 3 months
• Mid-Lower back pain for 6 months
PATIENT PRESENTATION

PPD was placed...

Came back positive at 26 mm
PATIENT PRESENTATION

PPD was placed…

   Came back positive at 26 mm

HOWEVER…

   • Received BCG vaccine as a kid in Tanzania

   • Cleared for TB at immigration

   • No exposures to TB, no sick contacts, only travel in >15 yrs was to Maine and NYC

   • Recent HIV test was negative, never incarcerated, no IVDU

   • No cough, hemoptysis, SOB
The patient was admitted to the hospital for further workup...
OVERVIEW:

1. Image the **BRAIN**
   - MRI Review
   - Results
   - CNS Manifestations of TB
   - Differential

2. Image the **SPINE**
   - Results
   - Differential
   - MSK Manifestations of TB

3. Image the **CHEST**
   - Findings
   - Expected findings with TB
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What is MRI?

- MRI magnet creates a strong **magnetic field**
- Protons within tissue align to magnetic field => equilibrium
- Radiofrequency pulses applied = push out of equilibrium
- Measure signal emitted as return back to alignment at different points in time
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Why MRI in this case?

- Excellent Soft Tissue Contrast
- Pulse sequences utilized to differentiate between cerebral tissues
- Relevant Indications: Mass lesions, tumors, infection, inflammation
### MRI: Indications

**Clinical Condition:** Headache

**Variant 11:** New headache. Suspected meningitis/encephalitis.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
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<th>RRL*</th>
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<tr>
<td>MRI head without and with contrast</td>
<td>8</td>
<td>See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
</tr>
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<td>MRI head without contrast</td>
<td>7</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>CT head with contrast</td>
<td>6</td>
<td></td>
<td>0</td>
</tr>
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<td>6</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>CT head without contrast</td>
<td>5</td>
<td>Perform this procedure to rapidly rule out mass lesion prior to lumbar puncture.</td>
<td>0</td>
</tr>
<tr>
<td>MRA head without and with contrast</td>
<td>3</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>MRA head without contrast</td>
<td>3</td>
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<td>CTA head with contrast</td>
<td>3</td>
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**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
**T1 Weighted Images**

**SHORT TE AND TR**

T1 = longitudinal relaxation, time needed to regain longitudinal relaxation after rf pulse

**T2 Weighted Images**

**LONG TE AND TR**

T2 = transverse relaxation, decay, rotation as it relaxes after rf pulse
**T1 Weighted Images**

- **Black (No H):** Air, Calcium, Bone
- **Dark:** CSF, edema
- **Grey:** White and grey matter
- **Bright:** Fat, Gd contrast

**T2 Weighted Images**

- **Black (No H):** Air, Calcium, Bone
- **Dark:** Gray and White matter
- **Bright:** CSF, Edema, Blood

*Companion Patient 1: Normal MRI- T1 vs T2*
MRI: T1 vs T2

**T1 Weighted Images**
- FLUID is DARK
- FAT is BRIGHT

**T2 Weighted Images**
- FLUID is BRIGHT
- FAT is DARK

*Companion Patient 1: Normal MRI- T1 vs T2*
**MRI: T1 vs T2**

**T1 Weighted Images**

- FLUID is DARK
- FAT is BRIGHT

**T1 C+:** Good for recognition of BBB disruption, vascular changes

**T2 Weighted Images**

- FLUID is BRIGHT
- FAT is DARK

**T2 C+:** Good for anatomy and brain lesions, but can’t differentiate lesion from CSF

*Companion Patient 1: Normal MRI- T1 vs T2*
FLAIR: Fluid Attenuated Inversion Recovery

Essentially the same as T2, but with signal from CSF suppressed

Companion Patient 2: Normal MRI- T2 vs FLAIR
OVERVIEW:

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Results: T1

Our patient:

**T1** Axial (Pre-Contrast)

![MRI Head, Axial, T1 C-](image)

Our patient:

**T1** Axial (Post-Contrast)

![MRI Head, Axial, T1 C+](image)
Results: T1

Our patient:

T1 Axial (Pre-Contrast)

Lesion not visualized in the affected area on T1 without contrast

MRI Head, Axial, T1 C-

Our patient:

T1 Axial (Post-Contrast)

There is a ring enhancing lesion in the right frontal lobe, clearly visualized on T1 after contrast administration

MRI Head, Axial, T1 C+
Results: T1 vs T2

Our patient:

T1 Axial (Post-Contrast)

MRI Head, Axial, T1 C+

Our patient:

T2 Axial (Post-Contrast)

MRI Head, Axial, T2 C+
Our patient:

**T1** Axial (Post-Contrast)

Same ring enhancing lesion seen earlier

**T2** Axial (Post-Contrast)

Periventricular hyperintense lesion seen in affected right frontal lobe
Results: $T_1$, $T_2$, FLAIR
Types of Edema

VASOGENIC EDEMA:
• Results from a breakdown of the BBB, most common
• Think: trauma, infection, tumors, inflammation

CYTOTOXIC EDEMA:
• BBB maintained, second most common
• Think: Ischemic infarcts (early), intoxications

INTERSTITIAL EDEMA:
• Transudative edema resulting from increased pressure
• Think: Hydrocephalus

OSMOTIC EDEMA:
• Edema caused by change in plasma osmolality
• Think: Hyponatremia
Types of Edema

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- Results from a breakdown of the BBB, most common
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- Edema caused by change in plasma osmolality
- Think: Hyponatremia
Findings?

Our patient:

C+ T1

MRI Head, Axial, T1 C+

C+ T2

MRI Head, Axial, T2 C+

Our patient:

FLAIR

MRI Head, Axial, FLAIR

Results: T1, T2, FLAIR

• Ring-enhancing Lesion
• Vasogenic Edema
Results: Multiple Lesions

- Ring-enhancing Lesions
- Vasogenic Edema
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1. **Intracranial Tuberculoma:** Conglomerate granulomatous (caseous) foci within the brain parenchyma

\[\text{C+T1: Ring Enhancing Lesion:}\]

- Hyperintense ring: Collagenous fibers
- Hypointense ring: outer inflammatory infiltrates
- Inner: Caseating necrosis

Kyoung, Kim
1. Intracranial Tuberculoma: Conglomerate granulomatous (caseous) foci within the brain parenchyma

2. TB Meningitis

*Most common CNS manifestation. LP is best to diagnose (high protein, low glucose, lymphocytic pleocytosis, +/- TB on smear). Can see signs of increased pressure on CT.
1. Intracranial Tuberculoma: Conglomerate granulomatous (caseous) foci within the brain parenchyma

2. TB Meningitis

*Most common CNS manifestation. LP is best to diagnose (high protein, low glucose, lymphocytic pleocytosis, +/- TB on smear). Can see signs of increased pressure on CT.

3. Spinal tuberculous arachnoiditis:

Focal inflammatory disease leading to gradual encasement of the spinal cord in gelatinous or fibrous exudate.
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Ring Enhancing Lesions

RING ENHANCING LESION DIFFERENTIAL:

1. Metastasis
2. Infection
3. Demyelinating Disease
RING ENHANCING LESION DIFFERENTIAL:

M A G I C A L   D R

Metastasis
Abscess
Glioblastoma Multiforme
Infarction
Contusion
Atypical organisms
Lymphoma
Demyelination
Radiation

Bacterial: Mycobacteria, Nocardia, Actinomyces
Fungal: Crypto, Histo, Aspergillus
Parasites: Neurocysticercosis, Toxoplasmosis, Echinococcus, Entamoeba
RING ENHANCING LESION DIFFERENTIAL:

- Metastasis
- Abscess
- Glioblastoma Multiforme
- Infarction
- Contusion
- Atypical organisms
- Lymphoma
- Demyelination
- Radiation

Some helpful differentiating features...
Ring Enhancing Lesions

RING ENHANCING LESION DIFFERENTIAL:

- Metastasis
- Abscess
- Glioblastoma Multiforme
- Infarction
- Contusion
- Atypical organisms
- Lymphoma
- Demyelination
- Radiation

Companion Patient 4: Multiple Metastases

MRI Head, Axial, T1/C+

Multiple lesions
Usually at Grey-white matter junctions

Khosla, Anil
Ring Enhancing Lesions

RING ENHANCING LESION DIFFERENTIAL:

- Metastasis
- Abscess
- Glioblastoma Multiforme
- Infarction
- Contusion
- Atypical organisms
- Lymphoma
- Demyelination
- Radiation

Companion Patient 5: Abscess

MRI Head, Axial, T1/C+
MRI Head, Axial, FLAIR

Thin, regular, enhancing rim
Extensive edema relative to lesion

Gaillard
RING ENHANCING LESION DIFFERENTIAL:

- Metastasis
- Abscess
- Glioblastoma Multiforme
- Infarction
- Contusion
- Atypical organisms
- Lymphoma
- Demyelination
- Radiation

Companion Patient 6: GBM

MRI Head, Axial, T1/C+

Irregular, heterogenous, solitary lesion

Often crosses corpus callosum
RING ENHANCING LESION DIFFERENTIAL:

- Metastasis
- Abscess
- Glioblastoma Multiforme
- Infarction
- Contusion
- Atypical organisms
- Lymphoma
- Demyelination
- Radiation

Companion Patient 7: MS

Paraventricular white matter lesions

“Open ring sign”

MRI Head, Axial, T1/C+
OVERVIEW:

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   - Differential

2. **Image the SPINE**
   - Results
   - MSK Manifestations of TB
   - Differential

3. **Image the CHEST**
   - Findings
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### ACR Appropriate Criteria: Low Back Pain

**Variant 3:** Patient with one or more of the following: suspicion of cancer, infection, and/or immunosuppression.

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<td>MRI lumbar spine without and with contrast</td>
<td>8</td>
<td>Contrast useful for neoplasia subjects suspected of epidural or intraspinal disease. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td></td>
</tr>
<tr>
<td>MRI lumbar spine without contrast</td>
<td>7</td>
<td>Non-contrast MRI may be sufficient if there is low risk of epidural and/or intraspinal disease.</td>
<td>O</td>
</tr>
<tr>
<td>CT lumbar spine with contrast</td>
<td>6</td>
<td>MRI preferred. CT useful if MRI is contraindicated or unavailable, and/or for problem solving.</td>
<td>⭐⭐⭐</td>
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<td>X-ray lumbar spine</td>
<td>5</td>
<td></td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>Tc-99m bone scan whole body with SPECT spine</td>
<td>5</td>
<td>SPECT/CT may be useful for anatomic localization and problem solving.</td>
<td>⭐⭐⭐⭐</td>
</tr>
<tr>
<td>CT lumbar spine without and with contrast</td>
<td>3</td>
<td></td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>X-ray myelography lumbar spine</td>
<td>2</td>
<td></td>
<td>⭐⭐⭐⭐</td>
</tr>
<tr>
<td>Myelography and postmyelography CT lumbar spine</td>
<td>2</td>
<td>In some cases postinjection CT imaging may be done without plain-film myelography.</td>
<td>⭐⭐⭐⭐⭐</td>
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*Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level
MRI: Indications

Which imaging modality?

MRI

Relevant Indications:
High suspicion for infection, malignancy
Greater than 12 weeks of symptoms

Advantages:
More sensitive than plain radiographs and CT, without the radiation exposure
Detection of soft tissue defects, neurological impingement
Can accentuate edematous areas
Better characterizes the lesion itself
Results: Sagittal T-Spine

Our Patient:

**T1** Pre-Contrast

**T2** Pre-Contrast

*MRI T-Spine, Sagittal, T1/C*-

*MRI T-Spine, Sagittal, T2/C*-

PACS, BIDMC
Our Patient: **T1** Pre-Contrast

Intervertebral Discs

Vertebral Body

CSF (dark)

Spinal Cord

Our Patient: **T2** Pre-Contrast

CSF (bright)

**MRI T-Spine, Sagittal, T1/C-**

**MRI T-Spine, Sagittal, T2/C-**

**BIDMC**
Results: Sagittal T-Spine

Our Patient:

**T1 Pre-Contrast**

Our Patient:

**T1 Post-Contrast**
Results: Sagittal T-Spine

Our Patient:  
\textbf{T1} Pre-Contrast

\textbf{T12}  
Enhancing mass within T12 vertebral body

Our Patient:  
\textbf{T1} Post-Contrast

\textbf{T12}
MRI: Axial T-Spine

Our Patient: T11 Vertebral Body (Normal)

MRI T-Spine, Axial, T2

Image from: Advanced Practice Strategies

PACS, BIDMC
Axial T-Spine Anatomy

Our Patient: T11 Vertebral Body (Normal)

MRI T-Spine, Axial, T2

Image from: Advanced Practice Strategies
Our Patient: T11 Unaffected Vertebral Body

Our Patient: T12 Affected Vertebral Body

MRI T-Spine, Axial, T2
Results: Axial T-Spine

Our Patient: T11 Unaffected Vertebral Body

Our Patient: T12 Affected Vertebral Body

MRI T-Spine, Axial, T2

Lesion in Vertebral Body

Mass effect on the Spinal Cord and Thecal Sac

Epidural Fat Impingement

Epidural Fat

PACS, BIDMC
Results: Axial T-Spine

Our Patient: T11 Unaffected Vertebral Body

Our Patient: T12 Affected Vertebral Body

Epidural Fat Impingement: notice loss of normal epidural fat border

Mass effect: Note lack of CSF seen on this T2
Results: Axial T-Spine

*Remember: NERVE ROOTS EXIT BELOW THE VERTEBRAL BODIES IN THE THORACIC SPINE

Our Patient: Normal (T11 – T 12)

Our Patient: Abnormal (T12- L1)
*Remember: NERVE ROOTS EXIT BELOW THE VERTEBRAL BODIES IN THE THORACIC SPINE

Our Patient: Normal (T11 – T12)

Our Patient: Abnormal (T12- L1)

Impingement on the Neuroforamen
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TB: Skeletal Manifestations

In order of prevalence:

→ Pott’s Disease
→ Arthritis
→ Osteomyelitis (non-vertebral)
→ Epidural Abscess
→ Psoas Abscess
TB: Skeletal Manifestations

In order of prevalence:

- Pott’s Disease
- Arthritis
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- Psoas Abscess

Our Patient: Pott’s Disease

MRI, T-spine, Sagittal, T2
TB: Skeletal Manifestation

In order of prevalence:

- Pott’s Disease
- Arthritis
- Osteomyelitis (non-vertebral)
- Epidural Abscess
- Psoas Abscess

Hip > ankle > elbow > wrist > shoulder

Companion Patient 8: TB Hip Arthritis
TB: Skeletal Manifestations

In order of prevalence:

→ Pott’s Disease
→ Arthritis
→ Osteomyelitis
→ Epidural Abscess
→ Psoas Abscess

Companion Patient 9: Chest Wall TB- Osteomyelitis

Ribs, skull, phalanx, pelvis, long bones

Grover et al.
TB: Skeletal Manifestations

In order of prevalence:

→ Pott’s Disease
→ Arthritis
→ Osteomyelitis (non-vertebral)
→ Epidural Abscess
→ Psoas Abscess

Companion Patient 10: TB Psoas Abscess

Worry about tracking down into groin

CT Abdomen, Axial, C+

Golden et al.
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At this point:

- HA, n/v → Ring enhancing lesions on MRI
- Back pain → Enhancing mass in T12 vertebral body
- Night sweats, weight loss
- Positive PPD, with hx of BCG vaccine
At this point:

-HA, n/v → Ring enhancing lesions on MRI

-Back pain → Enhancing mass in T12 vertebral body

-Night sweats, weight loss

-Positive PPD, with hx of BCG vaccine

Our Narrowed DDX:
TB
Endocarditis
Neoplastic (Lymphoma)
Infectious, other
OVERVIEW:

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3. Image the **CHEST**
   - Findings
   - Expected findings with TB
Results: CHEST

What would you start with?

Chest XR

If positive findings

Chest CT
Results: CHEST XR

Our Patient: Initial CXR AP

Right apical nodular opacities

Our Patient: Initial CXR Lateral
Results: CHEST CT

Our patient: Initial Chest CT

Right posterior apical cavitary lesion
## TB: Pulmonary Findings

**LESIONS: NON-SPECIFIC**

- Undetectable
- Focal Infiltrates
- Lobar Infiltrates
- CAVITATION *rare in primary*
- Caseating Granuloma
- Abscess
- Miliary Nodules
TB: Pulmonary Findings

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- Undetectable
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- Abscess
- Miliary Nodules

**LOCATION OF LESIONS:**

**Primary Infection:** Anywhere, Middle and Lower

** Reactivation:** Apical and posterior segments of upper lobe or upper segments of lower lobe

Jones, et al
TB: Pulmonary Findings

**LESIONS: NON-SPECIFIC**
- Undetectable
- Focal Infiltrates
- Lobar Infiltrates
- CAVITATION *rare in primary
- Caseating Granuloma
- Abscess
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**LOCATION OF LESIONS:**
- Primary Infection: Anywhere, Middle and Lower
- Reactivation: Apical and posterior segments of upper lobe or upper segments of lower lobe

**LYMPH NODES:**
- Ghon Lesion: Calcified parenchymal tuberculoma
- Ranke: Ghon Lesion + Calcified ipsilateral draining lymph node

**Companion Patient 11:**
Ghon Lesion and Ranke CompleX

*CT chest, Axial, C+*

*CT chest, Axial, C-*
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FINAL DIAGNOSIS

Our patient: CT – Guided T12 Biopsy

SPUTUM SAMPLE

Acid Fast Bacilli $\rightarrow$ Mycobacterium TB confirmed by NAAT

PACS, BIDMC
TREATMENT

“RIPE” Therapy:

Rifampin
Isoniazid
Pyrazinamide
Ethambutol

+ Moxifloxacin and IV Amikacin

For drug resistant TB, common in Tanzania

+ Dexamethasone
TREATMENT

Our patient: Initial CXR AP

Our patient: CXR 2 weeks s/p therapy
Patient X did well on the therapy outlined above. His HA, N/V, and back pain all resolved early after initiation of therapy. His imaging, as seen above, continued to improve accordingly.

After a long hospitalization, he was discharged home on antibiotics and a dexamethasone taper. He had outpatient follow up scheduled at TB Clinic and with Infectious Disease.

Our patient was found to be HIV negative and appeared otherwise immunocompetent, without any known exposures to TB. The etiology of his reactivation vs primary TB infection thus remains unclear.
Acknowledgements:

Gillian Lieberman, MD
Jennifer Steinkeler, MD
Komal Talati, MD
References:


References cont...


