A Journey Down The Canal

Radiological Assessment of Spinal Cord Masses

John Berry-Candelario HMS III
Gillian Lieberman, MD BIDMC
Objectives

- Patient review
- Anatomy of the spine
- Imaging techniques
- Classification of spinal masses
- Patients revisited!
Let’s meet our 2 patients
Patient #1 – History and presentation

HD is a 67 year old female who presents with lower extremity weakness for the past six months. It worsened in the last two months resulting in frequent non-traumatic falls.

Pertinent positive is urinary urgency.

PMH includes previous back surgery of unknown reasons.

Received myelogram, however results unavailable.

PE remarkable for decreased sensation from T7 down.
Patient #2 – History and presentation

CR is a 40 year old male who reported atypical leg soreness after riding of an all-terrain vehicle. Soreness was greater than after similar episodes of riding. Progressive weakness developed in the right leg.

Pertinent negatives are no difficulty with bowel or bladder function.

PMH and PE unremarkable.
Indications for imaging the spine

- Increased weakness in the lower extremities
- Changes in bowel or bladder function
- Saddle anesthesia – Sensory loss occurring over the buttocks, posterior-superior thigh and perianal region
Imaging Techniques
# Imaging Modalities of the Spine

<table>
<thead>
<tr>
<th>Imaging Modality</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain film</td>
<td>Modest visualization of the vertebrae, low cost, fast</td>
<td>No clarity of the fluids and soft tissue, radiation exposure</td>
</tr>
<tr>
<td>CT</td>
<td>Clear visualization of bony structures, some visualization of soft tissue structures</td>
<td>Limited visualization of soft tissue, radiation exposure,</td>
</tr>
<tr>
<td>MRI</td>
<td>Best modality for soft tissue visualization, no radiation exposure. Test of choice for lower extremity weakness and bowel/bladder dysfunction.</td>
<td>Difficult to evaluate cortical bone and calcifications, expensive relative to other modalities</td>
</tr>
<tr>
<td>CT Myelography</td>
<td>Used when MRI is contraindicated, allows visualization of spinal cord and nerve roots, can evaluate for lesions within the spinal canal</td>
<td>Invasive, involves the injection of contrast into the thecal sac</td>
</tr>
</tbody>
</table>
Let’s review spine anatomy!
Anatomy Review: Basics

- 31 Pairs of Spinal Nerves
  - 8 cervical
  - 12 thoracic
  - 5 lumbar
  - 5 sacral
  - 1 coccygeal

- Conus tapers at ~L1/2

- Cauda equina falls freely at this level
Anatomy Review: Vertebrae and Spinal nerves


http://www.backpain-guide.com/Chapter_Fig_folders/Ch05_Anatomy_Folder/Ch5_Images/05-4_Overall_Spine.jpg
Anatomy Review: Axial view of vertebrae

Eisen, A. Anatomy and localization of spinal cord disorders. In: UpToDate, Basow, DS (Ed), UpToDate, Waltham, MA, 2009
Anatomy Review: Cross section of spinal cord – Spinal nerves

Eisen, A. Anatomy and localization of spinal cord disorders. In: UpToDate, Basow, DS (Ed), UpToDate, Waltham, MA, 2009
Anatomy Review: Cross section of spinal cord – White matter tracts

Eisen, A. Anatomy and localization of spinal cord disorders. In: UpToDate, Basow DS (Ed) UpToDate Waltham MA, 2009
Spinal Cord Masses
Spinal Cord Masses

Anatomic Classification

1. **Extradural**
   - Arise outside the dura
   - From the osseous spine, intervertebral disc and adjacent soft tissue
   - Relevant imaging findings: Focal, exophytic mass displacing the thecal sac

2. **Intradural extramedullary**
   - Arise inside the dura but outside the spinal cord
   - **DISPLACES THE SPINAL CORD**

3. **Intradural intramedullary**
   - Arise from the spinal cord
   - Most common lesions are malignant neoplasms in the form of glioma
Intraspinal Masses

Intradural

Intramedullary

Extradural

Extramedullary

Key:

3a-Develops outside spinal cord but potentially compresses nerves and blood vessels

3b-Invades from the bone. Typical of metastatic tumors

3c-Develops along soft tissue between the vertebrae.

http://www.mayoclinic.org/spinal-cord-tumors/types.html
Spinal Cord Masses - Subcategories

- Benign
- Cystic (and other tumorlike masses)
- Malignant
- Metastases
Let’s identify a list of specific masses in these subcategories.
# Spinal Tumors

<table>
<thead>
<tr>
<th></th>
<th>Extradural</th>
<th>Intradural Extramedullary</th>
<th>Intradural Intramedullary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benign</strong></td>
<td>Hemangioma</td>
<td>Meningioma</td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td>Osteoid osteoma</td>
<td>Nerve sheath tumors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Osteochondroma</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cystic</strong></td>
<td>Synovial cyst</td>
<td>Epidermoid</td>
<td>Multiple Sclerosis</td>
</tr>
<tr>
<td></td>
<td>Arachnoid cyst</td>
<td>Dermoid</td>
<td>Syringomyelia</td>
</tr>
<tr>
<td></td>
<td>Eosinophilic granuloma</td>
<td></td>
<td>Transverse myelitis</td>
</tr>
<tr>
<td><strong>Malignant</strong></td>
<td>Chordoma</td>
<td>Rare</td>
<td>Ependymoma</td>
</tr>
<tr>
<td></td>
<td>Lymphoma</td>
<td></td>
<td>Astrocytoma</td>
</tr>
<tr>
<td></td>
<td>Sarcoma</td>
<td></td>
<td>Hemangioblastoma</td>
</tr>
<tr>
<td><strong>Metastases</strong></td>
<td>Breast</td>
<td>Seeding from the CNS</td>
<td>Breast</td>
</tr>
<tr>
<td></td>
<td>Lung</td>
<td></td>
<td>Lung</td>
</tr>
<tr>
<td></td>
<td>Prostate</td>
<td></td>
<td>Lymphoma</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leukemia</td>
</tr>
</tbody>
</table>
Benign

- Hemangioma
- Osteoid osteoma
- Osteochondroma
Companion Patient #1: Hemangioma on CT

CT with IV and oral contrast - Revealed a mass with low attenuation. Further work up only necessary if the patient was symptomatic.
Cysts and others tumorlike masses

- Synovial cysts
- Arachnoid cysts
- Eosinophilic granuloma
Companion Patient #2: Arachnoid on MRI

T1-weighted - Revealed a hypointense signal of a well-circumscribed mass that was compressing the spinal cord.

T2-weighted - Revealed a hyperintense signal of the same lesion.

Produced by URMC Radiology

http://www.urmc.rochester.edu/SMD/rad/Hollar_HTML/sld028.htm
Malignant

- Chordoma
- Lymphoma
- Sarcoma
  - Osteosarcoma
  - Chondrosarcoma
  - Multiple Myeloma
Companion Patient #3: Chondrosarcoma on MRI

T2 Sagittal with contrast- Demonstrates a large, well-circumscribed mass compressing the spinal cord. It enhances with a mixed signal but is mostly hyperintense.

Produced by URMC Radiology

http://www.urmc.rochester.edu/SMD-rad/Hollar.HTML/sld040.htm
Metastases

- MOST COMMON EXTRADURAL MALIGNANT CANCER
- Breast, lung, and prostate cancer are the most prevalent
- Initial site of lesion are the vertebral bodies
Metastases

T2 Sagittal with contrast - Demonstrates an enhancing hyperintense signal. It is a poorly-marginated mass compressing the spinal cord.

Produced by URMC

http://www.urmc.rochester.edu/SMD-rad/Hollar.HTML/sld048.htm
Intradural Extramedullary
Benign

- Meningioma
- Nerve sheath tumors
  - Neurofibroma
  - Schwannoma
Meningioma

T1 SAGITTAL with contrast - Demonstrates a moderately enhancing, well-circumscribed mass.

T1 AXIAL with contrast - Demonstrates displacement of the spinal cord.

Produced by URMC

http://www.urmc.rochester.edu/SMD/rad/Hollar_HTML/sld057.htm
Cysts and other masses

- Epidermoid
- Dermoid
Dermoid

T2 Sagittal

T1 Sagittal

Produced by URMC

http://www.urmc.rochester.edu/SMD/rad/Hollar_HTML/sld064.htm
Metastases

- Can arise from inside or outside the CNS
- Usually findings are discovered in the lumbosacral region
Intradural Intramedullary
Cysts and other masses

- Multiple Sclerosis
- Syringomyelia
- Transverse Myelitis
Syringomyelia

T1 Sagittal with contrast

T2 Sagittal

Produced by URMC

http://www.urmc.rochester.edu/SMD.rad/Hollar_HTML/sld074.htm
Malignant

- Ependymoma
- Astrocytoma
- Hemangioblastoma
Astrocytoma

T2 Sagittal  

T2 Sagittal  

T1 Sagittal

Produced by URMC

http://www.urmc.rochester.edu/SMD.rad/Hollar_HTML/sld087.htm
Metastases

- Rare
- Primary malignancies include: breast, lung, lymphoma, leukemia, and malignant melanoma
Metastases

T1-weighted with contrast

Produced by URMC

http://www.urmc.rochester.edu/SMD.rad/Hollar_HTML/sld093.htm
Patients Revisited
1.6x2.4cm mass lesion in the thoracic spinal canal at T6-T7.
What is happening to the spinal cord?

Displacement

T2 Axial No Contrast – This image demonstrates the intradural, extramedullary location of the mass.
Patient HD

What is that?

T2 Axial Post-gadolinium contrast
T2 Axial Post-gadolinium contrast – Indicates an enhancing lesion with a dural tail.
CT Sagittal Reformatted – Calicifed component of the intradural mass. Notice the lack of bone involvement above and below the lesion.
Patient HD

- Differential Diagnosis includes:
  - Nerve Sheath Tumor
  - Meningioma
  - Metastases

- What’s next?
  - Biopsy specimens
Patient HD

Pathology Report

- Multiple fragments of soft tissue in one section
- Multiple fragments of white and erythematous soft and bony tissue
- No atypical features
Patient HD - definitive diagnosis

MENINGIOMA
Patient HD - Epilogue

SY was discharged home after surgery under normal instructions.
Appointment made for surgical follow up visit in 7-10 days.
Brain tumor clinic visit set for July.
Patient CR

T2 Sagittal without contrast – Indicates an intramedullary mass at ~T11/T12 that is nodular yet irregular, measuring 2.1x1.0 cm AP x 1.3 cm transverse.
T1 Axial and Sagittal with contrast – Indicates an enhancing intramedullary mass at ~T11/T12.
Patient CR

- **Differential Diagnosis includes:**
  - Primary Spinal intramedullary masses
    - Ependymoma
    - Astrocytoma
    - Hemangioblastoma

- **What’s next?**
  - Biopsy specimen
Patient CR

- Intraoperative smears revealed a glioma producing many glial processes.
- Nuclear pleomorphism
- Permanent Section revealed infiltration and significant anaplasia
- Mitotic figures identified
Patient CR - definitive diagnosis

ANAPLASTIC ASTROCYTOMA
Patient CR - Epilogue

RB’s diagnosis resulted in nonsurgical management – chemotherapy.

Despite a stable recovery and no growth to the masses at 3 month follow up, RB’s condition began to deteriorate. Neurological deficits increased. Numerous comorbidities developed.

RB was discharged from BIDMC to palliative care; therapy was ceased.

RB receives pain management.
Recap

- Review of the anatomy of the spine and its functional correlates
- Explored the different anatomical classification of spinal masses
- Identified MRI with IV-contrast as the test of choice for spinal masses
- Utilized this imaging modality to demonstrate spinal masses for patients reporting lower extremity weakness and/or bowel/bladder dysfunction
Acknowledgments

- Jean-Marc Gauguet, MD PhD
- Alice Fisher, MD
- Jay Pahade, MD
- Nagamani Peri, MD
- Rafael Rojas, MD
- Gillian Lieberman, MD
- Maria Levantakis