Imaging of the Malignant Spine

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Imaging of the Malignant Spine

Learning Objectives

- Basic understanding of the anatomy of the spine
- What imaging modalities are best suited to image the spine
- Understand the most common findings of cancer and treatment changes on the spine
- Become aware of some of the newer imaging techniques to evaluate the spine

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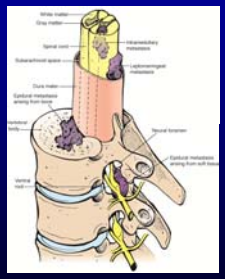
Spine Anatomy and Terminology

- Epidural
- Intradural
- Intramedullary



Stubblefield MD and O'Dell MW, editors. Cancer Rehabilitation: Principles and Practice. 2009

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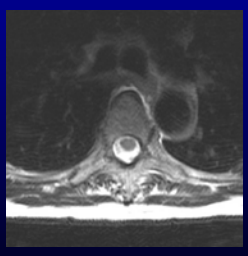
Spine Anatomy and Terminology

Post myelogram axial CT

MRI Axial T2



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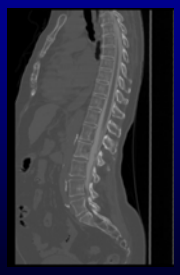
Spine Anatomy and Terminology

Sagittal CT

axial CT



MRI Axial T2

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Imaging Options

MRI

CT

Myelography

Plain Films

Bone scan

PET-CT

The primary goal is to identify disease to allow early intervention and to prevent neurological deterioration

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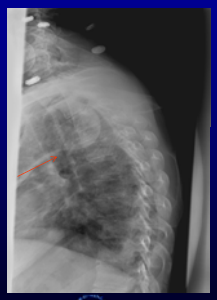
Plain films

- Quick & easy, but often don't tell the whole story
- Up to 50% of bone needs to be destroyed before lesion is visible on radiographs
- Can identify collapse deformities
- Best to look at hardware



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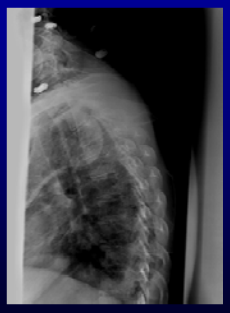
Plain Films



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Plain Films

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Plain Films

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Bone Scan

- More sensitive than plain films for detecting spine metastasis
- Often also abnormal by disease processes other than tumor-degenerative change
- Some tumors such as multiple myeloma or tumors limited to the marrow are not detected
- Can identify non spinal bone lesions that maybe accounting for symptoms

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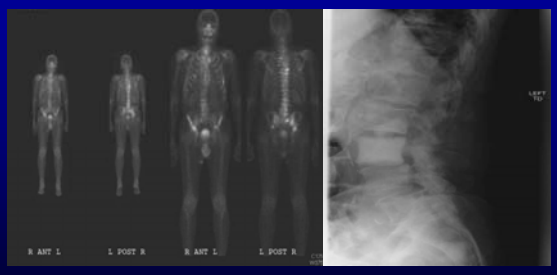
Bone Scan



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Positron Emission Tomography

- Most common tracer is radioactive Fluorodeoxyglucose (^{18}F-FDG)
- Often combined with CT
- Standarized uptake value (SUV)
- Other tracer becoming available

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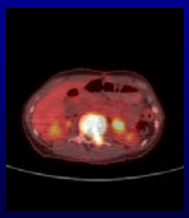
FDG-PET



Metastatic melanoma

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Computed Tomography

- Quick, 8-16-32-64 slice scanners can cover the entire spine under 2 minutes.
- Often available 24/7
- Sagittal and coronal reformations
- Intravenous contrast can help identify soft tissue components
- Usually complimentary to either Myelography or MRI or FDG-PET

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Computed tomography

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Computed tomography

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Computed Tomography

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Myelography

- Invasive procedure
- Often combined with a post myelogram CT
- Largely replaced by MRI
- Used in patients that have a contraindication to MRI or those patients that have spinal instrumentation that degrades MR imaging.

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Myelography

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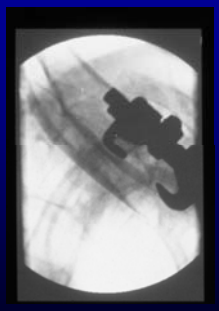
Myelography



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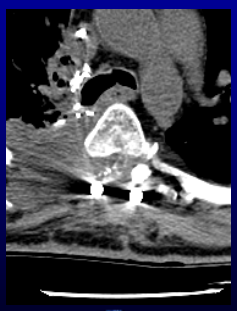
Myelography



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Magnetic Resonance Imaging

- The workhorse of oncologic spine imaging
- Increased availability and accessibility
- Noninvasive
- High tissue contrast
- Multiplanar capabilities
- Most sensitive and specific modality for imaging spine abnormalities

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Magnetic Resonance Imaging

T1 T1 contrast FSE-T2 T2-STIR

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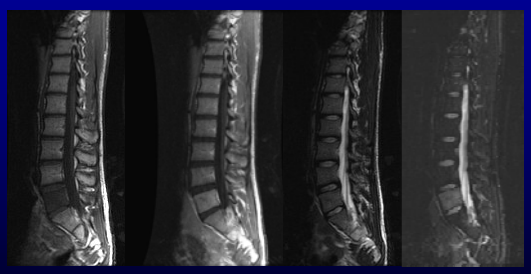
Typical appearing bone metastasis on MRI



T1 | T1 contrast | FSE-T2 | T2-STIR

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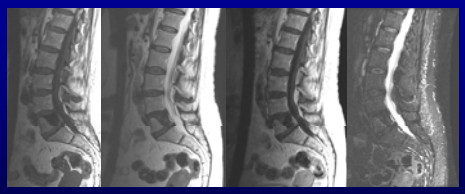
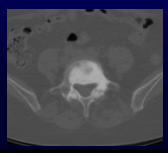
Sclerotic Metastasis





Typically remain “dark” on all sequences

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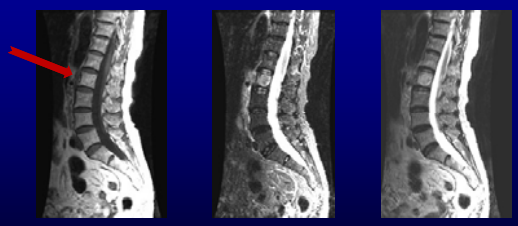
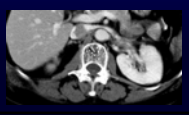
Most common benign tumor Hemangioma





Hemangiomas are typically “bright "on all sequences

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Radiation Change

Pre RT

Post RT

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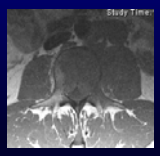
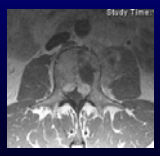
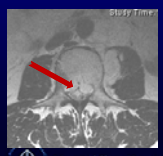
Epidural Disease typically starts in the vertebrae







The ventral epidural disease held in check by the posterior longitudinal ligament

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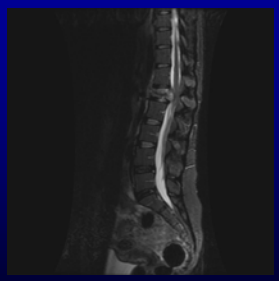
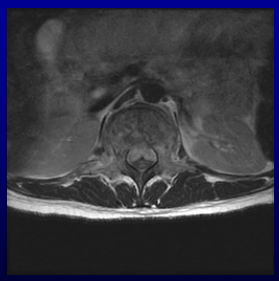
Epidural Disease





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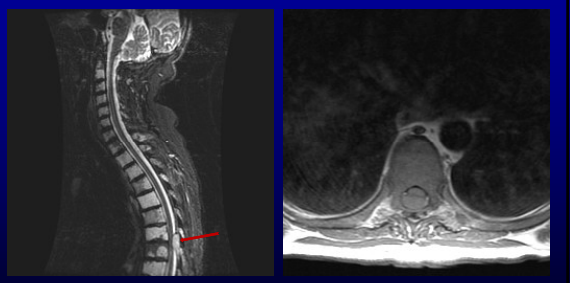
Epidural Disease



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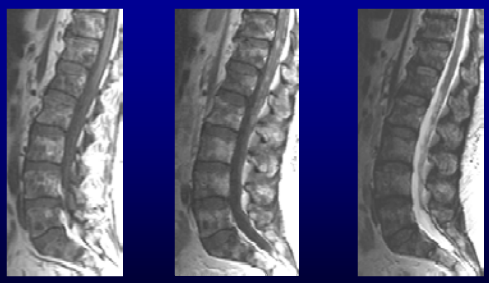
Intradural Leptomeningeal Disease



T1 | T1 contrast | T-2

Often leptomeningeal disease cannot be seen without intravenous contrast

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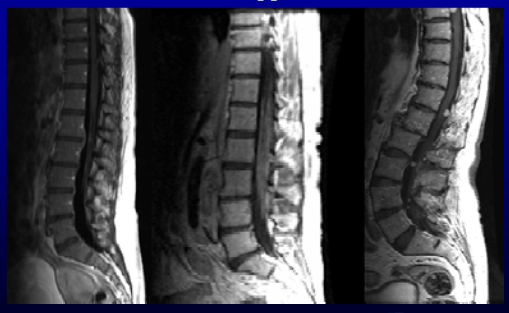
Leptomeningeal Disease

Different appearances



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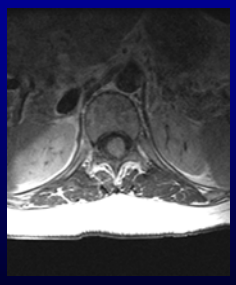
Intramedullary Disease
Spinal Cord metastasis



Much less common than epidural or leptomeningeal disease
Often associated with concurrent brain metastasis

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Advanced Imaging of the Spine

Magnetic resonance imaging
- Faster imaging
- DCE: Perfusion imaging
- Diffusion weighted imaging
- Neurography
- Tractography
- Spectroscopy

Computed Tomography
- Dual Energy CT scanners
- Better soft tissue contrast

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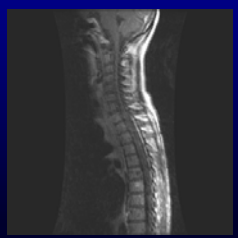
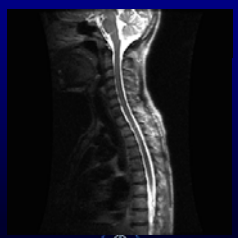
Ultrafast Techniques: Half-Nex single shot

Can compensate for patient motion at the expense of lesion conspicuity





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Dynamic Contrast Enhancement: MR Perfusion Imaging

- Asses vascularity
- Determine capillary density
- Determine permeability
- Potential to evaluate spine lesions before and after therapy
- Identify early failures: treatment modification
- Easily combined with DWI and standard MRI

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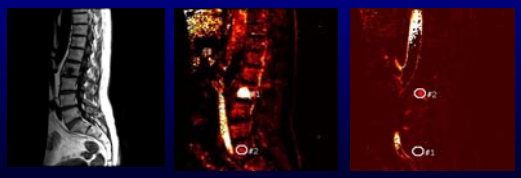
Materials and Methods

- V_p and K_{trans} of the metastasis were normalized as a ratio to adjacent nonirradiated marrow and compared pre and 1 hour post RT



T1 Ktrans Vp

L2 metastatic prostate

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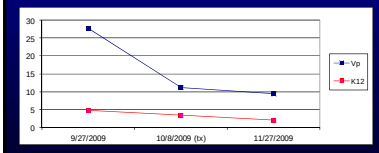
Materials and Methods

- Ratios of V_p and K_{trans} to adjacent marrow were plotted on a graph. Percent change Pre and one hour Post RT also computed.



L2	% change from baseline
V_p	-60%
K_{trans}	-29%

L2 metastatic prostate

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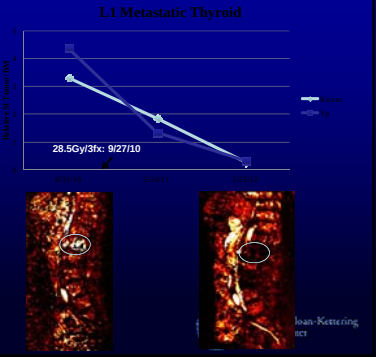
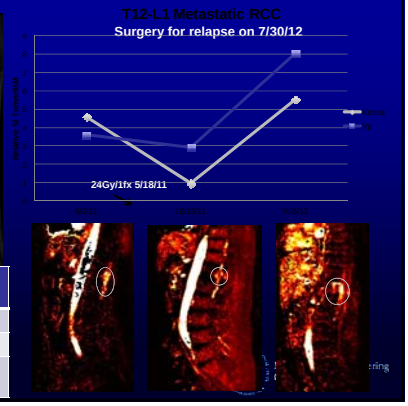
Metastatic Thyroid Cancer

LC at 18 mo FU



LC	% Change from BL	
#128	V_p	K_{trans}
8 mos	-69%	-44%
14 mos	-92%	-92%

Local Recurrence



LR	% Change from BL	
#40	V_p	K_{trans}
5 mos	-18%	-79%
14 mos	+49%	+20%

Preliminary Results

- Local control (n=19)
  - Average **V_p decreased 66%**
  - Average **K_{trans} decreased 50%**
- Local recurrence (n=4)
  - Average **V_p *increased* 41%**
  - Average **K_{trans} *increased* 4%**
- K_{trans}: **p=0.013**; V_p: **p=0.0007**

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Preliminary Results

- Local control (n=19)
  - Average **V_p decreased 66%**
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- Local recurrence (n=4)
  - – Average **V_p *increased* 41%**
  - – Average **K_{trans} *increased* 4%**
- K_{trans}: **p=0.013**; V_p: **p=0.0007**

Predicted local tumor recurrence at least 6 months before standard imaging

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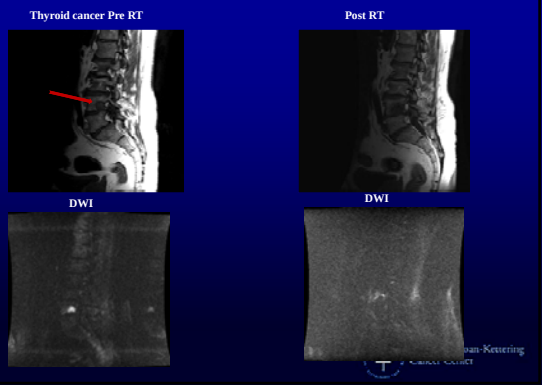
Diffusion Weighted Imaging



Diffusion Neurography-Tractography

- Imaging based on molecular water motion
- Takes advantage of differences in the diffusibility of water in nerves and adjacent soft tissues
- The magnitude and direction of flow can also be determined-tractography

Filler,A. Neurosurgery, 2009

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Diffusion Neurography-Tractography

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Diffusion Neurography-Tractography

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Dual Energy Computed Tomography

Better tissue contrast

Reduce metal artifact

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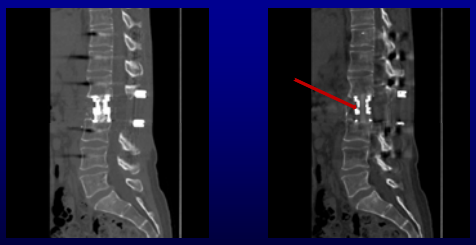
Dual Energy Computed Tomography
Metal Artifact Reduction Software



Decreased artifact from the hardware allows visualization of the bone graft in the vertebral cage

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Thank You

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