THE LIGHT AT THE END OF THE TUNNEL

LINDSAY J. ROWE

M.App.Sc (Chiropractic), M.D.,
D.A.C.B.R., F.C.C.R.(C), F.A.C.C.R., F.I.C.C., F.MSK.R., F.R.A.N.Z.C.R.

ASSOCIATE PROFESSOR, DIAGNOSTIC RADIOLOGY
Faculty of Medicine
University of Newcastle
Newcastle, Australia

ADJUNCT PROFESSOR
School of Chiropractic
Murdoch University
Perth, Western Australia

ADJUNCT PROFESSOR
School of Chiropractic
North Western Health Sciences University
Minneapolis, USA

SENIOR STAFF SPECIALIST RADIOLOGIST
Department of Medical Imaging
John Hunter Hospital
Newcastle, Australia

LINDSAY J. ROWE

M.App.Sc (Chiropractic), M.D.,
D.A.C.B.R., F.C.C.R.(C), F.A.C.C.R., F.I.C.C., F.MSK.R., F.R.A.N.Z.C.R.

Dr. Lindsay J. Rowe, Chiropractor, Medical Doctor, Radiologist, Educator and Author is well known in the Chiropractic Profession. He is a unique presenter using diagnostic imaging as the medium to blend knowledge, experience and humour with perspectives from both chiropractic and medical viewpoints unique in the healing professions.

Dr. Rowe received his Chiropractic degree with honours in 1979 from the Royal Melbourne Institute of Technology in Melbourne, Australia. He subsequently qualified as a chiropractic radiologist, became chairman and Head of Departments at Canadian Memorial Chiropractic College in Toronto, Canada and North Western College of Chiropractic in Minneapolis, United States.

In 1993 he graduated in Medicine in Newcastle Australia and after extensive hospital experience qualified as a Consultant Diagnostic Radiologist in 1999 and became a Fellow in Musculoskeletal Radiology from the University of California, San Diego. Since 2000 he has practised diagnostic and interventional radiology in Newcastle as Associate Professor in Radiology and Senior Staff Specialist Radiologist. During 2005 to 2008 he has been involved with Upright Weight Bearing MR for spinal disorders.

There is great demand for his presentations around the globe to provide practitioners with the knowledge and expertise in diagnostic imaging relevant to their practice. In this conference there will be a focus on participants grasping the fundamentals of interpretation of Magnetic Resonance Imaging (MRI) especially of the spine. This is achieved by a synthesis of skills and knowledge derived from clinical practice, plain film radiography, anatomy and pathology.

With the spectacular technological advances in imaging the gap between clinical practice and incorporating findings into appropriate management has been on divergent paths. This conference is aimed at narrowing this chasm and making a difference to those that seek your care.

THE PROGRAM

I. OVERVIEW
1. IMAGE MODALITY SELECTION
A. REVIEW OF "RED FLAGS"

Red Flag Item	Description	Rationale	Imaging
Trauma	History of minor or major trauma, motor vehicle accident, fall, strenuous lifting	Possible fracture, especially in an older or osteoporotic patient	X-Ray CT MR
Age	50 years or more	Increased risk of cancer, abdominal aortic aneurysm, fracture, infection	MR CT
History of cancer	Past or present history of any type of cancer	History of cancer increases the risk of cancer-causing low back pain. Back pain may be caused by metastic tumors arising from the kidney, thyroid, prostate, breast, lung	MR Bone Scan
Fever, chills, night sweats	Fever over 100 degrees Fahrenheit, a sensation of being cold, waking up sweating, temperature changes at night	Constitutional symptoms may increase the risk of infection or cancer	MR
Weight loss	Unexplained weight loss of over 10 pounds in 3 months, not directly related to a change in activity or diet	May be indicative of infection or cancer	MR CT
Recent infection	Recent bacterial infection such as a urinary tract infection	Increases the risk of infection	MR
Immunosuppression	Immunosuppresssion resulting from a transplant, intravenous drug abuse, or prolonged steroid use	Increases the risk of infection	MR
Rest/night pain	Pain that is not relieved with rest or awakens a patient at night, unrelated to movement or positioning	Increases the risk of cancer, infection, or an abdominal aortic aneurysm	MR
Saddle anesthesia	Absence of sensation in the second-fifth sacral nerve roots, the peri-anal region	Cauda equina syndrome	MR CT
Bladder dysfunction	Urinary retention, changes in frequency of urination, incontinence, dysuria, hematuria	May indicate cauda equina syndrome or infection	MR CT
Lower extremity neurological deficit	Progressive or severe neurological deficit in the lower extremity	May indicate cauda equina syndrome	MR

B. SPINAL IMAGING MODALITIES

1. CONVENTIONAL IMAGING

DIGITAL IMAGING

- No cassette
- No film
- No Chemistry
- Laser Printers

PACS

- Patient Archive Communication System
- All images with reports
- Can be recalled remotely on PC
- Web-based accessed

INTERPRETATIONS

- High resolution monitors
- Image manipulation
- Remote reporting
- Comparison examinations

INDICATIONS

- Biomechanics
- Anomalies
- Degenerative Changes
- Inflammatory arthropathies
- Fractures
- Infections
- Neoplasms
- Osteoporosis

2. MAGNETIC RESONANCE IMAGING

Patient Comfort

- Short scanning times
- Larger bore diameter
- Shorter bore length

Fast Image Acquisition

- Improved coil and gradient technology

Detail Resolution

- Small lesions

Upright Weight Bearing Studies

- Compression pathology
- Disc derangements
- Dynamic studies

INDICATIONS

- Anomalies
- Degenerative Changes
- Disc disease
- Inflammatory arthropathies
- Fractures
- Infections
- Neoplasms
- Osteoporosis
- Spinal cord/nerve disease
- Muscle disease

3. COMPUTED TOMOGRAPHY

NEW DEVELOPMENTS

HELICAL CT

MULTISLICE TECHNOLOGY

Patient Comfort
- Short scanning time
- Smaller contrast dose
- Continuous Imaging
- Volume acquisition

Fast Image Acquisition
- Vascular phase

Detail Resolution
- "Isotropic Imaging"
- Multiplanar reconstructions, 3D, 4D
- Smaller calculi, smaller lesions, smaller bone lesions

CTA- CT Angiography
- Peripheral venous injection
- Scan in arterial phase

4. ULTRASOUND

High resolution musculoskeletal probes

Doppler vascular imaging

5. NUCLEAR MEDICINE

CT capability
- CT-SPECT

PET scanning

6. INTERVENTIONAL RADIOLOGY

Facet blocks: Medial Branch blocks

Discography: Pattern of extravasation best depicted by CT
- Some advocating MRI

Myelography: Replaced by MR
- Performed with CT when MR can't be done

Epidural steroid injections
- Often performed blindly
- Needle placement confirmed best with CT

Biopsy
- Guided with CT sometimes with CT-flouroscopy

Vertebroplasty
- Placement of bone cement in vertebral body
- For osteoporotic compression fractures

2. PRINCIPLES OF MR PHYSICS

A. EQUIPMENT

ROOM

- Lined by Faraday cage and copper
- Elimination of external radiofrequency waves, cosmic radiation
- Provides uniform magnetic free environment

TABLE

- Non ferromagnetic
- Patient lies supine on it
- Patient holds an emergency button and presses if wishes to stop

MAGNET

- Superconducting
    - Super cooled by liquid helium to 20-70 Kelvin
    - Must provide uniform magnetic field
    - One end north, one end south ("Bo")
- Bore
    - Hole in the middle
        - Determines size of patient accepted
        - Magnetic field best at epicentre

GRADIENT COILS

- Change magnetic field slightly from head to foot
- Allows slice selection location and plane of imaging
- System which produces loud noise during examination

SURFACE RADIOFREQUENCY COIL

- Functions as a "send and receive" device
- Focuses RF pulse to exact location, thickness and intensity
- Specific coils for specific body parts
- Placed over body part to be imaged
- Receives signal emitted from body part by location and intensity

CONTROL CONSOLE

- Technologist drives the machine
- Selects imaging parameters
- Talks to patient
- Manipulate images

B. PHYSICS

THE PROTON DANCE

SUMMARY

- Random spin, random tilt of H protons
- In the magnet, tilt North-South, Spin at same rate
- RF pulsed from the side of North-South
- H protons gain energy from RF
    - Tilt out of North-South alignment, spin same
    - RF pulse turned off, protons come back to North-South
        - Give off energy as RF wave ("signal")
        - Spin becomes asynchronous between protons
    - Signal measured
        - Strength (whiteness = high signal = more H)

C. IMAGING PLANES

AXIAL

SAGITTAL

CORONAL

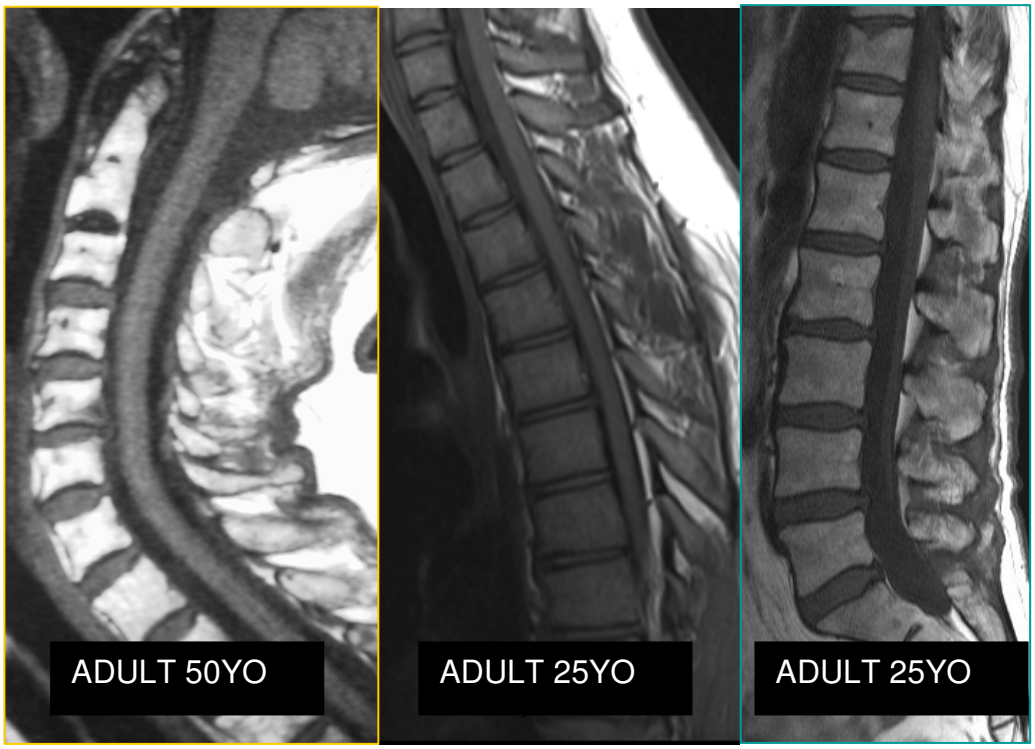
D. IMAGING SEQUENCES

T1
T2
PROTON DENSITY (PD)
STIR
GRADIENT ECHO
FAT SATURATION
GADOLINIUM
MR ANGIOGRAPHY (MRA)

T1 SEQUENCE

"Short-Short": Short TR (<800msec), Short TE (<30msec)

STRENGTHS	***WEAKNESS***
Anatomical detail	Does not show edema
Fat, subacute blood	
Marrow pathology	



Fat will be bright, water intermediate signal. Note fatty (yellow) marrow in 50yo, red marrow in 25 yo.

T2 SEQUENCE

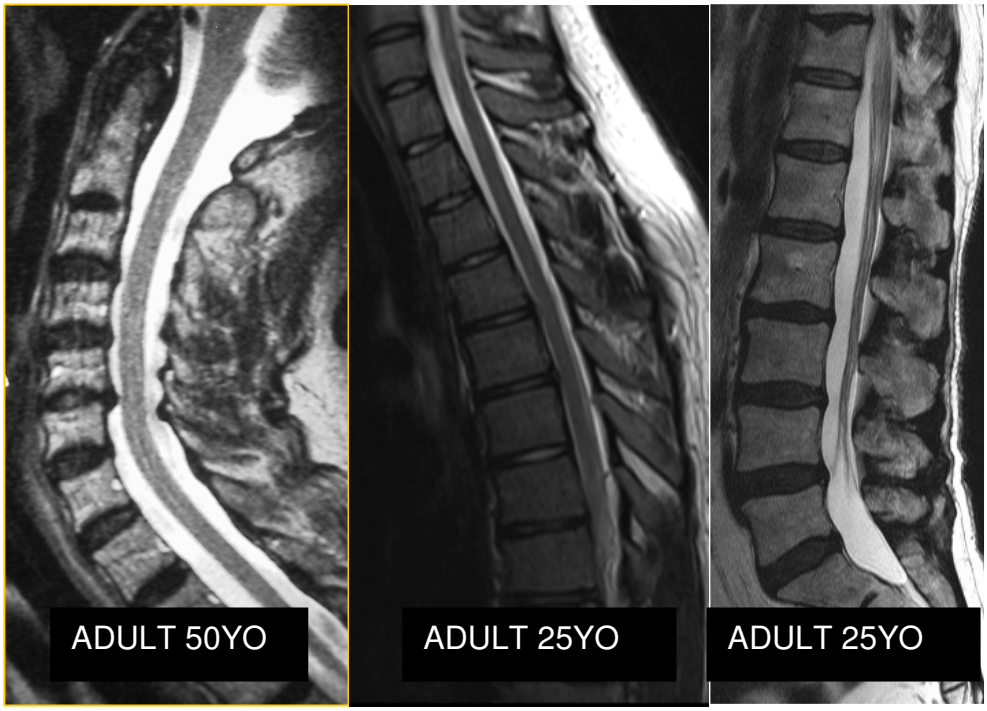
"Long-Long": Long TR (>2000msec), Long TE (60msec)

STRENGTHS

- Detection of water
- Detection of edema

WEAKNESS

- Longer imaging time
- May not show subtle edema



Water will be high signal (T2=H2O), fat remains high signal.

PD SEQUENCE

"Short-Long" (internmediate) TR>1000msec, TE<30msec

Use especially in extremities

STRENGTHS

- Anatomical detail
- T1 and T2 properties
- Good for tendons

WEAKNESS

- Edema not always visible
- Poor tissue contrast ("flat")

STIR SEQUENCE

TR>2000msec TE>30msec

Apply an inversion pulse first

- Enhances water signal
- Cancels effects of fat ("fat saturation")

STRENGTHS

- Enhances edema
- Inherent fat saturation
- Long section imaging
- Wide field of view

WEAKNESS

- Poor anatomical detail
- Long imaging time
- Motion artifact

T1 FS GADOLINIUM SEQUENCE

Gadolinium is paramagnetic and best depicted on T1 images

Combine with fat saturation

Takes away high signal on T1 of normal fat

Anything bright will be due to gad enhancement

STRENGTHS

Any condition which has vascular permeability will enhance

Scar, infection, tumour operative sites, trauma

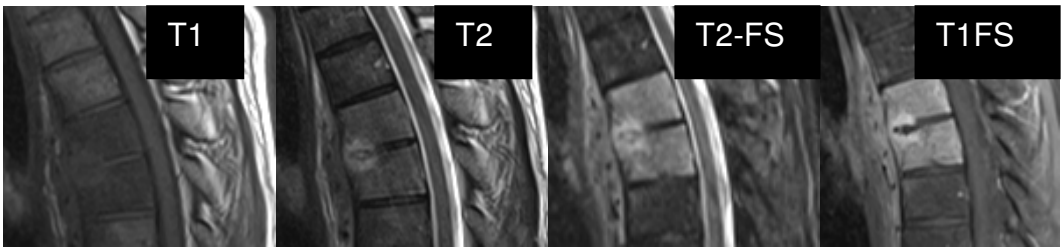
WEAKNESS

Must have normal renal function

Risk of systemic nephrogenic fibrosis

Must use in combination with fat saturation (t1=bright fat)

Enhancement is non-specific-many causes



MRA

Magnetic Resonance Angiography

Use flow void of moving blood ("black blood technique")

STRENGTHS

Show arterial vessels

No contrast required

Excellent for large to medium vessels

WEAKNESS

Aneurysm may not fill

Slow / turbulent flow

Small vessel detail poor

Calcium not well seen

SUMMARY OF SEQUENCE UTILITY

SEQUENCE	STRENGTH	WEAKNESS
T1	Anatomical detail Fat, subacute blood Marrow pathology Use with Gadolinium	Does not show edema Bone detail lacking
T2	Detection of water Detection of edema Longer imaging time Good with hardware	Need Fat Saturation to show marrow edema May not show subtle edema Fast spin echo makes fat bright
PD	Anatomical detail T1 and T2 properties Good for tendons	Edema not always visible Poor tissue contrast (“flat”)
STIR	Enhances edema Inherent fat saturation Long section imaging	Poor anatomical detail Long imaging time
T1 FS GAD	Enhances inflammation Vascular permeability Many conditions enhance-scar, infection, tumour, surgery	Must have normal renal function Risk of systemic nephrogenic fibrosis Must use in combination with fat saturation Enhancement is non-specific
MRA	Show arterial vessels No contrast required Excellent for large to medium vessels	Aneurysm may not fill Slow / turbulent flow artefacts Small vessel detail poor Calcium not well seen

PATIENT PREPARATION

- Clear on indications
- Clarify cost
- Take previous studies
- Warnings
    - Exclude contraindications
    - Claustrophobia
    - Noise
    - Length of examination
    - Need for Gadolinium

MRI CONTRAINDICATIONS

- Ferromagnetic material
    - Orbit metallic foreign body
    - Cardiac pacemakers
    - Some heart valves
    - Cochlear implants
    - Jewellery
    - Tattoos
    - Acupuncture needles
- Body habitus
- Claustraphobia

II. CERVICAL SPINE

1. NORMAL ANATOMY – PRINCIPLES OF INTERPRETATION

CERVICAL SPINE SEQUENCES

BASIC

SAGITTAL T1
SAGITTAL T2
AXIAL T2

ADDITIONAL

SAGITTAL STIR
SAGITTAL GRADIENT ECHO
T1 FS

METHOD OF INTERPRETATION

1. *IDENTIFY THE PATIENT*
2. *IDENTIFY AND INTERPRET SCOUT IMAGES*

3. *LOCATE SAGITTAL T2*
   Find mid sagittal image
   Follow parasagittal images left and right to IVF
   A: Alignment
   B: Marrow signal
   C: Disc spaces, facet joints
   S: Spinal cord, soft tissues (anterior, posterior)

4. *LOCATE SAGITTAL T1*
   Repeat as for T2 but look carefully at-
      Bone marrow signal
      Ligaments

5. *LOCATE AXIAL T2*
   Start at highest level and identify disc levels
   Find pedicles, disc space is just above
   Identify posterior disc margin and note shape and size
   Identify the spinal cord and subarachnoid space
   Locate exiting nerve roots

LIST OF CERVICAL SPINE ANATOMICAL STRUCTURES

ATLAS

- Anterior arch
- Atlantodental interspace
- Lateral masses
- Posterior arch

AXIS

- Dens
- Facet joints

C3-C7, T1-T3

- Disc
  - Hydration
  - Height
  - Posterior shape
- Vertebral body
  - Shape
  - Marrow signal
  - Discovertebral junction
- Spinal cord

POSTERIOR SOFT TISSUES

- Splenius cervices
- Ligamentum flavum
- Facet joint capsule
- Posterior longitudinal ligament

ANTERIOR SOFT TISSUES

- Retropharyngeal
- Retrolaryngeal
- Carotid and vertebral arteries
- Thyroid

2. DISC DISEASE

- Assess
  - Disc height
  - Disc Hydration
  - Osteophytes
  - Posterior disc margin
  - Discovertebral junction
  - Central canal size
  - Lateral canal size

- C6-C7 most common level followed by C5-C6
- CT has sensitivity of 80% (lack of epidural fat)
- MRI has sensitivity of 95% plus
- “Hard disc herniation”: osteophytes at posterior border
  - (low T1 and T2 signal)
- “Soft disc herniation”: no osteophytes.
- Assess nerve root compression on
  - T1 sagittals
  - T2 axial

DISCOVERTEBRAL CHANGES (MODIC CHANGES)

Parallel with disc degeneration

TYPE I: ***High T2, intermediate T1***

Linked to painful in level 80% of cases (?)

Often progress to non painful Type II

TYPE II: ***High T1, intermediate to high T2***

Non painful

TYPE III: End plate sclerosis (hemispherical spondylosclerosis).

Non painful

CLASSIFICATION	T1	T2	COMMENTS
TYPE I	LOW	HIGH	Vascularised fibrous tissue
TYPE II	HIGH	INTERMEDIATE	Fatty Marrow
TYPE III	LOW	LOW	Bone Sclerosis

3. FACET DISEASE

Best seen on sagittal T1 and T2

Elongated facet surfaces

Subchondral edema

Degenerative slip of segment above

(degenerative spondylolisthesis)

Synovial cyst occasionally

Narrow central and lateral canals (stenosis)

4. BONE DISEASE

MALIGNANT TUMORS

Most common tumours:

Primary Tumors (33%)

Multiple Myeloma

Lymphoma

Chordoma

Secondary (Metastatic) Tumors (66%)

Osteolytic (66%)

Osteoblastic (20%)

Mixed (5%)

METASTATIC TUMORS

Osteolytic

Primary Sites - Females: Breast, lung, colon

Males: Lung, colon, prostate

First lesion discovered in bone in 25% of cases

XR: 30-50% loss of bone density before visible

Loss of cortex-trabeculae: pedicle destruction

("one-eyed pedicle sign")

Pathological collapse: *Vertebra plana*

Loss of anterior and posterior body heights

CT: Subtle destruction signs

MRI: for bone involvement and cord involvement

High on T2, Intermediate on T1

High on STIR

Gad enhaancement

Osteoblastic

Solitary or multiple lesions
Large or small lesions
"Ivory" vertebra: Entire vertebral sclerotic density usually *without* expansion.
MR: T1 Low T2 Low

MULTIPLE MYELOMA

AKA: Myelomatosis, Kahler's disease

Most common primary malignant tumor of bone
uspect in any patient above 50 years who has widespread pain,
Blood test often first clue
ESR up, anemia, reversed A:G ratio, abnormal proteins (gamma globulins), high ca++
Imaging often lags behind presentation

XR: Frequently normal
Diffuse osteopenia
Pathological fractures (vertebra plana)
DDX: metastatic, myeloma, osteoporosis
Discrete localised medullary lesions ("punched out")
MR technique of choice
Intermediate on T1, High to intermediate on T2, STIR high
Variable Gad enhancement

PLASMACYTOMA

Variant presentation
40-50 years old, few symptoms, single lesion often multi septated
Spine, pelvis, ribs
Transforms to multiple myeloma in 66% of cases within 10 years.

BENIGN TUMORS

HEMANGIOMA

Most common benign tumour of the spine; 11% of autopsies
T10-L2 most common; least common in cervical spine
Most remain asymptomatic except if
Soft tissue mass
Often enlarges during pregnancy
Involve the posterior elements (uncommon)
Show large cystic spaces

XR: Normal
"Corduroy cloth" appearance: Accentuated vertical trabeculae

CT: *"Spotted vertebra":* On CT thickened
Trabeculae seen in cross section as dots.

MRI: Three patterns:

I. High signal on T1 due to fat, intermediate on T2 (diagnostic pattern)
II. High signal on T1 and T2 due to hypervascularity and inflammatory change
III. Intermendiate on T1 and T2 due to marrow fibrosis.

5. INFECTIONS

Uncommon but greater incidence within persons who are:

Immunocompromised: HIV, alcoholics, drug addicts, diabetics, illness

"S" joints: SI, symphisis, spine, sternoclavicular

Recent surgery: oral or elsewhere, spinal intervention

Recent infection: may be minor skin irritation or urinary infection

Lumbar > Thoracic> Cervical > SI

Seeds usually by hematogenous route of Batson's venous plexus

Staphylococcus most common; less common E.coli, and TB

Pain, fever and malaise

Imaging findings lags behind clinical presentation ("radiographic lag time")

XR: 21 days latent period

Classic triad: Loss of disc height
Destroyed contiguous end plates
Soft tissue swelling

Heals by ankylosis

Bone scan: positive in less than 24 hours- use white cell label technique

CT: End plate destruction, paravertebral swelling.

MRI: Bone marrow edema (T2), fluid in disc, paravertebral swelling

Demonstration of complicating extradural abscess.

6. SPINAL CORD DISEASE

MYELOPATHY

Chronic degenerative disease of the spinal cord axons

Most commonly due to loss of axons from chronic ischemia

Cervical spine in 90% of cases

Ataxia, upper limb hyper-reflexia, Lhermitte's sign

Causes: Spinal stenosis- congenital, degenerative disc-facet disease

Trauma- axonal rupture

Infection- transverse myelitis, Gullain-Barre

Vasculitis- Lupus

Vasculopathy- Diabetes, aortic surgery, prolonged hypotension

Demyelinating disease : MS

MRI findings: Cord atrophy (smaller)

High intrinsic cord signal on T2 or (STIR/FLAIR)

SYRINX

Cavity in the spinal cord

Expansion of normal central canal of the cord

Causes- Idiopathic (syringomyelia)
Trauma
Tumour

CORD TRAUMA

Varities of injury with different prognoses.

Spinal cord shock (concussion)

Neurological dysfunction - normal MRI

RECOVERY IN WEEKS

Spinal cord contusion

Neurological dysfunction with abnormal high signal on T2 (edema) only

USUALLY RECOVER OVER MONTHS WITH VARIABLE DISABILITY

Diffuse axonal injury (DAI)

High signal on T1 (Hemorrhage) and T2 (edema)

PERMANENT INJURY

Cord atrophy and post traumatic syrinx

Sign of axonal damage and gliosis.

Central fluid filled cavity on T2 and small diameter cord

SCIWORA: Spinal cord injury without radiographic abnormality.

CORD TUMOUR

Make up less than 5% of spine tumors

Sites: EXTRADURAL: Outside the dura
INTRADURAL: Within the dura
INTRAMEDULLARY: Within the cord

MRI technique of choice but often seen on CT but less sensitive

EXTRADURAL

Outside the dura

Metastasis / lymphoma / leukemia

-in vertebral body or paraspinal soft tissues

XR: Vertebral body destruction, loss of pedicle

MRI: Compresses from the outside in- cord displaced
Broad mass lesion which enhances

INTRADURAL

Within the dura

Most commonly meningioma

– 80 percent in the thoracic cord and women
Also neurofibroma and metastases

XR: Vertebral body / pedicle erosion / wide intervertebral foramen

MRI: Compresses from the outside in- cord displaced
Circumscribed mass lesion which enhances

INTRAMEDULLARY

Within the cord

Most commonly astrocytoma and ependymoma (conus)

XR: Normal radiograph
"Bracket pedicles": Thinned pedicles on inner margins
"Elseberg-Dyke" sign: increased interpediculate distance
Posterior body scalloping, Widened intervertebral foramen

MRI: Cord is expanded
Syrinx, Circumscribed mass lesion which enhances

6. TRAUMA, WHIPLASH AND SOFT TISSUE INJURY

A. CRANIOCERVICAL JUNCTION FRACTURES

a. *Craniocervical Disassociation*

i. Disruption of cranio-cervical junction ligaments
ii. Frank atlanto-occipital dislocation
iii. Often fatal and involve high speed MVA
iv. Pedestrians and frequently children.
v. Dens- clival interval and alignment

b. Occipital condyle fractures

i. CT best test to demonstrate
ii. Three types: I- tip, II-Base III- Comminuted

c. Alar Ligament Tears

i. MR is the only assessment
ii. Not reliably imaged even in normal individuals
iii. Need dedicated MR technique

B. INJURIES OF THE ATLANTOAXIAL JOINT

1. ATLAS

a. Posterior Arch

i. Most common fracture of the atlas
ii. Usually hyperextension injury
iii. Best seen on "off lateral" (10 degrees lateral head tilt)
iv. Stable fracture- occasional vertebral artery and C1 nerve injury
v. Often accompanies dens fracture
vi. *Differential Diagnosis of Congenital Clefts*
* Smooth, sclerotic margins
* Hypertrophied anterior arch of atlas ("polo mint sign")

b. Jefferson's Fracture ("Burst Fracture")

i. Compression injury
ii. Four fractures: paired anterior and posterior arches
iii. Unilateral "variant" Jefferson's fracture
-unilateral 2 fractures
iv. Radiographic signs:
* C1 *prevertebral* soft tissues
->5-7mm
- Convex contour
* *"Overlap sign":* lateral displacement
* *"Double D sign":* double shadow anterior arch
* *Fractures* of the atlas posterior arch
* Transverse ligament+alar ligaments often torn

v. Differential Diagnosis of Congenital Clefts
* *Pseudospread of the atlas*: variant of children
* *Bipatite atlas:* Anterior + posterior C1 arch clefts

c*. Transverse Atlantal Ligament (TAL) Injuries*

Leads to excessive anterior translation of atlas on axis
Referred to as *"Atlantoaxial instability"*

i. Rare as a single injury
ii. Odontoid fractures first usually before the TAL ruptures
iii. May accompany recurrent trauma; multiple hangings (!), boxers, bronco riders
iv. Other associations:
*Down's syndrome – up to 50% have a lax or absent TAL
* Occipitalization and Klippel Feil syndrome
* Inflammatory arthropathy
(50% RA, 40% PS, 5% AS)
* Pharyngeal infections in children
- Grisel's disease
* Dens anomalies
(agenesis/hypoplasia/os odontoideum)
* Skeletal dysplasia (SED etc)

v. Remains asymptomatic until at least 10-12mm ADI
"Steele's Law of Thirds": Atlas ring is filled by:
1/3 dens *1/3 cord* *1/3 "safety" space*

2. AXIS

a. Odontoid Fractures

i. *Type I*
* Tip of the dens # at insertion of the alar ligaments
* <5% of dens fractures
* Stable fracture
* DDx in children 4-12 years of age with normal
"Summit ossification" center (ossiculum terminale)

ii. *Type II*
* Through base of dens
* Most common type, 50%
* Displaced and non displaced
* Fracture line visible in <50% of cases on XR
* *"Odontoid tilt" sign* - > 5 deg lateral tilt on APOM
* Prevertebral soft tissue swelling
* Up to 25% have non-union
* CT best method for identifying fracture

iii. *Type III*
* Base of dens with and into vertebral body
* Second most common type, 45%
* Difficult diagnosis with many missed
* *"Ring" sign*- # through the axis ring visible
* *"Fat C2" sign*- vertebral body appears expanded
* Prevertebral swelling
* CT best method for identifying fracture
* MR to assess the cord

iv. *Non Union*
* As high as 10-25% usually type II (base #)
* Assess stability at 8 weeks with flexion and extension
* Hypertrophic fibro cartilage may impinge the cord
* Occasionally see in patients unaware of previous fracture
Present with cord compression symptoms
* Dens may completely resorb

v. *Os Odontoideum*
* Most likely long-standing old type II non-union
* Smooth sclerotic margins of ossicle + axis base
* Enlarged, sclerotic and angular C1 anterior arch
* MR always done to evaluate tissue in cleft
Fibrous tissue- often hypertrophies, impinge
Fluid- can also impinge the cord
* MR always to assess
Cord (myelomalacia, syrinx)
Brainstem, cerebellum and vertebral arteries

b. Hangman's Fracture

"Traumatic spondylolisthesis"
Bipedicular fracture of the axis
Usually extension injury
*Subtle anterior slip of C2 often only sign
* Fractures are vertically obliqued close to the posterior vertebral body surface- need oblique views and CT to clearly see

c. Vertebral Body

Most common fracture associated with dens fracture
Tear drop fracture of anterior-inferior corner

3. LOWER CERVICAL VERTEBRAL BODY FRACTURES

a***. Flexion Teardrop Fracture***

Anterior inferior corner of vertebral body
Compressive, flexion injury
Fracture appears relatively innocuous; often cord injury
* Fracture penetrates inferior end plate
* Triangular anterior inferior fragment
* Small adjacent prevertebral soft tissue swelling
* Retrodisplacement of posterior vertebral body
* Disc space often reduced- disc disruption
* Full spectrum of cord injury- hematoma, edema

b. Extension Tear Drop Fracture

Smaller anterior inferior corner vertebral body fracture
Avulsion, extension injury
More severe cord injury due to *"pincer mechanism"*-
Retrodisplacement and in-folding of lig flavum

c. Burst Fracture

Axial compression injury
Multiple fragments (comminution)

d. Avulsed anterior ring epiphysis

(Traumatic Anterior Limbus Bone)
Occur up until 18 years old most commonly 12-16.
C3-C6 most common levels
Implies discovertebral separation
Visible on Plain XR and CT, MR may not depict

4. LOWER CERVICAL POSTERIOR ARCH FRACTURES

a. Pedicle

Uncommon as an isolated injury;
Usually with vertebral body #
CT diagnosis

b Articular Pillars

Extension injury; lower segments
Very difficult on routine study- pillar views and CT
*DDx- variant notch in superior facet of C7

c. Lamina

Uncommon as an isolated injury
Usually with vertebral body #
CT diagnosis

d. Transverse Process

Lower segments especially C7
Seatbelt injury
Usually associated with brachial plexus injury
APLC and CT
*DDx Cervical rib
Elongated transverse process
Ununited T1 TVP apophysis

e. Spinous Process

C6-T3 avulsion fracture
Fracture line wide due to distraction
Distal fragment displaced inferiorly
"Double spinous process" sign on APLC
* DDx Ununited spinous apophysis
Nuchal bone

5. LOWER CERVICAL DISLOCATIONS

a. Bilateral Facet Dislocation

Flexion injury

*Anterior+flexed displacement of superior segment

"*Acute kyphosis*" sign

* Loss of adjacent disc (disrupted)

b. Unilateral Facet Dislocation

Flexion with rotation injury

Reduced unilateral rotation and lateral flexion- "torticollis"

* Segmental rotation and lateral flexion above

* Subtle anterior slippage of involved segment

* *"Bow tie" sign*- dislocated pillar in front

c. Perched Facets

Facets are subluxed and lie close to dislocating

6. SOFT TISSUE INJURY

a. Muscle

MR method of choice-altered signal on T2 and STIR

Rarely myositis ossificans

Splenius cervices, Longus colli

b. Ligaments

MR method of choice; T1 for detail, T2 for edema

Ligamentum flavum most common ligament seen torn

Joint Capsule second most common ligament seen torn

c. Bone marrow

Edema shown by MR T2 and best on STIR

Due to trabecular microfractures

* Sub end plate regions

* Sub facet and articular pillars

Most common injury consistently present and missed

d. Intervertebral disc

MR method of choice T2 and STIR

Variety of injuries

Annular tear: Loss of annular continuity

Vacuum sign has no predictive value

Disc herniation: Annular tear with high signal disc

Discovertebral separation: tear at disc-cartilage

e. Brachial Plexus Injury

May see high signal in nerve roots

Root avulsions see as pseudo cysts at exit foramina

Need dedicated brachial plexus protocols

Stir and T2 fat suppressed coronals

T1 and T2 Fat Saturation sagittals

7. VERTEBRAL AND CAROTID ARTERY ASSESSMENTS

METHODS OF INVESTIGATION

RADIOGRAPHY
ULTRASOUND
ANGIOGRAPHY
MAGNETIC RESONANCE ANGIOGRAPHY (MRA)
COMPUTED TOMOGRAPHY ANGIOGRAPHY (CTA)

VARIATIONS OF THE VERTEBRAL ARTERY

Stylohyoid Ligament
Thyroid cartilage
Entry at C7 TF
Asymmetrical size
Absence
PICA Termination
Posterior Ponticle
Tortuosity and dilatation

ASSOCIATIONS

Occipitalisation

Odontoid anomalies

Block vertebra

ABNORMALITIES OF THE VERTEBRAL ARTERY

Osteoarthritis (DJD)

Scalenus insertions

Atherosclerosis

Fibromuscular hyperplasia

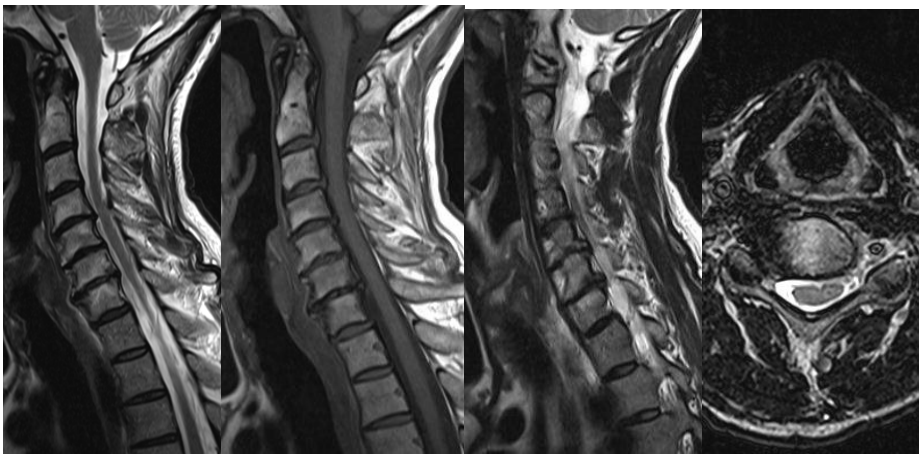
Aneurysms

Dissection

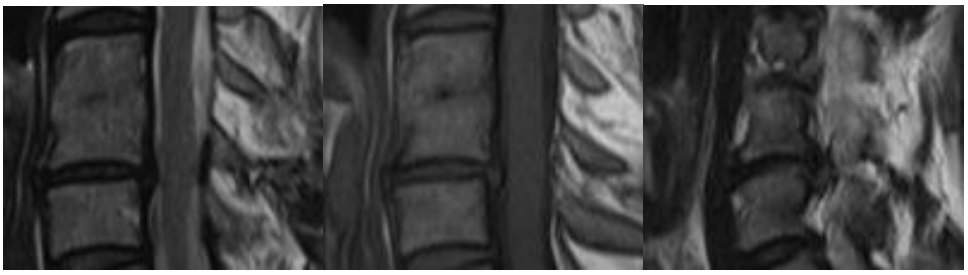
Subclavian Steal

CERVICAL SPINE CASES - “SHADES OF GREY”

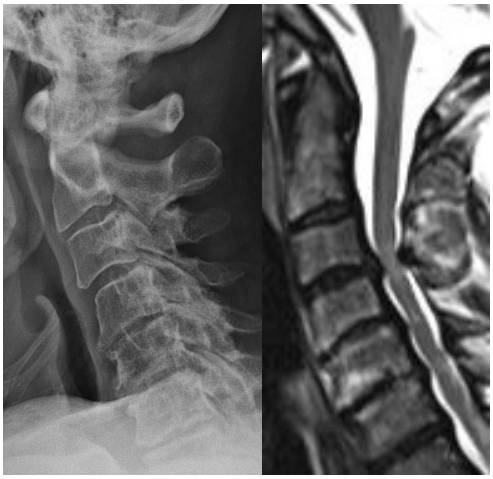
CASE 1. A 45 YEAR OLD WITH RIGHT ARM PAIN AND PARESTHESIA TO THE INDEX FINGER

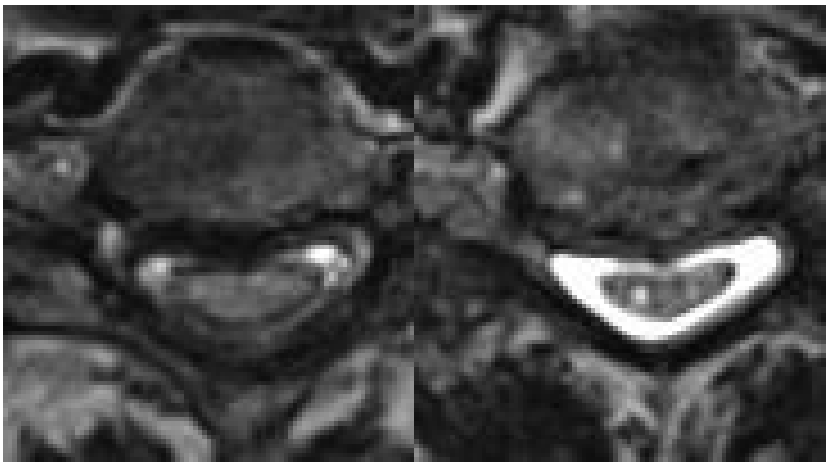


CASE 2. A 32 YEAR OLD MALE RUGBY PLAYER WITH NECK PAIN AND LEFT ARM WEAKNESS.

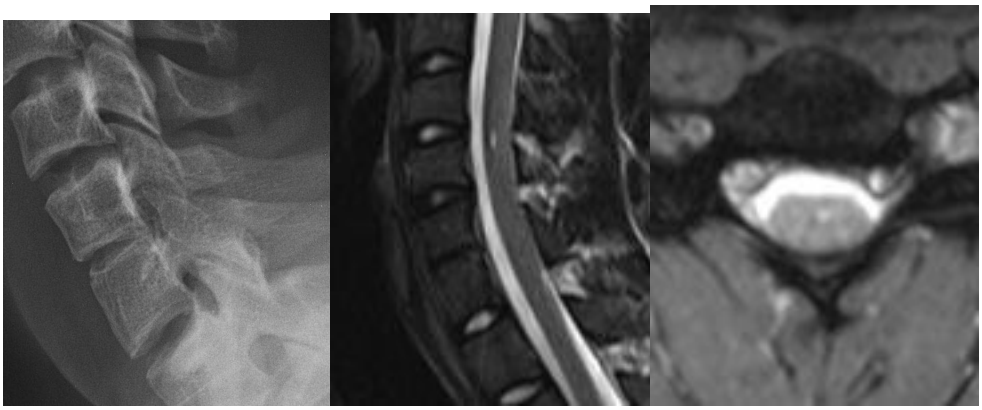


CASE 3. A 65 YEAR OLD MALE WITH BILATERAL ARM WEAKNESS AND PAIN





CASE 4. A 36 YEAR OLD MEDICAL PRACTITIONER WITH HORNER'S SYNDROME AND RIGHT ARM SHOULDER WEAKNESS.



CASE 5. A 45 YEAR OLD MALE WITH NECK PAIN.

THORACIC SPINE

NORMAL ANATOMY / PRINCIPLES OF INTERPRETATION

THORACIC SPINE SEQUENCES

BASIC

SAGITTAL T1
SAGITTAL T2
AXIAL T1
AXIAL T2

ADDITIONAL

SAGITTAL STIR
SAGITTAL GRADIENT ECHO
T1 FS GADOLINIUM

METHOD OF INTERPRETATION

1. *IDENTIFY THE PATIENT*
2. *IDENTIFY AND INTERPRET SCOUT IMAGES*

3. *LOCATE SAGITTAL T2*
   Find mid sagittal image
   Follow parasagittal images left and right to IVF
   A: Alignment
   B: Marrow signal
   C: Disc spaces, facet joints
   S: Spinal cord, soft tissues (anterior, posterior)
4. *LOCATE SAGITTAL T1*

   Repeat as for T2 but look carefully at-
      Bone marrow signal
      Ligament

5. *LOCATE AXIAL T2*
   Start at highest level and identify disc levels
   Find pedicles, disc space is just above
   Identify posterior disc margin and note shape and size
   Identify the spinal cord and subarachnoid space
   Locate exiting nerve roots

LIST OF THORACIC SPINE ANATOMICAL STRUCTURES

T1-T12

- Disc
  - Hydration
  - Height
  - Posterior shape
- Vertebral body
  - Shape
  - Marrow signal
  - Discovertebral junction
- Facet joints
- Costovertebral joints
- Spinal cord

POSTERIOR SOFT TISSUES

- Ligamentum flavum
- Facet joint capsule
- Posterior longitudinal ligament

ANTERIOR SOFT TISSUES

- Pleural surfaces

DISC DISEASE

- T6-T11 Most common sites
- Common finding on MRI and many false positives
- Often calcified nucleus on XR- best to evaluate with CT
- MRI technique of choice in uncalcified HNP
- Often prominent end plate linear track

SCHEUERMANNS DISEASE

- Disease of unknown cause
- Due to multiple Schmorl's nodes
- Produces increased kyphosis

Sorenson criteria

- 3 or more contiguous segments
  - *Wedged more than 5 degrees*
    - *Irregular end plates*
  - *Loss of disc height*

Spectrum of severity

- Most are asymptomatic
- 75% involve the thoracic spine
- 25% involve upper lumbar spine
- 20% have associated spondylolisthesis

Complications

- *Kyphosis, scoliosis*
- *Degenerative disc disease*

FRACTURES OF THE VERTEBRAL BODY

1. Anterior Compression Fractures

a. Synonyms: crush / wedge / slice / grand ma fracture

b. Plain film features

* Usually superior end plate
* *"Wedge"* shaped with loss of anterior vertebral body height
* *"Step" sign*: cortical offset at anterior body margin
* *"Zone of impaction" sign*: linear sclerosis at fracture
  Due to overlap of impacted bone or reactive callus
  Sign of fracture in last 12 weeks
* Adjacent disc degeneration- takes at least 12 months
* Para spinal line sign: deflection due to hematoma

c. CT

* Characterize fracture and identify associated fractures

d. MRI

* Spinal cord and nerve root involvement
* Disc integrity

e. Bone scan

Subtle, undiagnosed fractures show as "hot spots"
Can remain active for up to 2 years post fracture

2. Posterior Compression Fractures

Unusual as an isolated injury
Always exclude pathology or congenital anomaly

3. Combined Fractures

a. Pathological Fracture ("Vertebra Plana")

* Anterior and posterior collapse
* Often seen in : Osteoporosis
  Metastatic disease
  Multiple Myeloma
  Other malignancy

b. Burst Fracture

Axial loading with multiple fragments

4. Identifying Age Of Fractures

Often a critical question but not always answerable

a. Recent Fractures

* *"Step" sign*: sharp, angular cortical offset at ant body margin
* *"Zone of impaction" sign*: linear sclerosis at fracture
  Due to overlap of impacted bone or reactive callus
  Sign of fracture in last 12 weeks
* Lack of adjacent disc degeneration- takes at least 12 months
* Para spinal line sign: deflection due to hematoma
* MR shows bone marrow edema
* Bone scan "hot" but can remain active for up to 2 years

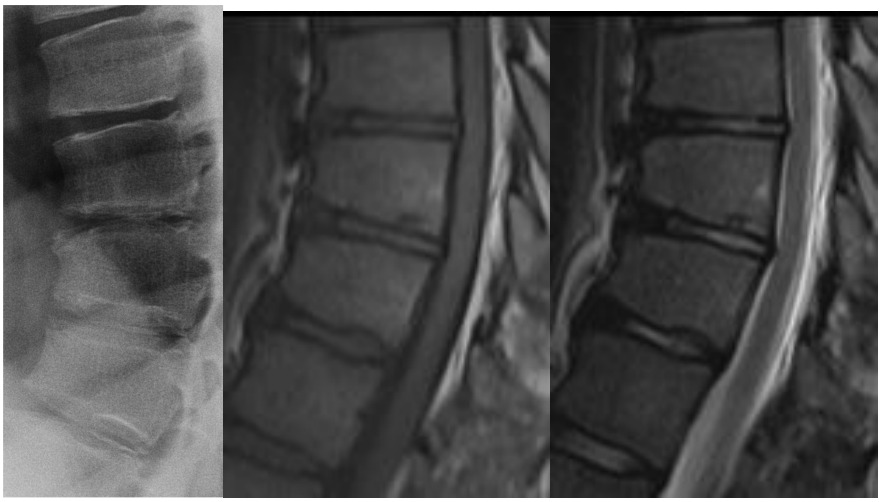
b. Old Fractures

* Smooth margins, remodeled surfaces
* No zone of impaction
* Normal Para spinal line
* Adjacent disc degeneration
* Normal bone scan

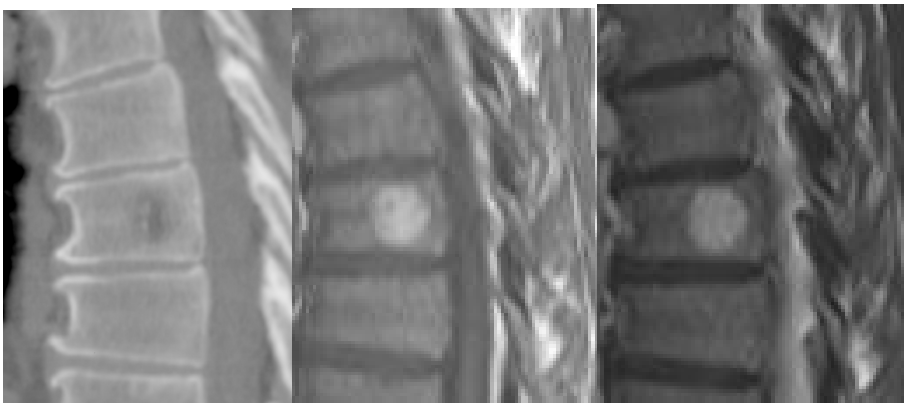
THORACIC SPINE CASES- SHADES OF GREY

CASE 1. A 16 YEAR OLD FEMALE WITH PAIN

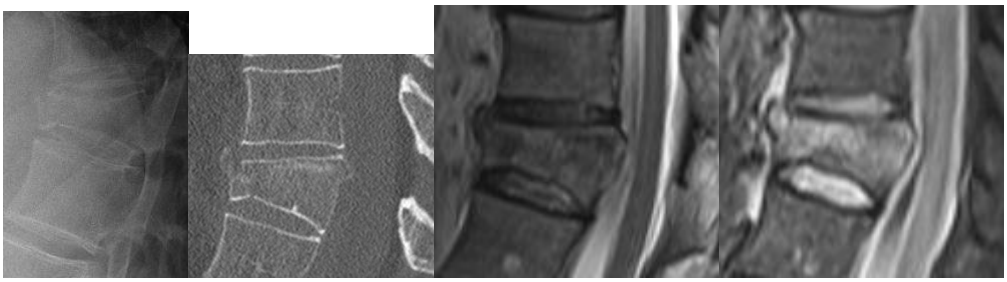
CASE 2. AN 18 YEAR OLD MALE WITH THORACIC SPINE PAIN.



CASE 3. A 62 YEAR OLD FEMALE WITH PREVIOUS BREAST CANCER NOW THORACIC SPINE PAIN.



CASE 4. A 46 YEAR OLD MALE WITH ACUTE BACK PAIN.



LUMBAR SPINE

LUMBAR SPINE SEQUENCES

BASIC

- SAGITTAL T1
- SAGITTAL T2
- AXIAL T1
- AXIAL T2

ADDITIONAL

- SAGITTAL STIR
- SAGITTAL GRADIENT ECHO
- T1 FS GADOLINIUM
- MRA

METHOD OF INTERPRETATION

1. *IDENTIFY THE PATIENT*
2. *IDENTIFY AND INTERPRET SCOUT IMAGES*
3. *LOCATE SAGITTAL T2*
   - Find mid sagittal image
   - Follow parasagittal images left and right to IVF
   - A: Alignment
   - B: Marrow signal
   - C: Disc spaces, facet joints
   - S: Spinal cord, soft tissues (anterior, posterior)
4. *LOCATE SAGITTAL T1*
   - Repeat as for T2 but look carefully at-
     - Bone marrow signal
     - Ligaments
5. *LOCATE AXIAL T2*
   - Start at highest level and identify disc levels
   - Find pedicles, disc space is just above
   - Identify posterior disc margin and note shape and size
   - Identify the spinal cord and subarachnoid space
   - Locate exiting nerve roots

LIST OF LUMBAR SPINE ANATOMICAL STRUCTURES

L1-L5

- Disc
  - Hydration
  - Height
  - Posterior shape
- Vertebral body
  - Shape
  - Marrow signal
  - Discovertebral
- Facet joints
- Spinal cord
- *Posterior soft tissues*
  - Multifidus
  - Ligamentum flavum
  - Facet joint capsule
  - Posterior long lig
- *Anterior soft tissues*
  - Psoas
  - Aorta

I. ANATOMICAL HOUSE

Conceptual approach to understanding disc disease and the relationship to exiting nerves.

The Three Stories

Each vertebral segment can be conceptualized as having three “floors”.

A. The First Floor- The Intervertebral Disc Zone

At the level of the intervertebral disc.

Intervertebral disc
Posterior longitudinal ligament
Epidural venous plexus
Epidural fat
Facet joints
Ligamentum flavum
Nerve root
Thecal sac

B. . The Second Floor - The Foraminal Zone

At the level of the intervertebral foramen.

Vertebral body
Epidural venous plexus
Nerve root
Dorsal root ganglion
Epidural fat
Lateral canal divisions
- Lateral recess
- Sub-articular
- Foraminal (sub-pedicular)
- Extra-foraminal (“far-out” zone)

C. The Third Floor- The Pedicle Zone

At the level of the pedicle.

Contents:

Vertebral body
Pedicle
Basi-vertebral vein
Lateral recess
Nerve root
Epidural fat

NB: 1. Up to 15-30 percent of asymptomatic persons have an abnormal disc on CT of the lumbar spine.

2. Up to 50 percent of asymptomatic persons have an abnormal disc on MR of the cervical or lumbar spines.

II. DISC BULGING

Loss of water and proteoglycans; redundant annulus around entire disc

XR: Normal, early osteophytes, loss of disc height
CT: Convex posterior margin
MRI: Convex posterior margin, annulus usually intact
Contributes to central and lateral canal stenosis

III. INTERNAL DISC DISRUPTION

Annular tears exposing nuclear material to the immune system

Pain from outer third of the annulus

CT: Vacuum in outer annulus

Discography and combined with CT- "CT Discography" main method of diagnosis

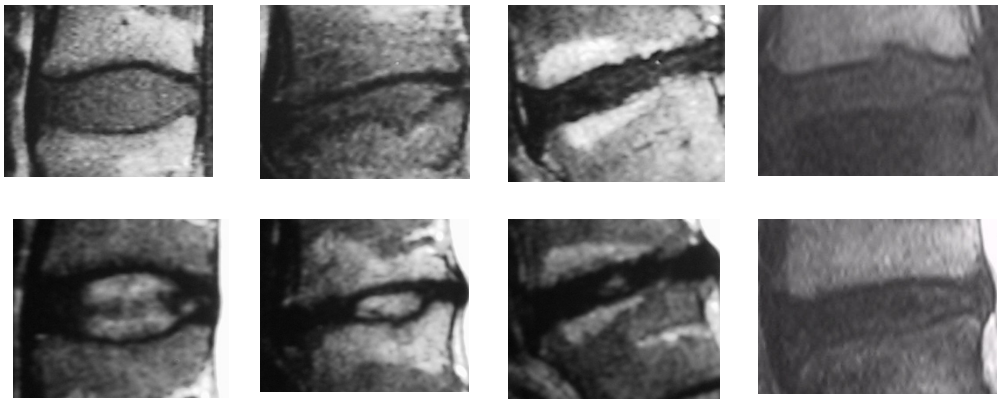
HIZ- high intensity zone on MR in annulus

IV. DISC RESORPTION

Rapid collapse of the disc, vacuum with few osteophytes

MODIC CHANGES AT THE DISCOVERTEBRAL JUNCTION

NORMAL TYPE 1 TYPE 2 TYPE 3



Normal Edema Fat Sclerosis

V. DISC HERNIATION

Lateral selects a single root/ central more roots

Disc may dissect superiorly or inferiorly

Reduce 30% of initial volume in first year and then less than 5% in following 5 years

Central large herniations can result in cauda equina syndrome (MRI best study)

May be associated with epidural hematoma

Chronic herniation signs: calcification, vacuum, osteophytes

VI. DISC SEQUESTRATION

Free fragment

VI. SPONDYLOLISTHESIS

Rare as an isolated acute # -

usually a chronic unhealed stress #

* L5: 90% L4: 8% L1-L3: 2%

* 5% of the Caucasian population, higher in athletes

i. Unilateral Spondylolysis (Wilkinson's syndrome)

* Contralateral sclerosis of pars and pedicle

* Sclerosis disappears when get second defect

ii. Bilateral Spondylolysis

* Usually between 10-14 years of age
* Slip follows within one year

No slip through adult years is typical

May slip secondary to disc degeneration later

MRI IN SPONDYLOLISTHESIS

T1, T2, STIR or T2FS

Status of the pars defect

Bone

Cartilage

Edema

Nerve compression

Associated disc herniation

LUMBAR SPINE CASES - “SHADES OF GREY”

CASE 1

CASE 2

CASE 3

CASE 4

CASE 5

CASE 6

CASE 7

IV. SACROILIAC JOINT

NORMAL ANATOMY / PRINCIPLES OF INTERPRETATION

JOINT COMPONENTS

- ANTERIOR
  - SYNOVIAL
- POSTERIOR
  - LIGAMENTOUS
- SUPERIOR
- INFERIOR

ARTICULAR CARTILAGE

- SACRAL
- ILIAC

BONE LANDMARKS

- SYNOVIAL SURFACES
- ARTICULAR CREST
- LIGAMENTOUS CREST

MRI SEQUENCES

CORONAL T2FS OR STIR
AXIAL T2 FS

JOINT DISEASE

- OSTEOARTHRITIS
- OCI
- DISH
- SENILE ANKYLOSIS
- INFLAMMATORY
  - GRADING SACROILIITIS
    - 0: NORMAL
    - 1: SUSPISCIOUS - BLURRED JOINT SURFACE
    - 2: ABNORMAL- EROSIONS, ALTERED JOINT SPACE, SCLEROSIS
    - 3: MARKED DISEASE- EROSIONS, SCLEROSIS
    - 4. ANKYLOSIS
- CRYSTAL
- SEPTIC

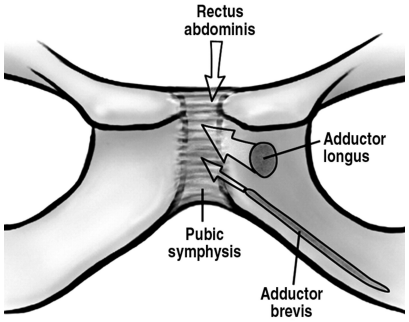
BONE DISEASE

1. INSUFFICIENCY FRACTURE
   - Most common sacral pathology over the age of 65 yeaars of age
   - Osteoporosis with fall or hip replacement

Sacral and Groin pain on standing
Fractures not evident on X-ray
Fractures parallel SIJ and connect across S2-3
“H” fractures

2. BONE TUMOUR
   Sacral foraminal lines key structure

V. PUBIC SYMPHISIS



ABNORMALITIES

Derangement of the articular disc
- -secondary cleft sign (fluid in cleft off midline)
- -coronal STIR /T2FS

Osteitis pubis
- -bone marrow edema
- -axial and coronal T2FS
- -later bone resorption

Muscle tear
- -rectus abdominus-adductor longus aponeurosis tear
- -axial, coronal, sagittal T2FS

SHOULDER

1. IMAGING PROTOCOLS

Always plain films: AP with internal and external rotation then supplementals

AC Joint/clavicle: Angled up 15 degrees, weights
GH Joint: rotate 45 degrees
Dislocation: lateral scapula
Abduction: AC joint, GH instability
—always include the apex of the lung

Ultrasound next study in Australia, Canada and Europe
MRI always in the US
MR ARTHROGRAM—placement of contrast (gadolinium) into joint cavity

Technique of choice in the assessment of:
Subtle rotator cuff tears
Previously operated shoulders
Labral tears
Recurrent dislocation

Can be done two ways:
1.Direct-- injection into the joint
Iodinated dye introduced for CT
Gadolinium for MRI
2. Indirect-- intravenously and then exercised

2. FRACTURES

a. Humerus
Greater tuberosity= “flap fracture”
need external rotation view
Surgical neck
Comminuted head
Shaft spiral fractures

b. Clavicle
Distal may be overlooked; heal with exuberant callus
Most common birth injury

c. Scapula
Body, neck

3. DISLOCATION

a. Acromioclavicular joint
i. Grade 1
ii. Grade II
iii. Grade III
iv. Post Traumatic Osteolysis of the Clavicle (PTOC)
* Resorption of distal clavicle surface
* Cysts, surface irregularity
* acromion surface is normal
* Weight lifters, overhead throwers

b. Glenohumeral joint

Anterior and inferior
Associated with:
Anterior labral/ bony avulsion- **the "Bankart lesion"**
Impaction fracture of the posterior superior humeral head
"**Hill- Sachs defect".**

4. LABRAL LESIONS

a. Bankart – anterior inferior separation;
plain film and CT for bony lesions

b. SLAP lesion – superior labrum anterior-posterior tear
Needs MR preferably with gadolinium arthrogram

c. Bennett lesion – posterior labral-bony avulsion in high velocity throwers such as baseball pitchers

5. ROTATOR CUFF TEARS

Most commonly the supraspinatus tendon
MRI is the gold standard in imaging;
MRI: 92% sensitivity for tears
US: 90% sensitivity for tears but allows dynamic assessment

"CRITICAL ZONE"- watershed area of relative avascularity 1cm from insertion.

Most common site for degeneration and tear

a. Full thickness
With or without retraction
XR: Humerus elevated within the glenoid
Cysts and roughened greater tuberosity
Subacromial osteophytes
US: Hypoechoic zone
MRI: Fiber discontinuity
Fluid within the tear

b. Partial thickness
Intrasubstance
Undersurface
External surface
c. Tendonitis- inflammation
d. Tendinosis- infiltration with myxoid material; prone to tear
e. Calcific tendonitis
f. Impingement:US diagnosis: on abduction sliding tendons beneath the acromion.
Impingement evident as no sliding +THICKENING

6. Biceps Lesions

a. Bursitis

Fluid around the tendon

Pain on compression

b. Dislocation

Usually with subscapularis tears

Show dynamically with ultrasound

HIP

HIP ALIGNMENT ASSESSMENT

1. Shenton's line
2. Iliofemoral line
3. Klein's line
4. Skinners line
5. Teardrop distance
6. Femoral angle
7. Acetabular margin.

COMMON VARIANTS

1. Acetabular notch

"Pseudo defect" of acetabulum

2. Os acetabulae
3. Bone island

Oval and orientated along trabecular lines

SLIPPED FEMORAL EPIPHYSIS

Usual age is 11-14 years

Often referred knee pain

Radiographic signs:

Decreased vertical height of epiphysis

Wide, irregular growth plate

Positive Klein's line

Up to 25% can be bilateral

LEGG-CALVE-PERTHES DISEASE

Usual age is 6-10 years

Limp; Episodes of "Transient Synovitis"

Sudden onset of pain / hip contracture; self limiting 7-10 days

Radiographic signs

Sclerosis

Fragmentation

Crescent sign- subchondral fracture

Deformity- mushroom deformity

MISELLANEOUS BONE LESIONS

1. Simple bone cyst

Thin sclerotic rim, may expand bone, no matrix- prone to fracture

2. Fibrous dysplasia

Thick sclerotic rim, smokey matrix ("ground glass")

3. Fractures

Subcapital / Mid cervical / Basicervical (intra articular)
Intertrochanteric / Subtrochanteric / Trochanteric (extra articular)
Pathological
- Neck / shaft
- Lesser trochanter

Treatment
- Pins
- Pin and Plate
- Prosthesis- Austin Moore, total hip

3. Bisphosphonate fractures

Aledronate therapy for osteoporosis implicated
Bilateral subtrochanteric femur fractures

I. TRANSIENT SYNOVITIS

4-12 years
Sudden onset of hip pain, refusal to walk
Aseptic joint effusion, relieved by aspiration
Diagnose with ultrasound

J. TROCHANTERIC DISORDERS

Bursitis: MR shows T2 high signal / fluid over trochanter
Tendonitis: High T2 signal within the tendon
Tendon avulsion: Gluteus medius / minimus

K. LABRAL INJURY

Separation of labrum most commonly superiorly
Anterior pain- severe and intermittent with specific movements
XR: NAD
- Os acetabulae
- Cysts

MR Arthrogram
- avulsion, tear or perilabral cysts

L. OSTEOARTHRITIS

Classic features:
- Loss of superior joint space
- Osteophytes at head margin
- Lateral shift of femur
- Geodes- subchondral cysts
- Variable sclerosis
- Complicating avascular necrosis

M. FEMORO-ACETABULAR IMPINGEMENT (FAI)

Over coverage odf the femoral head by the acetabulum
Results in cartilage-bone impaction at superolateral joint
XR- failure of acetabular overlap of femoral head
Osteoarthritis in young
Femoral neck "bump"
MR: Cartilage loss
Labral tears
Bone marrow edema at impingement sites head and acetabulum

N. AVASCULAR NECROSIS

Key sign is collapse of the articular cortex- *"step" sign*
Usually only affects upper third in wedge or oval shaped
Over 50% become bilateral
MRI most reliable early and late diagnostic method
FICAT staging
I. No imaging signs
II. Bone marrow edema
III. Collapse
IV. Cysts
V. Acetabular changes

KNEE

IMAGING PROTOCOLS

XR: Four views—AP (weight bearing), AP intercondylar, Lateral, Tangential (Skyline)
Bone injuries, effusions, patellofemoral alignment
US: Cysts, effusions
CT: Tumors, fractures
MR: Intra articular and ligament derangements, bone marrow edema

FRACTURES AND DISLOCATIONS

Fractures less common than dislocations and ligament / meniscal injuries
Tibial plateau: varus-valgus injury
Segond Fracture- avulsion fracture of the lateral tibial condyle

PATELLOFEMORAL DISORDERS

1. Chondromalacia patellae

MRI diagnosis—disease of the retropatellar surface
Grade 1: Histologic change only
Grade 2: Fibrillation
Grade 3: Fibrillation with denudation
Grade 4: Fibrillation with denudation with bone changes
Grading does not have prognostic value

2. Patella dislocation

Small patella
Femoral trochlear dysplasia (shallow patellofemoral sulcus)

Dislocates laterally and then reduces often spontaneously
Characteristic pattern of bone marrow edema
Lateral femoral condyle, medial patella

3. Osgood Schlatter's disease

Thick tendon
Edema of subcutaneous tissue and tendon
Bone ossicles

4. Patella tendonitis ("Jumper's knee")

MR diagnosis: US less sensitive
Edema of tendon substance at tibial or femoral attachment
Pre-patellar bursitis often coexists

5. Hoffa's disease

Rare- inflammation of the infra patellar fat

6. Quadraceps / patellar tendon rupture

Patellar Baja: low lying patella (quadriceps)
Patellar Alta: high riding patella (patella tendon)

7. Miscellaneous disorders

Bursitis
Effusion
Plicae syndrome
Iliotibial band friction syndrome

B. MENISCAL INJURIES

Concept of the different zones of the meniscus
"Red" zone: vascularised and able to repair, outer third
"White" zone: non vascularised, no repair

1. Medial meniscus tear

a. Radial

b. Longitudinal ("bucket handle")

c. "Parrot beak"

d. Intrasubstance horizontal tear

e. Mucoid deposition

2. Lateral meniscus tear

a. Radial

b. Longitudinal

c. Cyst

C. LIGAMENTOUS INJURIES

1. Medial Collateral Ligament (MCL)

a. Grade 1

b. Grade 2

c. Grade 3

d. Pelligrini Stieda disease

2. Lateral Collateral Ligament (LCL)

3. Posterior Cruciate Ligament (PCL)

4. Anterior Cruciate Ligament (ACL)

D. MISCELLANEOUS DISORDERS

1. Chondral lesions

2. Osteochondral defects (Osteochondritis dissecans)

3. Synoviochondrometaplasia

4. Osteoarthritis