

SHADES OF GREY
BIENNE, SWITZERLAND
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CLINICAL IMAGING CORRELATIONS

	XR	MRI	CT	BS	US	PET
BONE	4	3	1	2	5	1
MARROW	4	1	3	2	5	1
DISC	3	1	2	5	0	0
FACET	3	2	1	4	0	0
JOINT EFFUSION	4	1	3	0	1	0
SYNOVIAL CYST	0	1	2	0	0	0
CENTRAL STENOSIS	4	1	2 MYL	0	5	0
LATERAL STENOSIS	5	1	2 MYL	0	0	0
NERVE	0	1	2 MYL	0	0	0
CORD	4	1	2	0	5 <1YO	0
MENINGES	5	1 GAD	2 CON	0	0	0
HARDWARE	2	3	1	4	5	0
FAILED SURGERY	4	1 GAD	2 CON	3	5	0
ARTERIES	4	3	1 CON	5	2	5
VEINS	0	3	1 CON	0	2	0
MUSCLE	5	2	3	5	1	5
TENDON , LIGAMENT	4	1	3	0	1	5
SKIN	0	2	3	5	1	5
VISCERA	5	2	1	5	1	2

KEY TO RANKINGS (based purely on sensitivity and specificity to detect disease):

1: Gold standard 2: Excellent 3: Good 4: Fair 5: Poor 0: No application

GAD: Intravenous Gadolinium enhanced T1 with Fat Saturation (T1 GAD FS)

CON: Intravenous Iodinated Contrast then CT

MYL: Lumbar puncture with Contrast in subarachnoid space then CT (CT Myelogram)

SESSION 1. CLINICAL IMAGING STRATEGIES OF THE SPINE (WHAT AND WHEN)

RED FLAGS ITEM DESCRIPTION, RATIONALE AND IMAGING METHODS

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 MRI
Age	50 years or more	Increased risk of cancer, abdominal aortic aneurysm, fracture, infection	MRI spine CT Chest CT Abdomen
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 metastatic tumors arising from the kidney, thyroid, prostate, breast, lung	MRI spine CT Chest CT Abdomen Mammogram Barium Colon
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	MRI spine
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	CT Chest CT Abdomen MRI Spine
Recent infection	Recent bacterial infection such as a urinary tract infection	Increases the risk of infection	MRI Spine
Immunosuppression	Immunosuppression resulting from a transplant, intravenous drug abuse, or prolonged steroid use	Increases the risk of infection	MRI Spine
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 Myositis Spondyloarthropathy	MRI Spine CT chest CT Abdomen, CTA Full body MRI (STIR) SIJ X-ray SIJ MRI

Red Flag Item	Description	Rationale	Imaging
Saddle anesthesia	Absence of sensation in the second-fifth sacral nerve roots, the perianal region	Cauda equina syndrome	MRI Spine MRI Pelvis
Bladder dysfunction	Urinary retention, changes in frequency of urination, incontinence, dysuria, hematuria	May indicate cauda equina syndrome or infection	MRI Spine MRI Pelvis
Lower extremity neurological deficit	Progressive or severe neurological deficit in the lower extremity	May indicate cauda equina syndrome	MRI Spine
Headache	Red Flag Headache Thunderclap	May indicate hemorrhage, infection, tumour, thrombosis, hydrocephalus	CT with CTA MRI with MRA and MRV

CONVENTIONAL X-RAY (XR)

INDICATIONS

- Curvature assessment
- Asymptomatic anomaly detection
- Red Flags: Fracture, sacroiliitis
- Degenerative joint disease: disc height, degenerative spondylolisthesis

ADVANTAGES

- Accessible
- Inexpensive
- Fast
- Good bone detail
 - 90% fractures detectable
 - 30-50% rule for bone destruction visibility
- Wide field of view
- Baseline assessment
- Weight bearing
- Monitoring disease progress / response
- User friendly

DISADVANTAGES

- Radiation dose
- False sense of security
- Poor soft tissue detail
 - Disc
 - Bone marrow
 - Cord, nerve roots
 - Muscle
 - Paraspinal
- Intermediate sensitivity
 - 30-50% loss of bone before detectable

COMPUTED TOMOGRAPHY (CT)

INDICATIONS

- MRI contra indicated or not tolerated
- Bone disease (congenital, fractures, infection, tumour)
- Stenosis
- Disc displacements
- Visceral and vascular disease
- Post surgical hardware assessment
- Intravenous contrast to show enhancing abnormalities

ADVANTAGES

- Accessible
- Fast (<5 secs)
- High sensitivity and specificity
- Excellent detail (especially bone and calcium)
- Few contra-indications
 - Pregnancy, <160kgs (300lbs), agitation
 - Medical devices
- Long sections imaged
- Reconstructions easily and quickly available
 - Isotropic images (no detail loss)
 - MPR (axial, sagittal, coronal, obliques), 3D
- Claustrophobia friendly
- Hardware depiction
- Wide field of view (FOV)

DISADVANTAGES

- Radiation Dose
- Moderate cost
- Patient artifact factors (large size, motion)
- Intrinsic soft tissue detail poor dependant on fat
- Edema not clear or subtle

MAGNETIC RESONANCE IMAGING (MRI)

INDICATIONS

- *GOLD STANDARD* in spine and joint imaging
- Disc disease
- Nerve, chord and meningeal disease
- Bone marrow disease (fractures, infection, tumour)
- Stenosis (central and lateral)
- Failed back syndrome
- Paraspinal disease

ADVANTAGES

- Non ionising radiation
- High sensitivity
 - Tendon, ligament tears, bone marrow disease
 - Soft tissue tumours, joint effusions
 - Disc structure
 - Cord and nerve disease
- High specificity

DISADVANTAGES

- Expense
- Motion artifacts
- Long examination times
- Magnetic field artifacts
- Contraindications (implants, foreign bodies, tattoos)
- Claustrophobia
- Complications (heat, dizziness, contrast issues)
- Poor fine bone detail
- Narrow field of view (FOV)
- Interpretation error
- Young children need general anaesthetic (?8yo)
- "Disease behaviour findings"-Large number of asymptomatic findings (variants, degenerative)

ULTRASOUND (US)

INDICATIONS

ADVANTAGES

- Soft tissue masses or swellings
- New born cord and conus assessment
- Joint and bursal effusions
- Peripheral joint dynamic impingement (supraspinatus)
- Doppler study:
 - Vascular disease (DVT, stenosis)
 - Inflammation
- Non ionising radiation
- Vascular disease first line assessment
- High sensitivity
 - Tendon, ligament tears
 - Soft tissue tumours
 - Joint effusions
 - Cyst identification and characterization
 - Lymph node disease

DISADVANTAGES

- Operator dependent
- Metal incompatibility
- Large patients difficult to image
- Only for superficial structures
- Poor bone detail
- Narrow field of view (FOV)
- Interpretation error
- Difficult comparison reviews

POSITRON EMISSION TOMOGRAPHY (PET)

INDICATIONS

- Malignancy

ADVANTAGES

- High sensitivity for high metabolic activity disease
 - Soft tissue, bone tumours, Metastasis assessment
 - Lymph node disease, Staging of disease
 - Response to treatment

DISADVANTAGES

- Limited availability and expensive
- Not useful for degenerative joint disease

INTERVENTIONAL RADIOLOGY STUDIES

- FACET AND SACROILIAC INJECTIONS
 - Intra-articular
 - Medial branch blocks
- FORAMINAL INJECTIONS
 - Transforaminal epidural peri-neural space
- EPIDURAL INJECTIONS
 - Spinal canal extradural space
- DISCOGRAPHY
 - Intra-discal
- MYELOGRAPHY
 - Subarachnoid space
- PERIPHERAL JOINT INJECTIONS
 - Arthrogram
 - Aspiration
 - Therapeutic injection
- PERCUTANEOUS BIOPSY
 - Soft tissue, Intra-discal, Bone
- VERTEBROPLASTY
 - Osteoporosis, Spinal bone tumour

1000-1030: SESSION II. PRINCIPLES OF MRI

PRINCIPLES OF MRI SEQUENCES

THE PROTON DANCE

- **OUTSIDE THE MAGNET**
 - Hydrogen (H) protons are small bipolar magnets (North and South)
 - Spinning, gyrating randomly
 - Bound to other atoms which affects ability to do these movements
- **IN THE MAGNET**
 - Has north and south poles
 - Random H atoms now align N-S with magnetic field
 - Can't measure them in this alignment
 - Apply RF pulse at angle to N-S alignment specific for hydrogen
 - H atoms gain RF energy and tilt out alignment and move synchronously together
 - Pulse turned off and H return to N-S alignment and begin asynchronous motion
 - As they return N-S and random motion they give off radio wave ("signal")
 - Signal given intensity and location
- **RADIOFREQUENCY PULSE**
 - Generated by RF "Coil"
 - Manipulate the features of the RF pulse to get T1, T2 and other images
 - Enters at selected angle to long axis of magnet (Flip angle; eg: 90, 180)
 - Turned on for a specified time
 - Turned off for a specific time
 - Time to echo "TE"
 - Repeated many times ("pulse sequence")
 - Done at set time intervals- Time to repetition "TR"



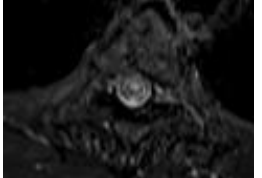
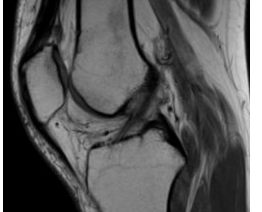
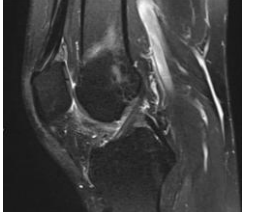


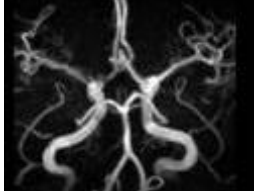
IMAGING PLANES

- **SAGITTAL**
 - "Lateral": long section view
- **AXIAL**
 - Transverse: short section
- **CORONAL**
 - "AP view: long section

IMAGE THICKNESS

- Variable
- 1-5mm thick
- **THIN SECTION IMAGES**
 - Improves small detail depiction such as nerve roots
 - Reduced contrast and fine point resolution (noise to signal ratio)
 - Long imaging times
 - More movement artifacts
- **THICK SECTION IMAGES**
 - Improves contrast and fine point resolution
 - Averages tissues through the slice thickness "volume imaging"
 - Shorter imaging times
 - Less artifacts

MRI SEQUENCES

SEQUENCE	STRENGTH	WEAKNESS	
<i>T1</i>	Anatomical detail Fat, subacute blood Marrow pathology Use with Gad+FS	Does not show edema Bone detail lacking Doesn't depict cartilage well	
<i>T2</i>	Detection of water Detection of edema Longer imaging time Good with hardware	May not show subtle edema Fast spin echo makes fat bright	
<i>T2 FS</i>	Better detail than STIR White densities are water Good for cartilage	Smaller area of coverage (FOV) Depends on good fat suppression	
<i>PD</i>	Anatomical detail T1 and T2 properties Good for tendons and ligaments (extremity)	Edema not always visible Poor tissue contrast ("flat")	
<i>PD FS</i>	Improves detail Edema accentuated Good for tendons and ligaments	Sensitivity for edema less than T2 FS or STIR	
<i>STIR</i>	"Light bulb" sequence Enhances edema Inherent good fat saturation Wide	Poor anatomical detail Long imaging time	
<i>T1 FS GAD</i>	Enhances inflammation Vascular permeability Many conditions enhance-scar, infection, tumour, surgery	Normal renal function Must use in combination with fat saturation (won't confuse fat with Gad) Over estimates pathology	
<i>MRA</i>	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	

PRINCIPLES OF MRI INTERPRETATION

- SPINE
 - SAGITTAL
 - T2
 - Mid sagittal
 - Out each side to foramina
 - STIR
 - Mid sagittal
 - Out each side to foramina
 - T1
 - Mid sagittal
 - Out each side to foramina
 - AXIAL
 - Locate SIJ
 - Find L5 disc
 - Use three storey approach
 - CORONAL
 - T2: scoliosis, cauda equina
 - STIR: cauda equine, conus, praspinal, pelvis
 - GAD
 - SAGITTAL
 - AXIAL
- EXTREMITY
 - CORONAL
 - STIR OR PD FAT SAT
 - AXIAL
 - T2 FS
 - SAGITTAL
 - T2 FS
 - PD FS

1030-1100: SESSION III. SHADES OF GREY: CERVICAL SPINE

IMAGING PROTOCOLS

- 1. Normal Plain Radiographs**
 - a. Initial procedure in most clinical situations
 - b. Two view series adequate
- 2. Computed Tomography (CT)**
 - a. Known fracture evaluation
 - b. Fragment location, cord impingement
 - c. Subtle unsuspected fracture- high velocity injury
 - d. Bony stenosis, OPLL
 - e. Hardware evaluation
 - f. Tumor characterization
 - g. Bony congenital anomalies
 - h. MR incompatible patients
- 3. Magnetic Resonance Imaging (MRI)**
 - a. Nerve/cord/disc/soft tissue injury
 - b. Brachial plexus injury/abnormality
 - c. Subtle fractures of the vertebral bodies
 - d. Marrow disease
- 4. Nuclear Medicine**
 - A. Subtle, undefined fractures
 - b. Metastatic disease

■ **SHADE OF GREY 1: CONGENITAL ANOMALIES**

■ **ODONTOID ANOMALIES**

■ **OCCIPITALISATION**

■ **ATLAS ARCH ANOMALIES**

■ **BLOCK VERTEBRA**

■ **CONGENITAL SPONDYLOLYSIS**

■ **C2**

■ **C6**

■ **CERVICAL RIB**

■ **SHADE OF GREY 2: ARTHROPATHY**

■ **DEGENERATIVE DISC DISEASE**

■ **DISH**

■ **AS**

■ **PSORIASIS**

■ **RHEUMATOID ARTHRITIS**

■ **CPPD**

■ **SHADE OF GREY 3: NEUROLOGICAL**

■ **DISC HERNIATION**

■ **NERVE COMPRESSION**

■ **MYELOPATHY**

- SYRINX
- MULTIPLE SCLEROSIS
- TUMOUR
- SHADE OF GREY 4: TRAUMA
 - ATLAS FRACTURE
 - DENS FRACTURE
 - VERTEBRAL BODY FRACTURE
 - LIMBUS BONE
 - PILLAR FRACTURE
 - CLAY SHOVELER'S FRACTURE
- SHADE OF GREY 5. INFECTION
 - DISCOVERTEBRAL
 - EPIDURAL ABSCESS
 - PRE-VERTEBRAL ABSCESS
 - HADD LONGUS COLLI
 - GRISEL'S DISEASE
- SHADE OF GREY 6: TUMOUR
 - BLASTIC METASTASIS
 - LYTIC METASTASIS
 - MULTIPLE MYELOMA
 - PLASMACYTOMA

- OSTEIOD OSTEOMA

- ANEURYSMAL BONE CYST

- SHADE OF GREY 7: VASCULAR
 - VERTEBRAL ARTERY

 - CAROTID ARTERY

- SHADE OF GREY 8: PARAVERTEBRAL SOFT TISSUE
 - THYROID

 - LYMPH NODE ENLARGEMENT

1100-1200: SESSION III. SHADES OF GREY: THORACOLUMBAR SPINE

IMAGING PROTOCOLS

- 1. Normal Plain Radiographs**
 - a. Initial procedure usually
 - b. Two view series adequate
 - 2. Computed Tomography (CT)**
 - a. Known fracture evaluation
 - b. Fragment location, cord impingement
 - c. Subtle unsuspected fracture- high velocity injury
 - d. Spondylolysis / listhesis
 - e. Surgical hardware evaluation
 - f. Bone disease characterization
 - g. Bony congenital anomalies
 - h. MR incompatible patients
 - 3. Magnetic Resonance Imaging (MRI)**
 - a. Nerve/cord/disc/soft tissue injury
 - b. Subtle fractures of the vertebral bodies
 - c. Marrow disease
 - 4. Nuclear Medicine**
 - Subtle, undefined fractures
-
- SHADE OF GREY 1: CONGENITAL ANOMALIES
 - HAHNS VENOUS CLEFTS

 - NUCLEAR IMPRESSIONS

 - BLOCK VERTEBRA

 - PEDICLE AGENESIS

■ LUMBOSACRAL TRANSITIONAL SEGMENT

■ SHADE OF GREY 2: ARTHROPATHY

■ DEGENERATIVE DISC DISEASE

■ DISC DEHYDRATION

■ DISC RESORPTION

■ DISC VACUUM

■ DISC BULGE

■ DISC PROTRUSION

■ ANNULAR FISSURES (HIZ)

■ END PLATE CHANGES (MODIC CHANGES)

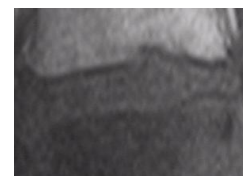
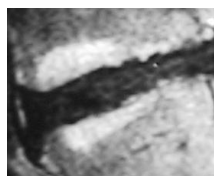
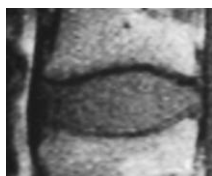
NORMAL

TYPE 1

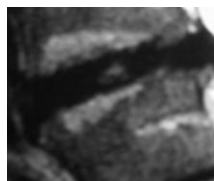
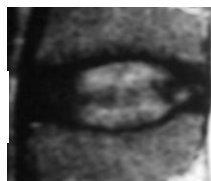
TYPE 2

TYPE 3

T1



T2



Normal

Edema

Fat

Sclerosis

■ DISH

■ AS

■ SHADE OF GREY 3: NEUROLOGICAL

■ CENTRAL STENOSIS

■ LATERAL STENOSIS

- LATERAL RECESS
 - FORAMINAL
 - EXTRAFORAMINAL

- MYELOPATHY

- SYRINX

- MULTIPLE SCLEROSIS

- TUMOUR

- CORD INFARCTION

- SHADE OF GREY 4: TRAUMA
 - VERTEBRAL FRACTURE
 - COMPRESSION FRACTURE

 - PATHOLOGICAL FRACTURE
 - Posterior and anterior collapse
 - Loss of pedicle
 - Location- beware the L5 compression fracture

 - BURST FRACTURE

 - CHANCE FRACTURE

 - TRANSVERSE PROCESS FRACTURE

 - LIMBUS BONE

 - SCHMORL'S NODES

 - SCHEUERMANN'S DISEASE

 - SPONDYLOLISTHESIS

- **SHADE OF GREY 5. INFECTION**
 - **DISCOVERTEBRAL**

 - **PSOAS ABSCESS**

 - **EXTRADURAL ABSCESS**

- **SHADE OF GREY 6: TUMOUR**
 - **BLASTIC METASTASIS**

 - **LYTIC METASTASIS**

 - **MULTIPLE MYELOMA**

 - **PLASMACYTOMA**

- **SHADE OF GREY 7: VASCULAR**
 - **AORTO-FEMORAL DISEASE**

- **SHADE OF GREY 8: PARAVERTEBRAL SOFT TISSUE**
 - **MYOSITIS**

1400-1530: SESSION V. SHADES OF GREY: UPPER LIMB

SHOULDER

1. IMAGING PROTOCOLS

XR: 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

US: Ultrasound next study in Australia, Canada and Europe

Rotator cuff pathology

Dynamic impingement

Bursitis

Biceps tendonitis

MRI: always in the USA

Rotator cuff pathology

Bursitis

Intra-articular detail: synovitis, labrum, articular cartilage

MR ARTHROGRAM—placement of contrast (gadolinium) into the 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:

i. Direct-- injection into the joint

Iodinated dye introduced for CT or gadolinium for MRI

ii. 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

Should see callus in 3 weeks: if not may have non union

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:

“Bankart lesion”: Anterior labral/ glenoid bony avulsion

“Hill- Sachs defect”: Impaction fracture posterior superior humeral head

4. LABRAL LESIONS

- a. *Bankart* – anterior inferior separation; plain film and CT for bony lesions
- b. *SLAP lesion* – superior labrum anterior to posterior tear of the labrum
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 and get thicker
Described as “bunching”

6. Biceps Lesions

a. Bursitis

Fluid around the tendon

Pain on compression

b. Dislocation

Usually with subscapularis tears

Show dynamically with ultrasound

ELBOW

1. IMAGING PROTOCOLS

XR: Always plain film studies first
AP, AP oblique, Lateral
Need radial head view many times

Radiocapitellar Line

Fat Pad sign- Lateral projection

>90% will have an intra-articular fracture of the elbow
Most commonly radial head

US: Joint effusion, bursitis, lateral epicondylitis, tendon abnormalities

CT: Bone defects, loose bodies, osteoarthritis

MRI: Joint cartilage, joint effusion, synovitis, ligaments, tendons

2. OSTEOLIGAMENTOUS AVULSIONS

a. *Medial epicondyle avulsion*

Little Leaguers elbow: avulses and displaces inferiorly; then overgrows

b. *Collateral ligament avulsions*

Throwing sports valgus stress- usually anterior band of lateral collateral
Stress radiographs
US and MRI

3. FRACTURES

a. *Fat pad sign*

i. Supracondylar fracture

ii. Radial head fracture

b. *Osteochondritis dissecans- capitellum*

4. DISLOCATION

Most commonly posterior dislocation of the olecranon

5. BICEPS TENDON AVULSION

MR superior to US

6. RADIO-BICIPITAL BURSTITIS

Either MR or US

7. LATERAL EPICONDYLITIS

Tear of undersurface of extensor carpi radialis brevis tendon (ECRB)

GRADES

MILD: Tendinosis, small tear (<20%)

MODERATE: Moderate tear (20-80% of tendon thickness), thinned

SEVERE: Large tear >80% of tendon thickness

XR: Irregular lateral epicondyle on xray; may see dense calcification

US: Hypo-echoic tear, thickened, disordered, high signal, hypervascular

MR: High signal tendon, soft tissue edema, retraction

8. TRICEPS TENDON INJURIES

Partial tears/ retraction

9. OLECRANON BURSTITIS

US

DDX: Gout, RA nodules

WRIST AND HAND

1. IMAGING PROTOCOLS

- XR: Minimum of 4 views- PA, PA ulnar flexion, Oblique, lateral
Specific Scaphoid views
- US: Tenosynovitis, tendon injury, ganglion
- MRI: Occult bone injury, tendons, ligaments
- CT: Occult fracture, fracture management, bone tumors

2. FRACTURES

a. Colle's: *Distal radius, dorsal angulation of the distal fragment*

b. Smith's: *Reversed Colle's, volar angulation of the distal segment*

c. Scaphoid: *Usually through the waist*

Proximal pole prone to avascular necrosis

Complications

Avascular necrosis, non union, radiocarpal arthritis, median n.

SNAC WRIST

Scaphoid Non union Associated Collapse

d. Scapholunate disassociation

Ruptured interosseous scapolunate ligament

PA view with clenched fist

Widened S-L space ("Terry Thomas" sign)

Lunate rotates usually dorsally

DISI instability

(Dorsal Intercalated Segmental Instability)

SLAC WRIST

Scapho-lunate associated collapse

e. Boxers and drillers wrists

Degenerative arthropathy of both wrists

f. Hook of hamate

Raquet/ handle sports

Ulnar nerve neuropathy

3. SOFT TISSUES

a. Tendons: Tenosynovitis- US, MRI

b. Swellings: Ganglion- US, MRI

c. Median Nerve: US, MRI

CARPAL TUNNEL

Classic signs: Enlarged nerve proximal to tunnel

High signal nerve

Unreliable when normal study (High false negative)

d. Triangular Fibrocartilage (TFCC)

Develop tears in disc most common. sometimes attachments

MR best technique

4. ULNAR IMPACTION SYNDROMES

Positive ulnar variance

Bone marrow edema of lunate and ulna head or styloid

1600-1700: SESSION VI. SHADES OF GREY: LOWER LIMB

HIP

1. IMAGING PROTOCOLS

XR: 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

US: Ultrasound next study in Australia, Canada and Europe

Rotator cuff pathology

Dynamic impingement

Bursitis

Biceps tendonitis

MRI: always in the US

Rotator cuff pathology

Bursitis

Intra-articular detail: synovitis, labrum, articular cartilage

MR ARTHROGRAM—placement of contrast (gadolinium) into the 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:

ii. Direct-- injection into the joint

Iodinated dye introduced for CT or gadolinium for MRI

ii. Indirect-- intravenously and then exercised

2. HIP ALIGNMENT ASSESSMENT

1. Shenton's line

2. Iliofemoral line

3. Klein's line

4. Skinners line

5. Teardrop distance

6. Femoral angle

3. COMMON VARIANTS

1. Synovial herniation pit (Pitts Pit)

Eccentric femoral neck lesion with sclerotic cortex

2. Acetabular notch

"Pseudo defect" of acetabulum

3. Os acetabulae

4. Bone island

Oval and orientated along trabecular lines

4. TRAUMA

AVULSION INJURIES OF THE PELVIS

Ischium: Hamstring attachments

a. Bony avulsion

i. Ischial apophysis avulsion between 12-18 years

ii. Apophysis fragments and enlarges post avulsion

iii. Hamstrings remain attached to avulsed bone

iv. "Rider's bone"

b. Hamstring tendon avulsion

ASIS: Sartorius avulsion

AIIS : Rectus femoris avulsion

Iliac Crest: Erector spinae avulsion

Adductor Avulsive Injuries: Adductor longus and brevis, pectineus insertion
Irregularity and sclerosis of pubic bone
Changes of osteitis pubis

FRACTURES

Body of pubis
Superior ramus
Inferior ramus/ischium
Acetabulum

PATHOLOGICAL FRACTURES

Malignancy
Motheaten/permeative destruction

Trochanteric avulsion

Benign

Geographic: Bone cyst, fibrous dysplasia

INSUFFICIENCY FRACTURES

Most commonly sacrum, pubis, proximal femur, knee, ankle, foot

“H” Fractures

Combined bilateral vertical and S2–S3 horizontal fractures
Most commonly in osteoporosis- *“insufficiency fracture”*
Often after hip prosthesis
Occasionally long distance runners
* Plain radiographs often normal
Offset of anterior sacral surface at S2
Break in foraminal lines, may see linear sclerosis
* CT and MR show fracture lines
* Bone Scan shows avid uptake at all three fracture sites
“H” or “Honda” sign

Proximal femoral shaft

10 years post aledronate therapy
“Thigh splints”
Plain film diagnostic
Subtrochanteric Cortical “beak”
MR and Bone scan equivocal
See changes prior to fracture- can be pinned prophylactically

PEDIATRIC HIP PAIN

IMAGING PROTOCOLS

XR: First line examination
US: If XR negative to exclude hip effusion
CT: If identified bone abnormality
MRI: Definitive study. May need general anesthetic

TRANSIENT SYNOVITIS

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

Resolves 2-4 weeks, can be recurrent
Always differentiate from septic arthritis clinically.
When in doubt aspirate

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
MR: High signal at growth plate
Metaphyseal bone marrow edema

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

TROCHANTERIC DISORDERS

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

OSTEOARTHRITIS

Classic features:
Loss of superior joint space
Osteophytes at head margin
Lateral shift of femur
Geodes- subchondral cysts
Variable sclerosis
Complicating avascular necrosis
XR first then MRI
Early OA best examined with MR for cartilage loss

LABRAL INJURY

Anterior pain- severe and intermittent with specific movements
Diagnose by MR
Non contrast MR: shows avulsion, tear, perilabral cysts
MR Arthrogram: Gold standard, shows contrast leak

FEMORO-ACETABULAR IMPINGEMENT (FAI)

Over coverage of the femoral head by the acetabulum
Results in cartilage-bone impaction at superolateral joint
Two types:

Cam FAI: Asymmetrical femoral head
Hinge FAI: Previous Slipped epiphysis, Perthes, OA
XR- CAM FAI
Failure of acetabular overlap of femoral head

Osteoarthritis in young
Femoral neck “bump”
HINGE FAI
Large lateral acetabular osteophyte
Altered femoral head shape
MR: Cartilage loss
Labral tears
Bone marrow edema at impingement sites head and acetabulum

AVASCULAR NECROSIS

Key sign is collapse of the articular cortex- “*step*” sign
Usually only affects upper third in wedge or oval shaped fashion
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

BONE MARROW EDEMA (BME) SYNDROMES

Unknown cause for MR demonstrated (T2 FS, STIR) edema of hip marrow
“Transient Bone Marrow Edema Syndrome”
“Migratory Osteoporosis”
Always DDX is tumour and infection
Treat with Aledronate (bisphosphonate)

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. Quadriceps / 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

Mucoid deposition

2. Lateral meniscus tear

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

ANKLE AND FOOT

IMAGING PROTOCOLS

- XR: Three views- AP, AP oblique and lateral
Fractures, bone lesions
- MRI: Stress injuries, ligament – tendon injuries
- US: Tendon injury

FRACTURES

1. Lateral malleolus
2. Medial malleolus
3. Talus
Osteochondritis dissecans
4. Calcaneus
Compression fractures- assess with Bohlers angle, CT for subtalar joint

TENDON AND LIGAMENT INJURY

1. Achilles
Ultrasound or MR (best)
2. Tibialis posterior
Spontaneous sudden flat foot in female over 50 years of age
3. Impingement syndromes
Os trigonum
Anterior
Medial
Lateral
4. Ligament injury
Anterior talofibular ligament
5. Plantar fasciitis