Non-Interpretive Skills
Ordering MSK Imaging
Before You Begin

This module is intended primarily for clinical medical students or interns intending to learn or review non-interpretive radiology skills.

Please note that while not integral, this module series assumes some familiarity with basic imaging techniques and interpretive skills. If you wish to learn or review these concepts, please see our “Interpretive Skills” module series.

If material is repeated from another module, it will be outlined as this text is so that you are aware
Radiology

Basic MSK Imaging Concepts

What can imaging do?

Why now?
Module Outline

• Imaging Basics
  • Orientation
  • What type of image
    Modality

• Take home “rules” that apply universally
Image Interpretation entails:

1) Technical skills and awareness
2) Knowledge of pathophysiology
3) Orientation
4) Common sense

One must apply a gross integrated knowledge and understanding

*** It is not just a question of memorizing structures!!
In the big picture.... Radiologists

- Diagnose, evaluate treatment or disease progression
- As consultants, we specialize in supporting a working diagnosis

But for right now....

Understand the anatomical images.

- Formulate a logical understanding of exam ordering
- Break down images or exams into components and understanding of what can be learned in that type of study
- Create an observation methodology
Radiation Exposure Basics

Please see our “Radiation Safety” module for a more granular discussion

Some relative numbers:

- PA CXR: 0.05 mSv
- Thoracic CT Scan: 7 mSv  (= about 150 CXRs!)
- Natural Background Radiation per year: 2.5 mSv
General Radiation risk: Examples

If we ask the question: how much will radiation exposure increase my chances of cancer death over my lifetime? Let’s look at the relative risk of 1 in a million chances of dying of activities common to our society:

- Smoking 1.4 cigarettes (lung cancer)
- Eating 40 tablespoons of peanut butter
- Spending 2 days in New York City (air pollution)
- Driving 40 miles in a car (accident)
- Flying 2500 miles in a jet (accident)
- Receiving 10 mRem of radiation (cancer)
Mayo, J. R. et al. Radiology 2003;228:15-21
Graph compares lifetime mortality risk from cancer per sievert to age at the time of exposure.

Note: Difference between Women and Men

Note: Difference and diminished risk with aging

Mayo, J. R. et al. Radiology 2003;228:15-21
Musculoskeletal Studies

Common indications/complaints:

- Pain
  - Bone or soft tissue
  - Site – focal or diffuse
  - Chronic vs. acute
- Acuity
- Trauma/accident
- Ongoing known diagnosis (eg. Rheumatoid arthritis) – needed for progression
- Known Diagnosis with potential MSK ramifications (eg. Crohn’s disease)
Goals

To use common cases and situations to accentuate best ordering practices

** Please refer to “Image Interpretation Skills” for a more detailed explanation of how to interpret different imaging modalities.
MSK Imaging

4 Main imaging modalities:

- **Plain Films (GMI)**
  - Fractures, acute setting, initial look, And “GMI” stands for general medical imaging

- **CT**
  - 3-D reconstruction, greater detail – best look at osseous structures

- **MRI**
  - Best look at bone marrow, soft tissues – yet limits and costs

- **U/S**
  - Peds and joints/ligaments - largely
Plain Film

Identify - what is being imaged

Use landmarks

Be sure to use recommended number of projections

Especially –
• Hands, feet and ankles - 3 views!
• Or L-spine - 5 views! Given overlapping anatomy
Basic Principles
This single view – shows what?
Use of all Views provided

*And order the optimal number.*

Radiologists are there to assist/advise.

Lateral is best in this fracture
Anterolithesis.

Demos alignment issues
Same Patient –

Shows with oblique Imaging the pedicle:

Fractured pedicle or Spondylololitheosis or “broken neck of the dog”

So often 1 or 2 views is not adequate to exclude most pathology – ask for advice from Radiology to determine what is needed clinically – when in doubt.
Plain Film

Fracture Terminology

5 Key Words – are *not* interchangeable

A. Displacement
B. Angulated
C. Impacted
D. Distracted
E. Overlap

Transverse vs. Oblique vs. Comminuted
See what?
This is a “night Stick” fracture – hit with a baton (direct blow)

*Clinical History or mechanism of injury* is especially important in MSK — can alter exam performed and or needed, given subtlety
Plain Film:

Very helpful in just confirming alignment

Anatomical position – consider basic normal and look for deviation – often this again takes multiple projections given overlapping structures – *which must be ordered*
Anterior Shoulder Dislocation – humoral head is “under” the coracoid (should be under the acromion)
Plain Film

Consider: Cortical vs. Medullary Bone

- Cortical Integrity – breaks and erosions
- Density
- Trabecular Pattern
- Lytic vs. Sclerotic

Outline each bone and scan for focal cortical disruption/changes
Scapular spine Fracture
Plain Film

Periosteum – should be unapparent

“All Thickening” or “irregularity”

(Especially seeing layers – are worrying -- implies longer time course)

Fracture repair – or “Callus” represents a normal periosteal response – that is calcifying
Plain Film

Consider:  Cortical vs. Medullary Bone

- Cortical Integrity – breaks and erosions
- Density
- Trabecular Pattern
- Lytic vs. Sclerotic
Dx: Fibrous dysplasia
Thickened Cortex, expansile and associated ground glass changes
Suspected Chondrocarcinoma

Though you see cortical thinning – you need additional views or CT/MR to evaluate internal matrix
Osteomyelitis ankle with ulcer – need many views.

Combo of findings. Ulcer/irregular skin (large arrow), irregular osseous cortex and bone lucency
Plain Film

Soft Tissue - evaluation

- Check for swelling
- Expected fat planes

Fat is useful and outlines muscles and other structures
Massive soft tissue
Neurofibromatosis – NF 1
Plain Film

Patient Positioning

Must be “Patient controlled” –

Ordering Specialty views/projections

! Provides insight to function and ligaments
Compare the following two Cases –

Case 1 and Case 2
Both represent advanced disease –

Yet it is the relative symmetry of Case 2 – which assists in suggesting Rheumatoid Arthritis

Diseases have patterns – not always adhered or absolute though ordering exams properly or most effectively – allows Radiology to best narrow the differential

So it was especially helpful to have opposite hands for side by side comparison!

(Case 1 - is massive Gout)
Prior Exams can be especially helpful – in assisting detection! Subtle changes are more evident. Definitely tell your Radiologist about “prior outside” images if known.
Pelvic and hip fractures

CT is helpful – yet 3D reconstruction can be assistive for surgeons in OR planning.
New Case:

Hx:
Patient Feels “Mass” – over upper arm
Soft tissue mass – no underlying osseous abnormality/change.
Soft tissue density (fat outlines the outer margin)
The Blue line demarcates the region of specialized *Fat Saturation* – the zone towards the midline is “fat suppressed”, proving tissue composition.

Special MR sequencing proves this is a fat containing mass.

Yet – not all MRIs are preformed similarly.

*Clinical data drives the protocol performed*, so data supplied by the referring MD is central to quality studies (and not wasting valuable Resources!)
New Case: New pain following football injury

Nothing to be seen – (including other views)
MRI – is far more sensitive for specific abnormalities, Largely those that are soft tissue related

When in doubt – high quality clinical data (and “clinical question To be answered” - will assist directing the patient imaging needs.

Never hesitate to call your radiologist – or check out ACR Appropriateness Criteria online.
Some joint MR exams – are best when augmented with very diluted Gadolinium.

Gadolinium – not unlike iodine and how Iodine based contrast assist detection in radiography – Gad.

Demonstrates enhancement on T1 imaging, often highlighting vessels, vascular tissues or tumors.
When asked and ordered - the Radiologist will under fluoroscopy guidance inject fluid into the joint to enhance detection of more subtle or potentially missed findings.

In this case – the injected shoulder demonstrated complete tearing of the rotator cuff (see long arrow), double headed arrow shows the supraspinatus tear and retraction.
Arthroplasty and foreign materials - can generate artifact -

Call radiology to determine what imaging is best: CT - over MR
New Case:

Thigh pain with running
New Case:

Thigh pain with running

Very faint questionable periosteal reaction.
Serial imaging or supplemental imaging, can be helpful. In this case – a focal stress fracture is evident.

(Never hesitate to call Radiology!)
Ultrasound – also is useful in the correct hands.
Different case – yet MR is useful too but more costly and takes time.
Imaging Guidelines

• A variety of imaging guidelines exist to guide healthcare providers when ordering exams
• For example, the Ottawa Ankle Rules provide physicians with physical exam findings that warrant an X-ray in the setting of foot/ankle trauma
  • Source: http://www.theottawarules.ca/ankle_rules

• Additionally, the American College of Radiology (ACR) publishes appropriateness criteria for diagnostic imaging
  • Source: https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria

Please take some time to review these resources or bookmark them for when you are on-service
Additional Cases
46 y.o. patient presents in the ER with acute knee pain, following a collision.
Radiograph request:

Motor Vehicle Accident ("MVA"); Rule out fracture
Motor Vehicle Accident (MVA): Rule out fracture

What conditions might cause pain?

- Torn or damaged soft tissue (muscles, tendons, ligaments)
- Bone abnormalities – fracture, bone bruise, avulsion
Consider the Acuity!

Some exams are faster to obtain – especially 24/7 (such as the ER)

Initial imaging may provide insight as to whether additional imaging is needed – emergent or at a later date
Tibial plateau fracture – needed 4 views to be confident that there was no depression.