

Imaging Modalities: Clinical Reasoning and Key Instructional Elements: Radiography



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Disclosure

- No relevant financial relationship exists

Objectives

- Determine the most appropriate radiographic views according to patient/client presentation, current best evidence for diagnosis, and current best evidence for reducing ionizing radiation exposure.
- Understand basic concepts of radiographic image acquisition and interpretation.
- Determine the relevance of visualized pathology to clinical decision-making.

Diagnostic Imaging Reveals Pathology...

But, The Patient History and Clinical Examination Provides Relevance

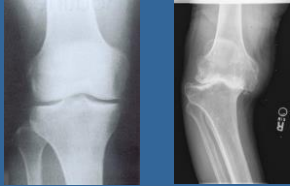
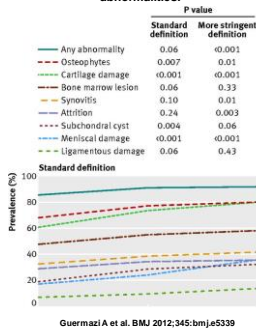


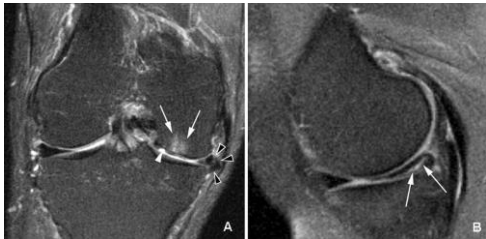
Fig 3 Prevalence of osteoarthritis features on MRI in knees without radiographic osteoarthritis stratified by age group with standard and more stringent definitions of MRI abnormalities.



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Fig 2 Knee with multiple abnormalities on MRI indicating early stage osteoarthritis despite lack of radiographic osteoarthritis.

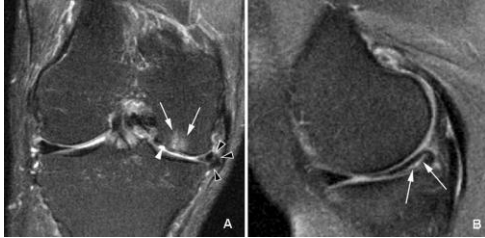


Guermazi A et al. BMJ 2012;345:bmj.e5339

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Knee with multiple abnormalities on MRI indicating early stage osteoarthritis despite lack of radiographic osteoarthritis. A: coronal fat suppressed proton density weighted image shows several features of early OA detectable only by MRI. White arrowhead shows focal full thickness cartilage defect at central weight bearing part of medial femur. In addition there is adjacent subchondral bone marrow lesion presenting as area of ill defined hyperintensity (arrows). Black arrowheads show meniscal extrusion at medial joint line causing bulging of neighbouring medial collateral ligament (no arrow). B: sagittal proton density weighted image shows isolated degenerative horizontal oblique tear of posterior horn of medial meniscus extending to undersurface of meniscus adjacent to posterior tibial surface (arrows). No associated cartilage damage or subchondral bony alterations are seen



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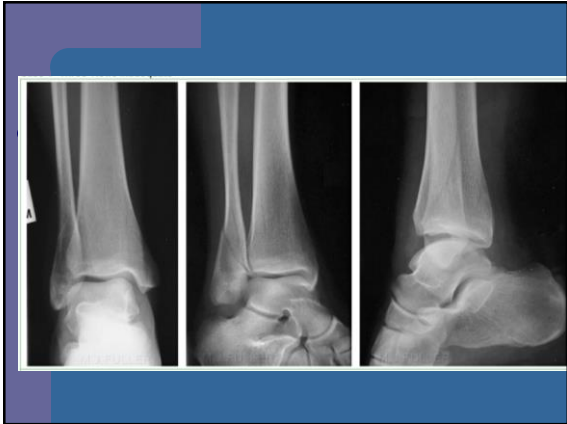


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Key Principles of Diagnostic Imaging

- Do no harm
- Use diagnostic imaging only when you are positive findings will alter the intervention
- Always get at least 2 views
 - Need 2 views to be interpretable
- Diagnostic imaging is a small component of the greater examination
- Diagnostic images are special tests
 - Should be placed in the context of the entire examination
 - Consider mechanism of injury, history and physical exam





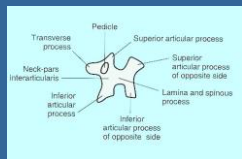
Key Principles of Diagnostic Imaging “Do no harm”

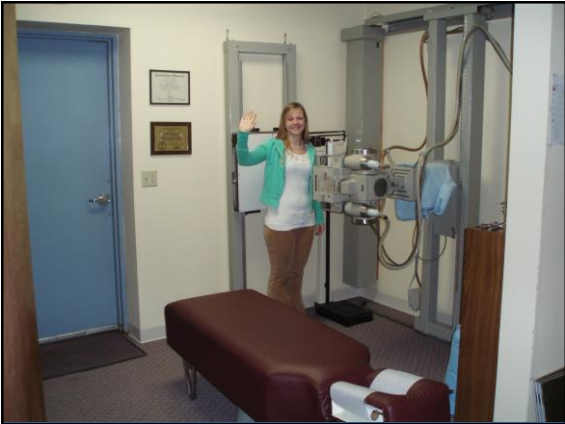
- Consider diagnostic yield
- Conventional radiographs generally first
- Use shielding whenever possible
- Lowest dose view
- A-P and lateral but not obliques for L-spine
- P-A rather than A-P for scoliosis views
 - 3-7x reduction in lifetime ionizing radiation
 - Reduces risk of breast cancer by 3-4x and thyroid cancer by 2x (Levy et al. 1996)

Oblique Projection




- Patency of facet joint
- Pars Interarticularis





Diagnostic Imaging In Physical Therapist Practice

- When to request imaging?
 - How quickly is imaging needed?
- Patient education
 - What is required for this?



The Canadian C-Spine Rule

1. Any High-Risk Factor That Mandates Radiography?
 Age ≥65 Years
 or
 Dangerous Mechanism*
 or
 Paraesthesia in Extremities

↓ No

2. Any Low-Risk Factor That Allows Safe Assessment of Range of Motion?
 Simple Floor and MVC†
 or
 Sitting Position in ED
 or
 Ambulatory at Any Time
 or
 Delayed Onset of Neck Pain‡
 or
 Absence of Midline C-Spine Tenderness


↓ Yes

3. Able to Actively Rotate Neck?
 ≥1° Left and Right

↓ Able

(No Radiography)

Stiell, I. G. et al. JAMA 2001;286:1841-1848



Incidence / Diagnosis of Severe C-spine Injury

- 1.7 % of those with head and neck injuries presenting to the ED will actually have significant pathology (n=8924)
- Canadian C-Spine Rules in alert patients following trauma (for significant c-spine injury)
 - 100% sensitive
 - 43% specific

(Stiell I, 2000)

ACR Appropriateness Criteria

Variant 2: Suspected acute cervical spine trauma. Imaging indicated by clinical criteria (NEXUS or CCR). Not otherwise specified.

Radiologic Procedure	Rating	Comments	BRL
CT cervical spine without contrast	9	With sagittal and coronal reformats.	☆☆☆
X-ray cervical spine	6	Lateral view only. Useful if CT reconstructions are not optimal.	☆☆
Myelography and post myelography CT cervical spine	1		☆☆☆☆
CTA head and neck	1	See variant 6.	☆☆☆☆
MRI cervical spine without contrast	1	See variant 3.	○
MRA neck with contrast	1	See variant 6. May be performed without contrast if gadolinium-based agents are contraindicated.	○
Arteriography cervicocerebral	1	See variant 6.	☆☆☆

Rating Scale: 1-2 Usually not appropriate; 3-5 May be appropriate; 7-9 Usually appropriate

*Relative Radiation Level

Radiographic Terminology

Osteoblastic

- Radiopaque
- Opacity
- Sclerosis
- Hypertrophic bone
- Increased radiodensity
- Blastic lesion
 - Reparative
 - Reactive bone

Osteoclastic

- Radiolucent
- Lucency
- Osteopenia
- Decreased radiodensity
- Lytic lesion or 'lysis'
 - Bone destroying



Fig 1. The Osteoporosis Sagittal sections (left) and corresponding low radiated X-ray (right) showing signs of bone destruction characteristic of osteoporosis.

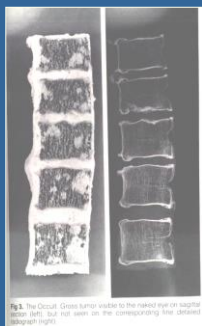
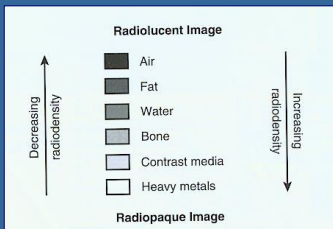


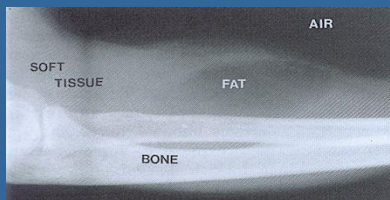
Fig 2. The Osteoporosis Coronal sections (left) and corresponding low radiated X-ray (right) showing signs of bone destruction characteristic of osteoporosis.

Wong DA et al, Spine, 1990

Shades of Gray & Radiodensity



Lipoma

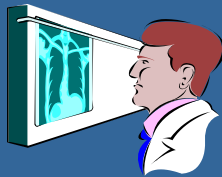


Gulp! She swallowed her own engagement ring
Woman's boyfriend hid it in milkshake to propose; happily, the crisis passed



Radiographic Evaluation (*The ABCs*)

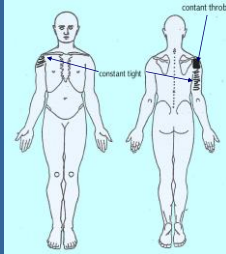
- Alignment
- Bone Density
- Cartilage Spaces
- Soft Tissues



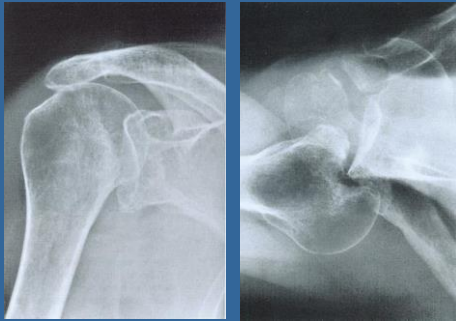
Alignment

1. Size of bone
2. Number of bones
3. Shape and contour of bone
4. Bone and joint position

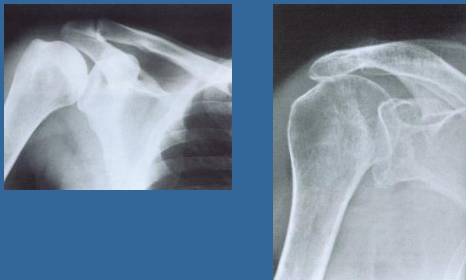
Case Discussion



- 35 yo male; presents to urgent care clinic after falling onto outstretched arm off of his front porch
- CC: Pain and decreased AROM



Anterior to Posterior Projection

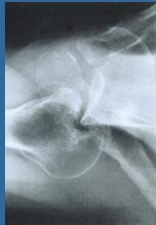


Axillary Projection

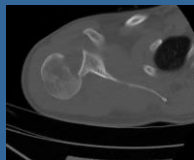


gt	greater tuberosity, humerus
hh	humeral head
c	coracoid process, scapula
ac	acromion process, scapula
acj	acromioclavicular joint
g	glenoid
cl	clavicle

Axillary Projection

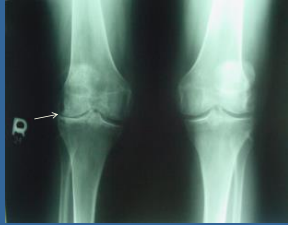


Posterior Shoulder Dislocation



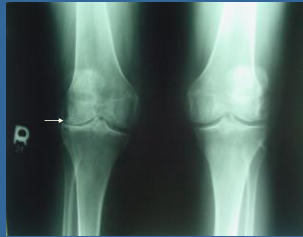
Bone Density

1. General bone density
2. Focal bone density
3. Trabecular alteration



Cartilage Space

1. Joint Space
 - Width
 - Symmetry
2. Subchondral Bone
 - Contour
 - Density
3. Growth plates/Epiphyses



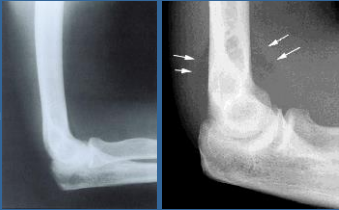
Soft Tissue

1. Gross musculature
2. Joint Capsule
 - Increase volume
 - Fat Pad Sign
3. Periosteum



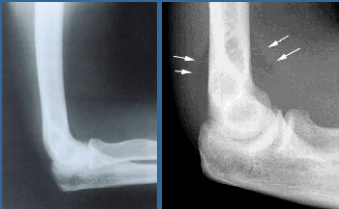
Soft Tissue

1. Gross musculature
2. Joint Capsule
 - Increase volume
 - Fat Pad Sign
3. Periosteal elevation

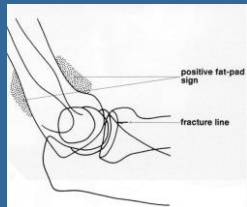


Positive Fat Pad or Sail Sign

- Suggestive of
occult radial head
fracture



Positive Fat Pad Sign



34-year-old female deployed soldier with a chief complaint of worsening bilateral anterior shin pain for the past 8 weeks with running

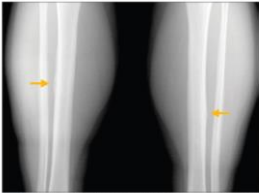


FIGURE 1. Anterior conventional radiographic view of the bilateral tibia and fibula demonstrating cortical thickening through the midtibial regions bilaterally consistent with stress reaction changes (arrows). Furthermore, a transverse lucency through the cortex of the right midtibial region was noted, which was consistent with a stress fracture.



FIGURE 2. Lateral conventional radiographic view of the right tibia and fibula demonstrating cortical thickening through the anterior midtibial region consistent with stress reaction changes and a transverse lucency through the cortex of the anterior midtibial region which was consistent with a stress fracture (arrow).

References

- Boyles RE, Gorman J, Pinto D, Ross MD. Physical Therapist Practice and the Role of Diagnostic Imaging. J Orthop Sports Phys Ther 2011;41:829-837.
- Deyle GD. Musculoskeletal imaging in physical therapist practice. J Orthop Sports Phys Ther. 2005; 35: 708-721.
- Deyle GD. The role of MRI in musculoskeletal practice: a clinical perspective. J Man Manip Ther. 2011; 19:152-161.
- Haverstock BD. Foot and ankle imaging in the athlete. Clin Podiatr Med Surg. 2008;25:249-62.
- Hillman BJ, Goldsmith JC. The uncritical use of high-tech medical imaging. N Engl J Med. 2010;363(1):4-6. Epub 2010 Jun 23.
- Jarrvik JG, Dayo RA. Diagnostic evaluation of low back pain with emphasis on imaging. Ann Intern Med. 2002;137:586-597.
- Lennon RI, Riyat MS, Hilliam R, Anathkrishnan G, Alderson G. Can a normal range of elbow movement predict a normal elbow x ray? Emerg Med J. 2007;24:86-88.
- Stiell IG, Greenberg GH, McKnight RD, et al. A study to develop clinical decision rules for the use of radiography in acute ankle injuries. Ann Emerg Med 1992;21:384-390.
- Stiell IG, Greenberg GH, Wells GA, et al. Derivation of a decision rule for the use of radiography in acute knee injuries. Ann Emerg Med 1995;26:405-413.
- Stiell IG, Wells GA, Vandemheen KL, et al. The Canadian C-spine rule for radiography in alert and stable trauma patients. JAMA 2001;286:1841-1846.

Thank you!