Advances in Musculoskeletal Imaging

Linda Probyn, MD, FRCPC
MSK Radiologist
Disclosure

• I have no commercial or financial interests related to the subject matter of this presentation
Objectives

At the end of this presentation, the participant will be able to:

1. Discuss new advances in bone, soft tissue and joint imaging
2. Understand the optimal modality for imaging common musculoskeletal conditions
3. Summarize advanced imaging techniques
Wilhelm Rontgen
Heated filament emits electrons by thermionic emission

Electrons are accelerated by high voltage

X-ray tube

x-rays produced when high speed electrons hit the metal target
Radiography

- Film processing
- Computed Radiography (CR)
- Digital Radiography (DR)
Radiography

- Digital Radiography
Image Adjustment:
window & level
Ultrasound

- 1940’s used for therapy using heat & disruptive effects
- Developed as a diagnostic tool in saline
- Direct contact transducer

Woo J. A short History of the development of Ultrasound in Obstetrics and Gynecology. www.ob-ultrasound.net/history1
Ultrasound
Ultrasound
Ultrasound

Tendon:
Fibrillar, linear pattern
Ultrasound

- Readily available
- Safe
- Anatomy
Ultrasound

• Good spatial resolution:
• 0.3 – 3 mm (XR, CT, MRI 1 mm)
• Compare other side
• Communicate with pt.
• Dynamic
Ultrasound

- Good spatial resolution:
  - 0.3 – 3 mm (XR, CT, MRI 1 mm)
- Compare other side
- Communicate with pt.
- Dynamic
Ultrasound

- Achilles tear
Ultrasound

- Function:
  - blood flow
  - tissue perfusion
  - tissue stiffness
- Shear wave

Drononaki EE, Allen GM, Wilson DJ, Ultrasound elastography for musculoskeletal applications. BJR, 85(2012), 1435-1445
Structure

• Nerves
  – Multiple axons bundled together in fasicles
  – Surrounded by echogenic perineurium

Nerve Sheath Tumour
Neuropathy – Ulnar Nerve

- Guyon’s canal

Ganglion cyst compressing the ulnar nerve
Pitfall - Anisotropy

- Beam reflected away from transducer if probe not perpendicular to the structure
- Appears hypoechoic
Pitfall - Anisotropy

- Solution
  - Heel toe transducer in longitudinal
  - Rock transducer in transverse
Ultrasound

Limitations:

- Deep structures hard to penetrate or obscured
- Body habitus
- Air
Ultrasound

• Focal Zone Adjustment
Tenosynovitis

- Distention of tendon sheath with fluid or synovial hypertrophy
- +/- hyperemia
Tendinosis

- Degeneration of the collagen
- US
  - Hypoechoic tendon enlargement
  - +/- hyperemia
Screw Impingement

• Metalwork can impinge upon nerves and tendons
• Dynamic assessment helpful
CT

• 1971 – Godfrey Hounsfield developed CT scanning and first successful scan of cerebral cyst
CT
CT

- Single detector
- Multi detector
CT

coronal and sagittal reformatting
CT

- Metal reduction

CT

• Dual energy

CT

- Fracture imaging
- Axial images
- 2D & 3D reformats
Press Release:

2003 Nobel Prize

October 6, 2003

The Nobel Assembly at Karolinska Institutet has today decided to award The Nobel Prize in Physiology or Medicine for 2003 jointly to:

Paul Lauterbur & Peter Mansfield

"For their discoveries concerning Magnetic Resonance Imaging"
MRI

- patient in a **strong** magnetic field
- multiplanar imaging
- excellent soft tissue contrast
- ideally suited for MSK
CT

MRI

MRI T1

MRI T2 fat sat

Soft tissue contrast
MRI
Metallic Artifact
MRI

Ultrashort TE Pulse Sequences:

- Imaging of fibrocartilage at enthesis

MRI

- Cartilage
- Laminar appearance
- Reflect variation in T2 values across the cartilage

Grade 1
Grade 2
Grade 3
Grade 4
MRI

• AFF
Imaging of Early Inflammatory Arthritis

- Radiographs:
  - Gold standard
  - Cannot detect pre-erosive inflammatory change
Imaging of Early Inflammatory Arthritis

Joints ache just thinking about it?
When diagnosed early, Rheumatoid Arthritis can be better managed.
Imaging of Early Inflammatory Arthritis

- MRI and US
  - Excellent soft tissue contrast
  - Direct visualization of synovitis and erosions
Erosions/Synovitis

Ultrasound

- Margins of joints
- Associated with synovitis
- New microvascular imaging
Erosions/Synovitis

MRI

- Juxta-articular
- Synovitis, enhancement
- Gadolinium
  - ↑ sensitivity
  - Differentiate effusion vs. synovitis
  - ↑ cost
Nuclear Medicine

- Bone scan
- Very sensitive, not specific
Nuclear Medicine

‘Non-specific uptake xiphoid process region of the sternum. Correlation with clinical examination suggested.’

‘Unless there has been trauma to these sites I cannot exclude metastatic disease and further radiologic correlation is recommended.’

‘This likely represents a normal variant, however, correlation with x-ray is recommended to rule out loosening or other pathology.’

‘Clinical correlation and further investigation with a left shoulder radiograph is recommended.’

‘Suspected degenerative change midcervical spine, radiograph would be confirmatory.’

‘Possible traumatic injury to the sternoclavicular joints bilaterally. Radiographic correlation is recommended.’

‘Mild focal activity within the left acetabulum anteriorly which is non-specific and could be related to either degenerative changes or a metastatic deposit.’
‘**Non-specific** uptake xiphoid process region of the sternum. Correlation with clinical examination suggested.’

‘Unless there has been trauma to these sites I cannot exclude metastatic disease and further **radiologic correlation** is recommended.’

‘This likely represents a normal variant, however, **correlation with x-ray** is recommended to rule out loosening or other pathology.’

‘**Clinical correlation** and further investigation with a left shoulder radiograph is recommended.’

‘Suspected degenerative change midcervical spine, **radiograph would be confirmatory**.’

‘Possible traumatic injury to the sternoclavicular joints bilaterally. **Radiographic correlation** is recommended.’

‘Mild focal activity within the left acetabulum anteriorly which is **non-specific** and could be related to **either degenerative changes or a metastatic deposit**.’
PET

• Positron emission tomography
• Functional imaging for metabolic processes
• Demonstrates biologically active molecules
PET CT

• Fusion of metabolic and anatomic information

Nuclear Medicine

- Bone Density
Nuclear Medicine
Interventional

• Arthrography
• Joint injections and aspiration
• Biopsy
  – ultrasound guided
  – CT guided
• Spinal intervention
  – nerve root blocks
  – facet joint injections
  – discograms
Interventional

• Ultrasound
  – Dry needling
  – Steroid
  – PRP
  – Fibroblast

Pre

Post

Courtesy: Dr. Mark Cresswell
Quality

- Store images (PACS)
- Compare with previous & other imaging
Quality

Appropriateness criteria
- Evidence based guidelines
- Appropriate imaging and treatment decisions for specific clinical conditions
Quality

• Aim to decrease radiation and eliminate unnecessary procedures
Quality

• Radiation
  – Dose reduction techniques
  – CT – reconstruct images

• Contrast Agents
  – CT & MRI
  – Much safer
Plain Films

• Basic concepts
Unexpected Findings

- AFF on ultrasound
“You see, Ms. Jenkins, by doubling up on patients in the MRI, we’re able to cut costs in half, thereby passing the savings on to you.”
Summary – Take Home Points

• Advancements in ALL imaging modalities
• Improved patient care & safety
• Need to maintain high quality
• Consideration for cost
The End

Linda Probyn, MD FRCPC
linda.probyn@sunnybrook.ca
References