IMAGING OF ACUTE KNEE INJURIES

ASSOCIATE PROFESSOR ANDREW WHAN
• X-Ray
• Computed Tomography
• MRI
• Ultrasound – limited role in knee and acute injuries
• Nuclear medicine bone scan – limited role
• Fluoroscopy – limited role
KNEE TRAUMA DDX

- **Acute trauma - Common**
- Fractures
- Patella dislocation
- Ligamentous disruption – ACL, PCL, MCL, LCL & posterolateral corner
- Meniscal tear
- Chondral or osteochondral injuries
- Soft tissue bruising / haematoma
- Bone bruising
- A combination of the above
KNEE TRAUMA DDX

• Acute trauma – Less common
• Knee Dislocation
• Rarely neurovascular injuries
• Ruptured Bakers Cyst
• Tendon tear – patella, quadriceps, hamstring
• Morel-Lavallee
PLAIN X-RAYS

• Still the mainstay of imaging
• 2-D tissue attenuation map
• good specificity
• less sensitive than CT or MRI
• Bones > soft tissues
• Low dose for extremities
• cheap, accessible, mainstay
• Less affected by metal
• DO X-RAYS FIRST
• Covered by Medicare
PLAIN X-RAYS

• X-rays - 2 orthogonal views
• For trauma – 2 Std views - AP and horizontal beam lateral x-rays (ie. Different to OA)
• Good for fractures, large effusions & lipohaemarthrosIs, underlying OA
• An x-ray does not always exclude a # - extra views, repeat x-rays, other modalities
• Extra x-ray views – skyline patella, oblique views
NORMAL KNEE X-RAYS
ABNORMAL KNEE X-RAYS
WHEN ARE X-RAYS INDICATED?

- OTTAWA KNEE RULES
- X-ray only required in acute knee injury with one or more of the following
  - Age 55 or older
  - Fibula head tenderness
  - Isolated patella tenderness
  - Inability to flex knee > 90 degrees
  - Inability to weight bear for 4 steps
  - HIGH SENSITIVITY / LOW SPECIFICITY
COMPUTED TOMOGRAPHY (CT)

- Cross sectional images - MDCT volume data with reconstructions including 3D
- Fast ++
- No IV contrast needed for trauma (except for CTA)
- Moderate soft tissue contrast
- Excellent depiction of bone detail
- High # sensitivity, exquisite detail complex #s
- Relatively little metal artefact eg. osteolysis around TKR with modern metal artefact reduction techniques
- Covered by Medicare
- Readily available
CT IS (RELATIVELY) HIGH RADIATION DOSE

- C. 10 -100 times X-ray dose (2-10mS)
- C. = to Nuc Med (bone scan 4 mSv)
- BUT dose is much less of an issue for extremities – non radiosensitive tissues, tightly collimated beam
- Background av. Annual Radiation c. 3 mSv
- New dose reduction technology – iterative reconstruction (40-50% reduction)
3D CT Tibial Plateau #
MRI

- Excellent soft tissue contrast
- Good spatial resolution
- Multiple planes or volume of data
- No radiation
- Movement susceptible
- Other artifacts problematic eg. metal, movement
- Longer scan times eg. 15-80 mins (KNEE MRI - 20-30 minutes)
- Availability more restricted, smaller FOV
MRI KNEE

- BEST IMAGING TEST FOR:
  - Meniscal tears
  - Ligamentous injuries – ACL, PCL, MCL, LCL, MPFL
  - Occult bone injuries – bone bruising, minimally displaced fractures
  - Acute chondral and osteochondral injuries
  - Acute patellar dislocation
  - MOST COMMON MSK MRI – Utility and accuracy is well supported in the literature
WHAT IS MRI?

- Magnetic Resonance Imaging
- Images hydrogen nuclei – water
- Powerful superconducting magnet – very strong static magnetic field
- Uses RF pulses of energy to stimulate hydrogen nuclei and readout the resulting signals which vary with tissue type
- 1.5T versus 3T versus 7T
MRI
• THE MAGNET IS ALWAYS ON!!!!!!!!!!!!!!!!!!!!!!!

• Strict safety protocols for the design of MRI suites – multiple zones with increasing security

• Fastidious screening of anyone going into the MRI room

• Special equipment eg oxygen bottle

• Projectile risk

• Noise

• Heating (SAR)

• Peripheral nerve stimulation
MAIN CONTRAINDICATIONS

- PACEMAKERS – most BUT now MR conditional pacemakers can permit MRI scans – strict protocol to follow
- COCHLEAR IMPLANTS
- ANEURYSM CLIPS – newer ones generally compatible
- FERROMAGNETIC FOREIGN BODIES eg. eye, bullets
- Others – some aortic stent grafts, implanted infusion pumps, implanted neuro-stimulators, pacemaker leads, pulm art catheters, intra-aortic balloon pump
- WE NEED TO KNOW THE SPECIFIC ANEURYSM CLIP DETAILS OR STENT DETAILS
- NB - SOME IMPLANTS ARE SAFE AT 1.5T BUT NOT 3T
MRI – RELATIVE CONTRAINDICATIONS

• Claustrophobia – Sedation options

• Non-cooperative/agitated

• Uncontrolled movement disorders
THESE ARE NOT CONTRAINDICATIONS TO MRI

• Almost all orthopaedic hardware
• Most surgical clips
• Most vascular stents
• Prosthetic heart valves
• IUDs
GADOLINIUM CONTRAST

- Helpful for certain indications but not needed for most MRI studies
- CI in pregnancy
- CI in severe renal impairment (eGFR < 30) – risk of NSF (nephrogenic systemic fibrosis)
- NOT REQUIRED FOR MOST KNEE MRIs INCLUDING FOR TRAUMA
MRI IN PREGNANCY

• OK as far as we know – caution still appropriate
• Generally avoid in first trimester
specialists can refer MRI knee for any clinically relevant indication
GP MRI MEDICARE ITEMS FOR ADULTS (>16Y):

- **KNEE** – **ACUTE TRAUMA** +
  - INABILITY TO EXTEND THE KNEE SUGGESTING ACUTE MENISCAL TEAR
  or
  - CLINICAL FINDINGS SUGGESTING ACL TEAR

& PATIENT NEEDS TO HAVE HAD KNEE X-RAYS
GP MRI MEDICARE ITEMS FOR CHILDREN(<16Y):

- **KNEE** – AFTER X-RAYS FOR ? INTERNAL DERANGEMENT
CASE 1

• 25 yo with twisting injury playing AFL
• Acute pain and swelling
• Unable to continue playing
• ? ACL
ACUTE KNEE INJURY ?ACL
CASE 2

• 33 yo woman with ongoing knee pain and locking after a netball injury

• X-RAYS – Small effusion, Nil else
CASE 3

- Acute knee injury in 15 yo netballer
- Acute pain and swelling
CASE 3
CASE 4

• 41yo with twisting injury skiing while at the snow for the weekend. Unable to ski the rest of the weekend.

• Moderate swelling and pain
CASE 5

• 28 yo with persisting lateral knee pain several weeks after injury
CASE 6

• 55 yo woman with persistent severe knee pain after a minor trip
• X-rays unremarkable
• Tender medial joint line
BONE MARROW OEDEMA SYNDROME
>> COLLAPSE ("SONK")

INITIAL MRI

6 MONTH F-UP
CASE 7

- 15 yo with knock to knee playing soccer
- Persisting anterior knee pain
• 45 yo male with persistent knee pain noted after mild knee sprain playing tennis
• Pain keeping him awake at night
CASE 9

- 21 yo with previous history of knee problems as a teenager with increasing pain and catching in knee after relatively minor sports injury
CASE 9
CASE 10

• 26 yo front seat passenger in a high speed MVA

• Obvious knee deformity
POSTEROLATERAL CORNER INJURY
CASE 11

• 23 yo male with significant pain post knee injury
• Unable to weight bear
CASE 12

- 54 yo male with twisting injury and increased pain in swelling in knee
LEARNING POINTS – IMAGING FOR ACUTE KNEE INJURIES

• X-RAYS – first line, useful BUT do not exclude fractures and very limited for Ax of internal derangement

• CT – excellent for fracture delineation or ongoing fracture suspicion with no fracture on X-ray

• MRI – best test for internal derangement. Very good for occult fractures
Associate Professor Andrew Whan
Director BMI
Andreww@barwonhealth.org.au

"Off hand, I'd say you're suffering from an arrow through your head, but just to play it safe, I'm ordering a bunch of tests."