



Applications of SPECT/ CT in Orthopaedic Practice

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Introduction

- Increasing utility in Orthopaedic Practice
- Improved technology
 - Improved software resulting in better image fusion
 - High quality multislice CT
- Correlation with other cross sectional imaging
- Greater interest from MSK radiologists
- Major role in problem solving when other imaging inconclusive
- Important role to play in assessment of implanted devices and assessment of bony fusion

3 Phase Bone Scan

- Has been mainstay of orthopaedic nuclear imaging.
- Dynamic and blood pool phases useful physiologic information especially re inflammation/infection
- Inject ^{99m}Tc labelled with HMDP which is incorporated into bone at sites of osteoblastic activity.
- Delayed phase reflects level of osteoblastic activity
- Advantages:
 - Large anatomical coverage
 - Low cost
- Disadvantages:
 - Low resolution
 - Low sensitivity compared with SPECT
 - Poor anatomic localisation
 - Lack of specificity

3 Phase Bone Scan



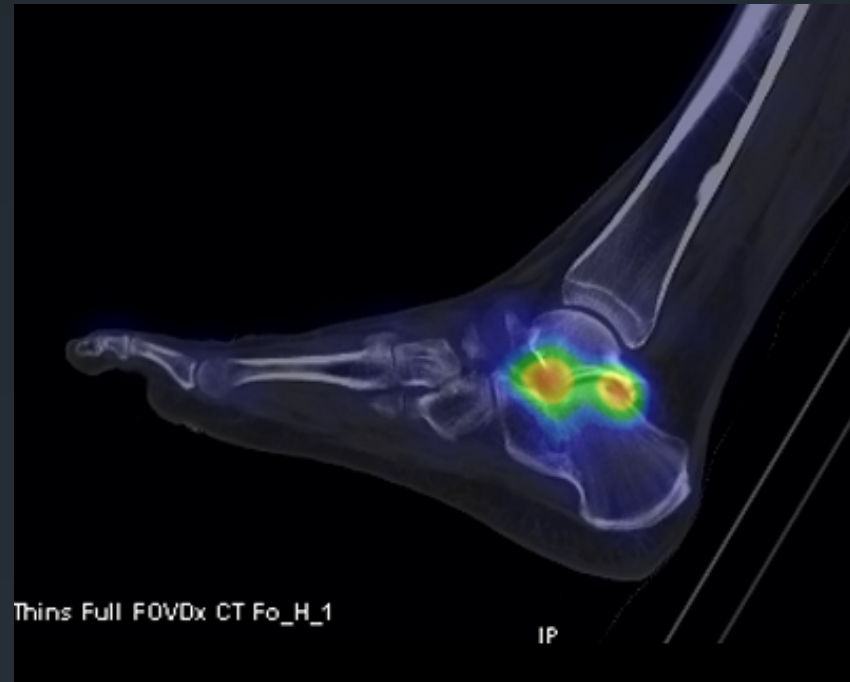
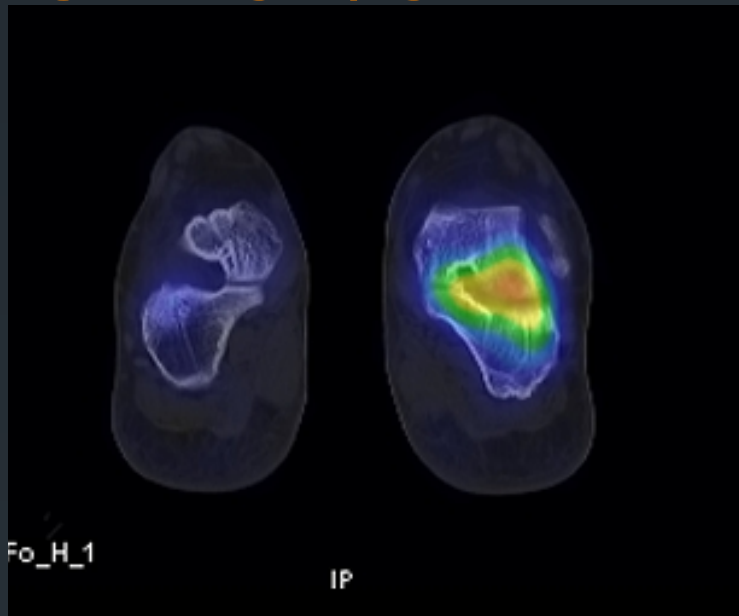
SPECT Scanning

- Single Photon Emission Computed Tomography (SPECT)
- Obtain planar image(similar principle to CT) of anatomy which can be reconstructed in multiple planes.
- Advantages:
 - Improved sensitivity and anatomical localisation
 - Relatively low resolution
- Disadvantages:
 - Poor specificity
 - Difficult for referrers to interpret
 - No compensation for body size(no attenuation correction) can result in spurious results

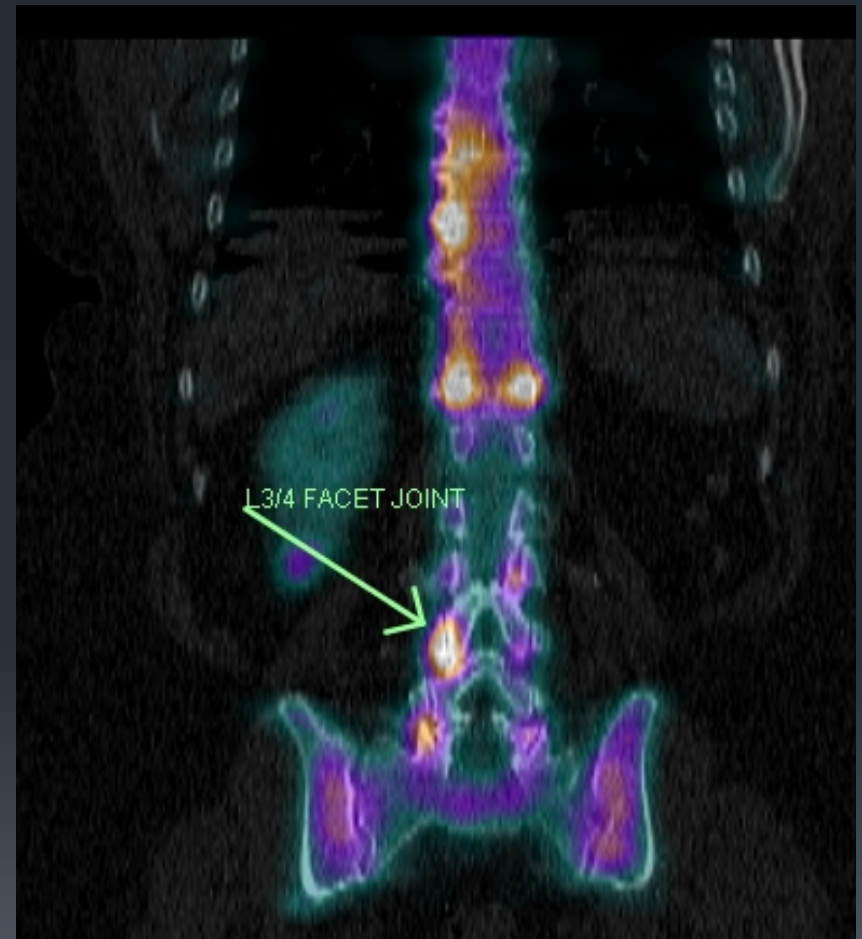
SPECT/CT: Background

- Hybrid system of a SPECT nuclear medicine scanner and a CT scanner
- Has until recently been hampered by poor quality of CT scanner
- The CT scanner allows for attenuation correction to compensate for body size /tissue density resulting in more accurate representation of uptake.

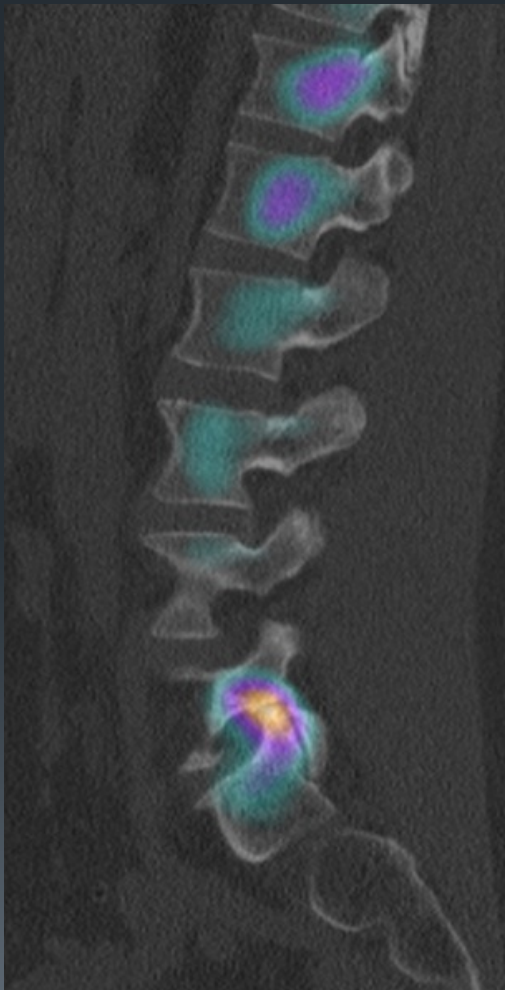
SPECT/CT



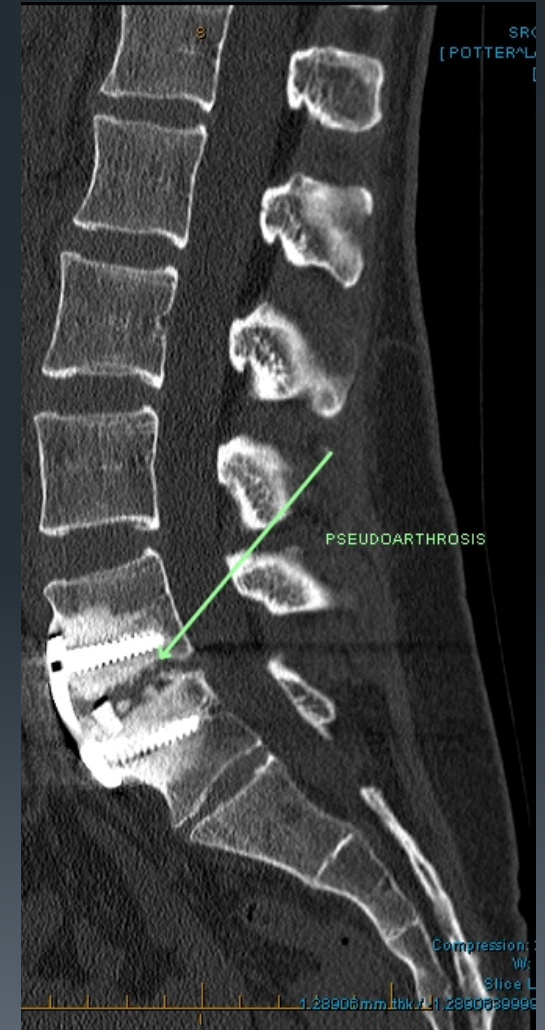
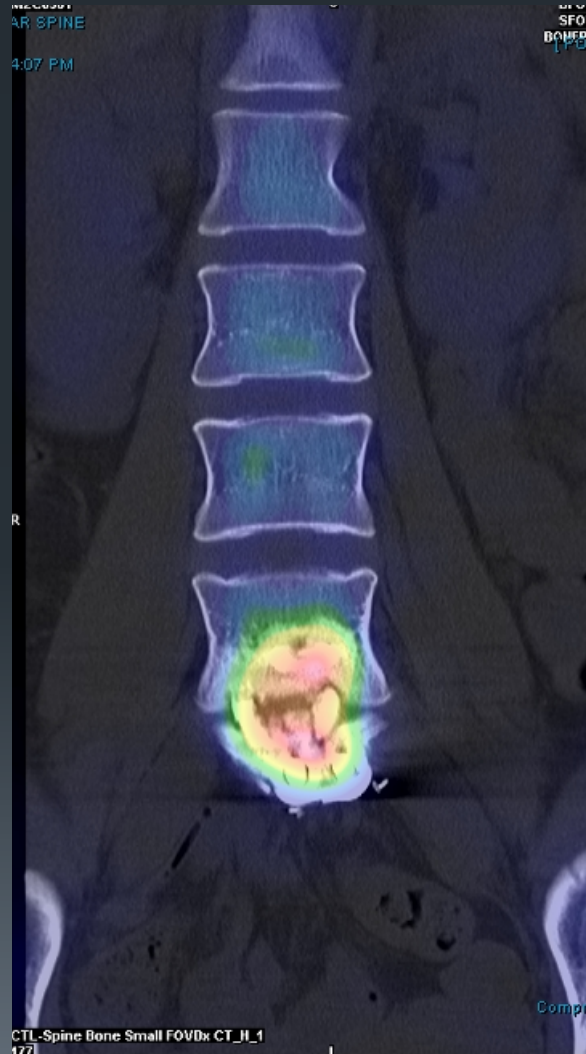
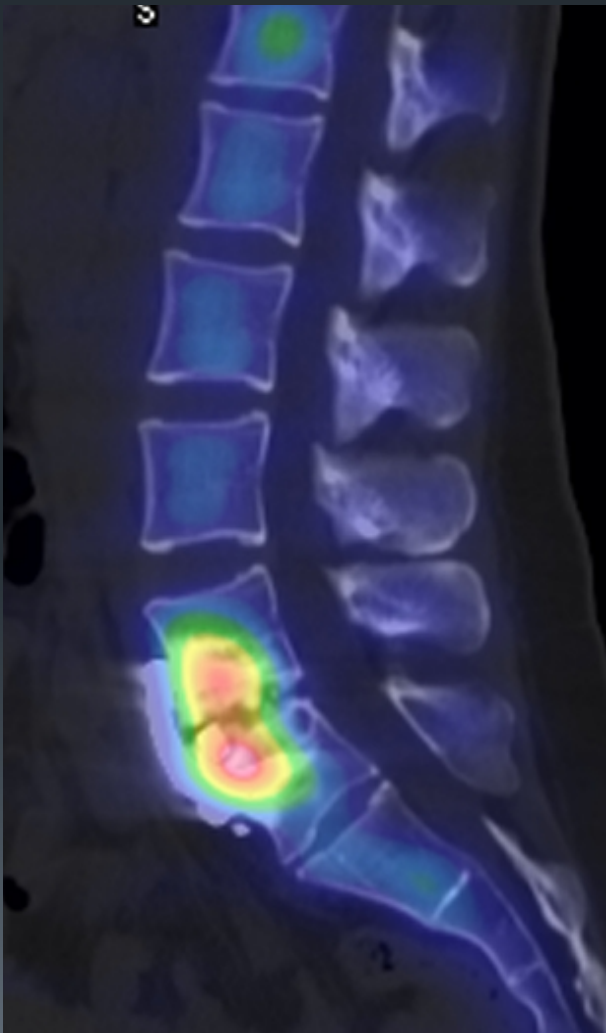
SPECT/CT Image Quality: Evolution



SPECT/CT: Evolution of Image



Pseudarthrosis



SPECT/CT: Spine Indications

- Stress response/ fractures
- Pars defects? Healed /symptomatic
- Tumours e.g. Osteoid osteoma
- Fracture healing
- Location of pain generator especially in widespread degenerative changes – Cervical spine axial pain
 - Endplate changes /Neurocentral joints
 - Facet joint disease
 - Osteophytes/DISH
- SI joint disease
- Post spinal surgery



SPECT/CT: Spine

- Important modality in assessment of source of spinal pain in pre and post operative patients.
- SPECT/CT allows detection of foci of inflammation/ increased osteoblastic activity and accurate anatomic localisation/lesion characterisation.
- Increased osteoblastic activity associated with osteoarthritis, implant loosening, failure of fusion, infection, fracture i.e.altered bone stress
- Usually performed after MRI assessment to confirm suspected cause of pain or if MRI inconclusive.
- Less susceptible to metal artefact
- Also useful in patients who cannot have an MRI.
- Unexpected causes of spine pain.
- Get a non contrast abdominal scan for free.

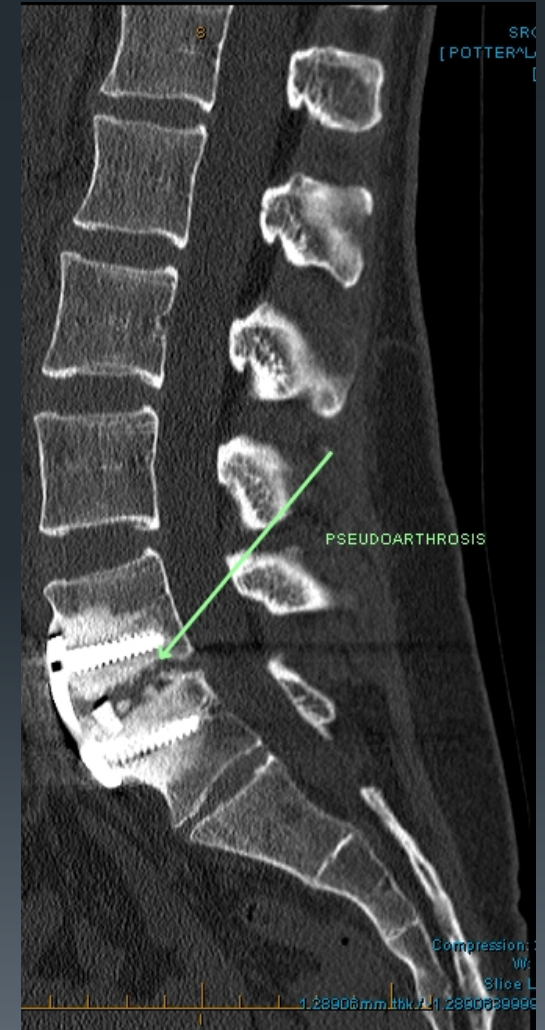
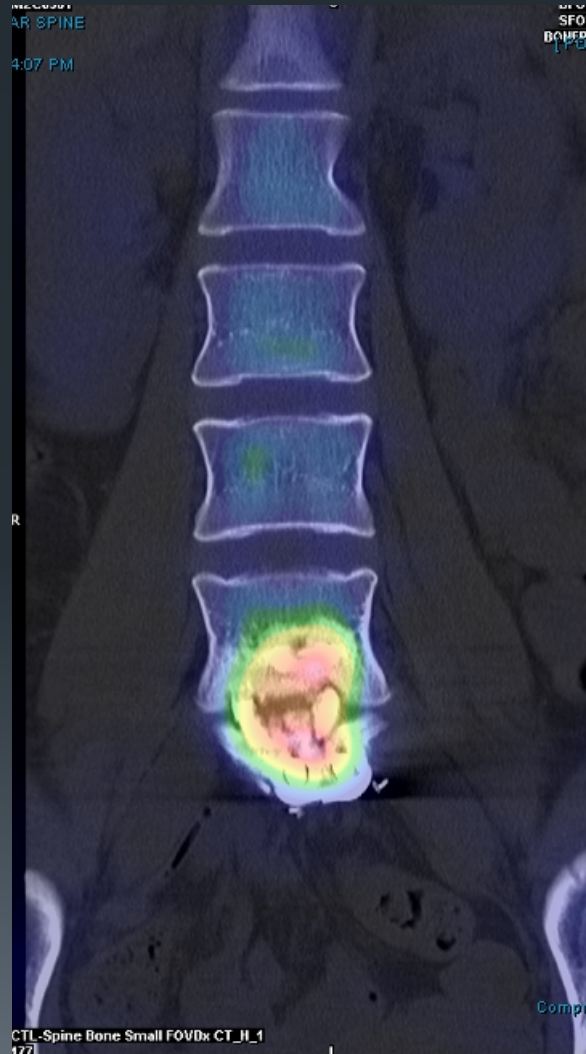
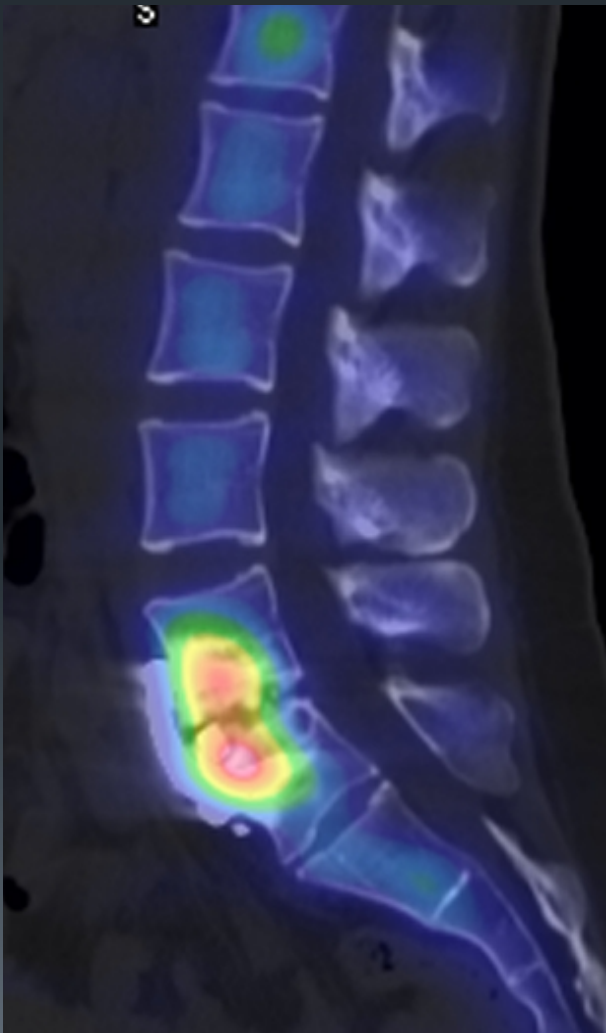
SPECT/CT: Spinal Fusion

- 10% of spinal fusion complicated by pain.
- 14% reintervention rate 4 yrs post surgery, 19% after 11 yrs
- SPECT/CT has been shown to have high sensitivity and specificity in detection of pseudoarthrosis and implant loosening.
- Also assessment of adjacent segment failure such as disc failure and facet joint degeneration.
- The combination of SPECT and high resolution CT allows one stop assessment with less total radiation dose.
- Must wait at least 1 year post surgery before scanning to allow activity to normalise.
- Cost effective compared with PET/CT

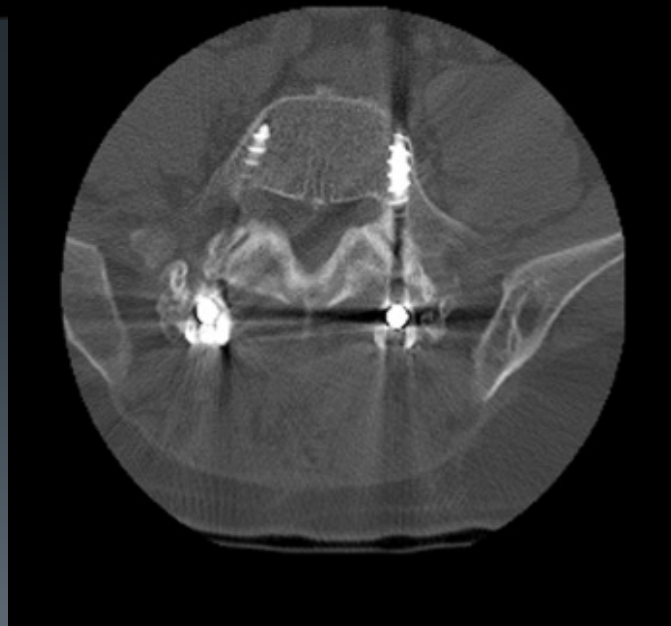
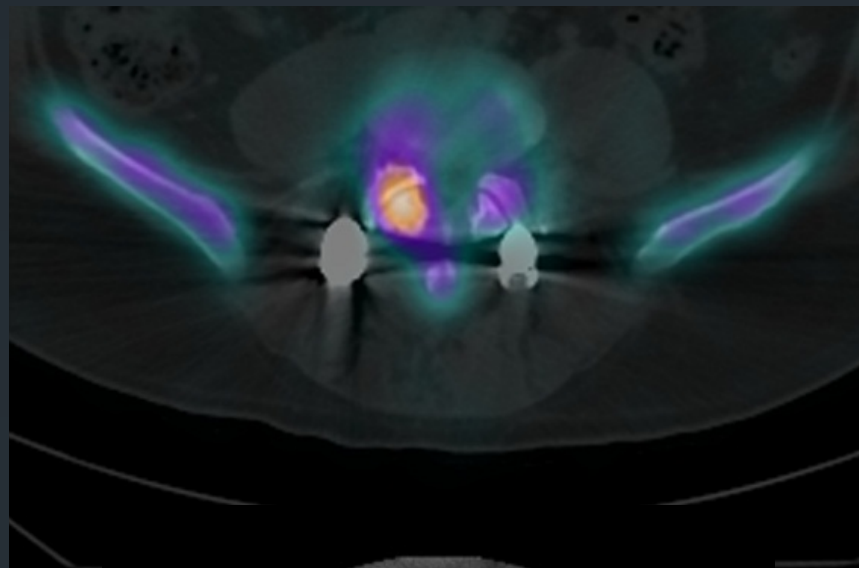
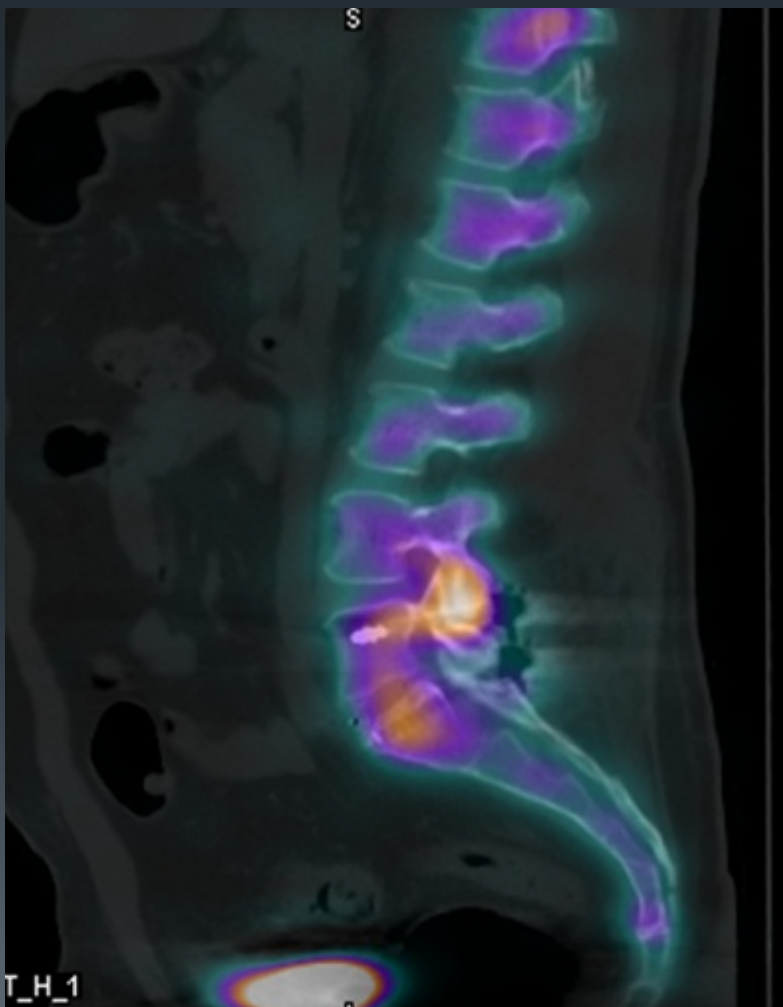
Instrumented Spinal Fusion

- Pseudarthrosis incidence 5-30% in various series
 - Up to 50% asymptomatic
 - Diagnosis difficult Persistent cleft after 12-18/12 sign of pseudarthrosis.
 - In 8% CT falsely predicts pseudarthrosis.
 - Lack of SPECT uptake around cages showing subsidence or surrounding lucency on CT suggests false positive
- Pedicle screw loosening-
 - Clear zones on digital xray 6/12 post surgery disappear with progression of bony union. (Tokuhashi et al) Clear zone 2 yrs post surgery highly predictive of pseudarthrosis. High CT and SPECT concordance.
 - SPECT/CT signs of loosening-Markedly increased activity(compared with background) at typical sites of loosening around screws
- Facet joints
 - Morphologic changes on CT correlate poorly with symptoms. Fat suppressed MRI better but metal artefact.
 - SPECT/CT useful in cases with metal or multilevel changes.

Pseudarthrosis



Fusion: Adjacent level failure



SPECT/CT: Instrumented Spinal Fusion

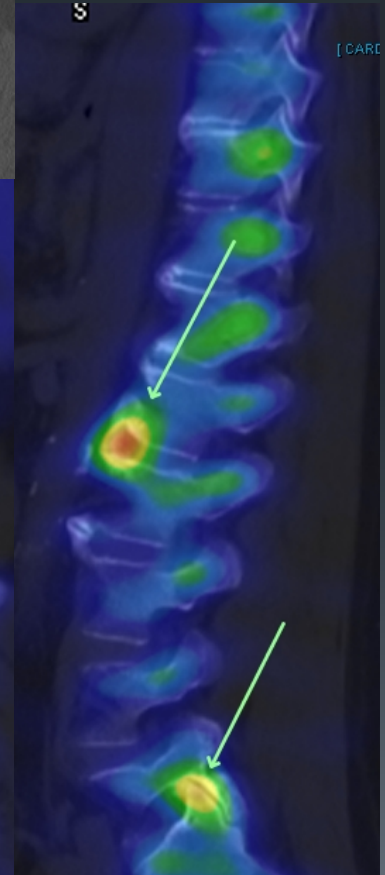
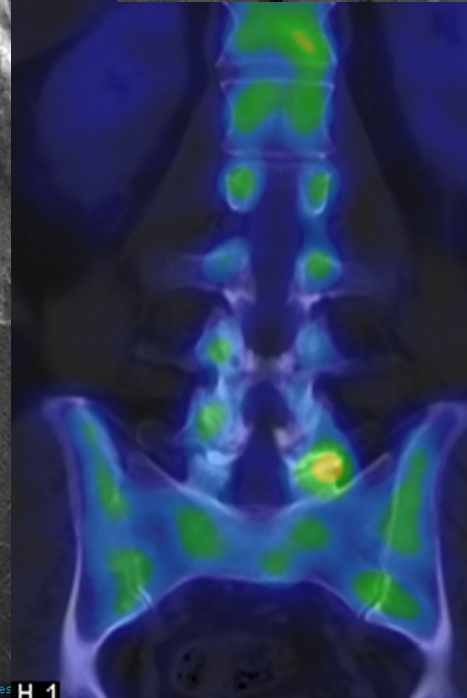
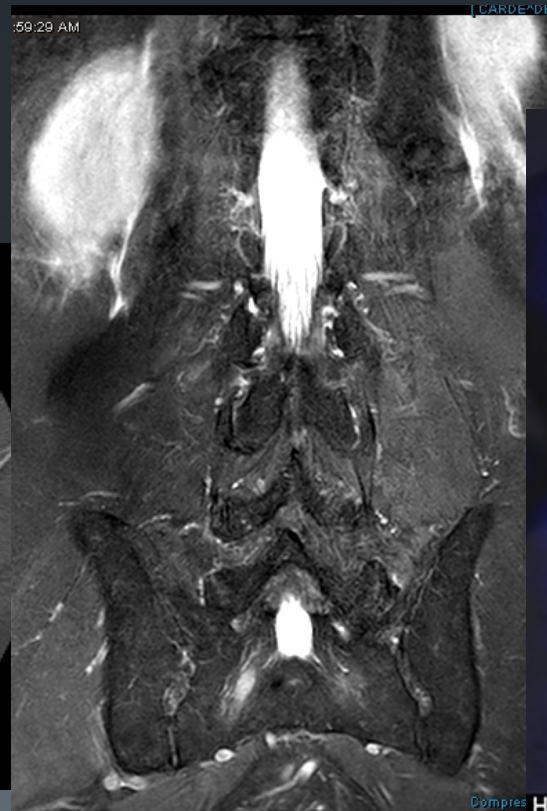
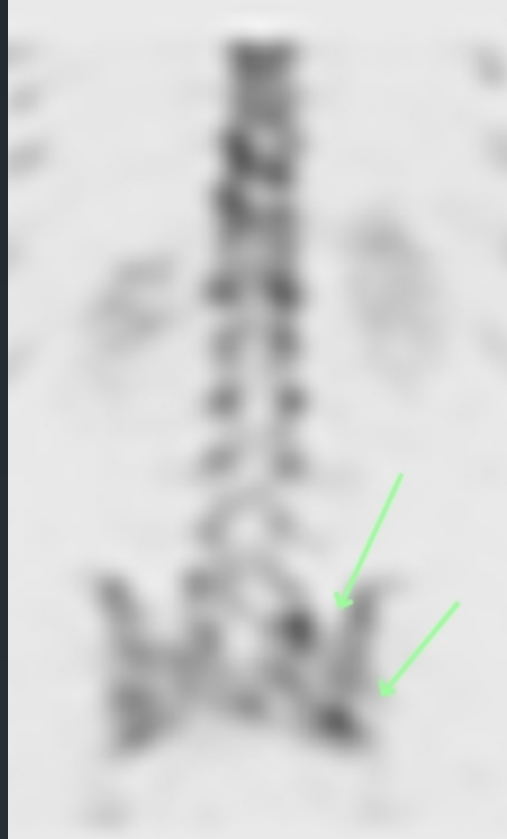
- Sensitivity of SPECT/CT for loosening-100%
- Specificity 87%
- Overall accuracy 92%
- Alternative cause in SPECT/CT negative for loosening
 - Facet joint disease
 - Disc degeneration
 - SI joint disease
- >1yr post op activity has usually normalised



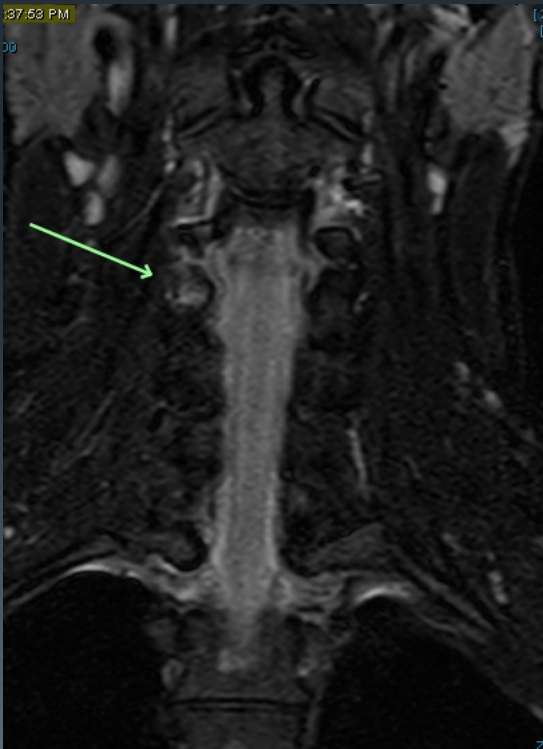
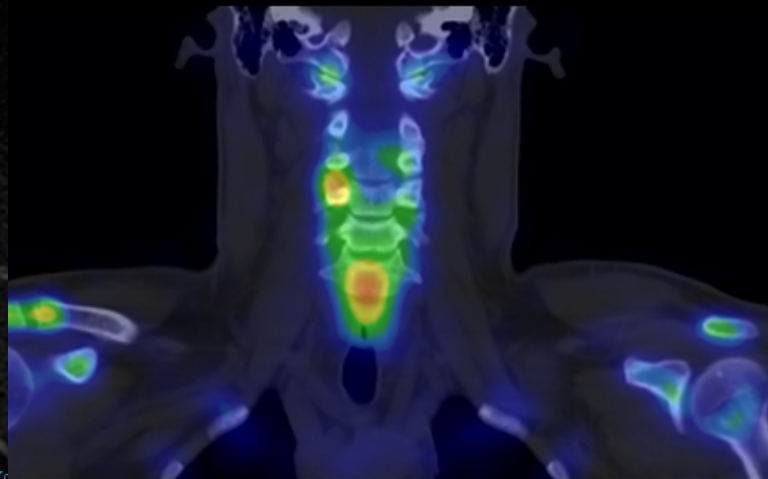
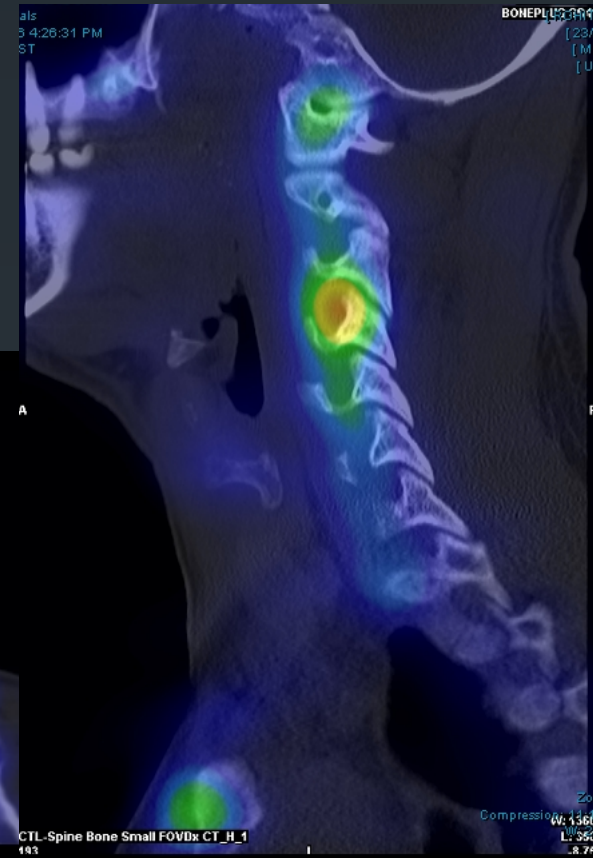
SPECT/CT: Spinal fusion

- False positive causes
 - Scanning too early
 - Fusion misregistration (facet jt vs screw)
- Hardware loosening can be ruled out if negative SPECT scan
- Gold standard surgical reintervention
- Clinical followup in negative scans is alternative

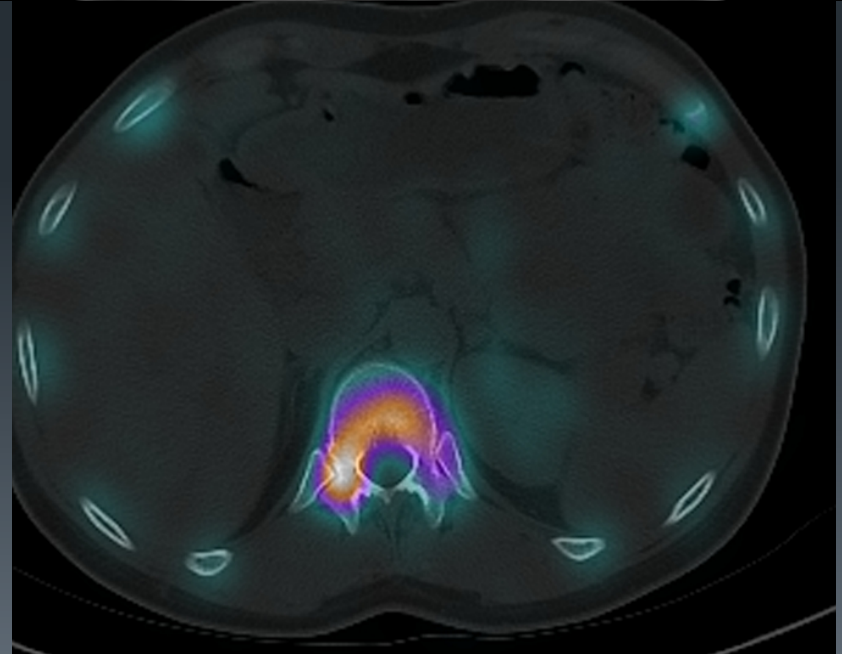
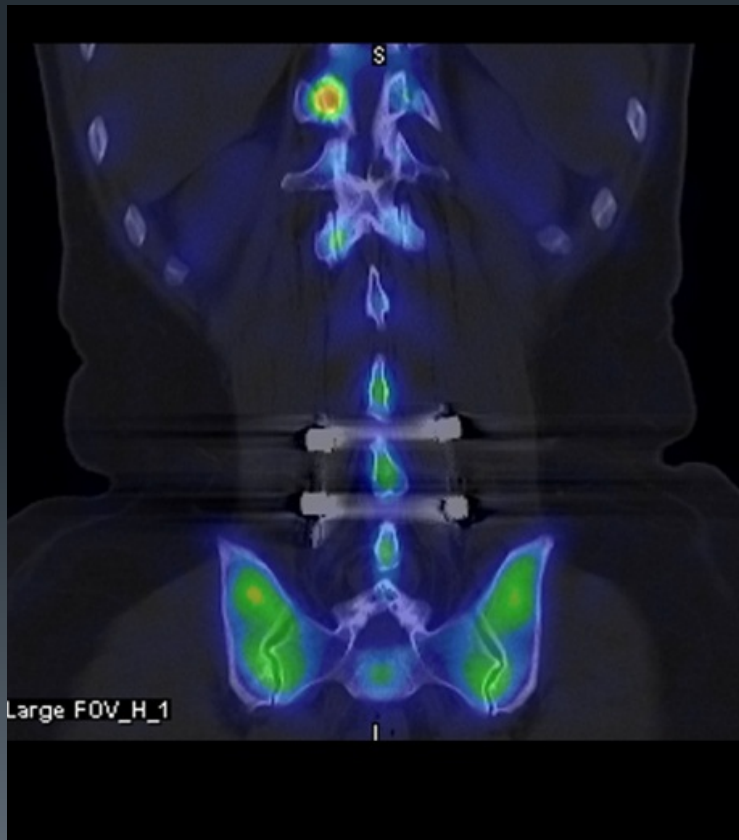
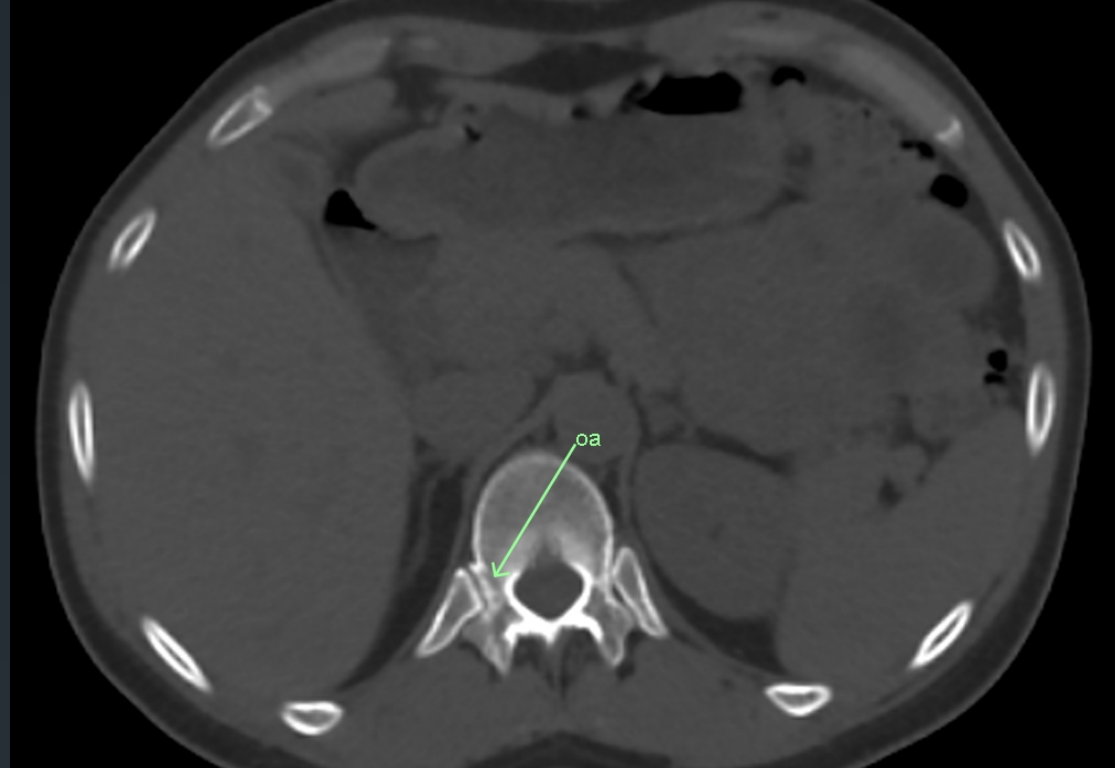
Facet joint osteoarthritis and DISH



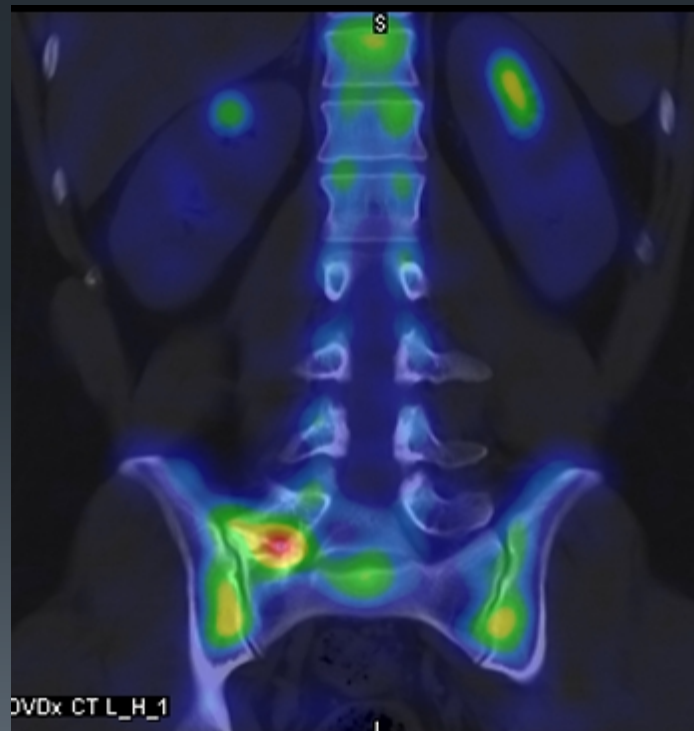
Osteoid Osteoma vs LCH



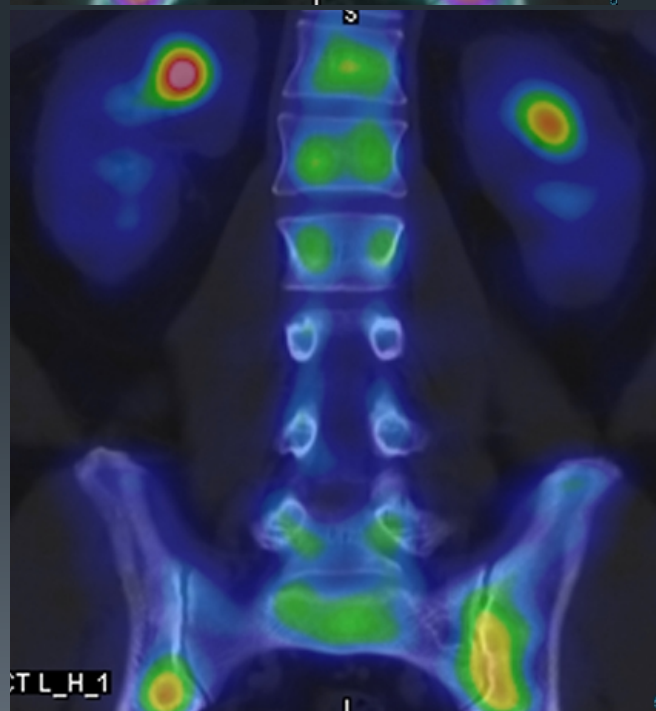
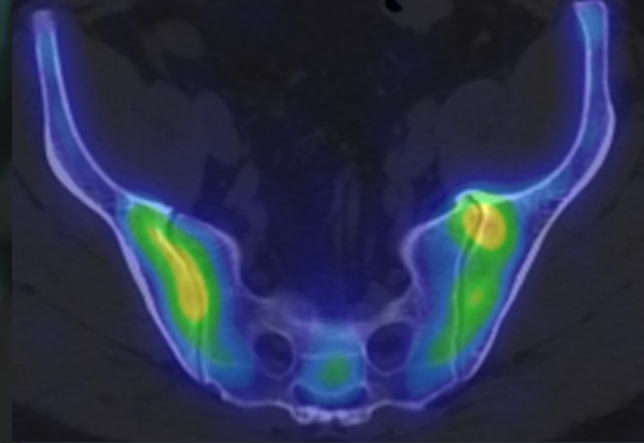
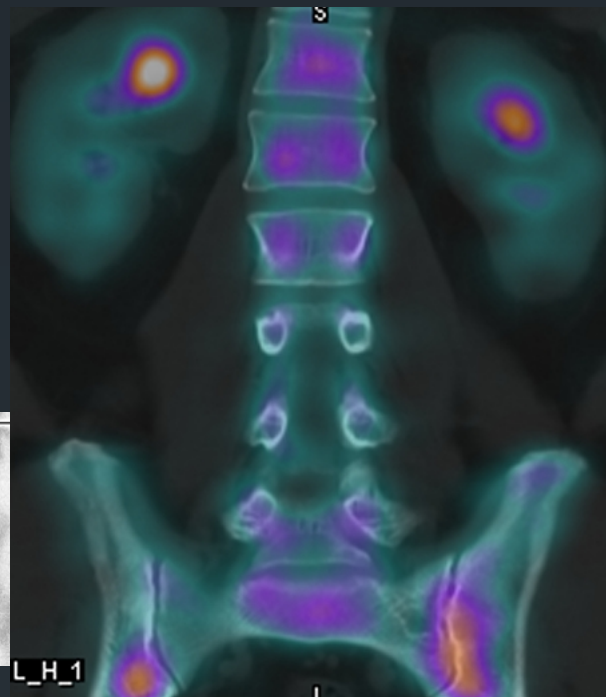
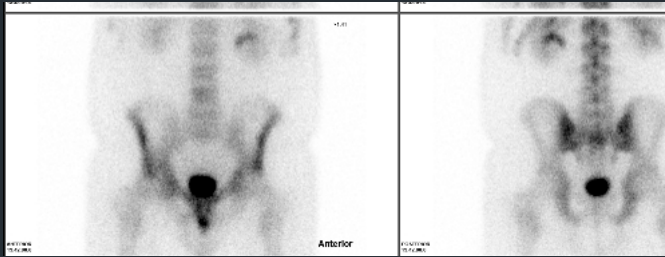
Costo vertebral



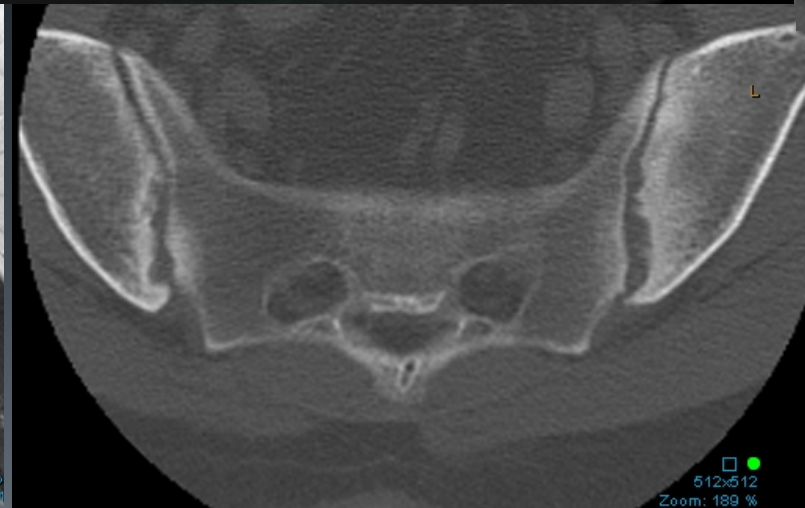
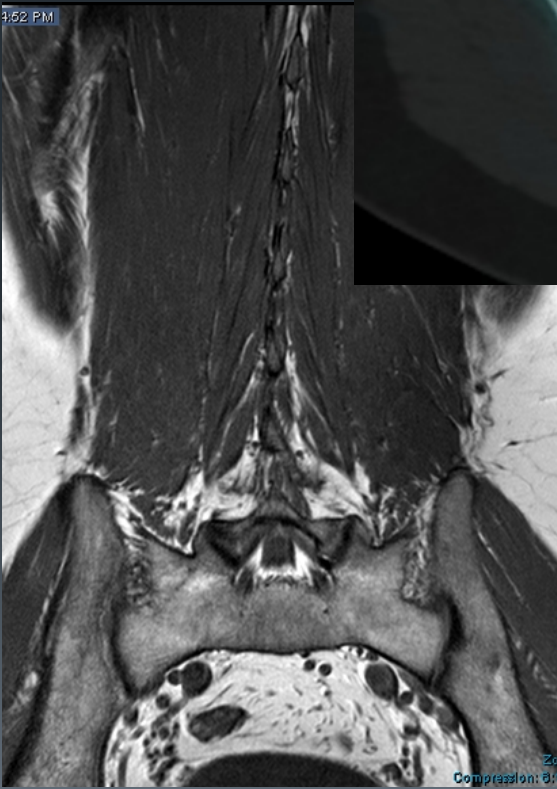
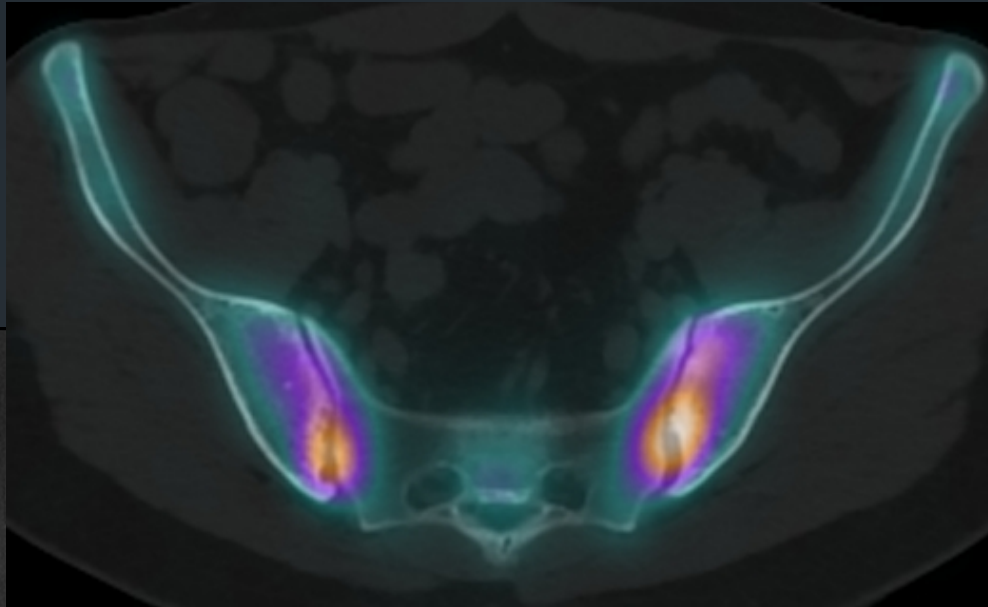
Pseudarthrosis



Sacroiliitis: Buttock Pain



Sacroiliitis



SPECT/CT: Ankle and Foot

- Identification of pain generators can be problematic due to complex anatomy.
- Most cases sorted out with Xray and MRI.
- In case of normal/inconclusive Xray and MRI SPECT /CT can be helpful.
- Can help localise pain generator especially on background of widespread degenerative change.
- SPECT/CT very useful in presence of of metalware eg status of arthrodesis union
- Multiple abnormalities
- Poorly localised pain
- Congenital abnormalities such as coalitions, synchondroses
- Impingement

SPECT/CT vs MRI: Ankle and Foot

- Sensitivity: MRI and CT similar
- Specificity : High for SPECT /CT of 48% vs 24% for MRI
- MRI most effective diagnostic modality in assessing foot and ankle pain
 - Limitations: Subtle structural changes and when several coexistent lesions
 - MRI detects many asymptomatic lesions which impairs its diagnostic specificity.
- Increased uptake on SPECT closely associated with increased bone turnover
- Pathologic uptake on SPECT well correlated with symptoms
- Small joints of foot and ankle-uptake closely correlated with pain or pain relief post anesthetic injection
- Complimentary modalities: Markedly increased specificity and minimal reduced sensitivity when lesion positive on both
- Radiation dose not an issue due to extremities not being rad sensitive
- Ankle SPECT/CT 5.5mSv with diagnostic CT.

SPECT CT LEFT ANKLE
Fusion - Sagittals
Se: 20/10/2016 12:58:58 PM
Acq: #629423-ST
Se: NM #25
Im: 80/128

SRO Greenlane
[TREATOR*FERGUS*JOHN DANIEL]
[30/03/1978]
[M] [038Y]
[CNW4051]

CNW4051

SA

DFOV 50.0 crr
SFOV 50.0 crr
BONEPLUS SS4

AI

PS

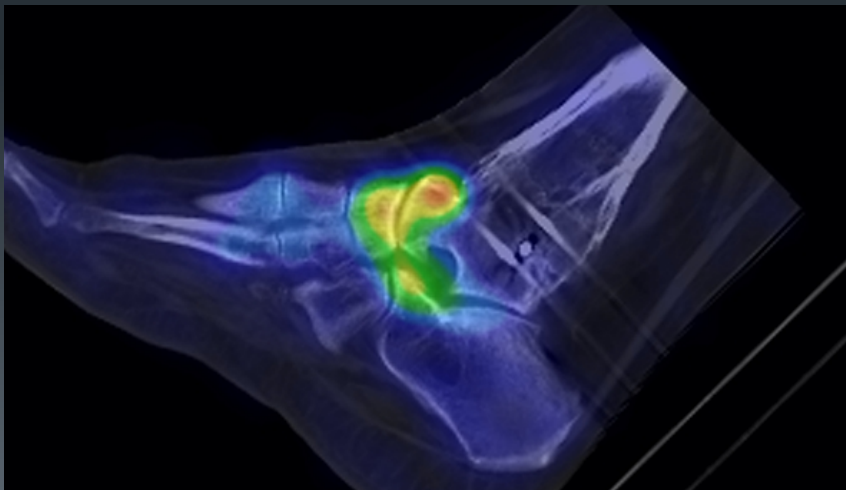
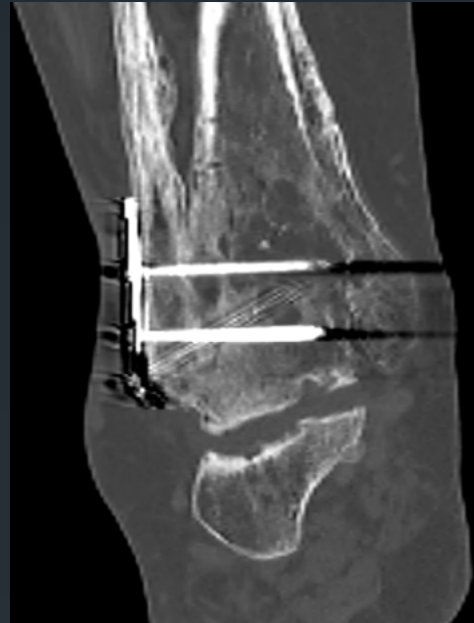
CTBone Thins Full FOVDx CT Fo_H_1
318

IP

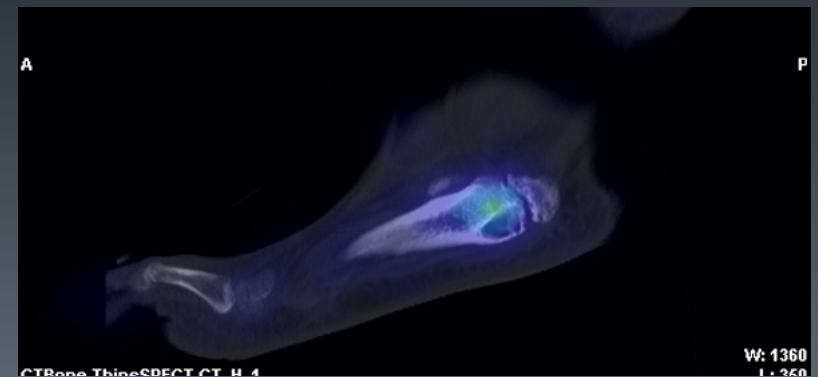
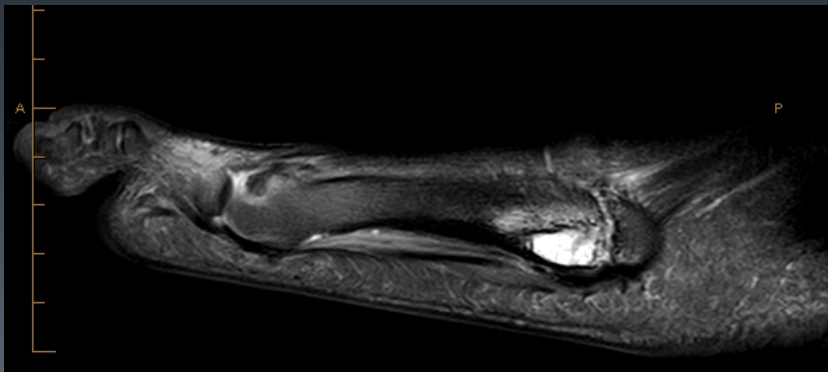
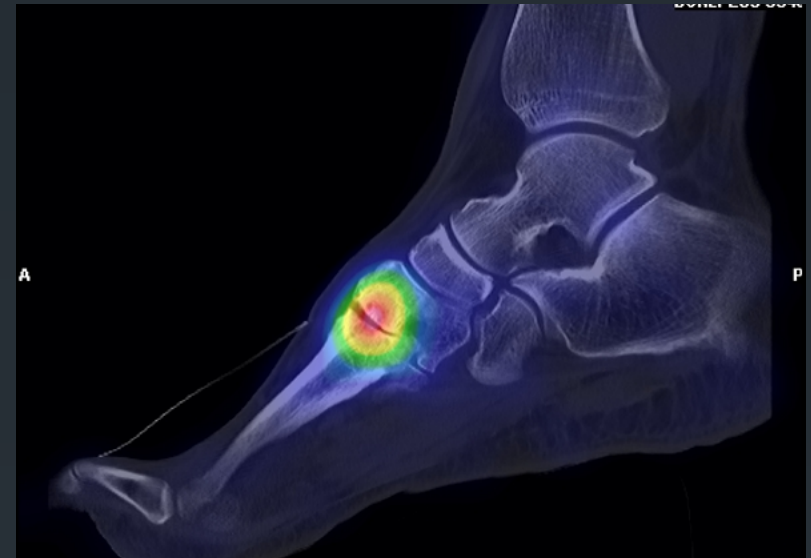
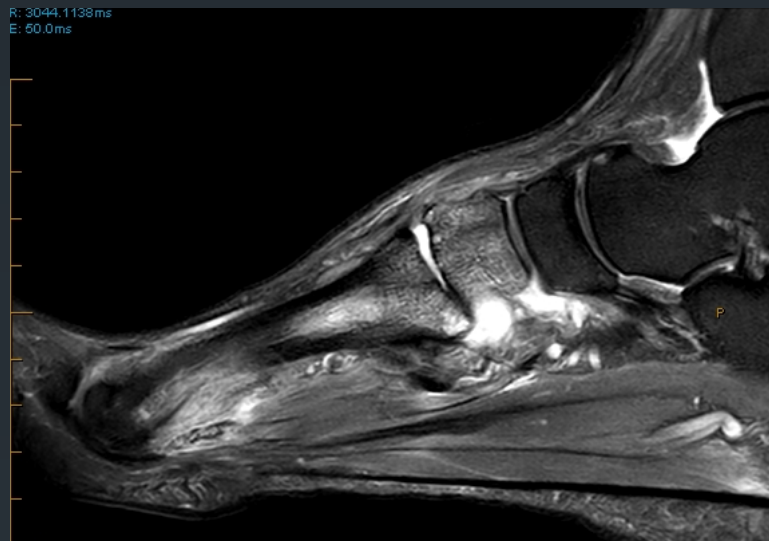
W: 1360
L: 350
59.57

C ☐ ☒
512x268
Zoom: 116 %
Compression: 22:1 (lossless)
W: 255 L: 128

Anterolateral pain post Fusion



TMT Joint Osteoarthritis





SPECT/CT: TKJR

- Diagnosis of loosening complex
- On planar bone scans

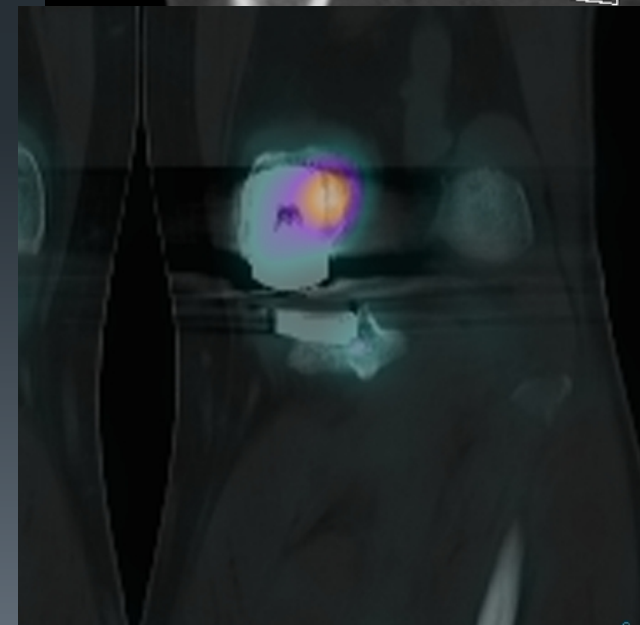
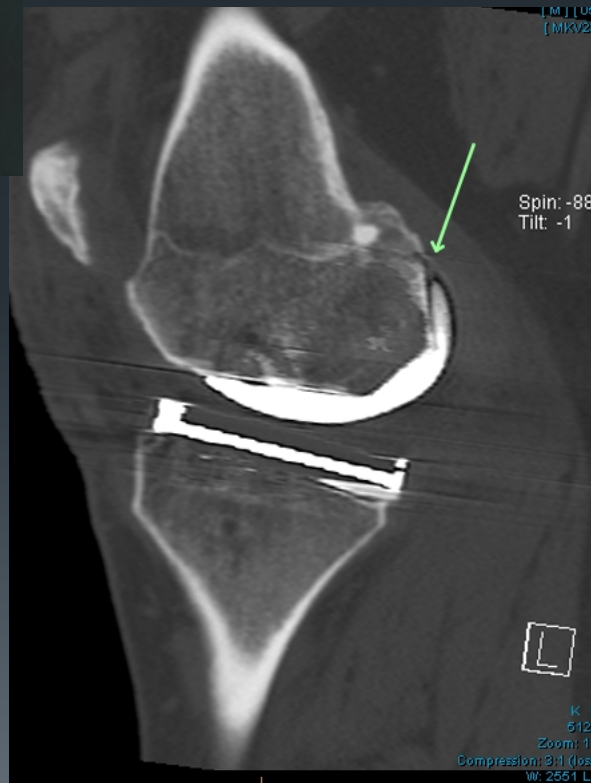
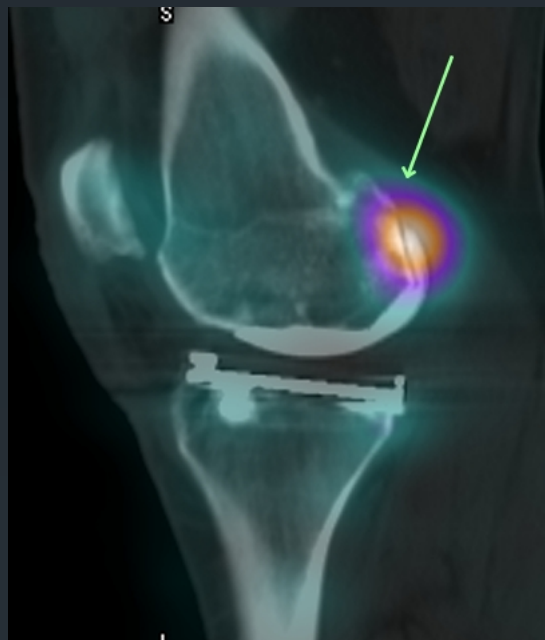
SPECT/ CT: TKR Assessment

- Hot patella high association with pain
- Negative -patellofemoral problems unlikely
- Component positioning:
 - Coronal: Varus /valgus position of tibial component- increased uptake due to bone remodelling-early loosening or collapse
 - Femoral malrotation: Internal rotation –patellar maltracking e.g. edge loading lateral patellar facet
 - Tibial malrotation-internal rotation causes increased MCL forces and medial joint pain.
- Use of CT with metal artefact reduction software can help visualise osteolysis/fractures.

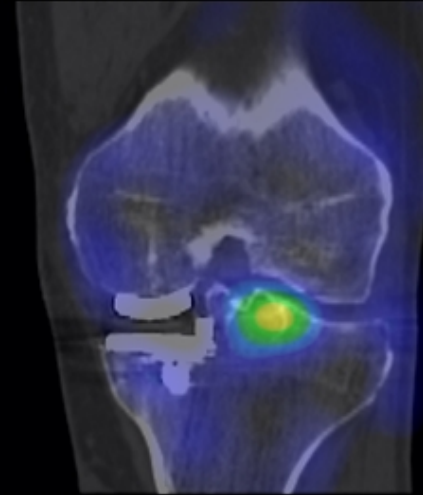
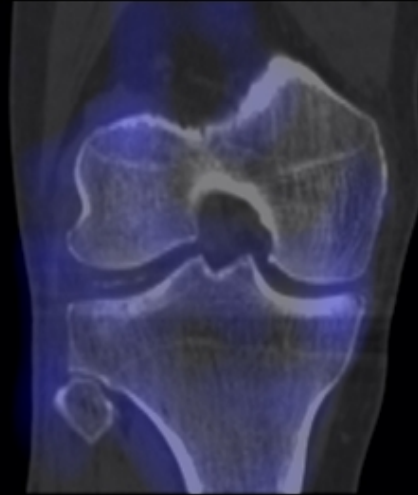
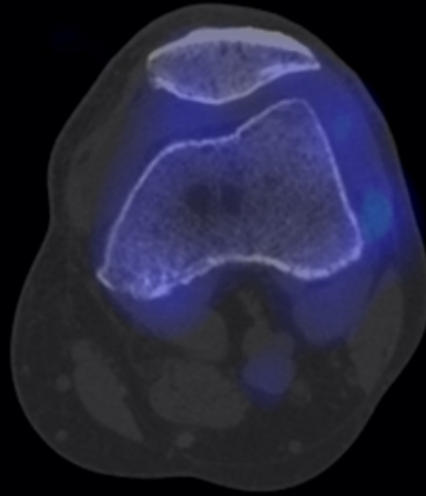
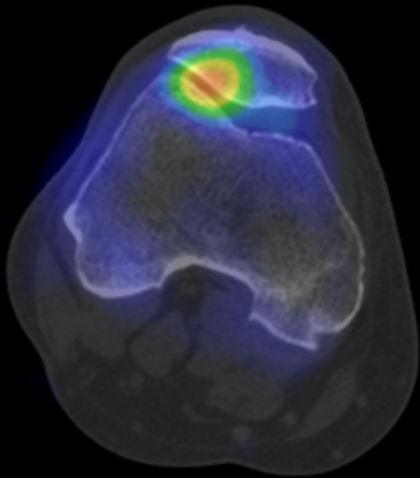
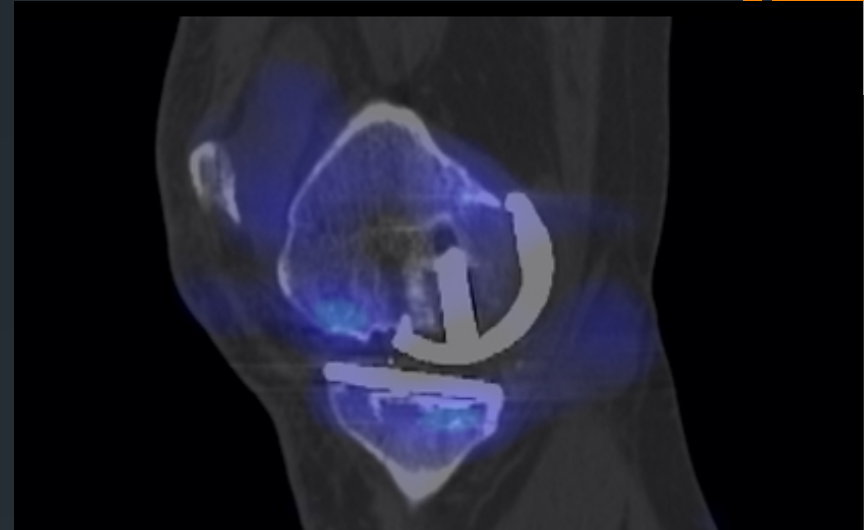
SPECT CT :TKR assesment

- Small percentage persistent pain post TKR
 - Infection
 - Aseptic loosening
 - Instability
 - Malposition of TKA
 - Arthrofibrosis
 - Patellofemoral
- Aseptic loosening
 - micromotion and attempts to stabilise cause increase secretion of calcified bone matrix and increased uptake on bone scan and SPECT
 - Look for osteolysis /lucency on CT
- Patellofemoral problems
 - Progression of OA
 - Patellofemoral maltracking
 - Overstressing due to patella baja
 - Femoral component malpositioning

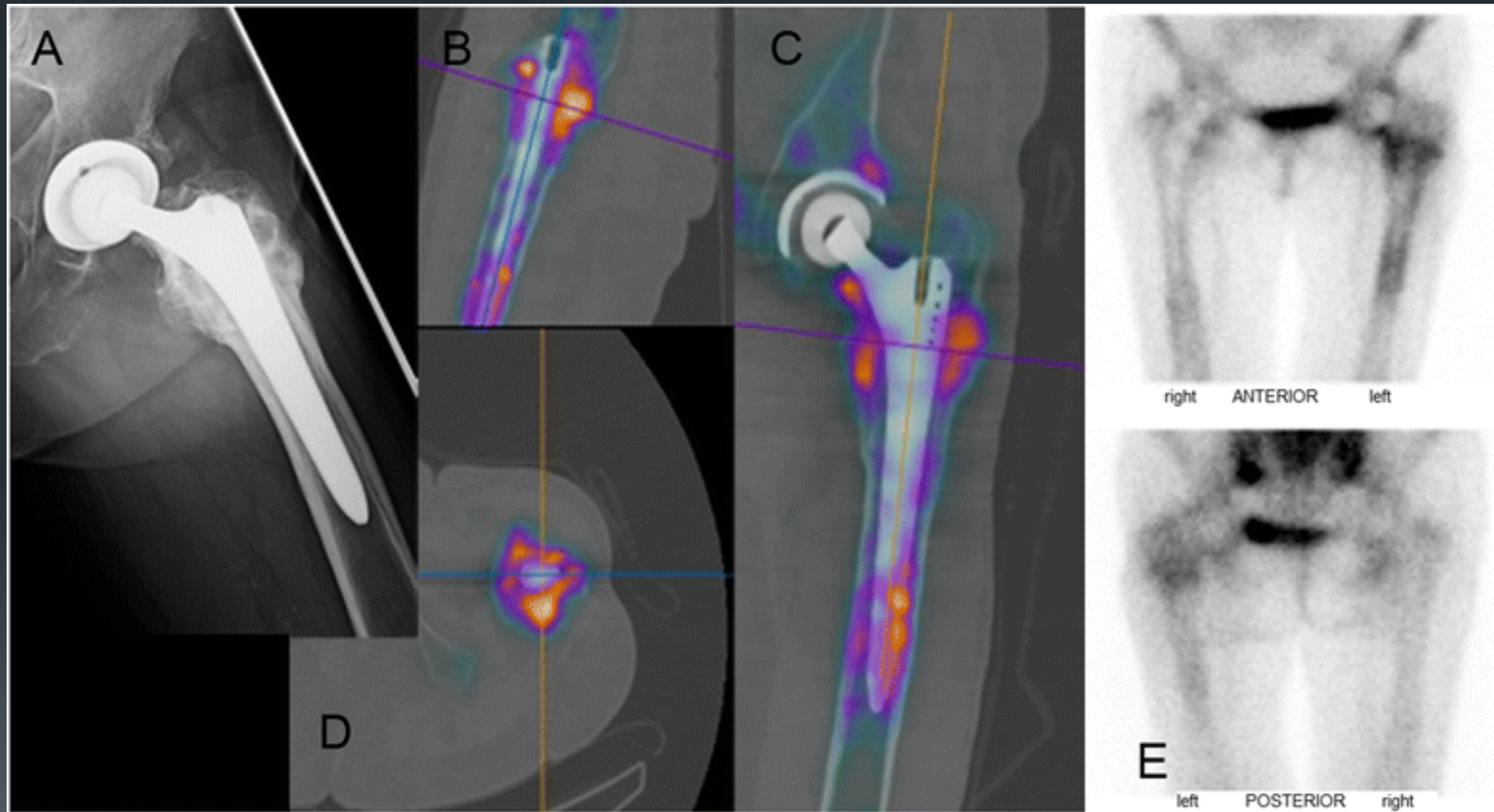
Unicompartment TKR



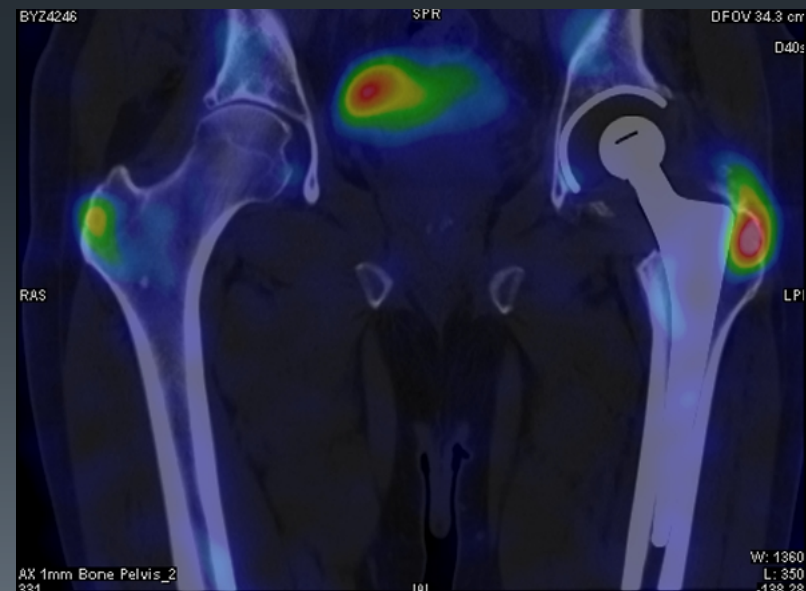
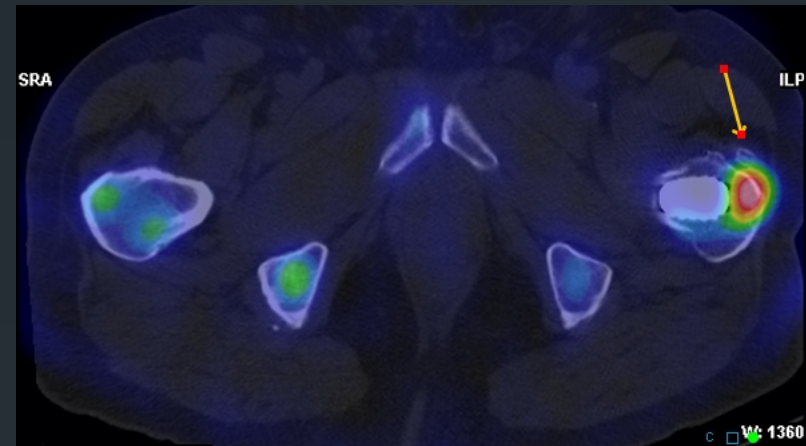
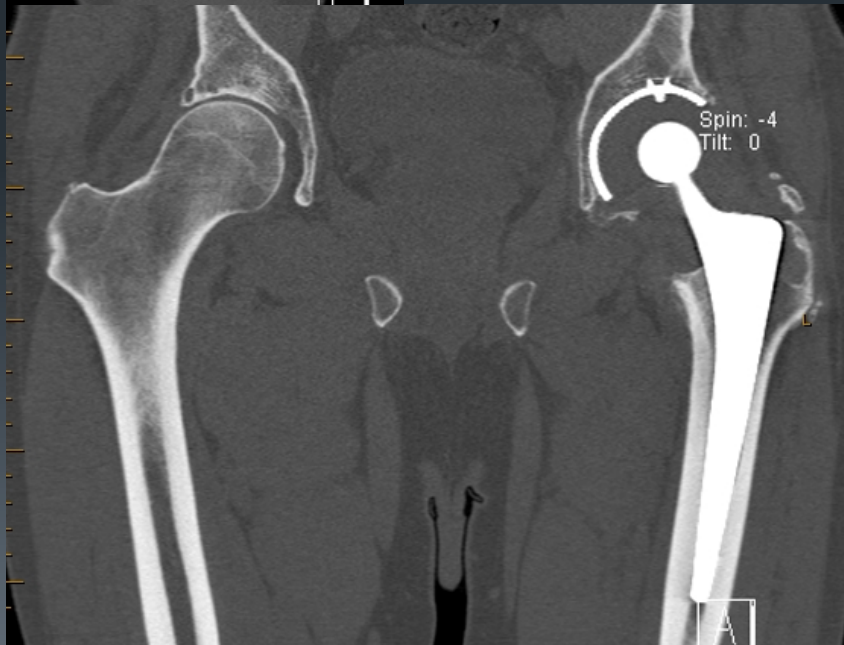
Unicomp TKR



SPECT/CT: THJR Aseptic Loosening



THJR Osteolysis



SPECT/CT: Heterotopic Bone

