SPECT CT IN CHILDREN
Initial Experience

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Initial experience of SPECT CT at GOSH

- Paediatric CT protocols finalized in 2011
- Well aware of avoiding unnecessary radiation exposures in children
- Selective use of the CT component
- Bone pain:
  - Extremity pain
  - Back pain
- Selective use with MIBG SPECT
- Parathyroid adenomas / hyperplasia

Initial experience of SPECT CT at GOSH

- NO use of SPECT CT in DMSA scans
- In other cases,co-registration of SPECT with cross-sectional imaging acquired at a different time (lung, neuroblastomas, some DMSA SPECT in rare cases of cross-fused renal ectopias, bilateral Wilms')

Bone pain:

extremities
spine

INJURIES OF THE LOWER LIMB

- Injury to tendons, bursae and capsular structures
- Impingement syndromes
- Plantar fasciitis
- Bony and ligament injuries
- Talar dome fractures
- Fractures of the plafond and interosseous membrane
- Fractures of the tarsal bones
- Metatarsal stress fractures
- Tarsal coalition

GOSH SPECT GUIDED CT SCAN

Extremity Protocol
(under 8 yrs of age)

- mAs = 30
- kVp = 80
- Tube rotation time = 0.8 secs
- Collimation = 2 x 1.0 mm
- Pitch = 1.75
- Scan slice width = 5mm

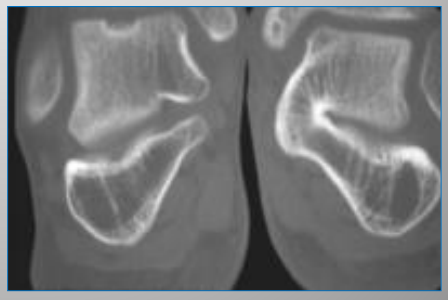
GOSH SPECT GUIDED CT SCAN

Extremity Protocol
(over 8 yrs of age)

- mAs = 50
- kVp = 80
- Tube rotation time = 0.8 secs
- Collimation = 2 x 1.0 mm
- Pitch = 1.75
- Scan slice width = 5mm

Painful Tarsal Coalition

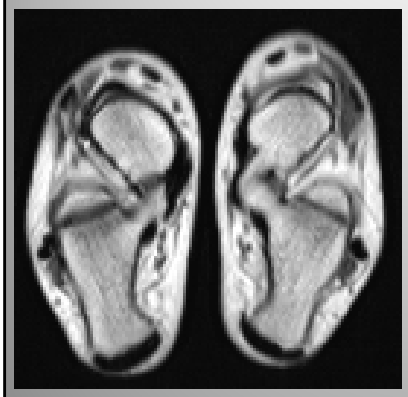
- Abnormal bridging across 2 or more tarsal bones resulting in painful deformity of the hindfoot with restricted motion
- Three types:
  - Fibrous
  - Cartilaginous
  - Osseus
- Bilateral in 50% cases



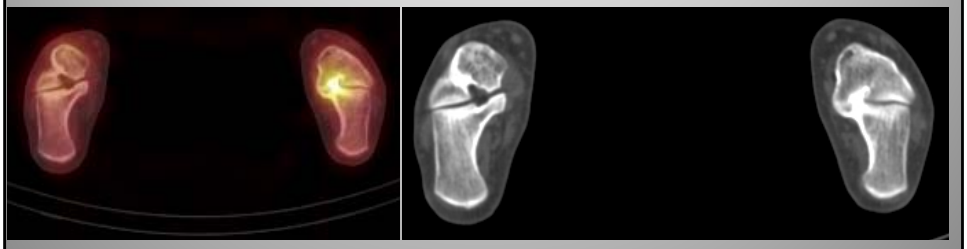
- Talo-calcanear (middle facet) at the level of the sustentaculum tali and calcaneo-navicular most common variants

14 yr old girl
History of tarsal coalition in the right foot; persisting pain in L foot
MRI shows a mature coalition

In view of the MRI findings the orthopaedic surgeon was inclined to expectant management



SPECT CT FEET – extra radiation exposure 1.41 mSv



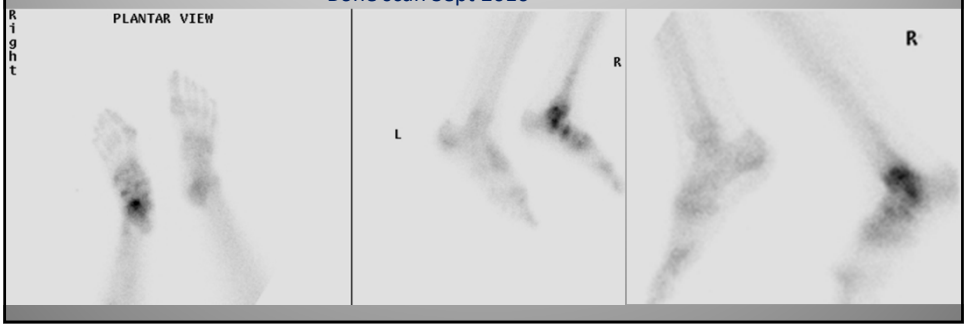
Markedly increased uptake in the left talo-calcaneal tarsal coalition. Complete fusion of the middle facet joint

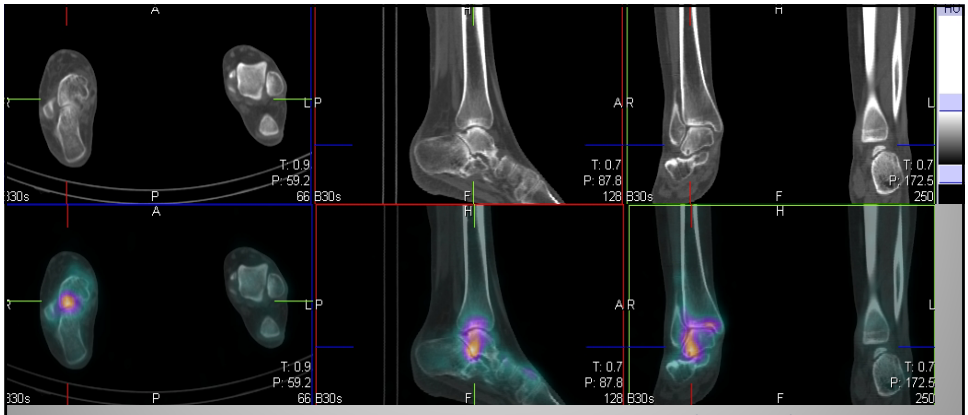
In view of the bone scan findings, the surgeon proceeded to a talo-coalition excision
Symptoms gradually improved

Foot pain after surgery

- 14 yr old girl. Spastic diplegia. Calcaneal lengthening operations (osteotomy) in 2006 and 2009
- Persisting right foot pain pain. ? Coming from previous osteotomy
- Tender over calcaneus distally and laterally

Bone scan Sept 2010





Bone scan SPECT CT Sept 2010 – total extra radiation exposure 1.41 mSv

Highly vascular, metabolically active process involving the following sites:

1) The right ankle joint;
2) The right sub-talar joint;
3) The right talo-fibular joint;
4) The anterior aspect of the right calcaneus laterally.

The right calcaneal osteotomy does not show increased tracer uptake

The appearances are compatible with an on-going active inflammatory process likely caused by altered bone mechanics.

THE CLINICALLY SUSPICIOUS AREA WAS NOT POSITIVE ON BONE SCAN

In view of the findings on the bone scan, the girl had talo-calcanear fusion in Nov 2010

X-ray following R calcaneo-talar joint

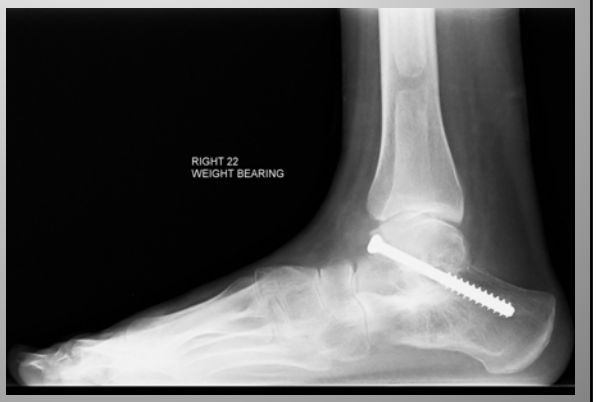
A few months after calcaneo-talar fusion, recurrent pain R foot, with limited walking ability

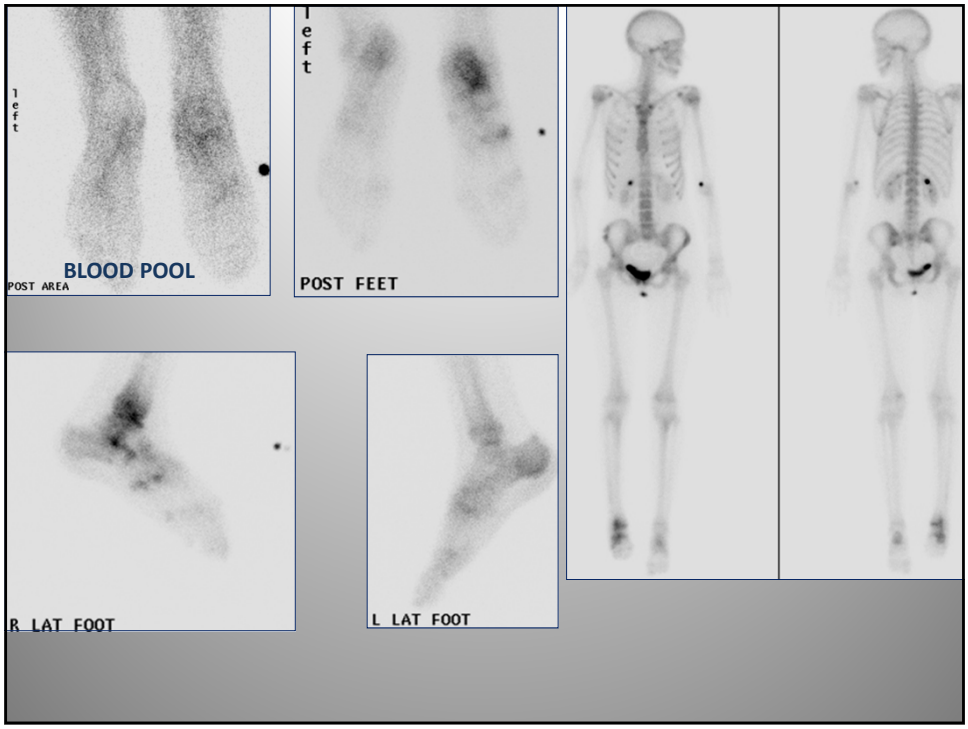
Very tender lateral aspect of her calcaneus and calcaneo-cuboid joint

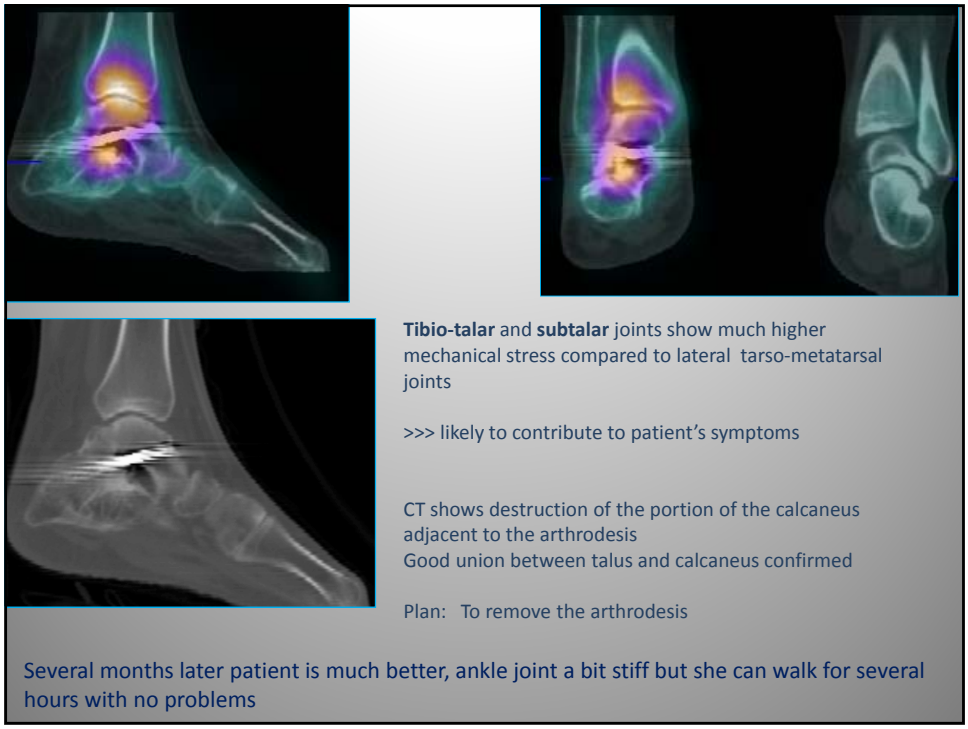
X-ray July 2011: good subtalar fusion, no problem with surgery

Possible sources of pain:
- Metal work related
- Calcaneo-cuboid joint
- Ankle joint
- Neuropathic

Repeat bone scan ordered







Tibio-talar and **subtalar** joints show much higher mechanical stress compared to lateral tarso-metatarsal joints

>>> likely to contribute to patient's symptoms

CT shows destruction of the portion of the calcaneus adjacent to the arthrodesis
Good union between talus and calcaneus confirmed

Plan: To remove the arthrodesis

Several months later patient is much better, ankle joint a bit stiff but she can walk for several hours with no problems

Teaching points

- SPECT CT was critical to identify the source of the pain and direct management
- MRI difficult when metal work in place
- Anatomical detail provided by CT co-registered with functional information provided by the bone scan essential
- Relatively low extra radiation exposure

Back pain
Sports injuries

GOSH SPECT GUIDED CT SCAN

Spine Protocol
(under 8 yrs of age)

- mAs = 50
- kVp = 80
- Tube rotation time = 0.8 secs
- Collimation = 2 x 1.0 mm
- Pitch = 1.3
- Scan slice width = 5mm

GOSH SPECT GUIDED CT SCAN

Spine Protocol
(over 8 yrs of age)

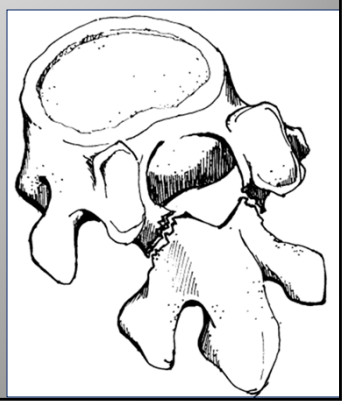
- mAs = 24
- kVp = 110
- Tube rotation time = 0.8 secs
- Collimation = 2 x 1.0 mm
- Pitch = 1.3
- Scan slice width = 5mm

Back pain in adolescents

- **Mechanical back pain**: due to acute or chronic musculo-tendinous or ligamentous injuries
- **Discogenic** back pain
- **Spondylolysis** and **spondylolisthesis**: repetitive flexion and extension of the low back >>> stress fractures of the pars interarticularis
- Direct or indirect local **injury**
- **Tumours**

Spondylolysis

- Stress fracture of the pars interarticularis often related to repetitive flexion and extension of the low back (tennis, gymnastics, cricket)
- Bilateral spondylolysis >>> spondylolisthesis (anterior subluxation of the involved vertebra)
- Mostly at level of L5/S1 (sometimes L4/L5)



Bone scan:

- Shows bone stress associated with radiographically occult injuries
- Assesses metabolic activity when spondylolysis evident radiographically
- SPECT easily distinguishes pars fracture from facet joint pathology

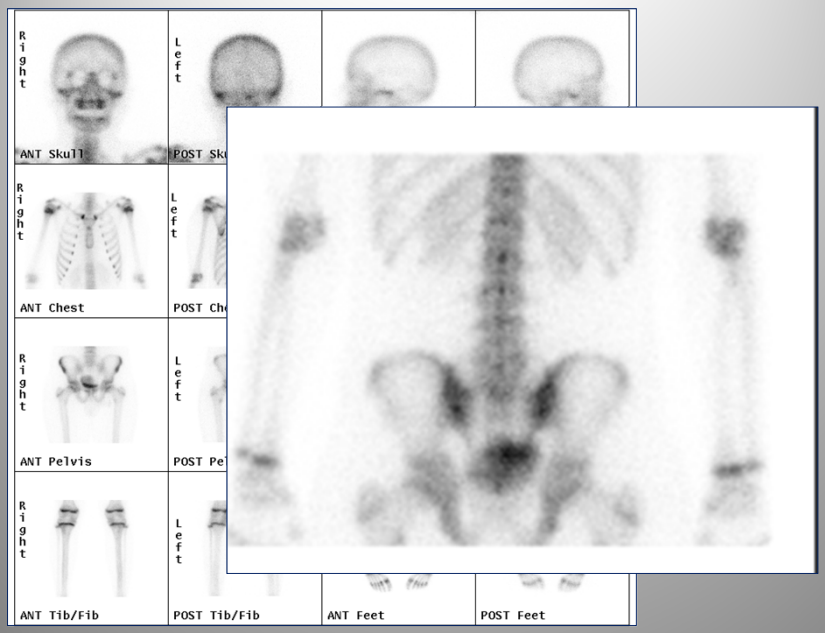
Metabolically active pars fracture: potential for healing

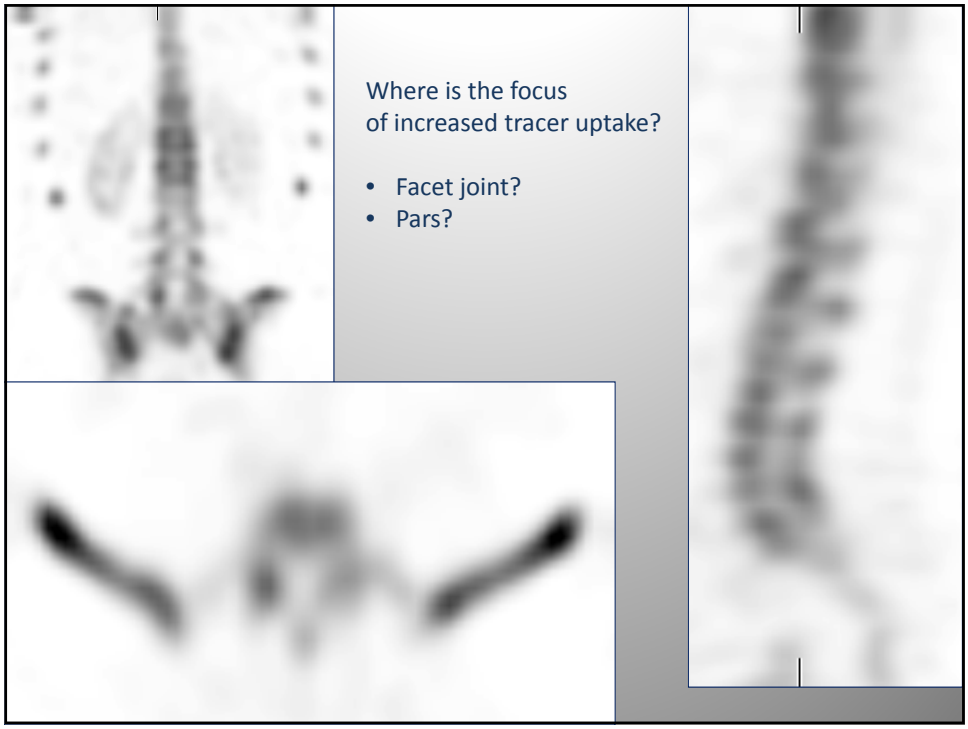
Inactive pars fracture: long standing, unlikely to heal

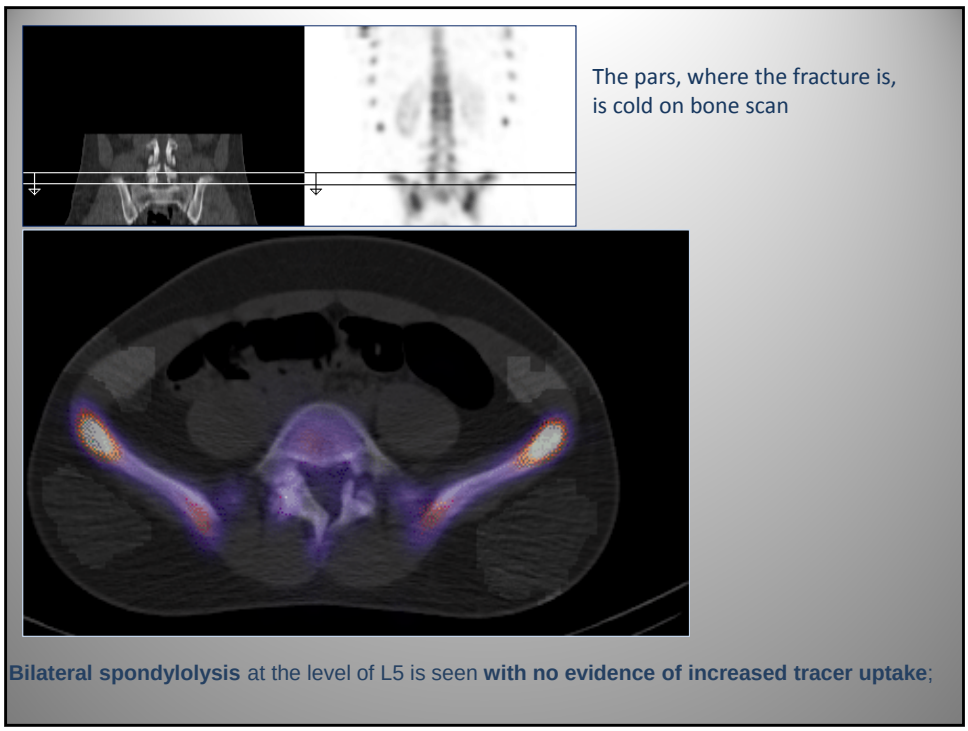
Surgical outcomes for spondylolysis based on pre-operative SPECT:

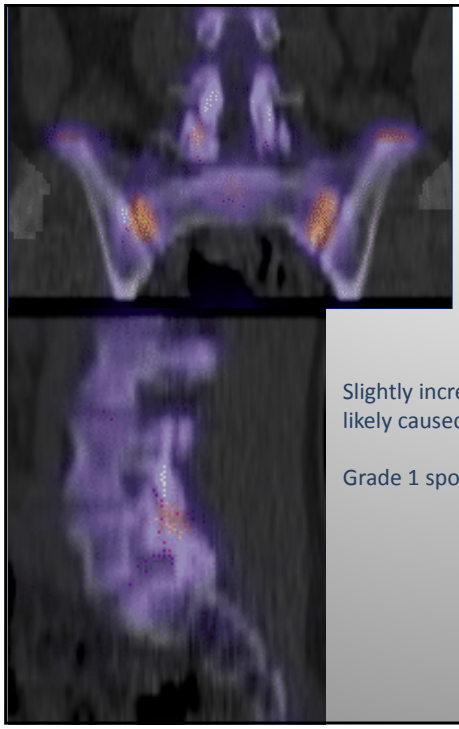
Patients with positive SPECT had better outcome vs negative SPECT (Ryan NMC 1994)

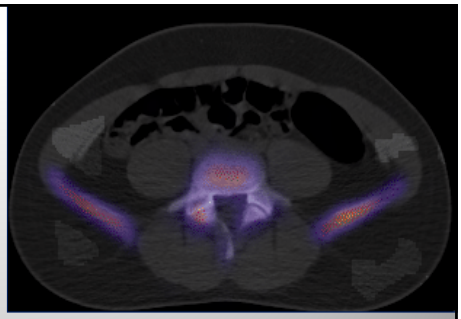
Assess potential for healing of pars fracture or surgical repair




Where is the focus
of increased tracer uptake?
• Facet joint?
• Pars?


The pars, where the fracture is,
is cold on bone scan
Bilateral spondylolysis at the level of L5 is seen with no evidence of increased tracer uptake;



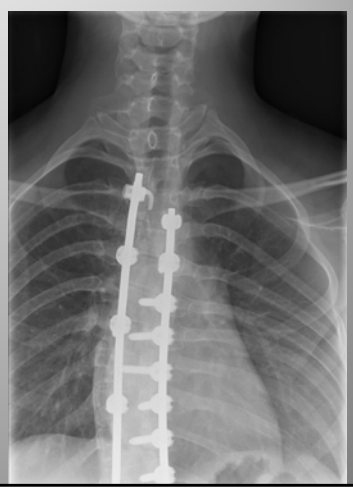


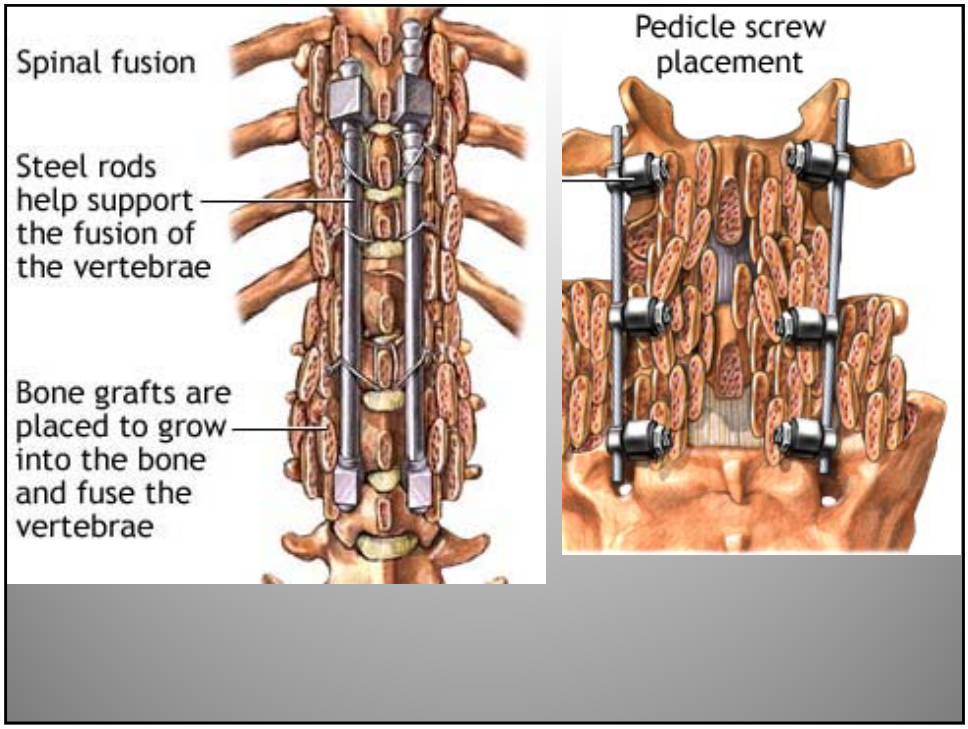
Slightly increased tracer uptake in the **right facet joint of L4/L5** likely caused by altered biomechanics

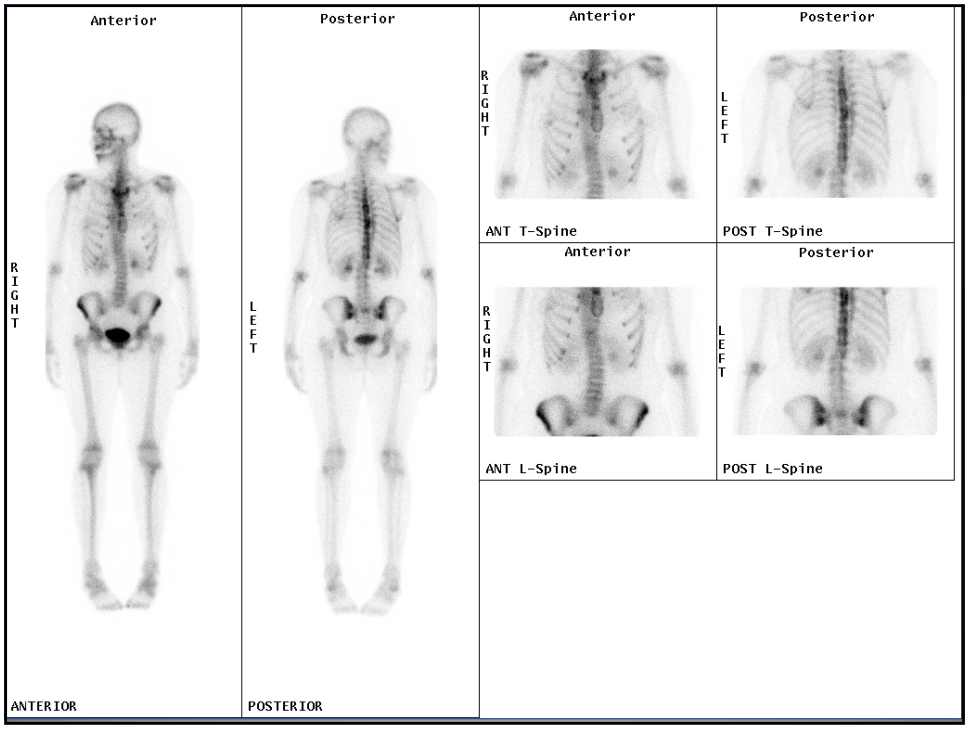
Grade 1 spondylolisthesis of L5 on S1.

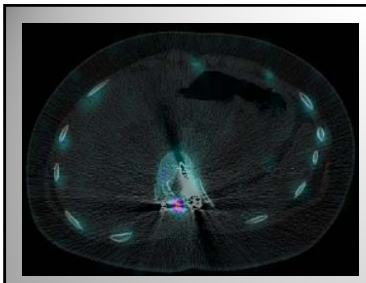
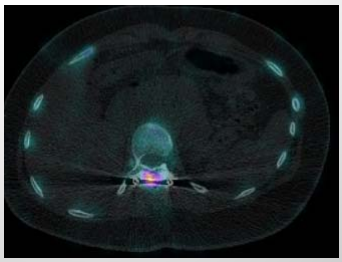
BACK PAIN AFTER SPINAL FUSION

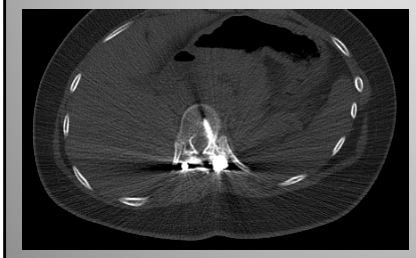
- 16 y old boy, history of adolescent idiopathic scoliosis and SLE
- Posterior instrumented spinal fusion in 2008
- Continues to complain of neck and back pain, intermittent in nature, no referred or radicular type leg symptoms
- Plain x-ray satisfactory




Spinal fusion
Steel rods help support the fusion of the vertebrae
Bone grafts are placed to grow into the bone and fuse the vertebrae
Pedicle screw placement

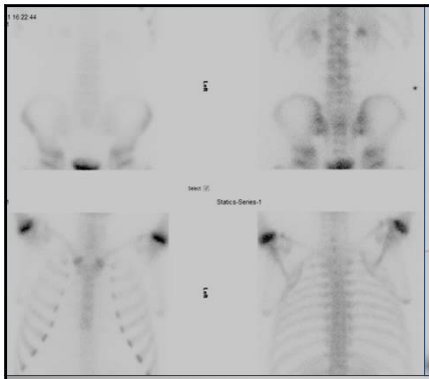
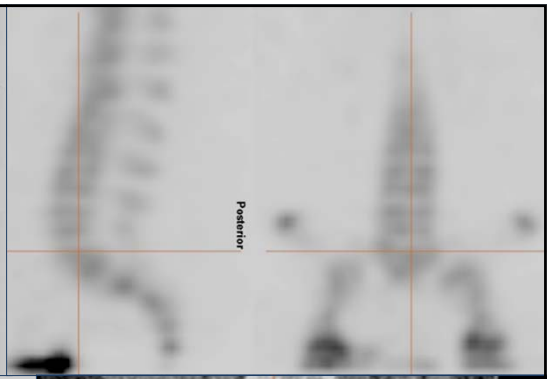

Anterior
Posterior
RIGHT
LEFT
ANTERIOR
POSTERIOR
Anterior
Posterior
RIGHT
LEFT
ANT T-Spine
POST T-Spine
Anterior
Posterior
RIGHT
LEFT
ANT L-Spine
POST L-Spine



SPECT CT thoraco-lumbar spine
Total extra radiation exposure 2.68 mSv

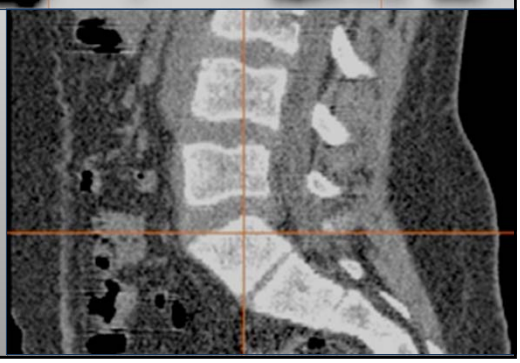
Increased uptake in the region of the bone graft material between the metal work, possibly reflecting low grade inflammation
No definite abnormality seen on CT as a cause for back pain

Low back pain

Retrolisthesis L5/S1

No abnormal tracer uptake on bone scan

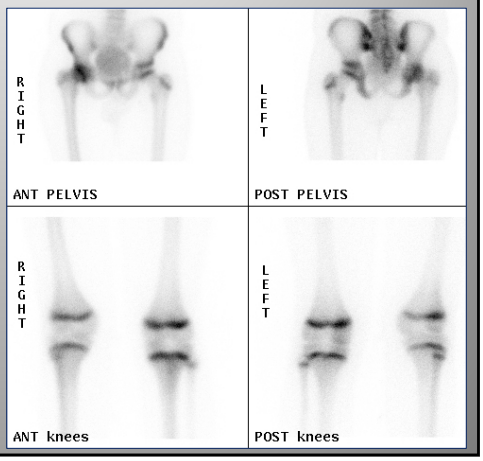


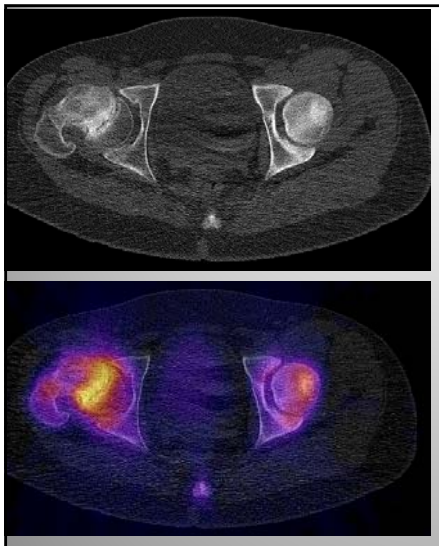
VIABILITY OF FEMORAL CAPITAL EPIPHYSIS

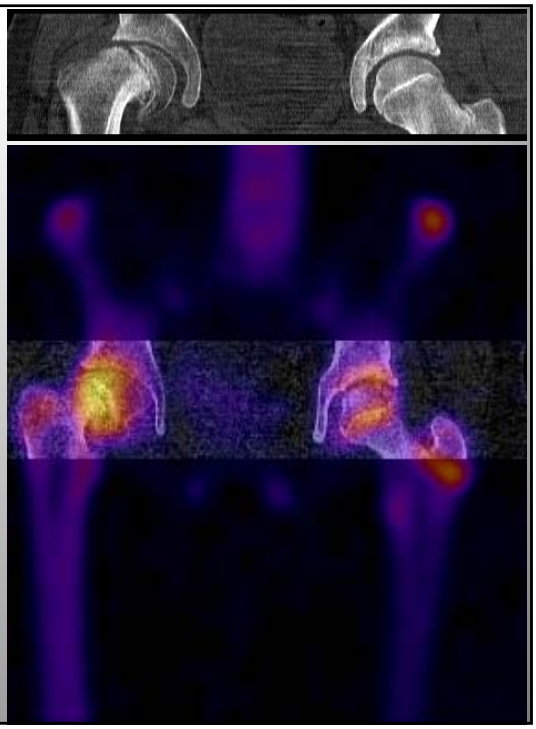
13 y old boy, pain in R hip with stiffness
Diagnosed by GP with R slipped capital femoral epiphysis, confirmed on CT

For subtrochanteric osteotomy

Bone scan to assess viability of R femoral capital epiphysis







SPECT CT
Extra radiation exposure 1.41 mSv

Viable R femoral capital epiphysis

MIBG IN NEUROBLASTOMA

Is the CT component necessary in neuroblastoma MIBG scanning?

- If CT is the main cross-sectional imaging modality in your hospital, >>>> MIBG SPECT and full diagnostic CT with i.v. contrast at the same time
  - one GA session (if needed)
  - No additional radiation burden
  - One appointment, two examinations
- If MRI is the main cross-sectional imaging, perhaps just fusing SPECT on to the MRI may be a viable option

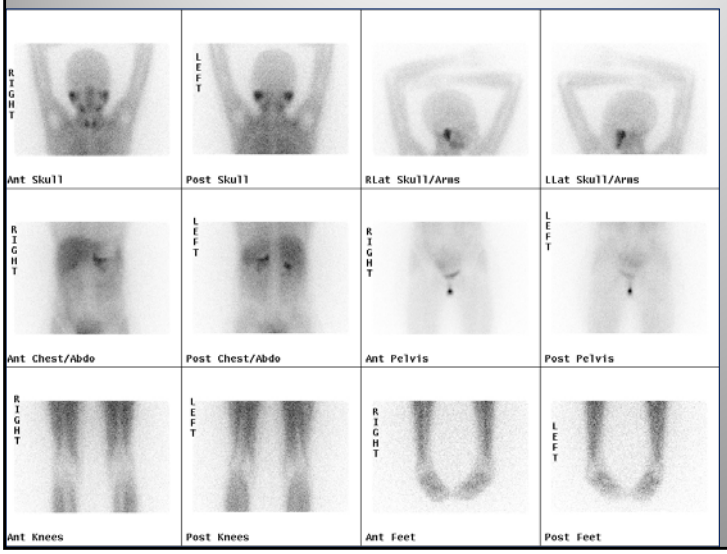
GOSH MIBG SPECT GUIDED CT SCAN

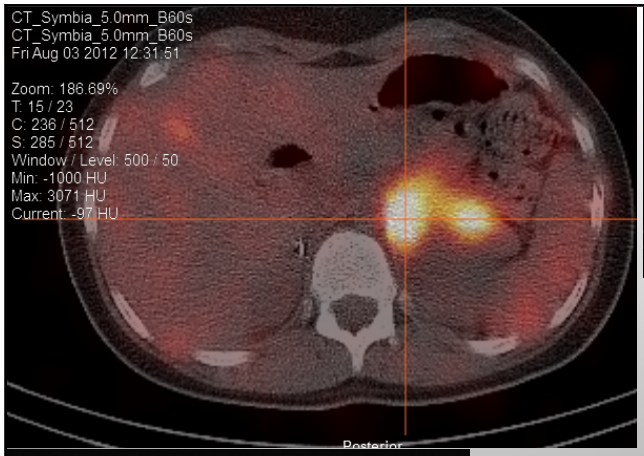
Acquisition parameters

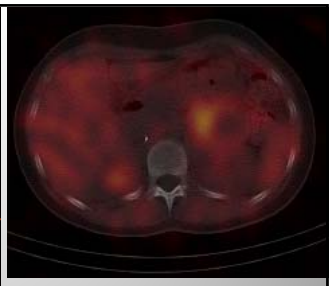
- mAs = 33
- kVp = 80
- Tube rotation time = 0.8 sec
- Collimation = 2 x 5.0 mm
- Pitch = 2
- Scan slice width = 6mm

MIBG – Better anatomical localization

15 yr old boy, history of von Hippel Lindau syndrome
MRI findings suggestive of L phaeochromocytoma
R adrenalectomy in 2008 for R phaeochromocytoma



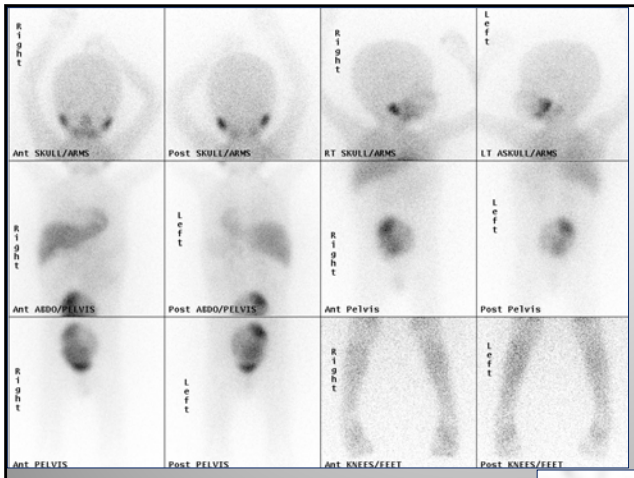




Limited SPECT CT
Extra radiation exposure = 0.93 mSv

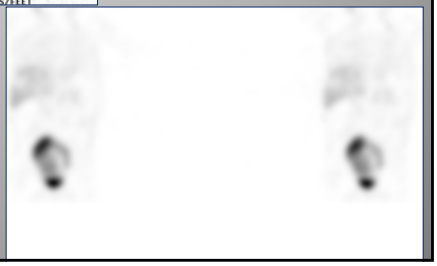
Only abnormal uptake in L suprarenal lesion

Activity in the right upper quadrant visible on the planar images was tracer in the renal pelvis



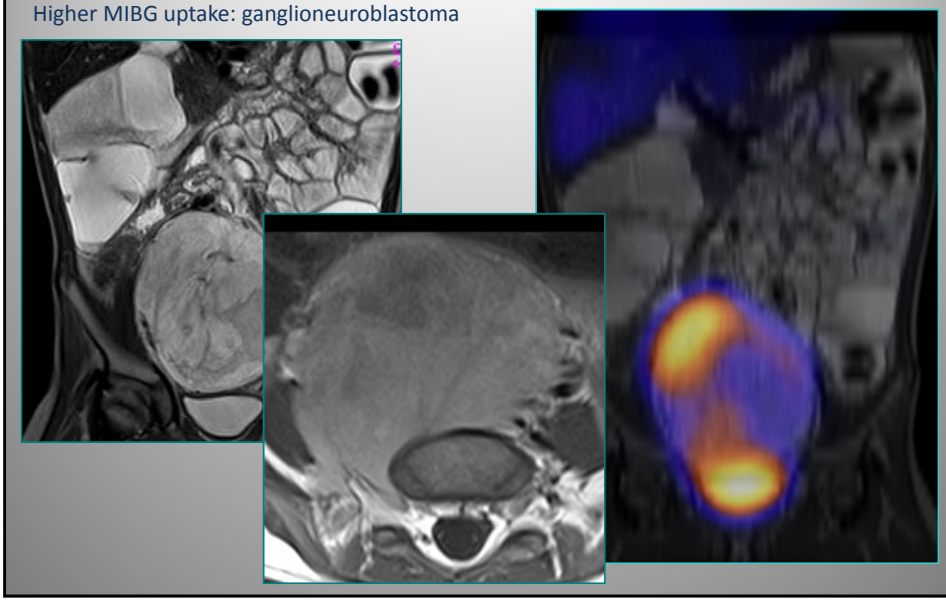
2.5 yr old child
Large pelvis ganglioneuroma
On repeat biopsy ganglioneuroblastoma

Treated with 2 Etoposide / carboplatin



CO-REGISTRATION OF SPECT ON TO MRI USING AVAILABLE SOFTWARE

Lower MIBG uptake: ganglioneuroma
Higher MIBG uptake: ganglioneuroblastoma

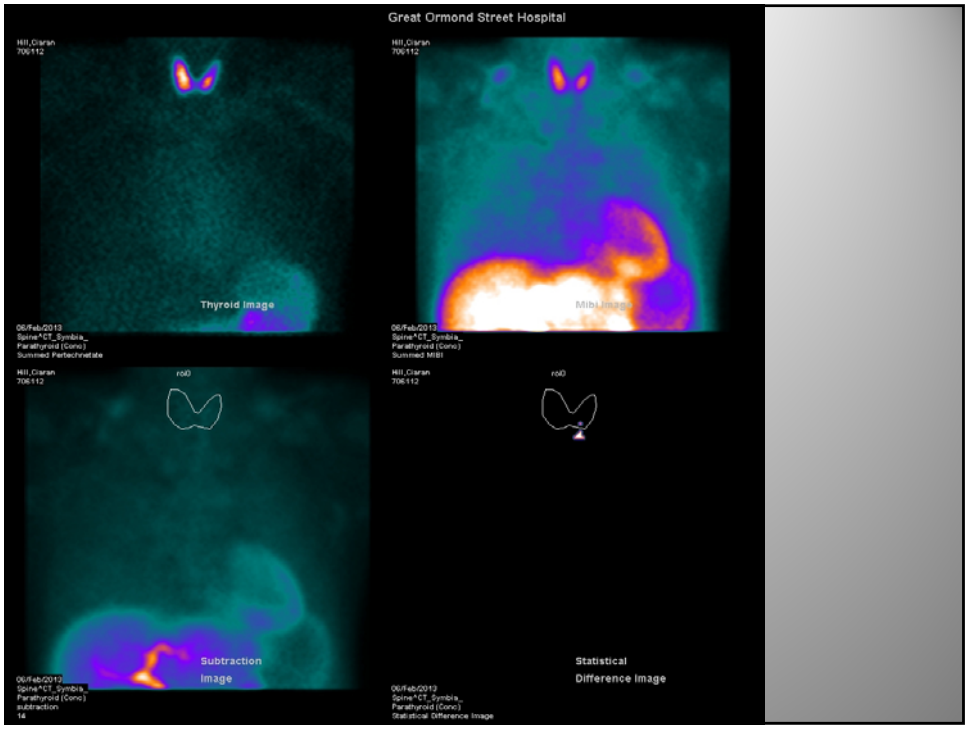


PARATHYROID - NECK

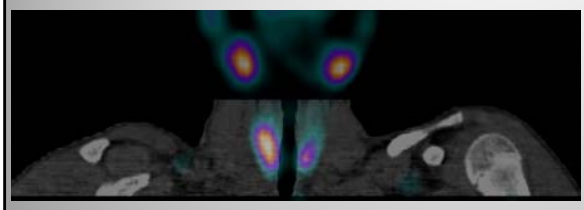
GOSH SPECT GUIDED CT SCAN

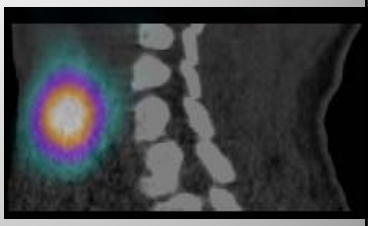
Parathyroid Neck Protocol

- mAs = 20 (under 1 yr)
- = 26 (under 6 yr)
- = 35 (over 6 yr)
- kVp = 110
- Tube rotation time = 0.8 secs
- Pitch = 1.6
- Scan slice width = 1.25



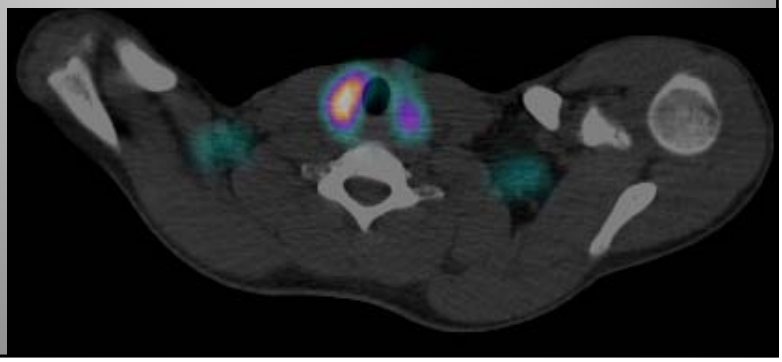
15 yr old boy, CRF, presentation with raised PTH levels, normalized with medical therapy
? Persisting parathyroid hyperplasia / adenoma





SPECT CT neck

Extra radiation exposure 2.35 mSv



SPECT CT IN PAEDIATRICS

- Still early days
- Radiation burden from CT component major issue: keep it as low as possible to answer the clinical question
- Paediatric friendly CT protocols needed
- Limited CT to the area of interest
- Experimental work with CT phantoms needed to establish the lowest possible dose from CT
- Musculo-skeletal pathology likely to benefit from SPECT CT

Thank you!