Bone Hybrid (SPECT/CT) Imaging

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  - No

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  - No
**Reduction of lesions of undetermined significance on WB bone scan by bone xFOV SPECT/CT**

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R: rétrospectif
P: prospectif

*M Abulizi & F Paycha, Méd Nucl 2015*
Clinical interest of axial SPECT/CT
A summary of published studies

✓ SPECT/CT contributes to lessen the rate of undetermined hot spots seen on planar BS (~ 70 %)

✓ SPECT/CT reduces the need to order new radiological exams (one-stop shop concept)

✓ Accuracy of bone scintigraphy is foremost increased by a reliable identification of degenerative arthropathies in spine
Diagnostic pathway of bone SPECT/CT in 6 steps

1) Epidemiological (incidence and prevalence of main conditions) and clinical (is the patient painful or not?) data

2) Pathophysiological reminders centered on most frequent bone and joint disorders (e.g., bone metastases, degenerative joint disease)

3) Display CT+SPECT/CT lay out, selecting best view (axial, MPR, reoriented) is key, 3-D VRT adjuncts

4) Selection of 4 key features of the lesion of interest, first on metabolic then on morphological portion of hybrid imaging (topographic features, type of matrix, margins and limits, locoregional extension)

5) Quantitative measures (SUV, uptake, density) of lesion of concern

6) Derivation of the differentials (gamut sketched out according to similar features and epidemiology, selection of a pivotal imaging feature)

Paycha F, Méd Nucl 2010
Spine SPECT/CT multiple (FOV) Acquisition protocol

- Injected activity: 9 MBq/kg
- Planar whole body scan
  - Scanning speed: 15 cm/min
- SPECT
  - Matrix: 128 x 128
  - Step-and-shoot: 15-25 s/step
  - 3 FOV including cervical spine!
  - Upper limbs along torso
- CT low dose
  - Tube voltage: 120 kV
  - Ixt = 50-80 mAs
  - Pitch = 1-1.5
  - Collimation: 6 x 2 mm
  - Kernel B08s SPECT AC
  - Window: spine
  - FOV: 500 mm
  - CT slice thickness = 2 mm

Total exam duration ≈ 35 min
12 min (WB) + 23 min (SPECT/CT)

Kuwert, EJNMMI 2010
Paycha, Méd Nucl 2012 & 2015
Ratib, HUG course 2012
Palmedo, EJNMMI 2014
Spine
Comparative epidemiology of spine conditions

By decreasing frequency:
- Pseudo-tumours (Paget prev = 3% of pts > 40 years)
- Bone metastases (prev = 70% in breast cancer)
- Hem. Malignancies (Myeloma: incid = 5/100 000)
- Primitive bone tumours (Chondrosarcoma: incid = 0.5/million)

Pseudo-tumours group
- Paget’s disease
- Spondylolysis (DJD)
- Langerhans cell hist. (LCH)
- SAPHO syndrome
- Tuberculous spondylitis
- Hydatid cyst
- …
Planar spine imaging:

Limited assurance in specificity and sensitivity
Clinical context

- Female, 75-year-old
- Low back pain with nocturnal awakening
- NSAID ineffective
- Past history: breast cancer

Whole body scintigram is normal!? 
Degenerative discopathy L4-L5 + Schmorl’s node
Lodwick IA high uptake vertebral lesions
L4-L5 degenerative discopathy + Schmorl’s nodes

Congruent local pattern SPECT+/CT+
Degenerative changes of L4-L5 associated with repetitive mechanical stress and aging

Rathmell JP

JAMA 2008
Spinal DJD: CT pattern
Association of mirroring geodes abutting in intersomatic space
and dome-shaped sclerosis areas (reminder)
Planar whole body bone scintigraphy

Clinical presentation

- F, 63-year-old
- Baseline study T1N0M0 R breast invasive ductal carcinoma
- Medical history: LBP with recent nocturnal inflammatory bouts
Lumbar spine SPECT/CT
Baastrup disease
(a.k.a. kissing spine)

- Arthritic joints between the spinous processes was first described by Baastrup in 1933
- L4-L5 single location as a rule
- Hypertrophy of spinous processes of adjacent vertebral bodies in close approximation; i.e. arthritic joints between the spinous processes joints undergo reactive degenerative changes
- Etiology uncertain, may be related to excessive lordosis with degeneration of intervening ligaments
- Can cause LBP but mostly asymptomatic > 70 year-old

Fused VRT – slab mode

Baastrup C. Acta Radiol 1933; 14: 52–54
Kwong Y. AJR 2011; 196: 1156–1159
Prescher A. Eur J Radiol 1998
Baastrup disease
FDG PET/CT appearance: A note of caution!

PET/CT axial view
*Loop-hole image* exhibiting pseudo-metastatic hypermetabolic focus of spinous process

PET/CT sagittal view
*Key image* featuring mirroring hypermetabolic foci of L3-L4 inter-spinous joint
Facet syndrome
Focal hot spot post. arch

- Lumbar ++ and lower thoracic spine
- Exacerbated by hyperlordosis, overweight and disc degenerative changes
- Pain due to stretching or irritation of zygapophyseal capsule (copiously innervated)
- Imaging:
  - Joint space narrowing
  - Sclerosis and subchondral cysts (geodes)
  - Global joint hypertrophy
  - Joint subdislocation ant., post. or rot. (degenerative spondylolisthesis)
  - Synovial cyst (lat. epidural area [compression] or in

Axial SPECT/CT pattern: Mushroom cap

Zygapophyseal osteoarthritis
DISH (Diffuse Idiopathic Skeletal Hyperostosis) 
a.k.a. Forestier disease

- Increased uptake antero-lateral part of vertebral body on SPECT
- ± matching with flowing osteophytes involving the anterolateral aspect of the thoracic spine on CT
- 4 consecutive vertebral bodies (certainty criterium)
- Relative preservation of intervertebral spaces height
- Complication: Acute spinal fracture

Hyperostosis developing in entheses of spine and peripheral skeleton

Thoracic: 95%
Lumbar: 95%
Cervical: 80%

Unspecific back pain

Resnick & Niwayama, Radiology 1976
Sclerosing joint±enthesis conditions in spine
SPECT/CT regional patterns

DJD  DISH  JAPAN  SPA
Synthetic clinical vignette

When both specificity and sensitivity are lacking...
A (not so) solitary hot spot of L3 in a breast lobular carcinoma patient
Clinical setting

- F, 59-year-old
- L infiltrative lobular carcinoma 6 cm Ø N+ operated
- Baseline work-up
- Moderate LBP with R irradiation

Planar whole body scan

Solitary hot spot in L3 of undetermined significance?
Hot spot (SPECT) + osteolysis L3 R half-body + space occupying tissular lesion (CT)
SPECT/CT cervical spine

Hot spot (SPECT) + osteolysis (CT) C2 odontoid

Low back pain. PC
Davis
ACR
Appropriateness
Criteria®
Date of origin: 1996 Last review date: 2008
Pattern-oriented pathway in SPECT/CT: Application to spine prevalent conditions
Hot spot: intra-somatic or posterior arch?

Bone tumors & pseudo-tumors gamut

Rule: malignant lesions
- Metastasis
- Lymphoma
- Plasmocytoma/myeloma
- Chordoma

Exceptions: benign lesions
- Hemangioma
- Bone island
- Langerhans cell histiocytosis
- Giant Cell Tumor (GCT)

Rule: benign lesions
- Osteoid osteoma/Osteoblastoma
- Aneurysmal cyst of bone (ABC)

Exceptions: malignant lesions
- Chondrosarcoma
Cartilaginous vertebral end-plates and disc: A blockade to metastatic spread

✓ Cartilaginous vertebral plates (CP) and intervertebral disc block the way of cancer cells crossing from one vertebra to the neighbouring one.

Deteriorated disc and/or CP loose this property+++  

❖ 3 malignant tumours are notorious to cross the disc:  
   ❖ Lymphoma  
   ❖ Chordoma  
   ❖ Chondrosarcoma

A. MRI T1-sequence: Metastatic nodule displaying hyposignal contiguous to intersomatic space

B. Anatomical slice evidencing metastatic lesion sparing cartilaginous vertebral plates

Kakitsubata Y. Joint Bone Spine 2009; 76: 50-56
Clinical vignettes
Miscellaneous conditions
The clinical problem

• M, 78-year-old
• Admitted in emergency ward for febrile acute back pain
• Diffuse tenderness of the thoracic spine without neurologic deficit
• Lab findings:
  – CRP = 204 mg/L
  – Leucocytes = 11900
  – Blood cultures positive for *S. aureus*
• Spondylodiscitis is an emergency diagnosis to be secured or excluded
• MRI contraindicated because of pacemaker
• Performing a SPECT/CT or proves paramount but patient is painful and restless
Bifocal hot spots: Vertebral end-plates

Spondylodiscitis

SPECT features:
« Sandwich pattern »

CT features:
• Vertebral endplate destruction
• Hypodensity and flattening of disc gas ± within the disc
• Reactional sclerosis
• Paraspinal soft tissue swelling
• Obliteration of fat planes around the vertebral bodies
Hot spots: vertebral end-plate

Clinical scenario
- Low velocity trauma
- Osteoporosis
- Age >70 years

Intense homogeneous increased uptake fully delineating vertebral upper end-plate

Low back pain. PC Davis, ACR Appropriateness Criteria®
Date of origin: 1996 Last review date: 2008
Clinical presentation

- Prostate cancer operated 3 months ago
- Gleason score?
- Baseline PSA = 23 ng/mL
- Hormonotherapy ongoing
- No bone pain
Developmental error = focus of arrested resorption of mature cortical bone in the process of endochondral ossification (hamartoma)

- High prevalence incidentaloma = 10%
- It is a no-touch lesion
- Asymptomatic
- Most common sites: pelvis and long bones, spine is rarely involved
- $\varnothing < 1.5$ cm in 70% of cases
- Nodule increased density > body cortical density
- Bone scan uptake may be increased in 25% of cases if ongoing remodeling
- Bone island is FDG-negative
Sclerotic metastasis: Comparison of measurements

HU densities (CT) and turn-over (SPECT)

Densities:
BM = 500 HU
Spongiosa = 100 HU

Density ratio = 5

Uptake ratio BM/spongiosa:
= 3.7
Clinical presentation

- F, 23 year-old
- Progressive R cruralgia
- No motor deficit
- Past medical history: Ø

GCT Key features

- 20% of benign tumors
- Spine: 7% (sacrum: 90%)
- Main age group: 20 - 30 years
- Geographic lucency, no sclerotic rim
- Expansion surrounding tissues: 80%
- Eccentric location
- CT: “Soap bubble appearance”
- SPECT: “Doughnut sign”
- FDG: avid tumor malignant-like SUV

J Aoki, Radiology 2001; 219: 774-777
SPECT axial view centered on L3
CT axial view centered on L3
SPECT/CT axial view centered on L3
CT: Tumor developing in L3 body containing areas of necrosis invading R foramen resulting in partial vertebral collapse

SPECT: Solitary defect R 2/3 vertebral body + crescent increased uptake confined to L 1/3 body
Main malignant tumors originating in spine (adults)

- Chordoma
- Chondrosarcoma
Chordoma: Bone scintigraphy

Clinical presentation

• F, 66-year-old
• Progressive bilateral brachialgy

Whole body + Cervical spine SPECT

Within normal limits!
Chordoma: CT + MRI

**CT:** Lysis of vertebral body + epidural invasion

**MRI:** Mushroom pattern (sag.) hypoT1/hyperT2
Chordoma
The key facts

- Rare tumors arising from vestigial embryonal notochord remnants
- Axial distribution: sacro-coccygeal (60 %) > sphenoorbital (25 %) > spine (15 %) [1/3 cervical segment]
- Vertebral body location most frequent
- Intervertebral disk invasion
- Epidural extension
- Local aggressiveness entailing high recurrence risk
- Therapy = resection ± external beam radiotherapy
- Key prognostic factor: *en bloc* excision ++
Imaging double discrepancy: Pivotal features to unmask chordoma

- Extraosseous expansion >> Intraosseous proliferation

- Positive cross-sectional anatomic imaging (CT, MRI) at variance with negative cross-sectional metabolic imaging ($^{99m}$Tc-BP, $^{18}$F-FDG)

Un piège diagnostique potentiellement létal : chordome révélé par une large lésion lytique de C3 normofixante à la scintigraphie osseuse aux bisphosphonates-($^{99m}$Tc).

F. Paycha et al.

Médecine Nucléaire - Imagerie fonctionnelle et métabolique - Vol. 30 - n° 07 - 2006
The solitary “ivory” vertebra

- **Malignancies**
  - Sclerotic metastasis
    - Prostate
    - Breast
    - NET
    - Lymphoma (Hodgkin)

- **Benign conditions**
  - Paget’s disease
  - SAPHO syndrome
  - Tuberculous spondylitis

Sclerotic metastasis

- F, 42-year-old
- Inflammatory LBP
- Medical history: uterine cancer, Crohn’s disease
SPECT/CT centered on L4

Diffuse VB heterogeneous increased uptake congruent to sclerotic area
Mickey Mouse pattern on planar imaging:
Always a vertebral Paget’s disease?

Classically:
- Local pattern = Mickey Mouse
  \[ \text{PPV} = 70\% \]
- General pattern =
  Mickey Mouse +
  Associated bone abnormalities elsewhere suggestive of Paget’s disease
  \[ \text{PPV} = 88\% \]

Paycha F, EMC 2001
Clinical setting

- M, 67-year-old
- NSCLC of L upper lobe operated in Nov. 2008
- Baseline bone scan
SPECT increased uptake rim circumscribing CT osteolysis
Mickey Mouse pattern on planar imaging: Always a vertebral Paget’s disease?

- Ultimate diagnosis: Vertebral metastases featuring mixed (sclerotic/lytic) phenotype

- Trap in 2D imaging for depiction of uptake abnormalities of short bones (vertebrae):
  - Lumping together hot and cold spots result in a misleading global appearance of homogeneous increased uptake

- Advantage in 3D hybrid imaging for depiction of uptake abnormalities of short bones (vertebrae):
  - Accurate description of hot and cold spots
  - CT Correlation by matching hyperdensity and hypodensity areas

Mickey Mouse pattern on planar imaging: Always a vertebral Paget’s disease?
Paget’s disease: X-rays

Clinical data

- Osteitis deformans
- 90% are over age 55, rare before age 40
- 15% monostotic
- 90% asymptomatic

Cardinal radiographic features

1. Cortical thickening
2. Accentuation and coarsening of trabecular pattern
3. Enlargement of bone contours
4. Advancing wedge of resorption

Clinical setting

- M, 73-year-old
- Prostate cancer
- Chronic intermittent LBP
- Baseline work-up
Paget’s disease: Scintigraphy

Scintigraphic patterns

• High level intensity of scintigraphic abnormalities:
  • Phases I, II

• No scintigraphic abnormality:
  • Burn-out disease (phase III-no longer active)
  • Bisphosphonates-controlled

Same patient
Differential diagnosis with sclerotic metastasis
MRI (and CT!) pivotal feature:
Preservation of the intravertebral fat
TB spondylitis
(Pott’s disease)

- M, 32-year-old
- IV drug-addict
- Inflammatory LBP
- Ivory vertebra in T10
- Bacteriology: M. Tuberculosis
Clinical presentation
- F, 47-year-old
- Inflammatory LBP

Medical history
- HIV infection under HAART
- Multisystem TB 10 years ago

Imaging
- Plain X-rays: Ø
- Bone scan: Mixed lesions scattered over axial skeleton: cervico-thoraco-lumbar spine, ribs, pelvic girdle

Biopsy
- Axillar ADP: Large cell B lymphoma
Lymphoma tumoral infiltration starts in hematopoietic marrow. In theory, one surmises invasion of spine occurs in a diffuse way, homogeneous or heterogeneous, in hematological malignancies, in contradistinction of a focal way for bone metastases.

Clinical presentation

- F, 29-year-old
- Caucasian
- LBP lasting for 1 year
- Good general health
- Past medical history: Ø
- Biological tests:
  - $V_S(1\text{st h}) = 17$
  - CRP = 0.6 mg/L
Planar bone scan exhibits a special locoregional pattern

1. Increased uptake L4, L5, S1 vertebral bodies ++
2. Increased uptake syndesmophytes of L4-S1 segment ++
3. Increased uptake of CAVL of L4-S1 segment ?
SPECT/CT Pelvi-lumbar FOV
Lumbar spine: Sagittal view
MRI lumbar spine
Sagittal T2 FATSAT sequence
SAPHO syndrome

spondylitis L4 – S1, ossification CAVL
All in all,
Bone scan picture
(planar & SPECT/CT)
makes you suspect...

SAPHO syndrome
SAPHO syndrome: a « SKIBO » disease (SKin+BOne manifestations)

- Synovitis
- Acne
- Pustulosis
- Hyperostosis
- Osteitis

Common features
- Spine involvement: 10-35%
- Thoracic segment dominant
- Vertebral end-plates osteosclerosis
- Non-marginal asymmetrical paravertebral ossifications


Freyschmidt J, Eur Radiol 2001
SAPHO
Spinal ligaments ossification

Case Report

Ossification of the Posterior Longitudinal Ligament of the Cervical Spine and SAPHO Syndrome

DENIS MULLEMAN, SALOUA MAMMOU, ISABELLE GRIFFOUL, PHILIPPE GOUPILLE, and JEAN-PIERRE VALAT

ABSTRACT. We describe a case of cervical cord compression due to ossification of the posterior longitudinal ligament of the spine (OPLLs) in a 43-year-old Vietnamese patient with SAPHO syndrome (synovitis, acne, pustulosis, hyperostosis, and osteitis). Idiopathic OPLLs is mainly reported in 50- to 60-year-old men, particularly in Japanese, with a prevalence of 2%. Cervical myelopathy may occur. In addition to OPLLs in patients of Asian origin, the condition has also been described in association with ossifying diseases, including ankylosing spondylitis (AS) and diffuse idiopathic skeletal hyperostosis (DISH) but not previously, to our knowledge, with SAPHO syndrome. (J Rheumatol 2005; 32:1361-4)

Key Indexing Terms:
OSSIFICATION
SAPHO SYNDROME
POSTERIOR LONGITUDINAL LIGAMENT
ANKYLOSING SPONDYLITIS
Osteosclerotic enthesitis
Spinal ligaments ossification
To ascertain diagnosis you are looking for...

Cutaneous signs!
SAPHO syndrome
Anatomic spread variant
SAPHO syndrome: posterior thoracic location
The solitary “ghost” vertebra
“Ghost vertebra”

- Lytic metastasis
- Myeloma/plasmacytoma
- Haemangioma
- Bone infarct
Clinical background

- F, 60-year-old
- No back pain
- Rectal carcinoma initial work-up
  - Solitary L2 defect?
SPECT/CT BP-(99mTc)
Full spine: axial, sagittal, coronal views
NaF-(18F) PET/CT
Full spine: Sagittal views

Close-up imaging:
- Healthy skeleton
- Metastases
  - Sclerotic
  - Lytic
  - Trabecular
- Osteoarthritis
- Non-metastatic lesions
  - Side-effects
  - Comorbidities
NaF-(18F) PET/CT vs spine MRI

CT spine: Nothing to report!

Congruency NaF PET – MRI: Osteolytic/osteoclastic bone mets vertebral bodies (trabecular bone)
Hemangioma

- SPECT: Cold-in-hot
- CT: «polka dot» axial, «temple pillars» sagittal/coronal

GCT

- SPECT: extended defect + partial hot crescent
- CT: geographic osteolysis with expansion to surrounding tissues

Plasmacytoma

- SPECT: body defect +/- faint incomplete uptake rim
- CT: expansile osteolysis of body, vertical dividing walls, empty pedicle

DIFFERENTIAL TRIAD

FRONT-TO-FRONT GAMUT
Vertebral infarct

SPECT+/CT-/MRI+

pattern

N Aide, J Rheumatol 2007
Full spine
3 FOV SPECT/CT: Clinical indications

- Because WB scan is abnormal
  - Spinal hot spot of undetermined significance on WB scan: Diagnostic role
  - Spinal or extra-spinal hot spot(s) suspected of bone met(s) on WB scan: Pronostic/pre-therapeutic role

- Although WB scan is normal
  - Unusual LBP associated with red flags contrasting with normal WB scan
  - Abnormalities disclosed on anatomical and/or other molecular imaging modalities
  - Increase of blood concentration of tumor and/or bone markers
  - Condition (benign/malignant) at high-risk of spinal lesions
Hip
Clinical context

- M, 80 year old
- Prostate cancer treated 10 years ago
- Asymptomatic
- Biochemical relapse: PSA = 100 ng/mL 1.5 year ago
- Androgen deprivation: PSA = 10 ng/mL 1 month ago
- ALP = 160 UI/L
Whole body scan surveillance

SCINTIGRAPHIE OSSEUSE
10/12/2008

SCINTIGRAPHIE OSSEUSE
07/05/2010

FACE ANTERIEURE
FACE POSTERIEURE
$2^\text{nd}$ bone scan: Blood pool images
3rd bone scintigraphy
Whole body scan
SPECT/CT pelvis
SPECT/CT pelvis fused VRT
The 4\textsuperscript{th} dimension of bone & joint conditions: \textbf{Time}

1. Yearly progression rate of Paget’s disease is roughly 1 cm

2. Pagetic extension to whole coxal bone takes 30 years, involvement of whole pubic rami takes 15 years

3. Size progression of naive bone metastases can be assessed by imaging between 1 and 6 months time interval

4. Progression of hip osteoarthritis is featured by narrowing of joint space by -0.20 à -0.30 mm/year

5. Progression of lesions of fibrous dysplasia is exceptional in adults
Diagnosis: Solitary mixed phenotype bone metastasis
PET/TC FCH-(18F)
Pelvis: axial + coronal views

L external iliac adenopathy
Differential osteosclerotic/osteoblastic solitary lesion MRI (& CT!) of phase 3-pagetic bone: Visualisation of fatty transformation of bone marrow
Paget’s disease

Clinical data
- Osteitis deformans
- 90% are over age 55, rare before age 40
- 15% monostotic
- 90% asymptomatic

Cardinal radiographic features of Paget’s disease
1. Cortical thickening
2. Accentuation and coarsening of trabecular pattern
3. Enlargement of bone contours
4. Advancing wedge of resorption

Scintigraphic pattern
- High level intensity of scintigraphic abnormalities:
  - Phases I, II, III
- No scintigraphic abnormality:
  - Burn-out disease (no active)
  - Bisphosphonates-controlled
Whole body bone scan

Paget’s disease « Canonical form »

Clinical presentation
F, 70 years old
R hip intermittent limping for 1 year
Total ALP=235 (N<115)

Past history
diabetes mellitus type 2, high index of suspicion of mesenteric GIST
Pelvis MIP CT + SPECT/CT  
Axial – Coronal - Sagittal
Pelvis axial views
SPECT + SPECT/CT + CT
Pelvis fused VRT
Ant, Post, RPO, RAO
Clinical presentation
Subacute mechanical but persistent pain L groin
X-rays inconspicuous
Past medical history
DTC operated + 131 I 14 years ago
Bone scan
Heterogeneous bone lesions
L ½ pelvis + R SIJ
Morphological cross-sectional imaging
CT + MRI
Litigious
Bone biopsy
Bone metastase from prostatic origin

focused hot spot
= skip metastasis!
Skull: Osteoporosis Circumscripta

Yarmulke sign

Kunin JR et al.
Tibia:
Paget’s disease of anterior tibial tubercle

Paget Disease of the Anterior Tibial Tubercle

Two Unusual Causes of Peripatellar Nonmetastatic Positive Bone Scans in Patients with Malignancies: Case Reports

John W. Turner, Ibrahim B. Syed, and Richard P. Spencer
Pearls

- Differential diagnosis: Solitary sclerotic bone lesion focused in pelvis in man: Bone metastasis from prostate cancer (bony pelvis: 20% bone mets from prostate ca) or Paget (bony pelvis: 70% of pagetic lesions)
- Associated pelvis pain: High index of suspicion of bone metastasis
- Bone lesion focused on a portion of pelvic bone: Bone met suspected
- Diagnostic procedure: “Metabolic” (FCH PET) or pathologic biopsy
References

PAINFUL JOINT?
SEARCHING FOR THE CULPRIT!
Clinical context

- M, 54 year old
- Epidermoid lung cancer recently diagnosed
- Initial work-up: Mediastinal adenopathies
- Addressed for recent incapacitating pain in R knee
BP-(Tc99m) whole-body bone scan
SPECT/CT: MIP + axial + coronal
Pelvis SPECT/CT: Zoomed coronal views
Effraction of R acetabulum
Pelvis X-ray
MDCT bony pelvis
Zoomed transaxial views

Diagnosis
Bifocal osteolytic metastases
R acetabular roof + femur head

Pearls
• Caveat! Skeletal lesion may be remote to referred pain
• Undeserved/outdated bad press for bone scan in lung cancer
Clinical presentation

- M, 65 year-old
- Lung adenocarcinoma, LUL, T2a N3 M1b
- Known osteolytic metastases:
  - R 3rd rib
  - Proximal épi-méta-diaphyseal portion of L femur
- L bottom pain for 1 month
- MDCT pelvis: Normal
Pattern SPECT+/CT- (/MRI+)
Lower limbs
Clinical presentation

• F, 40 years old

• Oligoarticular subacute inflammatory severe pain

• Medical record
  – Chronic real failure of undetermined origin
  – Ongoing corticosteroid regimen for dermatologic facial tumour
### Diagnosis of avascular necrosis: SPECT/CT or MRI?

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<th>Specificity</th>
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<td>SPECT/TDM</td>
<td>90%-100%</td>
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<tr>
<td>IRM</td>
<td>95%-100%</td>
<td>85%</td>
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*SM Jackson. Orthop Clin N Am 35 (2004); 315–320*

Ostéonécrose idiopathique vs ostéonécrose secondaire: Extension loco-régionale

Atteinte localisée: condyles fémoraux ou plateaux tibiaux

Atteinte extensive: idem + métaphyses +/- diaphyses
### Primitive vs secondary avascular necrosis

#### Features comparison

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<th>ON secondaire</th>
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</tr>
<tr>
<td><strong>Bilatéralité</strong></td>
<td>0 %</td>
<td>30 %</td>
</tr>
<tr>
<td><strong>Caractère multifocal</strong></td>
<td>0 %</td>
<td>30 %</td>
</tr>
</tbody>
</table>

From J. Narváez

*Rheumatology 2000*
Foot CRPS type I (formerly aka RSD) ??

Clinical history
Persistent pain in the R foot 8 months after a fall with inconspicuous initial X-rays

Diagnosis?
1. Talar dome occult fracture
2. Talo-crural arthropathy
3. Tibial posterior tendinitis
4. Post. subtalar arthropathy
5. CRPS I
SPECT/CT: MIP-CT-fused

Diagnosis please?

1. Talar dome occult fracture
2. Talo-crural arthropathy
3. Tibial posterior tendinitis
4. Post. subtalar arthropathy
5. CRPS I
SPECT/CT-Triangulation
Disease Versus Etiology: The Distinction Should Not Be Lost in the Analysis

**SPECT/CT pattern**

Post subtalar arthropathy

hot spot (→) flagging delayed union complicating an overlooked talal fracture exhibiting a normal uptake (→)
Follow up plain X-rays R foot

Posterior subtalar arthropathy caused by talar atrophic non-union of an overlooked traumatic fracture (•)

Subtalar arthropathy: SPECT+/CT+
Non-union fracture: SPECT-/CT+

Pearl: Post. subtalar arthropathy always secondary!
Conclusion
SPECT pattern

↓

SPECT-CT pattern

4 possible combinations:

Concordant pairs:
- SPECT+/CT+
- SPECT-/CT-

⇒ Reliable SPECT-CT pattern in ascertaining or discarding a diagnosis!

Discordant pairs:
- SPECT+/CT-
- SPECT-/CT+

⇒ False-positive of one modality or false-negative of the other one?

⇒ Localisation of symptomatic lesion?
### Likely scenarios for bone (S)PE(C)T/CT patterns

<table>
<thead>
<tr>
<th>(S)PE(C)T</th>
<th>CT</th>
<th>Prevalent conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>Positive</td>
<td>Cortical bone metastases, osteoid osteoma, osteosarcoma, infectious spondylodiscitis, recent vertebral crush fracture (&lt; 9 mo) Hypertrophic non-union Paget’s disease phase II fibrous dysplasia (85%)</td>
</tr>
<tr>
<td>Positive</td>
<td>Negative</td>
<td>Spongious bone metastases*, lymphoma, avascular necrosis stages I-II, fissure, contusion, enthesopathy, periostitis, Paget’s disease phase I</td>
</tr>
<tr>
<td>Negative</td>
<td>Positive</td>
<td>Spongious bone metastases* (breast ILC++), myeloma, fibrous dysplasia (15%), hemangioma, chordoma, bone island, Intra-osseous lipoma old vertebral crush fracture (&gt; 9 mo) atrophic non-union Paget’s disease phase III</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
<td>Intra-medullary metastases myeloma very early and early spinal spondyloarthritis</td>
</tr>
</tbody>
</table>
Structure without function is a corpse. . .
function without structure is a ghost.

— Stephen Wainwright

Quoted by David W. Townsend, J Nucl Med 2008
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See you next year in Barcelona for the Bone & Joint CME!

The post-operative spine