Bone Scintigraphy

Dr. Vijayan Manogran
Hospital Umum Sarawak
Kuching

Theory

- Diphosphonates absorbed onto bone surface
- This reflects osteoblastic activity and vascularity
- Most sensitive imaging modality to detect osteoblastic response (in fractures, metastatic disease, infections, metabolic disease)

Indications

- Neoplastic disease (to detect OR monitor metastatic OR evaluate primary)
- Infectious (detect acute or chronic OM & monitor therapy)
- Trauma (fracture or prosthetic jts)
- Arthritis and related disorders (OA, sacroilitis, synovitis)
- Osteonecrosis
- Metabolic bone disease
- Soft tissue calcification
- Skeletal pain of unknown cause

What agent used?

- 99mTechnitium MDP
- Adults 15-25 mCi
- Children 200 microCi

Equipment

- Collimator
- Gamma camera
- IV tray

Patient Prep

- No barium studies within 2 previous days
- Must consume extra liquids during the 3 hours between injection and imaging
- Must empty bladder frequently during tHe study
- Must empty bladder completely preceding the imaging

Procedure

- IV administration
- Takes 2-4.5 hrs for imaging
- Ptt to remove jewellery, belt buckle, coins, metal buttons
- Position ptt on pallet, arms at side, secure feet together.True anterior-posterior position, secure head if necessary

Types of scan

- Whole body
- Limited
- Three phase
- SPECT

The ideal radio pharmaceutical characteristic:

1. Easily and cheaply generated
2. Radiochemically pure
3. Non-toxic
4. Should emit only gamma rays (100–200keV energy)
5. Half-life long enough to complete investigation
6. Half-life short enough to minimize patient radiation risk

Bone Scan

- Diagnostic accuracy of about 95% for skeletal metastatic disease (sensitive but not specific)
- Most commonly used: 99m Tc-methylenediphosphonate, MDP (medronate)
- Reflects osteoblastic activity and skeletal vascularity at sites of active bone formation
- Purely lytic lesions very rarely result in uptake
- **Often positive before plain X-ray changes are apparent, 6 months**
- Bone scan vs Xray vs MRI

Indications in Urology

- Staging of cancer
- Assessment of response to therapy in patients with cancer
- Investigation of bone pain in urological patients
- Investigation of hypercalcemia

When to do?

- Not done if PSA < 10 & Gleason </= 3 + 3 unless symptomatic
- Flare reaction upon hormonal therapy for CaP --> repeat after three months
- Equivocal cases in CaP --> repeat scan after hormonal therapy --> ?response
- Role is less clear in other urological malignancies

Factors Affecting Bone Scan

- Benign and malignant bone disorders: false positive: fractures, infections, necrosis, Paget's disease, degenerative changes and primary bone tumors
- Pronounced lumbar lordosis / scoliosis --> seemingly asymmetrical uptake
- Residual tracer in the urinary tract which may obscure skeletal areas of interest (should catheterise the patient)
- Excessive patient movement during imaging
- Extravasation or spillage of tracer which may confuse analysis (remove/change clothing if required)

Ca Prostate (CaP)

- One third ptts with CaP will present with skeletal metastases
- Skeletal spread uncommon (<2%) in PSA < 2; present in > 90% of CaP with PSA > 50
- PSA < 10 and Gleason < 3+3: the yield in a patient without bone pain does not justify a bone scan
- Prognostic role: mortality at 2 years in patients with and without a positive scan at presentation is 45% vs 20%
- Patients with disseminated CaP may demonstrate a "superscan"
  - A symmetrical increased uptake throughout the skeleton
  - Minimal soft tissue activity
  - Absent or dim renal outlining

Soloway Grading

TABLE 5.3. Soloway grading of bone metastases at diagnosis

Grade	Appearance on bone scintigraphy
0	Normal, no metastases
1	1–5 lesions compatible with bone metastases
2	6–20 lesions compatible with bone metastases
3	More than 20 lesions but not a "superscan"
4	A "superscan" with more than 75% of axial skeleton, proximal humeri and femora involved

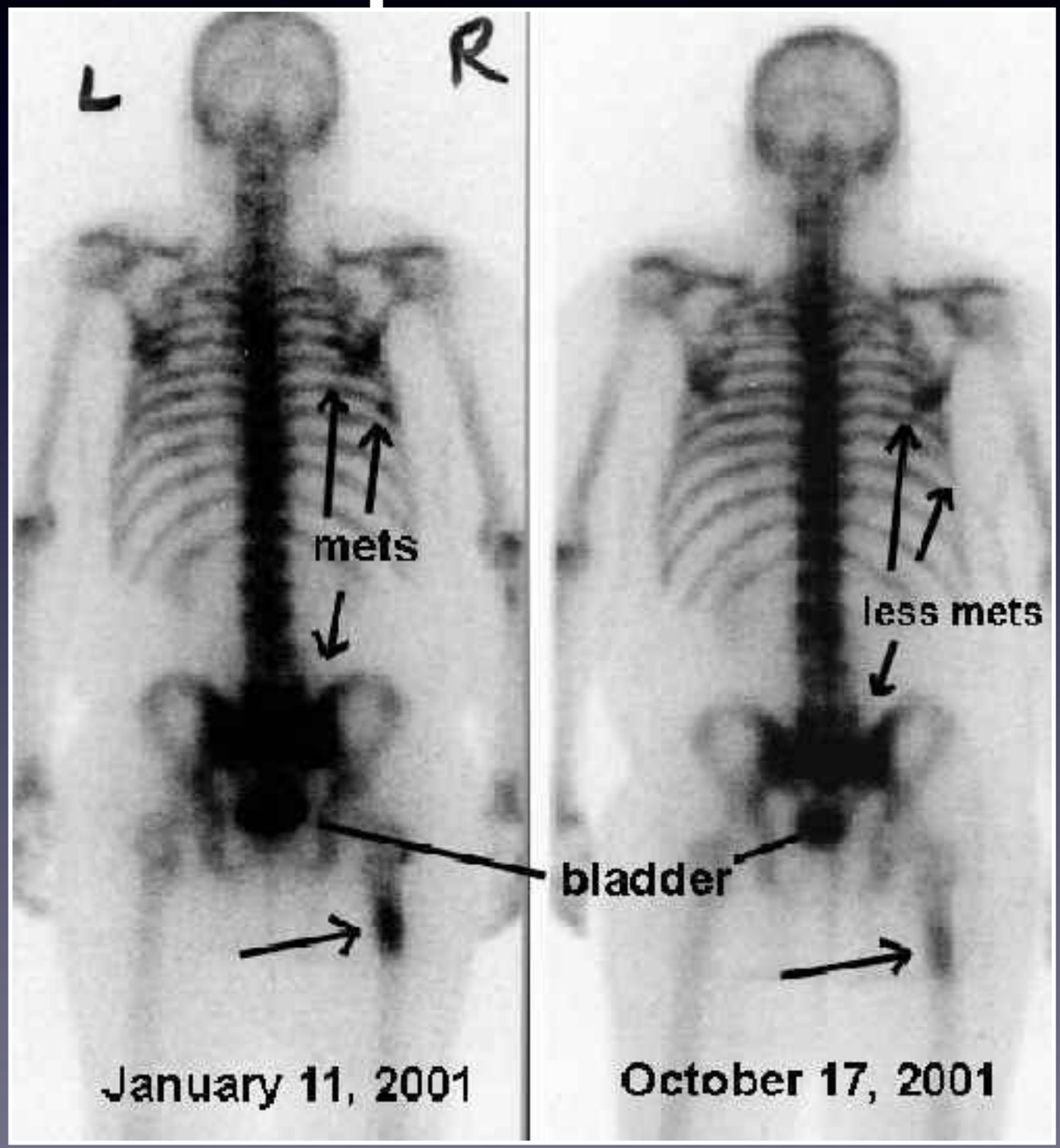
TABLE 5.4. Survival by Soloway grade (9)

Soloway grade	Survival at 3 years	Survival at 5 years
0	97%	96%
1	78%	68%
2–4	44%	21%

Advantages & Disadvantages

ADVANTAGE	DISADVANTAGE
Accurate method, sensitive	Radiation
Whole skeleton scanned	Lengthy
	Not specific
	Prone to artefacts

Bone Scan for Monitoring of Response to Tx



Indeterminate Lesions

Problems with bone scintigraphy:

- Not specific --> indeterminate lesions

How to improve findings of indeterminate lesion?

- MRI
- SPECT-CT
- 18-F PET and/or 18-F PET/CT

MRI

- MRI > sensitive than bone Scintigraphy
- But not easily available, high cost, long time (area to scan is large)
- May provide more accurate findings but needs further study to determine usage in initial staging
- May be useful to help identify status of indeterminate lesions

SPECT-CT

- Single photon emission CT alone allows better distinction of benign vs malignant changes (more exact localization) BUT also not specific
- Combining SPECT-CT allows field of view of the CT to be guided by the SPECT
- Initial image from SPECT reviewed and CT field determined (interval of < 3 minutes)
- CT done in bone view only (less radiation dose)
- CT image reconstructed (3mm cuts) and images fused with SPECT

SPECT-CT

- Allows definite diagnosis in 92% of axial skeleton lesions classified as indeterminate

Romer et al. Roentgenpraxis. 2005

- Highest diagnostic gain in spine, thorax and pelvis

18- F FDG PET/CT

- 18-FDG PET not recommended in detecting bone metastasis in CaP -- > metabolically quiescent
- 18-F (fluoride) more sensitive than bone Scintigraphy & lesser false negative than bone Scintigraphy or SPECT
- Integration of PET & CT with 18-F tracer has sensitivity of 100% and specificity of 88%
- New horizons?

18-F-NaF PET

- Superior sensitivity cf bone scan and comparable to 18-F FDG
- 18-F-NaF also has greater diagnostic yield cf 18-F FDG PET
- 18-F NaF also detected more bone mets and additional sites of metastasis cf 18F-choline PET

THANK YOU