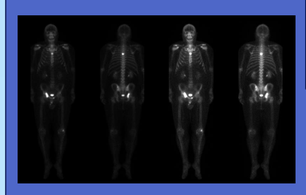
Is 1 second per projection SPECT CT sufficient as an adjunct for problem solving in planar bone scintigraphy? A case series utilising a new technique

Hull University Teaching Hospitals NHS Trust

Dr Amanda Isherwood (amanda.isherwood1@nhs.net), Rita Cabral, Professor Ged Avery
Hull Royal Infirmary/ Castle Hill Hospital

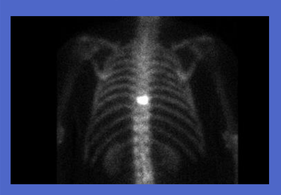
In relation to this presentation, I declare that there are no conflicts of interest.

Whole body bone scan



Quick
Cheap
Sensitive

PROBLEM
Non-specific



Solitary 'hot spot'
Metastasis?
Fracture?
Infection?

SOLUTION?
Add SPECT/CT
BUT…
Time consuming:
15-20 min per bed position
Patient fatigue
Reduced capacity

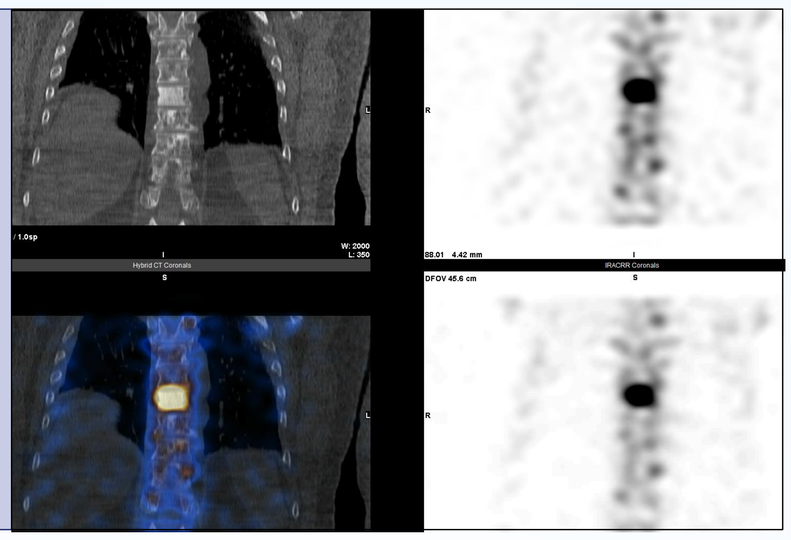
NEW SOLUTION
Ultrafast 1 second per projection SPECT CT
Adds <4 mins scan time per patient
No additional appointments



Case 1 - Metastasis

Whole body bone scintigraphy (left) demonstrating a 'hot spot' in the mid thoracic spine (red circle)

Coronal thoracic images from superfast SPECT (top and bottom far right) are noisy but adequate to localise the abnormality on fused images (bottom right) to T8, which on CT (top right) is sclerotic. The rest of the spine demonstrates abnormal bone architecture of widespread bone metastases. The lesion is a metastasis.

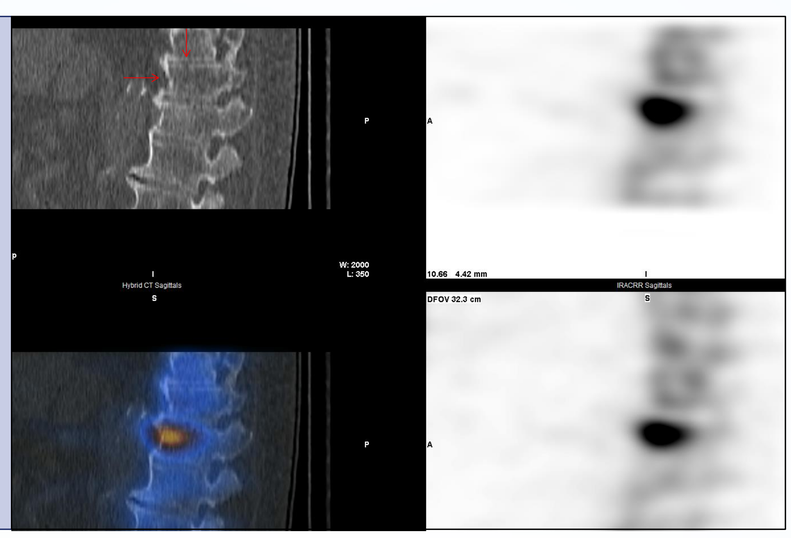




Case 2 – Fracture

Whole body bone scintigraphy (left) demonstrating a 'hot spot' in the lower thoracic spine (red circle)

Sagittal thoracic images from superfast SPECT (top and bottom far right) localise the abnormality on fused images (bottom right) to anterior T12. CT (top right) demonstrates subtle breaches in the superior and anterior vertebral cortex (red arrows). There is subtle reduction in anterior vertebral body height. The lesion is a fracture.

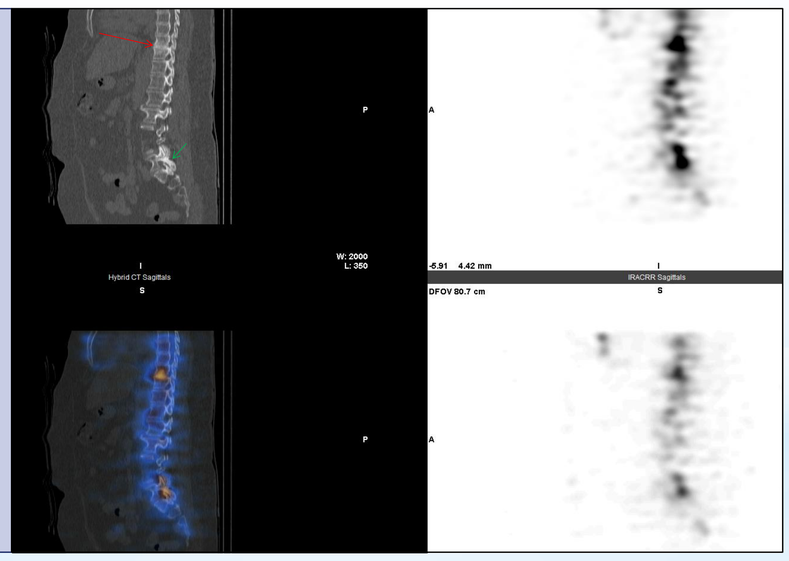




Case 3 – Degenerative

Whole body bone scintigraphy (left) demonstrating 'hot spots' in the mid thoracic spine and left side of L5 (red circles).

Sagittal thoracic and lumbar spine images from superfast SPECT (top and bottom far right) localise the abnormality on fused images (bottom right). CT (top right) demonstrates loss of disc height and adjacent sclerosis at T9/T10 (red arrow) and degenerative facet joints at L4/5 and L5/S1 (green arrow). The lesions are degenerative joint disease.

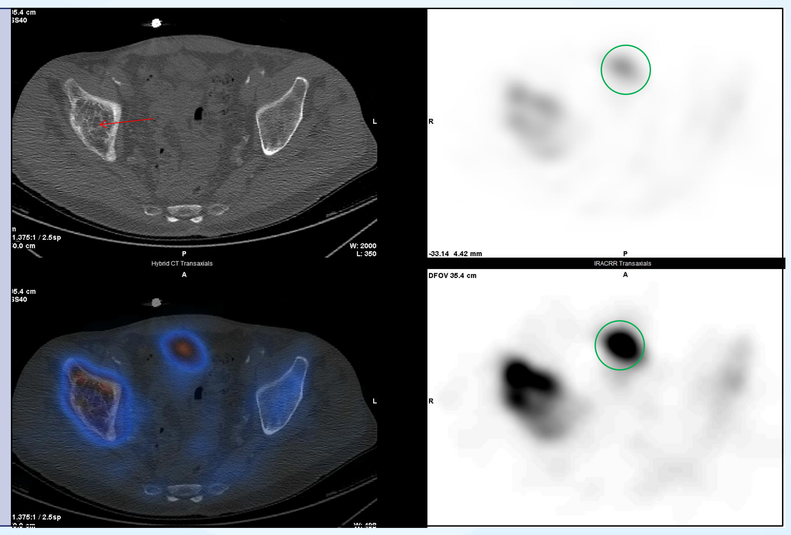




Case 4 – Paget's disease

Whole body bone scintigraphy (left) demonstrating uptake throughout the enlarged right hemi pelvis (red circles).

Axial images just above the level of the acetabular roofs. Superfast SPECT (top and bottom far right) localise the abnormality on fused images (bottom right) to the right hemi pelvis. The anterior uptake is the urinary bladder (green circles). CT (top right) demonstrates classical trabecula coarsening and bone expansion of Paget's disease (red arrow).



Background

Whole body bone scintigraphy is relatively inexpensive, quick and has good sensitivity[1] [2]. However, as tracer uptake is seen in several processes including trauma, infection and malignancy, the problem is lack of specificity [3]. Good if no uptake or widespread uptake in a pattern typical of metastases. Difficult when there is a single 'hot spot' [2].

SPECT CT can help and has been shown to increase the negative predictive value in assessing a single spinal lesion to 98% [5]. But standard SPECT is time consuming, adding up to 15-20mins for every bed position required [6, 7]. This can tax patient compliance and reduce scanning capacity.

Studies show that ultrafast SPECT/CT produces reproducible diagnostic results as an add on to whole body bone scan [8, 9]. These studies have used an ultrafast protocol of 10 seconds per view over 16 views compared to standard SPECT of 20 seconds per view over 32 views [8, 9].

We report cases from our new superfast SPECT CT protocol utilising a 1 second per view over 24 views step and shoot continuous acquisition approach reducing SPECT scan time to less than 2 minutes and whole SPECT CT to less than 4 mins, to problem solve a solitary 'hot spot' lesion as an add on to a whole body bone scan.

Scan Parameters

Standard SPECT
GE Discovery 870 DR gamma camera with High Resolution Sensitivity collimators. Matrix 128 x 128, zoom factor of 1.0 and a duration of 120 x 12s projections over 360°. Total SPECT scan time of 16 minutes including rotation time. Resolution recovery evolution for bone software used in processing.

Super fast SPECT acquisition
Same as for standard SPECT, except duration was a step and shoot continuous acquisition approach of 1 second per projection with a view angle of 15 degrees and a total angular range of 360 degrees i.e. 24 x 1 second projections over 360 degrees. A total SPECT scan time of 1 minute and 33 seconds. The High Resolution Sensitivity collimator allows acquisition between steps.

Conclusion

Further to prior studies which successfully utilised a 10 second per projection approach for ultrafast SPECT, we demonstrate that as little as 1 second per projection over 24 views with continuous acquisition between steps on a GE Discovery 870 DR camera can produce diagnostically useful images in less than 2 minutes as an add on to whole body planar bone scintigraphy.

A larger study on a wider population to establish reproducibility of results is needed. Implementation of this on a wider scale could reduce the time burden on nuclear medicine departments of performing SPECT CT in addition to basic whole body bone scintigraphy for problem solving solitary lesions.

References:

1. 1 .Blake GM P-HS, Cook GJ, Fogelman I. Quantitative studies of bone with the use of 18F-fluoride and 99mTc-methylene diphosphonate. *Semin Nucl Med* 2001:28–49.
2. 2 .Hamaoka T, Madewell JE, Podoloff DA, Hortobagyi GN, Ueno NT. Bone imaging in metastatic breast cancer. *J Clin Oncol* 2004,**22**:2942-2953.
3. 3. Saha S, Burke C, Desai A, Vijayanathan S, Gnanasegaran G. SPECT-CT: applications in musculoskeletal radiology. *Br J Radiol* 2013,**86**:20120519.
4. 4 .Van den Wyngaert T, Strobel K, Kampen WU, Kuwert T, van der Bruggen W, Mohan HK, *et al.* The EANM practice guidelines for bone scintigraphy. *Eur J Nucl Med Mol Imaging* 2016,**43**:1723-1738.
5. Savelli G, Maffioli L, Maccauro M, De Deckere E, Bombardieri E. Bone scintigraphy and the added value of SPECT (single photon emission tomography) in detecting skeletal lesions. *Q J Nucl Med* 2001,**45**:27-37.
6. 6. Utsunomiya D, Shiraishi S, Imuta M, Tomiguchi S, Kawanaka K, Morishita S, *et al.* Added value of SPECT/CT fusion in assessing suspected bone metastasis: comparison with scintigraphy alone and nonfused scintigraphy and CT. *Radiology* 2006,**238**:264-271.
7. Palmedo H, Marx C, Ebert A, Kreft B, Ko Y, Turler A, *et al.* Whole-body SPECT/CT for bone scintigraphy: diagnostic value and effect on patient management in oncological patients. *Eur J Nucl Med Mol Imaging* 2014,**41**:59-67.
8. Zacho HD, Manresa, J., Aleksyniene, R., Ejlersen, J. A., Fledelius, J., Bertelsen, H., & Petersen, L. J. Three-minute SPECT/CT is sufficient for the assessment of bone metastasis as add-on to planar bone scintigraphy: prospective head-to-head comparison to 11-min SPECT/CT. *EJNMMI Research* 2017,**7**.
9. Zacho HD, Aleksyniene R, Ejlersen JA, Fledelius J, Petersen LJ. Inter- and intraobserver agreement in standard and ultra-fast single-photon emission computed tomography/computed tomography for the assessment of bone metastases. *Nucl Med Commun* 2020,**41**:1005-1009.