CLINICAL IMPACT OF TARGETED SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY/COMPUTED TOMOGRAPHY (SPECT/CT) BONE SCINTIGRAPHY ON THE ASSESSMENT OF BONE METASTASIS IN CANCER PATIENTS.

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Introduction

Bone is one of the most common sites of distant metastasis. The diagnosis of metastatic disease is complicated. A wide range of pathological conditions may affect the musculoskeletal system, including infection, trauma, and malignant disease. Anatomical and functional imaging modalities are used for the detection and characterization of metastasis. CT and MRI detect normal or doubtfully abnormal bone density changes, but the sensitivity of these modalities in detecting early malignant bone involvement and malignant marrow infiltration is relatively low.

Functional radioisotopic imaging modalities play an important role in the clinical management of cancer patients. However, several limitations have been associated and indeterminate/equivocal lesions often require further investigation as well as a combination of more than one imaging procedures. SPECT/CT combines two complementary imaging modalities, SPECT and CT within a single gantry, giving anatomical and functional information. A better characterization of equivocal findings could be obtained showing the nature of lesions and distinguishing metastatic to non metastatic lesions

Purpose

We investigated the clinical impact of single photon emission computed tomography/ computed tomography (SPECT/CT) bone scintigraphy (BS) combined with 16-slice CT on metastatic work up and treatment planning in a large cancer patient series.

Materials & Methods

- Between January 2019 and January 2020, a total of 600 patients (318 men and 282 women, aged 13-90 years, median age 51,5) with different types of cancer (breast cancer, prostate cancer, lung cancer, melanoma, colorectal cancer, etc.) were prospectively recruited to our department. Inclusion criteria consisted of bone pain, equivocal or suspicious CT and/or elevated tumour markers. All 600 oncological patients underwent wbPBS for staging or restaging purposes. 272/600 patients had equivocal or suspected bone metastatic lesions on wbPBS. 265/272 underwent a targeted SPECT/CT BS on designated regions. 7/272 patients did not complete the imaging tests and were excluded from the study.

Table 1. Demographic and clinical data on the total sample and for each subgroup of patients.

	Total sample	Patients with equivocal wbPBS findings	Patients with wbPBS diagnosis	P value[1]
N	600	272 (45.3%)	328 (54.7%)	
Age (years)				
Mean	56.2	67.7	63.1	
SD (range)	12.9 (13-90)	12.1	13.3	0.001
Gender				
Men	318 (53.0%)	150 (55.1%)	168 (51.2%)	
Women	282 (47.0%)	122 (44.9%)	160 (48.8%)	0.3
Cancer type				
Breast	222 (37.0%)	85 (31.3%)	137 (41.8%)	0.008
Lung	154 (25.6%)	64 (25.5%)	90 (27.4%)	0.3
Prostate	129 (21.5%)	60 (22.1%)	69 (21.0%)	0.7
HNC	16 (2.6%)	8 (2.9%)	8 (2.4%)	0.7
CUP	16 (2.6)	14 (5.1%)	2 (0.6%)	0.001
Liver	14 (2.2%)	5 (1.8%)	9 (2.7%)	0.5
Bladder	11 (1.9%)	7 (2.6%)	4 (1.2%)	0.2
Gynaecological	9 (1.5%)	5 (1.8%)	4 (1.2%)	0.5
Renal	8 (1.4%)	4 (1.5%)	4 (1.2%)	0.8
Colon	7 (1.2%)	5 (1.8%)	2 (0.6%)	0.2
Melanoma	3 (0.5%)	3(1.1%)	--	0.6
Other	11 (1.8%)	7 (2.6%)	4 (1.2%)	0.2

Whole body planar bone scintigraphic imaging (wbPBS)

- Patients were intravenously injected with 740 MBq (20mCi) of Tc-99m methylene diphosphonate (MDP).
- Three hours after injection, a wbPBS (anterior and posterior projection) scan was performed on a dual head SPECT/CT 16 slices γ camera (GE Discovery NM/CT 670)

- **SPECT/CT bone scintigraphy (BS)**

- For patients with inconclusive results on planar wbPBS, a targeted SPECT/CT BS imaging was acquired immediately after the wbPBS in designated areas.
- SPECT protocol involved the following parameters: 15 s per frame, step and shoot acquisition, 64 projections with 180 degrees rotation for each camera head, and a 128 X 128 matrix.
- A low-dose CT scan was performed immediately after SPECT acquisition with the patient in the same position.
- Image analysis was performed on a dedicated workstation.

Interpretation

- Lesions were scored as: a) benign (score 1): any focal of increased uptake in anatomical areas as cartilage, joints, b) malignant (score 2): high intensity uptake within the vertebral body and or multiple areas of increased uptake throughout the body, and c) equivocal (score 3): any lesion that does not fulfil the above criteria.
- Final diagnosis was based on the 16 slices CT of the SPECT/CT corresponding to the area of increased uptake of the radiotracer on wbPBS and SPECT images.
- Findings on CT corresponding to degenerative changes or fractures were considered as benign whereas lytic, osteosclerotic, on CT were considered as metastatic.

Results -1

- 328/600 patients (803 lesions) had a definite diagnosis from wbPBS and were excluded from our study. 272/600 had equivocal findings.
- 265/272 patients were re-evaluated with a targeted SPECT/CT BS. 7/272 patients with equivocal findings could not be analysed with SPECT/CT BS due to technical problems.
- Diagnostic findings on SPECT/CT were obtained on 227/265 pts (85.7%). One hundred three patients (38.9%) were considered as non metastatic and 124 patients (46.8%) as metastatic. 38 patients (14.3%) were considered as inconclusive.

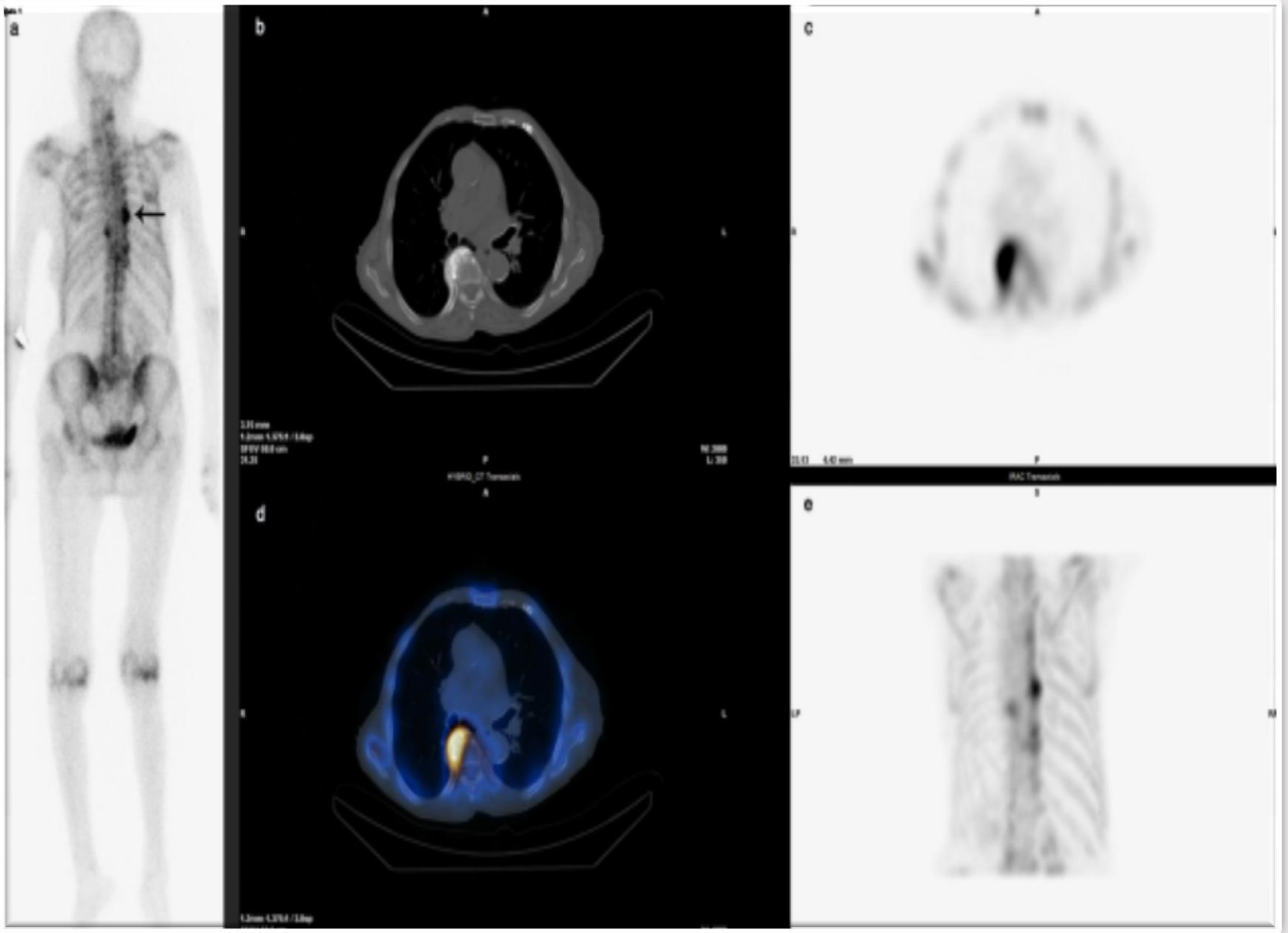
Results -2

- Diagnostic findings on SPECT/CT were obtained for 592/668 (88.6%) lesions compared to 15.4% for wbPBS.
- Three hundred seventeen (47.5%) lesions were classified as definitely benign (score 1).
- Two hundred seventy five (41.2%) patients were classified as definitely malignant metastatic lesions (score 2).
- A total of 76/668 lesions (11.4%) were indeterminate/unclear (score 3)
- the percentage of indeterminate lesions was reduced to 11.4% compared to 83.1% found on wbPBS.

Results -3

Finally, the addition of SPECT/CT BS helped identify 36 additional lesions compared to wbPBS alone, with conclusive results obtained for 30/36 lesions (83%);

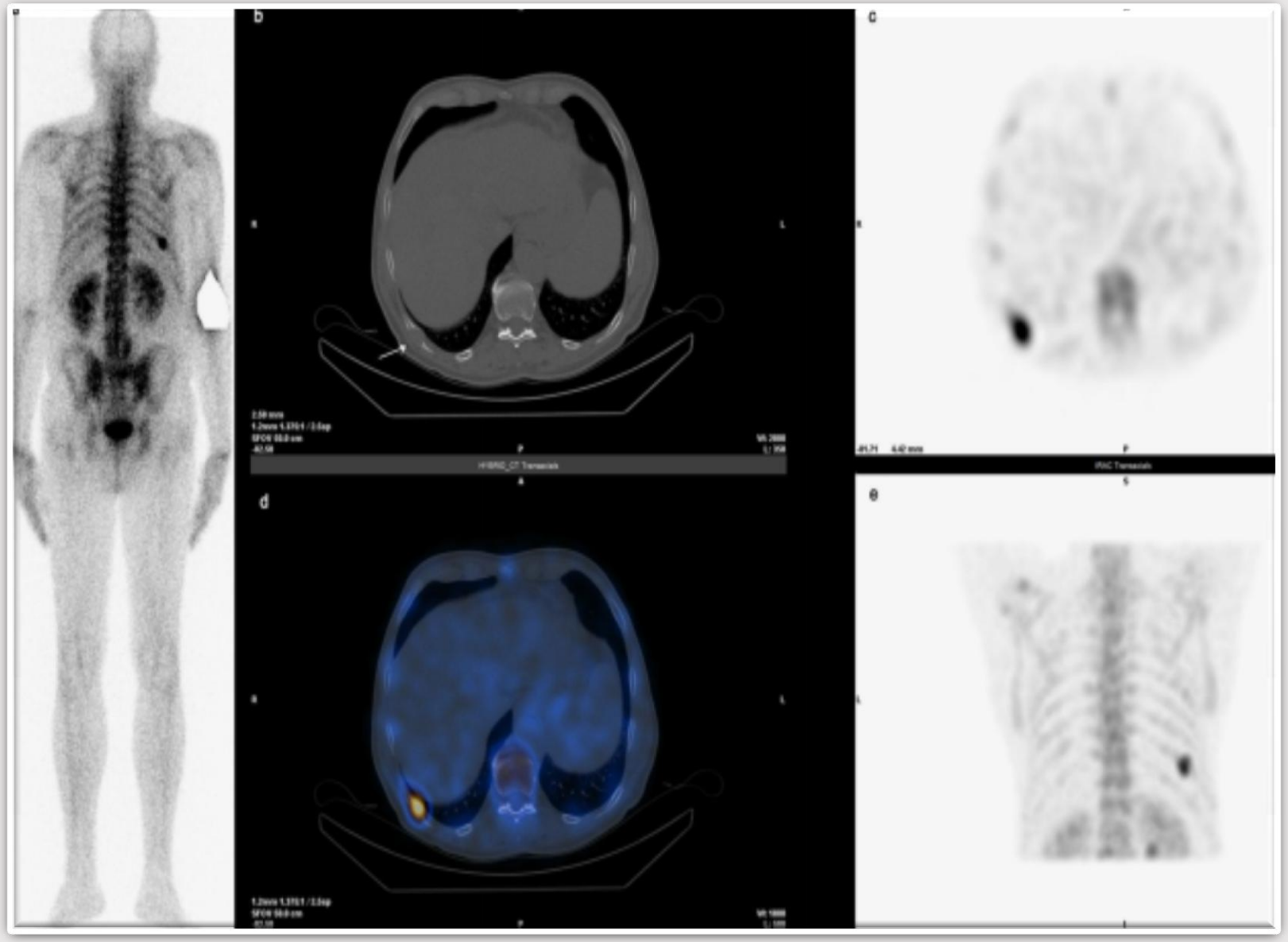
- 8/30 (26.7%) lesions were evaluated as benign,
- 22/30 as metastases (76.7%), and
- 6/36 lesions (13.9%) were classified as unclear.



75-year-old patient with breast cancer and back pain.

WBS: multiple lesions of pathological increased uptake of the radiotracer in thoracic vertebras (probably metastatic lesions)

SPECT/CT: confirmed non metastatic lesions (osteophytic lesions)



66-year-old patient with with cancer of unknown primary (CUP). .

WBS: single focal increased uptake in posterior arch of 10th rib (solitary bone metastasis or fracture).

SPECT/CT: confirmed a single metastatic lesion (lytic lesion on CT part)

Conclusions

- SPECT/CT changed the diagnosis by ruling out or confirming metastatic disease compared to wbPBS.
- SPECT/CT reveals more lesions not observed on wbPBS.
- SPECT/CT has essential implications on earlier decisions on treatment management, improving the quality of life by reducing patient anxiety.
- there was a significant reduction in the number of patients who needed further evaluation with other imaging modalities (11.4% vs 84.8%), thus preventing unnecessary delays in diagnosis.

- Drawbacks:
  - Cost
  - the characterization of lesions as benign or malignant based on the CT part of SPECT/CT modality and on subsequent clinical course and not on histopathological confirmation.