



SPECT/CT findings of suspicious vertebral metastasis on planar bone scintigraphy

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ABSTRACT

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Whole-body planar bone scintigraphy (WPBS) is a highly sensitive imaging method in the evaluation of bone lesions, but has a limited specificity. The aim of this study was to evaluate the contribution of SPECT/CT imaging method in the vertebral coloumn lesions which were interpreted as suspicious for metastasis on WPBS. A total of 56 patients who underwent SPECT/CT imaging due to the suspicious WPBS findings for metastasis on vertebral column were included in this retrospective study. Radiotracer accumulations on WPBS and SPECT/CT were determined. Based on the CT findings of SPECT/CT images, radiotracer accumulations were interpreted as benign/degenerative, malignant or suspicious for metastasis. Additional foci detected only with SPECT/CT were determined. A total of 121 foci were evaluated as suspicious for metastasis on WPBS. On SPECT/CT images, 67.8% of these foci were revealed with benign/degenerative lesions, 22.3% were evaluated as malign and 9.9% foci remained suspicious for metastasis. The number of benign/degenerative lesions was significantly higher than that of malign lesions. Pathological radiotracer accumulation was detected in extra 14 foci on the SPECT component of SPECT/CT. All of these foci were evaluated as benign/degenerative on fusion CT images. There was no statistically significant difference found between the total number of foci detected on WPBS and SPECT/CT. In conclusion, SPECT/CT was found to be able to identify a major part of the vertebral coloumn lesions which were interpreted as suspicious for metastasis and improve the diagnostic value of WPBS.

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1. Introduction

Vertebral column is the most common site of metastatic lesions in the skeletal system (Disibio and French, 2008). Whole-body planar bone scintigraphy (WPBS) is a highly sensitive and noninvasive imaging method and has been widely used for the evaluation of bone lesions for a long time (Horger and Bares, 2006). In many studies, WPBS has been reported to have a high sensitivity in identifying bone metastases. However, specificity is limited and radiotracer accumulates in several benign conditions such as degenerative joint disease, inflammation, benign tumours and trauma (Rybak and Rosenthal, 2001). In a study, the

specificity of WPBS for the characterization of isolated vertebral lesions was 36% (Sharma et al., 2013). Thus, degenerative pathologies are frequently observed in the joints of the vertebral column, localization of lesions is particularly important for differential diagnosis. Due to the low specificity of WPBS, additional diagnostic imaging techniques such as CT and MRI are often needed to characterize vertebral lesions.

Additional methods including single-photon emission computed tomography (SPECT) and SPECT/CT have been introduced to improve specificity of WPBS. SPECT imaging has increased the sensitivity and accuracy with higher lesion contrast and

crosssectional images (Ghosh, 2014). There are studies reporting that the localization of lesions could be determined with SPECT and thus the sensitivity could be increased relatively (Love et al., 2003). SPECT/CT, a fusion imaging method, combines high lesion contrast with SPECT and exact anatomical localization with CT which are very important factors for characterizing lesions (Kobayashi et al., 2005). The aim of this study was to evaluate the contribution of SPECT/CT imaging in vertebral lesions which were interpreted as suspicious for metastasis on WPBS.

2. Material and methods

A total of 56 patients with known malignancy who were referred to our center for WPBS between November 2017 and May 2019 were included in this retrospective study. According to the routine protocol of our center, additional SPECT/CT imaging had been applied to all patients because of suspicious findings for metastasis on vertebral column. This retrospective study was conducted in accordance with the ethical principles outlined in the 1964 Helsinki Declaration.

For WPBS imaging, patients were injected 740-800 MBq Tc-99m MDP intravenously. Anterior and posterior whole-body planar images were obtained after 2-3 hours of radiotracer injection with either Siemens Symbia True Point SPECT/CT gamma camera or GE Discovery NM 630 dual head gamma camera. SPECT/CT imaging was performed with Siemens Symbia True Point SPECT/CT gamma camera. Immediately after planar images, SPECT imaging were acquired with 25 second/image parameters and CT imaging with 40-60 mass, 130 KeV and 5 mm thickness parameters. Planar and SPECT/CT images were analyzed visually in separate sessions. The suspicious accumulations on vertebral column were determined on planar images. Radiotracer accumulations on the SPECT component of SPECT/CT images were interpreted as malignant, benign or suspicious for metastasis, based on findings of CT component. Presence of lytic, sclerotic, or mixed changes on CT images were suggested as malignant; osteophytes, spondylophytes, subchondral sclerosis or narrowing of the joint space were interpreted as benign/degenerative (Zhang et al., 2011). Lesions that did not meet the criteria for benign and malignant lesions were noted as suspicious for metastasis.

Pathological accumulations that were not observed on WPBS images but detected only with SPECT component of SPECT/CT were determined. SPECT/CT and WPBS findings were compared in terms of the number of total and suspicious lesions. The number and localization of benign/degenerative and malignant lesions observed on SPECT/CT were determined.

Distribution of variables was evaluated with Kolmogorov-Smirnov test. Chi-square test and Mann Whitney U test were used for categorical and

continuous measurements respectively. The threshold value of 0.05 was accepted for statistical significance in all tests. Statistical analysis of the data was performed with SPSS 21.0 package program.

3. Results

A total of 56 patients (32 males, 24 females) were included in the study. Mean age was 63 years and age ranges were 26–87 years. Underlying malignant disease was prostate carcinoma in 24 patients, breast carcinoma in 16 patients, lung carcinoma in 12 patients, unknown primary carcinoma in 3 patients and bladder carcinoma in 1 patient.

On WPBS images, a total of 121 foci were evaluated as suspicious for metastasis in the vertebral column. On SPECT/CT images, 82 (67.8%) of these foci were revealed with benign/degenerative lesions, 27 (22.3%) were evaluated as malign lesions and 12 (9.9%) foci remained suspicious for metastasis.

The number of benign/degenerative lesions was significantly higher than that of malign lesions in the interpretation of SPECT/CT images ($p < 0.05$). Of the 82 lesions consistent with benign/degenerative changes, 41 (50.0%) were in the vertebral corpus, 19 (23.2%) in the intervertebral space, 15 (18.3%) in the facet joints, 4 (4.9%) in the spinous process and 3 (3.6%) in the costovertebral joint. WPBS and SPECT/CT images of a patient with degenerative changes in L2.-L3. vertebrae were presented in Fig. 1.

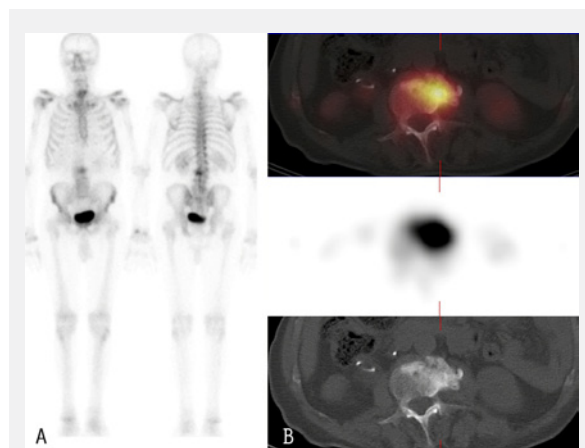


Fig. 1. Planar wholebody images of a 71-year-old male patient with prostate carcinoma showed osteoblastic activity in the left half of L2-L3 vertebra (A). CT images of SPECT-CT were revealed with degenerative changes in the vertebral corpus and intervertebral space (B).

The localizations of foci evaluated as malign lesions were as follows: 23/27 (85.2%) were in the vertebral corpus, 2 (7.4%) were in the peduncle, 1 (3.7%) was in the costavertebral junction and 1 (3.7%) was in the spinous process. Fig. 2 represented images of a patient with metastasis in L2. vertebra.

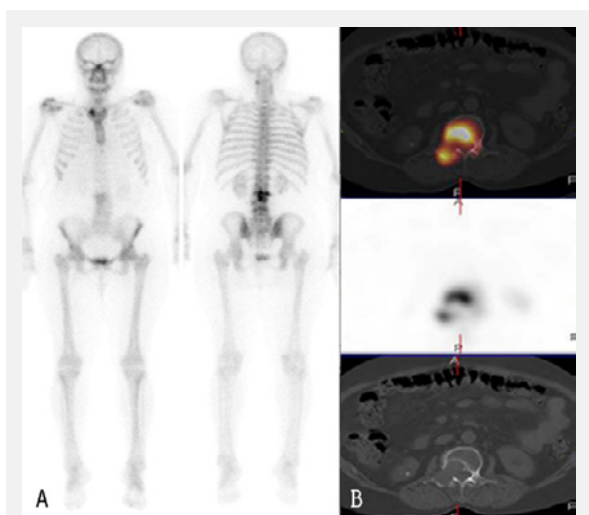


Fig. 2. Osteoblastic activity was detected in L2. vertebra on planar wholebody images of a 59-year-old woman with breast carcinoma (A). On SPECT-CT images, L2. There were destructive changes in the corpus with a soft tissue mass adjacent to the vertebra (B).

In a total of 12 foci, lesion characterization could not be made clearly and remained suspicious for metastasis; 4 foci in the vertebral corpus, 2 foci in the costavertebral joint, 3 foci in the spinous process and 3 foci in the facet joint. The localization of foci with benign/degenerative, malignant and suspicious findings were given in Table 1.

Table 1. SPECT/CT findings of vertebral coloumn lesions that were interpreted as suspicious for metastasis on whole body planar bone scintigraphy and extra benign/degenerative lesions detected only with SPECT/CT.

	SPECT/CT Imaging					
	Vertebral Corpus	Pedicle	Inter-vertebral Space	Costa-vertebral Junction	Spinous Process	Facet Joint
Malign	23	2	0	1	1	0
Benign/Degenerative	41	0	19	3	4	15
Suspicious	4	0	0	2	3	3
Extra lesions (Benign/Degenerative)	7	0	4	0	0	3

In addition to the 121 foci evaluated as suspicious on planar images, pathological radiotracer accumulation was detected in extra 14 foci on the SPECT component of SPECT/CT. All of these 14 foci were evaluated as benign/degenerative on fusion CT images; 7/14 were in the vertebral corpus, 4/14 were in the intervertebral space and 3/14 were in the facet joint. There was no statistically significant difference found between the total number of foci detected on WPBS and SPECT/CT. Images of a patient with additional benign/degenerative lesion in L5. vertebra on SPECT/CT images were presented in Fig. 3.

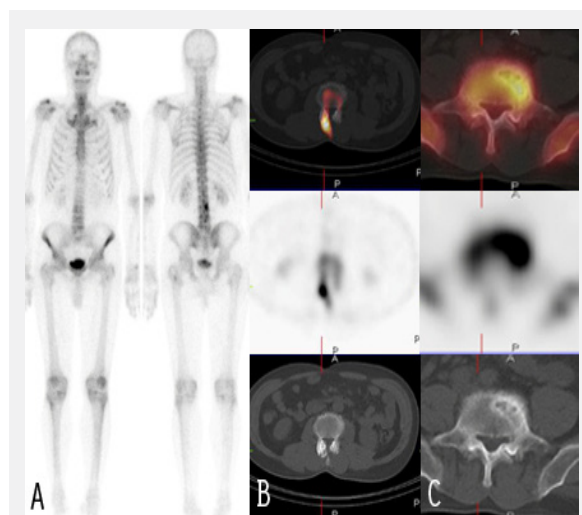


Fig. 3. A 62-year-old male patient with a history of prostate carcinoma had osteoblastic activity in the right half of the L3. vertebra on planar images (A). SPECT-CT images showed degenerative changes in the L3 vertebra facet joint (B). In addition, SPECT images showed an increased osteoblastic activity in the left half of the L5. vertebra corpus; CT findings were consistent with degenerative changes (C).

4. Discussion

Whole body planar bone scintigraphy has been the most widely used functional imaging modality to demonstrate metastatic bone lesions due to its widespread availability (Cuccurullo et al., 2013). Sclerotic bone metastasis can be distinguished very earlier on WPBS than on radiographs, because 5%-10% change in bone content is enough to detect a metastatic lesion on WPBS (Utsunomiya et al., 2006; Choi and Raghavan, 2012). Although the sensitivity of the technique is high, specificity is low because of some limitations and this makes the technic insufficient in the diagnostic procedure (O'Sullivan et al., 2015). Bone scintigraphy is nonspecific in the differential diagnosis of benign and malignant bone lesions and multipl degenerative and traumatic conditions accumulate radiotracer (Zhang et al., 2012). Morphological imaging methods are often required in addition to the WPBS to distinguish benign and metastatic lesions (Rajarubendra et al., 2010). SPECT/CT is a relatively new fusion imaging method that combines functional information by SPECT and morphological information by CT (Townsend, 2008). This retrospective study aimed to characterize vertebral coloumn lesions with SPECT/CT that were interpreted as suspicious for metastasis on WPBS.

The differential diagnosis of benign and malign bone lesions in patients with known malignancy is very important to determine treatment modality. In this study, 90.1% of the vertebral coloumn lesions which were suspected for metastasis on WPBS, were exactly localized and characterized with SPECT/CT.

CT findings were consistent with benign/degenerative morphological changes in most of the vertebral column lesions (67.8%) which were generally localized at vertebral corpus and intervertebral space. It is important that, no additional imaging modality was needed for further evaluation of these patients.

Various techniques have been developed in order to increase the specificity of WPBS in the detection of metastatic lesions. As WPBS had limited value in localizing lesions due to the superimposition of bones, SPECT imaging provided better localisation with axial, coronal and sagittal slices. Some studies showed that, SPECT has a significant contribution to the specificity over WPBS (O'Sullivan et al., 2015). However, since there was no anatomic marker, SPECT method was still insufficient to determine the exact anatomical location (Reinartz et al., 2000). Increased sensitivity with SPECT imaging especially in vertebral column lesions was also reported (Savelli et al., 2001). However, no significant difference was found in this study between the number of detected lesions on WPBS and SPECT.

More specific bone scans were achieved with the introduction of SPECT/CT imaging in clinical practice (Horger et al., 2004; Jiang et al., 2013). In addition to the advantage of SPECT's cross-sectional images, CT component provided accurate localization and morphological evaluation of osteoblastic areas (Palmedo et al., 2014). Adusumilli et al. reported a 74.5% increase in definitive classification and a 26.6% reduction in the equivocal findings with SPECT/CT when compared to WPBS (Adusumilli et al., 2019). Vertebral column evaluation for metastatic foci on WPBS has some extra difficulties because of small bone structures with high degenerative tendency close to each other. In a study on vertebral column lesions,

SPECT/CT reduced equivocal results by 94.4% and the diagnostic accuracy was found significantly higher than SPECT (58.9% vs 91.1%). SPECT/CT imaging was known to have an important contribution in the evaluation of vertebral lesions, in terms of lesion characterization and localization (Zhang et al., 2011; Zhang et al., 2013). In this study, most of the lesions were characterized by SPECT/CT and the findings were similar to the literature. Another important finding of this study was that most of the vertebral column accumulations were located in areas consistent with benign/degenerative morphological changes on SPECT/CT. As histopathological findings or follow-up scans could not be obtained and this was a limitation of the study, the presence of small metastatic foci that may have developed on degenerative background could not be ruled out. However, study results based on the morphological changes observed on CT showed similar findings with literature based on histopathological findings. Further studies are needed with larger patient groups with histopathological diagnosis or long-term follow-up findings.

In conclusion, findings of this study showed that SPECT/CT is an important tool for the characterization of vertebral column lesions which are suspicious for metastasis on WPBS. In most of the patients, accumulations were compatible with benign/degenerative morphological changes observed on CT and elimination of further diagnostic imaging in these patients was an important advantage of SPECT/CT. It is thought that, SPECT/CT imaging which is currently available in a small number of center in our country should be used for the characterization of vertebral lesions.

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