

## CASE REPORT

# Embolic infarction followed by serial bone SPECT and MR fusion images -the door to SPECT/MR-

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**Abstract :** We recently experienced a case of cerebral infarction incidentally found by whole body bone scintigraphy for the detection of bone metastasis from renal cell carcinoma. Additional bone SPECT and brain MR fusion images clearly demonstrated the wedge-shaped uptake of tracer corresponded to the abnormal intensity reflecting sub-acute cerebral infarction. Follow-up bone scan and fused images with MRI showed complete resolution of the abnormal uptake in chronic phase. A breakdown in the normal blood-brain barrier results in abnormal ionic calcium flux into the cells following altered cell membrane integrity leading to precipitation of calcium salts which eventually binds to bone imaging tracer such as  $^{99m}\text{Tc}$ -methylene diphosphonate. That is, increased accumulation of bone seeking agents represents lethal cell death. The recent development of software and hardware has enabled the fusion of functional and anatomic images. Image fusion between SPECT with various tracers and MRI is expected to provide clues as to the underlying cause of diseases and to decide our treatment planning in the near future. *J. Med. Invest.* 57 : 334-337, August, 2010

**Keywords :** bone SPECT, MRI, fusion, functional and anatomic images

## INTRODUCTION

Bone scintigraphy is mainly used for the detection of bone metastasis in patients with known malignancy, in which extra-osseous abnormal accumulations can be seen coincidentally. Bone imaging tracer such as  $^{99m}\text{Tc}$ -methylene diphosphonate is taken up by cerebral infarction (1) and myocardial infarction along with soft tissue calcification, infection and inflammation. In addition, the recent development of software and hardware has enabled the fusion of functional and anatomic images. We report a 54-year-old man with cerebral infarctions

longitudinally followed by bone SPECT and brain MR fusion images. To our knowledge, our report is first one in which cerebral infarctions were longitudinally followed by the fusion images.

## CASE REPORT

A 54-year-old man with persistent fever due to infectious endocarditis was referred to our hospital. He had no history of any medical illness and had not undergone surgery. Abdominal CT scan obtained after admission happened to depict left renal cell carcinoma (RCC) after which he underwent bone scintigraphy with  $^{99m}\text{Tc}$ -methylene diphosphonate ( $^{99m}\text{Tc}$ -MDP) for detecting metastatic lesions. Anterior planar image showed longitudinal strong uptake of tracer in left frontal region of head (Fig. 1A). Because the uptake was not characteristic

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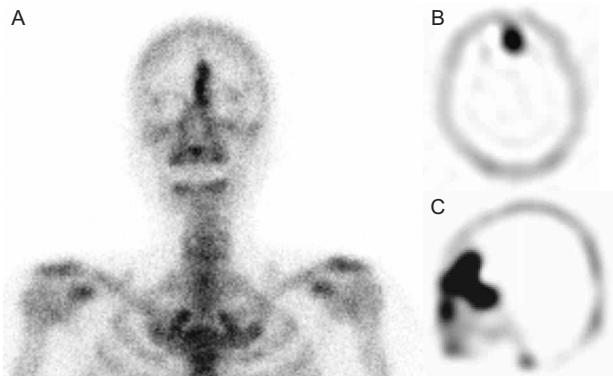


Figure 1. Bone scintigraphy (A) demonstrates longitudinal strong uptake of <sup>99m</sup>Tc-methylene diphosphonate in left frontal region of head. Bone SPECT images (B, C) indicate that the uptake exists in left frontal lobe.

of bone metastasis additional SPECT scans were added, which revealed that the uptake existed in left frontal lobe (Fig. 1B, C). Brain MRI examined on the following day showed slightly hyper-intense signal in the lesion on diffusion-weighted (DWI) (Fig. 2A), T2-weighted and fluid-attenuated inversion-recovery (FLAIR) (Fig. 2B) images which suggested

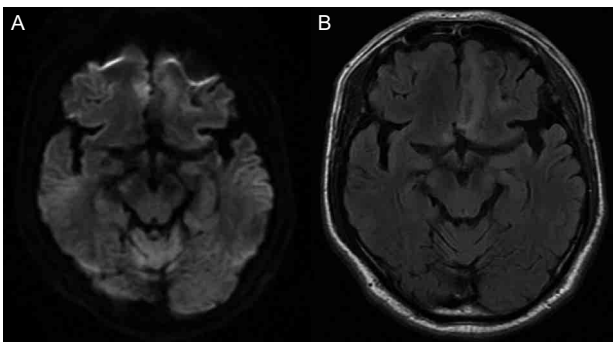


Figure 2. Axial fluid-attenuated inversion-recovery (A) and diffusion-weighted (B) MR images demonstrate slightly hyper-intense signal in left frontal lobe which suggest subacute embolic infarcts due to endocarditis with pseudo-normalization.

subacute embolic infarcts due to endocarditis with mild degree of pseudo-normalization. Brain MRI performed two weeks before bone scintigraphy had indicated almost no abnormality. Bone SPECT and MR images were readily fused by use of software (Fusion Viewer version 1.5, Nihon Mediphsics Co. Ltd., Nishinomiya, Japan). Abnormal uptake of tracer on bone SPECT perfectly corresponded with abnormal intensity on FLAIR image (Fig. 3). Sagittal view of the fusion images clearly delineated a wedge-shaped lesion which corresponds to left anterior cerebral artery (ACA ; A2-3) territory (Fig. 3C). Follow-up MR exams in the

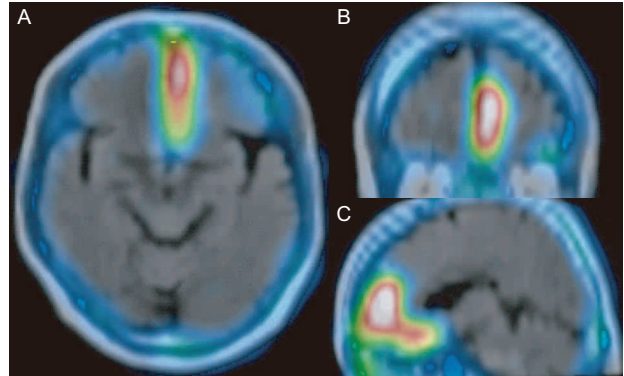


Figure 3. Bone SPECT and FLAIR fused images show that abnormal uptake of <sup>99m</sup>Tc-MDP perfectly corresponds with abnormal intensity on FLAIR images. A : axial image, B : coronal image, C : sagittal image.

chronic phase showed sharply-defined T2-high intensity and perfusion decrease. (not shown)

Three months later, he underwent bone scintigraphy again as preoperative study for detecting bone metastasis from RCC. The bone scan and fused images with MRI showed complete resolution of the abnormal uptake in left anterior lobe (Fig. 4, 5).



Figure 4. Bone scintigraphy on chronic phase shows complete resolution of the abnormal uptake in left anterior lobe.

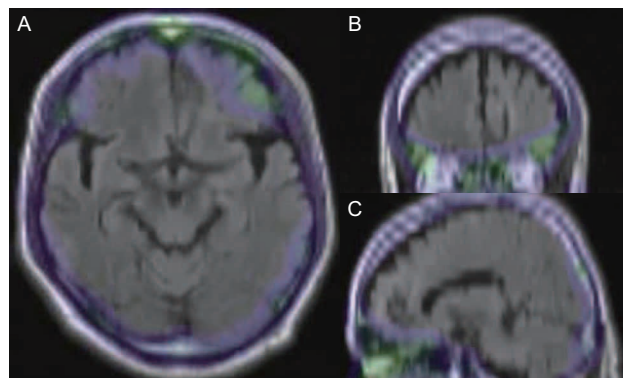


Figure 5. Bone SPECT and FLAIR fused images in chronic phase also show complete resolution of the abnormal uptake in left anterior lobe.

## DISCUSSION

Incidental cerebral uptake of bone imaging agents has been found in 0.17% of bone scans and in most cases is the result of intracranial malignancy (2). Extra-osseous uptake of bone imaging agents in cerebral infarction has been reported sporadically (3-8). A breakdown in the normal blood-brain barrier results in abnormal ionic calcium flux into the cells following altered cell membrane integrity leading to precipitation of calcium salts which eventually binds to  $^{99m}\text{Tc}$ -phosphate. Additional bone SPECT and brain MR fusion images combined molecular information with anatomic one which enabled the case to be diagnosed as subacute embolic infarction of left ACA territory. In addition, follow-up fusion images clearly showed the disappearance of  $^{99m}\text{Tc}$ -MDP accumulation in chronic phase (after three months of onset). There has been no literature describing in detail the critical period of the appearance and the disappearance of bone seeking tracer accumulation in cerebral infarct. Short interval follow-up exams using bone imaging tracer are difficult in practice, whereas bone scintigraphy can probably demonstrate cerebral infarcts as increased uptake in acute or subacute phase (within 18 days of onset) and as normalized one in chronic phase (after the 6th week of onset) based on previous case reports (3-8).

Molecular and anatomic image fusion has widely spread in recent years with the development of fusion software and hardware such as PET/CT and SPECT/CT scanners (9). In addition, combined PET/MR scanners have only recently been developed, and several MRI-based attenuation correction methods have been reported to obtain quantitative PET information (10, 11). MR images provide not only anatomic information but also abnormal intensity reflecting restricting microscopic proton diffusion [apparent diffusion coefficient (ADC) decrease] and T2 elongation of the lesion. The subtle ADC decrease seen in reversible lesions like transient ischemic attack (TIA) may correspond to a mild ischemia that does not cause advanced bioenergetic failure and subsequent permanent tissue injury (12, 13). Lesions detected by DWI with similar ADC changes have also been reported in association with reversal of DWI hyperintensities after intra-arterial thrombolysis in acute stroke patients (14). On the other hand, increased accumulation of bone seeking agents represents the damage of  $\text{Ca}^{2+}/\text{Mg}^{2+}$ -ATPase on cell membrane which leads to  $\text{Ca}^{2+}$  influx

into the cells and consequently lethal cell death.

Software image registration and fusion allow general versatility in the choice of modalities and facilitates image fusion of several modalities which reflect different kinds of molecular biologic characterization (15, 16). Uematsu et al. emphasized that normal distribution of FDG uptake in the head and neck regions delineated by multidirectional sections is important for effective co-registration of FDG-PET with MRI in their previous report (17). In this case using bone SPECT, tracer accumulation in cranial bones was used for accurate fusion with MR images. Moreover, since there are various kinds of SPECT tracer reflecting the pathophysiological characteristics, the development of hardware like combined SPECT/MR scanner as well as PET/MR scanner are expected to provide clues as to the underlying cause of diseases and to decide our treatment planning in the near future.

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