Hama Y. Brazilian Journal of Diagnostic Imaging. Radiographic, CT, MRI, and bone scintigraphy findings of patellar oligometastasis from rectal cancer. BJDI. 2024;1(1):2-7

https://doi.org/10.61528/bjdi.v1i1.7

Brazilian Journal of Diagnostic Imaging

BJDI: Diagnostic Imaging Research, Accessible to All

CASE REPORT

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# Radiographic, CT, MRI, and bone scintigraphy findings of patellar oligometastasis from rectal cancer

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**Abstract**

Solitary metastasis or oligometastasis to the patella from colorectal cancer is rare, and multimodal imaging findings, including MRI, have not been well discussed. We report the case of a 74-year-old man with patellar oligometastasis from rectal cancer that was initially missed on whole-body positron emission tomography (PET) and misdiagnosed on bone scan. Radiographs and CT scans showed an osteolytic patellar tumor that was hypointense with ill-defined borders on T1-weighted imaging and hyperintense with well-defined borders on diffusion-weighted imaging. We discussed the characteristic MRI findings of patellar metastases and the pitfalls of PET and bone scan.

**Key words**

Rectal Neoplasms, Magnetic Resonance Imaging, Neoplasm Metastasis, Patella

## Introduction

Solitary or oligometastases to the patella are rare and only a few cases have been reported [1-8]. But few patellar metastases from colorectal cancer have been reported, and there is little discussion of the MRI findings of patellar metastases [1-10]. Here we report a case of oligometastasis to the patella and discuss the radiographic, CT, MRI, and bone scintigraphy findings. All procedures performed in this case report were approved by the institutional review board and were performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its subsequent amendments. Informed consent was obtained from the patient for the use of clinical and imaging data.

## Case report

A 74-year-old man underwent endoscopy and was diagnosed with well to moderately differentiated adenocarcinoma of the middle rectum. Skull base to mid-thigh 18F-fluorodeoxyglucose positron emission tomography/computed tomography (18F-FDG PET/CT) showed increased uptake in the rectum, right lung and left supraclavicular lymph node, consistent with metastases (**Figures 1a-c**).

Since no other metastases or locoregional invasion were detected, he was diagnosed with oligometastatic rectal cancer (cT1b N0 M1c, AJCC 8e) and received systemic chemotherapy consisting of folinic acid, fluorouracil, oxaliplatin and bevacizumab. During the first course of chemotherapy, he developed pain in his left knee and underwent an x-ray. Plain x-ray of the left knee shows an ill-defined osteolytic tumor of the patella (**Figure 2**).

There is no periosteal reaction. Bone scintigraphy with Tc-99m-methylene diphosphonate (MDP) showed non-specific increased uptake of MDP in the left knee (Figure 3a), and the Bone Scan Index (BSI) (BONE NAVI, PDR Pharma Co., Tokyo, Japan) which uses artificial intelligence (AI) to quantify the size of lesions and uptake did not indicate metastasis in the left knee, but showed a false-positive metastatic lesion in the left rib (**Figure 3b**).

CT scans showed a heterogeneous osteolytic tumor with an irregular margin in the lower part of the left patella (**Figures 4a-c**), but there was no evidence of metastasis to the left rib.

T1-weighted MRI showed a heterogeneous ill-defined tumor with hypointensity compared to normal bone marrow (**Figure 5a**).

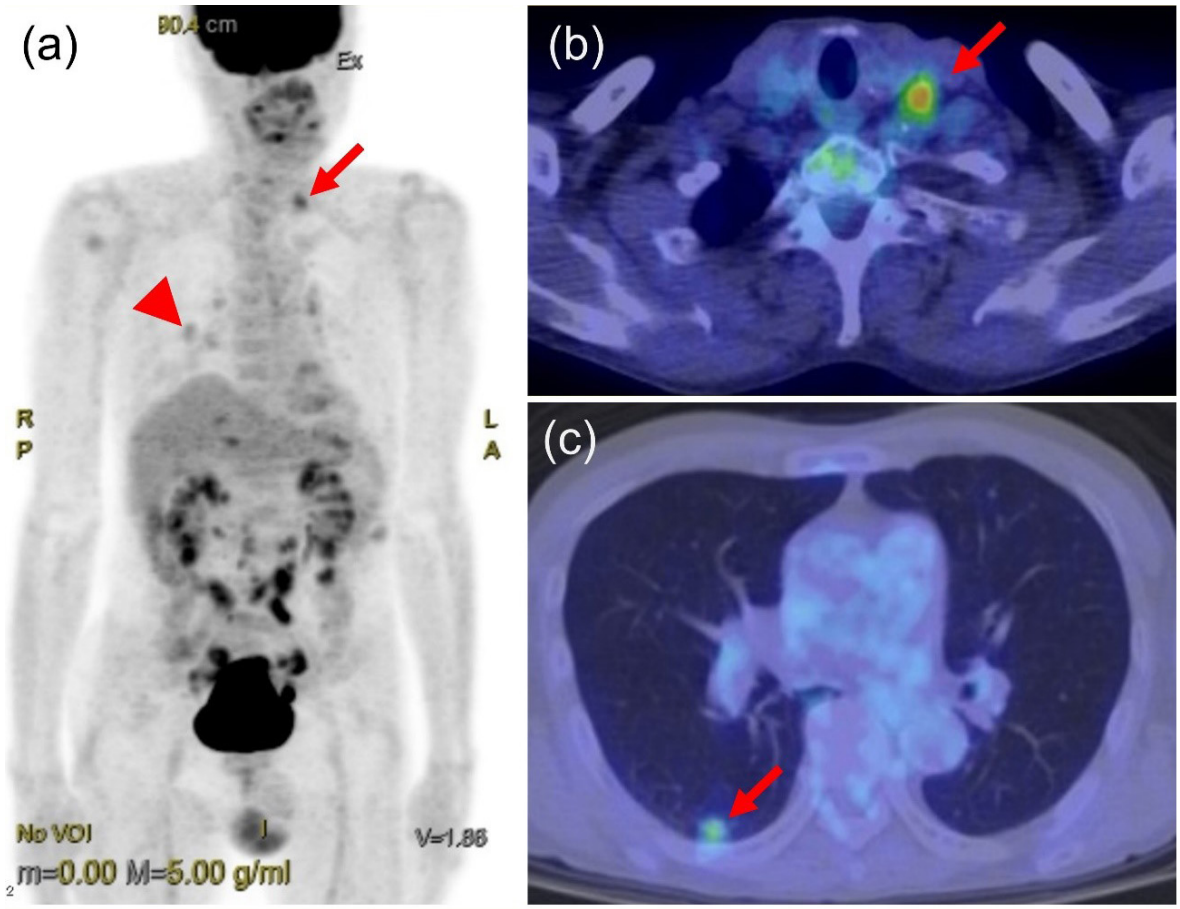


**Figure 1.** 18F-fluorodeoxyglucose positron emission tomography (18F-FDG PET)/computed tomography (CT) imaging. (**a**) Maximum intensity projection imaging of 18F-FDG-PET. The knee joint is not in the field of view because the image was taken from the base of the skull to the mid-thigh. FDG uptake in rectal cancer is obscured by urine in the bladder. Abnormal FDG uptake is seen in the left supraclavicular fossa (arrow) and right lung (arrowhead). (**b**) 18F-FDG-PET/CT shows abnormal uptake in the left supraclavicular lymph node (arrow), consistent with metastasis. (**c**) 18F-FDG-PET/CT shows abnormal uptake in the right lower lobe (arrow), consistent with metastasis.

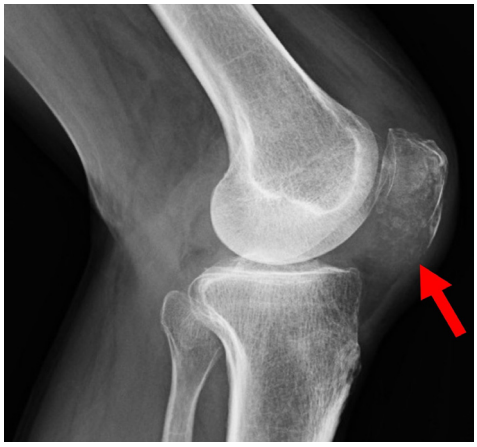

**Figure 2.** Plain x-ray of the left knee shows an ill-defined osteolytic tumor of the patella. There is no periosteal reaction.

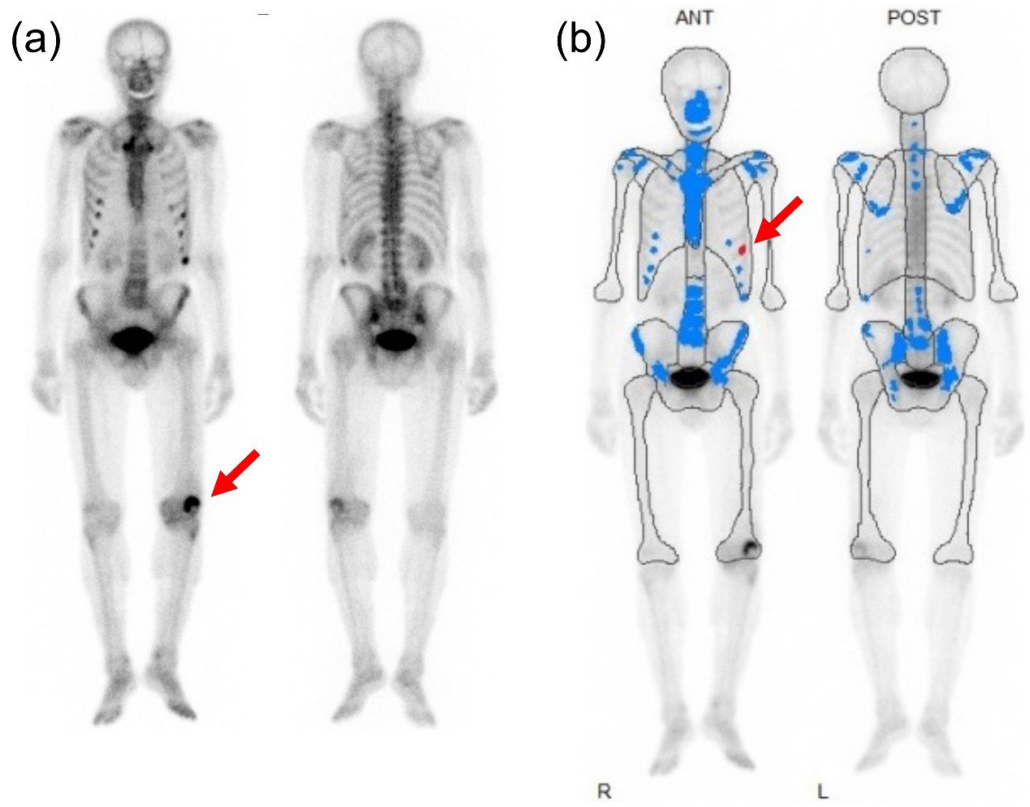


**Figure 3.** Bone scan. (**a**) Whole-body bone scintigraphy with Tc-99m methylene diphosphonate (MDP) showed no abnormal uptake throughout the body. There is a non-specific uptake of MDP in the left knee (arrow) consistent with osteoarthritis(arrow). (**b**) The AI-supported bone scan showed no metastases in the left knee, but abnormal uptake was noted in the left rib (arrow). Red areas indicate lesions suggestive of malignancy and blue areas indicate lesions suggestive of non-malignancy. An accumulation in the left knee joint was not recognized as a metastasis, and the false-positive finding was seen in the left rib.

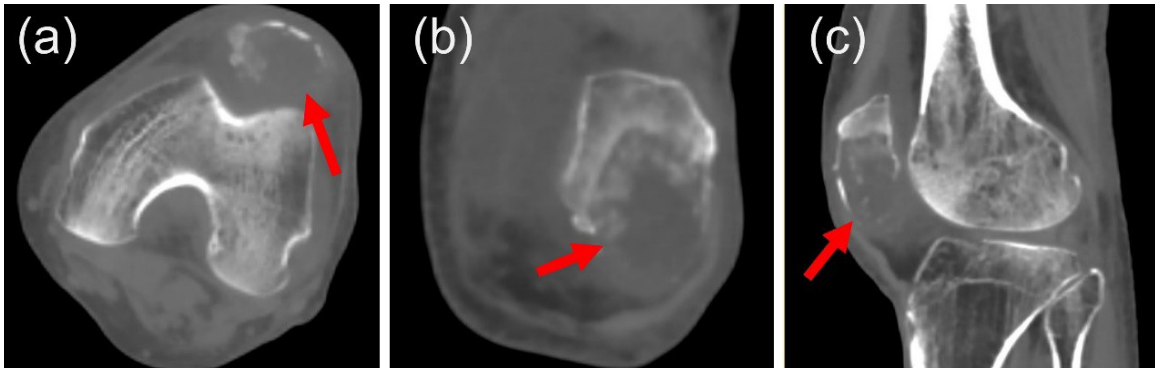


**Figure 4.** CT scan shows a heterogeneous osteolytic tumor with an irregular margin in the lower part of the left patella (arrows). (**a**) Transverse. (**b**) Coronal. (**c**) Sagittal.

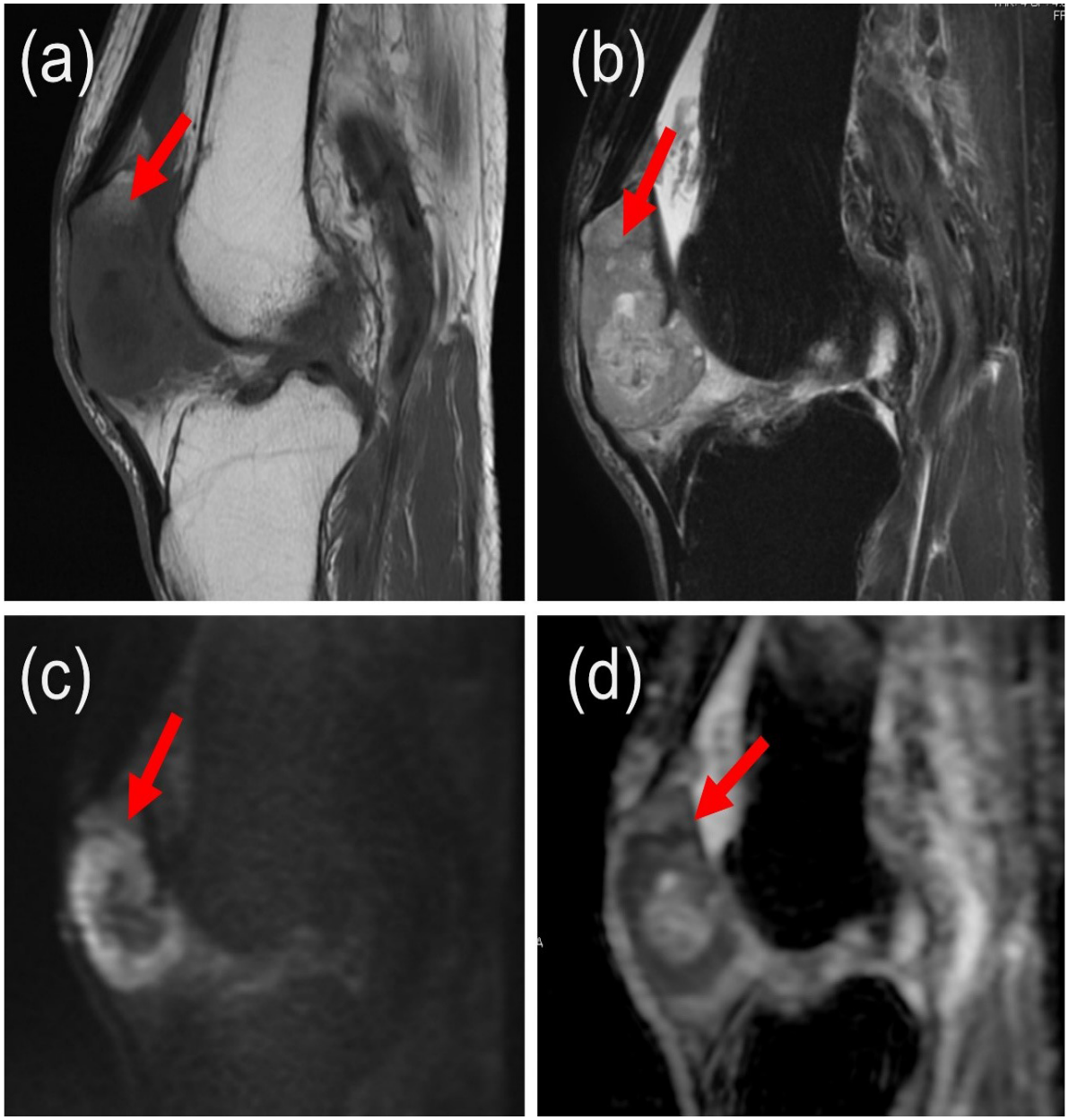


**Figure 5.** MRI of the left patella. (**a**) T1-weighted imaging showed a heterogeneous ill-defined tumor (arrow) with hypointensity compared to normal bone marrow. (**b**) Short tau inversion recovery imaging shows the tumor involving the patella with hyperintensity and intratumoral necrotic lesion. Tumor boundaries are indistinct (arrow). (**c**) Diffusion-weighted imaging shows that the periphery of the tumor was hyperintense, suggesting viable tumor cells, with a hypointense central portion, suggesting necrosis. The boundaries of the tumor are clear (arrow). (**d**) The apparent diffusion coefficient map generated from diffusion-weighted imaging showed that the tumor boundary was clear and the periphery of the tumor was hypointense, suggesting viable malignant cells (arrow).

Short tau inversion recovery (STIR) imaging shows the tumor involving the patella with hyperintensity and intratumoral necrotic lesion (Figure 5b). The tumor boundaries were indistinct, with an irregular component at the periphery of the tumor and intratumoral necrotic tissue. On the diffusion-weighted image (DWI), the periphery of the tumor was hyperintense, suggesting viable tumor cells, with a hypointense central portion, suggesting necrosis (Figure 5c). On the apparent diffusion coefficient (ADC) map, the tumor boundary was clear and the periphery of the tumor was hypointense (Figure 5d).

As the tumor was an osteolytic tumor with minimal periosteal reaction on plain radiograph and CT scan, and hypointense on ADC map at the periphery of the tumor with indistinct boundaries on T1-weighted image and STIR image with distinct boundary on ADC map, a diagnosis of patellar oligometastasis from rectal cancer was made. Since there was no suspicion of a primary bone tumor or other cause, biopsy was not performed. The patellar oligometastasis was treated with stereotactic ablative radiotherapy to relieve symptoms and control the tumor.

## Discussion

In this case report, radiographs and CT scans showed osteolytic patellar metastasis, similar to previously reported findings of patellar metastases from breast or lung cancer [**1,2**]. However, there are few reports on MRI findings of patellar metastases. In a previously reported case of patellar metastasis from breast cancer, the tumor showed hypointensity on T1-weighted imaging and hyperintensity on STIR imaging with indistinct boundaries, and these findings are similar to the current case [**1**]. The indistinct boundaries of the patellar metastatic lesion on T1-weighted and STIR images appear to be due in part to the unique hemodynamics of the patella. As a sesamoid bone, the patella does not have a direct arterial blood supply [**11**]. Instead, the patella, embedded in the quadriceps tendon, receives blood supply from both the subchondral bone vasculature and the periosteal blood vessels [**11**]. The limited blood supply, lymphatic drainage, and susceptibility to ischemia of the patella may contribute to the indistinct boundaries of the metastatic lesion due to peri-tumoral edema or congestion. However, DWI and ADC map can accurately delineate the tumor even when T1-weighted and STIR imaging obscure tumor boundaries due to peritumoral edema. This is the first report to present and discuss T1-weighted, STIR, and DWI images in a single case report.

This case report has several limitations. First, at the time of initial staging, the 18F-FDG PET/CT scan was taken from the base of the skull to mid-thigh and the patella was not imaged. Routine skull base to mid-thigh 18F-FDG PET/CT is a reasonable protocol to reduce radiation exposure and imaging time, but it also has the pitfall of missing metastatic lesions outside the scan field [12]. Second, bone scintigraphy may misdiagnose solitary or oligometastases to the patella when using AI support to diagnose bone metastases due to the small number of deep learning cases. A comprehensive review of radiographic, CT, and MRI findings, as well as clinical signs and symptoms, can lead to an accurate diagnosis.

In conclusion, a single case report cannot be generalized to other cases without further scientific validation, but patellar tumor showing hypointensity on T1-weighted imaging and hyperintensity on STIR imaging with indistinct boundaries and low signal on ADC map with clear margins indicates metastasis.

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