Whole-Body MRI for Accurate Assessment of Tumor Load of Bone Metastases Originate from Mamma Carcinoma

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Background

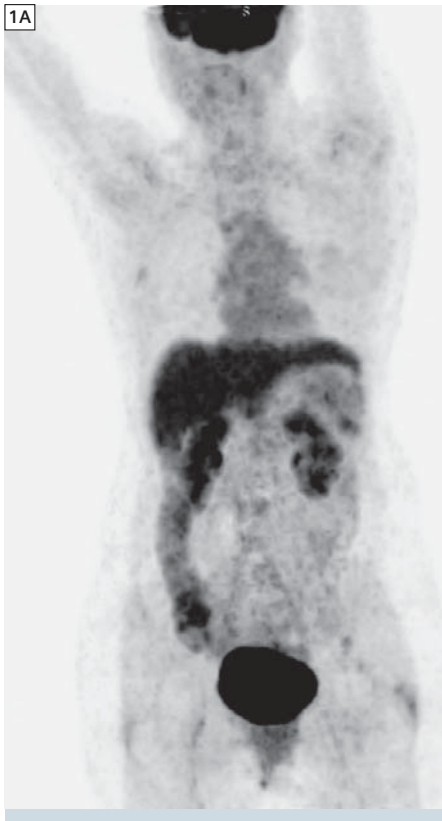
While large efforts in the early and precise detection of mamma carcinoma and therefore detection in a potentially curative stage have been undertaken, mamma carcinoma remains the main leading cause of cancer-related deaths in women. It is also known from a variety of tumor entities that the accurate and precise detection of metastases and estimation of tumor load is of high relevance for patient-adopted individualized therapy regimes. While mammography and ultrasound do play an important role for local assessment of tumor extend / recurrence, ultrasound of, for example, the liver and to some extent also the conventional x-ray of, for example, the chest do play a role in detection of extended diseases; the indications and clinical benefit of these imaging modalities for staging of metastatic breast cancer is the subject of debate. Another routinely-used technique for detection of distant metastases is bone scintigraphy. However, it is not an uncommon finding of mamma carcinoma bone filiae that they are characterized as lytic lesions without surrounding reaction of the bone matrix. In combination with the limited spatial resolution, this fact reduces the sensitivity of bone scintigraphy and can result therefore in an inaccurate or even false negative estimation of metastatic spread [1]. Additionally the pressure to optimize the diagnostic pathways in regards to staging accuracy, time consumption (including multiple referrals), costs and finally patient comfort have lead to an increased usage of computed tomography for fast and precise coverage of soft tissue and bones in patients with extended tumor disease. But relying mainly on morphologic changes, small bone metastases, as well as diffuse bone marrow infiltration and small lymph node filiae, are missed easily [2]. Within recent years, the application of PET/CT has increased especially the specificity in the detection of malignant lymph nodes. In combination with contrast-enhanced CT scans, a clear advantage of an 18F FDG PET/CT exam compared to the M-staging with x-rays, ultrasound and CT alone can be claimed. In contrast to other tumor entities, like lung cancer or malignant melanoma, however, the larger variation of degree of increased glucose metabolism of mamma carcinoma cells can result in more false negative PET findings [3, 4]. It has already been shown by several working groups, and for different tumor entities including breast cancer, that MRI with T2w fat saturated imaging sequences is superior to bone scinitgraphy and CT [5]. In the following two cases we show the advantages of MRI for imaging bone metastases originating from breast cancer. In both cases, there was the high clinical suspicion of a tumor recurrence with metastastic spread. The patient underwent therefore a combined whole-body 18F FDG PET/CT and a whole-body MRI (32-channel MAGNETOM Avanto) to complete tumor staging with special focus on the brain, liver and bone marrow. The whole-body MRI protocols were performed according to [6, 7]. For detection of bone metastases mainly three sequences were used:

a) coronal TIRM
b) transversal T2w TIRM covering the body trunk from pelvis to skull base and
c) contrast-enhanced transversal 2D (pelvis and abdomen; FLASH) or 3D (chest, VIBE) GRE sequences with fat saturation.

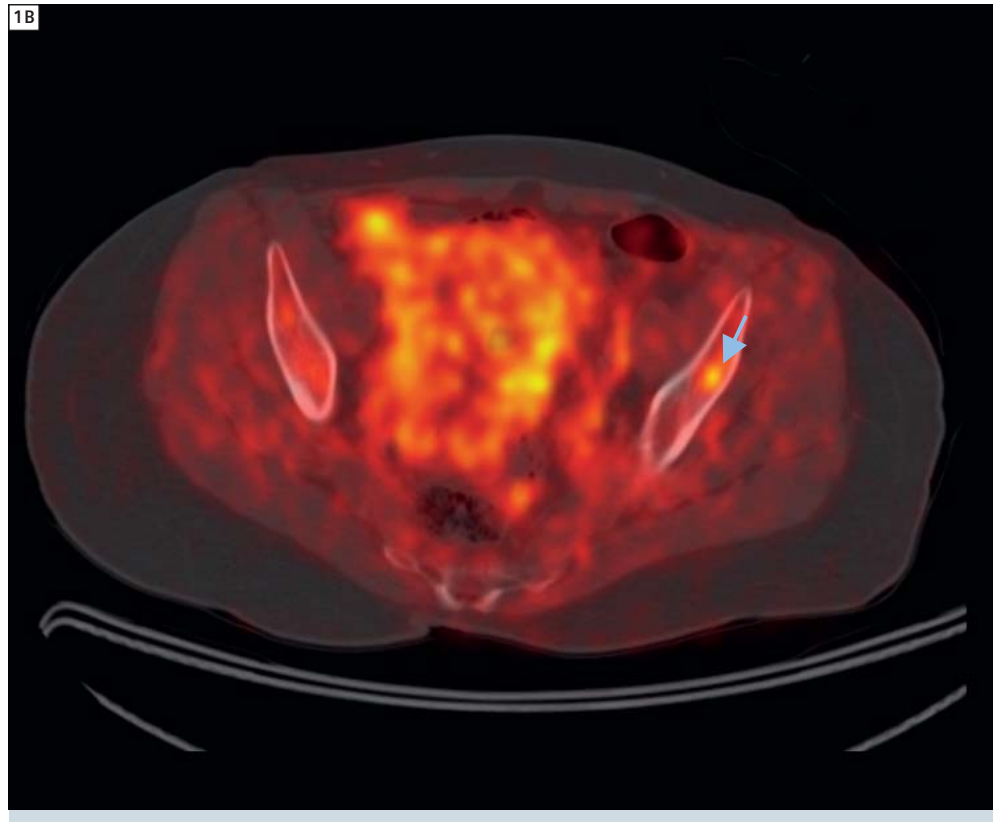
In the presented cases, our imaging protocol did not include a whole-body DWI with ADC mapping for improved tumor detection and for providing additional functional parameter for follow-up of therapy responses. Nevertheless, in all three cases, MRI had to be considered the most sensitive methodology for detection of bone metastases; however, the influence of the whole-body imaging modalities on the clinical outcome with the given therapy options for such advanced breast cancer patients has still to be answered. Nevertheless, whole-body (bone) MRI presents itself as the imaging modality of choice when an accurate assessment of bone metastases is required. To increase further the diagnostic confidence and to provide additional information about tumor biology and biological activity, future developments will combine PET with MRI within one examination and also different PET tracers such as 18Fluoride will be used.

Case 1

In this case a 66-year-old patient underwent a breast-preserving mastectomy 12 years ago (R0 resection). Two years later a local tumor recurrence was observed and therefore a breast ablation and later augmentation was performed. Within a time-period of approximately 1 ½ years a slow but constant increase of the CA 15–3 tumor marker has been observed. In contrast to PET/CT, MRI showed multiple small lesions with T2w hyperintense signal and corresponding contrast-media uptake. Most of these lesions measured less than one centimeter in their maximum diameter (Figs. 1D, E). In retrospect, a discrete irregular bone configuration /sclerosis with implied focal FDG uptake can be found, corresponding to a larger metastases. Neither a further pathologic focal FDG uptake nor lytic / sclerotic CT lesions could be detected. Based on MRI and in concordance to the clinical follow-up, a diffuse metastatic spread had to be diagnosed in this case.

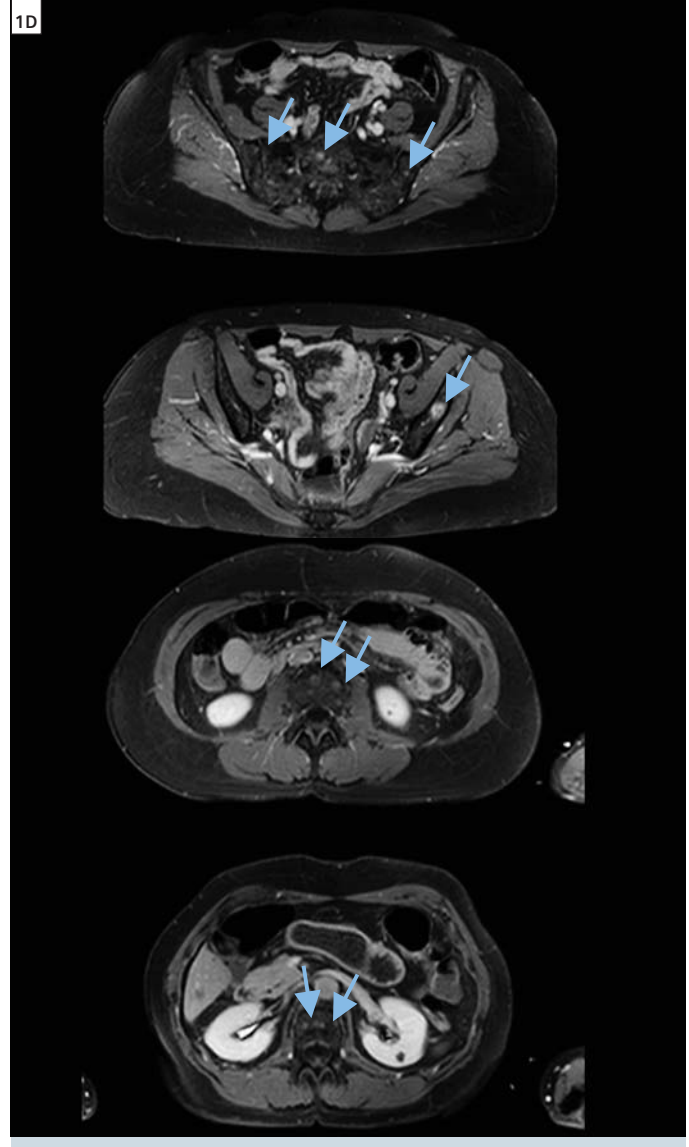


1A MIP of the FDG-PET examination.

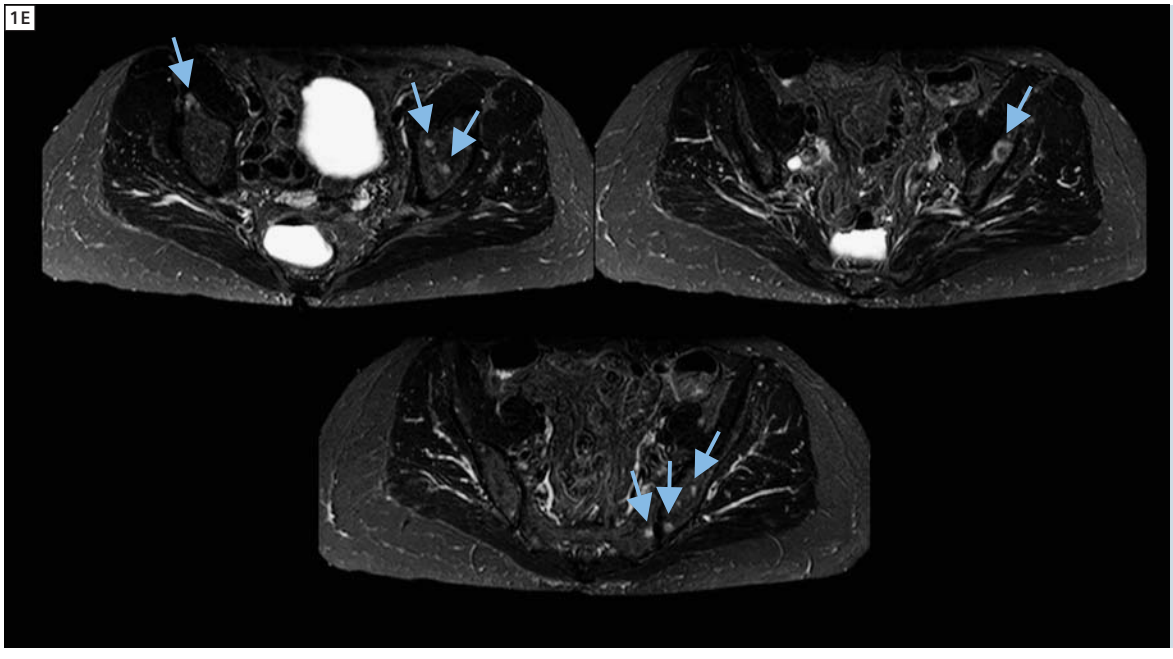


1B Focal uptake within the left iliac bone.

1C Corresponding to the PET scan, CT was able to visualize a small irregular sclerosis; further bone lesions could not be detected by FDG PET/CT.



1D Contrast-enhanced T1w 2D FLASH, demonstrating multiple smallest bone metastases.

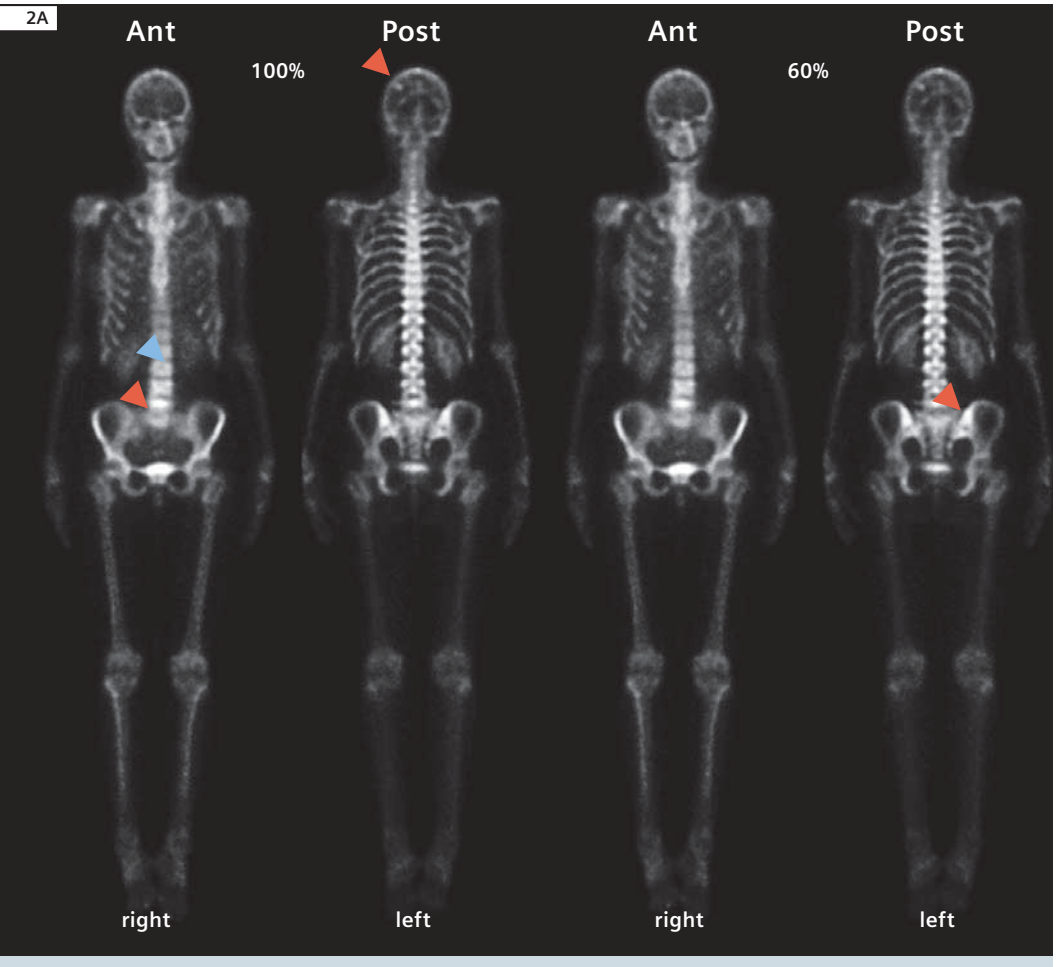


1E T2w TIRM; diffuse metastatic spread is obvious.

Case 2

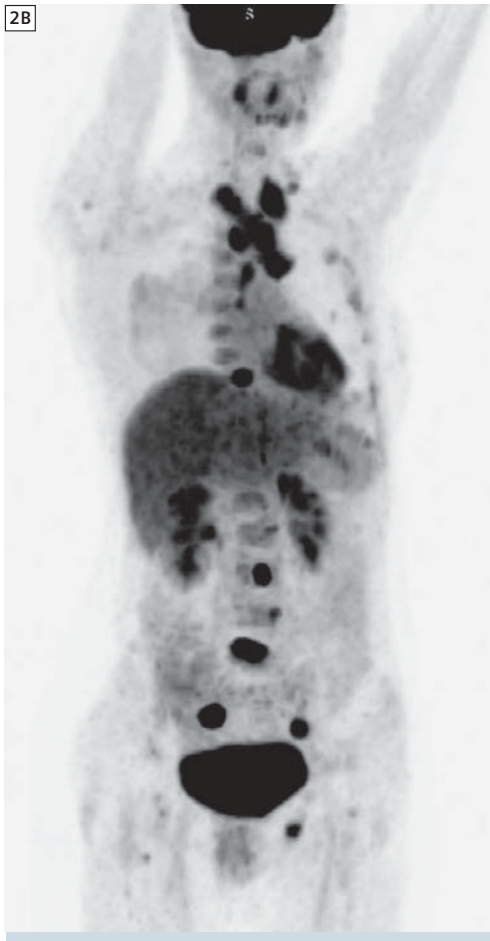
A 46-year-old patient underwent whole-body imaging because the routinely-acquired bone scintigraphy was inconclusive for bone metastases (Fig. 2A). A CT scan was performed directly after the bone scan but did not lead to a clear rule out or confirmation of a tumor recurrence. It should be mentioned that there were no other signs of tumor recurrence reported than the unclear bone scan, and the tumor markers were within normal range. The patient was initially diagnosed

2A

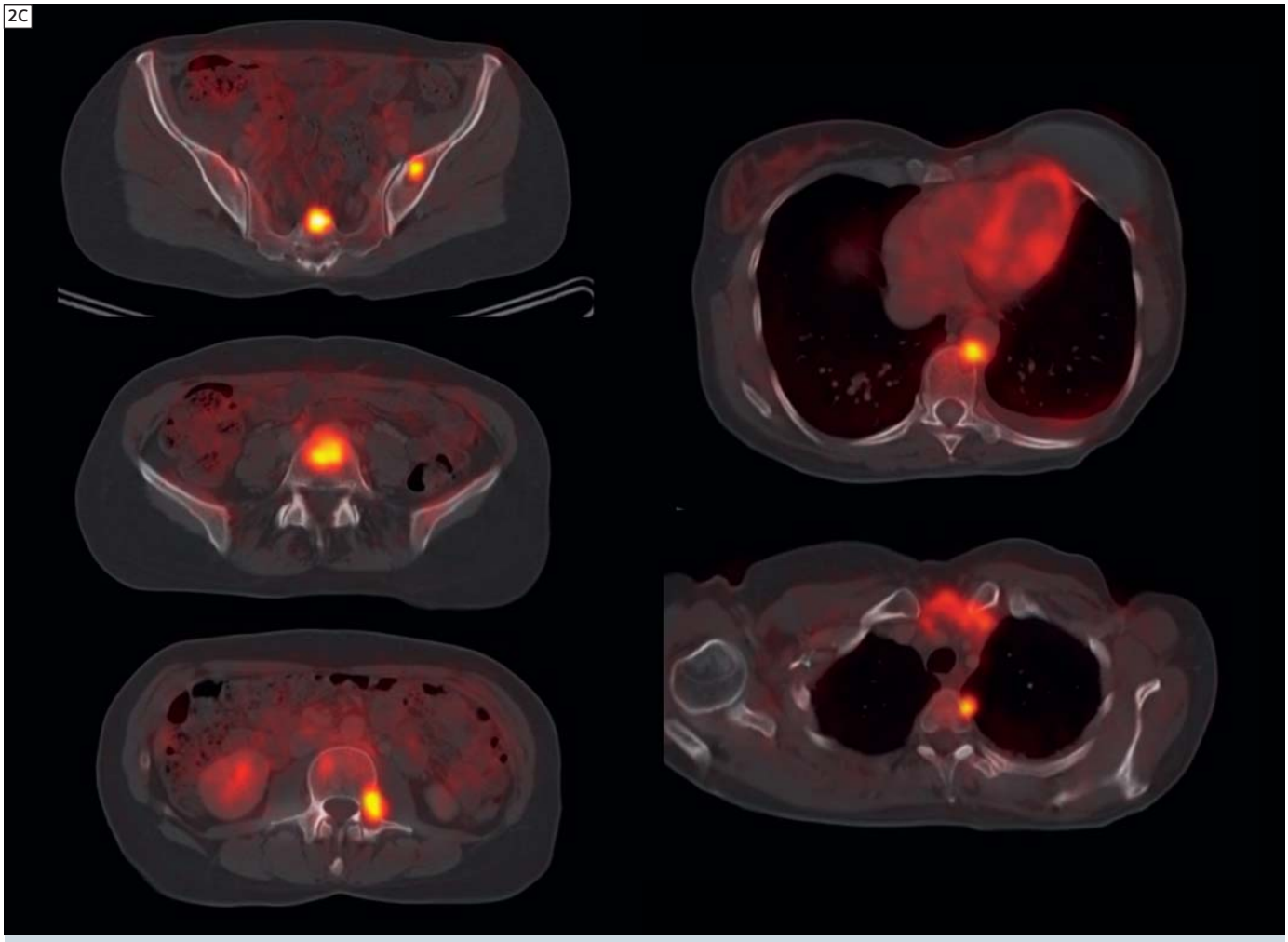


2A Bone scan suspicious for metastases (arrows).

2B



2B MIP of the FDG PET: multiple bone and lymph node metastases with clearly increased glucose metabolism are shown.



2C Corresponding PET/CT images demonstrating the extend of the multiple lytic bone metastases.

ten years ago with a breast cancer (pT1c pN1a (1/21) G2-3 M0) und underwent R0 breast ablation and LNE. Two years later a local tumor recurrence was diagnosed which resulted in a re-surgery, radiotherapy and chemotherapy. To definitively answer the question of a tumor recurrence, the patient was than sent to our department for a whole-body PET/CT and MRI. Based on PET/CT and MRI findings, an advanced tumor recurrence was diagnosed. Multiple osseous as well as mediastinal and cervical lymph node metastases are detected by high glucose metabolism on PET/CT (Figs. 2B, C) and MRI (Figs. 2D, E). MRI could visualize bone infiltration in more detail and its relationship to the spinal canal; however no differences in the total tumor load are obvious between the two imaging modalities. A hormone therapy was started and a partial remission could be achieved for this patient to date (18 months follow-up period; not shown).

References

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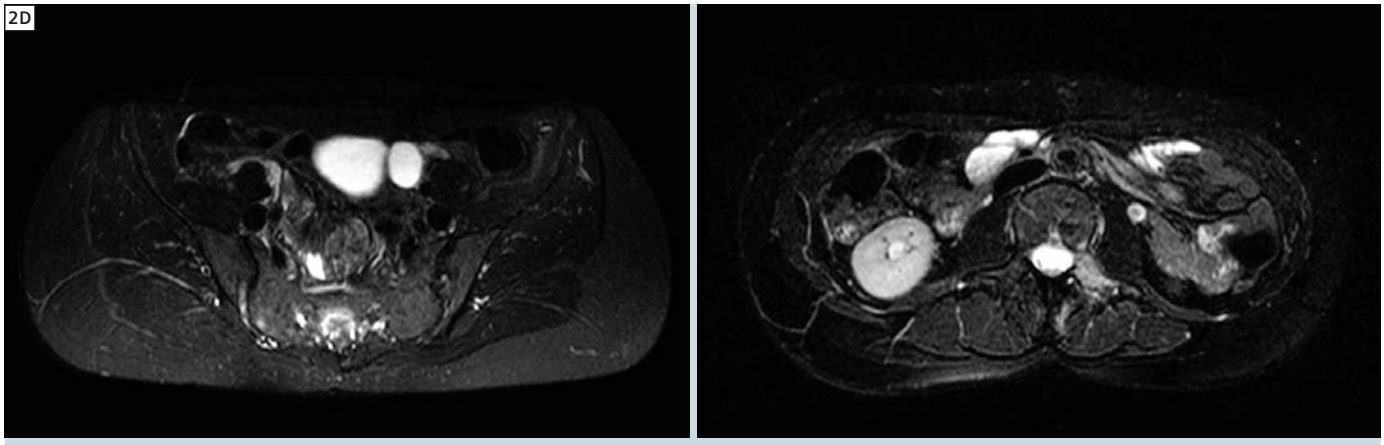
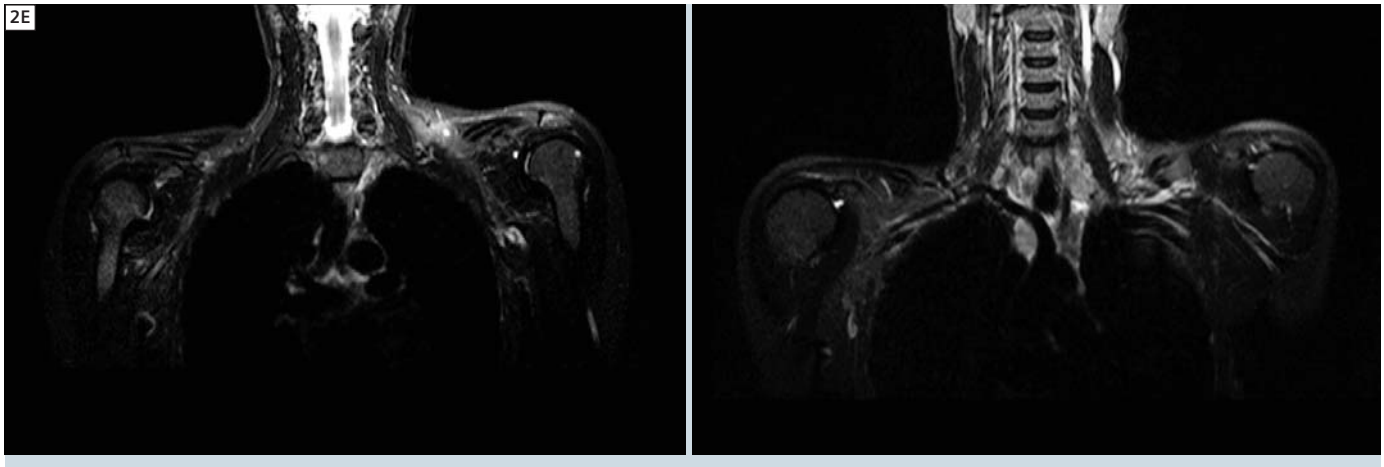


2D T2w TIRM MRI provides best delineation of bone metastases and the relationship to the spinal canal.



2E While PET/CT shows a higher diagnostic accuracy for small lymph nodes, in the presented case, MRI (coronal TIRM) could also stage the extension of the lymph node involvement correctly.

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