

Case Report:

Whole-body Oncologic Imaging with *syngo* TimCT

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Introduction

Imaging has long been indispensable in the diagnosis of cancer and the management of oncology patients. More recently, the addition of physiologic information via positron emission tomography (PET) to the anatomic information of conventional computed tomography (CT) has revolutionized the detection of cancer and the monitoring of treatment response. With PET/CT, imaging evaluation goes beyond simple anatomic size criteria to measure the metabolic activity of malignant lesions, heralding an exciting new era of tailored therapy, improved efficacy, and lessened patient impact [1]. Magnetic resonance (MR) imaging can provide analogous anatomic and physiologic information in a single unfused modality. Combined with the anatomic detail of conventional sequences, diffusion-weighted imaging (DWI) has shown promise in both the detection of malignant lesions and monitoring response to therapy [2]. Future application of developing MR techniques to oncologic imaging will provide new insights into disease detection, therapy and surveillance. MR has the potential to provide multi-dimensional anatomic, functional, and metabolic oncologic evaluation without the administration of radiotracers. However, the development and application of MR in oncologic evaluations has historically been complicated by limited anatomic coverage. Whole-body imag-

ing required in oncologic staging and surveillance has thus been infeasible given prohibitive scan times and patient impact. Tim (Total imaging matrix) technology improves on these coverage and time limitations by automating the table shifts and post-processing involved in multi-station exams. The next step in the solution lies in the combination of the Tim functionality with Continuous Table Movement (TimCT). For the first time, whole-body MR imaging is feasible and robust in conventional scan times, without off-isocenter artifacts or signal loss [3]. Anatomic coverage and time barriers now overcome, this innovation promises to unlock the full potential of MR in oncologic applications.

Method

Whole-body MR imaging was performed on a 3T MAGNETOM Trio, A Tim System, equipped with the *syngo* TimCT Oncology package. Three Body Matrix coils, the Spine Matrix, and the Head/Neck Matrix coil were used for imaging. The whole-body screening protocol was as follows:

- (1) Fastview localizer: skull base through upper thighs localization was acquired in coronal, sagittal and axial orientations.
- (2) TimCT HASTE: free breathing, skull base through upper thighs. Table speed 8 mm/s, slice thickness 5 mm, 256 base resolution.

- (3) TimCT BLADE TIRM: free breathing, skull base through upper thighs. Table speed 4 mm/s, slice thickness 6 mm, 256 base resolution.
- (4) TimCT Dixon: multiple breathhold, abdomen and pelvis. Table speed 8 mm/s, slice thickness 5 mm, 320 base resolution.
- (5) TimCT T1w FLASH Fatsat: precontrast, free breathing, skull base through upper thighs. Table speed 8 mm/s, slice thickness 5 mm, 320 resolution.
- (6) Inject contrast
- (7) VIBE: breathhold, abdomen only. Acquired in the arterial and portal venous phases. Slice thickness 3 mm, 320 base resolution, minimum TE and TR, with Quick Fatsat fat suppression.
- (8) TimCT T1w FLASH Fatsat: post contrast, free breathing, skull base through upper thighs. Table speed 8 mm/s, slice thickness 5 mm, 320 base resolution.
- (9) Multi-step DWI with ADC: free breathing, skull base through upper thighs. b values 50 and 800 s/mm².

Total imaging time was approximately 40 minutes. All patients tolerated the examination without difficulty. For each patient, there was an approximately 2 month interval between TimCT whole-body screening and the prior conventional examinations.

Clinical cases

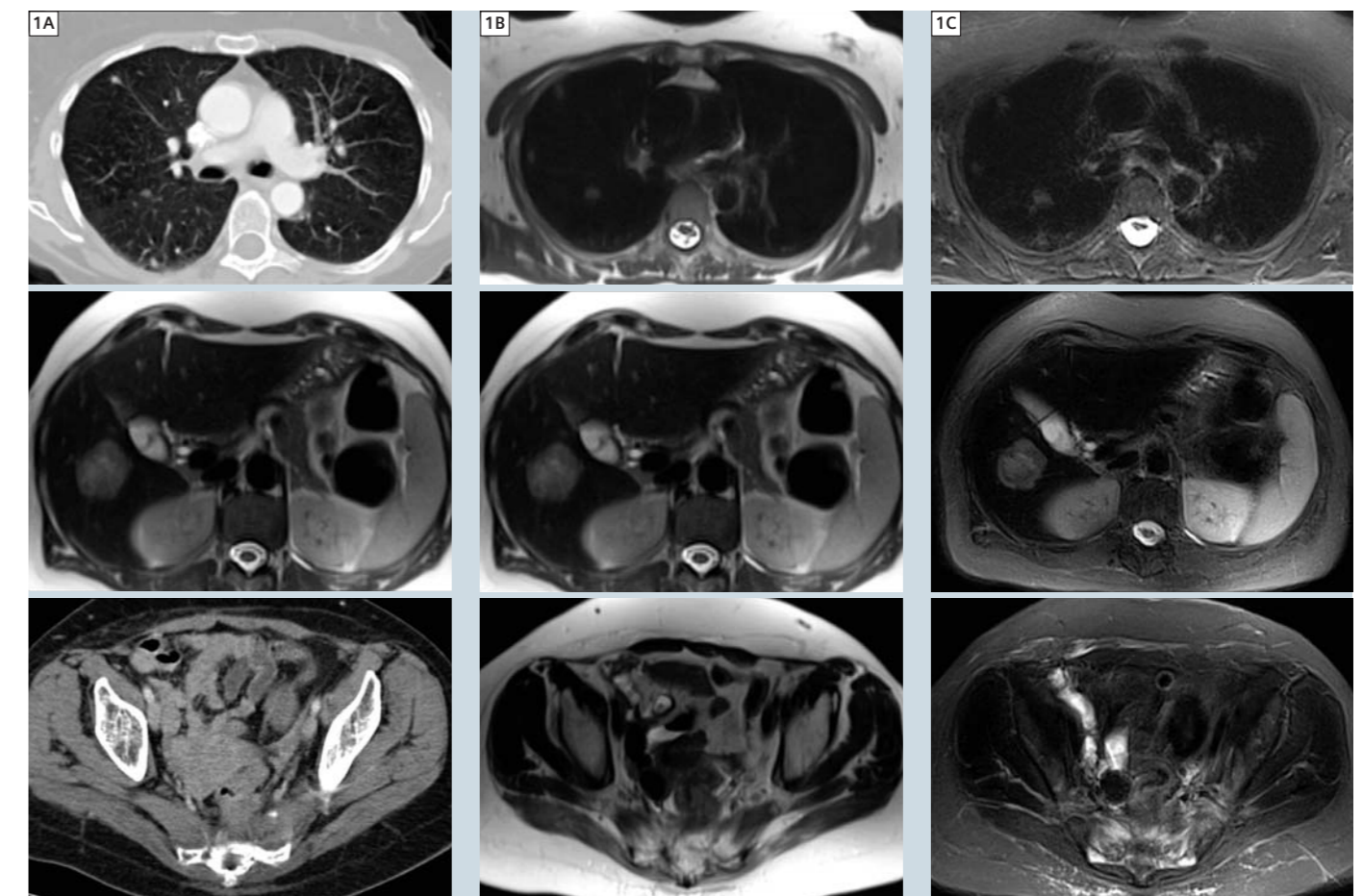
Oncologic patients were invited to volunteer for whole-body MR imaging with *syngo* TimCT Oncology and the above protocol. These images were compared with their prior routine imaging including FDG PET/CT, conventional contrast-enhanced CT (ceCT) and conventional MR. The studies were conducted under approved IRB and informed consent was obtained.

Patient 1

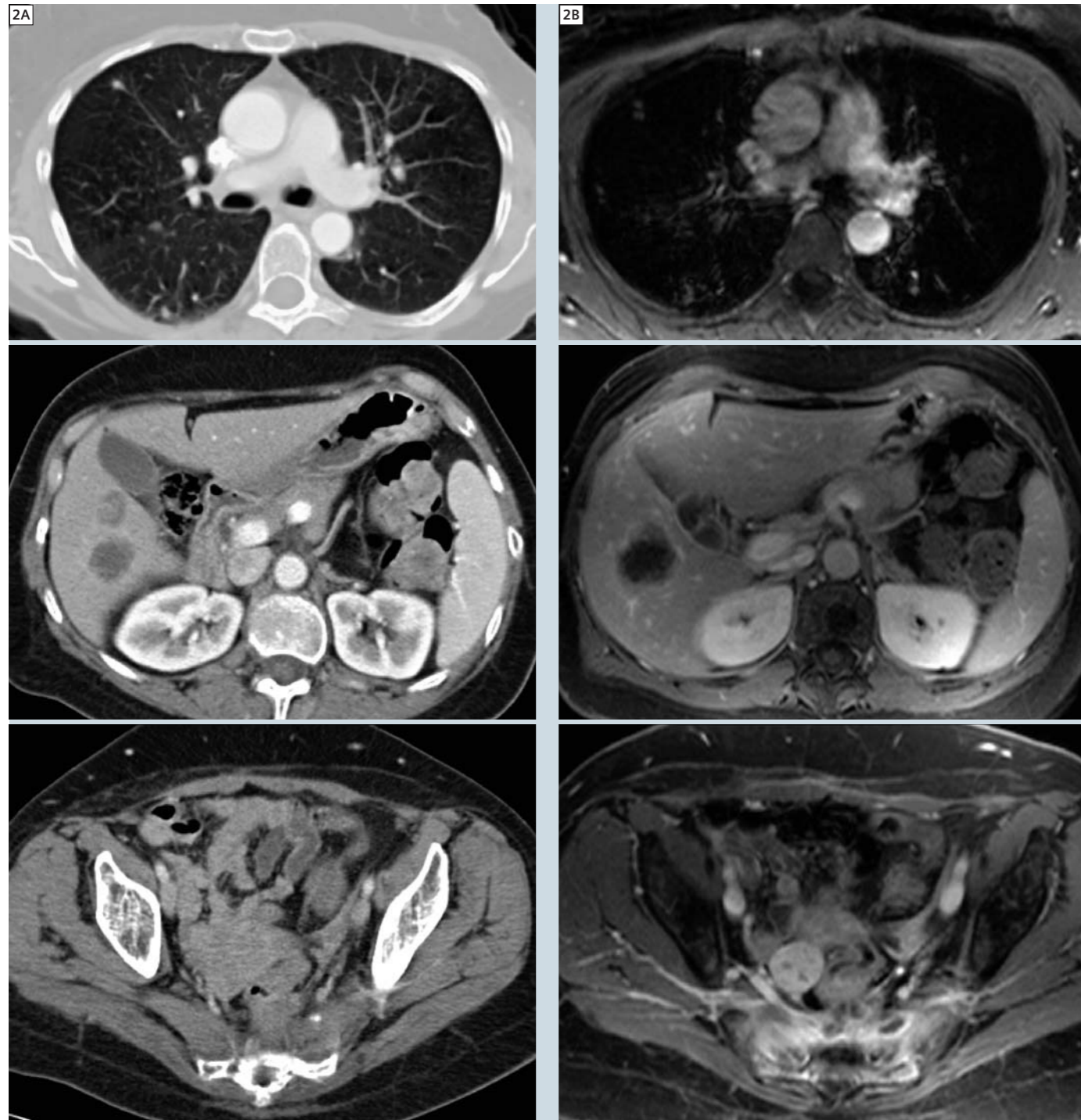
This is a 52-year-old female undergoing treatment for metastatic rectal adenocarcinoma. Figure 1 compares conventional

ceCT with non-fat-suppressed T2-weighted TimCT HASTE, and fat-suppressed T2-weighted TimCT BLADE TIRM. Images were selected at sites of metastatic disease in the chest, abdomen and pelvis. Within the chest, image quality is preserved despite non-breathhold technique, allowing ready detection of relatively small lung lesions and subcarinal lymphadenopathy. A metastatic lesion in the right hepatic lobe has evolved between the two examinations, but remains well seen. Invasion of the primary rectal mass into the presacral fat planes is better appreciated on MR than prior ceCT.

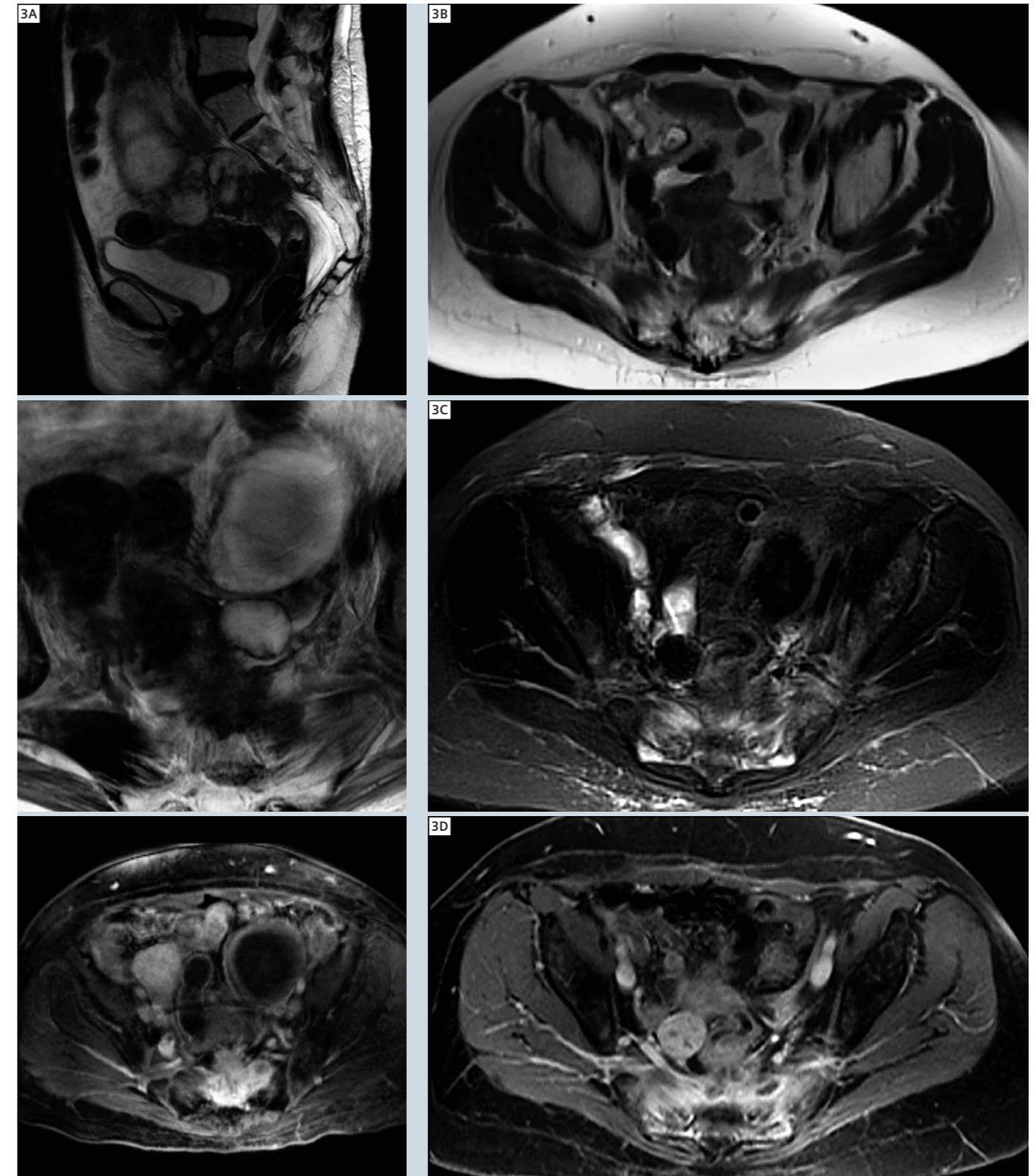
Figure 2 compares conventional ceCT with post contrast fat-suppressed T1 TimCT FLASH at additional levels in the chest, abdomen and pelvis. Again, image quality is preserved despite non-breathhold technique. The contrast-enhanced MR evaluation reveals small lung lesions, peripheral viable and central necrotic regions of the hepatic mass, and small abscess collections within the post-treatment presacral space. Figure 3 compares *syngo* TimCT images with conventional pre and post contrast MR images acquired at 1.5T. Image quality is preserved.



1 (A) ceCT, (B) TimCT HASTE, and (C) TimCT BLADE TIRM images selected from whole-body oncologic screening examinations.



2 (A) ceCT and (B) TimCT T1 FLASH post contrast images selected from whole-body screening examinations.



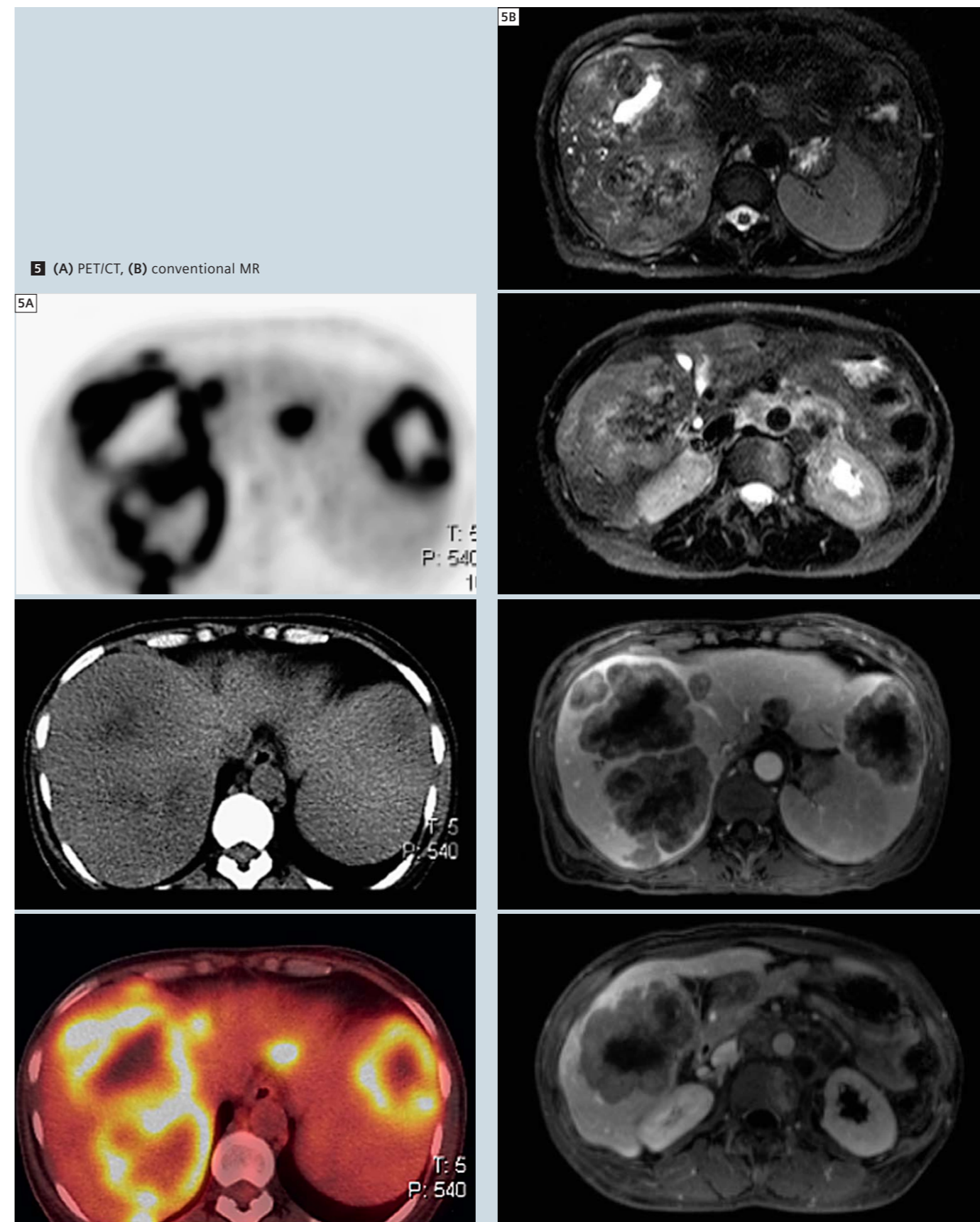
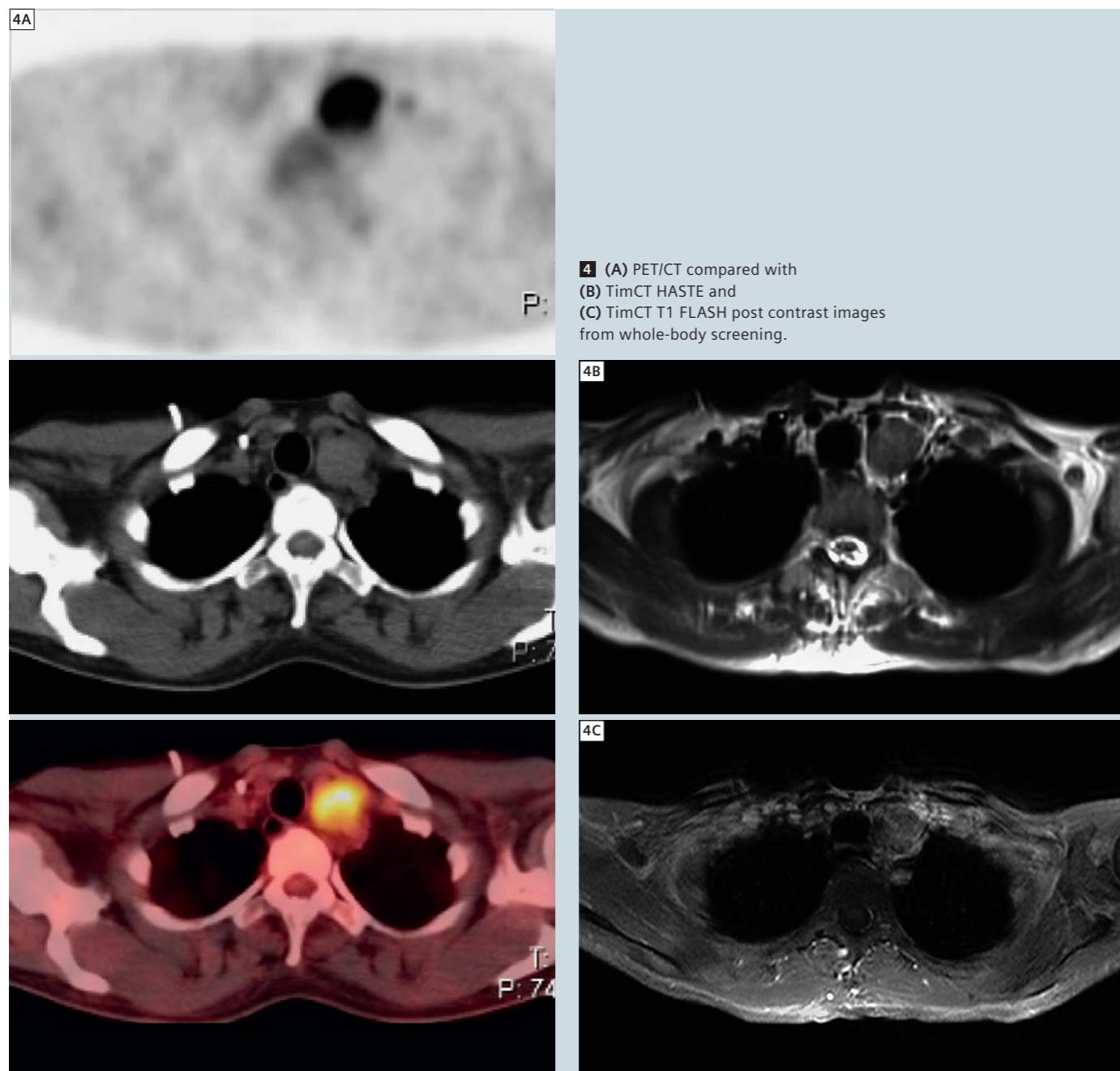
3 (A) Conventional MR images compared with (B) TimCT HASTE, (C) TimCT BLADE TIRM, and (D) TimCT T1 FLASH post contrast images selected from whole-body screening.

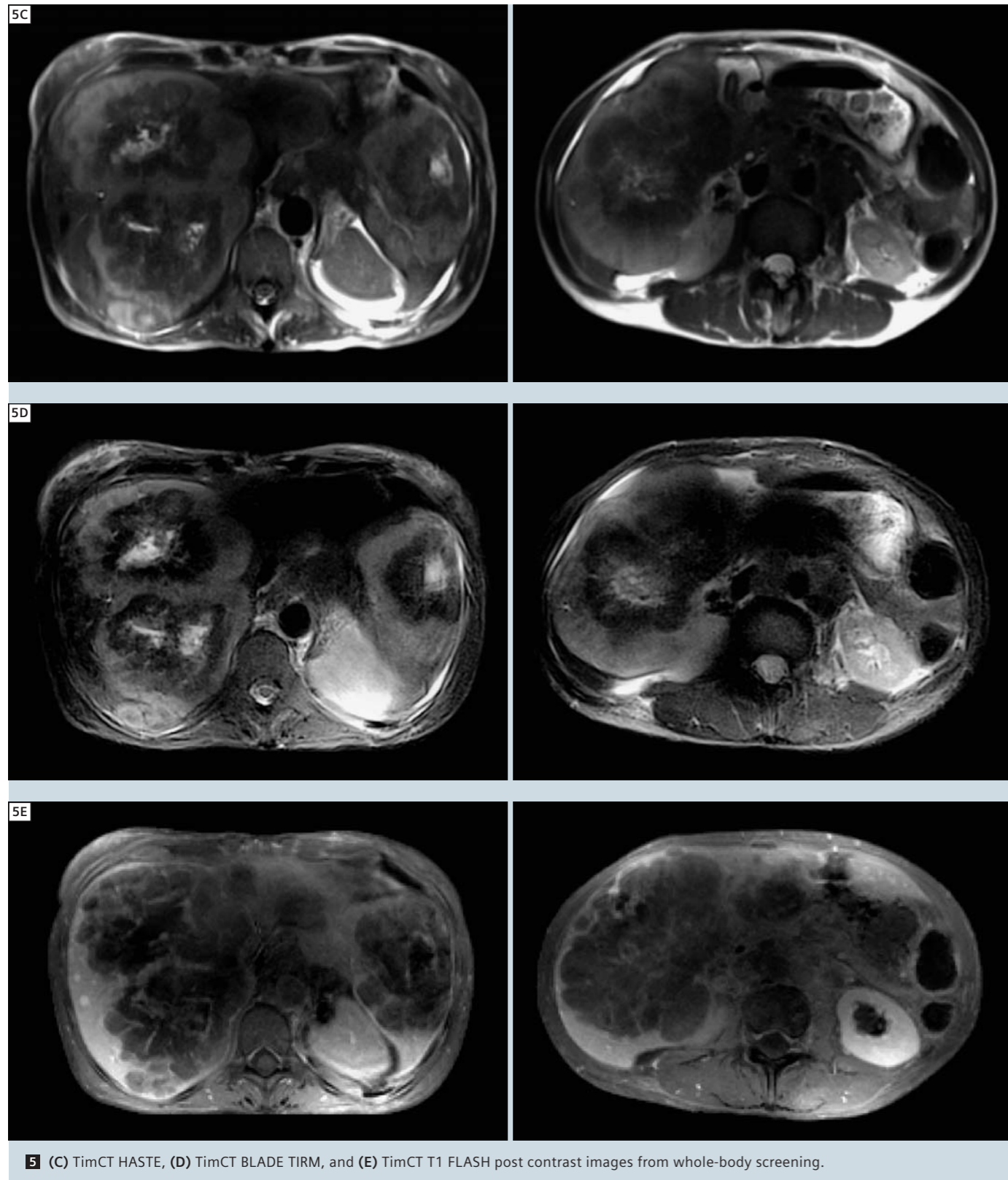
Patient 2

This is a 42-year-old female undergoing treatment for metastatic rectal adenocarcinoma. Figure 4 compares FDG PET/CT to TimCT HASTE and TimCT post contrast FLASH in the upper chest. A left supraclavicular lymph node metastasis is well demonstrated despite non-breath-hold technique.

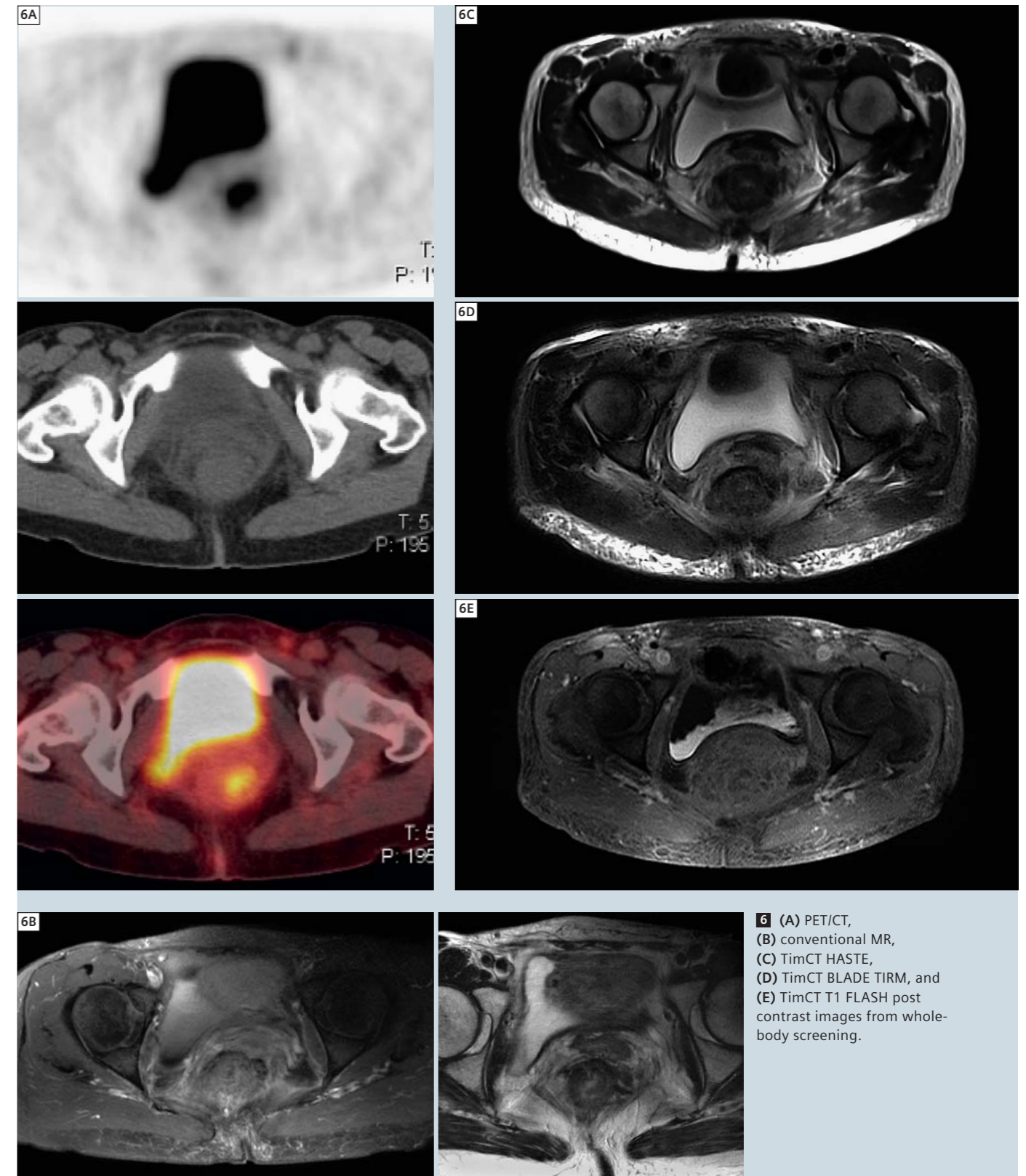
Figure 5 compares FDG PET/CT ceCT and conventional MR with TimCT HASTE, BLADE, and post contrast FLASH. Multiple large liver metastases have progressed over the 2 month interval. The metabolically active regions of tumor are seen as peripheral T2 hyperintense, enhancing rims on MR and TimCT images,

and are well-differentiated from central necrotic regions and the normal background liver. Figure 6 makes a similar comparison in the pelvis. The primary rectal mass with invasion into the left perirectal fat is again well-demonstrated on the TimCT images.





5 (C) TimCT HASTE, (D) TimCT BLADE TIRM, and (E) TimCT T1 FLASH post contrast images from whole-body screening.



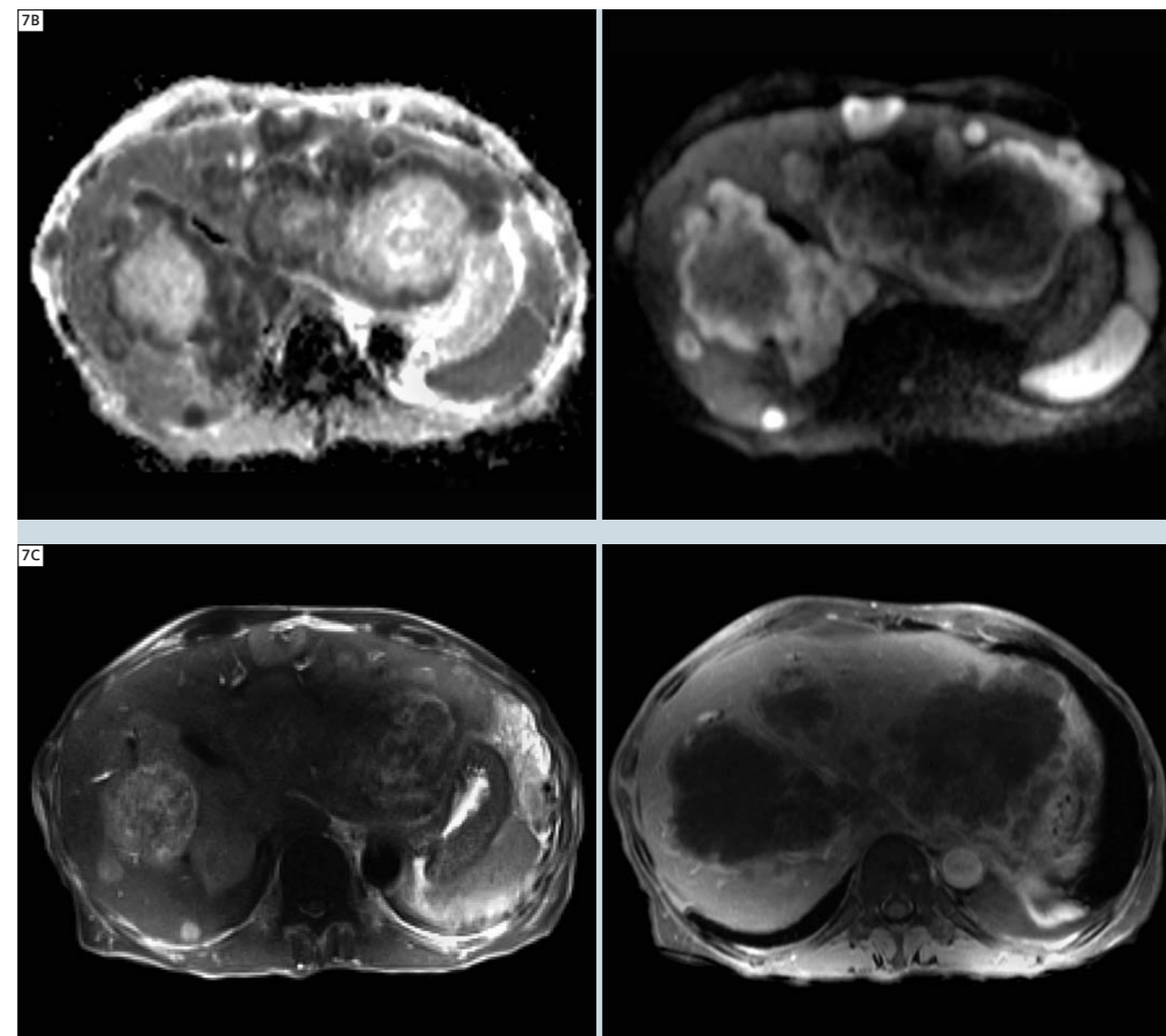
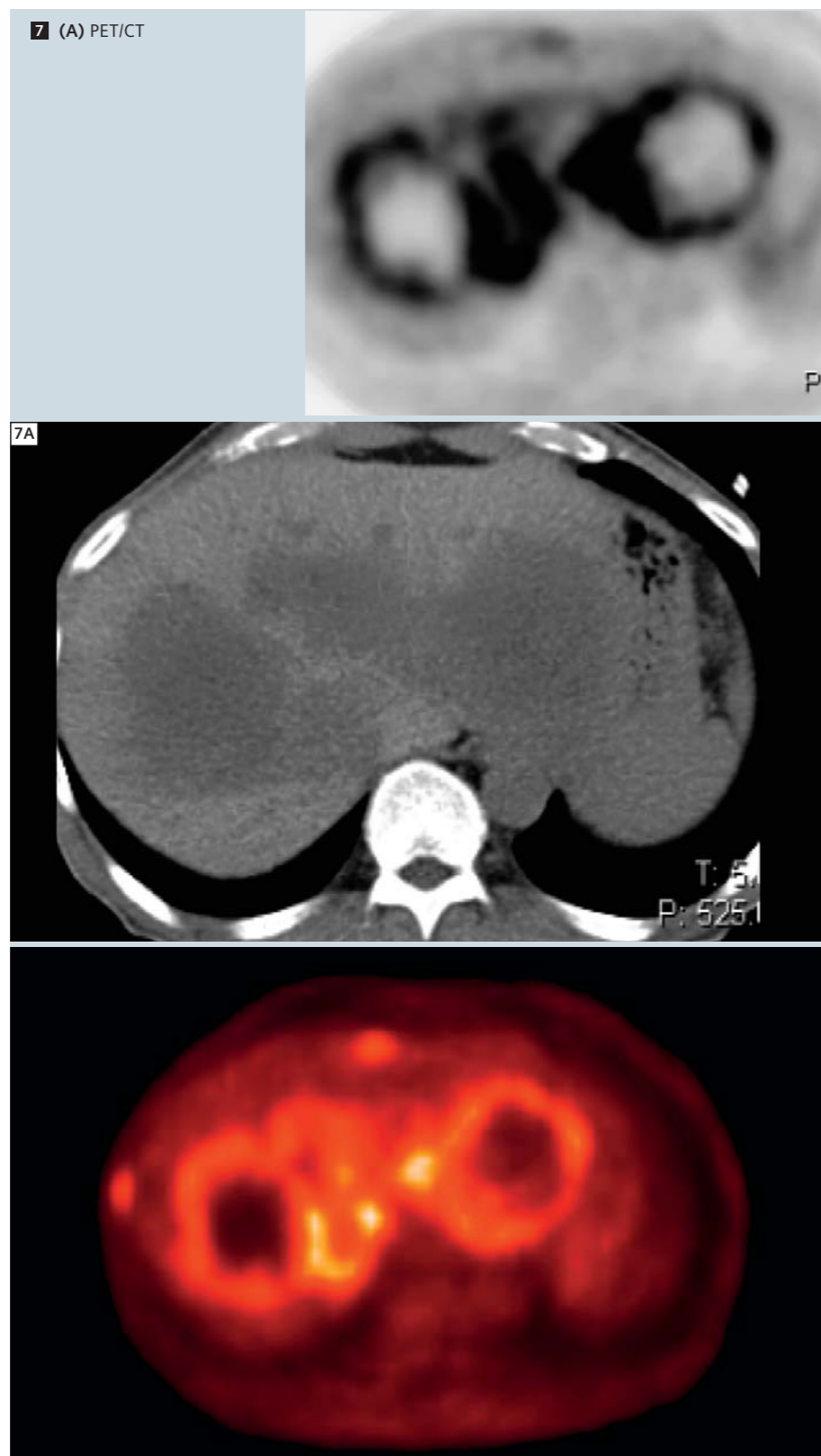
6 (A) PET/CT, (B) conventional MR, (C) TimCT HASTE, (D) TimCT BLADE TIRM, and (E) TimCT T1 FLASH post contrast images from whole-body screening.

Patient 3

This is a 60-year-old male patient undergoing treatment for metastatic colon cancer. Figure 7 compares PET/CT images with $b = 800$ diffusion-weighted and ADC images obtained during multi-station whole-body imaging. The TimCT HASTE and pre / and post contrast FLASH images from the same examination are also included. The DWI/ADC images clearly delineate the peripheral metabolically active tumor as shown on PET from the central necrotic regions. Note the diffusion restriction in the small right anterior rib metastasis, also demonstrated on PET. The metabolically active regions are seen as peripheral rims of intermediate T2 hyperintensity and enhancement on the TimCT HASTE and post contrast FLASH images.

Conclusion

As these cases and images show, the addition of *syngo* TimCT functionality makes whole-body MR oncologic evaluation a viable reality. Extended, whole-body anatomic coverage is now possible without off-isocenter artifacts or signal loss. In-plane image quality with the TimCT application is maintained in comparison to conventional MR. Non-breath-hold technique did not limit diagnostic quality in these patients. Skull-base to upper thigh coverage was achieved in standard imaging times of 30–40 minutes. With the addition of DWI to conventional sequences, functional-anatomic information correlation is possible through the whole-body field of view, but does not require administration of radiotracers or long uptake periods. TimCT has removed the barriers to whole-body MR evaluation, promising a new era of MR applications in oncology.



7 (B) multi-station diffusion-weighted and ADC, and (C) TimCT HASTE and post contrast T1w FLASH images.

References

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