

VIBE for Liver Imaging with *syngo* MR B17

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Volume Interpolated Breathhold Examination (VIBE) [1] is a well known technique for imaging of the liver. VIBE offers three-dimensional multi-phase acquisition before and following contrast administration under breathhold conditions. The dynamic behavior of the liver lesions and structures is typically analyzed by scanning pre-contrast,

arterial, portal venous, early equilibrium and 5 minutes delayed equilibrium phases of enhancement. This allows more accurate characterization than static pre or post-contrast analysis. In the *syngo* MR B17 software, new functionalities have been added to the VIBE sequence to better meet the clinical requirements. The following are

the most critical requirements for VIBE: uniform fat suppression, excellent tissue contrast, image sharpness, few artifacts, and short scan time. The new functionalities include a new k-space reordering scheme, a new fat suppression scheme, and a new reconstruction functionality.

K-space reordering scheme

A new k-space reordering scheme was introduced to improve image quality: Linear reordering in the slice (3D / partition) direction produces clean image quality, as it is less susceptible to artifacts and motion due to its smooth magnetization trajectory. It also allows for shortening the scan time as it does not require 'dummy' pulses to drive the signal into the steady state condition. The linear reordering acquisition is still 'single-shot' to maintain the short scan time. Furthermore, the linear reordering scheme reduces artificial enhancement of the liver edges.

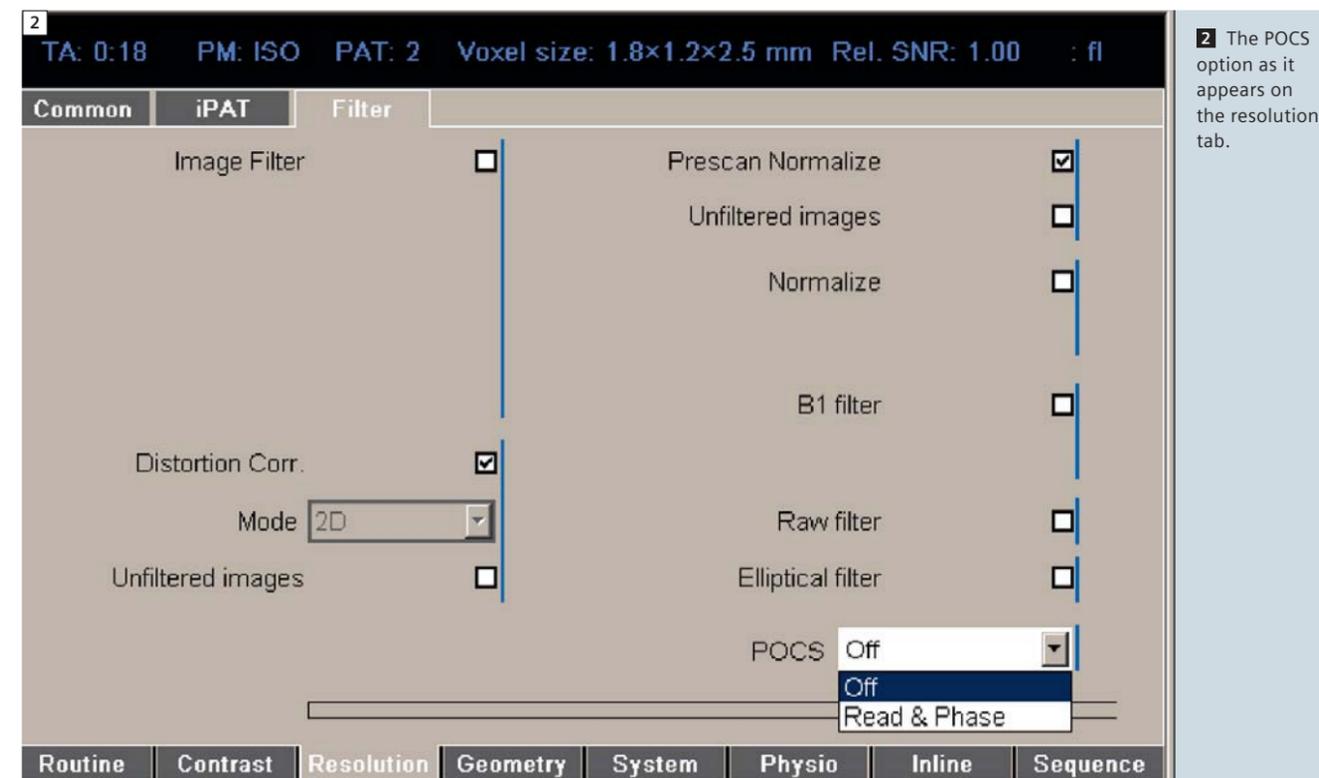
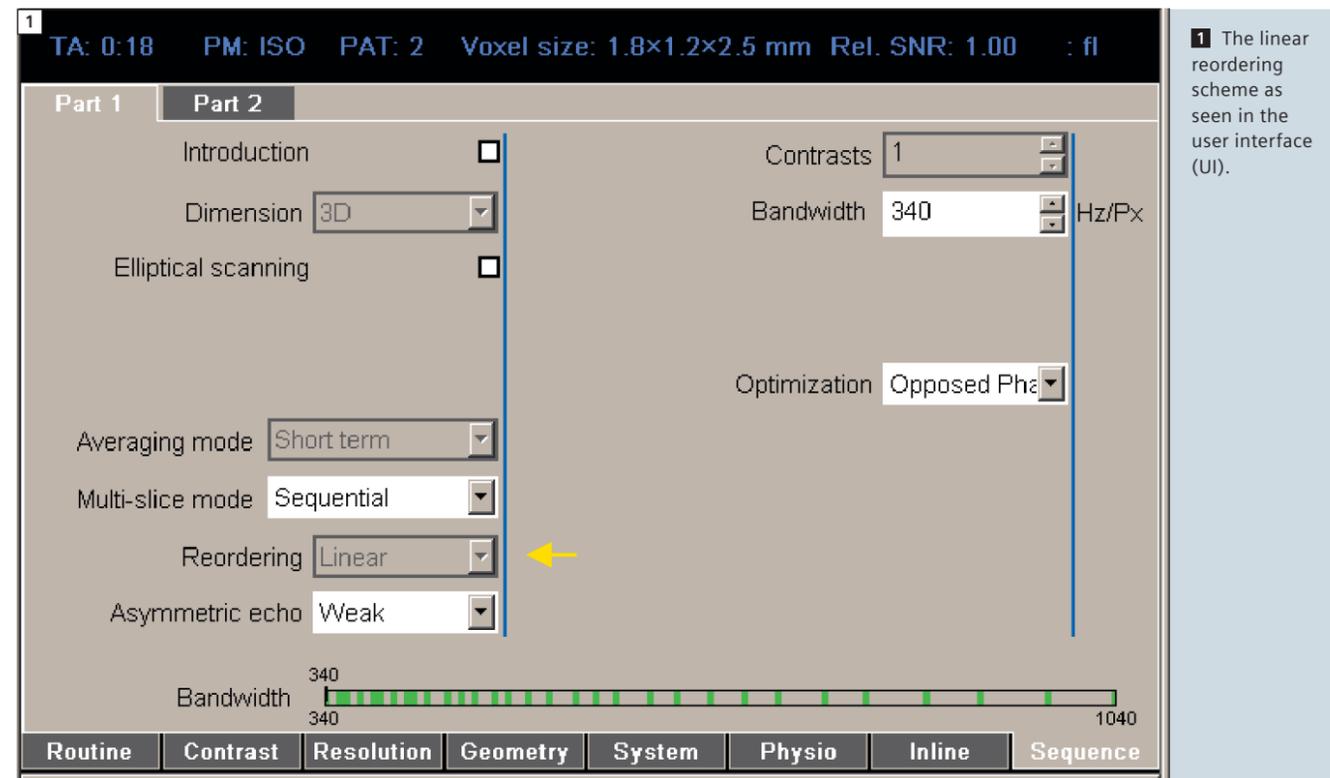
Fat suppression

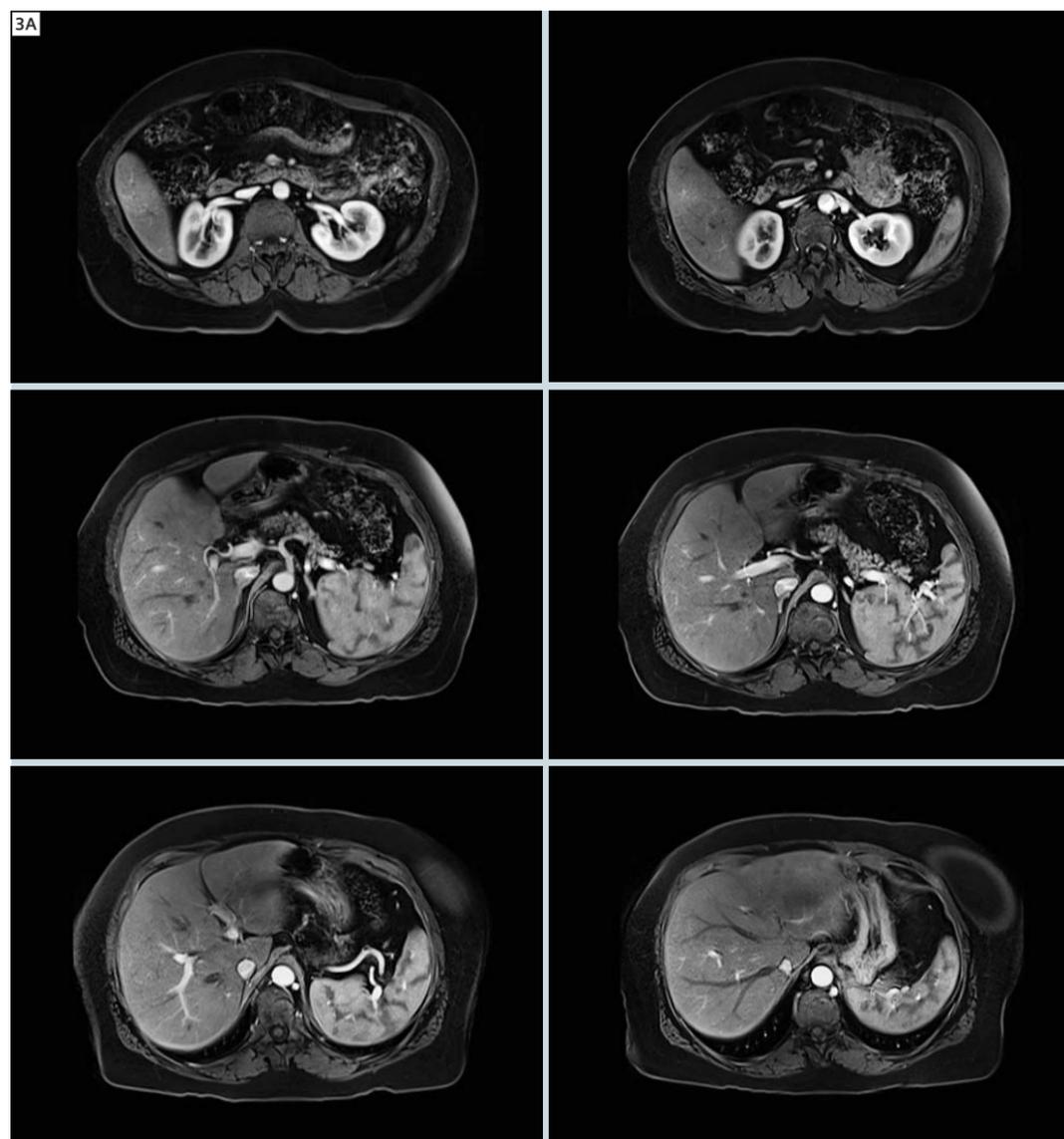
Linear k-space reordering is used in conjunction with the Q-Fatsat option available in the Contrast UI tab card. Internally, the flip angle of the fat saturation pulse is adjusted for nulling the fat signal at the center of k-space. This scheme produces uniform fat suppression for the liver. If the condition of zero fat signal at the center of k-space cannot be met, the reordering reverts to centric reordering in the slice direction, which was the standard setting up to now. This condition is dependent on the resolution parameters in the slice direction, on TR, and on the imaging flip angle. It is recommended that opposed phase TE is used for dark fat suppression when using asymmetric echo. It is also possible to use a reversed echo asymmetry to shorten the scan time by manually reducing the TR while maintaining the TE constant. For this, the TE has to be

long enough to allow a symmetric echo, and the echo optimization (on the Sequence – Part 1 UI tab card) must be None. Symmetric echo also produces uniform fat suppression with linear reordering scheme.

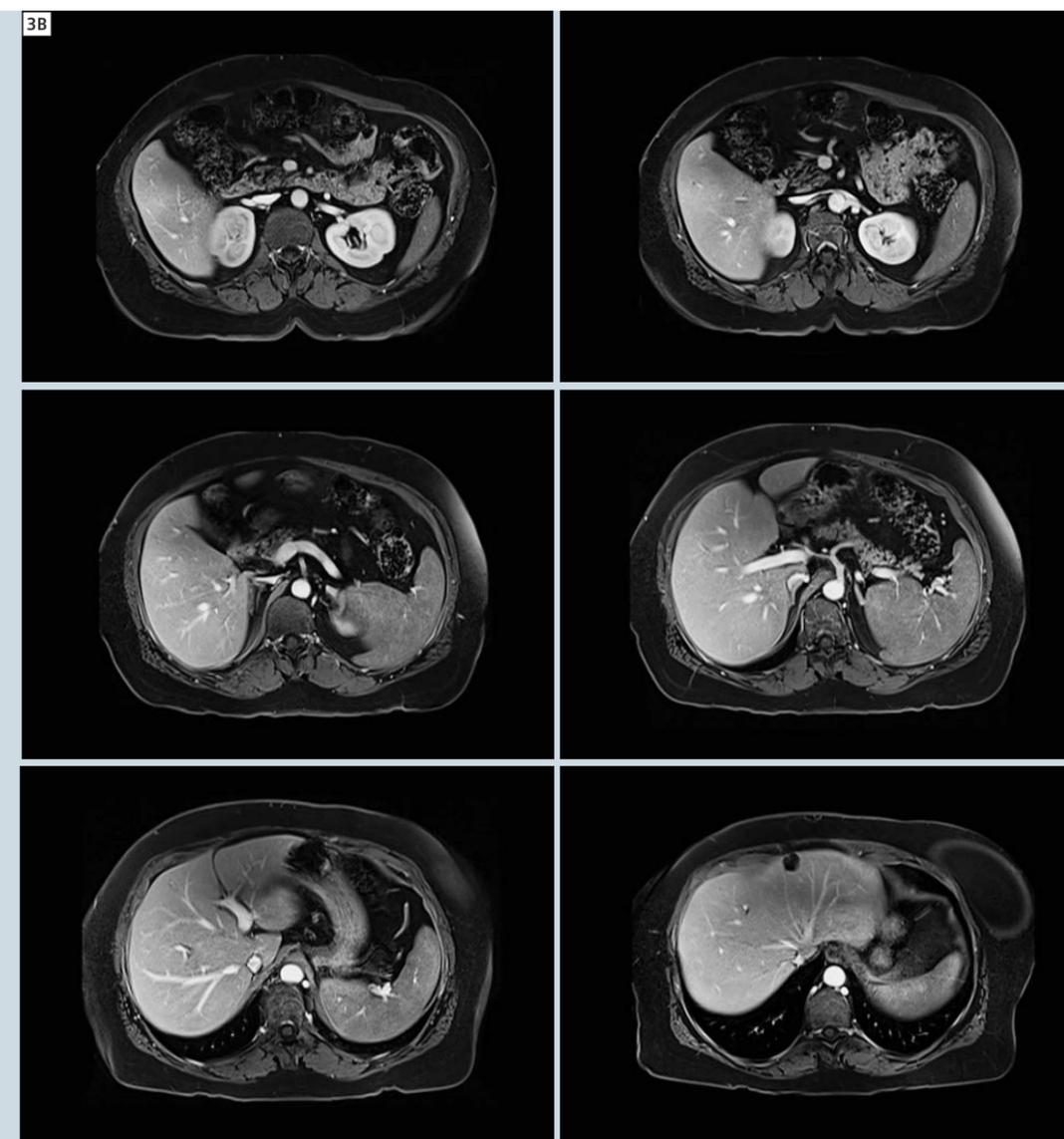
Reconstruction with Projection Onto Convex Sets (POCS)

A new option to enhance image reconstruction is also available in the *syngo* MR B17 software: Projection Onto Convex Sets or POCS can be selected on the Resolution – Filter UI tab card when using partial Fourier in the phase and/or read directions. POCS reconstruction will sharpen the image by reducing the blurring induced by partial Fourier acquisition.





3 Typical VIBE images obtained at 3T MAGNETOM Trio, A Tim system (A) Arterial phase.



3 (B) Portal venous phase. (Images courtesy of Washington University in St Louis.)

Examples of protocols

The followings are recommendations to acquire good image quality of VIBE for liver imaging:

- Q-Fatsat with linear reordering.
- 320 base resolution to increase image sharpness.

- 10 degree excitation flip angle at 1.5T system and 9 degree at 3T system for uniform fat suppression.
- Symmetric echo for image sharpness.
- Opposed phase TE if using asymmetric echo for uniform fat suppression.
- Slice partial Fourier = 6/8.

- Phase partial Fourier = Off for image sharpness.
- If further scan time reduction is necessary, select 7/8 phase partial Fourier. Using POCS will reduce blurring.
- Prescan Normalize filter.

Figure 3 shows the typical image quality of the arterial phase (A) and the portal venous phase (B) acquired at 3T MAGNETOM Trio Tim with the following parameters: Q-Fatsat with linear reordering, BW 446 Hz/pixel, base resolution 320, slice thickness 3 mm, echo

asymmetry Off, phase partial Fourier Off, TE 1.9 ms, TR 4.1 ms, 72 partitions, Prescan normalized, total acquisition time 19.72 seconds. These images show good fat suppression and good contrast enhancement.

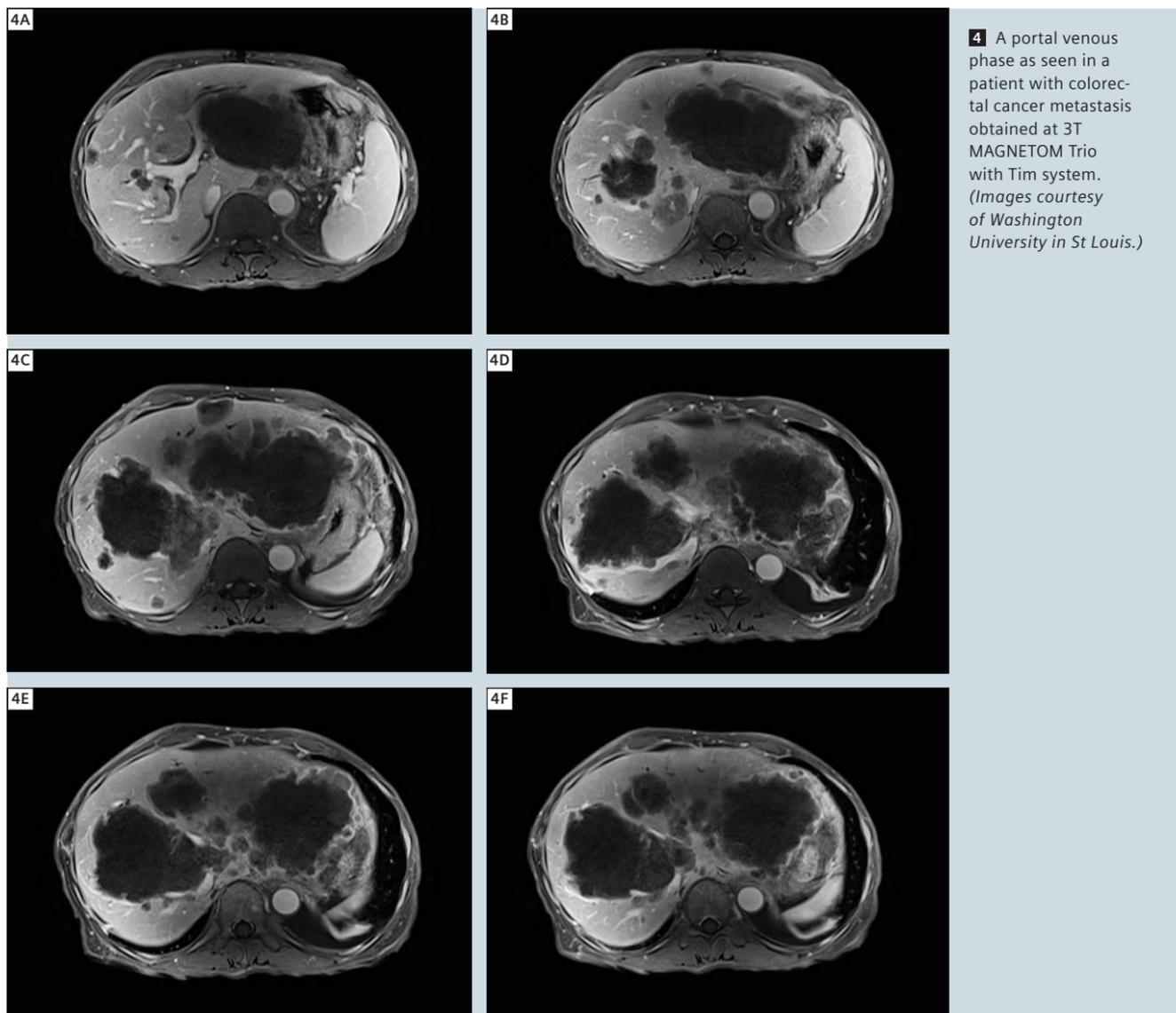
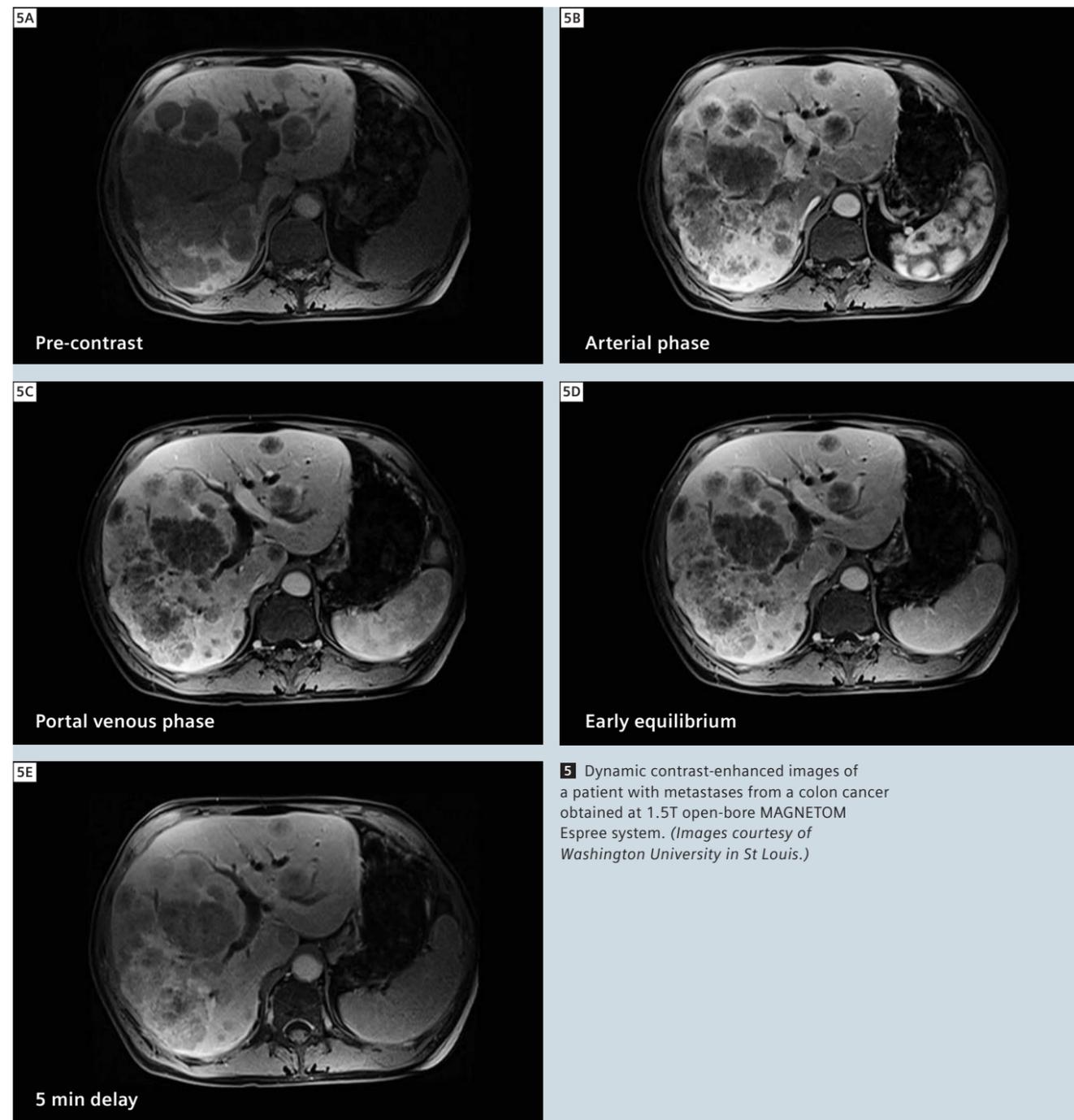


Figure 4 shows another example of clinical cases obtained from 3T MAGNETOM Trio, A Tim system. Images shown are the portal venous phase of a patient with metastases from a colon cancer obtained with the same 3T protocol mentioned above. Image sharpness and contrast enhancement are seen in this example.

Figure 5 is an example of a multi-phase contrast-enhanced VIBE scan on a 1.5T open-bore MAGNETOM Espree system of a patient with metastases from colon cancer with the following protocol: Q-Fatsat with linear reordering, BW 390 Hz/pixel, Base resolution 320, slice thickness 3 mm, echo asymmetry Off, phase partial Fourier Off, TE 2.2 ms, TR 4.4 ms, 72 partitions, acquisition time 24 seconds. These images show sharpness, good contrast enhancement, uniform fat suppression and reduced artifacts on an open-bore system.

Conclusions

New functionality of the VIBE sequence in the syngo MR B17 software allows improvements in fat suppression, tissue contrast, image sharpness, residual artifact, and scan time. The improvements in image quality are shown on both 3T and 1.5T systems.



References
 1 Rofsky NM, Lee VS, et al. Abdominal MR Imaging with a Volume Interpolated Breath-hold Examination. Radiology. 1999 Sept; 212(3):876-84.

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