The utility of TrueFISP in abdominal imaging: analysis of vascular assessment and liver lesion detection

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Purpose: Balanced steady-state free precession sequences such as TrueFISP have become standard sequences in cardiac imaging due to the intrinsic high signal of blood as a result of its T2/T1 signal characteristics and excellent SNR.[1,2] To date, we are aware of no study looking at the ability of the sequence to evaluate commonly assessed vessels of the upper abdomen. The purpose of our study was to assess how well upper abdominal vessels are visualized with TrueFISP relative to multiphasic contrast-enhanced 3D VIBE imaging, and at the same time to assess the sensitivity of TrueFISP in detecting liver lesions relative to HASTE, another fast, relatively T2-weighted sequence which could potentially be replaced by TrueFISP.[3,4]

Methods: Consecutive abdominal MR examinations with a 1.5T scanner (Avanto, Siemens Medical Systems) on 143 patients were performed with patients receiving both HASTE (TR 1000ms, TE 80ms, 256 X 192 matrix) and TrueFISP (TR 3.7ms, TE 1.8ms, 256 X 192 matrix) axial images first with a slice thickness appropriate for imaging the upper abdomen in one breath-hold (n=87, 7-10mm SL) and then with 5mm thick images (n=56). All patients also received gadolinium enhanced imaging with axial 3D VIBE images (TR 5.1ms, TE 2.5ms, SL 3mm, 256 X 176 matrix prior to interpolation) performed immediately after injection and at 1, 2, and 10 minutes. Two patients were excluded due to incomplete examinations, leaving 141 patients who were assessed independently by two blinded abdominal radiologists. Patients were randomized and sequences were assessed months apart, and each radiologist scored five abdominal vessels (hepatic veins, IVC, aorta, splenic vein, portal vein) on a scale of 1 (completely nondiagnostic for patency) to 5 (homogenous signal in vessel and high confidence of patency). Whichever 3D VIBE series showed the vessel the best was used for the purposes of scoring that vessel. At the same time, images were also assessed for the presence of thrombus in the vessels, and also for focal liver lesions. A total of 128 patients were assessed for liver lesions as patients with more than 20 lesions were excluded. Consensus review of all sequences provided the gold standard for liver lesion detection to which HASTE and TrueFISP were compared.

Results: Mean rating scores for each vessel combined for both radiologists are given in Table 1. Vessel scores for 5mm TrueFISP images were significantly higher than for 7-10mm images for all vessels ($p<0.001$). TrueFISP images had higher vessel scores at all slice thicknesses than HASTE ($p<0.001$). At 7-10mm, the IVC scored significantly higher ($p<0.001$) for TrueFISP than 3D VIBE, with no significant difference seen for the hepatic veins and higher scores for 3D VIBE for the other vessels ($p<0.01$). At 5mm slice thickness, however, TrueFISP resulted in significantly higher vessel scores ($p<0.001$) than 3D VIBE for all vessels (Figure 1) except the aorta (no significant difference). Thrombi were detected within seven vessels of six patients on both the TrueFISP and 3D VIBE sequences in every case (Figure 2). For the identification of liver lesions, for radiologist 1 the sensitivity of TrueFISP was 57% with 43 false positive lesions and the sensitivity of HASTE was 64% with 69 false positive lesions. For radiologist 2, the sensitivity of TrueFISP was 51% with 25 false positive lesions and the sensitivity of HASTE was 78% with 169 false positives.

Discussion: Our study shows that TrueFISP offers an attractive alternative to post-contrast 3D spoiled-gradient echo imaging for vascular assessment. This would be particularly useful in patients without intravenous access and in those who cannot properly breath-hold for the post-contrast images (since the rapid TrueFISP sequence is relatively motion-resistant). Even in patients without respiratory motion, 5mm TrueFISP images provided superior assessment of several vessels, particularly the IVC. As HASTE is also a rapid T2-weighted sequence, we were interested in whether TrueFISP could compete with HASTE in liver lesion detection, with an eye towards replacing HASTE in our protocols with TrueFISP if they were similar. However, TrueFISP sensitivity for focal lesions was inferior to HASTE, supporting the findings of a previous study using an older scanner.[5] The average total acquisition time (including setup) of two 5mm TrueFISP sequences sufficient to cover the upper abdomen of between two to three minutes means adding TrueFISP to a standard abdominal protocol would not unduly lengthen overall scan time.

Conclusion: Although poor for focal lesion detection, TrueFISP challenges post-gadolinium images as the gold standard and offers a fast alternative for vascular evaluation without the administration of IV contrast.

References:

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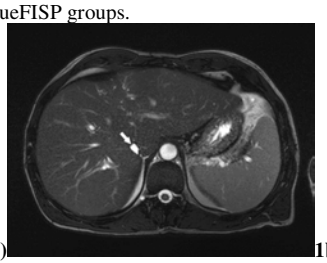
Table 1: Mean vessel ratings for both radiologists combined

Sequence and slice thickness group	Hepatic Veins	IVC	Portal Vein	Splenic Vein	Aorta
HASTE (7-10mm)	1.5	1.7	1.5	1.4	1.1
TrueFISP (7-10mm)	4.1	3.9	4.0	3.6	4.6
3D VIBE*	4.0	3.4	4.5	4.3	4.8
HASTE (5mm)	1.3	1.4	1.3	1.2	1.1
TrueFISP (5mm)	4.6	4.2	4.8	4.6	4.8
3D VIBE†	3.8	3.3	4.3	4.2	4.7

*All 3D VIBE acquisitions were with a 3mm slice thickness. Mean scores given are for 3D VIBE acquisitions for patients in the 7-10mm(*) or 5mm(†) HASTE and TrueFISP groups.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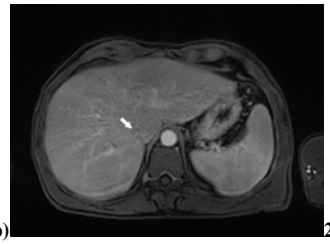
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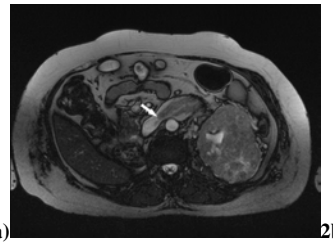
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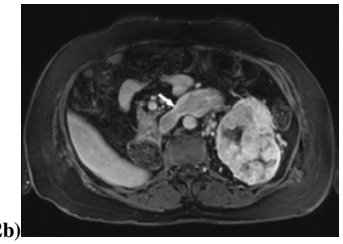
2b)

Figure 1: **a)** The intrahepatic IVC is of high signal (arrow) on this axial 5mm TrueFISP image through the liver. **b)** A 3D VIBE image at 1 minute after gadolinium injection shows a small amount of heterogenous signal within the vessel, and was felt to be inferior for the purposes of patency assessment.

Figure 2: Tumor thrombus within renal vein (arrow) is outlined better on the 5mm TrueFISP image **(a)** compared to the 3mm 1 min post-contrast 3D VIBE **(b)**.