

: True Fast Imaging with Steady State Precession(FISP) Fast Low Angle Shot(FLASH)

1

: True Fast Imaging with Steady state Precession(t-FISP) Fast Low
Angle Shot(e-FLASH) 가

: 가 62 1.5-T t-FISP
e-FLASH (liver dome)
56
(0: , 1: 50% , 2:50%
3:), (0: , 1:)
6 가

:
t-FISP (P<.05).
(P<.05). 6
e-FLASH t-FISP e-
FLASH t-FISP
: MR t-FISP e-FLASH
가

(MRI), (M- (5,6),
RA), (CT), (US) MRA

CT MRI MRA 가
가
(1). 가
(transjugular intrahepatic portosystemic shunt, t-FISP e-FLASH
TIPS) (bowel ischemia) 가
가 (2).

(3,4).
Fast Low Angle Shot(e-FLASH) true Fast
Imaging with Steady state Precession(t-FISP)
1997 7 1998 7
가
62 ()
42 , 20 , 52)
5
98 1998 11 4 1999 7 16 57

59 3 (0: , 1: 50 % , 2: 50 % , 3:) (0: 가 , 1: 가)

MRI 1.5-T (Magnetom Vision, Siemens, Erlangen, Germany) t-FISP e-FLASH (liver dome)

t-FISP { (TR) / (가 6 TE) = 4.8/2.3 msec; , 6.0 mm; , 1.5 3 mm; , 154 × 256; , 248 × 330 mm; , 70 ° , 1 } 19 . e-FLASH (TR/TE = 146/4.1 msec; , 6.0 mm; , 1.5-3 mm; , 136 × 256; , 225 × 300; , 80 ° , 1) 19 ± Wilcoxon 2-sample test 95%(P<.05)

e-FLASH (presaturation band) cir- cularly polarized (body array coil)

MR gadopentetate dimeglumine (Magnevist, Shering, Germany) 0.1 mmol/kg 30 , 60 , 90 , 5 e-FLASH 1 · 2 가 60 45 , 60 90 t-FISP 90 11 56 t-FISP(t) e-FLASH(e) t-FISP e-FLASH (P<.05) (Table 1); (t:2.83 ± 0.38, e:1.67 ± 0.54), 1 (t:2.44 ± 0.58, e:1.78 ± 0.60), 2 (t:2.49 ± 0.62, e:1.96 ± 0.72), (t:2.23 ± 1.03, e:1.89 ± 0.62), (t:2.75 ± 0.43, e:2.04 ± 0.70)

가 62 56 , 1 , 2 , , -



Fig. 1. A 36-year-old male patient with hepatocellular carcinoma at segment 7(not shown) without PV thrombosis
A. True-FISP image shows that the portal system shows relatively homogenous high signal intensity and a little flow artifact at the main portal vein, 1st and 2nd branches of portal vein, splenic vein, and spleno-portal junction.
B. Contrast-enhanced FLASH image shows that the portal venous system demonstrates heterogenous high signal intensity and much flow artifact(арrows) at each site.

($t: 2.20 \pm 0.64$, $e: 1.81 \pm 0.68$).

가, t-FISP (Fig. 1).

e-FLASH (spleno-renal shunt) 5

t-FISP

e-FLASH

t-FISP

1 \pm 0 e-FLASH 0.67 \pm 0.47

($P < 0.001$). t-FISP

가

e-FLASH 가

6

e-FLASH t-FISP

6

e-FLASH, t-FISP digital subtraction angiography (DSA)

1 t-FISP DSA 가

e-FLASH

t-FISP e-FLASH (Table 2)(Fig. 2).

MR

CT

CT

(portosystemic shunt) 가

Table 1. Mean Scores of Each Vessels in 56 Cases without PV Thrombosis

Vessels	t-FISP	e-FLASH	P-value
Main PV	2.83 \pm 0.38	1.67 \pm 0.54	< 0.001*
1st branch of PV	2.44 \pm 0.58	1.78 \pm 0.60	< 0.001*
2nd branch of PV	2.49 \pm 0.62	1.96 \pm 0.72	< 0.001*
Splenic vein	2.23 \pm 1.03	1.89 \pm 0.62	< 0.002*
SMV	2.75 \pm 0.43	2.04 \pm 0.70	< 0.001*
SP junction	2.20 \pm 0.64	1.81 \pm 0.68	< 0.005*

* : Wilcoxon 2-sample test

t-FISP : true Fast Imaging with Steady state Precession

e-FLASH : enhanced Fast Low Angle Shot

PV: portal vein

SMV: superior mesenteric vein

SP junction: spleno-portal junction

(7).

(motion artifact)

(1).

(time of flight) (phase contrast)

MRA

TIPS 가

(surgical clips), (in-plane saturation),

(complex flow)

가 “to-and-fro” 가

가 가

가 (8,9).

FISP FLASH

Unger (6)

(gradient echo technique)

, Runge (10)

가

e-FLASH FISP

가

FLASH (flip angle)

(section-selective low-flip-angle pulse)

(compensating gradient) (negative polarity (11).

section-selection gradient)

(gradient-spoiled) FLASH TR

TR

(transverse magnetization) 가

(spoiler gradient)

(12).

FLASH

Table 2. Six Cases with PV Thrombosis

Location of HCC	Location of PV thrombosis		
	DSA	t-FISP	e-FLASH
Case 1 C & P at S8	Rt & main	Rt & main	Rt & main
Case 2 C at S7	Rt	Rt	Rt
Case 3 C at S5	Rt	Rt	Rt
Case 4 C & P at S6	Rt & main	Rt & main	Rt, Lt, & main
Case 5 C & P at S6	Rt, Lt, & main	Rt, Lt, & main	Rt, Lt, & main
Case 6 P at S3	Lt	Lt	Lt

HCC : hepatocellular carcinoma

DSA : digital subtraction angiography

C : central portion

P : peripheral portion

S8 : segment 8 in liver

Rt : right

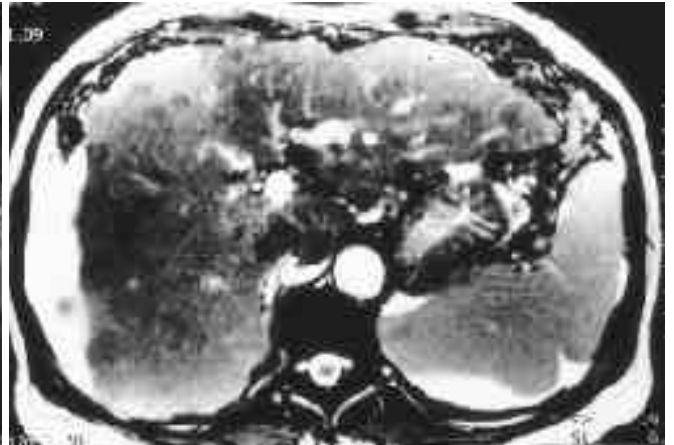
Lt : left

T1-
80° TR 146 msec, TE 4.1
T1-
FLASH
FLASH

가 , 가 e-
가 60 90
가 ,
가



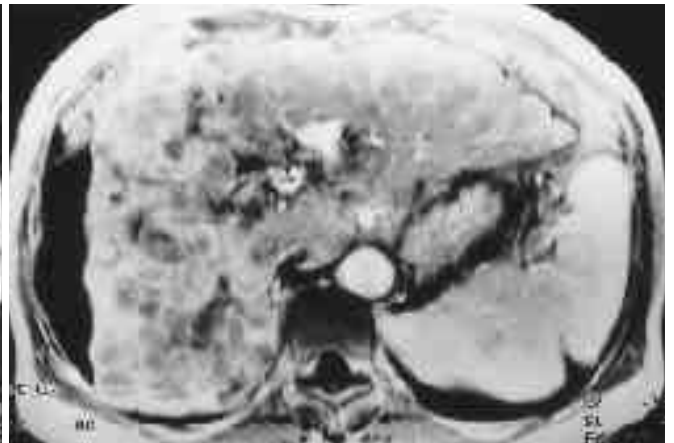
A



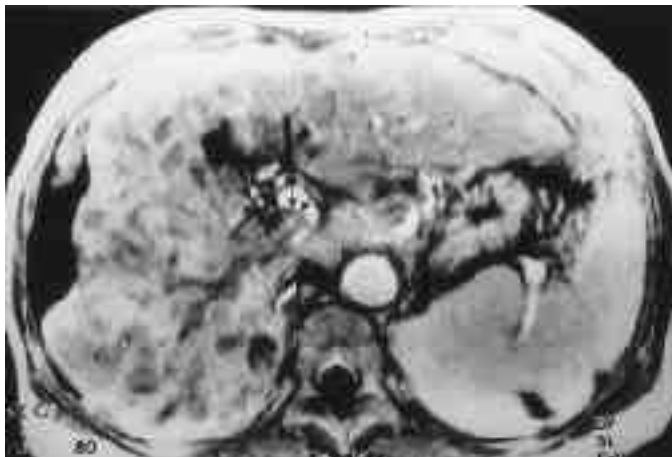
B



C



D



E

Fig. 2. A 54-year-old male patient with hepatocellular carcinoma involving central and peripheral portion of segment 6 and tumor thrombus within right and main portal vein

A. Portography via superior mesenteric artery shows partial obstruction at upper portion of main portal vein, but the left portal vein is patent.

B. True-FISP image at the level of left portal vein shows a tumor thrombus at the right portal vein(arrows) with patent left portal vein.

C. True-FISP image at the level of main portal vein shows a tumor thrombus extending to the upper portion of main portal vein(arrows).

D. Contrast-enhanced FLASH image at the level of left portal vein shows a suspicion of tumor thrombus at the left portal vein(arrow).

E. Contrast-enhanced FLASH image at the level of main portal

vein, a tumor thrombus at the right and main portal vein(arrows). Note hepatocellular carcinoma at central and peripheral portion of segment 6 in liver.

	t-FISP	FLASH	GRASS/FISP 가 (rewinding)	(phase-encoding gradients) FLASH (phase-encoding gradient step) (excitation)	T2*	T2	FLASH 가	TR (maximum intensity projection) 가	Rodgers(16) X-	e- 가
	FLASH	가	(phase coherence) 가 (read directions) t-FISP	FISP 가 FISP GRASS (phase-encoding),	TR	(first-order (phase shifts)	(flow arti- (image TR	e-FLASH t-FISP	t-FISP	e-FLASH
	FLASH	가	TR(TR<<T2)	T2 가 FLASH GRASS/FISP 가	T2	T1- (phase errors)	70 °, TR 4.8 T2-	msec, TE 2.3 msec	e-FLASH	t-FISP
	FLASH	가	(13).	(14).	가	TSE HASTE T2-	e-FLASH	(15)		

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MR Imaging of Portal System : Comparison between True-Fast Imaging with Steady State Precession(FISP) and Enhanced Fast Low Angle Shot(FLASH) Imaging¹

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Purpose : The purpose of this study was to compare true-fast imaging with steady state precession(t-FISP) with enhanced fast low-angle shot(e-FLASH) imaging of the abdomen in the assessment of the normal and abnormal portal venous(PV) system.

Materials and Methods : In order to evaluate the PV system, MR images using both t-FISP and e-FLASH sequences were obtained in 62 patients with hepatic mass. In 56 cases in which PV thrombosis was not demonstrated, images were evaluated for homogeneity and artifacts within the lumen of the PV system and the margin of the main PV. In the other six cases of PV thrombosis, conspicuity and extent of the thrombus were also compared.

Results : For each vessel, the mean score for homogeneity and artifacts was significantly higher in t-FISP images than in e-FLASH images($P < .05$), as were mean scores for the margin of the main PV ($P < .05$). In six patients with PV thrombosis, conspicuity of the thrombus as seen on t-FISP images was superior to that seen on e-FLASH images; similarly, the exact extent of the thrombus was more accurately defined on the former type of image.

Conclusion : For evaluation of the PV system, t-FISP MRI provides better imaging quality and better conspicuity with regard to the site and extent of PV thrombus, as compared with e-FLASH images.

Index words : Portal vein, MR

Magnetic resonance(MR), comparative studies

Magnetic resonance(MR), pulse sequences

Magnetic resonance(MR), technology

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