

Non-Contrast-Enhanced Abdominal MRA at 3T using Velocity-Selective Pulse Trains

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Introduction

Non-contrast-enhanced (NCE) magnetic resonance angiography MRA using velocity-selective (VS) pulse trains showed good quality in brain^{1,2}. The performance of velocity-selective based MRA on abdomen³ still requires evaluation, especially on 3T system.

We aimed to construct an NCE abdominal MRA protocol at 3T

- using velocity-selective pulse trains:
 - Velocity-selective saturation (VSS) pulse¹
 - Spatially selective inversion (SSI) plus VSS pulse²
 - Velocity-selective inversion (VSI)⁴ plus VSS pulse
- with large spatial coverage: whole abdomen
- without special planning.

Methods

The pulse sequence diagram is displayed in Fig. 1a). A VSS pulse train was placed right before acquisition modules to suppress static tissue. An adiabatic spatially selective inversion (SSI) pulse or a velocity-selective inversion (VSI) pulse train was applied with inversion delays to null static tissue background and venous signal. Fig. 1b-e) show the pulse train (b, d) and VS profiles (c, e) of VSS (b, c) and VSI (d, e) modules, respectively. When inversion pulses were not applied, the VSS module alone does not separate arterial from venous blood.

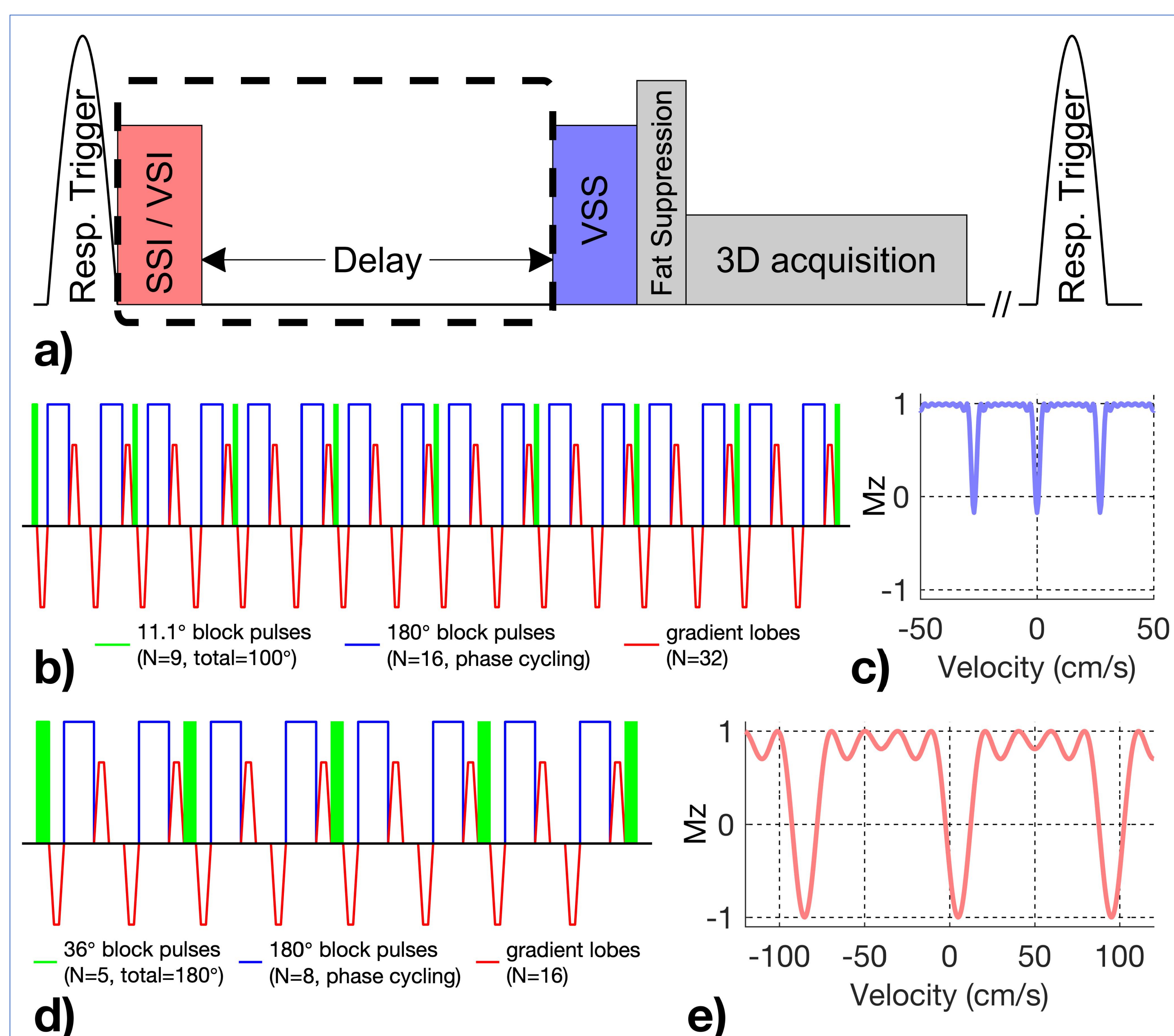


Figure 1: a) The diagram of the abdominal VS-MRA sequences. Modules in dashed box is for arteriography only. b) The diagram of the VSS pulse train and c) its corresponding velocity-selective profile. d) The diagram of the VSI pulse train and e) its corresponding velocity-selective profile.

9 healthy subjects (45 ± 15 yrs. 4 females) on:

- 3T Philips scanner, 32-channel chest array
- bSSFP, TR / TE / flip angle = 4.7 ms / 2.2 ms / 80°, TFE factor = 70,
- Resolution = 1.4 (FH) × 1.4 (LR) × 2.0 (AP) mm³
- FOV = 300 (FH) × 400 (LR) × 120 (AP) mm³,
- Compressed sensing (CS) factor = 8,
- Delay = 1200ms (SSI) and 700ms (VSI),
- Total acquisition times = 3-4 minuts (depending on breathing periods).

Four circular ROIs of arteries were manually drawn on abdominal aorta or iliac arteries at hepatic, renal, aortic bifurcation and iliac bifurcation levels. Background tissue ROIs were drawn on liver (for hepatic level), kidney (for renal level, right and left averaged), and the area below aorta bifurcation (for aortic bifurcation and iliac bifurcation levels).

Relative contrast ratios = (artery signal – tissue signal) / artery signal.

Results

MIPs of VSS, SSI+VSS and VSI+VSS images of 3 subjects are demonstrated in Fig. 2:

- Arteries, veins and portal system could be identified in VSS prepared angiography.
- SSI/VSI+VSS sequences suppressed venous and portal system.
- SSI+VSS provided better arterial details like small branches of renal arteries
- VSI+VSS preserved distal arteries like iliac arteries.

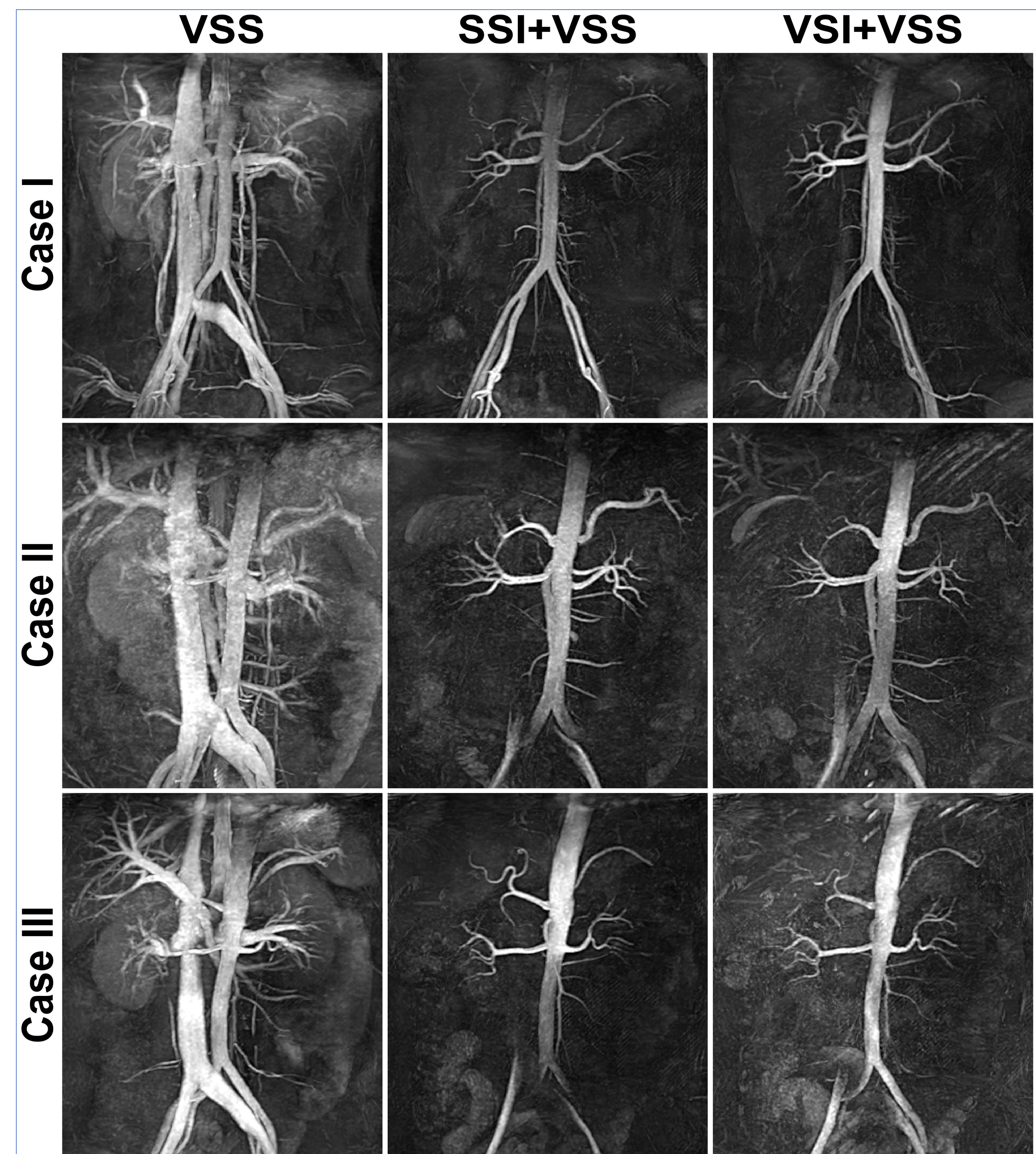


Figure 2: MIP Images of: Case I): 24-yo. female, Case II): 33-yo. male, and Case III): 58-yo. female .

Averaged relative contrast ratios of major abdominal arterial segments are compared in Fig. 3:

- VSS about 0.60-0.65 at all levels except 0.38 at the hepatic level.
- SSI+VSS and VSI+VSS both about 0.58-0.75 at proximal levels.
- At iliac bifurcation, SSI+VSS had much lower contrast than VSI+VSS, 0.15 vs 0.43

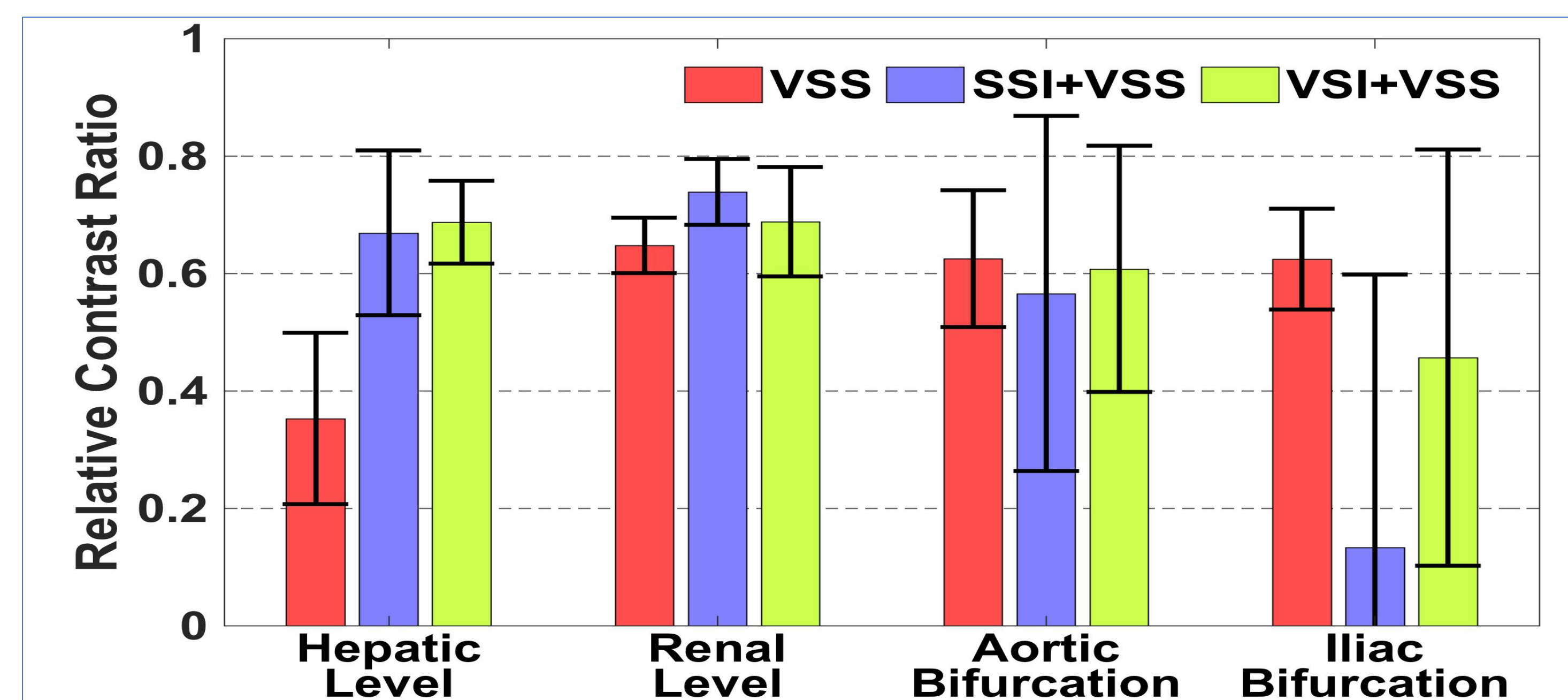


Figure 3: Relative contrast ratios of major arteries using VSS, SSI+VSS and VSI+VSS scans.

Discussion

- The feasibility of 3D abdominal VS-MRA sequences was evaluated at 3T for large spatial coverage.
- The SSI prepared method is inflow based and could be hampered by slow flow.
- The VSI based approach is less sensitive to slow arterial inflow.