

Improvement in Delineation of Peripheral Arteries using Non-contrast-enhanced 3D MRA with ECG-Triggered half-Fourier FSE: Additional Spoiler Pulses in the Phase Encode Direction

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ABSTRACT

Separation of arteries from veins can be achieved in non-contrast-enhanced peripheral MRA using ECG-triggered 3D half-Fourier FSE with read-out (RO) spoiler gradient pulses. However, the separation was limited to only the head-to-foot direction or the RO direction. Most of peripheral vessels are oriented in the head-to-foot direction; however, some arterial branches are oriented in the right-left direction. In this study, an additional PE spoiler gradient pulse was implemented in half-Fourier FSE and the technique gave better delineation of peripheral arteries oriented in the both directions.

INTRODUCTION

Recently reported non-contrast-enhanced peripheral MRA technique, flow-spoiled fresh blood imaging (FBI), allows separation of arteries from veins using ECG-triggered 3D half-Fourier FSE with flow-spoiling pulse in the read-out (RO) direction [1]. The technique applies flow-spoiling pulses in the RO direction (the head-to-foot direction) so that the arterial signals of systolic images are depicted in black blood and diastolic images in bright blood. In this manner, subtraction of diastolic from systolic images provides only the arterial signals. Most of the peripheral vessels orient in the head-to-foot direction and thus give good separation of arteries from veins; however, in some cases the anterior tibial arteries in the popliteal trifurcation are oriented in the phase-encode (PE) direction. In addition, some patients have distorted vessels around iliac arteries, which will be depicted in loss of signals in the PE direction [2]. Since near the centric k space acquisition is used, both systolic and diastolic-triggering gives good signals in the PE direction so that subtraction gives loss of arterial signals. In this study, we have implemented additional spoiler gradient pulses in the PE direction in order to differentiate the signal intensities in the systolic and diastolic-triggered images.

MATERIALS and METHODS

Figure 1 shows sequence diagrams for the original PE gradient, spoiler pulse, and the combined spoiler gradient pulses. All studies were performed on a 1.5-T silent MRI system (EXCELART/XGS, Toshiba, Tokyo), equipped with a QD whole body coil. Typical parameters of 3D acquisition were as follows: TR/TE_{eff} = 3 R-R intervals/30 msec, ETS of 5 msec, matrix of 256x256, TI of 150 msec, NAQ of 1, 26 slice partitions with a 4-mm thick slice (which was interpolated to a 2-mm slice), FOV of 38x38 cm, and an each ECG-triggered acquisition time of about 90 sec. Both diastolic and systolic-triggered images were acquired using the original PE gradient and the PE with spoiler gradient pulses.

RESULTS

Figure 2 shows MIP images the popliteal trifurcation region after subtraction of diastolic from systolic-triggered images. Figure 2a) presents the original PE gradient pulses without spoiler images and Fig. 2b) shows one with spoiler. Both give well-separated arterial images using flow-spoiled FBI technique. Note that a signal loss of the anterior tibial artery where the vessel oriented in right-to-left was prominent. This signal loss was caused by high signal intensities of diastolic and systolic source images, which sometimes mislead to a stenosis. On the other hand, the technique using the PE direction with spoiler Figure 2b) provides enough flow-dephasing effect in the PE direction so that signal loss was not seen after subtraction.

DISCUSSION

The additional spoiler pulses in the PE direction were implemented in ECG-triggered 3D half-Fourier FSE with the RO spoiler pulses. Application of spoiler pulses in both the RO and PE direction allows better separation of arteries from veins in both directions. Availability of controlling both directions allows avoiding two separate acquisitions for both directions [3]. Further clinical studies are now under work-in-progress.

In conclusion, we have shown that the implementation of the additional spoiler gradient pulses allows better separation of arteries from veins in the both directions.

REFERENCES

[1] Miyazaki M, et al, *Radiology* 227:890-896, 2003. [2] Urata J, et al, *RSNA* p165 2002. [3] Miyazaki M, et al, *JMRI* 8:505-507, 1998.

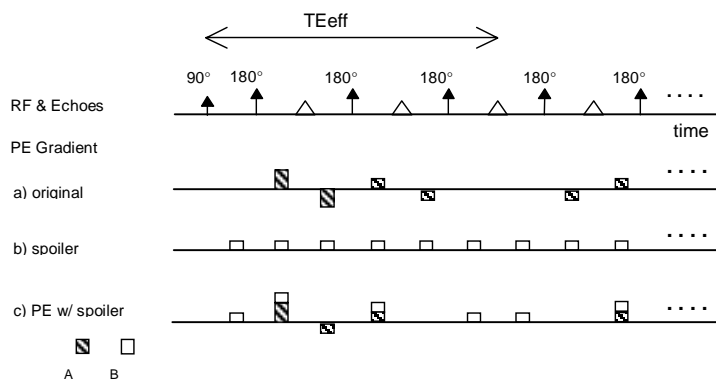


Fig. 1 PE gradient in FSE with original, spoiler, and PE with spoiler pulse.

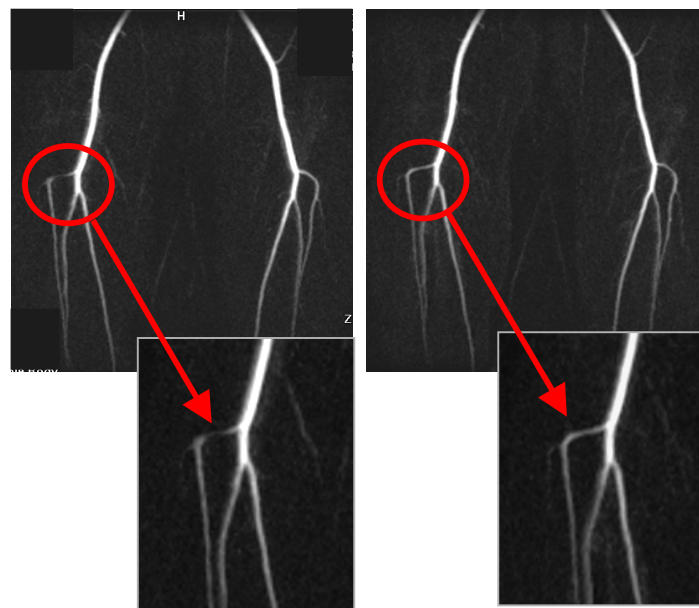


Fig. 2 Peripheral images without (left) and with the PE spoiler pulse (right).