

Double Background Suppression in Quiescent Inflow Single-Shot Imaging at 3T

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Purpose: Non-contrast technique Quiescent Inflow Single-Shot (QISS) imaging has been used for the evaluation of peripheral arterial disease (PAD) due to its fast and motion insensitive features [1]. In the standard setting of QISS, background suppression (BGS) is performed by using an imaging slice saturation pulse. However, due to the B0 and B1 inhomogeneity, ideal background suppression sometimes cannot be achieved, which leads to extra post processing procedure such as cutting undesired background signal in the MIP images to better visualize arteries. In this study, we propose a double background suppression method by extending the coverage of the tracking saturation slab to cover the imaging slice, and hypothesize that the tracking saturation pulse together with the imaging saturation pulse will offer improved imaging background suppression.

Methods: The study was approved by our institutional review board and informed consent was obtained. Seven healthy volunteers (28-65 years; 2 female) were enrolled and scanned by a Vantage Titan 3T scanner (Toshiba Medical Systems Corporation, Otawara, Japan) equipped with Atlas SPEEDER Spine coil and Atlas SPEEDER Body coil. Followed by the localizer, calf station was imaged using QISS sequences with ECG gating. QISS parameters: single shot bSSFP, TR/TE=3.4/1.7ms, 60-80 slices for one station scan, slice thickness=4.0mm, slice gap = -1.0mm, matrix: 128X256, FOV 32cmX39cm, parallel imaging factor =3, flip angle=85°, double fat sat, TD=150ms, QI=220ms, one slice/RR, refine in RO and PE direction; tracking sat offset=5.4cm. Three BGS methods (Figure 1) were tested: A) using the imaging slice saturation (tracking sat thickness=10.4cm) for single background suppression (S-BGS); B) extended tracking saturation slab (tracking sat thickness=11.2cm) for double background suppression (D-BGS); C) extended tracking saturation slab (tracking sat thickness=11.2cm) for background suppression without imaging slice saturation pulse (T-BGS). Contrast to noise ratio (CNR) between artery and background tissue was measured at 5 different slices at calf station for each volunteer; Overall MIP images were blindly scored by 2 experienced clinical scientists (0: low, 4: high). Student t-test was performed to compare the effects of different background saturation methods.

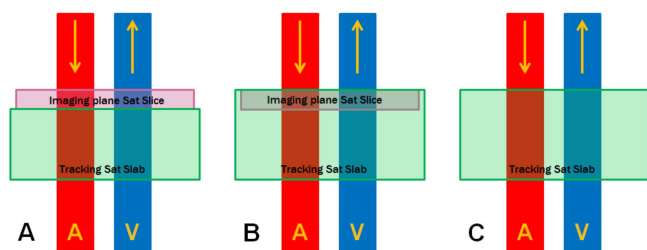


Figure 1. The coverages of imaging saturation slice (purple) and tracking saturation slab (green) for the three background saturation methods: A) single BGS by imaging slice saturation pulse; B) double BGS by imaging slice sat pulse and extended tracking sat pulse; C) only the extended tracking saturation pulse served for imaging slice saturation.

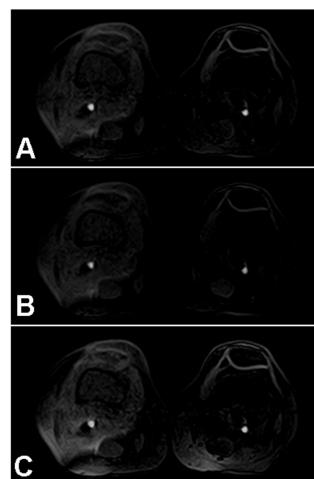


Figure 2. Typical 2D axial images of the same slice acquired by the 3 different background saturation methods.

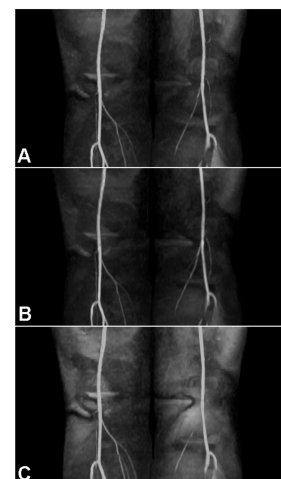


Figure 3. Coronal MIP images at calf station of a healthy volunteer acquired by 3 different background saturation methods.

Results: The CNRs of arterial signal against background signal are significantly different for the 3 background suppression methods. Double BGS (method B) gives the best CNR of arterial blood signal, while extended tracking sat to cover the imaging slice (method C) gives the lowest CNR. Among the MIP images acquired by the 3 methods, double BGS has the highest score for background suppression than the other two methods. Figure 2 shows a single slice acquired by using the 3 methods, clearly double BGS offers better background tissue suppression; Figure 3 shows the MIP images at calf station from a healthy volunteer, in which the images with double BGS displayed less background tissue signal. Note the 3 images in Figure 2 and 3 are windowed at the same level.

Discussion: We evaluated three background suppression methods for QISS at calf station at 3T, and found that double BGS using both imaging plane saturation pulse and extended tracking saturation pulse covering the imaging slice can greatly reduce the background signal. Single tracking saturation pulse served as suppressing both imaging slice and tracking slab (method C) has the lowest SNR of arterial signal and lowest CNR between artery and surrounding tissue, thus is not ideal for QISS background suppression, however, it could be an alternative method if SAR limit is reached or thinner slice is preferred for QISS. One has to note that insufficient background signal suppression by either method A or method C may hinder the delineation of smaller vessels, and extra cutting may be required to remove the impact of undesired background tissue in the MIP images. Further evaluation at thigh and pelvic stations are necessary to compare the effects of the three background suppression methods.

References

1. Edelman R. et.al, MRM 63:951-958, 2010