

Ungated quiescent-inflow single-shot (UnQISS) for Nonenhanced MRA of Peripheral Arterial Disease

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Purpose: The availability of accurate noninvasive imaging tests has decreased the need for preoperative digital subtraction angiography in the evaluation of peripheral arterial disease. Although highly accurate, contrast-enhanced MRA cannot be used in patients with severely impaired renal function. Nonenhanced MRA can provide a useful alternative for such patients. Existing techniques for nonenhanced MRA, such as subtractive fast spin echo and QISS MRA, require the use of cardiac gating to synchronize data acquisition to specific phases of the cardiac cycle. Moreover, specialized peripheral vascular phased array coils are required to provide sufficient signal-to-noise ratios (SNR) over the extensive peripheral arterial territory. This requirement limits the utility of nonenhanced MRA to sites that have a PV coil. We propose an ungated variant of quiescent-inflow single-shot MRA (**UnQISS**), which eliminates the need for both cardiac gating and peripheral vascular phased array coils.

Methods: The protocol was approved by the institutional IRB. Imaging was performed at 1.5 Tesla (Magnetom Avanto, Siemens AG, Erlangen, Germany). There are several distinctive features of this technique: (1) Instead of the typically short quiescent interval (QI) of 200-300ms used with ECG-gated QISS, a long QI is used that equals or exceeds the patient's RR interval. The long QI encompasses a full cardiac cycle, thus ensuring complete refreshment of saturated in-plane arterial spins irrespective of the when data are acquired with respect to the cardiac cycle. (2) Data were acquired with a prototype radial bSSFP pulse sequence, modified to support a golden angle (GA) trajectory. The GA radial readout is longer than with ECG-gated QISS MRA (180-240 views compared with 92 views for Cartesian QISS). (3) A phase-based reconstruction is used for fat suppression. Scan time is approximately twice that of ECG-gated QISS MRA (11-12 minutes for an 8-station peripheral artery UnQISS MRA).because of the longer TI and echo train.

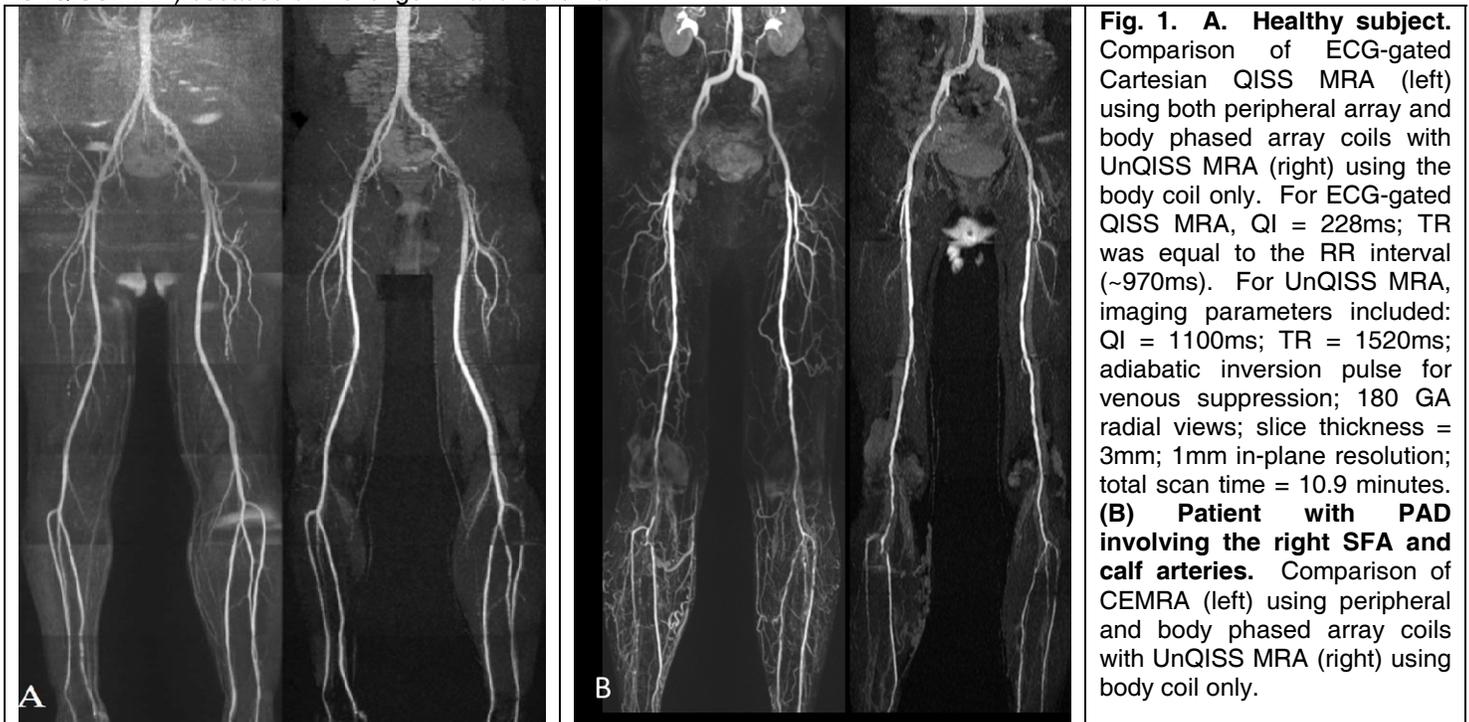


Fig. 1. A. Healthy subject. Comparison of ECG-gated Cartesian QISS MRA (left) using both peripheral array and body phased array coils with UnQISS MRA (right) using the body coil only. For ECG-gated QISS MRA, QI = 228ms; TR was equal to the RR interval (~970ms). For UnQISS MRA, imaging parameters included: QI = 1100ms; TR = 1520ms; adiabatic inversion pulse for venous suppression; 180 GA radial views; slice thickness = 3mm; 1mm in-plane resolution; total scan time = 10.9 minutes. **(B) Patient with PAD involving the right SFA and calf arteries.** Comparison of CEMRA (left) using peripheral and body phased array coils with UnQISS MRA (right) using body coil only.

Results and Discussion: Examples of UnQISS MRA using the body coil for signal reception are shown for a healthy subject (**Fig. 1A**) and a patient with PAD (**Fig. 1B**). The peripheral arteries (including small calf arteries) and diseased vessel segments are well shown by UnQISS MRA. The use of a radial k-space trajectory (as opposed to the usual Cartesian trajectory) is essential to avoid artifactual vascular signal variations. For instance, comparing Cartesian and radial UnQISS, the respective coefficients of arterial signal variation were 21.5% and 8.5%. With Cartesian, the central k-space lines dominate image contrast. Consequently, flow artifacts in central lines acquired fortuitously during periods of rapidly accelerating flow may substantially degrade the image. On the other hand, with a GA radial trajectory all views are equally weighted for the image reconstruction. Flow artifacts that may occur in a small minority of the views due to rapidly accelerating systolic flow have minimal impact on image quality, since they are diluted by the intact flow signals from the majority of other views. Moreover, the SNR of GA radial UnQISS is better than with ECG-gated QISS MRA because at least twice as many views are acquired.

Conclusion: UnQISS MRA allows peripheral nonenhanced MRA to be acquired without the need for cardiac gating. Moreover, the use of a lengthy echo train improves SNR and avoids the needs for parallel imaging, so that imaging can be done just using the body coil. These features simplify patient setup and expand availability of the technique to clinical MRI sites that do not possess specialized peripheral vascular phased array coils. The ability to do peripheral MRA with just body coil also simplifies the workflow in hybrid MR-PET systems where attenuation correction of phased array coils is, in general, challenging.

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