# Interactive MRA using ungated single-shot half-Fourier projection RARE

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## Introduction

Interactive MRI scanning interfaces are now available on commercial MR systems making use of fast acquisition sequences and rapid reconstruction. Initial applications using gradient echo sequences have included localisation for subsequent cardiac acquisitions and contrast medium arrival detection for triggering angiographic sequences. Abdominal applications have included interactive MRCP examination using a modified half-Fourier RARE sequence [1] that can be switched "on the fly" from conventional imaging to a "hydrographic" mode allowing interactive evaluation and identification of the biliary ducts and other fluid filled structures such as the small bowel, renal pelvicaliceal systems and ovarian follicles.

In a similar fashion the ability to interactively identify intra-abdominal vascular structures could have clinical application, for example rapid identification of the renal artery origins for positioning contrast enhanced angiography or determining the presence of small vessel patency in the hand or foot in peripheral vascular disease. Although gradient echo imaging using time of flight effects appear attractive for this process they are prone to in-plane flow saturation.

An unenhanced "fresh blood" angiographic method using a 3D half-Fourier single shot RARE sequence has been described by Miyazaki et al [2]. This utilises the difference in vascular signal between systole and diastole. The approach described by Miyazaki requires an initial timing acquisition to identify optimal systolic and diastolic timings for the area of interest followed by a gated 3D acquisition collecting both systolic and diastolic images. These are then post processed using a weighted subtraction and MIP technique to create angiographic images. This approach is too slow and restrictive for use in a real-time interactive setting which requires a flexible and widely applicable approach that can be implemented in real-time. This group has recently described a faster approach using using incremental ECG gating and thick slab projection imaging [3].

This work describes a similar but ungated approach using an interactive half-Fourier RARE sequence with fixed TR thick slab acquisitions implemented to provide "on the fly" processing and rapid identification of vascular structures as part of an interactive MR examination.

## Materials & Methods

A half-Fourier SSFSE sequence modified to work with an interactive interface (i/DriveProPlus, GEMS) was employed that utilised inner volume excitation to avoid image wrapping and driven equilibrium to improve SNR. All examinations were performed using a 1.5T whole body MR system (EchospeedPlus, Excite 10.0, GEMS) with a torso phased array receive coil. Parameters included a 256x256 or 384x256 matrix size with an 0.5 or 0.6 phase FOV and a slice thickness variable between 10 and 50mm combined with spectral fat saturation. A TR of just more than one cardiac cycle period (typically 1.1 to1.2x or 2.1 to2.2x) was chosen to move the acquisition timing through the cardiac cycle over approximately 10-20 heart beats with the aim of generating temporally
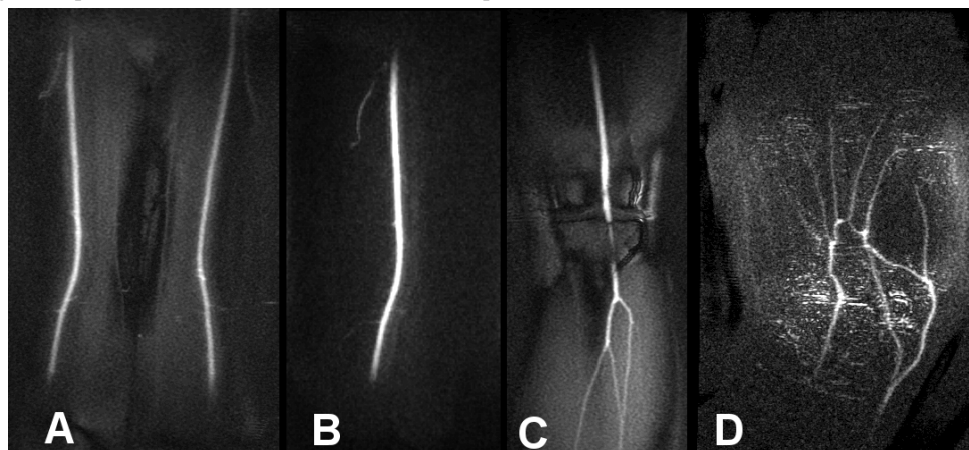


**Figure 1: Interactive MRA projection images (A) coronal femoral arteries, (B) sagittal right femoral artery, (C) left popliteal and distal trifurcation, (D) palmar arterial arcade in the hand.**

adjacent systolic and diastolic projection images regardless of the starting position in the cardiac cycle. Using a fixed TR ensured that after the first few excitations in the location of interest equilibrium of longitudinal magnetisation is reached and the static tissue signal becomes constant with, ideally, only signal changes resulting from systolic and diastolic vascular signal differences. The vascular difference signals were then extracted by subtracting adjacent temporal images, taking the magnitude values and averaging. This processing was implemented in IDL (RSI Systems) running on the host computer during image acquisition, and generating a cumulating image of the pulsatile vasculature in real-time. Volunteer images were obtained in the peripheral vasculature (wrist, thigh and leg) to avoid any effects of respiratory or gastro-intestinal motion.

## Results

In each location images were acquired over 10-40 heartbeats and the resulting averaged magnitude subtraction images are shown in figure 1. Good delineation of the arteries was obtained in each case with minimal venous contamination and moderate to excellent background suppression.

## Discussion

This work demonstrates that it is possible to use a simple ungated RARE based angiographic method with "on the fly" subtraction to identify peripheral arteries as part of an interactive examination. This could form part of an integrated study to set up more detailed contrast enhanced angiographic acquisitions or with further optimisation provide diagnostic information directly – for example regarding the lower limb run-off vessels in peripheral vascular disease patients. Further optimisation of interactive TR selection and subtraction processing methods is being carried out.

## References

[1]      Makki M et al JMRI 2002:16;85-93
[2]      Miyazaki M et al, JMRI 2000:12;776-783
[3]      Yamamoto A. et al Proc ISMRM 2003: 1709