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Meeting abstract

1139 Elimination of ghosting artifacts originating from body fluids with long T1 values in segmented ECG-gated IR-prepared sequences

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Introduction

Myocardial late enhancement images acquired with segmented ECG-gated inversion recovery (IR)-prepared sequences often exhibit bright ghosting artifacts which impede the identification of infarcted territory. The artifacts arise from body fluids with long T1 values (e.g. pericardial effusion, cerebrospinal fluid CSF, or pleural effusion). Fig. 1a shows ghosting artifacts arising from phantom II (T1 = 2600 ms). This ghosting in the phase encoding direction results from the sign oscillations and amplitude changes of the long T1 species caused by repeated IR pulses in segmented IR-prepared sequences (fig. 1b, blue line). Its severity depends, in part, on the time between successive IR pulses, as determined by the patient's RR interval and the trigger pulse. If the amplitude of the oscillating signal could be reduced or if the oscillation could be avoided altogether, the ghost would be virtually eliminated. To suppress signal from long-T1 species a non-selective saturation recovery (SR) or IR pre-pulse could be played. We chose to employ an IR pulse and a time delay as "suppression module" to allow maximal recovery of normal myocardium. Long T1-species are suppressed while image SNR remains unaffected. Such a sequence is not commercially available.

Purpose

To employ a long-T1 species suppression module consisting of a non-selective IR pre-pulse followed by a time delay to eliminate the ghosting artifacts in segmented ECG-gated IR-prepared sequences caused by the signal oscillations of body fluids with long T1 values.

Methods

We added a suppression module in front of the standard segmented ECG-gated IR-TurboFLASH sequence, which could be activated from the user interface. The pre-delay defined as time between the suppression IR pulse and the first IR pulse of the standard sequence was also controllable. On a 1.5 T clinical MRI scanner (MAGNETOM Avanto, Siemens Medical Solutions, Erlangen, Germany) we imaged three phantoms (I, II, and III) shown in figures 1a and 2a with different T1 values (I: T1 290 ms 'infarct', II: T1 2600 ms 'long-T1 species', III: T1 490 ms 'normal myocardium'). Sequence parameters included: TI 340 ms to null normal myocardium, RR 800 ms, trigger pulse 2, flip angle 15°, lines/segment 7, TE 3.85 ms, echo spacing 9 ms, bandwidth 130 Hz/pixel. Imaging was performed with the suppression off (fig. 1a) and on (fig. 2a, pre-delay 2600 ms). To quantify the ghosting severity we measured the SNR in the artifact area (blue rectangle in fig. 1a) and expressed it as a percentage where 100% corresponded to the suppression-off case. To assess the method's robustness towards a varying pre-delay time, we used pre-delays from 1300 ms to 2600 ms in increments of 100 ms and calculated the artifact SNR as above. The suppression module was evaluated in cardiac patients whose standard images demonstrated ghosting artifacts.

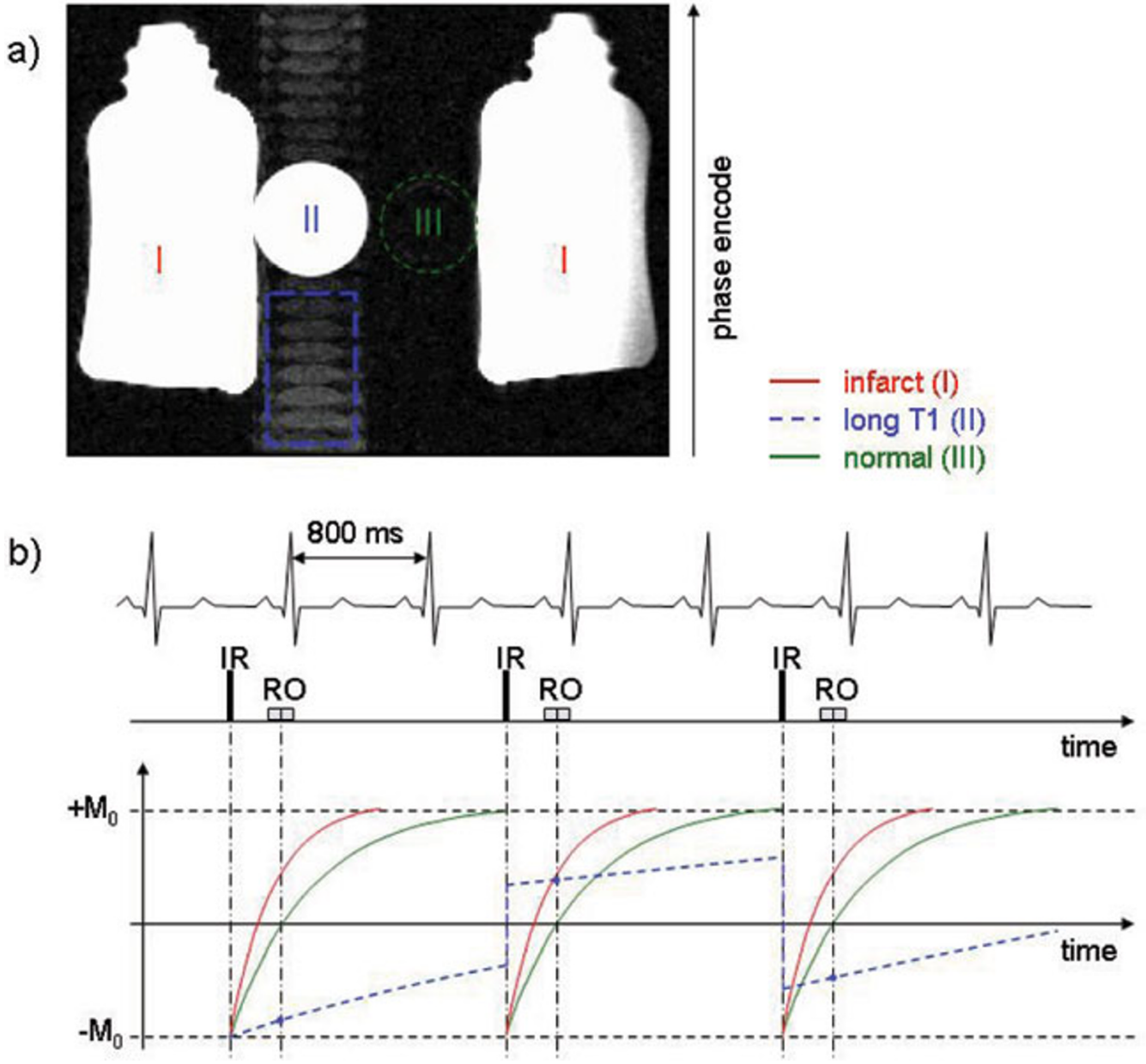

Figure 1

Results

The artifacts clearly present in the image obtained with the standard sequence (fig. 1) are not visible when using the suppression module (fig. 2). The relative artifact SNR for a 2600 ms pre-delay is 21% of the standard case. Fig. 3a shows the relative artifact SNR as function of the pre-delay. The artifacts are smallest over a broad range of pre-delays from 2200 ms to 2600 ms. The ghosting in the right ventricular cavity resulting from CSF (fig 3b) is completely eliminated by the suppression module (pre-delay 2600 ms, fig. 3c).

Conclusion

In phantom and in-vivo experiments playing a suppression module consisting of a non-selective inversion pulse and a pre-delay of 2200 ms to 2600 ms eliminates long-T1 species ghosting in segmented ECG-gated IR-prepared sequences without affecting the SNR of the myocardium. As artifacts due to multiple long-T1 species are suppressed using the same pre-delay the ghosting can be eliminated without scanner operator involvement.

figure 2

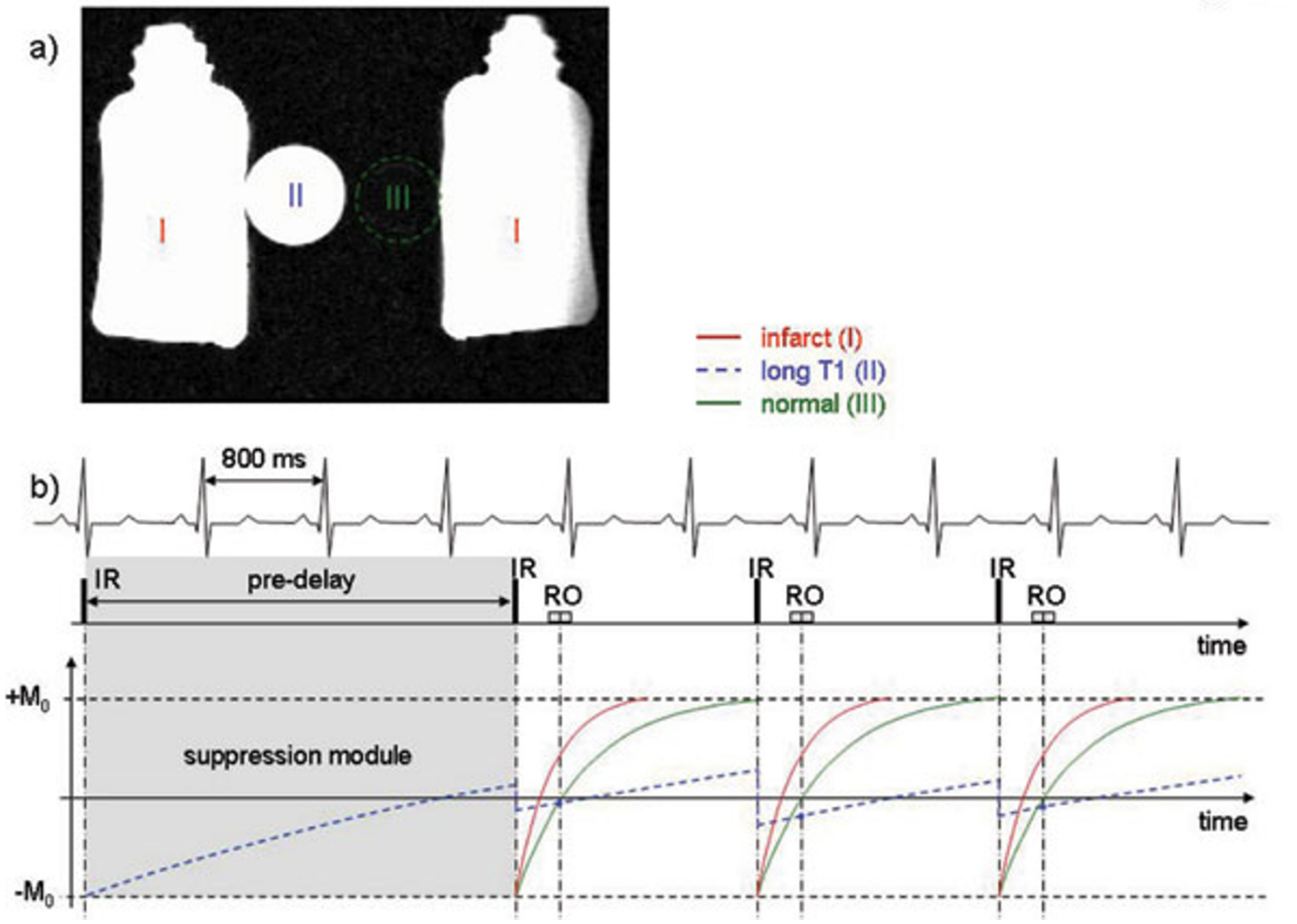

Figure 2

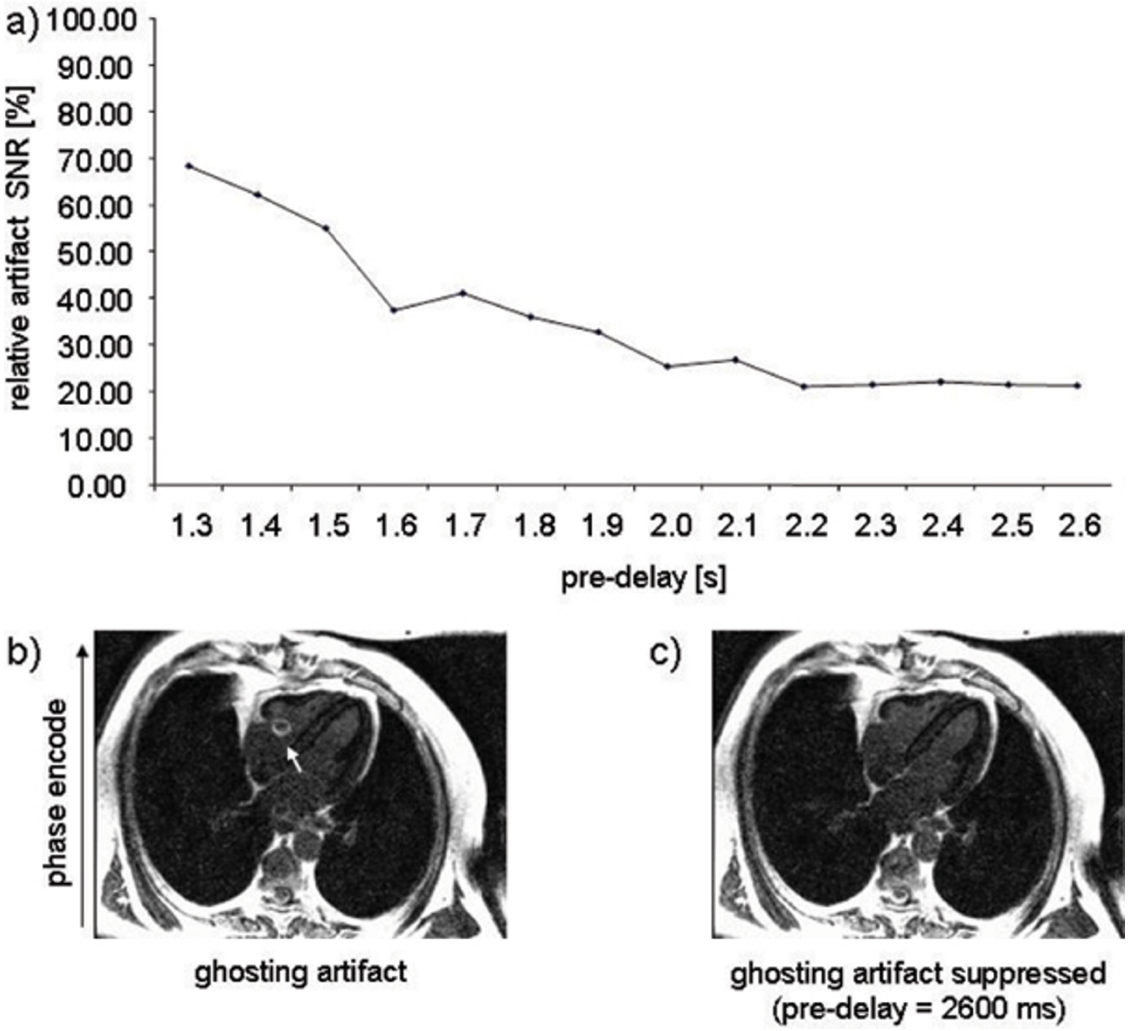

Figure 3
Late gadolinium-enhanced viability images from segmented ECG-gated IR-prepared sequences often exhibit ghosting artifacts due to signal oscillations of fluids with long T1 relaxation times. We developed an artifact suppression technique and tested it on a phantom and in cardiac patients.