

Comparison of prospective ECG-gated MRI with wireless, retrospective gated MRI for evaluation of heart function in healthy and infarcted mouse heart

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Introduction; Cardiac function often needs to be evaluated in genetically modified mice, e.g. after a myocardial infarction. To assess heart function, cardiac magnetic resonance imaging (MRI) is the method of choice, since it is noninvasive, and provides high temporal and spatial resolution for the left- as well as the right ventricle. In animal cardiac MRI, the quality of the ECG signal is variable and sometimes deteriorates over time, especially with mice that have suffered from a myocardial infarction or cardiac hypertrophy. Therefore we compared the ‘wireless’ retrospective gating method IntraGateFLASH (figure 1) with the standard prospective gating method FLASH in mice with infarcted hearts (n=11) as well as control mice (n=16).

Methods; Mice were imaged in a vertical 9.4T MR system (Bruker). Images of contiguous 1mm slices were made from apex to base with prospective and retrospective gating methods (figure 2), parameters are shown in table 1. Data were processed with dedicated software (Mass, Medis, Leiden, the Netherlands) to calculate cardiac function parameters for both the left-and right ventricle (LV and RV); end diastolic volume (EDV), end systolic volume (ESV), stroke volume (SV), cardiac output (CO), and ejection fraction (EF). Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated in a mid-ventricular slice in 5 healthy control mice.

Results; The SNR and CNR (table 2) of the retrospectively gated data are higher than the SNR and CNR of the prospectively gated data. There were no significant differences between the two gating methods found in the cardiac function parameters (table 3), neither in the control mice nor the mice who suffered from a myocardial infarction.

Conclusion; The ‘wireless’ retrospective gating method gives comparable results with regard to the cardiac function parameters between healthy control mice and mice with infarcted hearts. However, the ‘wireless’ method provides even better SNR and CNR when the acquisition time is kept equal. In conclusion, the ‘wireless’ retrospective gating method is suitable for routine use in cardiac magnetic resonance imaging in mice, even in mice who suffered from a myocardial infarction.

	Prospective gating	Retrospective gating
TE	1,976 ms	1,926 ms
TR	Dependent on heart rate (12-16ms)	5,239 ms
RF pulse	1 ms	300 μ s
Flip angle	22°	10°
Spectr. bandwidth	101010 Hz	75757 Hz
Acq. matrix	256x128	256x128
Recon. matrix	256x256	256x256
In-plane resolution	117 μ m	117 μ m
Averages/repetitions	4 av	128 rep
Cardiac frames	10	10
Total acquisition time	Varying from 1m25s to 3m00s	1m25s

	CNR	SNR myocardium	SNR blood
prospective	35,66 \pm 5,0	18,34 \pm 1,0	53,99 \pm 4,8
retrospective	46,08 \pm 5,7	39,24 \pm 1,0	85,32 \pm 6,2

Table 2: mean (\pm SD) CNR and SNR in mid-ventricular slices of 5 healthy control mice

Mean difference (%)	LVEDV	LVESV	LVSV	LVCO	LVEF
control	0,15 \pm 4,5	-4,13 \pm 9,2	2,89 \pm 7,9	4,33 \pm 8,4	2,74 \pm 5,3
infarct	-2,93 \pm 3,0	-2,27 \pm 3,0	-7,77 \pm 17,9	-7,77 \pm 17,8	-4,88 \pm 16,4

Mean difference (%)	RVEDV	RVESV	RVSV	RVCO	RVEF
control	1,97 \pm 5,4	0,69 \pm 13,1	3,13 \pm 7,0	4,57 \pm 8,6	1,03 \pm 5,3
infarct	8,90 \pm 18,3	11,2 \pm 21,1	8,45 \pm 22,5	8,45 \pm 22,4	-0,44 \pm 12,5

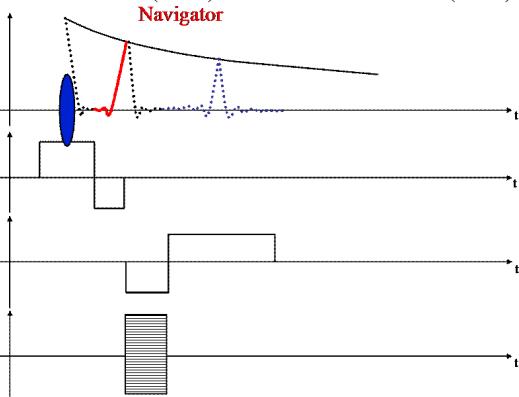


Figure 1: IntraGateFLASH sequence with navigator echo

Blue oval shape: RF pulse with flip angle θ

Red solid line: navigator

Blue dotted line: echo

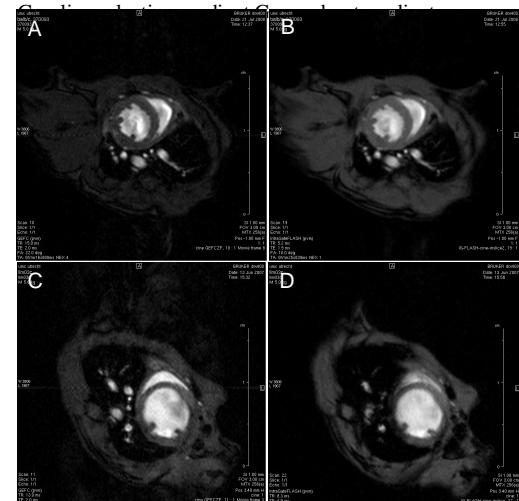


Figure 2: Mid-ventricular slice of a healthy mouse heart (A-B) and a mouse heart with an infarct (C-D); prospectively gated (A, C) and retrospectively gated (B, D) in end diastolic fase.

Table 3: mean percentile difference (\pm SD), in cardiac function, between the two gating methods. In healthy control mice (n=16) and mice suffering from an infarct (n=11).