Morton et al. Journal of Cardiovascular Magnetic Resonance 2012, 14(Suppl 1):P12
http://www.jcmr-online.com/content/14/S1/P12

Journal of Cardiovascular Magnetic Resonance

POSTER PRESENTATION Open Access

Advanced techniques improve the performance of myocardial perfusion imaging

Geraint Morton*, Masaki Ishida, Andreas Schuster, Tobias Schaeffter, Amedeo Chiribiri, Eike Nagel

From 15th Annual SCMR Scientific Sessions
Orlando, FL, USA. 2-5 February 2012

Background

Technical advances in cardiac magnetic resonance (CMR) perfusion imaging, particularly accelerated data acquisition methods, allow myocardial perfusion imaging with unprecedented spatio-temporal resolution. However, it is not clear how implementation of these advances affects perfusion image quality and artefacts and signal and contrast to noise ratios (SNR and CNR).

Methods

A standard ultrafast gradient echo perfusion sequence (st-GrE) was compared with an advanced kt-accelerated steady state free precession sequence (kt-SSFP) at 1.5T in a hardware perfusion phantom, healthy volunteers (n=16) and patients (n=31) with known or suspected coronary artery disease. Volunteers had both sequences at rest in alternating order. Patients underwent stress imaging with either st-GrE (15) or kt-SSFP (16) prior to X-ray coronary angiography.

The phantom was used to generate signal intensity curves and noise maps for SNR and CNR analysis. Human images were analysed by a blinded observer using a nominal scale for quality (0 non-diagnostic, 1 poor, 2 moderate, 3 good, 4 excellent) and respiratory artefacts (0 non-diagnostic, 1 severe, 2 moderate, 3 minor, 4 nil) and also for the presence of CAD in patients. Other analyses included the extent (% affected segments), transmurality (1: 1-25%, 2: 26-50%, 3: 51-75%, 4 76-100%) and duration (frames) of dark rim artefacts (DRA). Segmental SNR and CNR were also quantified using the mid ventricular slice in volunteers.

Results

Phantom studies demonstrated comparable SNR and CNR for both sequences: (SNR 54.7 & 53.9 and CNR 24.1 & 22.8 for st-GrE and kt-SSFP respectively). In normal hearts kt-SSFP imaging resulted in significantly improved image quality (p=0.003), SNR (21.0±6.7 vs. 18.8±6.6; p=0.009), CNR (15.4±6.1 vs. 14.0±6.0; p=0.034) and a reduced extent (p=<0.0001) and transmurality (p=0.0001) of DRA. In patients kt-SSFP imaging resulted in significantly improved image quality (p=0.012), and a reduced extent (p=<0.0001), duration (p=0.004) and transmurality (p=<0.0001) of DRA. Sensitivity and specificity for the detection of CAD against X-ray angiography was comparable with both sequences. There was a non-significant trend towards increased respiratory artefacts with kt-SSFP in both patients and volunteers.

Conclusions

Advanced high spatio-temporal resolution CMR perfusion imaging using a kt-SSFP technique results in significantly improved image quality, SNR and CNR and a reduction in the extent and transmurality of DRA compared to a standard sequence.

Funding

This work was supported by a European Union Grant (Grant number 224495 to GM, EN); the British Heart Foundation (Research Excellence Award RE/08/003 and FS/10/029/28253 to AS, EN); the Biomedical Research Centre (grant number BRC-CTF 196 to AS, EN) and the Wellcome Trust and EPSRC (grant number WT 088641/Z/09/Z to AC, EN).

Published: 1 February 2012

King's College London, London, UK

Table 1 Perfusion sequence parameters

Parameter	st-GrE	kt-SSFP
Acquired spatial resolution	1.7 x 1.9 x 10mm	2.6 x 2.8 x 10mm
Echo time (TE)	Shortest (range 1.61-1.91ms)	Shortest (range 1.29-1.59ms)
Repetition time (TR)	Shortest (range 3.6-3.9ms)	Shortest (range 2.59-3.18ms)
Flip angle	18°	50°
Prepulse	90°	90°
Prepulse delay	100ms	100ms
Acceleration technique	SENSE: factor 2	kt-BLAST: factor 5 with 11 training profiles (effective k-t factor of 3.8)

Table 2 Sequence comparison

	Volunteers					Patients				
	st-GRE		kt-SSFP		p value	st-GRE		kt-SSFP		p value
Image quality	n	%	n	%		n	%	n	%	
0 non-diagnostic	1	6%	0			0		0		
1 poor	0		0			3	10%	0		
2 moderate	12	75%	3	19%	0.003	12	40%	2	6%	0.012
3 good	3	19%	12	75%		12	40%	17	53%	
4 excellent	0		1	6%		3	10%	13	41%	
Respiratory artefacts										
0 non-diagnostic	0		0			0		0		
1 severe	0		1	6%		0		2	6%	
2 moderate	3	19%	5	31%	0.07	7	23%	7	22%	0.17
3 mild	7	44%	7	44%		8	27%	16	50%	
4 nil	6	38%	3	19%		15	50%	7	22%	
Dark rim artefact										
Extent(%)	39±13		15±12		<0.0001	33±14		12±10		<0.0001
Transmurality	1.83±0.58		1.02±0.06		<0.0001	1.57±0.40		1.07±0.17		<0.0001
Duration	10.6±3.56		9.7±2.51		0.373	10.8±3.7		8.0±2.7		0.004

doi:10.1186/1532-429X-14-S1-P12
Cite this article as: Morton *et al.*: Advanced techniques improve the performance of myocardial perfusion imaging. *Journal of Cardiovascular Magnetic Resonance* 2012 **14**(Suppl 1):P12.