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Reproducibility of First Pass Perfusion CMR at rest and during hyperaemia for estimation of myocardial perfusion

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Introduction

CMR has demonstrated excellent reproducibility for assessment of cardiac function, mass and volume. Reproducibility data for first-pass CMR perfusion estimates are sparse, but are important to monitor for example the response of therapies which affect myocardial blood flow.

Purpose

1. To assess intraobserver, interobserver and interstudy reproducibility of myocardial blood flow estimation from first-pass perfusion CMR in at rest and during hyperaemia.

2. To compare semi-quantitative and quantitative measurements.

Methods

11 volunteers (6 males, mean age 33 ± 7 years) underwent CMR perfusion on 2 separate days (mean interstudy delay = 84 ± 111 days, median delay = 7 days) on a 1.5 T Philips Intera system during adenosine-induced hyperaemia (140 mcg/kg/min, 0.05 mmol/kg Gd-DTPA) and rest. A pulse sequence optimised for acquisition of a single midventricular slice at systole was used (saturation recovery segmented gradient echo, 2 × SENSE TR/TE/flip 2.7 ms/1.0/15°, typical FOV 380 × 380 mm, matrix 160 × 160, slice thickness 10 mm, preparation pulse delay 150 ms, shot duration 130 ms). Endo- and epicardial contours were drawn. "Semi"-quantitative analysis calculated maximal upslopes of myocardial signal intensity of the entire slice, normalised to the LV blood-pool (Myocardial perfusion index, MPI) using MASS 6.0 (Medis, Leiden, The Netherlands). The myocardial perfusion reserve index (MPRI) was calculated as the ratio of hyperaemic over rest MPI.

Data generated in MASS were imported to a Fermi Function deconvolution algorithm implemented in Matlab (The MathWorksInc, USA) [1], that provided estimates of absolute myocardial blood flow (ml/g/min) with user input to correct for baseline and timing offsets between the input and tissue response functions. All measurements were performed by one observer, who repeated analysis of the first CMR scan after 4 weeks. In addition, a second observer performed separate blinded analysis of the first study.

Results

All measurements indicated good reproducibility of global CMR perfusion estimates (Table 1). Reproducibility was highest for intraobserver followed by interobserver cmparisons especially in stress studies and was lowest for interstudy comparisons. Semiquantitative measurements were generally more reproducible than fully quantitative analysis.

Conclusion

1. First-pass perfusion CMR with "semi"-quantitative and quantitative analysis has comparable reproducibility to other imaging modalities [2].

Table 1: Intraobserver, Interobserver and Inter-study reproducibility of CMR

	Semi quantitative (Unit less)			Quantitative (ml/g/min)		
	Rest MPI	**Stress** MPI	**Reserve Index**	**Rest**	**Stress**	**Reserve**
Intraobserver						
Mean ± SD	0.11 ± 0.02	0.18 ± 0.03	1.73 ± 0.3	1.94 ± 0.4	4.3 ± 0.6	2.3 ± 0.5
Mean%difference ± SD	0.46 ± 6.65	0.67 ± 3	0.7 ± 6	5.4 ± 14	8 ± 8	3.5 ± 16.8
Coefficiant of Variability(%)	7%	3%	5.4%	12%	8%	19.7%
p-value (Student *t* test)	0.89	0.92	0.46	0.61	0.18	0.81
Interobserver						
Mean ± SD	0.11 ± 0.02	0.19 ± 0.03	1.7 ± 0.3	1.9 ± 0.37	3.9 ± 0.5	2.14 ± 0.4
Mean%difference ± SD	9 ± 8	4.8 ± 4	4 ± 8.6	0.37 ± 20	10 ± 20	10 ± 27
Coefficiant of Variability(%)	9.8%	4.3%	4 ± 8.6	21.6%	20.6%	28.8%
p-value (Student *t* test)	0.18	0.45	0.63	0.99	0.14	0.22
Mean ± SD	0.11 ± 0.02	0.19 ± 0.03	1.79 ± 0.36	1.77 ± 0.3	4.2 ± 0.5	2.5 ± 0.42
Mean%difference ± SD	3 ± 17	0.9 ± 12	3.8 ± 24	13 ± 20	4.3 ± 21	17 ± 27
Coefficiant of Variability(%)	17.63%	13.6%	27%	22%	21.5%	28.9%
p-value (Student *t* test)	0.18	0.71	0.56	0.14	0.52	0.11

2. The lower interstudy reproducibility probably reflects at least in part physiological heterogeneity.

3. The higher variability of quantitative analysis in this study was probably the result of the cumulative variability of segmentation and subsequent Fermi-deconvolution with user input at both stages.

References

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2. Kaufmann PA, *et al.*: *Journal Nucl Med* 1999, **40:**1848-1856.