Reproducibility of Self-Gated Cardiac Functional MRI in Mice @ 11.7T

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Introduction: The use of cardiac functional MRI (cMRI) as imaging tool for global and regional assessment of myocardial contraction is gaining interest in the small animal model. Even though, cMRI is frequently been applied to longitudinal studies, the reproducibility of the often complex acquisition protocols/techniques has not been widely assessed. In this contribution the reproducibility of global functional parameters with a standardized self-gated imaging approach is investigated.

Methods: The study comprised the assessment of reproducibility of global cardiac functional parameters for repeated measurements and the impact of the respiratory rate.

The imaging protocol was standardized according to fig.1. Based on a coronal scout image (a), a semi-2ch (b) view was acquired, followed by a semi-4ch view (c) orthogonal to (b). Semi-SA views (d-f) were obtained orthogonal to (b) and (c) and used for final planning of the 2ch (g) and 4ch (h), in which the final stack of SA views was planned. All data was acquired applying a self-gating technique [1] (IntraGate, Bruker, Germany). The survey scans (a-f) were only compensated for respiratory motion, where the HR cine images (g-i) were reconstructed with 20 cardiac phases. All HR acquisitions were performed with 200 repetitions, a parallel imaging acceleration of 2, TE / TR = 0.95/5.75ms, flip angle = 20°, and spatial resolution = 117x117x480µm³. Global functional parameters including ejection fraction (EF), end-diastolic (EDV), end-systolic (ESV), and stroke volume (SV) were calculated semi-automatically (Segment [2]).

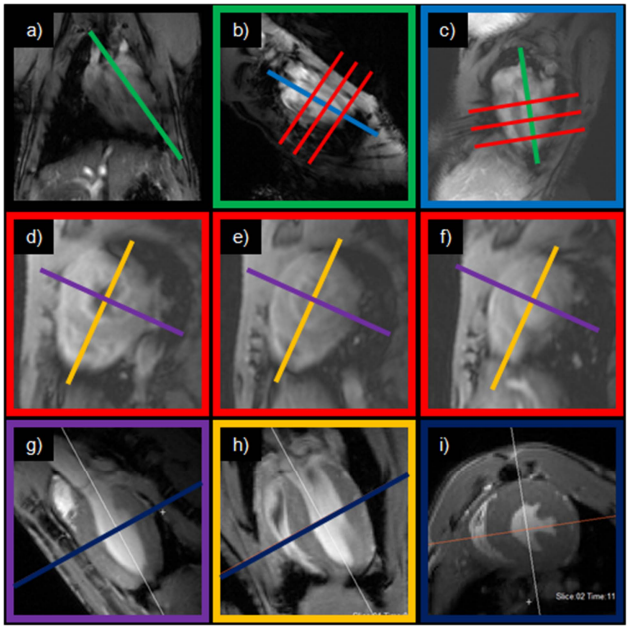

Fig. 1: Semi 2ch (b) is planned in coronal scout (a). Semi 4ch (c) is planned from semi 2ch. 3 sa views (d-f) are planned based on the semi 2ch and 4ch view and used for planning the 2ch (g) and 4ch (h) view. Final planning of the sa stack (i) is based on the 2ch and 4ch view.

The reproducibility of the entire imaging protocol including positioning of the animal was investigated by four subsequent measurements in 6 C57/BL6 mice. Measurement 1 and 2 were performed subsequently on day 1 (d11, d12) and measurements 3 and 4 subsequently at day 3 (d31, d32). For each measurement, the animal was repositioned on the cradle. The impact of the respiratory rate was investigated in two subsequent measurements in four C57/BL6 mice without repositioning for two different isoflurane doses, yielding respiratory rates in the order of 100 and 40 cycles per minutes (rpm).

Results: The results are summarized in Tables I-III. The 4 reproducibility measurements (Table I) show a high reproducibility of the global functional parameters for each individual animal over time. The variability between the age- and sex-matched animals (Table II) resulted much higher than the variability for each animal. Dependency on the respiratory rate appears minor (Table III), with higher standard deviations for 100 rpm, even though the heart rates was higher for 40rpm.

	σ(EF) [%]	σ(EDV) [%]	σ(ESV) [%]	σ(SV) [%]
M1	4,47	7,26	15,25	6,29
M2	1,26	10,57	9,34	11,34
M3	2,28	6,01	12,24	5,15
M4	4,40	4,71	14,47	2,54
M5	6,97	0,87	26,09	7,74
M6	3,23	3,39	5,44	5,57
	3,77	**5,47**	**13,81**	**6,44**

Table I: Intra-animal standard deviation σ in % of mean value .

Conclusion: Self-gated cardiac functional imaging provides a high reproducibility for repeated measurements. Intra-cohort variations appear higher than variations in a single animal over time. Lower respiratory rates facilitate higher reproducibility.

References: [1] Hiba et al., MRM 2007;58:745-53; [2] Heiberg et al., BMC Meg Imaging 2010;doi:10.1186/1471-2342-10-1

	σ(EF) [%]	σ(EDV) [%]	σ(ESV) [%]	σ(SV) [%]
d11	8,57	20,82	42,44	15,61
d12	9,79	20,09	46,51	12,10
d31	11,26	25,00	47,30	22,72
d32	10,43	28,07	47,11	27,82
	10,01	**23,49**	**45,84**	**19,56**

Table II: Intra-group standard deviation σ in % of mean value.

	EF	EDV	ESV	SV	HR	Resp.R
Mean 100	69	55,75	18	38	389,25	83
σ(100)	8,72	10,37	7,26	5,72	41,51	11,34
Mean 40	72	50,5	14,25	36,25	455,5	41,5
σ(40)	2,94	5,07	1,26	4,72	84,87	3,70

Table III: Dependency of the global functional values on the respiratory rate (100/40 = 100/40 respiratory cycles per minute).