

Appendix E1

MRI Methods

Parametric Mapping Sequences

Acquisition parameters used for parametric mapping are included in Table E3. For brain imaging, pixel-wise maps were generated in MATLAB (R2018a, Mathworks, Natwick, MA) using a 3-parameter monoexponential fit (T1 mapping) or 2-parameter monoexponential fit (T2 and T2* mapping). Regions-of-interest were manually drawn to calculate parametric values in each tissue. Fast inline parametric mapping sequences were used for cardiac and abdominal mapping (32–34), regions-of-interest were drawn on the inline pixel-wise maps using a Leonardo workstation (Siemens Healthcare, Erlangen, Germany).

Contrast Agents

Phantom T1 values were measured using an inversion recovery gradient echo sequence with multiple TIs (10–8000 ms) with TR = 15s. T1 was calculated using a 3-parameter monoexponential fit to the inversion recovery signal. Phantom T2 values were calculated using a spin echo sequence with TE = 10–1000 msec and TR = 15s. T2 was calculated using a 2-parameter fit to the monoexponential signal decay curve.

1.5T Literature Values for Parametric Mapping

The following references were used to generate range of literature values for T1, T2 and T2* at 1.5T for Table 1:

1. Vymazal J, Righini A, Brooks RA, et al. T1 and T2 in the brain of healthy subjects, patients with Parkinson disease, and patients with multiple system atrophy: relation to iron content. *Radiology* 1999;211(2):489–495.
2. Stanisz GJ, Odrobina EE, Pun J, et al. T1, T2 relaxation and magnetization transfer in tissue at 3T. *Magn Reson Med* 2005;54(3):507–512.
3. Siemonsen S, Finsterbusch J, Matschke J, Lorenzen A, Ding XQ, Fiehler J. Age-dependent normal values of T2* and T2' in brain parenchyma. *AJNR Am J Neuroradiol* 2008;29(5):950–955.
4. Kritsaneepaiboon S, Ina N, Chotsampancharoen T, Roymanee S, Cheewatanakornkul S. The relationship between myocardial and hepatic T2 and T2* at 1.5T and 3T MRI in normal and iron-overloaded patients. *Acta Radiol* 2018;59(3):355–362.
5. Grassedonio E, Meloni A, Positano V, et al. Quantitative T2* magnetic resonance imaging for renal iron overload assessment: normal values by age and sex. *Abdom Imaging* 2015;40(6):1700–1704.
6. Dabir D, Child N, Kalra A, et al. Reference values for healthy human myocardium using a T1 mapping methodology: results from the International T1 Multicenter cardiovascular magnetic resonance study. *J Cardiovasc Magn Reson* 2014;16(1):69.

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11. de Bazelaire CM, Duhamel GD, Rofsky NM, Alsop DC. MR imaging relaxation times of abdominal and pelvic tissues measured in vivo at 3.0 T: preliminary results. *Radiology* 2004;230(3):652–659.
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13. Deoni SC, Peters TM, Rutt BK. High-resolution T1 and T2 mapping of the brain in a clinically acceptable time with DESPOT1 and DESPOT2. *Magn Reson Med* 2005;53(1):237–241.
14. Westwood M, Anderson LJ, Firmin DN, et al. A single breath-hold multiecho T2* cardiovascular magnetic resonance technique for diagnosis of myocardial iron overload. *J Magn Reson Imaging* 2003;18(1):33–39.
15. Rakow-Penner R, Daniel B, Yu H, Sawyer-Glover A, Glover GH. Relaxation times of breast tissue at 1.5T and 3T measured using IDEAL. *J Magn Reson Imaging* 2006;23(1):87–91.
16. Giri S, Chung YC, Merchant A, et al. T2 quantification for improved detection of myocardial edema. *J Cardiovasc Magn Reson* 2009;11(1):56.
17. Barth M, Moser E. Proton NMR relaxation times of human blood samples at 1.5 T and implications for functional MRI. *Cell Mol Biol* 1997;43(5):783–791.
18. Stadler A, Jakob PM, Griswold M, Barth M, Bankier AA. T1 mapping of the entire lung parenchyma: Influence of the respiratory phase in healthy individuals. *J Magn Reson Imaging* 2005;21(6):759–764.
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Table E1: Contrast agents used for relaxivity calculations

Gadobutrol	<i>Gadovist</i> , Bayer Healthcare, Berlin Germany	0–10mM
Gadoterare meglumine	<i>Dotarem</i> , Guerbet, Villepinte, France	0–10mM
Gadopentetate dimeglumine	<i>Magnevist</i> , Bayer Healthcare, Berlin Germany	0–10mM
Gadofosveset	<i>Ablavar</i> , Lantheus Medical Imaging, North Billerica, MA	0–1mM
Gadofosveset +	<i>Ablavar</i> , Lantheus Medical Imaging, North Billerica, MA	0–1mM
Human Serum Albumin	+ HAS Fraction V, Millipore Sigma, Burlington MA (Catalog #12668)	0.2mM
Ferumoxytol	<i>Feraheme</i> , AMAG Pharmaceuticals Inc, Waltham MA	0–0.8mM
Gd-Dendrimers	[26]	0–0.02mM
Oxygen	N/A	0 mmHg, 159.6 mmHg, 760 mmHg

Table E2: Commercially available metallic guidewires and catheters tested for RF-induced heating at 0.55T. Devices with heating < 1°C after 2 minutes of continuous imaging are potentially suitable for in vivo application (final column).

Nitinol guidewires	<i>Hi Wire</i> , Cook Medical LLC, Bloomington IN	150 cm/0.035"/straight	✓
		150 cm/0.035"/angled	✓
		180 cm/0.035"/straight	✓
		180 cm/0.035"/angled	✓
		260 cm/0.035"/straight	x
		260 cm/0.035"/angled	x
	<i>Glidewire</i> , Terumo, Tokyo Japan	150 cm/0.035"/angled	✓
		150 cm/0.018"/angled	✓
		180 cm/0.035"/angled	x
		180 cm/0.035"/Micro-J	✓
		260 cm/0.035"/angled	x
		260 cm/0.018"/angled	x
	<i>Nitrex</i> , Medtronic Covidien EV3, Minneapolis MN	145 cm/0.035"/angled	x
		180 cm/0.035"/angled	x
Stainless steel braided catheters	<i>MultipackExpo</i> , Boston Scientific, Marlborough MA	6F	✓
	<i>SuperTorque</i> , Cordis Co, Milpitas CA	6F	✓

Table E3: Imaging parameters used for parametric mapping

	Acquisition	FOV (mm)	matrix	averages	Slice thickness (mm)	TE (ms)	TR (ms)	T1 (ms)	Receiver Bandwidth (Hz/Px)	flip angle (°)
Brain	Gradient echo T1 mapping	230 × 230	128	1	10	3.85	10000	100, 150, 200, 300, 500, 1000, 5000, 8000	300	15
	TSE T2 mapping	208 × 230	87 × 128	3	10	13, 25, 36, 48, 72, 96, 171	1000	N/A	120	150
	Gradient echo T2* mapping	230 × 230	123 × 128	2	10	4.84, 13.32, 21.8, 30.28,	790	N/A	130	25

						38.76, 47.24, 55.72, 64.2, 72.68, 81.16, 89.64, 98.12, 106.6, 115.08, 128.56, 132.04				
Cardiac and Body	MOLLI T1 mapping (bSSFP)	270 × 360	144 × 256	1	8	1.3	1036	Gated 4 (3)3 (3)2 scheme	545	35
	Cardiac T2- prepared bSSFP (prep lengths = 0 ms, 25s, 40 ms, 60s)	270 × 360	144 × 256	1	8	1.3	730	N/A	545	70
	Body T2- prepared bSSFP (prep lengths = 0 ms, 25s, 55s)	340 × 255	108 × 192	1	8	1.09	194	N/A	1184	70
	Multi-echo gradient echo	270 × 360	144 × 256	1	8	1.8, 4.6, 7.4, 10.2, 13.0, 15.8, 18.6, 21.4	361.5	N/A	590	15