Coronary MRA at 3 Tesla – A Qualitative Comparison of a Novel Adiabatic T2-Preparation with Classic MLEV4

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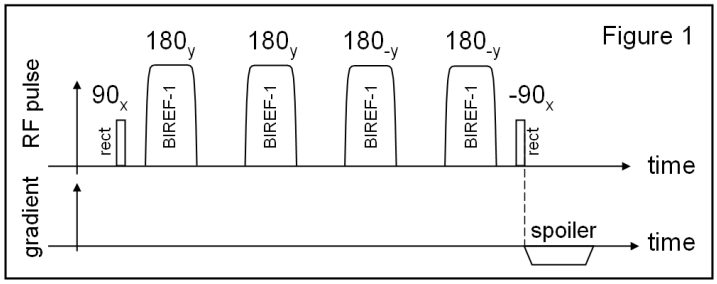
Target Audience: Physicians, Physicists, MR technologists

Purpose: At 3 Tesla, non-contrast coronary MR Angiography (MRA) relies on a B1-, B0-, and motion-robust T2-preparation (T2P) module to accurately depict coronary anomalies and stenoses. We previously developed an adiabatic T2P (AT2P) module [1] of required robustness, but tested it only for 2D imaging. In the current study, we systematically compared its clinical performance in 3D imaging to the standard method, the Malcolm Levitt four-refocusing pulse module (MLEV4) [2]. For both modules, we evaluated each coronary artery for its complete visualization and scored the vessel depiction-quality of the proximal segments. We statistically compared AT2P to MLEV4 results.

Methods: On a Siemens MAGNETOM Verio equipped with a 32-channel InVivo coil, 9 healthy volunteers (7 males, 2 females) were scanned twice using AT2P and MLEV4, respectively. All other parameters were identical (typical: T2P time 60ms, matrix 304 x 240, partitions 144, resolution 1.1x1.1x1.2 mm, integrated parallel acquisition (iPat) factor 2, 30 reference lines, TE 1.69 ms, TR 2.85 ms, gradient echo, flip angle 15°, SPAIR fat suppression). Figure 1 shows the AT2P module consisting of rectangular tip-down and flip-back pulses and four adiabatic B1-insensitive refocusing pulses (BIREF1 [3]). Two readers blinded to the applied T2P scored the vessel depiction-quality in six regions of interest (ROIs): "ostium of left main", "left main", "1st segment of LAD", "1st segment of LCX", "ostium of right main", "1st segment of RCA" on a four-points scale (0 poor/invisible, 1 mediocre, 2 good, 3 excellent). Furthermore, they evaluated visibility (0% no, 100% yes) of three coronary territories, a) the LAD to its distal segment, b) the LCX to its distal segment, and c) the RCA to the crux cordis. The MLEV4 and AT2P scores were statistically compared by a one-tailed paired t-test.

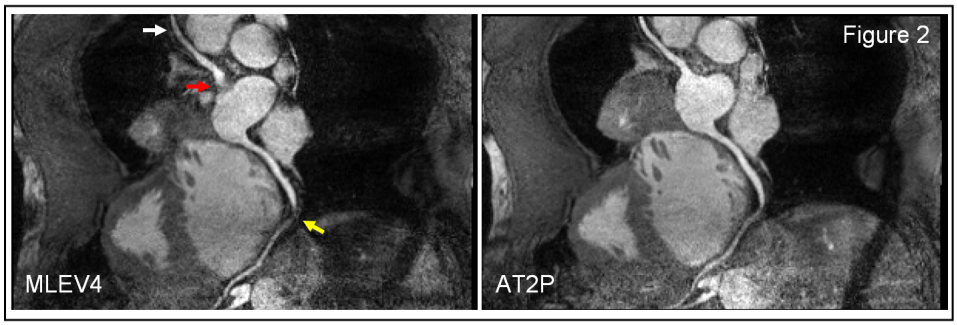


	Quality Assessment												Visibility					
	ostium of left main		left main		1st segment of LAD		1st segment of LCX		ostium of right main		1st segment of RCA		LAD to distal segment		LCX to distal segment		RCA to crux cordis	
module	MLEV4	AT2P	MLEV4	AT2P	MLEV4	AT2P	MLEV4	AT2P	MLEV4	AT2P	MLEV4	AT2P	MLEV4	AT2P	MLEV4	AT2P	MLEV4	AT2P
mean	1.56	2.22	1.56	2.33	1.67	2.33	1.33	2.00	2.00	2.78	2.00	2.89	56%	89%	22%	78%	67%	100%
sem	0.29	0.32	0.29	0.24	0.17	0.24	0.24	0.24	0.29	0.15	0.24	0.11	18%	11%	15%	15%	17%	0%
Different?	yes*		yes*		yes*		yes*		yes*		yes#		yes*		yes#		yes*	

*: $p < 0.05$, #: $p < 0.01$ Table 1

Results: In each ROI, vessel depiction-quality by AT2P was significantly better than by MLEV4. The three examined coronary territories a) - c) were fully visible in significantly more 3D image sets obtained with AT2P compared to MLEV4. Table 1 shows mean, standard error of the mean (sem), and p-value of the quality assessment and branch-visibility for all ROIs. Figure 2 shows a curved multi-planar reconstruction (MPR) from an MLEV4 and an AT2P data set. Note that the MLEV4 set shows ostial signal dropout of the left main coronary artery (red arrow) and signal reduction in the right coronary artery (yellow arrow), which could be misinterpreted as stenosis. The left circumflex (white arrow) appears sharper in the AT2P image.

Discussion: Whereas non-contrast coronary MRA remains challenging and works best for proximal coronary segments, the developed new adiabatic module represents a significant advancement towards a clinically useful solution. We compared the AT2P to the MLEV4 module at 3T, but are aware that the use of MLEV4 is usually restricted to field strengths below 3T.



Conclusion: The new AT2P module is suitable for coronary artery imaging at 3T and provides higher image quality compared to the existing MLEV4 technique.

References: [1] Jenista et al.: A Motion and Flow Insensitive Adiabatic T2-Preparation Module for Cardiac MR Imaging at 3 Tesla; MRM 2012; accepted for publication. [2] Brittain et al.: Coronary Angiography with Magnetization-Prepared T2 Contrast; MRM 1995;33(5):689-696. [3] Garwood et al.: The return of the frequency sweep: Designing adiabatic pulses for contemporary NMR. JMR 2001;153(2):155-177.