A DEDICATED 64-CHANNEL CARDIAC RECEIVE-ONLY PHASED ARRAY COIL: INITIAL EXPERIENCE

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Target Audience: Radiologists, Cardiologists, Physicists

Purpose: Due to cardiac and respiratory motion and a high percentage of uncooperative patients, speeding up data acquisition is of high interest in Cardiac MRI (CMR). Phased array [1] receiver systems with up to 128 channels [2] in combination with parallel imaging techniques [3, 4] are applied with the goal to achieve good imaging results in highly accelerated cardiac function measurements. In a previous study, a dedicated 64-channel receive-only phased array coil strongly adapted to the human thorax was developed for optimized imaging performance in CMR at 3T [5]. In this pilot study, CMR was performed in humans with the 64-channel receive-only phased array prototype coil in comparison to a routinely used 30-channel clinical setup to determine the accessible diagnostic image quality.

Methods: Accelerated cardiac cine images were obtained in three healthy volunteers (1 female and 2 males; ages 55, 30, and 55 years; heights 157 cm, 190 cm, 162 cm; weights 68 kg, 92 kg, and 103 kg) on a 3T Siemens MAGNETOM Skyra (Siemens AG, Erlangen, Germany). Volunteers were examined with the 64-channel cardiac phased array coil and the scanner's standard 30-channel clinical setup comprising the Body 18 Tim coil and 12 channels of the patient-table-integrated Spine 32 Tim coil. Functional CMR was performed using a 2D bSSFP cine imaging pulse sequence in the short-axis-view (SAX) and in four-chamber-view (4CH) orientation with 4 different acceleration factors (tGRAPPA, acceleration factors R = 3, 5, 7, and 8). The acquired CMR data was scored by an independent radiologist to assess image quality (1 = Excellent, 2 = Good, 3 = Satisfactory, 4 = Fair, 5 = Fail) and artifacts (0 = none, 1 = minor, 2 = strong). The rater was blinded to the coil used and the order of the CMR image series was randomized.

			R = 3	*R* = 5	*R* = 7	*R* = 8
Vol.1	SAX	64chnl.	2	2	2	---
		30chnl.	2	2	2	3
	4CH	64chnl.	2	3	---	---
		30chnl.	2	3	---	---
Vol.2	SAX	64chnl.	2	4	3	4
		30chnl.	2	2	3	4
	4CH	64chnl.	2	2	3	5
		30chnl.	2	3	4	5
Vol. 3	SAX	64chnl.	1	1	2	4
		30chnl.	2	1	3	5
	4CH	64chnl.	2	3	3	5
		30chnl.	3	4	4	5

Tab.1 Score values of image quality in three healthy volunteers (Vol.)

Results: Image quality was scored in a total of 43 image series in SAX and 4CH (Tab.1). The 64-channel cardiac phased array coil outperformed the Body 18/Spine 32 setup in 27% of all SAX images and 50% of all 4CH images. In all other cases image quality was equal. In one case, the commercial coil outperformed the 64-channel coil (SAX, R = 5, Vol.2). Lower score values with the 64-channel coil were achieved especially at acceleration factors R = 5 and R = 7. Using acceleration factors R = 5 and R = 7 in four-chamber view revealed superior image quality in comparison to the clinical setup in 80% of the examined image series. CMR images at R = 8 were of limited or no diagnostic value with both coils. Observed artifacts were off-resonance artifacts, reduced SNR due to high acceleration factors, and blurring due to imperfect breath-holding. Investigation of artifacts revealed no significant differences between the two coils independent of acceleration factor, slice orientation, or volunteer.

Discussion: The magnetic field simulations [5] suggested that lateral coil elements are important to obtain homogeneous SNR distribution and low g-factor values in the heart. Our in vivo measurements confirm these findings, resulting in higher diagnostic image quality especially at high acceleration factors with the 64-channel phased array prototype coil which is strongly adapted to the thorax. High signal was found in subcutaneous fat which potentially leads to an underestimation of the flip angle in the heart due to the heterogeneous receive fields, resulting in SNR degradation. For homogeneous signal intensity distribution, special care has to be taken to account for this in adjustment measurements and diagnostic images.

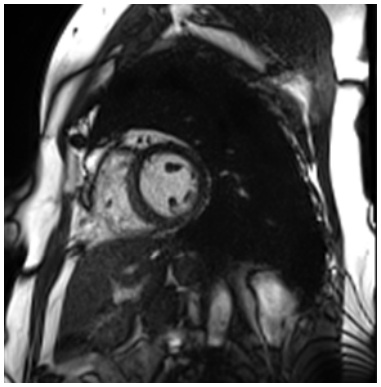

Fig.1 2D TrueFISP Cine SAX tPAT=7 FA / Res / FOV / Slice = 54° / 174x208 / 284mm x 339mm / 6mm TR (estimated) / TE = 3.6ms / 1.43ms

Conclusion: The 64-channel cardiac phased array prototype coil yielded improved diagnostic image quality compared to a commercial coil setup in accelerated 2D TrueFISP cine imaging. As expected, advantages with the 64-channel cardiac phased array were especially found at *R* = 5 and *R* = 7, in particular in four-chamber-view images. There, due to the slice orientation, more receive elements contribute to the overall signal intensity.

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