Cardiovascular MRI with Parallel Imaging and Matrix Coils – State of the Art Whole Body Imaging

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Introduction: Recent developments in magnetic resonance (MR) hard- and software now make it possible to cover large anatomic areas within a tolerable scan time. For these reasons and the lack of ionizing radiation as well as nephrotoxic contrast agents MRI has become a candidate for whole body screening (1-3). Up to now whole body MRI has suffered from reduced image quality with poor spatial and temporal resolution. The aim of our study was to develop a comprehensive cardiovascular whole body protocol with diagnostic image quality and to minimize scan time. The protocol included a global heart examination with functional and perfusion imaging as well as delayed contrast enhancement of the left ventricular myocardium, whole body angiography and examination of the lungs, brain and abdominal organs.

Materials and Methods: In the last 18 month we examined more than 120 individuals participating in a company healthcare program. All of the individuals were referred by their company medical officer and underwent routine examinations with conventional methods, e.g. ultrasound, x-ray, Stress-ECG etc, before the MR exam. The first 42 individuals underwent the exam on a 1.5T 8 channel standard MR system (Magnetom Sonata, Siemens Medical Solutions, Erlangen, Germany). All additional participants underwent the exam on a dedicated 1.5T 32-channel whole body MR system (Magnetom Avanto, Siemens Medical Solutions, Erlangen, Germany). Using parallel imaging techniques and a matrix coil system it was possible to perform a cardiovascular examination including real-time imaging of the heart with a temporal resolution of 48ms and dynamic cardiac perfusion MRI with TrueFISP (4, **Fig.1**). 3D-Gadolinium-enhanced MR angiography (3D-Gd-MRA) combined with parallel imaging and the matrix coil system was performed within 88 seconds to cover the arterial system from the carotid arteries down to the foot in only four steps with spatial resolution of 1x1x1mm in the carotid arteries and in all other regions less than 1.6x1x1.5mm (5, **Fig.2**). Scan time for single-shot lung imaging was shortened by a factor of 2. Image parameters for lung imaging included 256^2 matrix, slice= 6mm and a acquisition time of 19 seconds for 13 slices per breathhold. Image analysis was done by two blinded radiologists who scored whole body angiograms for vessel conspicuity, venous overlay and artifacts on a three point scale, 1 = excellent, 2 = moderate but diagnostic and 3 = poor, not diagnostic. For this evaluation whole body angiography was divided into 24 vessel segments. All exams were reviewed for the presence of pathological findings by two experienced radiologists blinded to one another.

Results: In the first 70 patients we detected 5 myocardial pathologies including 2 myocardial infarctions, 11 vascular pathologies that include renal and common carotid artery stenoses as well as occlusion of peripheral arteries. Lung imaging revealed 2 nodules and 2 infiltrates. Nearly 75% of all vessel segments were rated as “excellent” in terms of vessel conspicuity, nearly 80% showed no artifacts and more than 85% had no venous overlay. The inter- reader agreement in the angiographic evaluation was good with kappa values ranging between 0.671 and 0.756. The inter-reader agreement in the detection of pathological changes was even better with kappa values ranging between 0.662 and 0.905. Scan time was reduced to an average of 80+/-7min on the whole body scanner compared to 102+/-22min on the standard scanner.

Conclusion: Recent technical improvements such as parallel imaging techniques and matrix coil systems make it possible to perform a comprehensive cardiovascular whole body scan without compromising spatial or temporal resolution compared to established clinical exams. Scan time could be reduced to a tolerable range and good to excellent inter-reader agreement was observed largely resulting from consistent high image quality.

Figure 1:
High resolution imaging of 2, 3 and 4 chamber view in a single breathhold (a-c); Realtime imaging of the heart with a temporal resolution of 48ms (d-f)

Figure 2:
3D-Gd-MRA in 4 stations with a spatial resolution < 1.6x1x1.5mm

Figure 1

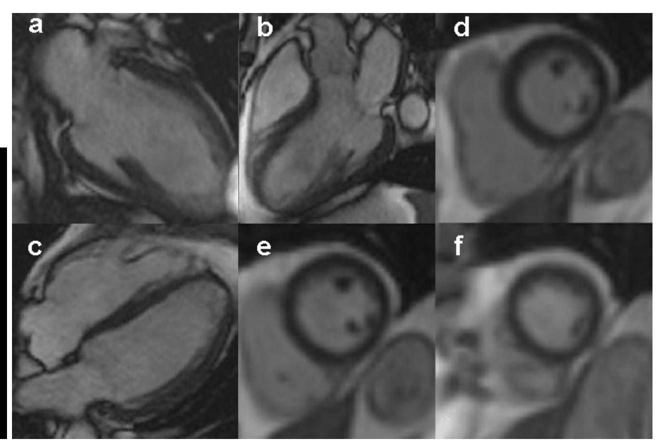
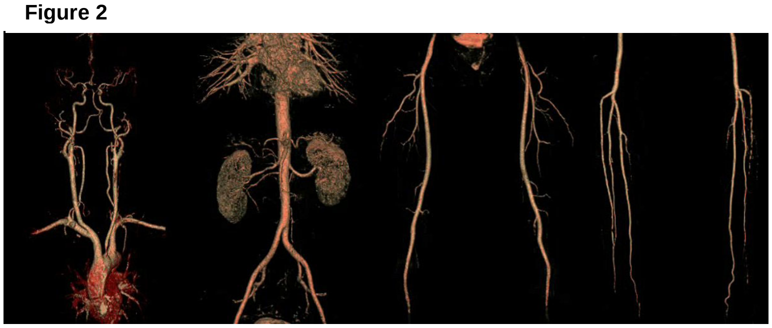


Figure 2



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