Whole-heart coronary MRA using 2D-SENSE

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INTRODUCTION:

Recently, an approach for "whole-heart" coronary MRA was proposed. In this method the whole heart is imaged with a large non-angulated 3D measurement volume [1]. To reduce the long scan time associated with large volume coverage, parallel imaging with reduction along one phase-encode direction has been employed [2].

In this work, accelerated "whole-heart" coronary imaging with sensitivity encoding in both phase encoding directions (2D-SENSE) was investigated [3]. An optimized coil setup was derived to reduce spatially dependent noise amplification with SENSE, and the dependence of signal-to-noise ratio (SNR) on field-of.-view (FOV) and reduction directions was studied. Using an optimized coil array and sequence settings, a total reduction factor of up to four is achieved with excellent image quality and visibility of the coronary arteries.

METHODS:

In SENSE images, the SNR depends on a spatially varying function g(r) (g-factor) [2]:

$$SNR(r)^{SENSE} = SNR^{full} / (g(r) * R^{1/2})$$

(r=position vector, R=reduction factor, SNR^{full}=SNR without SENSE) [3]. For a high SNR^{SENSE} at a given reduction factor two aspects need to be considered: a high base SNR independent of SENSE, and a low g-factor. The first condition can be achieved by using an appropriate coil and sequence settings whereas the second condition is dependent on the coil arrangement, the direction of reduction and the field-of-view (FOV). For coil setup optimization, an array of 6 rectangular coil elements (12x25 cm) was arranged in 12 different geometric configurations. For comparison, a commercial coil array was used. The measurements were performed on an elliptical phantom simulating the thorax. The average g-factor was calculated for different reduction factors within a volume approximating the position of the heart in-vivo.

The coil setup with the lowest g-factor was used for in-vivo SSFP imaging (TR = 5.8ms, TE = 2.6ms, flip angle = 140°, 16 RF excitations/cardiac cycle, 120 slices FOV = 240 x 240mm^2, resolution = 1 x 1 x 2mm^3 reconstructed to 0.5 x 0.5 x 1 mm). All measurements were performed on a 1.5T Philips Intera (Philips Medical Systems, Best, The Netherlands). The SNR and g-factor of 7 healthy volunteers were calculated for different FOVs on the path of the coronary arteries and compared to the commercial coil.

RESULTS:

The coil setup with the lowest g-factor was a symmetric arrangement of three rectangular coils in the front and in the back of the subject. A comparison of the average SNR along the coronary arteries between the optimized coil and the commercial coil is given in Figure 1. Figure 2 shows two exemplary in-vivo datasets obtained with R=3 and R=4. The dependency of the g-factor on FOV along the AP direction is illustrated in Figure 3. It was found that the FOV should be at least 2/3 of the AP dimension of the thorax. For smaller FOV's the g-factor on the coronary arteries increases significantly.

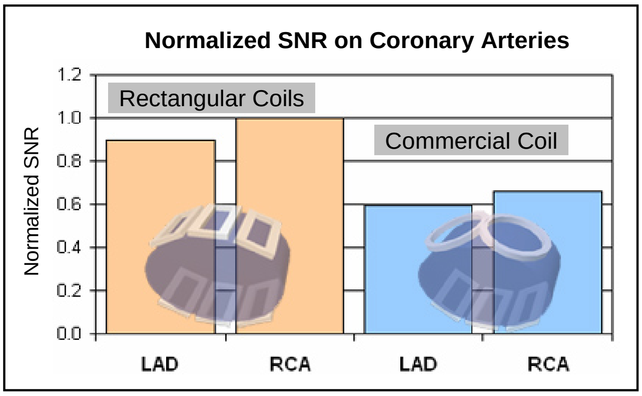

Figure 1: Comparison of the SNR on the coronary arteries between the optimized coil setup (right) and the commercial coil (left)

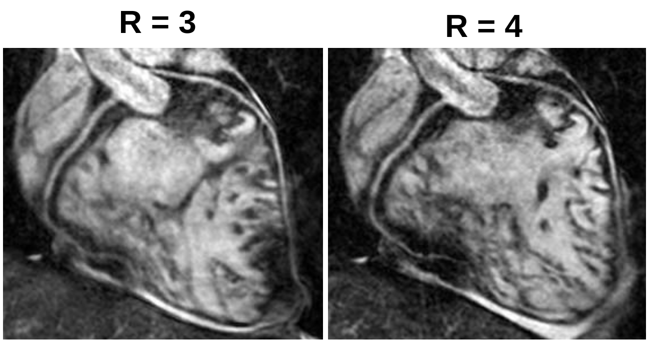

Figure 2: Two in-vivo images of the right and left coronary arteries acquired with the optimized coil setup with two different reduction factors.

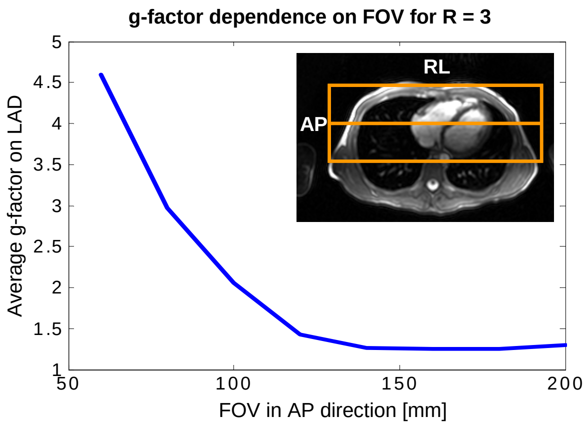

Figure 3: The average g-factor on the LAD depending on the FOV in AP direction (the inset shows the imaging volume on the heart).

DISCUSSION:

Using an optimized coil setup and sequence settings, lower g factors are achieved when compared to the conventionally used commercial coil array. This enables "whole-heart" coronary MRA with 2D-SENSE at acceleration factors of up to four.

REFERENCES:

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[3] Weiger M, et al., MAGMA **14**: 10-19 (2002)