Combination of Phased Array Coil Signal for Homogeneous Complex CSPAMM Images

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INTRODUCTION

Myocardial tagging such as CSPAMM (1) combined with HARP (2) is a powerful method to quantify myocardial motion of healthy and diseased hearts. As a prerequisite for functional indices calculated from the mid-myocardial layer, the endo- and epicardial borders should be detected reproducibly and desirably automatically. This detection is performed on HARM images as described earlier (3).

Usually, CSPAMM data are acquired with a synergy-cardiac coil. The images of the different coil elements are all combined into a modulus image, which could be used for the HARP analysis. However, the modulus operation generates additional k-space peaks at the position of the direct-current (DC) and 2nd harmonic peaks. The resultant crowding in k-space may lead to errors in HARP evaluation or may require a very narrow HARP filter, reducing the already limited spatial resolution of HARP. Therefore complex CSPAMM data should be used for the HARP analysis. The purpose of this work was to produce complex CSPAMM images combining the signal of all synergy elements in order to obtain a more homogeneous signal and improved HARM images over the whole myocardium for a better delineation of the myocardial borders.

METHODS

CSPAMM images with a tag-line distance of 8 mm were acquired in a healthy volunteer on a 1.5 T Scanner (Intera, Philips Medical Systems) using a commercial five-element synergy-cardiac coil. In order to produce complex CSPAMM images out of the four single coil images, the CLEAR (Philips brand name) algorithm, based on the Roemer reconstruction (4), was used. In a reference data set that was acquired beforehand, covering the whole heart of the volunteer, the complex coil-sensitivity S_C of each coil-element C was determined: $S_C = R_C / R_B$

R_C : reference image of coil C

R_B : reference image of body coil

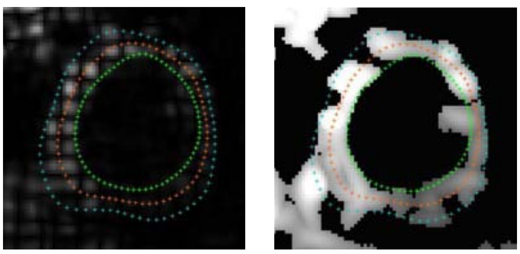
The CLEAR CSPAMM image I_{CLEAR} was produced as follows:

$$I_{CLEAR} = \frac{\sum_C S_C^* \cdot I_C}{\sum_C \left|S_C\right|^2}$$

I_C : CSPAMM image of coil C

For I_{CLEAR} and I_1 HARM images were generated and an adaptive threshold was applied. On these images, the endo- and epicardial borders were determined automatically and the calculated mid-myocardial line was tracked by HARP.

RESULTS

A


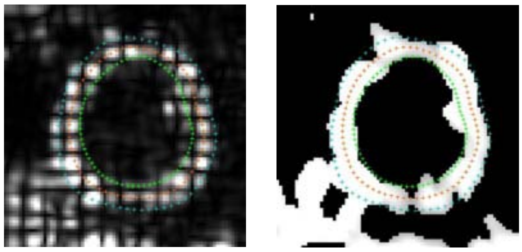

B

Figure 1: CSPAMM and HARM images from one coil (A) and from 4 coils combined with CLEAR (B). The endo- and epicardium are detected automatically, the mid-myocardium is calculated.

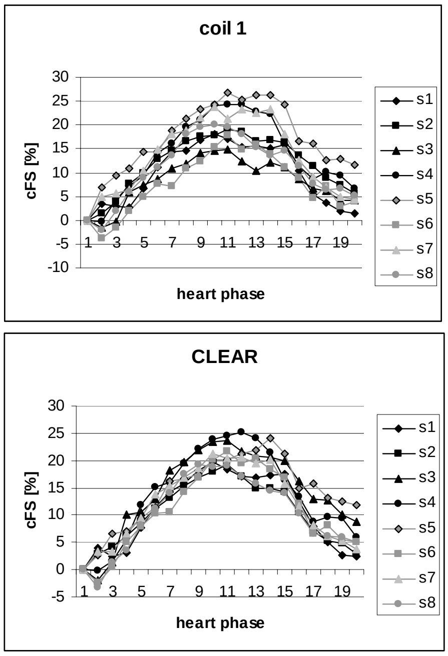
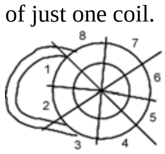


Figure 2: Circumferential shortening of the mid-myocardium tracked with HARP. The contraction pattern for the different sectors (s1-s8) is more homogeneous for the CLEAR CSPAMM data than for the data of just one coil.



DISCUSSION

With CLEAR, complex CSPAMM images can be produced, where the signal of all synergy-cardiac coil-elements are used. This leads to a homogeneous signal over the myocardium and therefore to a more reliable automatic detection of the myocardial borders (Fig. 1). The better definition of the mid-myocardium can also lead to more reliable function parameters. The circumferential shortening values extracted from the CLEAR CSPAMM data are comparable for the different sectors, according with earlier findings in healthy volunteers (5). The circumferential shortening value of sector 3, where the delineation of the epicardium failed on the image with one coil (Fig.1), is decreased compared to the one from the CLEAR CSPAMM image as expected for a epicardial layer.

The higher SNR of the CLEAR CSPAMM images may also allow for the acquisition of more heart-phases, leading to a higher temporal resolution, or for the usage of a broader HARP filter, leading to a higher spatial resolution of the HARP evaluation.

REFERENCES

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