Phase contrast imaging using sensitivity encoding and automatic coil sensitivity estimation: a feasibility study

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Introduction

When using the sensitivity encoding method for reducing scan times, knowledge of the individual coil sensitivities is mandatory (1). If the estimation of the coil sensitivities is performed separately from the following examinations, potential problems may arise if the object has changed position between the reference scan and the examination. One way to deal with this problem is to use an autocalibration method where the determination of coil sensitivities is performed within the scan for the actual examination (2).

The combination of phase contrast imaging and the sensitivity encoding (SENSE) method is clinically very useful and has been investigated in a number studies (3,4). The question of how the accuracy in phase contrast imaging is influenced when using sensitivity encoding and autocalibration signals (ACS-lines) has to date not been investigated. The purpose of this work was to study the feasibility of phase contrast imaging in combination with sensitivity encoding where the individual coil sensitivities are estimated by acquiring additional ACS-lines.

Material and methods

A data set simulating a phase contrast imaging measurement was created using four authentic complex valued coil sensitivities and a synthetic object (256×256 matrix). A region within the object (Fig. 1) was allotted a specific phase that corresponded to 25% of a chosen VENC value. The data set was reduced with 50%, 67% and 75% corresponding to acquisitions at different reduction factors, respectively. Individual coil sensitivity estimations were performed using various numbers of ACS-lines from each coil image. Ringing artifacts were suppressed by applying a Kaiser filter, as proposed in ref (2). The relative RMS error (E_{RMS}) of the measured phase values in ROI 1 was calculated for different numbers of ACS-lines and the mean measured phase value was calculated for ROI:s 2, 3 and 4.

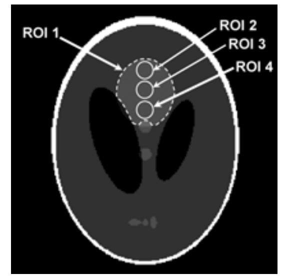

Figure 1. Object and region of interests (ROI:s) used in the study. All picture elements within ROI 1 were given a specific phase

Results

In Fig. 2 the E_{RMS} is shown for the three reduced data sets using different numbers of ACS-lines. When 25 ACS-lines are used the E_{RMS} is less than 5% for all reconstructed data sets. In Fig. 3 the difference between the measured mean phase value within ROI 2,3 and 4 and the true mean phase value is shown. With the use of 25 ACS-lines the measured mean phase difference was less than ±2,5% in all three ROI:s and for all three reduced data sets.

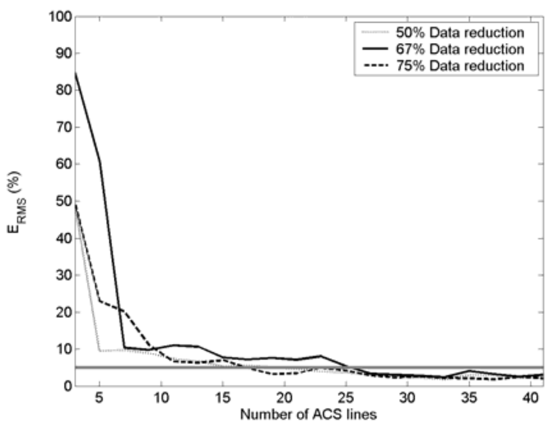

Figure 2. The relative RMS error (E_{RMS}) in phase images obtained from reconstructed data sets where 50%, 67% and 75% of the original data had been removed prior to reconstruction. The gray, horizontal line indicates an E_{RMS} of 5%.

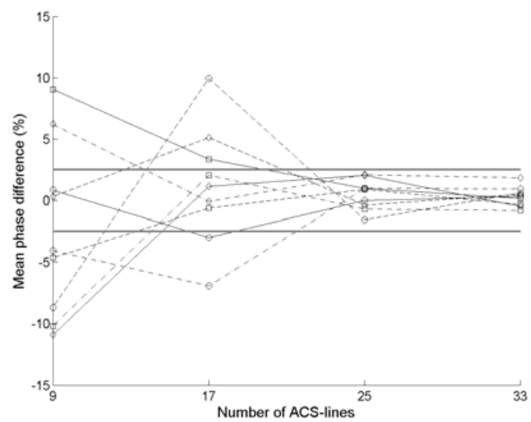

Figure 3. Mean phase difference for data sets reduced with 50% (solid), 67% (dashed) and 75% (dashed-dotted) measured in ROI 2 (circles), 3 (squares) and 4 (diamonds). The two gray horizontal lines indicate a mean phase difference of ±2,5%.

Discussion

The relative RMS error of the measured phases was high when using only a few ACS-lines, but decreased gradually as the number of ACS-lines increased. For a sufficient number of ACS-lines the RMS error was low for all reduction factors. The difference between the true and the measured mean phase within region of interests also decreased for an increased number of ACS-lines. In conclusion, it is feasible to obtain accurate velocity and flow measurements when combining phase contrast imaging, sensitivity encoding and automatic coil sensitivity estimation. The number of ACS-lines is decisive for the accuracy.

References

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