

Field-of-view Restrictions for Artifact-free SENSE Imaging

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Abstract

SENSE imaging reduces scan times by utilizing multiple receiver coils to unfold a reduced field-of-view (FOV) image into a full-FOV image. We describe and present *in vivo* examples of an artifact present when the final reconstructed full-FOV image is smaller than the object being imaged. This artifact is a fold-over/aliasing artifact which is present in the center of the image rather than at the edges of the image. This image domain artifact is due solely to the SENSE reconstruction, predictable and its location is based on the SENSE reduction factor. Knowledge of this artifact is necessary when prescribing SENSE acquisitions and interpreting the resulting images.

Introduction

SENSE (Sensitivity encoding) [1] is a new method which allows the collection of a reduced number of phase-encoding lines (without a loss of resolution) and hence a timesaving. SENSE uses a sophisticated reconstruction algorithm which removes the Nyquist ghosting resulting from the reduced number of phase-encoding lines and promises artifact-free images with an SNR penalty. SENSE imaging only provides artifact-free images when the final reconstructed full-FOV image is larger than the object being imaged.

Methods

Scanning was performed on a 1.5T clinical scanner (Philips Gyroscan Intera, Best, Netherlands). A flexible wrap around cardiac coil with five elements was used. The longer diameters of the coil elements were aligned to the head-foot direction. A balanced fast-field-echo sequence (TR/TE=2.6/1.3 FA=55) was used. Sensitivity maps were calculated by dividing the individual coil images by the body coil image. SENSE images were acquired in the axial, coronal, short-axis and vertical long axis orientations of the heart[2]. Images were purposely prescribed such that the reconstructed field-of-view was slightly smaller than the patients body size. Images in the same orientations were also acquired with a full set of phase-encoding steps. SENSE reduction factors of 1.2, 1.5 and 2.0 were used. Images were then evaluated for fold-over artifacts.

Results

Images reconstructed using a full set of phase-encoding lines had fold-over artifacts at the edges of the image (Fig 1A). SENSE images had characteristic artifacts in the center of the image (Fig 1C) as well as at the edge of the image.

The position of the artifact was dependent on the SENSE factor. Reduction of the SENSE factor moved the artifact to the edges of the image. No other artifacts were seen.

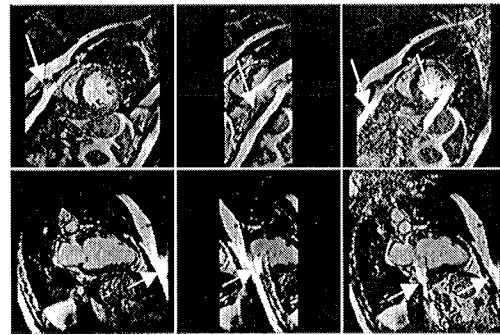


Figure 1: Images demonstrating the fold-over artifact (white arrow) in different two orientations **A)** Image acquired with full sampling; **B)** Reduced FOV image; **C)** SENSE full-FOV image; **Top row:** Short axis; **Bottom row** Vertical long axis; The artifacts which appears at the edge of the full FOV image (A) appears at the edge and center of the SENSE image (C).

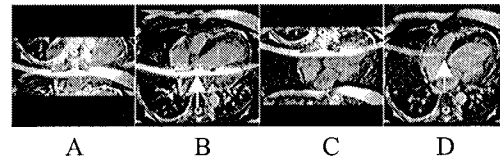


Figure 2: The aliasing artifact (white arrows) is positioned at the center of the image with a SENSE factor of 2.0 and moves upward as the SENSE factor is reduced.
(SENSE reduction factor 2.0) **A)** Reduced FOV image
B) SENSE full-FOV image
(SENSE reduction factor 1.5) **C)** Reduced FOV image
D) SENSE full-FOV image

Discussion

We have described and demonstrated an artifact particular to SENSE imaging. Since this artifact is often in the center of the image, interpretation may be impossible or difficult. Fold-over may obscure a stenosis in angiographic application. In functional imaging, fold-over may obscure parts of the myocardium. In certain cases, SENSE imaging may not provide a substantial decrease in scan time if the an image may be collected with N/2 ghosting which does not obscure the area of interest.

Care must be taken when acquiring multiple slices since these artifacts may occur in a wider part of the body. One should note that, this artifact may always be removed by increasing the image FOV.

References

1. Pruessmann, K.P., Weiger, M., Scheidegger, M.B. & Boesiger, P. SENSE: sensitivity encoding for fast MRI. *Magn Reson. Med.* 42, 952-962 (1999).
2. Pruessmann, K.P., Weiger, M. & Boesiger, P. Sensitivity encoded cardiac MRI. *J. Cardiovasc. Magn Reson.* 3, 1-9 (2001).