

Dedicated coil design for accelerated upper and lower GI imaging

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Introduction

Upper and lower GI imaging is usually done using breath hold techniques with total imaging time limited to less than 30 seconds [1]. Certain techniques, such as 3D acquisitions, cannot be applied in this short of a time span. Parallel imaging techniques allow shorter scan times for these acquisitions [2], but they also require dedicated RF coil designs. It is the purpose of this investigation to design a SENSE optimized coil array for upper GI and one for lower GI imaging. Imaging will be performed within a single breath hold.

Method

Two 16-channel coils were developed to be used in a 1.5T GE scanner with a 16 channel receive chain. A 16 channel upper GI coil was developed as a split C shaped coil (Fig 1). The rectangular coil elements have dimensions of 4.5cm by 32cm; adjacent coil elements are underlapped. The split C shape was chosen such that there would be no signal drop out on the lateral side of the liver. The length of the coil in the z direction was chosen to accommodate 97% of liver sizes. G factor maps at an average anterior to posterior distance of 16.5cm were simulated with this coil design in which the gap between the elements was varied. The optimum gap was found to be 5cm. The B field of the coil, assuming sum of square combination, was likewise simulated for the axial plane; the greatest field strength is along the outside of the body, nearest to the coil elements.

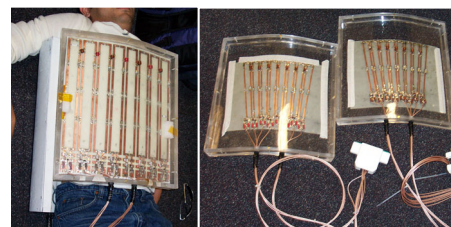


Figure 1: Upper GI design, C Shape (left), Lower GI design (right)

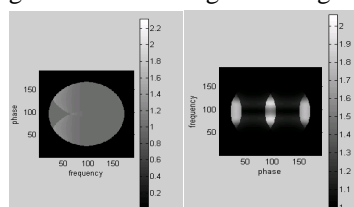


Figure 2: G-factor maps, Upper GI R=3 (left), Lower GI R=3 (right)

Additionally a 16-channel lower GI array coil was developed with a conductor lay out as shown in Fig 1. The coil is separated into two halves to provide good coverage of the lower abdomen; each 8-channel half traverses an overall area of 24cm by 18cm by 22cm, and coil elements are optimally underlapped in the LR direction. The dimensions were chosen to cover 97% of all lower GI dimensions. G factor calculations show good results at R=3 (Fig 2) and R=4. Decoupling between neighboring coil elements was generally better than <-20dB due to the application of decoupling transformers. Among next to nearest neighbors decoupling was achieved via low input impedance preamps ($R < 3$ ohms) and was generally better than <-15 dB.

Results

Results indicated that the upper GI coverage in the SI direction, 36 cm, is sufficient for 97-percentile liver imaging. A smaller SI coverage could be considered to optimize this coil. Lower GI coverage also exceeded expectations: it imaged beyond the expected

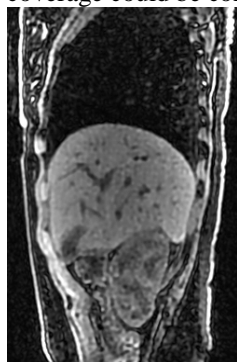


Figure 4: Upper GI Sagittal Image, R=4.6

24x18x12 trapezoidal pelvic cross section. The SNR for the upper GI array was sufficient for acceleration up to a factor of 4.6; the SNR for the lower GI array was sufficient for factor 3 imaging. Figure 3 shows a T2W FSE breath hold image using a 512x224 matrix (TR: 4750, TE 80ms) on the left; on the right, the same region is imaged using a self-calibrated LAVA scan with fat suppression. The image size of the accelerated image is 256x192; TR and TE were set to 4.7 and 2.2, respectively, for this 21 second scan. Figure 4 shows the limit of acceleration using the Upper GI coil. In this image, self-calibrated LAVA and fat suppression were used; the image matrix is 192x192, and TR and TE were set to 2.6 and 2.1, respectively. 96-4mm slices were taken during this 22 second scan. All images were obtained using traditional T2W FSE sequences and self-calibrated 3D fat suppressed sequences.

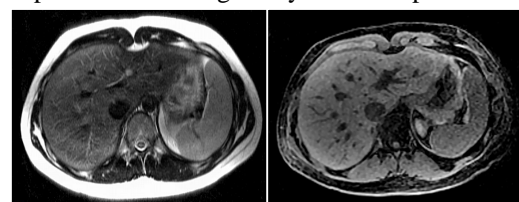


Figure 3: Upper GI Images: Unaccelerated (left) and Accelerated R=3 (right)

Conclusion

16 channel upper and lower GI coils were created that allowed high acceleration factors (4.6). Typical 3D liver examinations could be obtained in short scan times using a self-calibrated 3D technique using R=3. More importantly a sagittal acquisition allowed the use of 2D self-calibrated 3D acquisition. An acceleration factor of 1.7 in plane with 2.7 through plane gave a resultant final acceleration factor of 4.6. Thus large volumes can be acquired within a single short breath hold.

References

- [1] Katayama M et al. JMRI. 2001; 14: 439-449.
- [2] Pruessmann KP et al. Magn Reson Med. 1999; 42:952-962.