Massively Accelerated Comprehensive Volumetric Body Imaging Examinations with a 32-Channel MR-System

T. Niendorf[1,2], D. K. Sodickson[2], C. A. McKenzie[2], N. Farrar[2], C. J. Hardy[3], Y. Zhu[3], G. Kenwood[3], M. J. Harsh[4], N. M. Rosky[2]

[1]Applied Science Laboratory, GE Medical Systems, Boston, Massachusetts, United States, [2]Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, United States, [3]GE Global Research Center, Niskayuna, New York, United States, [4]GE Medical Systems, Waukesha, Wisconsin, United States

Introduction

Abdominal imaging examinations constitute a growing fraction of clinical MRI exams. A typical exam, for example for screening of the liver, consists of T_2-weighted studies with and without fat saturation, and T_1-weighted gradient echo studies prior to and following administration of contrast media. Since it can be difficult to obtain the full desired volumetric coverage during feasible breath-hold durations, acquisitions are sometimes partitioned into multiple breath-holds, which can result in misregistration of images. Furthermore, constraints on acquisition time have limited the use of three-dimensional spin echo imaging sequences for T2-weighted studies, despite the appealing properties of such sequences.

In this work, highly parallel imaging at acceleration factor of 8 to 12 was used to bring 3D volumetric abdominal examinations down to clinically acceptable breath-hold durations.

Methods

For highly parallel imaging of healthy adult volunteers, a 32-channel imaging system composed of four synchronized eight-channel GE EXCITE system cabinets linked to a whole-body 1.5T TwinSpeed scanner [1,2,3] was used. A 32-element coil array designed for highly accelerated imaging over large fields of view was used for imaging [1]. The array, pictured in panel (a) of the figure, consists of two regular 4 x 4 grids of rectangular loop elements placed above and below the subject. Accelerations were applied along each of the two phase-encoded dimensions in 3D imaging sequences to minimize SNR degradations associated with parallel imaging [4]. A low-resolution sensitivity reference was obtained prior to accelerated imaging, and parallel image reconstruction was performed using a generalized encoding matrix (GEM) [5] reconstruction.

For T_2-weighted imaging, an axial 3D fast-recovery fast spin echo (FRFSE) sequence was used with the following parameters: acceleration factor of 8 (4 LR x 2 SI) to 12 (4 LR x 3 SI), matrix size = 256 x 192, x 48 FOV = 40 cm x 40 cm x 24 cm, TE = 85 ms, TR = 417 ms, echo train length = 20, BW = 62.5 kHz.

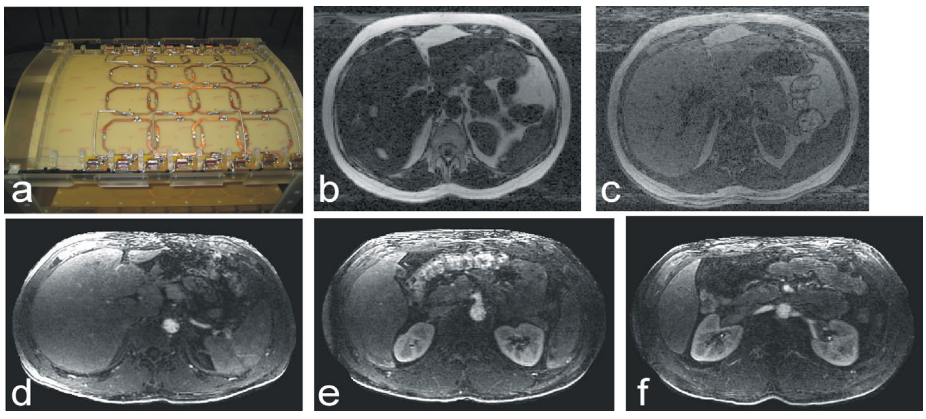
T_1-weighted imaging studies were performed with an axial 3D spoiled gradient echo sequence with the following parameters: acceleration factor of 12 (4 x 3), matrix size after reconstruction = 256 x 256 x 180, FOV = 44 cm x 44 cm x 40 cm, TE = 1.9 ms, TR = 4.6 ms, flip angle = 25°, bandwidth = 62.5 kHz. For contrast-enhanced studies, imaging was initiated approximately one minute following antecubital venous injection of 0.1 mmol/kg body weight of gadopentetate dimeglumine 2cc/sec (with a 20cc saline flush at 2cc/sec).

Results

Panel (b) of the figure shows one reconstructed image from a T_2-weighted 3D FRFSE data set without fat saturation. An acceleration factor of 8 (4 LR x 2 SI) was used for this study. Some residual aliasing of bright fat at the chest wall and the back are seen, but abdominal structures are well visualized. Panel (c) shows a corresponding image from a T1-weighted 3D SPGR data set. Panels (d-f) show three axial slice positions from a 12-fold accelerated (4 LR x 3 SI) post-contrast study. Enhancement of vascular and tissue structures may be appreciated.

Discussion

As might be expected, post-contrast studies were found to be particularly advantageous for high degrees of acceleration. SNR considerations limit achievable accelerations for T2-weighted or pre-contrast T1-weighted studies; however, acceleration factors ranging from 8 to 12 allowed large volumetric coverage in clinical feasible breath-holds. It might be noted that the volume of the T1-weighted studies used here is larger than is strictly required for abdominal imaging alone. This apparent lack of efficiency can be turned to advantage however in the context of a comprehensive examination. The same volumes of data may be used not only for liver screening but also for MRA of the renal arteries and abdominal vasculature. Furthermore, the use of large volumes simplifies scan prescription. Thus, as many-channel hardware becomes more readily available, highly-parallel imaging may be expected to be an enabling technique for routine body imaging applications.



References

[1] Zhu et al, ISMRM 2003, 22
[2] Hardy et al, ISMRM 2003, 471
[3] Dumoulin et al, ISMRM 2003, 431
[4] Sodickson et al, Med Phys 2001; 28:1629
[5] Weiger et al, MAGMA 2002, 14:10