Optimized Total Body MR using Advanced MOvements-Eliminated Total Body Acquisitions (AMOEBA)

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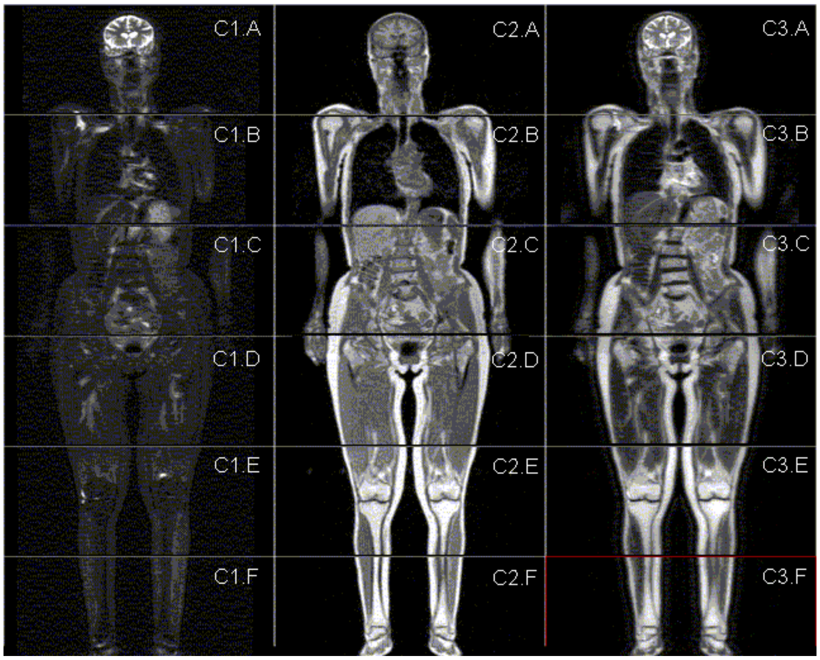
Introduction

Total Body Imaging using MR has recently gained much attention to screen for metastases in dedicated patient groups [1], [2]. A similar concept is used to generate overview spine images. Both methods require the imaging FOV to extend beyond the magnet's FOV (typically 40-50 cm in feet-head direction). This FOV extension is achieved in practice using a stepping table acquisition, in combination with an extended moving table top [3]. The scan time for such FOV-extended methods is largely determined by the inter-station delays in which the table is moved. Current practice requires the patient to be moved back and forth through the scanner when multiple contrasts are required (MOBI). In this study we introduce and demonstrate **A**dvanced **MO**vements-**E**liminated Total **B**ody **A**cquisitions (**AMOEBA**) as implemented on a routine clinical scanner. AMOEBA reduces the number of required inter-station movements for studies where multiple contrasts are acquired at extended FOVs by acquiring all contrasts at a given station prior to moving.

Methods

Imaging was performed on a Philips Intera 1.5T, equipped with a moveable table top extender. Table velocity and acceleration for inter-station movements are 180 mm/s and 150 mm/s^2, respectively. The Quadrature Body Coil was used for data reception in most studies. Dedicated phased-array coils were also employed to use the SENSE capabilities of the system, especially in the thorax and abdomen. Imaging is controlled using the ExamCards functionality, enabling integral planning, and throughput-optimized scanning orders. Volunteer scanning was approved according to local guidelines.



The Figure to the left shows a total-body imaging study using 3 contrasts (C1,C2 and C3), i.e. STIR, T1W and T2W. All scans use a FOV of 264 mm in FH an 528 mm in LR direction, have 32 consecutive slices of 8 mm, and use 6 to 7 stations. For STIR, we used a matrix size of 208a/256r and single-shot TSE (ETL 118); TR = 20 sec. For T2W-TSE, we used 208a/256r, single-shot TSE (ETL 102); TR 930 ms. Both have two packages. The T1W sequence is an FFE with TE/TR = 4.6/120; matrix size 192a/256r and 70% scan.
The standard scanning order (**MOBI**) is demostrated in the Figure, and described by the sequence
C1.A;C1.B;C1.C;C1.D;C1.E;C1.F,
C2.F;C2.E;C2.D;C2.C;C2.B;C2.A,
C3.A;C3.B;C3.C;C3.D;C3.E;C3.F.
To reduce the number of required movements, the scanning order (**AMOEBA**) was adjusted to
C1.A,C2.A,C3.A; C3.B,C2.B,C1.B; C1.C,C2.C,C3.C;
C3.D,C2.D,C1.D; C1.E,C2.E,C3.E; C3.F,C2.F,C1.F.
A semicolon indicates a table movement to adjust the patient position relative to the magnet's FOV.
Integral total-body planning is enabled by geometrical links between the FOVs per station. As such, the scans with different contrast can have different orientations (e.g. transversal and coronal). Scan time optimizations are possible per station by varying axial coverage.

Results and Discussion

We have introduced a new method for acquiring scans with multiple contrasts in total body imaging. Image Quality is comparable for a scan with the two sequences of stepping the table through the magnet's FOV. Consistency of the anatomical coverage and position is observed to be better for AMOEBA than for MOBI due to the reduced latency between scans with different contrast for a given station.
By sorting the acquisitions on required table position, the number of table movements in typical protocols (7-8 stations) is reduced from 18 to 6 by AMOEBE. This implies a reduction of the traversed path by 2 * (6-7) * 30 cm = 3.5-4 metres! Furtheron, the total examination time is reduced by 12 * (3.1 to 3.6) seconds, i.e. 38 to 43 seconds, for typical inter-station displacements of approx. 30 cm.
Further work is performed to optimize sequence parameters on required axial coverage per station, and implement total body imaging for 3T.

Conclusion

Significant examination efficiency gains are possible by eliminating the number of required table moves in total body imaging. We have demonstrated the feasibility of the AMOEBA technique in this respect. Eliminating movements not only reduces total examination time, it also improves patient comfort by requiring fewer displacements.

References

1 Walker RE et al., J Magn Reson Imaging. 11: 343, 2000
2 Walker RE, Eustace SJ, Semin Musculoskelet Radiol. 5: 5, 2001
3 O`Connell MJ et al., AJR Am J Roentgenol. 179: 866, 2002