Fast 3T Whole Body MR Exam utilizing 2 point DIXON T1 & T2w and streamlined workflow approach

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Target audience: Radiologists, Physicists, Technologists

Purpose:

In a whole body MR exam, T1w, T2w and Diffusion images (DWI) are often required to assess the morphological and functional characteristics of the lesions. Fat suppressed and non-fat suppressed T1 and T2w images provide a comprehensive characterization on the lesion but long scan time limits the number of imaging contrast one can acquire within a reasonable exam time. Also, STIR is often used to provide B0 & B1 in-sensitive fat suppression, but in the expense of SNR and scan time. In this study, we studied the feasibility of a fast whole body MR exam that provides 5 contrasts (Fat Sat and non-Fat Sat T1, Fat Sat and non-Fat Sat T2, DWI) [1] on 3T. We aimed to reduce exam by using 2-point DIXON techniques in T2w FSE and T1w LAVA, and streamlined workflow strategies.

Method:

In our approach, we proposed to use 2-pt DIXON techniques in both T2w FSE(FTED)[2] and T1w FGRE (LAVA-FLEX)[3] sequences to generate both fat sat and non-fat sat images in the same acquisition, thereby reducing the scan time. Also, there are additional advantages of SNR and fat sat homogeneity using 2-pt DIXON techniques. In addition, since 2-pt DIXON techniques are less susceptible to B0 & B1 inhomogeneity, the image quality will be less dependent on the exact center frequency for that station. We leverage this characteristic to further reduce scan time by sharing prescan values between stations. And we also employed auto-table movement to further streamline the workflow.

Whole body MR was performed on healthy volunteers on a GE 3T 60cm bore scanner (MR750) using the body transmit and receive coil. The scan parameters are listed in Table 1. Note that in DWI, where image quality is more sensitive to center frequency and shimming, shared prescan is not used.

Table 1.	T1w (Coronal) 4 stations	T2w (Coronal) 4 stations	DWI (Axial) 8 Stations	Total Time
Proposed Approach (5 image contrasts)	**LAVA-FLEX**	**FTED**	**DWI**	23min (including prescan, breath holding & table movement time)
	0:23min/station, 2:30min for 4 stations	1:06min/station, 5:30 for 4 stations	1:23min/station, 13:45min for 8 stations	
	FOV: 48cm(LR)x35cm(SI), pFOV: 1.37, TR/TE: 3.6ms/1.1ms, Flip angle: 12, Matrix: 224x160, Slice Thickness: 8mm , 32 slices, 1 Nex, Bandwidth = ±200kHz, No Phase Wrap. <Shared Prescan>	FOV: 49cm(LR)x35cm(SI), pFOV: 1.4, TR/TE: 5025ms/80ms, Refocusing Flip angle: 111, ETL: 16, Matrix: 320x128, Slice Thickness: 8mm , 28 slices, 1 Nex, Bandwidth = ±166.67kHz, Flow Comp. ON, LR Sat band <Shared Prescan>	FOV: 48cm(LR)x34cm(SI), pFOV: 0.7, TR/TE: 2200ms/46.4ms, STIR, TI: 229ms, Matrix:96x128, Slice Thickness: 8mm , 20 slices, Bandwidth = ±250kHz, b-value: 50 (3nex), 800 (15nex), 3-in-1, <No Shared Prescan>	
Conventional Approach (3 image contrasts)	**T1w FSE** (non-Fat Sat)	**STIR T2w FSE**	**DWI**	30min (including prescan, breath holding & table movement time)
	1:08min/station, 6 min for 4 stations	1:49min/station, 8 min for 4 stations	1:23min/station, 13:45min for 8 stations	
	FOV: 45cm(LR)x45cm(SI), TR/TE: 700ms/9.2ms, Refocusing Flip angle: 111, ETL: 6, Matrix: 512x160, Slice Thickness: 8mm , 28 slices, 1 Nex, Bandwidth = ±50kHz, No Phase Wrap <No Shared Prescan>	FOV: 45cm(LR)x45cm(SI), TR/TE: 2150ms/30ms, Refocusing Flip angle: 111, ETL: 20, STIR, TI : 190, Matrix: 320x128, Slice Thickness: 8mm , 28 slices, 1 Nex, Bandwidth = ±62.5kHz, No Phase Wrap, Flow Comp. ON <No Shared Prescan>	Same as above	

Results & Discussion:

Fig 1 shows T1w FSE non-Fatsat vs LAVA-FLEX InPhase with shared prescan. LAVA image quality is sufficient but scan time is reduced from 1:08 min to 23sec. This enables breathhold scan in chest and abdominal stations, reducing motion artifacts and misregistrations that arises from multiple breatholds in conventional T1w FSE. Fig 2 shows T2w STIR vs FTED, SNR increase was observed due to the elimination of STIR, and scan time also decreased due to elimination of inversion time. Fig 3 shows a complete whole body exam acquired in 23 min. (23% reduction).

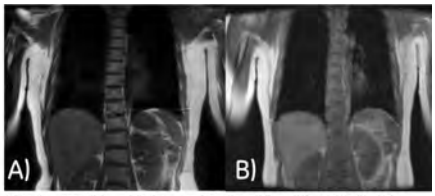

Fig1. A) T1w FSE vs. B) LAVA-FLEX (InPh)

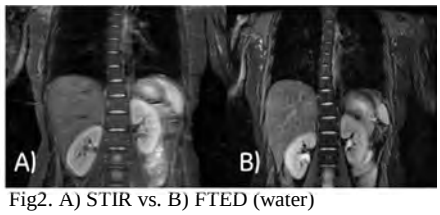

Fig2. A) STIR vs. B) FTED (water)

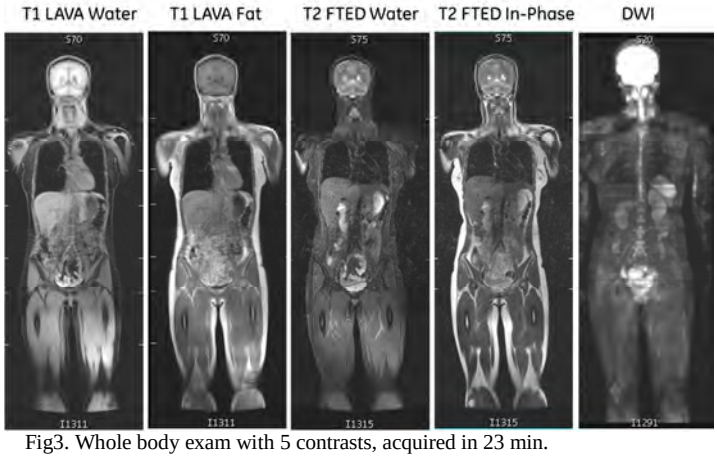

Fig3. Whole body exam with 5 contrasts, acquired in 23 min.

Conclusion:

In this work, we demonstrated a fast whole body imaging approach that provides 5 contrasts in 23 min. 2-point DIXON techniques helps provide Fat only and water only contrast for both T1w and T2w imaging, and provide robustness against B0 & B1 inhomogeneity. Streamline workflow feature such as shared prescan and auto-table-movement further reduce the total exam time without impacting image quality. The reduction in scan time will help drive more adoption of whole body imaging in the future.

References: [1] Ma et al, JMRI 2009; 29: 5, p1154–1162 [2] Ma et.al, MRM 2007; 58:1:p103-109, [3]Ma et.al, JMRI 2006; 23:1:p 36-41