Magnetic Resonance Imaging Intensity Correction and Normalization Using DESPOT1

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Introduction: The increased use of phased array and surface coils in MR imaging and the push towards increased (i.e 3T) field strength, coupled with the inevitable decrease in spatial uniformity of the acquired images has resulted in the need for robust image intensity correction methods. Here we re-introduce an approach for image intensity correction and normalization using quantitative T1 mapping. Traditionally, this approach has not been clinically viable due to the exhaustive scan time associated with conventional T1 mapping. The recent development and optimization of the rapid Driven Equilibrium Single Pulse Observation of T1 (DESPOT1)[1,2] technique, however, has removed this time factor. Here we evaluate the methods effectiveness in neurological and abdominal imaging applications.

Methods: Derivation of T1 from the SPGR signal equation, $SI=k(1-E_1)\sin\alpha(1-E_1\cos\alpha)^{-1}$ (where $E_1 = \exp(-TR/T1)$) cleanly separates T1 from the underlying RF intensity modulation, which is included in the k term, The T1 map can then be used to calculate "synthetic" T1-weighted images. Neural and Abdominal T1 maps were acquired (at 1.5T) using an 8 channel head array coil and a 4 channel torso array coil. Imaging parameters were: Brain: *FOV* = 25 x 25 x 13 cm^3, matrix = 256 x 256 x 128, *TR/TR* = 7.8ms/2.4ms, α = 4°,14° and *BW* = ±31.3kHz. Liver: *FOV* = 40 x 30 x 36cm^3, matrix = 200 x 150 x 60, *TR/TE* = 3.5ms/1.1ms, α = 3°,18° and *BW* = ±62.3kHz. Liver data were acquired using 1/2 Fourier reconstruction and the data was acquired during breathhold. From the calculated T1 map, synthetic T1-weighted images were obtained by substituting the values back into the SPGR signal equation using the acquired *TR* and α combination.

Results: Slices through the acquired brain and liver data and the corresponding calculate T1 maps and synthetic weighted images are shown in Figs 1 & 2. Signal intensity profiles through the acquired and synthetic images are also shown and demonstrate significant improvement in signal intensity uniformity across the synthetic images. In the brain images, the synthetic image demonstrates near perfect signal intensity symmetry between the left and right hemispheres. Within the liver image, intensity correction is most apparent in the subcutaneous fat layer.

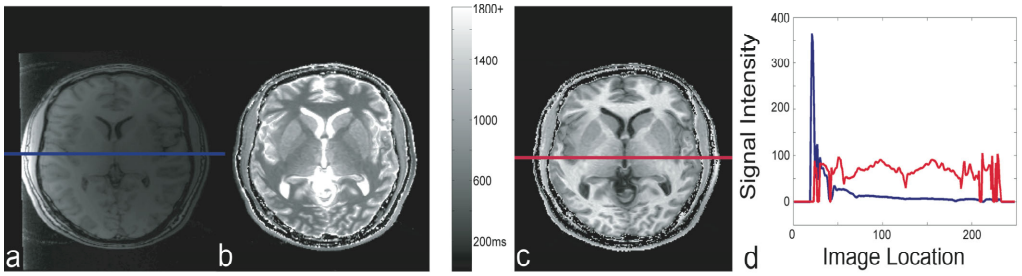

Figure 1: (**a**) Acquired, (**b**) T1 map, (**c**) synthetic T1-weighted image and (**d**) profile comparison of the neurological data.

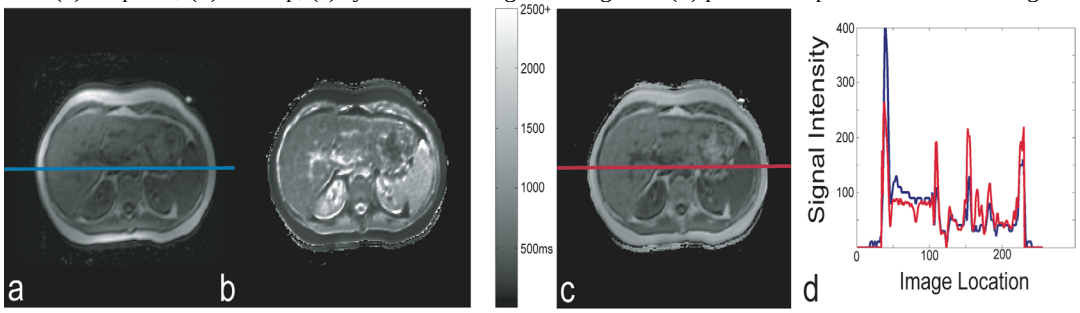

Figure 2: (**a**) Acquired, (**b**) T1 map, (**c**) synthetic T1-weighted image and (**d**) profile comparison of the liver data.

Discussion / Conclusions: As **t**he use of multi-channel volume and surface coils increases, the need for robust signal intensity correction will become more important. The proposed approach fulfills this role without suffering artifacts near the edges of structures, image blurring, or excessively increasing exam time. As the method provides absolute T1 maps, it also provides an easy means for signal normalization of images of different individuals or the same individual acquired at different time points. This aspect can be advantageous in long term longitudinal studies of disease progression or regression.

References: [1] Christensen KA et al. J Phys Chem 78:1971-1977, 1974, [2] Deoni SCL et al. MRM 49:515-526, 2003.