Combination of IDEAL and ARC imaging to obtain homogeneous fat saturation in the brachial plexus within clinically acceptable time parameters

A. M. Grayev[1], W. Sun[2], A. Shimakawa[2], A. Brau[2], P. Beatty[3], H. A. Rowley[1], L. R. Gentry[1], H. Yu[2], J. Brittain[2], and S. B. Reeder[1,4]

[1]Department of Radiology, University of Wisconsin, Madison, Wisconsin, United States, [2]GE Healthcare, Waukesha, Wisconsin, United States, [3]Global Applied Science Lab, GE Healthcare, Menlo Park, California, United States, [4]Department of Medical Physics, University of Wisconsin, Madison, Wisconsin, United States

Introduction: Comprehensive MR imaging of the brachial plexus and neck has been severely limited by poor fat suppression. The IDEAL (Iterative Decomposition of water and fat with Echo Asymmetry and Least squares estimation) method is a three-echo, chemical shift based approach that can provide homogeneous separation of water and fat despite B_0 and B_1 inhomogeneities[1]. Although IDEAL has been successfully applied to imaging the brachial plexus [2], it suffers from a three-fold increase in scan time. The purpose of this study was to combine IDEAL imaging with the Autocalibrating Reconstruction for Cartesian sampling (ARC) parallel imaging method to reduce the minimum necessary scan time while maintaining a high signal to noise ratio (SNR).

Theory: IDEAL acquisitions allow homogeneous separation of water and fat and create high SNR. Although IDEAL is highly efficient in that all echoes contribute optimally to image SNR, the minimum scan time can be problematic. In this work, we use the Autocalibrating Reconstruction for Cartesian sampling (ARC) parallel imaging method to reduce overall scan time. ARC is an autocalibrating partially parallel imaging method that efficiently reconstructs data without requiring coil sensitivity maps [3], which can be difficult to estimate accurately, especially in regions of low SNR (such as the lung) [4]. SNR losses from parallel imaging acceleration are offset by gains in signal to noise ratio gains from IDEAL. Therefore, the combination of IDEAL and ARC is highly complementary; ARC reduces the minimum scan time, while the high SNR performance of IDEAL balances the SNR penalty of the parallel imaging acceleration.

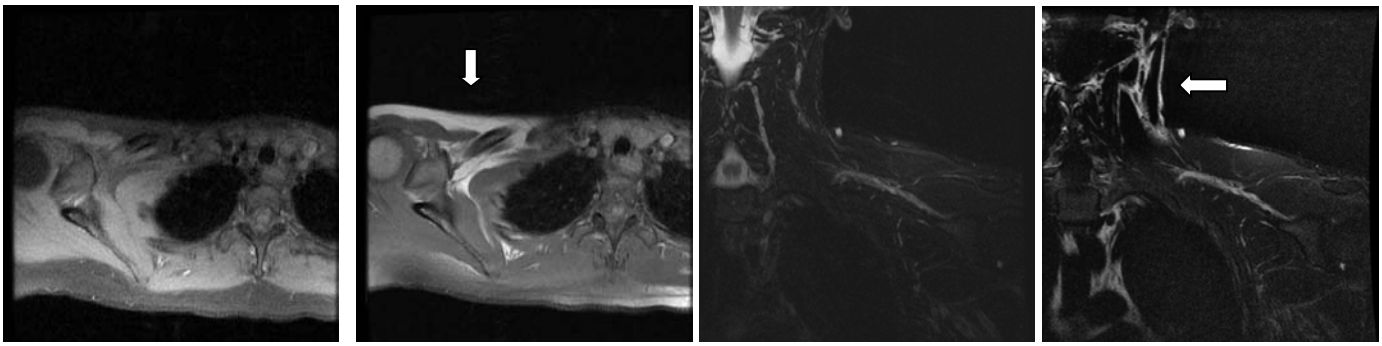
Materials and methods: After obtaining approval from our IRB and obtaining informed consent, imaging was performed using an 8 channel neurovascular array coil on a 1.5 T GE Signa Scanner (v 14.0 TwinSpeed, Waukesha, WI) with the following imaging parameters (Table 1).

	FOV (cm)	MATRIX	TE/TR	ETL	BW	Slices/Gap (mm)	Net Acceleration	Signal Averages	Scan Time (min)
Coronal T2 FSE-IDEAL	24 x 24	256 x 192	85/6050	14	± 41 kHz	4/1 30 slices	1.8	2	5:06
Axial T1 FSE-IDEAL	24 x 24	256 x 192	12/650-700	3	± 41 kHz	5/1 40 slices	1.7	1	5:28
Coronal T1 FSE-IDEAL	24 x 24	256 x 192	10/650 - 675	4	± 31 kHz	4.5/0.5 30 slices	1.7	2	6:06

Table 1: Clinical protocol used for imaging the brachial plexus with IDEAL and ARC.

IDEAL images were reconstructed with an on-line reconstruction algorithm, which provides separate water, fat and recombined in-phase (water + fat) and out of phase (water – fat) images. The remainder of the examination was completed using traditional T1 and T2 FSE sequences without and with fat saturation.

Results: Uniform separation of water and fat was seen throughout the brachial plexus. Images had high SNR and excellent image quality was seen in all images.



A **B** **C** **D**

Figure 1: Images from two healthy volunteers. A) Axial T1 FSE-IDEAL. B) Axial T1 FSE with fat saturation. C) Coronal T2 FSE-IDEAL. D) Coronal T2 FSE with fat saturation.

Discussion: IDEAL imaging provides homogeneous fat saturation throughout the neck and brachial plexus; however, until recently, the length of time needed to acquire the images limited clinical applicability. Combining ARC parallel imaging with IDEAL allows maintenance of high SNR performance within clinically acceptable scan durations.

References: **1.** Reeder, et al. MRM 2005 54:636-644, **2.** Reeder, et al. JMRI 2006 24:825-832, **3.** Brau et al. ISMRM 2006, pg. 2462, **4.** Griswold et al, MRM 2004 52:1118-26.