A New Strategy for Consistent Uniform Fat Suppression in Breast MR Imaging

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Introduction High spatial resolution T1 weighted fat nulled post contrast agent images are a cornerstone of breast MR examinations. These images provide morphological information relating to the lesion descriptors outlined in the BI-RADS lexicon (mass, margin, enhancement). However, in the presence of high fat signal, secondary to inefficient/ineffective fat nulling techniques, lesion descriptors can become ill-defined since the high signal intensity from an enhancing lesion is abutting the high signal intensity from poorly saturated fat resulting in a loss of detail. Traditionally, fat signal is nulled in breast MR by one of two techniques, chemical shift selective imaging sequence (CHESS) or spectrally selective inversion recovery. Both CHESS and spectrally selective inversion recovery techniques are sensitive to B_0 and B_1 inhomogeneities which result in inconsistent non uniform fat suppression, especially over large FOV's and at 3.0T where B_1 inhomogeneity is a concern. In this work we evaluate a new strategy whereby a water only excitation pulse is combined with an Adiabatic SPectral-selective Inversion Recovery (ASPIR) technique to provide robust and consistently uniform fat suppression.

Methods Gradient echo 3D T1W scans utilize a small flip angle (< 15^O). Using a Shinnar-Le Roux (SLR) spectral spatial pulse with such small flip angles results in B_1 insensitive water only excitation. To further increase the consistency of the fat suppression an ASPIR pulse is added which is insensitive to B_1 inhomogeneities. Nevertheless, both pulses are still sensitive to B_0. To reduce this sensitivity dual shim volumes (one per breast) are employed in the prescan to ensure accuracy shimming and centre frequency calculations. The hypothesis that two B_1 insensitive pulses combined with improved centre frequency tuning results in consistent fat suppression is tested in 10 patients and compared against the traditional acquisition with spectrally selective inversion recovery pulse based fat suppression. Sagittal and axial acquisitions were acquire in patients undergoing breast MR using an 8channel dedicated breast coil with the following parameters: 3D sagittal, TR/TE/TI 8.7/4.4/auto ms, flip 10^O, FOV 22x22cm, slice 3mm, matrix 384x384, locs 120, BW 100kHz, NEX 1, scan time 3min46sec. 3D axial, TR/TE/TI 8.1/4.3/auto ms, flip 10^O, FOV 32x32cm, slice 2mm, matrix 412x412, locs 92, BW 100kHz, NEX 0.7, scan time 1min57sec.

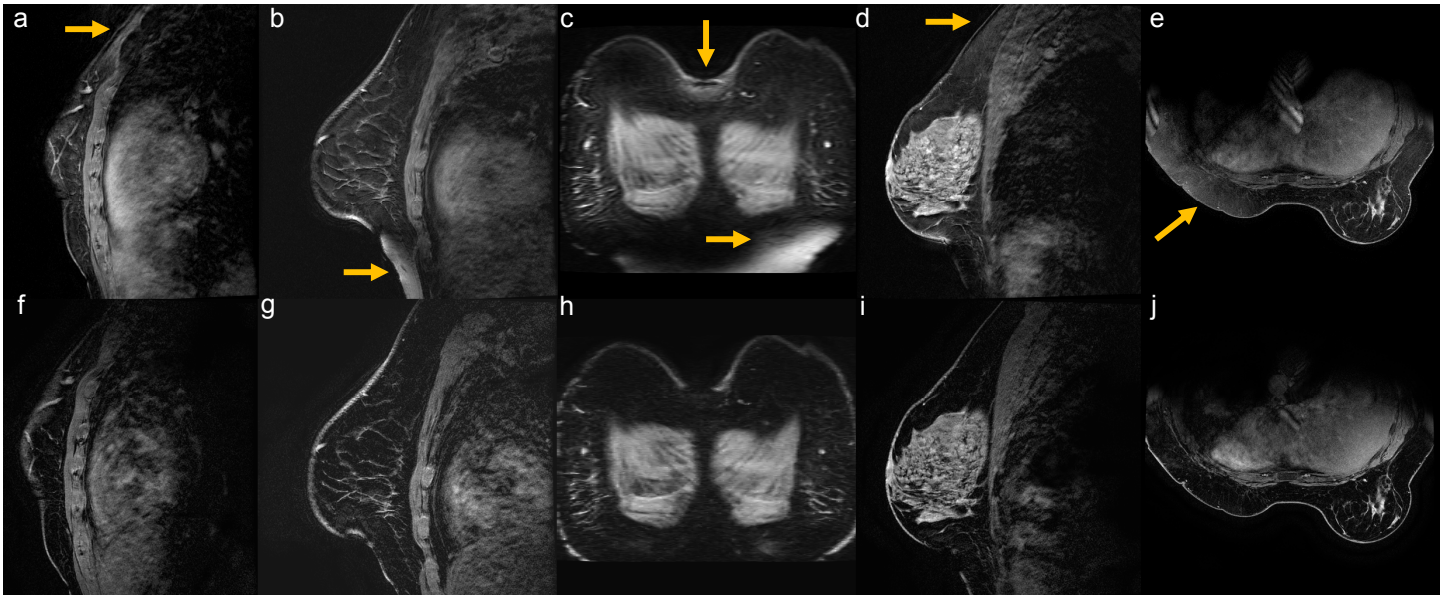

Fig. I. Top row: sagittal traditional fat sat (a and b), coronal reformat from b (c), sagittal traditional fat sat (d), axial traditional fat sat (e). Bottom row: sagittal spectral spatial ASPIR (f and g), coronal reformat from g (h), sagittal spectral spatial ASPIR (i),axial spectral spatial (j). Inconsistent fat sat marked with ***arrows***

Results Sagittal and axial traditional fat sat and spectral spatial ASPIR sequences were successfully acquired in 10 patients. Images were reviewed by a radiologist in terms of overall image quality. In all cases, spectral spatial ASPIR fat suppression was deemed superior to the traditional fat suppression method. Robust consistently uniform fat suppression was noted in all cases with the new spectral spatial ASPIR fat suppression. Further, chest wall detail appeared to be superior to the standard acquisition. Figure I demonstrates typical examples from both traditional fat suppression (top row) and water excitation combined with ASPIR fat suppression (bottom row) from the same individuals.

Conclusions The combination of a spectral spatial water only excitation pulse with an adiabatic spectral-selective inversion recovery pulse provides robust consistently uniform fat suppression over large FOV's (axial) and extensive right left coverage (sagittal) even at 3T.