Fat Saturation with Spectral Spatial Preparation Pulse for SSFP sequences

M. Hirano[1], T. Matsuda[1], A. Nozaki[1], K. Nagasawa[1]

[1]Imaging Application Tech Center, GE Yokogawa Medical Systems, Tokyo, Japan

Introduction:

Steady State Free Precession pulse sequences (FIESTA, True-FISP, Balanced-FFE) yields high signal and can depict vessels with high contrast to noise ratio. Therefore, it is clinically used in every region. However, it is necessary to use fat suppression feature to apply this technique for Abdominal Imaging. Several techniques about fat suppression for SSFP sequences were proposed so far, which were such as fat saturation with spectrally selective inversion pulse (CHESS), water excitation with binominal pulse and fat/water signal separation from Fourier data. Each technique has its advantage and disadvantage. For these shown above, one of fat suppression effect, repetition time (TR) or data acquisition time could be trade-off. A new approach described here is developed based on fat saturation with spectral spatial preparation pulse (SPSP Prep) for 2D multiple slice SSFP sequences. This technique allows good fat suppression effect with short TR and short scan time. The application of the technique promises to offer good abdominal imaging including MRCP and MR Angiography with no contrast agent.

Theory:

Spectral Spatial Pulse (SPSP) is primarily used for water excitation with some pulse sequences [1]. This also can be used with SSFP sequences, but it makes TR longer as is the case with the binominal water excitation. This trade-off causes banding artifact to the images. In this study, SPSP pulse is used for preparation pulse (SPSP Prep.) to suppress fat signal like CHESS pulse. However, these two pulses are different when it is continuously used in 2D multi slice scan. The timing charts of using the conventional CHESS pulse and the new SPSP Prep pulse are shown as Fig.1. CHESS suppresses fat tissues in all slices every time. But, continuous application of CHESS pulse will make fat signals reach steady state and the effect of fat suppression will be decreased. On the other hand, SPSP Prep suppresses fat tissues in each excitation slice. This means that fat tissues in each slice will be excited only at the time when the suppression is really needed.

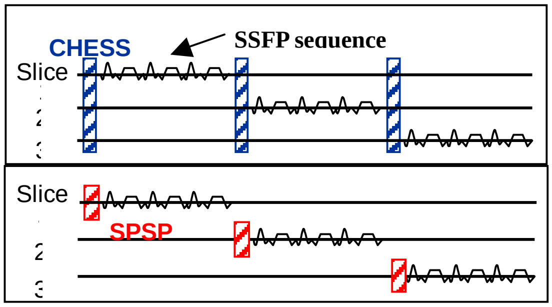

Fig.1 2D multi-slice pulse sequence chart of CHESS preparation (upper) and SPSP preparation (lower)

Materials & Methods:

Phantom and volunteer studies were performed on a 1.5 T MR scanner (Signa EXCITE ver10.0, GE Medical Systems, Milwaukee, WI). SPSP preparation pulse was embedded in the 2D FIESTA sequence. In phantom study, SPSP Prep pulse is applied on the plane both parallel and perpendicular to the imaging plane (slice selective plane) to verify the effect of SPSP Prep pulse.

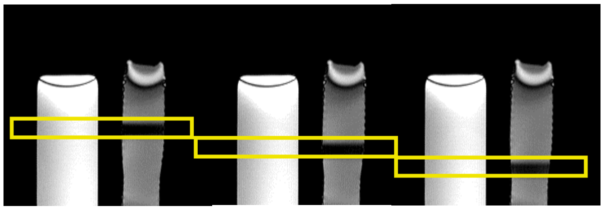

Fig.2 Water (left side of each image) and fat (right side) phantom images. Box shown in each image indicates the SPSP Prep pulse plane.

Results:

Fig.2 shows the results of phantom study that SPSP Prep pulse was applied perpendicular to the imaging plane. SPSP Prep pulse was changing its excitation slice at any image. Apparently, fat is suppressed only at the place which SPSP Prep pulse is applied in each image, while water is not affected at all. This means that SPSP Prep pulse was successfully working as it was expected. Also, the result of volunteer study (Fig.3) shows a good sat suppression.

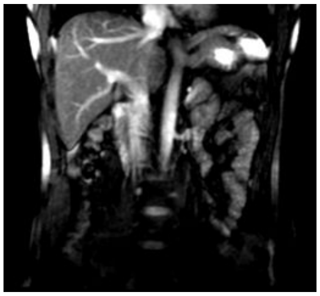

Fig.3 Volunteer Image (TE 1.6ms, TR 3.6ms, matrix 224x128, FA 70, RBW 100kHz, slice thickness 7.5mm, FOV 36 cm.)

Conclusions:

SPSP preparation fat saturation is useful for 2D multiple slice SSFP sequences because of not increasing both TR and scan time. Moreover, SPSP Prep is preferred to CHESS pulse which could be less fat saturation effect to be caused by continuous application. This technique has possibility that its application can extend to other 2D multiple slice sequences, such as 2D multi-shot multi-slice gradient echo and 2D fast spin echo sequences.

Reference: [1] C. H. Meyer, J. M. Pauly, A. Macovski, D .G. Nishimura, MRM, **15**, 287-304, 1990