

# FSE Triple-Echo Dixon (FTED) Preliminary Experience with a Novel Sequence for Fat Suppressed T2-weighted Abdominal MR Imaging

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**Purpose:** To evaluate a prototype FSE Triple-Echo Dixon (FTED) technique for breath-hold, fat suppressed T2-weighted imaging of the abdomen.

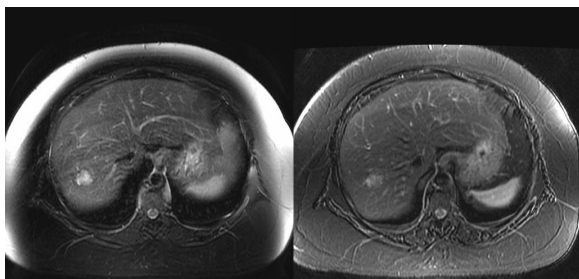
**Background:** Fat suppressed FSE T2-weighted imaging is an integral part of an abdominal MR examination. However, magnetic field inhomogeneities can degrade fat suppression and lead to artifacts that mimic or mask disease. The problem can be exacerbated when a typical large FOV is used for abdominal and pelvic imaging. A technique that provides rapid fat-suppressed T2-weighted imaging that is insensitive to field inhomogeneity would be clinically useful.

This study evaluates a prototype fast spin echo (FSE) based Dixon pulse sequence [1]. The sequence replaces each FSE readout gradient with three readout gradient pulses of alternating polarity. The length of these gradients is adjusted such that their respective echoes occur when fat and water are -180°, 0°, and +180° relative to each other. After data acquisition, a host computer based image reconstruction program commercially known as FLEX (or MEDAL) uses the three echoes as input and automatically generates separate water-only and fat-only images for each slice [2]. Since the pulse sequence acquires multiple echoes within a single pass, breath-hold acquisition of fat-suppressed T2-weighted images is possible even without parallel imaging.

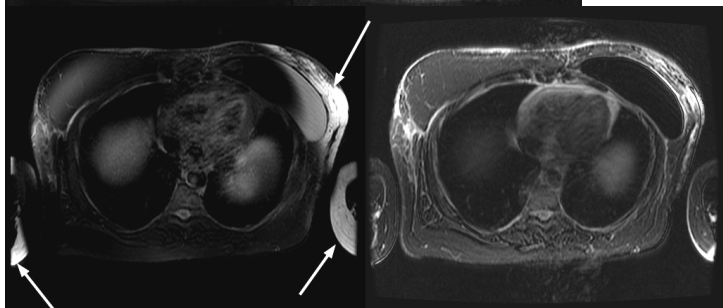
**Materials and Methods:** Forty patients (13 men and 27 women, mean age 50 yrs) referred for abdominal MRI were imaged with axial FTED (TR 2000-2100, TE 90, ETL 20, matrix 256 x 192, Nex 1, rFOV 0.8, slice thickness 7-8mm, 24 slices, bandwidth 64 kHz, time three 23 sec breath holds). Patients also were imaged with breath-hold T2-weighted FRFSE (TR 2050, TE 90, ETL 12, matrix 256x192, NEX 2, rFOV 0.8, slice thickness 7-8mm, 24 slices, bandwidth 32 kHz, ASSET x2, and time two 21 sec breath holds). Two radiologists independently compared the FRFSE and FTED images for overall image quality, homogeneity of fat suppression, image sharpness, anatomic detail, phase artifact, and other artifacts. Depiction of disease involving the liver, spleen, kidneys, biliary tree, pancreas, lymph nodes, adrenal glands, osseous structures, gastrointestinal tract, and peritoneum was recorded separately for the FRFSE and FTED images.

**Results:** FTED images successfully reconstructed water-only and fat-only images from the base images in all 40 cases. Water and fat separation was perfect in 36 (.90) patients. In 4 (.10) patients focal areas of fat and water swapping were present near the lung bases. Compared to FRFSE images homogeneity of fat suppression was superior on the FTED images in 38 (.95) of the 40 cases. The FTED images showed better anatomic detail in 25 (.63), and less susceptibility artifact in 19 (.47). The FRFSE images showed less vascular pulsation artifact in 31 (.78) cases, and less phase artifact from physiologic motion in 21 (.53) patients. Image sharpness and ringing were equivalent on the FTED and FRFSE images. For depiction of normal anatomic structures the FRFSE images were preferred for the liver in 8 (.20) patients, and FTED images preferred in 4 (.10), while the FTED images were preferred for the muscles in 36 (.90) and skin and subcutaneous tissues in 33 (.83) patients. For other anatomy including the kidneys, pancreas, spleen, spine, and vasculature there was no difference between the FRFSE and FTED images. There was no difference in lesion depiction on the FTED and FRFSE images. The FRFSE and FTED images depicted 13/14 and 14/14 liver lesions respectively. FRFSE depicted 8/8 and FTED 7/8 renal lesions. FRFSE and FTED both depicted 9 biliary abnormalities, lymphadenopathy in three patients, intestinal abnormalities in two patients, splenic abnormalities in three patients, and an adrenal lesion in a single patient. Ascites in seven patients and pleural effusions in ten patients were depicted on both the FRFSE and FTED images.

**Conclusions:** FTED is a robust sequence that provides breath-hold T2-weighted images with superior fat suppression, excellent image quality, and at least equal depiction of disease compared to conventional breath-hold T2-weighted FRFSE imaging.



**Figure 1:** FRFSE image (left) shows inhomogeneous fat suppression due to large patient size. The FTED water-only image (right) shows perfect fat suppression and excellent anatomic detail. Both FRFSE and FTED images depict the lesion in the right hepatic lobe.



**Figure 2:** FRFSE image with fat suppression (left) shows artifact (arrows) projected over the anterior chest wall, breast implant and both arms. FTED water-only image (right) shows perfect separation of fat and water signal. The FTED image also demonstrates excellent depiction of anatomic detail and shows the edema in the anterior and lateral chest wall bilaterally.

**References** [1]. Ma J, Son JB, Zhou Y, Le-Petross H, Choi H. Magn Reson Med 58:103, 2007. [2] Ma J. Magn Reson Med 52:415, 2004.