FAST SPIN-ECHO TRIPLE ECHO DIXON: INITIAL CLINICAL EXPERIENCE WITH A NOVEL PULSE SEQUENCE FOR SIMULTANEOUS FAT SUPPRESSED AND NON FAT SUPPRESSED T2-WEIGHTED SPINE MR IMAGING

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Purpose: To evaluate a prototype FSE Triple-Echo Dixon (fTED) technique for T2-weighted imaging of the spine with and without fat suppression compared to conventional T2-weighted fast recovery FSE (FRFSE) and inversion recovery fast spin-echo (STIR) imaging.

Background: FSE T2W imaging is an integral part the MR examination of the spine. Fat suppression improves the depiction of osseous and soft tissue abnormalities. Techniques for fat suppression, including CHESS, STIR, and spectral inversion at lipid (SPECIAL), are either highly dependent on the uniformity of magnetic field across the imaging volume or suffer from less SNR and poorer depiction of anatomic detail. We routinely perform T2W spine imaging with and without fat suppression using two separate acquisitions. A technique that is insensitive to field inhomogeneity and providing rapid T2-W imaging of the spine with and without fat suppression would be practically desirable.

This study evaluates a prototype 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 known as FLEX uses the three echoes as input and automatically generates separate water-only and fat-only images for each slice. Since the pulse sequence acquires multiple echoes within a single pass, rapid fat-suppressed T2-weighted imaging is possible. The 2nd echo of the source images with 0° phase off set is a non fat suppressed T2W image. The fTED acquisition thus provides T2W images with and without fat suppression in a single acquisition.

Materials and Methods: Sixty-one patients were referred for spine MRI. Sagittal fTED (TR 2517, TE 90, ETL 17, matrix 384 x 224, Nex 4, rFOV 1.0, slice thickness 3-4mm, 12 slices, bandwidth 64 kHz, time 2 minute 26 sec) provided fat suppressed water only images and non fat suppressed T2W images. Patients also were imaged with sagittal STIR (time 2 min 42 seconds) and sagittal T2W FRFSE (time 2 min and 55 sec). We compared the STIR and fTED water images and the T2W FRFSE and fTED T2W images for overall image quality, homogeneity of fat suppression, anatomic sharpness, motion artifact, CSF flow artifact, and susceptibility. Depiction and detection of marrow edema, soft tissue edema, cord lesions, disc herniation, epidural abscess, discitis, hematoma, and tumor were compared.

Results: FTED sequence successfully reconstructed water-only and fat-only images from the source images in all 61 cases. Water and fat separation was perfect in 58 (.95) patients. For the two observers the fTED water images demonstrated less motion in 55 (.90) and 59 (.97) of the 61 patients ($p < .05$), better anatomic sharpness in 50 (.82) and 52 (.86) patients ($p < .05$) and less CSF flow artifact in 6 (.10) ($p > .05$) and 8 (.13) ($p < .05$) patients. There was no significant difference between fTED and STIR images in homogeneity of fat suppression, or chemical shift artifact ($p > .05$). The T2 FRFSE and the fTED T2W images showed equivalent motion artifact, CSF flow artifact, and chemical shift artifact. T2 FRFSE images showed better anatomic sharpness in 25 (.41) and 22 (.36) cases. There was no difference in lesion depiction and detection on the fTED water and STIR images, or the fTED T2 and T2 FRFSE images, including marrow edema in 31 patients (31), soft tissue edema (29), cord lesions (4), disc herniation (55), epidural abscess (2), discitis (2), and spine tumors (8).

Conclusions: FTED is a robust sequence that efficiently provides both fat suppressed and non fat suppressed T2W images of the spine with excellent image quality, equal depiction and detection of disease and a 56% reduction in scan time compared to conventional STIR and T2W FRFSE imaging.

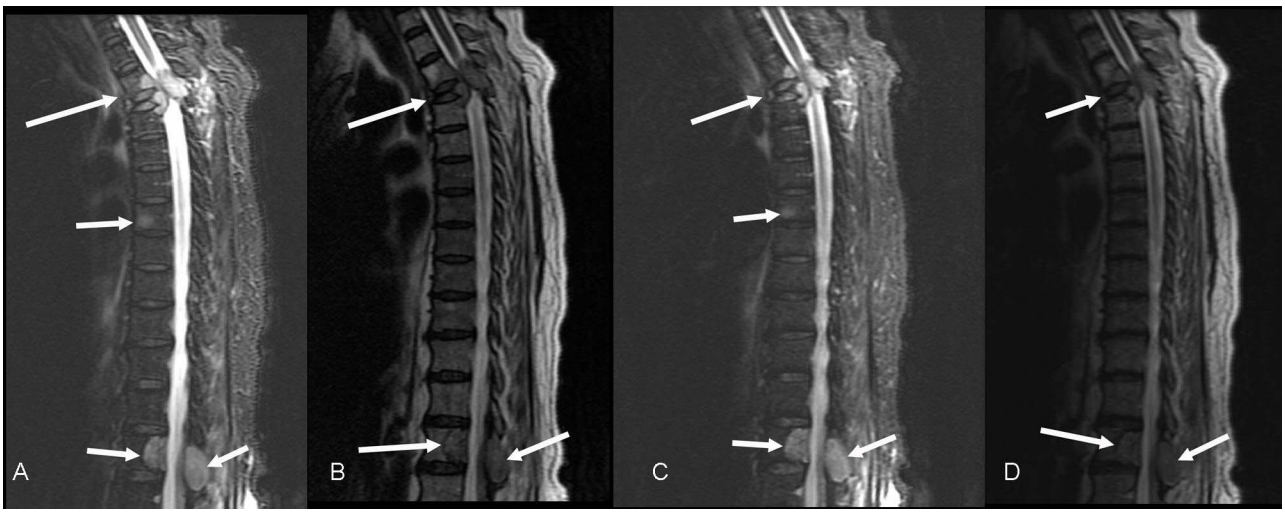

Figure 1: 52 year old female with metastatic cancer. Multilevel osseous metastases and an upper thoracic pathologic vertebral compression fractures are depicted equally well on both the fTED water (A) and STIR (C) images. Improved anatomic sharpness of the fTED sequence is noted. The T2W fTED image (B) and the T2 FRFSE image (D) confirm the multifocal tumor (arrows). In this case the anatomic sharpness was better on the T2 fTED image. Time of acquisition of fTED was 2:26 compared to 5:37 for combined STIR and T2 FRFSE.

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.