

## IDEAL Fat Image in Bone Marrow: Comparison of Metastatic Neoplasm and Benign Marrow Abnormalities

S. Nagata<sup>1</sup>, Y. Uchiyama<sup>1</sup>, N. Tanaka<sup>1</sup>, T. Abe<sup>1</sup>, M. Uchida<sup>1</sup>, K. K. Amrami<sup>2</sup>, and N. Hayabuchi<sup>1</sup>  
<sup>1</sup>Kurume University Hospital, Kurume, Fukuoka, Japan, <sup>2</sup>Radiology, Mayo Clinic, Rochester, MN, United States

**Introduction:** MRI is superior to other imaging modalities in evaluating bone marrow because it is remarkably sensitive in detecting lipid; therefore, MRI can be used to detect processes that alter the relative amounts of fat and water in bone marrow [1]. In-phase–opposed-phase technique may also be useful for differentiating benign from neoplastic processes within bone marrow by detecting small amounts of microscopic fat within benign lesions [2, 3]. Iterative decomposition of water and fat with echo asymmetry and least-squares estimation (IDEAL) is a three-point water–fat separation method that uses asymmetric echoes and least-squares fitting to achieve the maximum possible SNR performance [4, 5]. IDEAL technique simultaneously produces in-phase, opposed-phase, fat, and water images in clinically acceptable scanning times. The aim of this study is to correlate in-phase–opposed-phase with fat image of IDEAL technique and assess the usefulness of the fat image of IDEAL in differentiating metastatic neoplasm from benign marrow abnormalities in vertebral marrow.

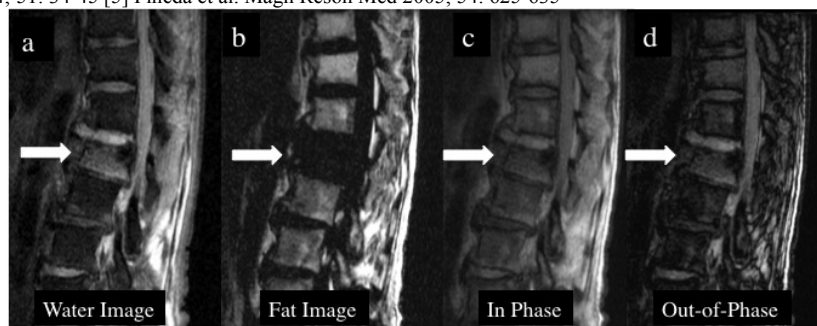
**Methods:** Experiment- A total of 198 normal vertebrae and 47 lesions in 29 patients (17 women, 12 men; mean age, 65.5 years; age range, 34–87 years) who were consecutively imaged on a 3.0-T MRI scanner were enrolled in this study. Forty-seven lesions consisted of metastatic neoplasm (n=20), endplate degeneration (n=14), compression fracture (n=5), hemangioma (n=4), and spondylitis (n=4). Sagittal IDEAL T2-weighted fast spin-echo images (T2FSE) of spine were acquired (Fig. 1). The sequence parameters for IDEAL T2FSE were as follows: TR/TE 3,000-3500/85ms, FOV 30cm, slice thickness 4 mm, matrix 320×192, acquisition time 3min 30sec.

Image Evaluation- We analyzed signal-to-noise ratio (SNR) using IDEAL fat image for: 1) Correlation with the percent decrease on out-of-phase images compared with in-phase images at all normal vertebrae. 2) Differentiation between normal vertebrae and lesions. 3) Differentiation between metastatic neoplasm and the other lesions. Statistical analyses were done using a Spearman correlation coefficient and a two-tailed unpaired *t* test.

**Result:** 1) There was a good negative correlation of SNR using IDEAL fat image with the percent decrease in signal intensity on out-of-phase images compared with in-phase images at all normal vertebrae ( $r = -0.57, p < 0.001$ , Fig. 2). 2) The mean SNR of normal vertebrae and lesions was  $31.1 \pm 15.2$  and  $14.6 \pm 18.7$  on IDEAL fat image, respectively. There was significantly difference between them ( $p < 0.001$ ). 3) The mean SNR of metastatic neoplasm and the other lesions was  $3.3 \pm 4.0$  and  $20.4 \pm 22.5$  on IDEAL fat image, respectively. The mean SNR of metastatic neoplasm was significantly lower than that of other lesions ( $p < 0.001$ , Fig. 3).

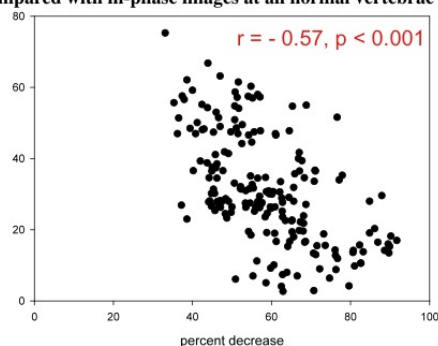
**Conclusion:** Fat image of IDEAL is a sensitive method for assessing fat content of bone marrow and can help to predict the likelihood of metastatic or non-metastatic lesions.

**Reference:** [1] Hwang et al. Skeletal Radiol, 2007; 36: 913-920 [2] Disler et al. AJR, 1997; 169: 1439-1447 [3] Zajick et al. Radiology, 2005; 237: 590-596 [4] Reeder et al. Magn Reson Med. 2004; 51: 34-45 [5] Pineda et al. Magn Reson Med 2005; 54: 625-635



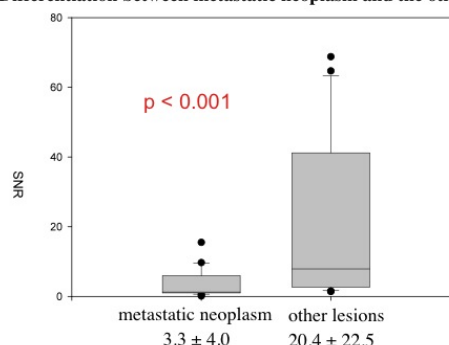
**Fig 1.** 81-year-old male with prostatic cancer. Metastatic lesion at L1 vertebra (arrow) was detected as slight high intensity area on water image (a) and very low intensity on fat image (b). SNR of the lesion is 0.6 on fat image. Signal intensity is 54 on in phase image (c) and 39 on out-of-phase image (d) (percent decrease of 27).

**Correlation with the percent decrease on out-of-phase images compared with in-phase images at all normal vertebrae**



**Fig 2.** There was a good negative correlation of SNR using IDEAL fat image with decrease in signal intensity on out-of-phase images compared with in-phase images at all normal vertebrae.

**Differentiation between metastatic neoplasm and the other lesions**



**Fig 3.** The mean SNR of metastatic neoplasm and the other lesions was  $3.3 \pm 4.0$  and  $20.4 \pm 22.5$  on IDEAL fat image, respectively. The mean SNR of metastatic neoplasm was significantly lower than that of other lesions.