New application screening for malignant tumors using the lesion to spinal cord ratio (LSR) in diffusion weighted images

M. Takahashi[1], Y. Takehara[2], T. Natsume[3], N. Tooyama[4], K. Ichijo[4], H. Sakahara[2], and A. Nozaki[5]

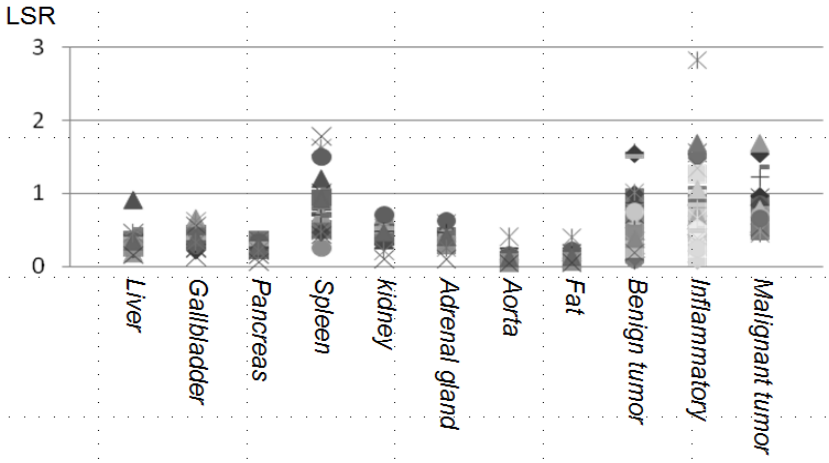
[1]Seirei Mikatabara General Hospital, Hamamatsu, Shizuoka, Japan, [2]Hamamatsu University of Medicine, [3]Seirei Hamamatsu General Hospital, [4]Seirei Mikatabara General Hospital, [5]GE Healthcare Japan

Introduction The primary application of diffusion-weighted (DW) magnetic resonance (MR) imaging has been in the ischemic diseases of the central nervous system. In combination with the advent of the echo-planar imaging and parallel imaging technique, DW imaging is now available in the abdominal area with fast data acquisitions, which has minimized the effect of gross physiologic motion from respiration and vascular pulsation. It has been used to differentiate between tumor and normal tissues by using ADCs. However, a differential diagnosis made on the basis of ADC may not be equally applicable to abdominal imaging because of the B_0 inhomogeneity, and image distortions. In addition, it is complicated to calculate ADC in general practice, and furthermore, it is practically impossible to place a consistent region of interest (ROI) over the lesions across a range of *b* values with different degrees of image distortion. In our study, we focused on the signal intensity of the lesion-to–spinal cord ratio (LSR) with the use of high–*b* value DWI performed with multiple excitations. We suggest that this is a more practical and robust tool for differentiating malignant tumors from other lesions. The purpose of this study was to optimize LSR map in screening for malignant lesions from benign lesions on high–*b* value DW images without using ADC.

Material and Method We calculated LSRs of normal abdominal organs of twenty patients and one hundred seven lesions (57 benign tumors, 16 acute inflammatory lesions and 33 malignant tumors) of eighty seven patients. All MR imagings were performed on a 1.5T scanner using a body phased-array coil. Parameters used for DWI was SE-EPI (TR (ms) / TE (ms) of 4000-5000/56, RBW (kHz/pixel) of 250; NEX of 4, ASSET factor of 2, FOV of 32 (cm), 128x96 matrix, 3 mm slice thickness, 0 mm gap) Motion probing gradients with b values of 800 s/mm2 and 0 s/mm2 were employed in all directions. The highest signal of the spinal cord in all sections of each patient was used in calculating LSRs. Based on the results of the above-mentioned studies the LSR mapping software was developed and tested.

Results and discussions The average values (CV) of the LSRs of the liver, the gall bladder, the pancreas, the spleen, the adrenal gland, the aorta and fat was 0.34 (0.45), 0.39 (0.33), 0.28 (0.21), 0.91 (0.48), 0.46 (0.22), 0.40 (0.26), 0.11 (0.41) and 0.12 (0.40), respectively. In normal abdominal organs, the LSR of the spleen, the kidney, the adrenal gland and the gall bladder were relatively high; however, most LSRs were less than 0.5 except for the spleen (Graph 1).LSRs of benign tumors, inflammatory lesions and malignant tumors were 0.46 (0.71), 0.65 (0.88) and 0.74 (0.42), respectively (Fig. 1). The LSR was higher in malignant tumors than in inflammatory lesions and benign tumors, but there were significant overlaps. In order to make the negative predictive value (NPV) 100%, the required cut-off level was 0.45.In this same condition, the specificity and positive predictive values were relatively low (i.e.; specificity of 56.2% and PPV of 50%) ; however, may be acceptable for the purpose of tumor screening. Based on these results, we developed LSR map application, which calculates LSR of all pixels in DWI and highlight the value over 0.45 in the color map. The software of DW color map was used for the clinical practice, and more effective screening for malignant lesions was feasible to date (Figure 1).

Conclusion Focusing on the ratio of signal intensity of the lesion to that of the spinal cord (LSR), more robust and effective screening for malignant lesions may be feasible with diffusion weighted image.



Graph 1. the LSR of normal abdominal organs and lesions

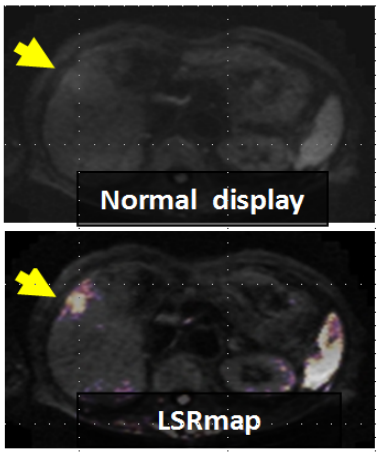


Figure 1. Case of HCC