

# Quantitative Assessment of Anemic Patients' Bone Marrow Using Apparent Diffusion Coefficient with GRAPPA

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## Introduction

MR imaging is an ideal technique for non-invasively studying bone marrow cellularity in large portion. MRI of bone marrow in patient with anemia has been reported [1,2]. However there are few quantitative studies directly measuring in patient with anemia [3,4]. The aim of the present study is to compare between apparent diffusion coefficient (ADC) of diffusion-weighted image (DWI) between anemia patient and normal subject bone marrow.

## Material and method

During 42 months period (April 2004 to October 2006), 13 patients with anemia (6 males and 7 females, 45-83 years old [mean 67.8]) were included in this study. Thirteen age-matched normal bone marrow subjects (45-81 years old [mean 67.9]) were included. Inclusion criteria were anemia, based on Hb below 9 mg/dl and normal bone marrow criteria based on normal blood cell count, and no history of malignant, hematologic, or systemic disease. All patients were studied with 1.5 T MR imaging units (Symphony Quantum and Sonata, Siemens, Germany) with a phased array spine coil. In addition to the routine sequences such as T1-weighted images and fast STIR images, DWIs were obtained with spin-echo sequences with GRAPPA, a parallel imaging technique, (acceleration factor = 2) and the following parameters: repetition time (TR) = 1000; echo time (TE) = 38; field of vision (FOV) = 280 × 280 mm, thickness = 5mm; and b factors = 0, 400, and 800. The reconstructed voxel size was 2.2 × 2.2 × 5.0 mm. The ADC was measured from regression using three b-values in each vertebra with software of the employed MRI system. The region of interest was measured mid-sagittally, at the L2 vertebrae and excluding the cortex. Mean and standard deviation (SD) were calculated for the ADC of each vertebra. The mean values of ADC were compared using unpaired t test. Significance was defined as  $P < 0.01$ .

## Results

The mean ADC values of the L2 to L4 vertebrae for each group were (mean±SD): anemia patients: (0.46±0.15mm<sup>2</sup>/sec) and normal subjects: (L2: 0.22±0.17×10<sup>-3</sup> mm<sup>2</sup>/sec) (Fig. 1, and Figs. 2). The mean ADC values of anemia patients were significantly higher than that of normal subjects ( $P < 0.01$ ).

## Discussion and conclusion

In this study the mean ADCs of anemia were significantly higher than those of normal subjects. Nonomura's group reported that low cellularity bone marrow yielded a low ADC value and one of high cellularity yielded a high value in the bone marrow [4]. As those anemia patients may be hyper cellular bone marrow, ADC value of anemia patients may show high ADC values.

In conclusion, ADC values of DWI could be helpful information in distinguishing anemia patients and normal subjects.

## References

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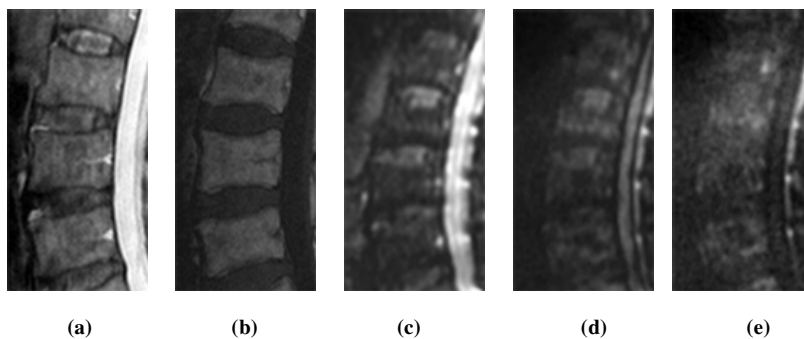


Fig. 1 A 76-year old female of anemia patient (Hb=7.2 mg/dl): ADC=0.45×10<sup>-3</sup> (a)STIR(b) T1-weighted image (c) DWI (b factor=0) (d) DWI (b factor=400) (e) DWI (b factor=800)

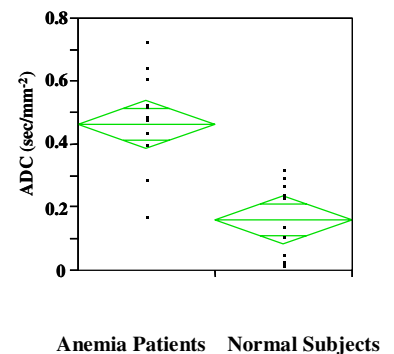


Fig.2. ADC Values Distributions