

Age Dependence of Signal Intensity Ratio of In-phase and Opposed phase Image in Normal Spinal Bone

E. Kozawa¹, N. Nishi², Y. Sato², S. Watanabe³, and J. Tanaka²

¹Radiology, Saitama Medical University, Hidaka, Saitama, Japan, ²Radiology, Saitama Medical University, Japan, ³Central Radiology, Saitama Medical University, Japan

Introduction

Relative signal intensity ratio of in-phase and opposed phase study is a well established method for assessing of fat and water components in the adrenal adenoma [1]. Recently researchers and published materials evaluate vertebral compression fracture or bone marrow invasion via this method has shown [2, 3]. Though a few reports were introduced to evaluate of relative signal intensity ratio of normal bone marrow, there is no report of use of SIR in the lumbar spine influenced by age [4].

The purpose of our study is the determination of SIR relations from normal subjects with age.

Materials and methods

Sixty-five consecutive patients (38 male and 27 female patients; aged 21 to 78 years, mean 50.4) were studied with 1.5-Tesla MRI units (Magnetom Quantum and Sonata, Siemens, Germany) with a phased-array spine coil for benign diseases—back pain or sciatica—or suspected spinal cord disease. Inclusion criteria were normal bone marrow, based on normal blood cell count, and no history of malignant, hematologic, or systemic disease. Patients were divided into a young-to-middle-aged group (Group 1: 21 to 49 years) and an old-aged group (Group 2: 50 to 78 years). In addition to the routine sequences such as T1-weighted, and T2-weighted images, all patients underwent dual-phase chemical shift sequences with TE=4.7 msec for in-phase and 2.3 msec for opposed-phase. This sequence was obtained with TR of 140 msec, flip angle of 90 degree, one excitation, a 256x240 matrix, FOV of 300x300 mm and 4 mm thickness. Signal intensity ratio (SIR) values were defined and measured: **SIR=opposed-phase signal intensity / in-phase signal intensity**

The region of interest was measured mid-sagittally, at the L2 to L4 vertebrae and excluding the cortex. Mean and standard deviation (SD) were calculated for the SIR of each vertebra. The mean values of SIR were compared using Mann-Whitney rank test and commercially available software (JMP; SAS Institute Inc.). Significance was defined as $P < 0.01$. Furthermore, SIR values and aging change were analyzed by linear regression.

Results

The mean SIR values of the L2 to L4 vertebrae for each group were (mean \pm SD): Group 1: (L2: 0.36 \pm 0.11; L3: 0.40 \pm 0.10; L4: 0.40 \pm 0.09) and Group 2: (L2: 0.56 \pm 0.15; L3: 0.55 \pm 0.14; and L4: 0.54 \pm 0.14). The mean SIR value of Group 1 was significantly higher than that of Group 2 ($P < 0.01$) (Fig. 1 and Fig.2).

The mean SIR values show positive linear correlation with age between SIR and age. R^2 for each vertebra level were: L2: 0.44; L3: 0.49; and L4: 0.44. The increase rates of SIR with decade age were: L2: 6.0%; L3: 6.0%; L4: 5.6% (Fig. 3).

Discussion and conclusion

The SIR values of Group 1 were low and of Group 2, high. The relative proportion of fat cells in red marrow is low at birth and increases with age. As young-to-middle-aged adult with red marrow yields low signals from water and fat of about the same proton on opposed phase, SIR value could show low. As old-aged adult with yellow marrow yields high signals from rich fat proton on opposed phase, SIR value could show high.

In this study, in the course of aging, there is an increase in measured SIR values of about 5.6-6.0 % decade of age. De Bisschop E and colleagues reported an increase in fat content relative to water with age of about 7% per decade on MR spectroscopy (MRS) [5]. An increase proportion in SIR value have shown almost same in fat content relative to water on MRS.

In conclusion, the SIR values of normal bone marrow could be strongly influenced by age.

References

1. Namitomo T, et al. Radiology 218: 2004, 2004.
2. Zampa V, et al. Eur Rad 12: 1881, 2002.
3. Kozawa E, et al. JMRI 20: 1020, 2004.
4. Zajick DJ jr et al, Radiology 237: 529, 2006.
5. De Bisschop E et al. Bone 14: 133, 1993.

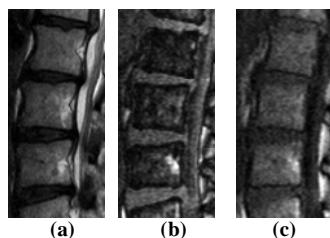


Fig. 1 A 29-year old female:
SIR (L2: L3: L4=0.22: 0.28: 0.36)
(a)T2-WI (b) OP image (c) IP image

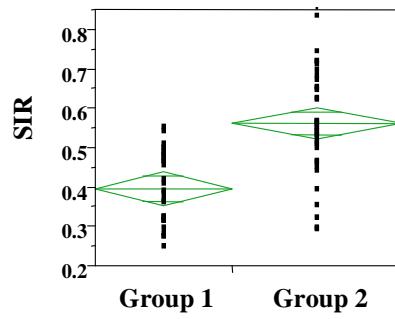


Fig. 2 SIR of normal volunteer at L3 vertebra
Diamonds represent means and 95%
confidence intervals of means.

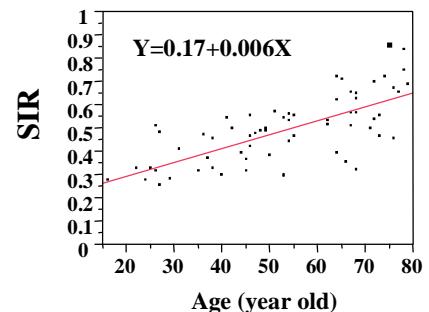


Fig. 3 SIR with aging change at L3 vertebra