Apparent diffusion coefficient and fractional anisotropy in the vertebral bone marrow

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INTRODUCTION:

Yeung et al described that fat degeneration of bone marrow related to osteoporosis , i. e., low BMD, was reflected by a decreasing apparent diffusion coefficient (ADC) [1]. Is this relation applicable to all fat fraction levels? If not, what affects it, and how does it change? To assess the state of cancellous tissue, we analyzed ADC and fractional anisotropy (FA) in the vertebral bone marrow.

METHODS:

On a 1.5-T MRI, single shot diffusion echo planar imaging was used with b factors of 0 and 1000 s/mm^2, diffusion-sensitizing gradient in six directions, sensitivity encoding technique, effective TE of 74 ms, and TR of 1800 ms. ADC and FA were determined in the lumbar vertebral body of twelve normal subjects (age range, 10 - 75 years), and then compared with the BMD obtained with dual-energy X-ray absorptiometry (DXA). Moreover, fat fraction of the bone marrow was measured with spectral presaturation with inversion recovery in the same subject.

RESULTS and DISCUSSION:

A strong negative correlation was found between ADC and DXA-BMD below moderate fat fraction in the vertebral bone marrow (Fig. 1), i.e., dependence on trabecular architecture. Moreover, significant correlation was noted between ADC and fat fraction in this region (Fig. 2). There was a positive correlation between FA and DXA-BMD (Fig. 3), and no correlation between FA and FF in the vertebral bone marrow (Fig. 4), i.e., independent of fat fraction. Figer 5 shows a model of the trabecular bone architecture, and how BMD or fat fraction affect the water diffusion of bone marrow (Fig. 5).

CONCLUSION:

Diffusion analyses with ADC and FA make it possible to obtain more detailed information of the structure of cancellous tissue and the bone metabolism.

REFERENCES:

[1]. Yeung DK, et al, JMRI, 19: 222-228, (2004).

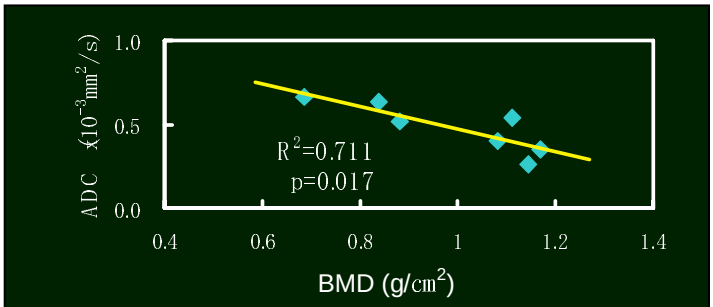

Fig. 1. Relation between BMD and ADC

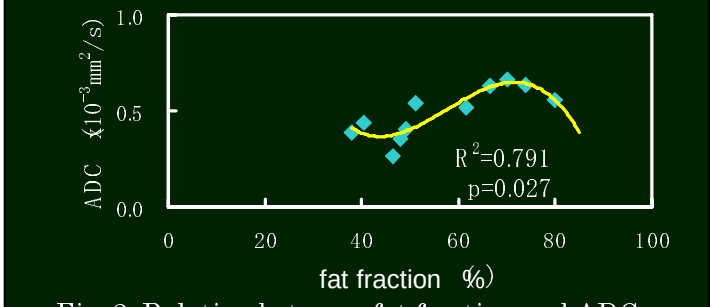

Fig. 2. Relation between fat fraction and ADC

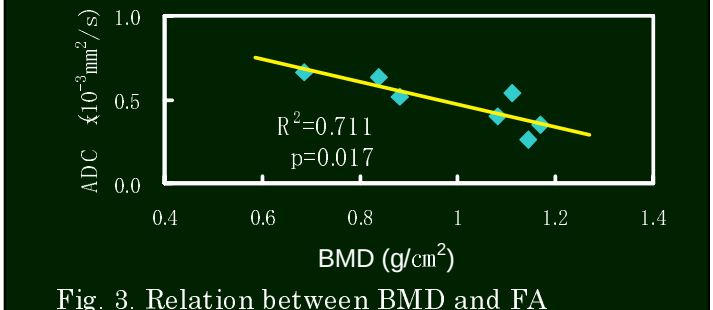

Fig. 3. Relation between BMD and FA

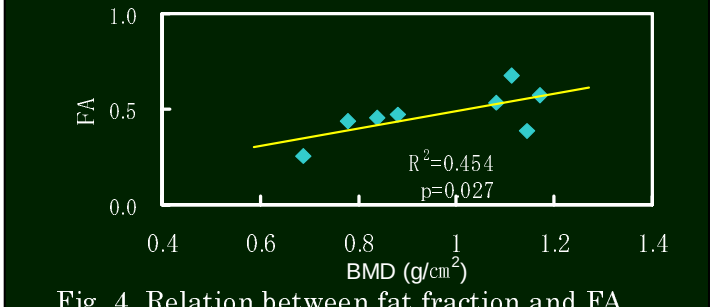

Fig. 4. Relation between fat fraction and FA

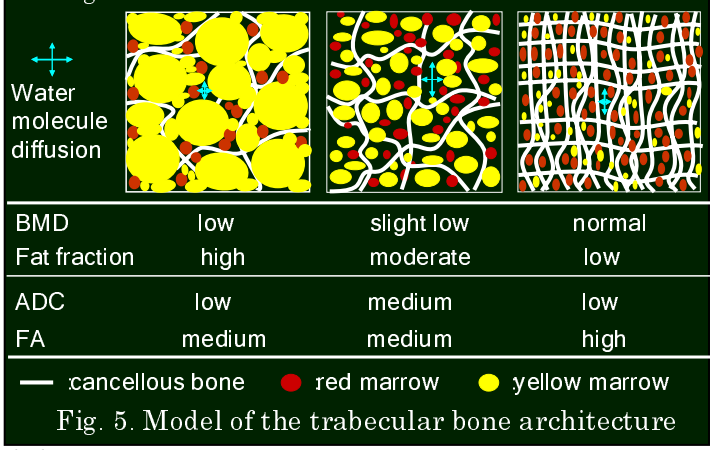

Fig. 5. Model of the trabecular bone architecture