# $^1$H MRS as a novel quantitative method for osteoporosis detection.

***P.Menshchikov*[1,2,3], *T.Akhadov*[1], *A.Ivantsova*[1], *M.Ublinskiy*[1,3], *A.Manzhurtsev*[1,3], *N.Semenova*[1,2,3]**

[1]*Clinical and Research Institute Emergency Paediatric Surgery and Trauma, Moscow, Russia*

[2]*Semenov Institute of Chemical Physics of RAS, Moscow, Russia*

[3]*Emanuel Institute of Biochemical Physics of RAS, Moscow, Russia*

## Introduction

Osteoporosis is skeletal disease characterizing by a decrease in bone mineral density (BMD). It leads to an increased risk of fractures, for instance compression vertebral fracture (CVF)[1]. Dual-energy x-ray absorptiometry (DXA) and quantitative CT (QCT) are commonly accepted methods for assessing of the disease. Spectra were obtained by localized proton magnetic resonance spectroscopy ($^1$H MRS) from the cancellous bone (CB) of the vertebra (Fig. 1A). Figure 1(B) shows a typical spectrum from the CB. There are two main peaks in the spectrum: water peak (δ = 4.66 ppm) and peak from bulk methylene protons of fat (δ = 1.20 ppm). The fat fraction index (FF) was calculated using following:

$$FF = \frac{I_{fat}}{I_{fat}+I_{water}} \quad (1)$$

The aim of the study was to explore the relationship between FF and BMD in children.

## Methods

Seventeen patients (10.9 ± 2.4 years) with CVF were studied. QCT was used to determine the BMD [mg / cm3] in vertebrae L3, L4 using Philips Brilliance 16. $^1$H MR spectra (STEAM, TE = 12.8ms, TR = 3000 ms, voxel size = 20×15×10mm) were acquired from CB of lumbar vertebrae L3, L4 (Fig. 1A)) using MRI Philips Achieva 3.0T.

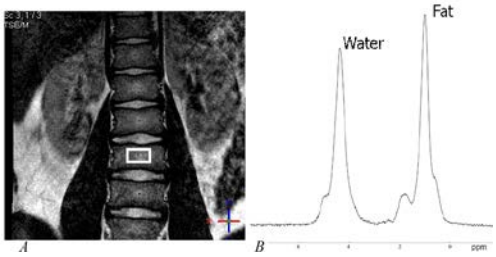


*Fig.1. (A) VOI position; (B) Typical spectrum from vertebrae*

## Results

Correlation analysis revealed significant inverse correlation link (*R = -0.51, p = .001*) between FF and BMD for all vertebrae of all patients (Fig.2). Patients were classified into two groups: 7 mild CVF patients (1-2 damaged vertebrae) and 10 severe CVF patients (more than 2 damaged vertebrae). Intergroup analysis revealed significant increase FF (*p <.005*) and a reduction of BMD (*p <.005*) in patients with severe CVF as compared to mild CVF.

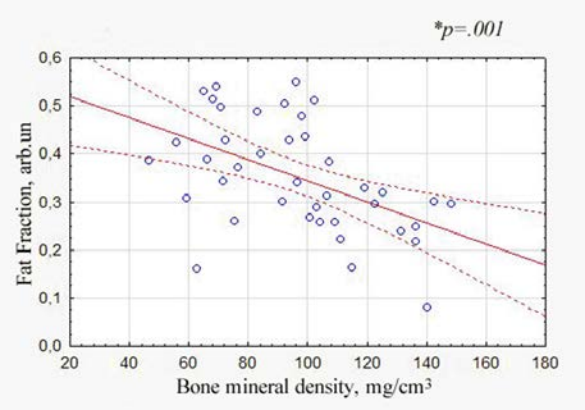


*Fig.2. Significant correlation between FF and BMD*

## Discussion

In the present work, we have studied, for the first time, correlation between FF and BMD. A similar significant correlation link between these parameters measured in the lumbar vertebra was also found in people of middle and old age[1]. Results of in vivo studies and results of previous histological studies[2], which showed age-related replacement of bone tissue with the yellow bone marrow in vertebrae, confirm that the decrease in mineral density and the increase in fat content in the bone marrow occur in parallel for different age groups. Our findings demonstrate that severe compression vertebral fractures are associated with higher FF values and lower BMD values, while in case of mild compression vertebral fractures we can see lower FF values and higher BMD values. That is in a good agreement with[3] where positive correlation between BMD and vertebrae biomechanical strength was revealed too.

## Conclusion

Revealed investigations shows that changes in fat content in the vertebra bone marrow measured with 1 H MRS can be used for assessing bone mineral density. A significant advantage of such technique is the absence of ionizing radiation on a patient that can be used for screening even children.

**References**

*[1] Baum T., Nardo L. et al. Journal of Magnetic Resonance Imaging, 35(1): 117–124.*

*[2] Meunier P, Aaron J, et al. ClinOrthopRel Res 1971;80:147–54.P.*
*[3] Karampinos D., Ruschke S. et al Journal of Osteoporosis Volume 2015.*