**Introduction:** Background

According to the previous report, the evaluation of avascular necrosis (AVN) was mainly based on the proton magnetic resonance image, such as T1 and T2 weighted images and enhancement pattern with contrast agent injection. The proton magnetic resonance spectroscopy (1H MRS) was never used. The 1H MRS was commonly used in evaluating the cerebral disorders, such as epilepsy and acute infarction. The fat itself has plenty of proton and 1H MRS will be the appropriate method evaluates the fat tissue. The water also had plenty amount of proton. Thus, we consider the possibility to evaluate the ratio of intraosseous fat and water by using the proton MRS. In recent years, several investigators started to use the PRESS, STEAM or QCSI techniques to study the fat and water component of human vertebral body. They also found the lipid-water ratio demonstrated by 1H MRS was abnormal in patients with leukemia, aplastic anemia and Gaucher disease. The therapeutic result was also followed by 1H MRS. Not only the patients, but also the normal subjects were studied with 1H MRS according to different age and gender.

Proton magnetic resonance spectroscopy (MRS) can measure the lipid and water components within bone marrow accurately. Our previous cross-sectional study revealed significant MRS differences between the intact femoral heads of patients with unilateral avascular necrosis (AVN) and healthy femoral heads of the control group. However, due to lack of and impossibility of biopsy, we can not be certain that the differences indicate early change of osteonecrosis. In addition, it is a cross-sectional study without long-term follow-up, we also can not be sure that the MRS can diagnose osteonecrosis earlier than MRI, nor as a prognostic predictor.

**Purpose**

Therefore, we perform MRI and MRS study again after at least two years. We expect that some patients should develop osteonecrosis on their previously intact hips.

**Materials and Methods:** MRS was performed on the intact hips of 38 patients with unilateral femoral AVN. They were followed and MRS study was performed after at least two years. The lipid spectrum of the MRS was further divided into three peaks, at 2.1ppm, 1.2ppm and 1.0ppm. (Fig 1) Three variables were used to describe each peak: integration, amplitude, and line width. The completeness of epiphyseal scar was also recorded as a prognostic factor.

**Results:** 10.5% (4/38) patients developed a new AVN lesion on the previous intact femoral heads in a two-year follow-up period. They are all male. In lipid peaks at 2.1 and 1.0ppm, the integration showed significant differences between these four patients and the rest 34 patients (p<0.05; two-sample t-test). In the lipid peak at 2.1ppm, the amplitude showed significant differences (p<0.05; two-sample t-test).

The logistic regression showed that only the integration and amplitude of the lipid peak at 2.1ppm had significant effect on the prediction of AVN.

The risk of AVN progression is related to the completeness of epiphyseal scar.

**Conclusion**

The lipid spectrum of MRS on the femoral head at risk of AVN could play a role in predicting its prognosis of possible progression into AVN, as early as two years.

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**Fig 1 MRS spectrum of the femoral head**

By applying the statistical technique of “Classification and Regression Trees (CART)”, we can define a cut-off point of the variables which predicts the progression of AVN. Before adjusting the confounding of age and sex, patients whose integration value of the lipid peak at 2.1ppm is higher than 565, had a 33.0 folds greater risk to develop AVN, comparing with whose value lesser than 565. After adjusting the confounding of age and sex, the relative risk increased to 48.7 folds.

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**Discussion:** Literature review

In most cases mentioned by Schellinger et al (2000), the lipid signals were with various lipid fragments generally not solved. Brix et al (1993) mentioned that the lipid signal is composed of at least eight fractions, it is the methylene group at 1.6 ppm that contribute the largest signals and another ester group at its left aspect. In our experience, we are easily to detect methylene or ester peaks at the range of lipid spectrum from 0.8 to 1.8 ppm mentioned by Amano et al (1997). This alteration in internal chemical contents of femoral head may play more important role than vascular factor or others in the increasing risk of avascular necrosis.

The explanation of our results

In our study, the lipid peak at 2.1ppm showed significant increase in the patients who was prone to develop new AVN lesions. According to the literature (Brix, 1993), this part of the lipid may represent the ester group. In other words, the lipid composition had changed, by transforming its chemical compounds into ester groups, in the high risk patients.

Further animal study and pathologic examination is required to correlate the spectroscopic findings.