

# Articular cartilage injury associate with acute rupture of anterior cruciate ligament injury in the knee: Assessment with T2 mapping

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## Purpose

Anterior cruciate ligament (ACL) rupture has been associated with early occurrence of osteoarthritis (OA), which was originally believed to be due to instability derived from ACL insufficiency. However, recent studies showed more than half of the patients who had ACL reconstruction will develop OA changes within 10 years after an ACL rupture<sup>1</sup>). These findings suggest that the initial injury to the articular cartilage and subchondral bone may also play a role in the development of OA. On the other hand, the relationship between acute ACL rupture and cartilage injury has not been well documented. One of the reasons for the little understandings in the relationship between ACL rupture and cartilage injury has been that there was no effective and non-invasive evaluation method of cartilage injury.

Transverse relaxation time (T2) mapping is a magnetic resonance (MR) imaging technique that has the potential to quantitatively evaluate deterioration of molecular composition and structural integrity of articular cartilage<sup>2</sup>). The aim of this study is to evaluate the relation between acute ACL rupture and cartilage injury by using T2 mapping. We especially focused on the relationship between the presence or absence of bone bruise and cartilage injury overlying bone bruise.

## Materials and methods

Forty seven knees of 47 patients (21 women and 26 men, mean age 26.9±5.6 years) with acute ACL rupture were studied with an MR imaging system at 1.5 Tesla (Signa, GE Medical Systems, Milwaukee, WI). Fat-suppressed T2 weighted imaging and T2 mapping in the coronal plane were performed, and T2 value of the cartilage at medial and lateral condyle was measured. For the comparison of T2 value, 40 knees of 20 healthy volunteers (16 males, 4 females, mean age 34.9 ±6.2 years) without symptoms of knee pain or previous medical treatment concerning knee trauma underwent T2 mapping as the same manner. A multi-spin-echo (MSE) sequence was used for T2 measurement, and scanning parameters were 1500 msec TR, 8 TEs of 12.4-99.2 msec, 140×140 mm field of view, 3.0-mm slice thickness, 384×384 matrix, and 1 excitation. To evaluate the relationship between acute ACL rupture with and without bone bruise and cartilage injury, T2 value of cartilage at medial and lateral condyle and mean value of entire cartilage at femoral condyle of healthy volunteer were measured. Then each T2 value of cartilage at medial and lateral condyle of the patients without bone bruise and affected and unaffected condyle of the patients with bone bruise were compared. In 33 patients, operative findings of cartilage at the time of ACL surgery were evaluated and compared with the MRI findings. Unpaired and paired T-test was used for statistical evaluation, and statistical significance was defined as p<0.05.

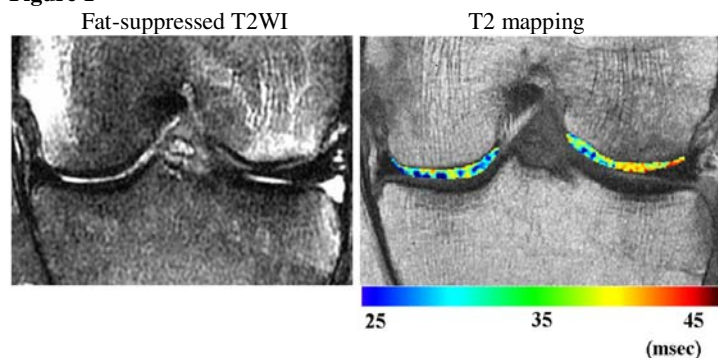
## Results

Of the 47 patients, 24 had a bone bruise at lateral femoral condyle. Within the patients without bone bruise, T2 values of cartilage at medial and lateral condyle were 31.7ms and 33.1ms. T2 values of cartilage at medial and lateral condyle within the patients with bone bruise were 32.5ms and 37.9ms. T2 values of the cartilage overlying bone bruise were significantly higher than that in healthy volunteer and unaffected condyle. T2 values of cartilage at medial and lateral condyle within healthy volunteer were 31.1±4.4 ms and 32.3±3.7 ms, mean 31.6±4.1. T2 values of cartilage at medial and lateral condyle within patients without bone bruise were 31.5±2.3 ms and 33.1±3.1 ms and were not significant to that in healthy volunteers. The operative findings of cartilage were well correlate with the MRI findings.

## Discussion

In this study, a significant increase in the T2 of cartilage at the femoral condyle with bone bruise was observed. On the other hand, no significant increase in the T2 of cartilage at the femoral condyle without bone bruise was observed. It is known that T2 value increases with the loss of collagen anisotropy and increase in water content observed in the damaged or deteriorated cartilage. Thus the presence of bone bruise at the femoral condyle after acute ACL rupture was thought to indicate the presence of cartilage deterioration at that site. Deterioration of articular cartilage associate with bone bruise should be taken into account in clinical treatment for acute knee injury.

## Figure 1



## References

- 1) Daniel DM, et al. Fate of the ACL-injured patient. A prospective outcome study. *Am J Sports Med*, 22: 632-644, 1994
- 2) Nieminen MT, et al. T2 relaxation reveals spatial collagen architecture in articular cartilage: a comparative quantitative MRI and polarized light microscopic study. *Magn Reson Med*, 46: 487-493, 2001

## Figure 1

Increased signal intensity on fat-suppressed T2 weighted image was observed at the lateral femoral condyle (left). Prolonged T2 value in the lateral femoral cartilage was observed with the T2 map, indicating the presence of degeneration within this area (right).