THE ULTRASOUND CAN EVALUATE MACROSCOPICALLY UNDETECTABLE CARTILAGE DEGENERATION IN RABBIT OSTEARTHRITIS MODEL

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Purpose: Early diagnosis of osteoarthritis is important, although the diagnostic method is not fully established yet. In our group, ultrasound cartilage evaluation system has been developed in order to examine material properties of the articular cartilage. The ultrasound reflected wave correlates the macroscopic osteoarthritis progression (ICRS grade). In this study, we investigated whether ultrasound has the potential to detect the macroscopically undetectable cartilage degeneration with rabbit osteoarthritis model.

Methods: This investigation was approved by the Animal Research Center of our university. Eighteen female Japanese white rabbits were used. Under general anesthesia, a medial parapatellar incision was made to expose the bilateral knee joint, and the patella was laterally dislocated. Then, the both anterior cruciate ligaments were exposed and the left anterior cruciate ligament transection (ACLT) was performed and instability was manually confirmed. The patella was reduced, and joint capsule and skin were closed. The rabbits were sacrificed at 1, 2, 4, 12 weeks after the operation and 4 rabbits were assigned for each group. Two untreated rabbits were used as 0 week control. The lateral femoral condyle (LFC) was evaluated in this study. The cartilage was scored macroscopically from 0 (intact) to 4 (massive cartilage defect) by two investigator. The mechanical properties of the cartilage were measured with our ultrasound cartilage evaluating system with wavelet transform method. The maximum magnitude of the reflected wave from the surface of the articular cartilage was defined as signal intensity. The paraffin section of the LFC was evaluated in this study. The cartilage was stained with safranin-O/fast green, haematoxylin/eosin (HE) and evaluated. The data was statistically analyzed with Mann-Whitney U test or Student T test appropriately. P < 0.05 was set to significant difference.

Results: The macroscopic score of the left LFC (ACLT) was median: 0 (minimum: 0- maximum: 0) at 0, 1 and 2 weeks, 0.5 (0-1) at 4 weeks and 2.25 (1-3) at 12 weeks. The score of the right LFC (sham) was 0 (0-0) at 0, 1 and 2 weeks, 0 (0-0.5) at 4 weeks and 0.5 (0.0-0.5) at 12 weeks. At 12 weeks, there was significant difference between the macroscopic score of the left (ACLT) and the right (sham). The signal intensity of the left knee was decreased as the time going. At 2 weeks, the signal intensity of the left (ACLT) and right (sham) were 0.74±0.20 and 1.19±0.29, respectively (p < 0.05). There were significant differences between the signal intensity of the left (ACLT) and the right (sham) at 2, 4, and 12 weeks. In the histology of the left LFC, slight fibration and decrease of safraninO staining were observed at 2 weeks. At 12 weeks, the cartilage of the left LFC resulted in osteoarthritic change with severe fibration, cell clustering and decrease of safraninO staining.

Conclusions: Although there was no macroscopic change at 2 weeks, the signal intensity of the anterior cruciate ligament transection knee was significantly decreased (38% decrease to sham). At 2 weeks, the cartilage degeneration was already observed in the histology. The ultrasound analysis has the possibility to detect the very early change of the osteoarthritics.