**Loading and knee-alignment have significant influence on cartilage T2 in porcine knee joints**

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**Introduction**

Quantitative knee MR imaging, such as delayed gadolinium enhanced MRI of cartilage (dGEMRIC) and T2 mapping, provides reliable, non-invasive assessment of microstructure compositions and degenerative changes of the articular cartilage. [1] However, quantitative MR imaging in more physiological conditions under loading or knee mal-alignment was poorly investigated. We developed a non-metallic pressure device for excised porcine knee joints which allowed MR imaging under variable loading or knee alignment conditions. The purpose of this study is to assess influence of loading and knee alignment on T2 mapping of the femoral cartilage in the porcine knee joint.

**Material and Methods**

Ten porcine knee joints were harvested en block with intact capsule and surrounding muscle, and were imaged using the custom-made pressure device and 3.0T MR imaging system. Sagittal T2 maps were obtained at knee neutral alignment without external compression (Condition A), under mechanical compression equivalent to 10 mm displacement (Condition B), under the same compression after it remained for 10 minutes (Condition C), and under the same compression with the knee 10° varus alignment (Condition D). T2 maps were calculated using a monoexponential fit from 2D multi-spin echo sequences. T2 values of deep, intermediate, and superficial layers of the medial and lateral femoral cartilage at the weight-bearing area were compared among those conditions using a custom-made software (Fig 1). After imaging, cartilage contact pressures between the femoral and tibial cartilages were measured using pressure-sensitive film, and were correlated with cartilage T2 measurements.

**Results**

On unloading (Condition A), the average T2 values of deep/intermediate/superficial layer were 59±3.7ms/62±7.6ms/67±6.4ms in the medial cartilage, and 63±7.5ms/65±9.2ms/72±7.8ms in the lateral cartilage, respectively. T2 values in both medial and lateral superficial layers had significantly higher values, compared to those in the deep zone (p < 0.05).

In the medial cartilage, average T2 values of deep/intermediate/superficial layer were decreased by 1.4%/13%/6.0% on loading (Condition B), and were further decreased by 4.3%/19%/17% on varus alignment (Condition D), as compared with those values at Condition A (Fig 2,3). In the lateral cartilage, those T2 values were decreased by 3.9%/7.7%/4.2% at Condition B, but were increased by 1.6%/9.6%/7.2% at Condition D. There was a significant decrease of T2 value in the intermediate layer of the medial cartilage at both Condition B and Condition D (p < 0.05). However, there was no significant difference in the T2 values between Condition B and C at any zone.

The total contact pressure at medial/lateral cartilage was 47±8.4N/46±5.1N respectively at Condition B, and 94±21N/35±7.8N at Condition D. These values were significantly correlated with the T2 value in the intermediate zone of medial cartilage (Condition B/D: r=0.484/0.784) and lateral cartilage (r=0.485/0.636).

**Discussion**

Decreased T2 on loading was assumed to reflect deformation of collagenous architecture or extrusion of water content within the cartilage. [2] In the present study, response of T2 change to loading or alignment change was variable between the medial and lateral cartilages, and among the deep, intermediate, and superficial layers. Those T2 changes were significantly related with contact pressure measurements by pressure-sensitive film. Our results may indicate that quantitative assessment of MR imaging for the cartilage differs in various physiological conditions, and T2 mapping under loading allows non-invasive, biomechanical assessment of site-specific stress distribution in the cartilage.

**References**


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**Fig1**: Three layers of femoral cartilage

**Fig2**: T2 mapping of femoral medial cartilage at each Condition

**Fig3**: Change of T2 values at each Condition
Changes were calculated as (each Condition – Condition A)/Condition A*100

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