

## T1rho MRI of Acute Anterior Cruciate Ligament (ACL) Injured Patients at 3T

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**Introduction** Anterior cruciate ligament (ACL) injury is associated with increased risk for the development of knee osteoarthritis (OA) 10-20 years after the injury (1, 2). T1rho mapping has been shown to be suggestive of variations in cartilage proteoglycan (PG) loss (3). Very few studies have used the MR imaging techniques to evaluate ACL injury and associated cartilage degeneration (1, 2). Some investigators have demonstrated that T1rho MR imaging can detect the cartilage matrix changes of ACL-reconstructed knees (1). Another study (2) has applied the contrast enhanced MRI (dGEMRIC) technique to assess knee cartilage in patients with ACL injury and indicated that ACL-injured patients are correlated with post-traumatic OA. The aim of this study was to evaluate and compare subregional and whole T1rho values (median  $\pm$  interquartile range) of femorotibial cartilage in patients with acute ACL injury compared to healthy controls and patients with minimal (Kellgren-Lawrence [KL] grade 2) to moderate (KL3) osteoarthritis (OA) at 3T.

**Methods** Fifty-three subjects (n = 36 males and n = 17 females, ranging in age from 18 to 89 years, mean  $\pm$  SD = 44.6  $\pm$  19.7 years) with normal knees to minimal-moderate OA based on radiographs [Kellgren-Lawrence (K-L) grading scale 0, 2, and 3] were recruited (4, 5). Approval for this study was obtained from the local institutional review board (IRB), and informed consent was obtained from all the

subjects. All the MRI experiments were performed on a 3.0T clinical scanner utilizing an 8-channel phased array knee coil (transmit-receive). 3D T1rho-weighted images with parallel imaging (AF = 2) were acquired with TR/TE = 175/2.04 ms, spin-lock frequency = 300Hz, number of slices = 30, time of spin-lock (TSL) = 2/10/20/30 ms, slice thickness = 3 mm, matrix = 256X128, FOV = 15 cm, bandwidth = 260 Hz using the GRE sequence based on the spin-lock techniques (6). Cartilage T1rho (median  $\pm$  interquartile) values were evaluated in sixteen subregions and two whole regions for femorotibial cartilage in each subject as defined in Refs (7, 8, 9). Wilcoxon rank sum test and mixed model two-way analysis of variance (ANOVA) were performed to determine whether there were any statistically significant differences between subregional and whole T1rho values of femorotibial cartilage among healthy controls, patients with acute ACL injury, and OA patients with KL2-3.

**Results and Discussion** Representative T1rho maps of femorotibial cartilage in the lateral (a, c, e) and medial (b, d, f) compartments obtained from a healthy control (a, b), a patient with acute ACL injury (c, d), and a patient with minimal-moderate OA (KL2-3) (e, f), respectively. The color bar on the right shows the T1rho values range of distribution. As is shown in Table 1, lateral femoral anterior cartilage subregion (62  $\pm$  6 milliseconds, median  $\pm$  interquartile range) in patients with acute ACL injury had significantly higher T1rho values (P < 0.05) than whole femorotibial cartilage and all cartilage subregions except lateral femoral anterior (LFa) in healthy controls. There were statistically significant differences (P < 0.05) between cartilage T1rho values of lateral tibial central and medial tibial posterior subregions in healthy controls and those of all subregions and whole femorotibial cartilage in osteoarthritic patients with KL2-3. Lateral tibial central cartilage subregion (42  $\pm$  12 ms) in patients with acute ACL injury had lower T1rho values (P < 0.05) than all cartilage subregions and whole femorotibial cartilage in osteoarthritic patients with KL2-3.

**Conclusion** The preliminary results suggest that T1rho values had statistically significant differences in specific subregional femorotibial cartilage in patients with acute ACL injury compared to all subregions and whole femorotibial cartilage in healthy controls and OA patients with KL2-3. These findings imply that cartilage T1rho mapping may be sensitive in staging the femorotibial cartilage disorder among patients with acute ACL injury, healthy controls and osteoarthritic patients with KL2-3.

**References** 1) Li X et al, Radiology 2011; 258: 505-514. 2) Neuman P et al, Osteoarthr Cartilage 2011; 19: 977-983. 3) Akella SV et al, Magn Reson Med 2001; 46: 419-423. 4) Kellgren J et al, Ann Rheum Dis 1957; 16: 494-501. 5) Kijowski R et al, Am J Roentgenol 2006; 187: 794-799. 6) Pakin SK et al, Magn Reson Med 2006; 56: 563-571. 7) Peterfy CG et al, Osteoarthr Cartilage 2004; 12: 177-190. 8) Eckstein F et al, Osteoarthr Cartilage 2006; 14: 974-983. 9) Wang L et al, Eur J Radiol 2011; doi:10.1016/j.ejrad.2011.07.017.

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**Fig. 1**

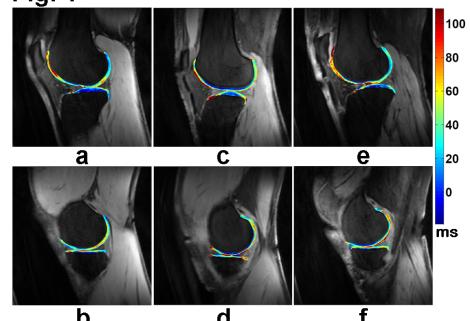


Table 1	median $\pm$ interquartile range (ms)		
	Healthy	ACL injury	OA (KL2-3)
LFa	62 $\pm$ 12	62 $\pm$ 6	68 $\pm$ 11
LFc	52 $\pm$ 6	52 $\pm$ 11	52 $\pm$ 9
Lfp	46 $\pm$ 9	45 $\pm$ 10	55 $\pm$ 6
MFa	51 $\pm$ 7	63 $\pm$ 13	63 $\pm$ 17
MFc	48 $\pm$ 4	53 $\pm$ 5	51 $\pm$ 13
Mfp	45 $\pm$ 9	50 $\pm$ 10	54 $\pm$ 7
LF	53 $\pm$ 5	54 $\pm$ 7	58 $\pm$ 8
MF	48 $\pm$ 5	54 $\pm$ 7	56 $\pm$ 9
F	51 $\pm$ 6	54 $\pm$ 4	58 $\pm$ 8
LTa	54 $\pm$ 9	57 $\pm$ 18	55 $\pm$ 11
LTC	43 $\pm$ 11	42 $\pm$ 12	48 $\pm$ 10
LTP	46 $\pm$ 9	50 $\pm$ 12	50 $\pm$ 7
MTa	49 $\pm$ 7	47 $\pm$ 12	48 $\pm$ 12
MTc	50 $\pm$ 10	47 $\pm$ 18	56 $\pm$ 5
MTp	42 $\pm$ 6	47 $\pm$ 19	51 $\pm$ 4
LT	48 $\pm$ 8	50 $\pm$ 11	52 $\pm$ 6
MT	47 $\pm$ 5	47 $\pm$ 14	52 $\pm$ 6
T	46 $\pm$ 7	50 $\pm$ 10	52 $\pm$ 7