

Knee cartilage evaluation using gag-CEST imaging at 3T: correlation to the arthroscopic grading

Takako Aoki¹, Hiroshi Kawaguchi², Takahiro Watanabe³, Yomei Tachibana⁴, Hiroshi Imai⁵, Benjamin Schmitt⁶, and Mamoru Niitsu⁴

¹Radiology, Saitama medical university hospital, Moroyama-machi, Iruma-gun, Japan, ²National Institute of Radiological Sciences, Japan, ³Saitama medical university hospital, Moroyama-machi, Iruma-gun, Japan, ⁴Saitama medical university, Japan, ⁵Siemens Japan K.K., Japan, ⁶Healthcare Sector, Siemens Ltd., Australia

Purpose: Mapping of glycosaminoglycan-chemical exchange saturation transfer (gag-CEST) is one of the imaging techniques to evaluate GAG concentration quantitatively. The purpose of this study was to investigate the relevance of gag-CEST mapping to clinical arthroscopic findings.

Methods: Ten patients, scheduled for arthroscopic surgery for anterior cruciate ligament reconstruction, were examined using a 3T scanner with a 15-channel TxRx knee coil. All subjects provided the informed consent for this IRB-approved study. T2 mapping (TR/TE=1000/13, 26, 39, 52, 65, 78ms, slice thickness = 3.5 mm, 256 × 256 matrix; FOV = 160 × 160 mm, scan time= 4 min) and 3D gag-CEST imaging with a prototype GRE sequence (TR/TE=690/3.6 ms; slice thickness = 3.5 mm; FA=12°, 256 × 256 matrix; FOV = 160 × 160 mm, scan time=13.5 min) were performed using B1 of 2.5 μT and 13 frequency offset point (range=±2.6 ppm, step =0.43 ppm). For B0 correction, the Z-spectrum was interpolated by a spline method to shift the minimum value to 0, and MTR asymmetry was calculated pixel-by-pixel. All calculations were performed using MATLAB (R2014a; The Mathworks, Natick, MA) with the following equations: $MTR_{asym} = [S_{sat}(-\sigma) - S_{sat}(+\sigma)] / S_0$ (**Fig. 1**). +σ is the frequency of highest MTR_{asym}. The international Cartilage Repair Society grading which was applied at arthroscopic surgery was collated with the MTR_{asym}.

Results: The MTR_{asym} of patients in grades 0 (N=6), 1A (N=1), 2 (N=1), 3C (N=1), and 4 (N=1) were 0.72~ 4.62 %, 2.47%, 0.24%, -0.41%, and -2.64%, respectively. **Fig. 2** shows the MTR_{asym} map of each grade.

Discussion: This study compared MTR_{asym} with the arthroscopic findings. MTR_{asym} decreased according to the increase x in grade. The negative MTR_{asym} indicates that the Nuclear Overhauser effect (NOE) associates with a magnetization transfer mechanism other than chemical exchange [1]. Patients in grade 1A had few differences compared with those in grade 0 (normal). Distinguishing between normal and borderline patients may be difficult. The current study suggested preliminary result, it is necessary to further collect the cases.

Conclusion: The CEST effect from gag-CEST showed a negative correlation with the clinical arthroscopic grading.

Reference: [1] Ling W, Regatte RR, Navon G et al. Assessment of glycosaminoglycan concentration in vivo by chemical exchange-dependent saturation transfer (gagCEST). PNAS 2008; 105(7):2266-2270.

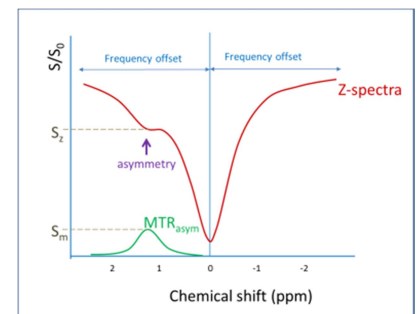


Fig. 1 The relations between Z-spectrum and MTR_{asym}.

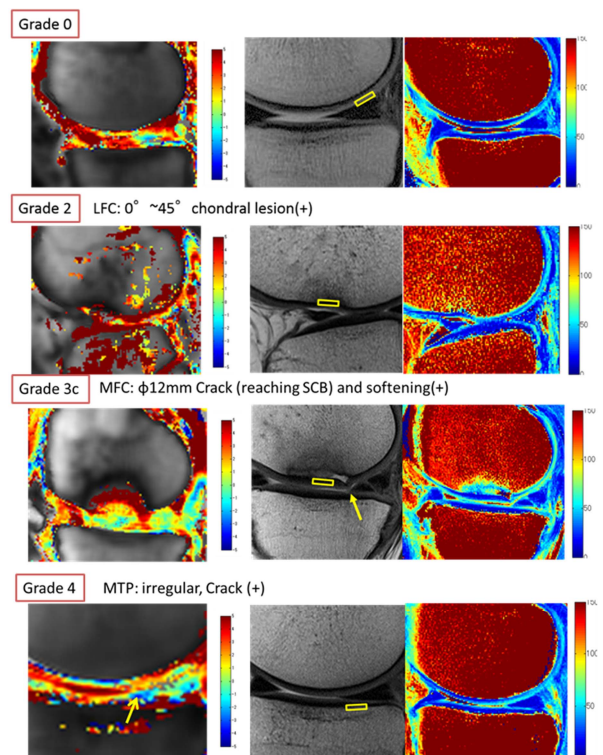


Fig. 2 MTR_{asym} map (left), ROI on PD image (middle), and T2 map (right) in 4 grades. Cartilage damage is not clear in the T2 map.