COMPARISON OF T1RHO IMAGING BETWEEN SPOILED GRADIENT ECHO (SPGR) AND BALANCED STEADY STATE FREE PRECESSION (B-FFE) SEQUENCE OF KNEE CARTILAGE AT 3 TESLA

Taiki Nozaki[1], Yasuhito Kaneko[1], Hon J. Yu[1], Kayleigh Kaneshiro[1], Ran Schwarzkopf[2], and Hiroshi Yoshioka[1]

[1]*Radiological Sciences, University of California, Irvine, Orange, California, United States,* [2]*Orthopaedic Surgery, University of California, Irvine, Orange, California, United States*

INTRODUCTION

T1rho-weighted MR imaging has recently been proposed as an attractive biomarker to existing conventional morphological MRI methods (1), and has been shown to be more sensitive to biochemical change in cartilage than T2 mapping. It enables us to detect early cartilage degeneration in early osteoarthritis patients before appearing morphological change (2). However the factors affecting the T1rho mapping such as MR sequences and operator-dependent manual cartilage segmentation is not well understood. Regarding MRI sequences, there are two basic types of fast gradient echo (GRE) sequences used in T1 rho mapping. One is a spoiled GRE sequence; residual transverse magnetization is spoiled. The other is a steady-state GRE sequence; transverse magnetization is not spoiled but is refocused to contribute to steady-state formation (3). The objective of this study was to investigate the difference of T1rho profiles between spoiled gradient echo (SPGR) and balanced steady state free precession (b-FFE) sequences.

MATERIALS AND METHODS

20 healthy volunteers (mean: 28.9 y.o., range: 19-38) were enrolled in this study. The study was approved by IRB, and written informed consent was obtained from each person. T1rho images of each subject were acquired with two types of pulse sequence: b-FFE and SPGR. All MR studies were performed on a 3.0-T unit (Achieva, Philips Healthcare, Netherland) utilizing an 8-channel knee receive-only RF-coil. Two sagittal T1rho-weighted images of each subject were acquired on the pulse sequence of b-FFE and SPGR. The acquisition parameters were as follows. SPGR: mode = 3D, fat-saturation method = PROSET, TR/TE = 6.4/3.4msec, Band width = 475Hz, ETL = 64, NEX = 1, FOV = 140*140mm, Slice thickness/gap = 3/0mm, Flip angle = 10 degree, Image-matrix = 512*512mm, number of slices = 31, Time of spin-lock (TSL) = 20/40/60/80msec, acquisition time = 4min09sec *4, b-FFE: mode = 3D, fat-saturation method = SPIR, TR/TE = 4.8/2.4msec, Band width = 606 Hz, ETL = 154, NEX = 1, FOV = 140*140mm, Slice thickness/gap = 3/0mm, Flip angle = 25 degree, Image-matrix = 512*512mm, number of slices = 31, Time of spin-lock (TSL) = 20/40/60/80msec, acquisition time = 3min57sec *4

Entire knee cartilage segmentation was performed by two raters independently slice by slice with Matlab (Fig.1). Inter- and intra- observer reproducibility between two imaging protocols was calculated. Relative signal intensity (SI) of each structure and relative contrast between structures of the knee were also quantitatively measured using Mann-Whitney test. The difference of T1rho values between SPGR and b-FFE sequences was statistically analyzed using the Wilcoxon signed-rank test.

RESULTS AND DISCUSSION

Average T1rho value of the entire knee cartilage on b-FFE was higher than on SPGR with significant difference ($p<0.05$) (Fig.2). The reproducibility of the segmented area and T1rho values was superior on SPGR than b-FFE (Table1). The intraclass correlation coefficient was 0.878 on SPGR and 0.836 on b-FFE, and the interclass correlation coefficient was 0.846 on SPGR and 0.824 on b-FFE, regarding to T1rho values. The relative SI of fluid was higher on SPGR, while that of subchondral bone was higher on b-FFE with significant difference ($p<0.001$) (Fig.3). There were also significant differences in relative fluid-cartilage, fluid-subchondral bone, and cartilage-subchondral bone contrast ($p<0.001$, respectively) between two sequences (Fig.4). These results suggest that the outline between subchondral bone and cartilage is more distinct and clearer on SPGR, although there is a possibility that negative contrast between fluid and cartilage better delineate cartilage surface on b-FFE.

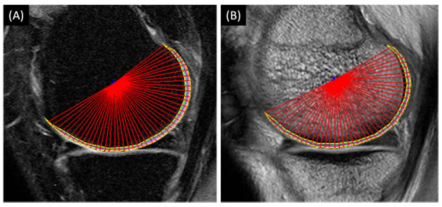

Fig.1 Sagittal images from T1rho sequence of knee MRI after manual segmentation with post-processing. (A) SPGR (B) b-FFE

	Analyses	Analyses	SPGR	b-FFE
Interobserver reproducibility	T1rho value	Interclass correlation coefficient	0.846 (0.757, 0.904)	0.824 (0.665, 0.903)
	Segmented Pixels	BA-correlation plot; r-value	0.641	0.588
		BA-difference plot; r-value	-0.065	-0.036
Intraobserver reproducibility	T1rho value	Intraclass correlation coefficient	0.878 (0.806, 0.925)	0.836 (0.741, 0.898)
	Segmented Pixels	BA-correlation plot; r-value	0.858	0.796
		BA-difference plot; r-value	0.171	0.16

Table1 ICCs and B-A plots for intraobserver and interobserver reproducibility

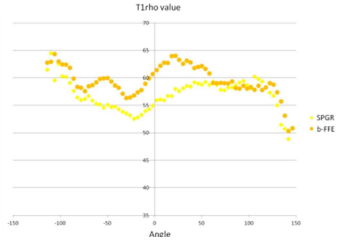

Fig.2 Comparison of T1rho values of entire knee cartilage between SPGR and b-FFE

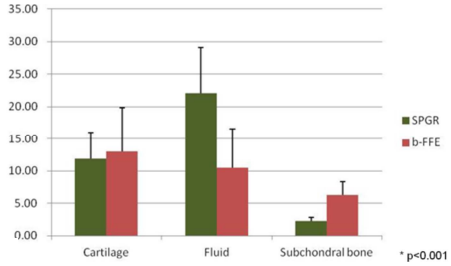

Fig.3 Mean values of relative signal intensity

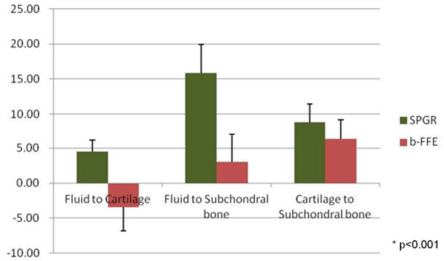

Fig.4 Mean values of relative contrast

CONCLUSIONS

Inter-reader and intra-reader reproducibility of measurement on knee cartilage T1rho mapping are excellent on both sequences and higher on SPGR than b-FFE. T1rho value tends to be higher on b-FFE than SPGR. We need to pay attention to factors of different sequences which causes variability of T1rho value in clinical applications.

REFERENCES

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