Comparison of Different Quantitative Approaches in $T_1\rho$ Relaxation Time Assessment of the Knee

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Introduction
Magnetic resonance (MR) imaging provides useful information for the assessment of articular cartilages (1). In addition to morphologic assessment, MR imaging can evaluate the biochemical properties of articular cartilages using various parameters (1-4). It has been reported that $T_{1\rho}$ relaxation time can be used to assess the glycosaminoglycan content of articular cartilages (1-4). In previous literature, four or five different $T_{1\rho}$ prepared images acquired with different times of spin-lock pulse (TSLs) have been used for the calculation. However, a prolonged time for MR examination is disadvantageous for the patient. In this study, we assessed a simplified method of calculating $T_{1\rho}$ relaxation times, which can be obtained using only two different $T_{1\rho}$ prepared images. This method allows the examination time to be shortened. Additionally, we investigated the quality and efficacy of this method for diagnosis of the knee.

Materials and Methods
Ten volunteers (age = 25 – 37, average = 30.2 years) were scanned on a 3 Tesla MR system (Achieva 3.0T, Quasar Dual, Philips Electronics) using an 8-channel T/R knee coil. Three of these 10 volunteers had a history of cartilage or meniscus injuries. Sagittal $T_{1\rho}$ maps were calculated with an in-house developed software using IDL 6.3 (ITT Inc. Boulder, CO, USA) from $T_{1\rho}$ prepared relaxation time can be used to assess the glycosaminoglycan content of articular cartilages (1-4). In prepared images. This $T_{1\rho}$ map (Fig. 1). However, the $T_{1\rho}$ map (lower left), $sT_{1\rho}$ map_1_40 and of the $sT_{1\rho}$ map_1_80 (upper right), c$T_{1\rho}$ map_40_80 (upper left), $sT_{1\rho}$ map_1_40 (upper middle), $sT_{1\rho}$ map_1_40 (lower middle), $cT_{1\rho}$ map (lower left), and 3D-WATSc image (lower middle) of the knee of a healthy volunteer.

Results
The entire imaging time required for $sT_{1\rho}$ maps (6min 30s) was three-fifths shorter than that of the $cT_{1\rho}$ map (16min 15s). The image quality of the $sT_{1\rho}$ map_1_40 and of the $sT_{1\rho}$ map_1_80 was the similar to that of the $cT_{1\rho}$ map (Fig. 1). However, the $sT_{1\rho}$ map_40_80 showed a poor image quality (Fig. 1). There was no significant difference in the $T_{1\rho}$ relaxation time between the $sT_{1\rho}$ map_1_80 and $cT_{1\rho}$ map (p > 0.05) (Fig. 2). The $T_{1\rho}$ relaxation times of the $sT_{1\rho}$ map_1_40 were lower and those of $cT_{1\rho}$ map_40_80 were higher than those of the $cT_{1\rho}$ map (Fig. 2). However, these differences were significant (p < 0.05).

Discussion
The simplified $T_{1\rho}$ calculation method has the same potential as the conventional method to diagnose articular cartilage. We speculated that it would be appropriate to select two $T_{1\rho}$ prepared images using the shortest and longest TSLs. However, the image quality would be poor if images using long TSLs only were selected because long TSL may decrease the signal-to-noise ratio of $T_{1\rho}$ prepared image.

References