Introduction: Prostate cancer is the second leading cause of death in men and the most commonly diagnosed malignancy. MRI has the advantage of determining the location, extension and metastatic involvement of prostate tumors (1,2). In clinical MRI, prostate cancer is usually detected as hypo-intensity in the prostate peripheral zone on T2-weighted images (3). However, benign conditions such as hemorrhage, prostatitis, hyperplastic nodules and previous radiation may also show similar T2 hypo-intensity. Diffusion weighted MR (4), MR spectroscopy imaging (5) and DCE MR imaging (6) may increase the accuracy of the diagnosis and staging of prostate cancer. T1p describes the longitudinal relaxation of MR signal in the rotational frame. T1p is sensitive to the tissue compositions and to the slow motion interactions between macromolecular protons and bulk water (7). It has been successfully used in the characterization of various physiologic and pathologic conditions such as brain tumors, myocardial metabolism, knee cartilage degradation, liver fibrosis and kidney function. In this study, we will assess the efficacy of T1p sequence for morphologic and quantitative imaging of the prostate in both healthy volunteers and patients diagnosed with prostate cancer.

Methods: All experiments were performed on a 3T Siemens Trio scanner using a body transmit RF coil and spine/body matrix coils. Four healthy volunteers and two patients diagnosed with prostate cancer (based on PSA measurement and biopsy) were enrolled in the study. The previously reported T1p preparation technique (8) was further modified to minimize sensitivity to both B0 and B1 field inhomogeneities. Four refocusing blocks were employed, as shown in Fig. 1. Each 180-degree refocusing RF pulse was configured with composite pulses to reduce artifacts. The TSL for this subject.

Results: Fig. 2 shows typical T2- and T1p-weighted prostate images acquired from a healthy subject. The estimated relaxation rate maps for R2 and R1p are also displayed. As expected, the peripheral zone (PZ) has longer T2 and T1p than that of the central zone (CZ), which shows a significantly higher degree of heterogeneities. Both T2 and T1p maps show remarkable uniformity in PZ for this subject. Studies other our healthy subjects also indicate that the T1p decay may not be exactly symmetric between the left and right PZ, as illustrated in Fig. 3, potentially due to the variations on granular structure.

Fig. 4 illustrated the T2-weighted image and the corresponding estimated T2 and T1p maps for patients diagnosed with prostate cancer. These patients had high PSA levels, but only one biopsy confirmed the presence of tumor cells. Compared to healthy subjects, patients demonstrated an elevated level of T2 heterogeneities in PZ. For patient 1 (first row), the lower right PZ shows a faster T2 and normal T1p decay. For patient 2 (second row), T2 and T1p maps suggest an abnormally fast T2 decay and normal T1p decay at the middle and lower part of the right PZ. The discrepancy between T2 and T1p in the suspected tumor lesion ROI may reflect its higher level of cellular contents.

Discussion: We have developed and applied a T1p sequence that was designed specifically to desensitize B0 and B1 field inhomogeneity to acquire in vivo human prostate T1p-weighted images and T1p mapping. Our study demonstrated that robust T2 and T1p quantification is feasible at 3T without the utilization of an endorectal coil. When combined with T2 measurement, the T1p quantification of the prostate may provide additional information to improve the diagnosis of prostate cancer.