PULSED-CONTINUOUS ARTERIAL SPIN LABELING MRI WITH MULTIPLE POST-LABELING DELAY IN RENAL CELL CARCINOMA: CLINICAL FEASIBILITY AND INITIAL RESULTS OF A COMPARATIVE STUDY WITH PARAMETRIC DYNAMIC CONTRAST-ENHANCED MRI

Nobuyuki Kosaka[1], Katsuki Tsuchiyama[2], Kazuhiro Shimizu[1], Yasuhiro Fujiwara[3], Tsuyoshi Matsuda[4], Tatsuya Yamamoto[1], Tatsuro Tsuchida[1], Nobuyuki Oyama[2], and Hirohiko Kimura[1]

[1]Department of Radiology, University of Fukui, Eiheiji, Fukui, Japan, [2]Department of Urology, University of Fukui, Eiheiji, Fukui, Japan, [3]Radiological Center, University of Fukui Hospital, Eiheiji, Fukui, Japan, [4]Global MR Applications and Workflow, GE Healthcare Japan, Hino, Tokyo, Japan

Target Audience: Clinical researchers interested in perfusion-weighted MRI.

Purpose: To evaluate the clinical feasibility of pulsed-continuous arterial spin labeling MRI (pcASL) with multiple post-labeling delay (PLD) to measure arterial transit time-corrected tumor blood flow (ATC-TBF) in renal cell carcinoma (RCC), and to clarify the relationships between ATC-TBF and several hemodynamic parameters produced by parametric dynamic contrast-enhanced MRI (DCE-MRI).

Methods: All protocols were approved by our institutional review board. Six consecutive RCC patients were prospectively enrolled (5 clear cell carcinoma; 1 chromophobe cell carcinoma). All MRI was performed using a 3.0 T clinical scanner. The pcASL images were obtained at 5 different PLD time points (0.5, 1.0, 1.5, 2.0 and 2.5 s) with the following settings: timing breath-hold; 2.0-s labeling; 2D-SE EPI sequence with background suppression; slice thickness, 8 mm; TR/TE, 5500/18.2 ms; matrix, 96×128; and 9 averages. DCE-MRI was performed with the following settings: gentle free-breathing; 0.2-mL/kg Gd-DTPA bolus-injection; 3D-Fast SPGR; slice thickness, 6 mm; TR/TE, 3.3/1.1 ms; flip angle, 20°; matrix size, 256×128; temporal resolution, 3.6 s; and acquisition time, 320 s. For pcASL data, maximum-sized ROIs were placed over tumor on each different PLD image, and ATC-TBF was calculated using single-compartment model analysis. Parametric maps (K^{trans}, k_{ep}, v_e, f_{pv}, initial area under the gadolinium curve to 90 s ($IAUGC_{90}$), bolus arrival time (BAT), contrast enhancement ratio (CER), and maximum slope) from DCE-MRI data were created using commercially available software, and the same maximum-sized ROIs were placed over tumor to measure hemodynamic parameters. Statistical correlations between ATC-TBF and each hemodynamic parameter were investigated using Spearman's rank correlation test. Values of $p<0.05$ were considered statistically significant.

Results: All image acquisitions and data post-processings were successfully achieved. In pcASL images, inhomogeneous high signals were visually identified in 5 clear cell carcinoma, while 1 chromophobe cell carcinoma showed only faint signals on pcASL image. ATC-TBF calculated by pcASL was 95.77±48.20 mL/min/100g (range, 22.02–155.17 mL/min/100g). Significant correlations to ATC-TBF were found in CER and maximum slope ($p<0.05$, $r^2=0.73$ and 0.66, respectively), while BAT, k_{ep}, and f_{pv} did not show significant correlations. K^{trans}, v_e, and $IAUGC_{90}$ showed non-significant tendencies toward positive correlations ($r^2=0.67$, 0.62, and 0.69, respectively).

Discussions: Arterial transit time is a key issue to determine quantity in ASL-MRI, and has been well-debated in brain imaging. However, little attention has been given to this issue in renal ASL-MRI. This study successfully calculated ATC-TBF of RCC using a series of pcASL images with 5 different PLD. This correction would be an advantage for intra- and inter-patient comparisons of TBF under future clinical protocols. Another question in oncologic ASL-MRI is what hemodynamic parameter influences "tumor blood flow", since immature leaky vessels in tumors differ substantially from normal vessels. Our initial results of positive correlations to K^{trans} and v_e imply that vascular permeability might also influence ASL-signals in RCC.

Conclusion: pcASL with multiple PLD was clinically feasible to measure ATC-TBF, which correlated with several hemodynamic parameters produced by parametric DCE-MRI.

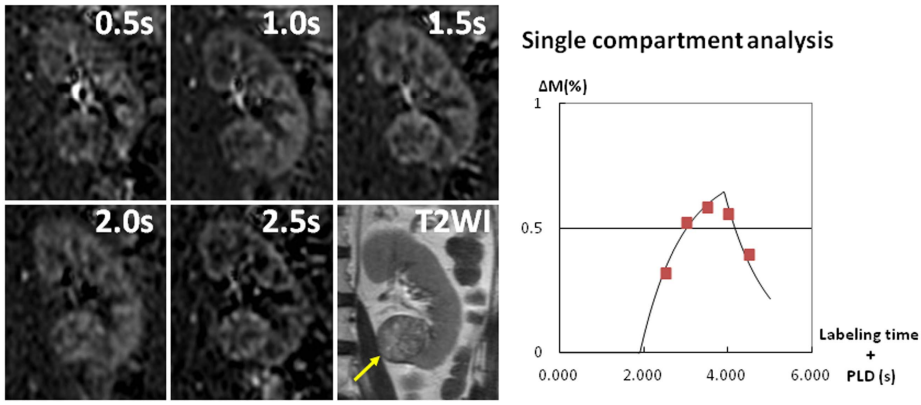

Figure Representative pcASL images of RCC at the different post-labeling delay time points. After obtaining signal intensities of RCC from pcASL images, arterial transit time-corrected tumor blood flow is calculated using a single-compartment model analysis.