

Clinical Feasibility Study for Renal Perfusion Imaging using Pseudo Continuous Arterial Spin Labeling at 3.0T

Yasuhiro Fujiwara¹, Hirohiko Kimura², Nobuyuki Kosaka², Tsuyoshi Matsuda³, Takuya Yachida¹, and Toshiki Adachi¹

¹Radiological Center, University of Fukui Hospital, Fukui, Japan, ²Radiology, University of Fukui, Fukui, Japan, ³Applied Science Laboratory Asia Pacific, GE Healthcare Japan Corporation, Tokyo, Japan

INTRODUCTION

A method that would allow non-invasive reliable assessment of the renal perfusion would be very valuable for many diseases such as hypertension, ischemia or acute renal failure which may cause the damage or loss of renal microvessels. Although arterial spin labeling (ASL) had shown great potential for measuring renal blood flow (RBF), ASL signal is weak in the order of few percents of the tissue signal. Therefore, to obtain reliable RBF maps in a clinically feasible exam time, reducing the number of averages and insensitization to motion or displacement during breath-hold periods especially in the abdominal region. So far, most of the reported human renal ASL perfusion studies have been performed with flow-sensitive alternating inversion recovery (FAIR) technique. However, the recent pseudo-continuous ASL (pCASL) scheme, which has been shown to provide higher efficiency than pulsed ASL techniques, could be more adequate for renal perfusion studies. The purpose of this study was to present the implementation of the pCASL technique in vivo RBF measurement and to evaluate the clinical feasibility with diagnostic image quality of ASL perfusion imaging of the kidney at 3.0T in the clinical setting.

MATERIALS AND METHOD

Renal perfusion imaging studies were performed on a clinical 3.0T GE Discovery 750 system using the product 32-channel body receiver array. Four healthy subjects were scanned with pseudo-continuous ASL (pCASL) at long labeling duration and FAIR. All healthy adults recruited for ASL renal perfusion studies were imaged under an IRB approved protocol. Images were acquired with a 2D SE echo planner image sequence. In pCASL, the following labeling and imaging parameters were used: G = 0.9G/cm, flip angle = 12degree, labeling duration = 4.0s, post labeling delay time = 2.3s, TR = 6.0s, TE = 17ms, FOV = 380 x 380mm², matrix size = 64 x 96, number of slice = 10, ASSET factor = 2, number of measurements = 18 (9 label-control pairs). Background suppression was achieved with pre saturation and 4 inversion pulses applied 1s after the beginning and the end of labeling RF pulse, 1.2s and 0.8s after labeling RF pulse to minimize instabilities from motion and other physiologic or instrumental fluctuations. FAIR imaging parameters were the same with the exception of the following: selective/spatially-confined inversion slab = 100/640mm, TR = 3.0s, number of measurements = 36 (18 label-control pairs). In both of them, the total imaging times were about 3 min during a 6 breath-hold (breath holds and interval times were taken 18s and 10s, respectively). We measured coefficient of variations (CV) at the renal cortex regions in FAIR and pCASL. Additionally, CV was measured at the situation of short acquisition time (36s, 72s) in each sequence.

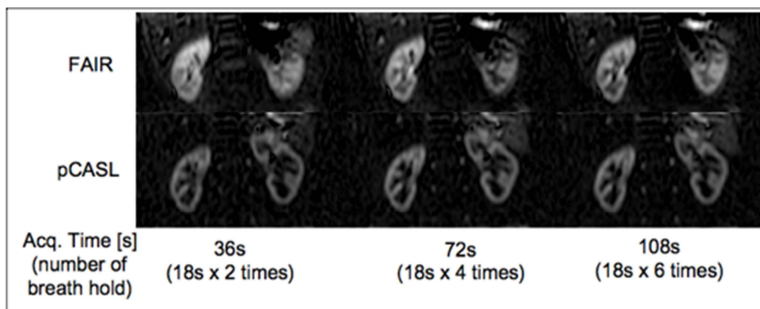


Fig.1 Perfusion images FAIR (upper row) and pCASL (lower row).

RESULTS

Figure 1 shows perfusion images using FAIR and pCASL sequence in a volunteer. Figure 2 demonstrates the relationship between acquisition time and CV from both methods in all volunteers. The average CV in five volunteers using FAIR and pCASL were 0.58 ± 0.19 and 0.37 ± 0.07 , respectively. In pCASL, reproducible perfusion images were obtained with lower CV in the condition of 6 breath holds. Whereas, FAIR seems to suffer with profound subtraction error even in the double averages than pCASL. The CV and standard deviation of perfusion images in pCASL were no difference between acquisition time 72s and 108s. Using pCASL, acquisition time could be minimized as short as 72s. Figure 3 shows M_0 and perfusion image in a volunteer with simple cyst using pCASL. The perfusion image showed that the renal cyst had very low signal intensity and was properly visualized.

DISCUSSION AND CONCLUSION

This study demonstrates the clinical feasibility for renal perfusion image using pCASL at 3.0T. The pCASL technique combined with long labeling, heavy background suppression was obtained clinically acceptable image quality within 3minutes in coronal planes without motion artifacts and subtraction error.

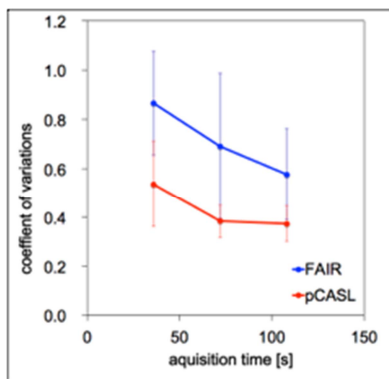


Fig.2 Relationship between CV and acquisition time using FAIR and pCASL.

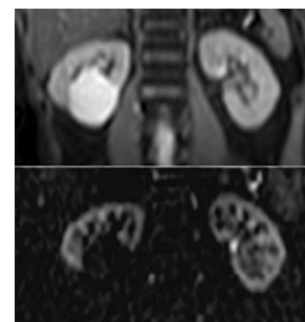


Fig.3 M_0 and perfusion image with simple cyst using pCASL