Selective visualization of renal artery using SSFP with Time-Spatial Labeling Inversion Pulse: Non-Contrast Enhanced MRA for patients with renal failure

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Abstract

The feasibility of True SSFP (steady state free precession) sequence in combination with Time-SLIP (Time-Spatial Labeling Inversion Pulse) method for selective visualization of renal artery without the use of contrast media was evaluated. The position and the inversion time of black blood inversion recovery pre-pulse were optimized with phantom and volunteer studies. Renal artery images were effectively obtained by applying selective inversion pulse in the imaging volume. Hemodynamics of renal artery was observed as well by altering black blood inversion time. This non-contrast enhanced technique is considered to be extremely useful for examination of patients with renal failure.

Introduction

Non-contrast enhanced MR angiography plays an important role in examining renal artery disease since the use of contrast media for patients with renal failure is not desirable. However, it is very difficult to visualize renal artery selectively using conventional time-of-flight or phase contrast angiography whose image quality significantly depends on direction of vessel, velocity and respiratory motion. Time-SLIP (Time-Spatial Labeling Inversion Pulse) is a novel imaging technique which enables selective visualization of blood flowing into the imaging volume by positioning the selective excitation pre-pulse for black blood image at arbitrary location independently of the imaging volume (Fig.1). Recently, the use of True SSFP (steady state free precession) sequence for non-contrast enhanced MR angiography has been well reported. The purpose of this study is to examine the feasibility of selective visualization of renal artery using True SSFP in combination with Time-SLIP technique.

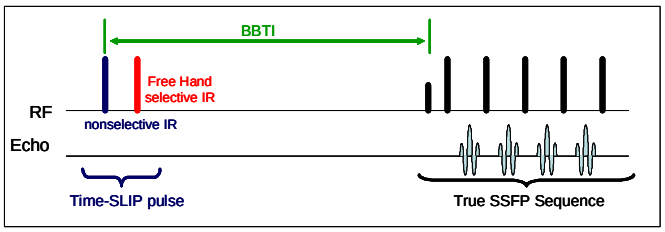

Fig.1 Sequence chart of Time-SLIP method.

Methods

All the studies were performed on a 1.5T MRI system (VISART/EX Toshiba Medical Systems, Japan). The effect of inversion time of black blood pre-pulse (BBTI) in visualization of flowing object was investigated using a tubular phantom with constant velocity water. Images were acquired with several locations of black blood pre-pulse from upstream of the flow to the imaging volume. Imaging parameters were TR/TE=5.4/2.7 msec, slice thickness of 10mm and flip angle of 90 degree. BBTI was varied from 200 msec to 1000 msec in increments of 200 msec. First, visualization of blood vessel was confirmed by imaging femoral artery of healthy volunteers with the same imaging parameters which were used in phantom studies. Secondly, renal artery images were acquired at various BBTI with the optimized black blood pre-pulse location found in femoral artery experiments. ECG triggering and fat saturation were applied for volunteer studies.

Results

In the phantom studies, low signal intensity region was observed in the imaging volume when selective inversion pulse was located at upstream of the flow. The BBTI did not make a significant difference in image quality. With IR pulse placed within the imaging volume, high signal intensity of inflow was found and longer BBTI resulted in wider area of inflow effect. The femoral artery studies showed the same tendency with the phantom experiment results. In volunteer studies, signal defect probably due to pulsation was improved with the use of ECG gating. Longer TI resulted in better image quality from the viewpoint of highlighted area of inflow arteries (Fig.2). As for renal artery, the same results with phantom and femoral artery studies were obtained and artery was selectively depicted (Fig.3).

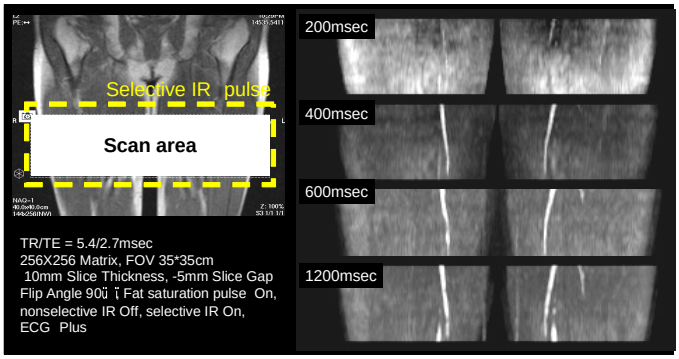

Fig.2 the femoral artery studies

Fig.3 the renal artery studies

Conclusion

True SSFP sequence in combination with Time-SLIP method can provide selective visualization of renal artery. This technique does not require time-consuming subtraction method for separation of artery from vein. Additionally, unwanted CSF signal which is visualized in regular SSFP sequence can be successfully suppressed. Time-SLIP provides not only anatomical information but also hemodynamics of renal artery and considered to be useful in screening, follow-up study and examinations for patients with renal failure.

Reference

"Intraportal Venous Flow Distribution: Evaluation with Single Breath-Hold ECG-Triggered Three-Dimensional Half-Fourier Fast Spin Echo MR Imaging and a Selective Inversion-Recovery Tagging Pulse", Ito K., et.al., AJR 2002,Vol 178,343-348