Evaluation of Non-Contrast Time-Spatial Labeling Inversion Pulse for Abdominal Angiography Compared to Contrast-Enhanced Angiography

E. J. Kelly, PhD[1], S. Saeger[2], and D. E. Neal, MD[2]
[1]Toshiba America Medical Systems, Tustin, CA, United States, [2]Radiology, Central Ohio Primary Care Physicians, Columbus, Ohio, United States

Purpose

In light of recent findings linking gadolinium based contrast media to the onset of Nephrogenic Systemic Fibrosis (NSF), it has become increasingly important to use non-contrast MR Angiography techniques to evaluate and diagnose renal artery stenosis and arterial disease. Time-Spatial Labeling Inversion Pulse (Time-SLIP) [1-3] is a non-contrast technique that has the ability to provide bright blood angiograms that may be diagnostically equivalent to contrast enhanced MRA (CE-MRA). Time-SLIP is based on an Arterial Spin Labeling (ASL) technique and utilizes a selective tag pulse to magnetically label the blood as it flows into or out of an imaging region [1]. In addition, specification of the Black Blood Time Interval (BBTI) controls the delay time between the application of the tag pulse and the inflow of fresh unsaturated blood. The utility of Time-SLIP to produce bright blood 3D angiograms of the renal arteries has been established by itself [1-3] and in comparison to contrast-enhanced computed tomographic angiography (CTA) [4]. The purpose of this study is to compare the image quality and diagnostic confidence of Time-SLIP to CE-MRA for evaluation of renal artery disease.

Materials and Methods

This study was conducted retrospectively on 20 subjects referred for an abdominal CE-MRA study. All examinations were performed on a 1.5T high performance scanner (EXCELART/Vantage $_{TM}$, Toshiba, Tokyo, Japan), equipped with the Torso-Speeder coil. Preceding the CE-MRA study, Time-SLIP was utilized in conjunction with 3D Steady State Free Precession (SSFP) to produce a bright blood angiogram. The top of the Time-SLIP tag pulse was placed at the top of the kidneys to label fresh blood flow in from the abdominal aorta while simultaneously suppressing the background signal. A BBTI of 1200ms was used to allow enough time for the unsaturated blood to travel into the kidneys and branching arteries while maintaining good background suppression. Parallel imaging and segmentation was used to keep the acquisition window short and respiratory gating was used to collect the data during quiescent periods. In all cases, the non-contrast Time-SLIP sequence was followed by a standard CE-MRA sequence. The CE-MRA and Time-SLIP datasets were compared in terms of overall image quality, visualization of renal arteries, and diagnostic confidence. Image reviewers were blinded to the type of study. Acquisition parameters for the Time-SLIP sequence were: TE/TR=2.5/5ms, Flip Angle = 120, Matrix = 256x256, Slice Thickness = 3mm, respiratory gating, parallel imaging factor = 2, BBTI = 1200ms, and CHESS fat saturation. Acquisition parameters for the CE-MRA sequence were: TE/TR=1.3/3.7, Flip Angle = 20, Matrix = 256x256, Slice Thickness = 2mm, parallel imaging factor = 2, and CHESS fat saturation. Reviewers qualitatively evaluated the images based on the following scale: 1 = poor, 2 = good, and 3 = excellent for image quality and 0 = non diagnostic, 1 = poorly defined, uncertain diagnosis, 2 = identified with probably diagnosis, 3 = clearly defined with highly probable/definite diagnosis for diagnostic quality.

Results

A direct comparison between Time-SLIP and CE-MRA angiograms from the same patient is shown in Figure 1, as an example. As seen in the figure, the two renal angiograms both have excellent image quality, although distal branches of the renal arteries are more clearly seen in the angiogram using Time-SLIP. There was no significant difference observed between the Time-SLIP datasets compared to the CE-MRA data sets for image quality. Image quality scores were 2.6±0.7 and 2.4±0.7 for Time-SLIP and CE-MRA, respectively ($p=0.4$). A significant difference was observed between Time-SLIP and CE-MRA in diagnostic quality. Diagnostic quality scores were 2.8±0.4 and 2.4±0.8 for Time-SLIP and CE-MRA, respectively ($p<0.05$).

Discussion

This clinical image evaluation study showed that the image quality is the same between Time-SLIP and CE-MRA, but diagnostic confidence scores were higher for Time-SLIP in this study. One of the major benefits to non-contrast angiography is that the timing of the contrast bolus does not have to be matched with image acquisition, and non-contrast exams are repeatable. Depiction of the renal branches was poor in CE-MRA, due to fast contrast bolus into renal parenchyma and venous return. This may contribute to the increased diagnostic confidence of Time-SLIP. CTA is highly accurate for diagnosing renal artery stenosis, but ionizing radiation and nephrotoxicity are major disadvantages. Likewise, CE-MRA is associated with development of NSF, which is a progressive disease that can inflict patients with renal impairment who undergo CE-MRA. Non-contrast abdominal angiography using 3D SSFP Time-SLIP has become increasingly important in the clinical setting. These results show that non-contrast angiography alone is sufficient to diagnose renal artery stenosis.

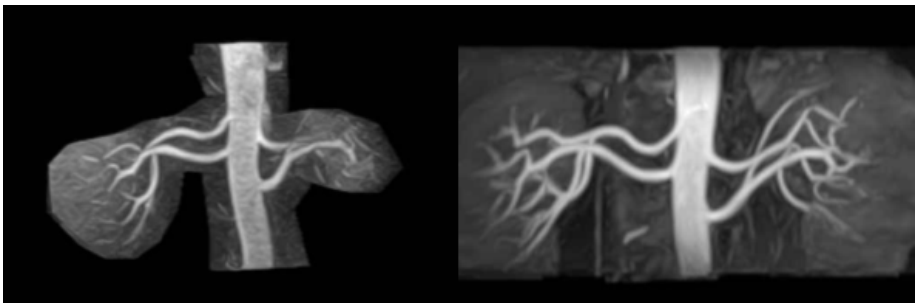

Figure 1. Direct comparison of the renal maximum intensity projection images acquired in the same patient with CE-MRA (left) and non-contrast Time-SLIP (right)

References

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